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Pollen Analyses from Early Bronze Age Barrows in Thy

by Svend Th. Andersen

INTRODUCTION

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

POLLEN ANALYSIS OF SOILS PRESERVED IN BARROWS

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

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

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

pollen spectra from the fill layers may indicate changes in land-use (Dimbleby 1985; Andersen 1992a; 1992b).

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

SITES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

POLLEN ANALYSES

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

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

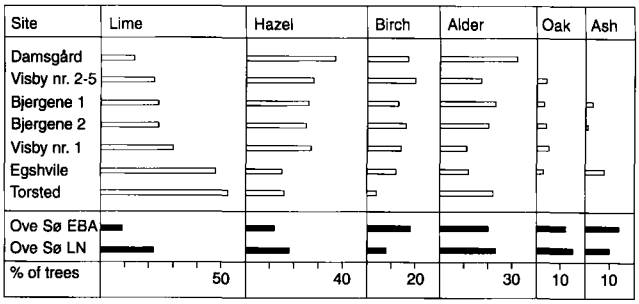

Fig. 2. Tree frequencies in samples from the six Bronze Age barrows, and in two samples from Ove Sø (EBA: Early Bronze Age, LN: Late Neolithic).

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

Tree pollen

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

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

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

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

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

Non-tree pollen

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

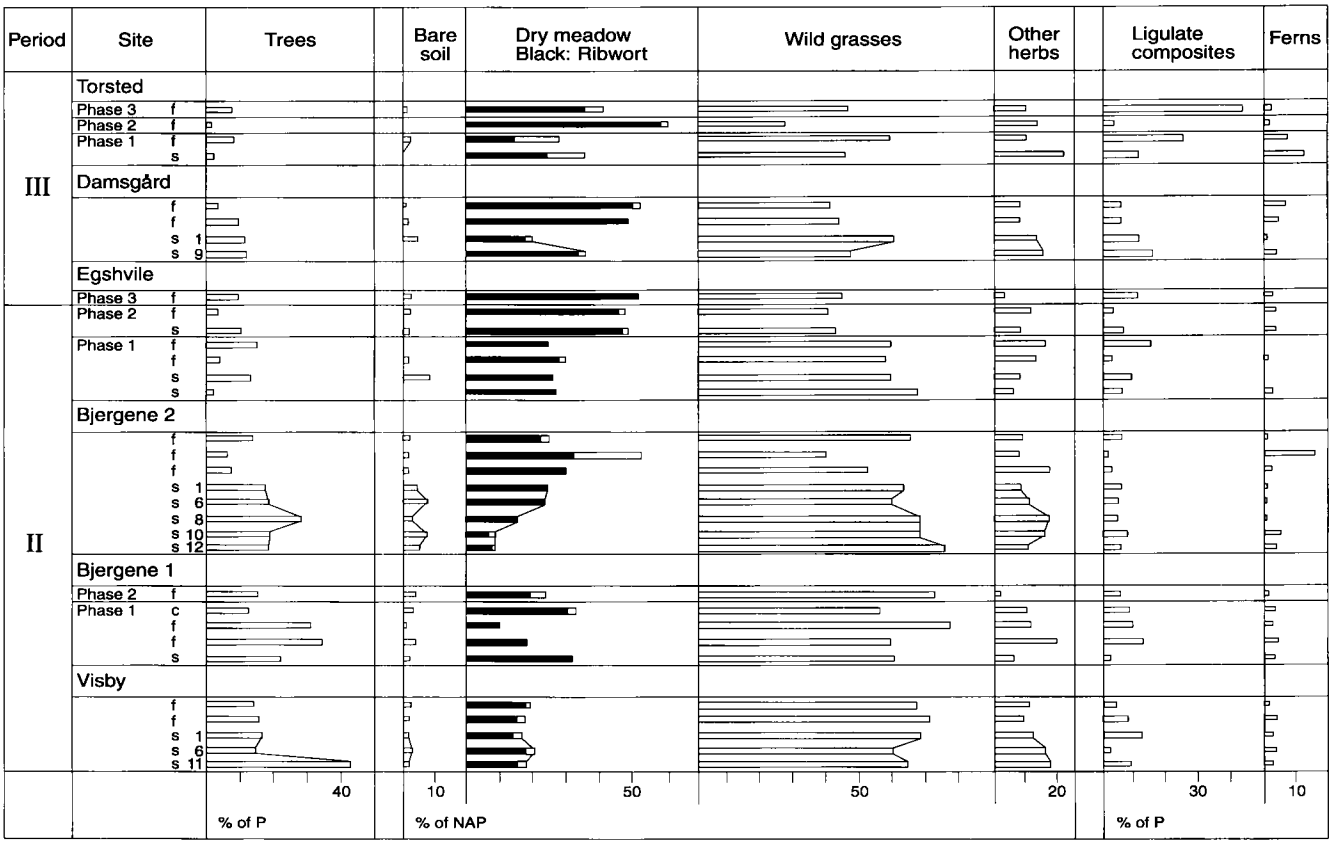

Fig. 3. Tree frequencies and non-tree pollen frequencies for samples from the six Bronze Age barrows. f: sample from barrow fill, c: sample from clay layer, s: sample from continuous soil horizons (the figures indicate depth levels in cm in the soil horizons). The percentage bars for samples from soil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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DISCUSSION

Statistical analysis

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

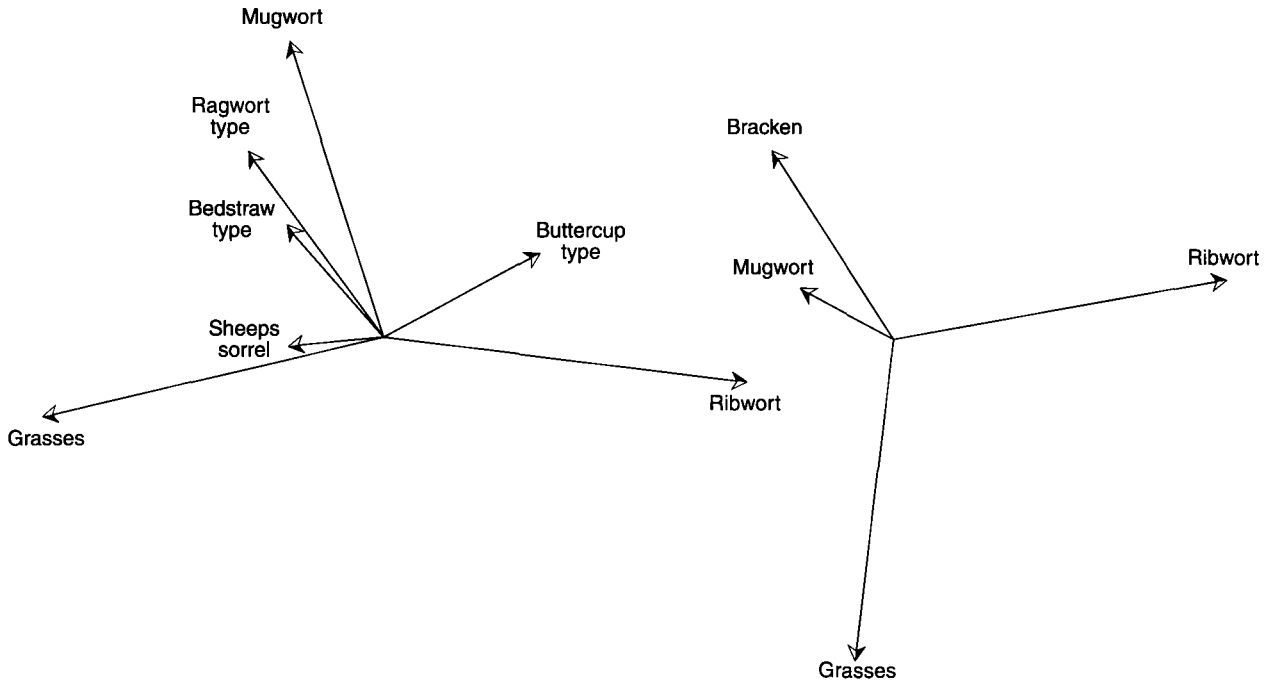

Fig. 4. Left, biplot of h-vectors for the most frequent pollen taxa (maximum percentage > 4,9) in samples from the six Bronze Age barrows. Right, biplot of h-vectors for the most frequent pollen taxa in samples from barrows from the Neolithic Funnel Beaker Culture (redrawn from Andersen 1991).

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

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

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

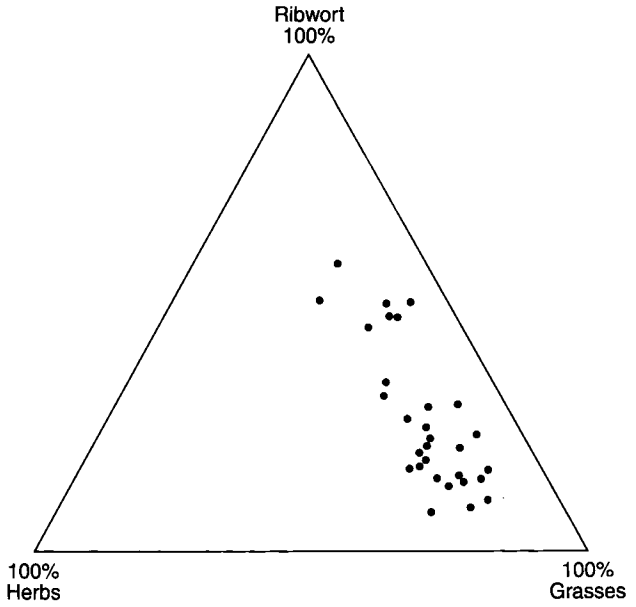

Fig. 5. Triangular diagram of pollen spectra from six Bronze Age barrows for pollen of ribwort plantain (100%), wild grasses (100%) and other non-tree pollen (herbs, 100%).

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

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

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

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

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

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

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

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

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

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Bronze Age Settlements and Land Use in the South Thy Sandhills

by David Liversage

Owing to an underlying interest in settlement patterns, problems of sampling and representativity receive a good deal of attention in Danish archaeology. There are two possible strategies. A defined area can be examined until its archaeological contents are clarified as far as this can be done, or a transect can be cut through it in hope of obtaining a representative sample of the archaeology of the area through which the transect passes. The studies being presented here fall into the category of transect survey. For several kilometres north of the western end of the Limfjord the North Sea coast is being rapidly eroded. As the coast advances inland, prehistoric settlements are exposed and washed away. By keeping the coast under archaeological surveillance a study can be carried out that is essentially similar to the transect survey of a motorway or pipeline investigation. The archaeology along a line cut through the countryside is thoroughly examined. The stretch of coast in question here runs for 12.5 km from the northern end of the sandbar that separates Fladesø lake (a cut off arm of the Limfjord) from the sea, almost to the village of Stenbjerg. Along this stretch the National Museum has been able with the help of some amateur archaeologists to record all the major prehistoric settlements and several minor ones in the 25-50 meters wide swathe through the landscape that has been washed away in 1966-1990.

Conditions for the preservation of archaeological and environmental material are particularly good, because the strata have been protected from disturbance by several meters of overlying sand and have lain a large part of the time since their formation below ground water level, which has spared them from many of the forces of natural destruction. Also the rise of the surface and alternation between layers of blown sand and stable, plant-grown surfaces gives possibilities for stratigraphical deposition that would not normally be present, and this includes stratigraphy of natural phenomena and not just archaeology. The investigations carried out at the "Summerhouse" site give an idea of the potential of environmental sciences to yield information about human impact on the landscape in this area and show how important it is to have collaboration from the environmental sciences.

Unfortunately the investigation of aeolian sediments with their many superimposed buried land surfaces and encapsulated settlements has been considerably neglected. Dune areas have much in common with peat bogs, but peat bogs are a familiar subject and therefore more favoured for research in Denmark than anything new. It is therefore not easy to obtain resources, and we are grateful for what support has been forthcoming for the present research.

The purpose of the present paper is to present the Bronze Age settlements that have been investigated during this project together with some hypotheses about the character of Bronze Age land use in the dune belt and more generally. Previous publications relating to the project are: Liversage & Singh 1985; Hirsch and Liversage 1987; Liversage *et al.* 1987; Liversage & Robinson 1988; Robinson & Kempfner 1988; Liversage 1989; Rowley-Conwy 1990; Robinson 1992; Liversage 1995; Liversage & Robinson 1995.

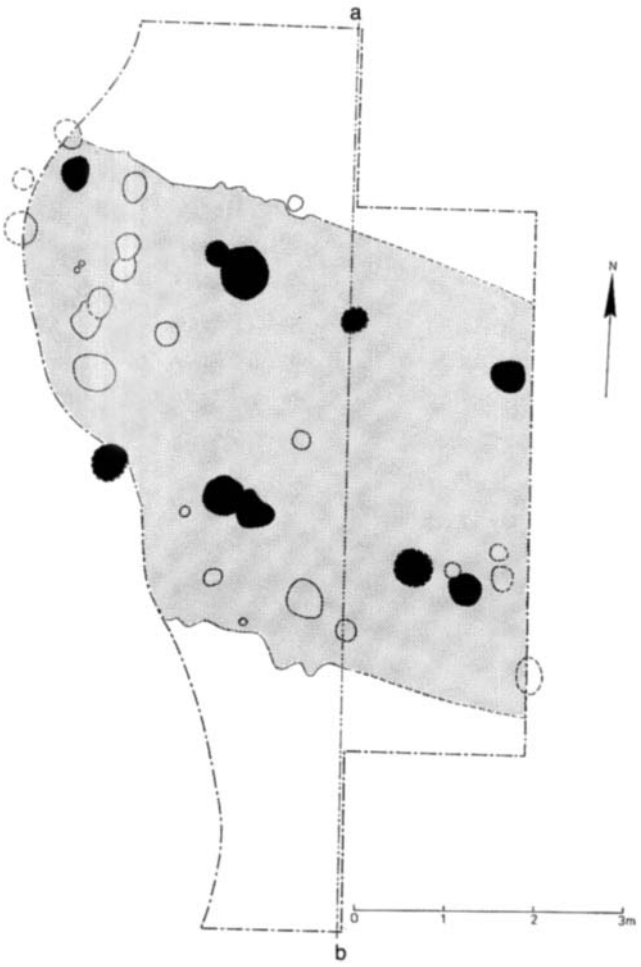

Fig. 1. Stenbjerg North, posthole plan.

THE SITES

Preliminary remarks

The sites are presented not in chronological order, nor in geographical or alphabetic order, but in the order in which they contribute to a discussion about land use in the last chapter. Each site is described concisely showing its special problems and contribution to archaeology in aeolian deposits. The pottery is described site by site and a dating scheme is put forward at the end, which lays no claim to being the newest in methodology, but it is hoped all the more will help the practical archaeologist to address practical dating problems.

Other finds are only described if especially interesting. Struck flint was found at all the sites, and is sealed above and below in a way that makes it absolutely sure that it was struck by the Bronze Age and early Iron Age inhabitants, but it is not dealt with in this paper. At most sites at least one small piece of natural amber was found, but there is no sign that amber was ever worked. Was this aimless gathering up, or was it wastage during collection for export?

Stenbjerg North

The site being called Stenbjerg North (Sb. 79, Nørhå parish) was discovered in 1980 by the Hirsch family, who in 1981 exposed and photographed several square meters of ard marks. The author visited the site together with D. Robinson in 1986, and later in the same year a rather rushed excavation was mounted together with the Hirsch family. Wind erosion had created a shelf at the time and it was possible to excavate the relatively large area of 34 m^2. Afterwards H. Holm discovered and examined a cooking pit with burnt stones close outside the house. This site showed that even when the substrate was blown sand settlements could remain in the same place for a substantial time and were directly accompanied by agriculture.

The occupation layer lay in the cliff about 6 m over the beach, with below it some older vegetation layers without archaeological finds. The excavation established that the ard marks lay at the lower interface of an old cultivated soil and were associated with a dwelling with sunken floor and postholes, which was dated by pottery to Period V[1] of the Bronze Age (Fig. 1). The width of the dwelling was about 4.6 m and the two parallel sides were orientated roughly WNW/ESE, which is the usual orientation of Bronze and Iron Age houses, and also of the field systems within which the houses stood. The length of the dwelling is unknown. The sunken floor lay about 25 cm below the base of the ploughsoil.

1 The normal Montelian period system is used. As this is based on metal, and as the current chronology deals with pottery exclusively, the reference to the various periods should be seen as an approximation only.

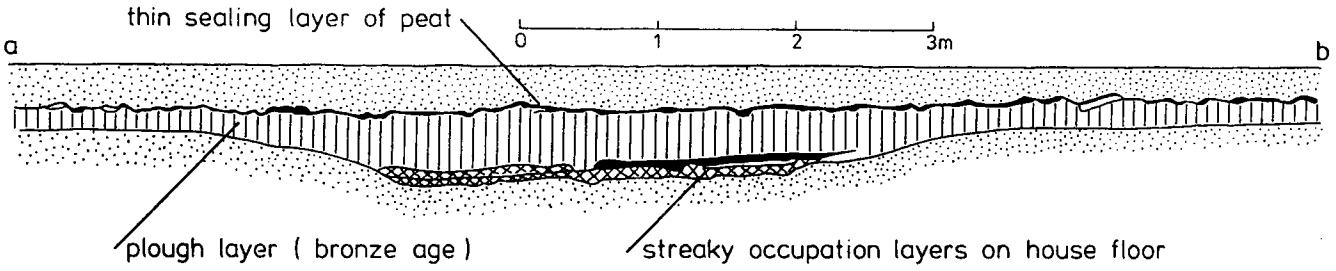

Fig. 2. Stenbjerg North, section across building.

A section across the feature at a-b on the plan is given as Fig. 2. The dirt on the floor was an approximately 12 cm thick deposit of brownish black, dirty, in places streaky sand, in which charcoal and a red mineral residue, no doubt left after burning peat, showed that fire had been regularly used. The sloping sides of the hollow are not the originally dug edges, but the final result of levelling and collapse after the building was demolished.

When the floor dirt was taken up numerous postholes were found (Fig. 1). All were sectioned and were found to be filled with pale to dark grey sand without unambiguous marks of the posts themselves, showing that these were extracted at the demolition of the building. The holes came in all sizes up to 60 cm in diameter.

The various evidence may be interpreted as follows. Two rows of roof-bearing posts ran parallel with the edges of the sunken floor. The distance between the two rows (centre of post to centre of post) was 2.4 m. The distance between any hole and the next in the same row varied from 1.3 to 2.4 m, which is unusually irregular. Some of the posts had been replaced during the life of the building. The second post from the west in the northern row had been replaced by a smaller post, which cut its hole; the second post from the west in the southern row had placed beside it a post in a much shallower hole cutting the top of the original hole. At the eastern end of the southern row there were two equal posts about 60 cm apart. One of these can have replaced the other, or there may have been a supernumerary post. That the house not only had stood until it needed repairing, but also that it was repaired and continued for a further time, shows that it was in use in all events for some decades.

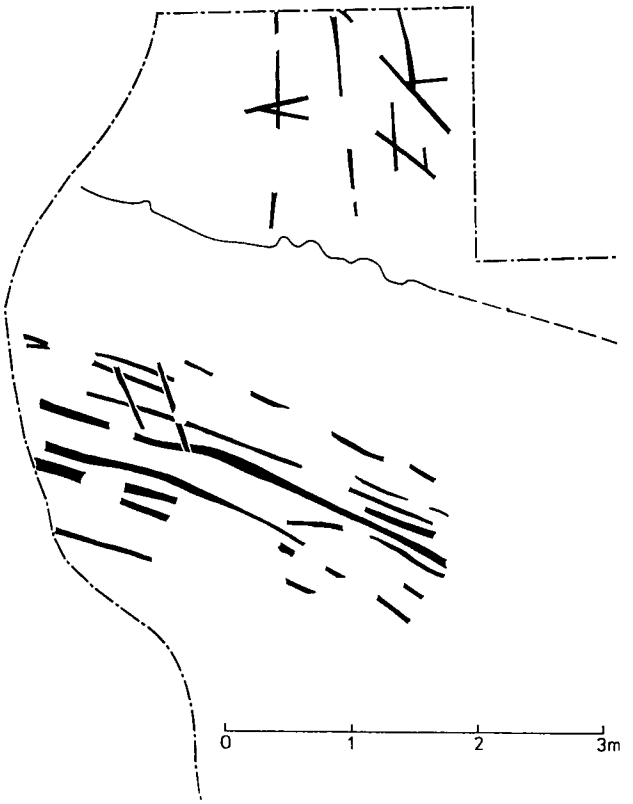

Fig. 3. Stenbjerg North, ard marks.

Though there was reasonable evidence of the roof construction, there were no signs of wall posts. Most Bronze Age houses had substantial rows of wall posts, but this one is unusual both for its sunken floor and its lack of wall posts. It is a simple dwelling that suggests that our inhabitants had a low social status!

It is not possible to explain all the other posts in the plan, but attention may be called to two pairs of deep posts in the westernmost part of the plan, each of which might be an original post and a replacement.

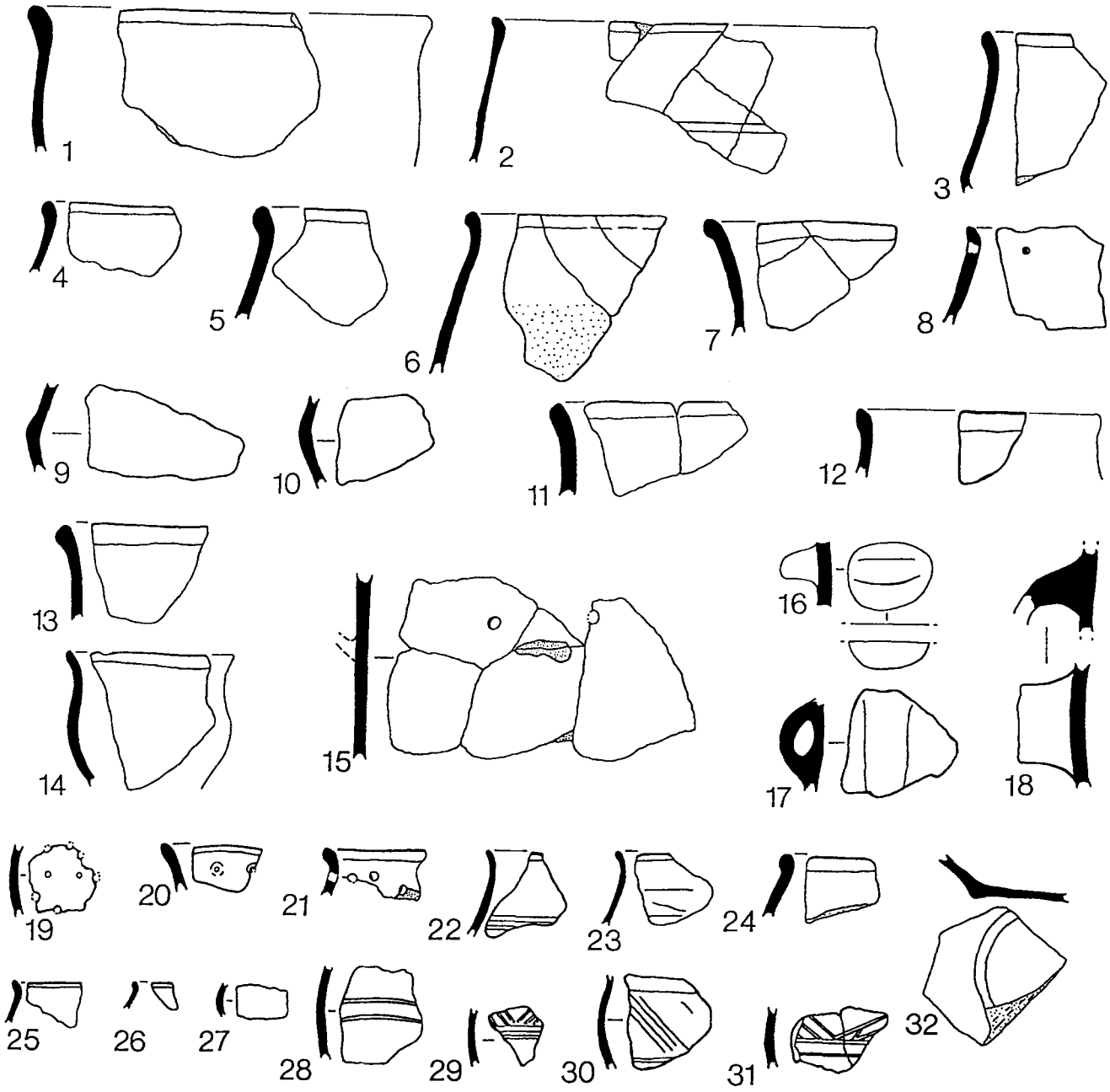

Fig. 4. Pottery from Stenbjerg North. Scale 1:3.

They could have been part of a transverse partition, but this is not certain. Attention should also be called to a number of small but deep stake holes. Such small holes could relate to internal furnishings. Their presence here may be due to the exceptionally good conditions of preservation in sealed layers in blown sand.

Not least interesting are the events, which took place after the dwelling was demolished. The area came under the plough, and the shallow pit that was all that remained of the house after demolition was not excepted. Ard marks were found south and north of the house (but here were only rarely visible because

the lower interface of the ploughsoil was much disturbed by animal burrows, which had obliterated nearly all the ard marks). They were also visible in the dirt on the house floor, where a great many furrows were visible running the long way of the hollow (Fig. 3) (owing to time pressure the marks were only planned over part of the floor). They were also occasionally visible at other levels in the house depression. The two furrows running NNW/SSE instead of WNW/ESE were plotted at a level about 10 cm above the others. The importance of this is that it shows that ploughing was not a once-only event after demolition of the building, but was repeated regularly as the hollow filled up. Cultivation continued until the hollow left by the old house was completely levelled up and the field surface over it quite flat, as can be seen in section a-b. This must indicate cultivation after the demolition of the building for a period that should at any rate be measured in decades.

The old cultivated soil (labelled "plough layer" in Fig. 2) was capped by a thin layer of peat in which lay many willow twigs which show there was a substantial period without deposition of further blown sand after the cessation of cultivation. It was certainly this prolonged pause that gave time for so much bioturbation. Some of the twigs were dated radiometrically (K-4909: 2420 ± 70 bp).

There was no success in determining the boundaries of the cultivated area. To the south a large blowout had removed the evidence, while to the north the plough layer simply faded out, becoming progressively peaty and laminated, and soon no more furrows could be found.

Pottery: The pottery from Stenbjerg North comprised 1454 sherds with a combined weight of 5.9 kg. The clay was usually tempered with broken up quartz, derived from granite if we may judge from the occasional mica. Some however was tempered with rounded quartz grains, which must be sand. Tempering material seemed somewhat unevenly distributed through the clay, as though mixing had not been very thorough. Surfaces ranged in an even gradient from rather rough to quite smooth. A coarse sandy slurry had been applied in a few cases (Fig. 4: 6), but a smooth grey-black slip is commoner, being betrayed where it peels off showing the coarser pottery underneath. The differences of thickness and aesthetic quality no doubt reflect different functions such as storage, cooking and eating. There is no sharp division of the ware into fine and coarse, but all intermediate stages are present.

Most sherds are small and none fit to give substantial portions of profiles, but there are nevertheless various clues to the types originally present.

The commonest was a jar with inward sloping neck and slightly articulated rim. Whether the neck was tall or short is normally unknown (Fig. 4: 2, 5, 6 and 8). A short neck is shown in Fig. 4: 3. Shoulder sherds are not common, but three examples are illustrated (Fig. 4: 3, 9 and 10), of which the second has a distinct bulging ledge while the shoulder of the others is more in the nature of a carination.

Bowls are indicated by outward sloping rims, but were less common (Fig. 4: 7, 11, 13 and 20, of which the last was a sieve). There seem not to be any of the form with high-rising handle joining rim and shoulder.

A very distinctive component of the pottery is the rare fine black ware (Fig. 4: 25-27). The sherds are only 2-3 mm thick with smooth, matt, blackish, slipped surfaces. The shapes seem much the same as those of pots of thicker ware, but the vessels were naturally smaller. Fig. 4: 25-26 are inward-sloping necks of unknown height with articulated rim, and Fig. 4: 27 is a slightly bulging shoulder.

Another kind of fine ware consists of decorated vessels, which so far as can be ascertained were necked bowls with walls not quite so thin as those of the fine black ware, and which often were not black but grey-brown or yellow-brown in colour. The decoration was executed with neatly incised straight lines and the motifs used were groups of horizontal lines and zones of multiple chevrons (Fig. 4: 22, 23-24, 28 and 29-31). This decoration can occur either on the shoulder, where the profile is convex, or on the neck, where it is concave. The lines range from very thin (Fig. 4: 22) up to 2 mm wide (Fig. 4: 28). The 20-30 sherds from this kind of fine ware provide most of the decorated pottery, but another rather unusual decoration is the pits flanking a now missing handle (Fig. 4: 15). This type of fine ware is found at other sites including Fragdrup (Draiby 1985), Voldtofte (Jensen 1967), and Bulbjerg (NM B9853), which places the Stenbjerg

North site in period V. There were thus two kinds of fine ware, the thin, plain blackish ware which is characteristic of the whole Late Bronze Age, and the decorated necked bowls, which are a specific form of ca. period V.

We may now turn to some specific details. Most rims were articulated by a slight outward bend. Some were completely unthickened (Fig. 4: 8, 11 and 14), but most were thickened. Though the amount of thickening is usually slight, the rims seen from the outside often appear to project like a lip Fig. 4: especially 4-7 and 13). Another common trait of the rim was the smoothing of its inner side in a distinctive way which left a single internal facet, as is clear in Fig. 4: 2, 5, 8, and is rather pronounced in Fig. 4: 12. This is easier to see on the sherds than on the drawings. It is an important diagnostic trait of much of the Late Bronze Age.

A small number of sherds had handles or marks showing where they had broken off. They took the form of rather poorly formed small strap handles (e.g. Fig. 4: 17), placed so far as can be seen on the necks of jars. There is no positive evidence in our material of handles springing from the rim. Fig. 4: 18 is part of an unusually wide strap handle. Related to handles are the small tongue-shaped protrusions which we call lugs (Fig. 4: 16). The lugs would have been useful for lifting, the handles for suspending.

Another form is the clay sieves, of which there are about 30 sherds, all of very ordinary quality. They had holes in the sides (Fig. 4: 19-21). The natural explanation is as strainers for making some kind of milk fermentation product, but the variety of forms and hole spacing leaves questions unanswered.

Stenbjerg South

This site (Sb 80, Nørhå parish) might have been more interesting if the initial discovery could have been followed up before it was too late. It lay 700 m south of Stenbjerg North and was found and trial excavated by the Hirsch family in 1981 and inspected by the author in 1982 and 1984 without any clear result. Since then it has not been accessible, and it must now be washed away. Retrospectively its special interest is that hollows were observed, which perhaps were similar

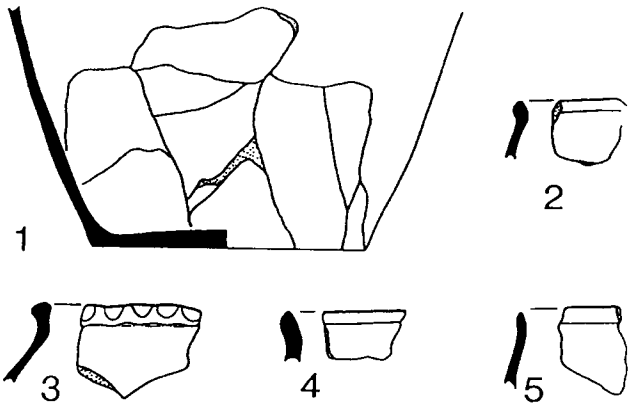

Fig. 5. Pottery from Stenbjerg South. Scale 1:3.

to the sunken house at Stenbjerg North, but this possibility did not come to mind before the excavation at Stenbjerg North. Also a posthole was seen. If the hollow(s) represented house(s) it might mean that a complete pot base discovered at a low level in a hollow (Fig. 5: 1) was a storage vessel in place in the floor. There was also a possible homogenised plough layer, but it was not possible to observe ard marks and it was not yet realised that ard marks could be obliterated by bioturbation.

The small amount of pottery recovered is basically of the same type as at Stenbjerg North (period V). Lipped rims were present, and some of the rims were smoothed inside in a way giving a sloping internal facet (Fig. 5: 2 and 4-5). This trait seems to be more pronounced at Stenbjerg South than Stenbjerg North.

The sherd with finger-marking on the rim (Fig. 5: 3) was found with a few other sherds 125 m further south again.

The pottery suggests that Stenbjerg North and Stenbjerg South were not far apart in time. However though both were from period V, they cannot be assumed necessarily to have been in use at the exact same time.

The "Summerhouse Site"

Stenbjerg North showed that dwelling and cultivation activity at these sites could have a substantial duration This was also shown by the Iron Age "Summerhouse Site" (Sb 29, Lodbjerg parish). An internation-

al panel of experts (Liversage *et al.* 1987) has already published a report on this site, but the results deserve to be recapitulated both for their own sake and because of their importance for understanding prehistoric land use. By showing how much can be learned by the application of scientific methods to sites buried under blown sand, the report gives an idea how much information may have been lost at sites like Stenbjerg North, where these methods were not applied.

Briefly, an old naturally podzolized land surface separated from the underlying till by a thin layer of blown sand had been brought under cultivation and thereby turned into an old cultivated soil. The old cultivated soil survived as a layer of homogeneous grey-brown sand with ard marks at its lower interface. The layer was reburied under blown sand soon after abandonment, so the marks did not have time to be significantly disturbed by bioturbation. The equivalent surface outside the field had a peaty, often streaky character with a much higher organic content (quantified in the pedological report). The cultivated area may therefore be regarded as a field whose northern and southern limits were revealed in the cliff by the change from a natural peat covered podzol to an old cultivated soil. The cultivated bit extended for about 60 m along the coast. All that can be said about its extension inland is that early in the 1990's it had disappeared, but in the mid 90's it reappeared again, so there may have been a further field boundary parallel with the coast (Per Nørnbjerg, personal communication). The field and surrounding uncultivated surface were well sealed by further layers of blown sand. The cultivated soil contained pottery which dates it to the early Pre-Roman Iron Age.

Where cultivation ended along the southern edge of the field ran a bank of wind-blown sand about 0.25 m high and 6 m wide. Northwards the field ended in a wet depression, which could probably have been used for watering domestic animals. Through the middle of the field ran a second bank of blown sand also 0.25 m high but only 2 m wide, showing that for a time there had been at least two fields in the cultivated island in the heath. The identification during the archaeological excavation of the field banks as drifts of blown sand was confirmed by M.-A. Courty's pedological study, which established a rather higher content of the silt and clay fractions in them (probably transported in the form of mull aggregates). Such low, broad, banks around "Celtic" fields in Denmark are common in sandy areas and are most probably blown dust caught in hedges. According to the pedological report the hedge theory also fits the high organic C content and the low C/N ratio of the material of the banks. Humus from an uncultivated surface outside the field has been C-14 dated (K4046: 2180 ± 85 bp).

It was clear that the field was a dwelling area. The old cultivated soil contained not only pottery, but also charcoal (both ordinary macroscopic pieces and finely-divided carbon dust observed only in the micromorphological mounts, where pieces of burnt daub and remnants of unburnt clay were also present).

The archaeological remains of at least one dwelling were found in the field. The traces took the form of a clay floor, which had been laid in a foundation hollow dug into the ploughsoil. The building must have stood for the normal life of a house, and had afterwards been ploughed over, as shown by the ard marks scraped into its upper surface. This also shows that the field was used for a substantial time, embracing both the life of the house and some further years of cultivation.

The amount of pottery present also showed that human activity must have been of a certain intensity.

The pedological study showed furthermore that the pH values were higher in the field than in the uncultivated soil outside. This is an indication of the decomposition of organic matter during cultivation and also a consequence of the admixture of ashes, as indicated by the micromorphology. Also the organic phosphate content was higher in the cultivated area than outside it, indicating that phosphate rich material had been added, probably in the form of food refuse, human and animal excrement, and ashes.

The research into the field also includes an important pollen analysis by Martin Munro from Queen's University, Belfast, who found that the original vegetation of the area had been heather moor, but that the impact of the settlement changed the local environment to one dominated by grasses and sedges together with a much more varied herbal flora of weeds of arable and pasture environments and a variety of other wild plants. The change in vegetation must have taken some time to effectuate and is further evidence of the duration of the settlement.

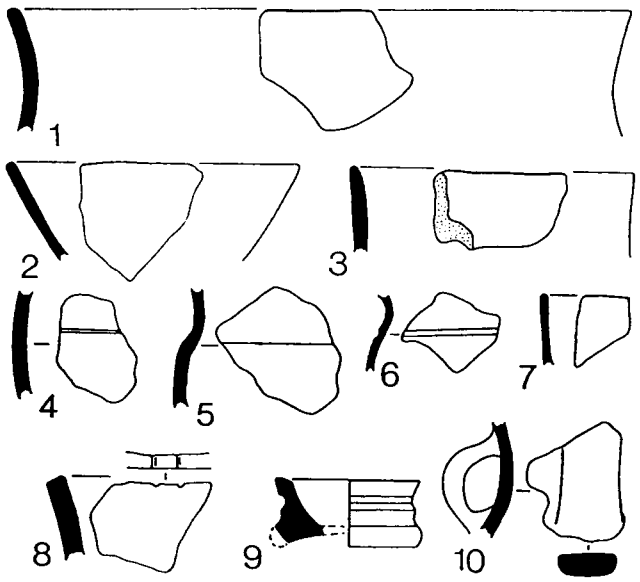

Fig. 6. Pottery from "Summerhouse Site", Iron Age. Scale 1:3.

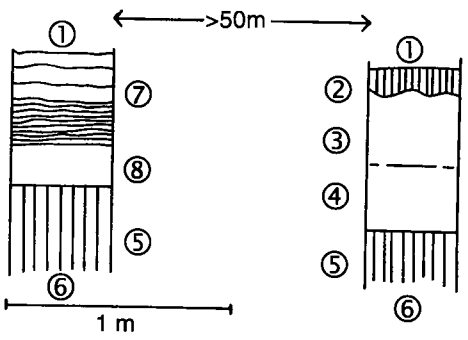

Fig. 7. Stratigraphy at Penbjerg South. 1: Blown sand with streaks of darker sand at base. 2: Homogeneous dark yellow-brown sand with small scattered stones and charcoal crumbs, and a few potsherds and flint flakes; ard marks at lower interface. 3: Streaky yellow-brown sand. 4: Firm sticky dark yellow-brown sand with a few small stones and crumbs of charcoal. 5: Dark sticky sand (old soil on underlying glacial deposit). 6: Yellow sticky sand (glacial). 7: Pale sand alternating with dark, strongly peaty sand, with most peat in its lower part. 8: brown silty sand with many small stones.

Summing up, the situation at the "Summerhouse Site" is much the same as at Stenbjerg North, but the data are clearer. At both sites there had been a cultivated area, probably surrounded by hedges, in which one or more houses had stood for the lifetime of a house and had then been ploughed over, so that continuous habitation and cultivation lasting at least several decades has to be inferred at both sites.

Pottery: The 768 sherds recovered together weighing 6 kg were from a highly fragmented material, and no major parts of profiles or significant fits were present. The typical ware is abundantly tempered with fine sand, but some sherds contain ragged pieces of quartz and possibly organic temper as well. The pots were thinner walled and smoother than in the Bronze Age, and the standard of potting seems to have improved.

The forms must have been jars and a smaller number of bowls, but very little of the shapes is preserved. Typically the rims bend out a little like fig. 6: 1. Many jars must have been of middle size and of reasonably even grey ware, but large, coarse, thick walled vessels were also present, though no rims or parts of their profiles are available for illustrating. The rims are never thickened - treatment is either simple rounding (Fig. 6: 7) or rounded-squared (Fig. 6: 1-2). Most of the rims are of jars with rather flat profile - a short slightly outward inclined neck curves gently around to a flat convex belly. The forms must have been like those published in large numbers by C.J. Becker (1961) from his period I. Handles are common, as also in Becker's material, and took the form of parallel-sided, flat-sectioned strap handles (fig. 6: 10) without the variety of handle types found in the Bronze Age.

The few bowls appear to have been shallow and open (Fig. 6: 2 and 8), and could more easily derive from forms like Fig. 17: 12-13 than from the earlier carinated bowls see below.

There are a few sherds of thinner, dark ware, which shows that the Late Bronze Age fine ware continued. Only one of them is worth illustrating (Fig. 6: 7). The ware is matt and unpolished, but is thin, even, and uniformly a dark grey-black in colour.

Decoration is rare, but a few sherds do have a single neatly incised horizontal line, which probably went right around the pot (Fig. 6: 4 and 6), and there are notches on the rim of Fig. 6: 8). Though not strictly

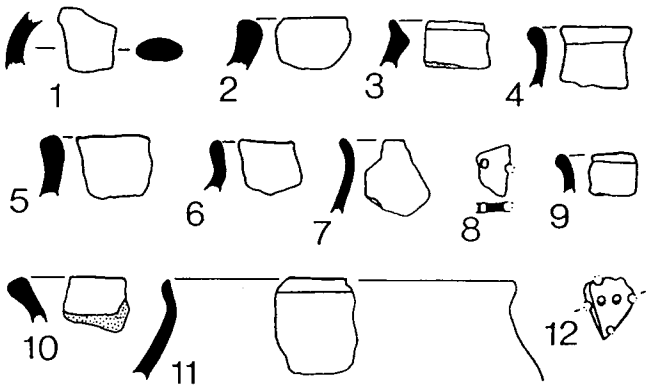

Fig. 8. Pottery from Penbjerg South. Scale 1:3.

decoration, some sherds show a sandy slurry, which is somewhat thinner and more regular than the slurry found in the Late Bronze Age.

Despite certain differences, this pottery is clearly a further development of Bronze Age pottery, especially the style found at Bodbjerg (see below), and reflects in handwork that the change from the Bronze to the Iron Age was evolutionary rather than revolutionary.

Penbjerg South

This site (Sb 30, Lodbjerg parish) confirmed that old ploughsoils were present in the blown sand area, but very little could be learned about it with the time and methods at our disposal. It is dated by scattered Late Bronze Age pottery, but in the first years a little pottery from the end of the Pre-Roman or beginning of the Roman Iron Age was also found (Fig. 8: 1, 2, 5, 10). This appears to have been limited to a small area and may be from a pit. A few calcined fragments of sheep bones kindly identified by Knud Rosenlund were found at the same time.

The stratigraphy of a test pit dug in 1978 is shown in Fig. 7 right. Ard marks at the layer 2/3 interface showed that layer 2 was an old cultivated soil. Layer 4 was very similar in character and may have been an earlier cultivated soil, but no ard marks were detected at its base, where there was no colour change, so they would have been invisible even if ploughing had taken place. The small amount of pottery from layer 4 may from its technology be Neolithic, and could be connected with the unpublished TRB settlement site of Penbjerg only about 150 m away. The small stones in the plough layers must have resulted from lateral transport from nearby till exposures. Layer 4 is thought to be blown sand mixed with the original weathering soil, layer 5, by bioturbation.

In 1982 a serious effort was made to trace the ploughsoil in both directions along the cliff and find how and where it ended. If the extent of cultivation were estimated from the pottery, it continued for 100-150 m, but the ploughsoil as such could not be followed nearly so far. The stratigraphy changed gradually. First the underlying paler yellow-brown sand (layer 3) wedged out, and then the homogeneous ploughsoil changed gradually without any sharp boundary to a streaky deposit, which still contained pottery and a little charcoal, but it seemed could never have been cultivated without destroying its streaky character.

A section through this recorded further north and four years later is given in Fig. 7 left. The upper layer (1) is the same in both profiles, but under it the north profile shows a streaky deposit (layer 7) of pale sand alternating with dark, strongly peaty sand. Clearly a deposit like this cannot have been ploughed, which would disturb the lamination. Below this came brown silty sand with many small stones (layer 8), which was the equivalent of layer 4 in the other section. The old soil on the glacial deposit, layer 5, is the same in both profiles.

In 1990 a new test pit was dug and samples taken for possible archaeobotanical study. It is felt that with more work in the field and laboratory it could still be possible to solve the riddle of this site. It must represent an inhabited cultivation area like Stenbjerg north or the "Summerhouse site", but we have not yet found a place where the house(s) stood and the archaeological material is rich.

Pottery: Only 188 sherds with a combined weight of 1.45 kg were recovered. Fig. 8: 2 and 5, are small rim sherds, which are noticeably thickened by the addition of clay on the inner lip. Fig. 8: 10 has a sharp angle inside the rim showing it had been broadly facetted in the late Pre-Roman manner. Fig. 8: 1 is a well made handle of oval section, which widens towards the ends. Facetted rims and handles of this type are

Fig. 9. "Middle" site Occurrence B during excavation, showing stratigraphy.

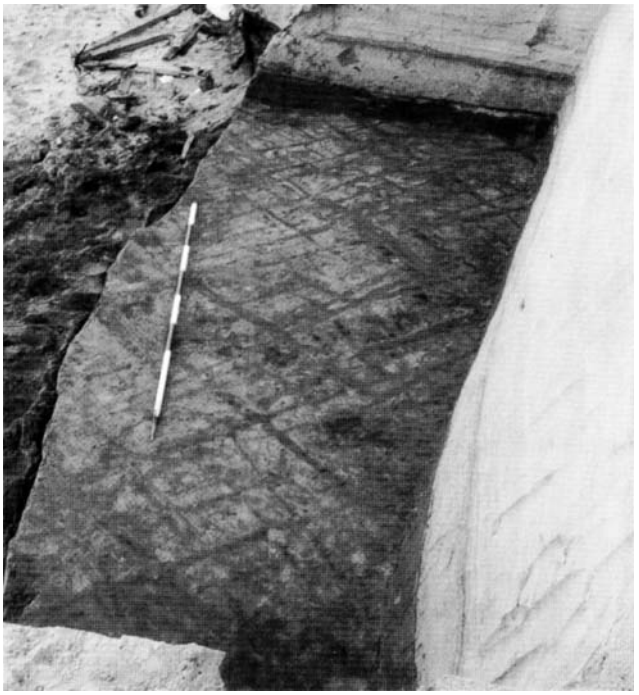

Fig. 10. Ard marks at "Middle" site.

typical of the end of the Pre-Roman Iron Age, and the finds also include some dense blackish body sherds which are probably of the same age. Harald Holm found this material in 1973-76. Iron Age sherds have not otherwise been found at Penbjerg South.

The rest of the test pits and sections produced Late Bronze Age wares. Fig. 8: 4 and 9 are lipped, slightly thickened rims, while Fig. 8: 3, 11 have a very marked internal facet and 6 has a slighter facet. These are rim features found at Stenbjerg North, whose dating must also apply here, but not necessarily to the extent that the two sites were in use simultaneously.

The "Middle" site

This name was given to a complex of settlements situated midway between Bodbjerg and Penbjerg (Sb 33 of Lodbjerg parish). The site was found by Harald Holm in 1976, and in the same year the National Museum excavated sections through two find concentrations, one Late Neolithic (Occurrence A),and about 100 meters south of it another from the Younger Bronze Age (Occurrence B). As coastal erosion progressed inland of where Occurrence A had been, Occurrence C appeared and was excavated in 1982 The excavations at the "Middle" site showed that settlements in blown sand could be on a considerable scale when measured in postholes and broken pottery. There was also yet another plough layer, but many questions about it remained unanswered.

The stratigraphical situation at Occurrence B in 1976 is shown in Fig. 9. Inclining dark and lighter sand layers slope down to the left, and on the right have been cut off by erosion from above. This is where the actual settlement may have been located. The sloping layers contained a considerable amount of pottery, but were low and wet. A trial pit cut somewhere near by in 1978 also struck much pottery, and sherds continued to be found in the vicinity until 1980 and 1981, but not later, and the site is certainly now washed away. Charcoal from Occurence B has been C-14 dated (K-3275: 3140 ± 80 bp).

A curious feature in the find layer was wads of unburnt clay with sand in it, the largest piece measuring 30 cm across. This may have been raw material for pottery, but the mixture seems somewhat different that seen in the sherds, and it may have had some other use.

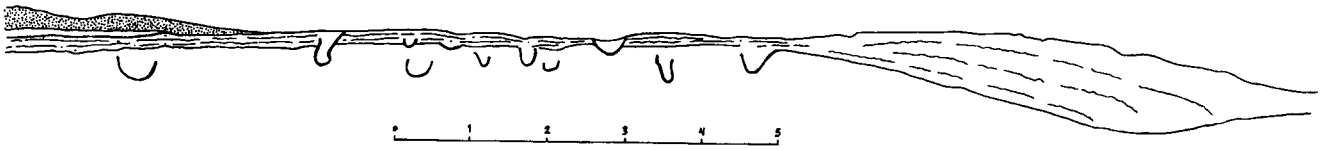

Fig. 11. Section through "Middle" Site Occurence C

When Occurrence A was excavated in 1980 a fine example of a plough layer with ard marks at the base was discovered and photographed (fig. 10). Unfortunately it could not be related to the stratigraphy in the main part of the excavation because there was a large sandslip between. The sherds in the ploughsoil were Late Neolithic in technology, but so were those in the underlying blown sand, which implied that the sherds in the ploughsoil were ploughed up from below. Conditions are quite compatible with the plough layer having been part of Occurrence C, which was found later, but it has never been possible to obtain proof or find the plough layer again.

In 1982 it became plain that important new Bronze Age material was being washed out, and it was given the name Occurrence C. As the cliff was very high and steep it was impossible to excavate much horizontal surface, but a continuous section 19 m long was cleared. This was not the entire length of the find-bearing strata, and it is estimated from miscellaneous diggings that at that time Bronze Age pottery could be found continuously along around 30 m of the cliff.

The section could not be cut vertically in the normal way because this could have provoked a landslip, and therefore it was cleaned and recorded sloping. The effect of this was that only the bases of the outer postholes appeared in the "section", and only the upper parts of the inner postholes.

As well as postholes, the section (Fig. 11) showed a 15-20 cm deep occupation layer deepening southwards into a deep midden filling up a pre-existing natural hollow. In the northern 2-3 m of the drawn section there was a separate upper occupation layer separated from the main occupation layer by a lens of clean sand. This upper occupation layer is a stratigraphically distinct unit, but the small amount of pottery recovered from it is not typologically distinct from the rest of the material. The section is considerably simplified compared with the field drawings. The upper occupation layer was a single black deposit, but the main occupation layer was streaky with many thin yellow, grey and blackish streaks, while the stratification of the deep midden was diffuse. Charcoal from the bottom of the midden has been C-14 dated (K4048: 2760 ± 75 bp).

The postholes were concentrated around the middle of the section. Their close spacing suggests that there was not one, but a number of successive structures but nothing can be said about building plans with the available information, and many details of the site are unclear. The amount of pottery found in this small excavation shows that the total amount at the site must have been large. From this and the postholes, which are so closely spaced that they must represent two or more building phases, it can be deduced that the settlement lasted a long time, but unlike Stenbjerg North and the "Summerhouse Site" it was not ploughed over after abandonment.

It is important to note that the settlement here was not only fairly prolonged, but was also extensive. Pottery was found not only at Occurrences B and C, but also in small quantity north of Occurrence C, including some by a hearth some scores of meters away, and also in low-lying strata south of Occurrence B. It seems likely that the area with direct settlement traces in the form of pottery was at least 200 m across. Animal bone was not preserved, but animal teeth sometimes survived in a decayed condition. As cattle, pig, and horse teeth were represented it may be concluded that the inhabitants practised a varied animal husbandry. The same is probably true of the other sites.

Pottery: The amount recovered from Occurrence B was fairly moderate (505 sherds weighing together 4.85 kg). Some were large, and substantial parts of pots, including one complete profile, could be reconstructed. The clay was for the most part abundantly gritted

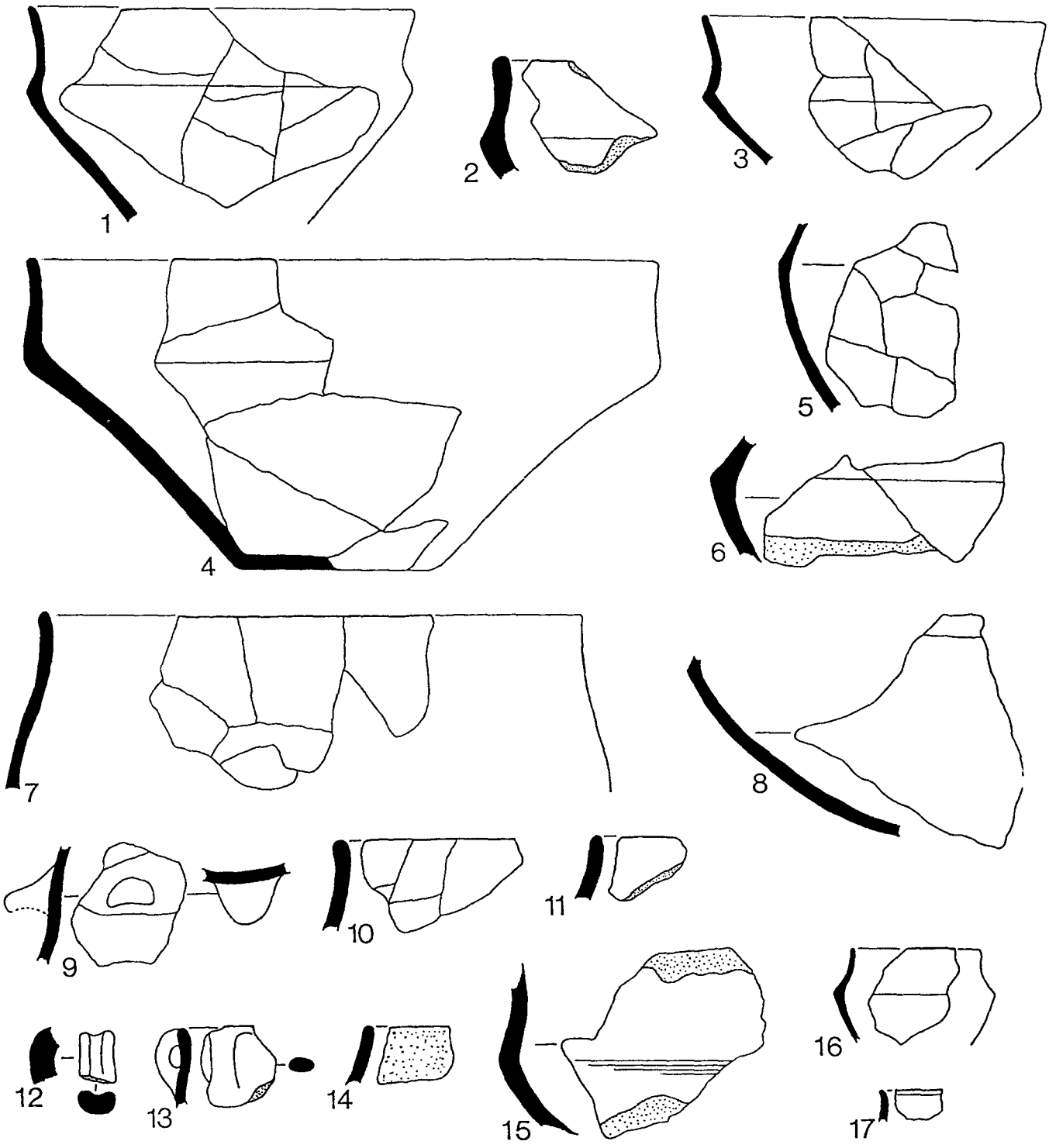

Fig. 12. Pottery from "Middle" site Occurrence B. Scale 1:3.

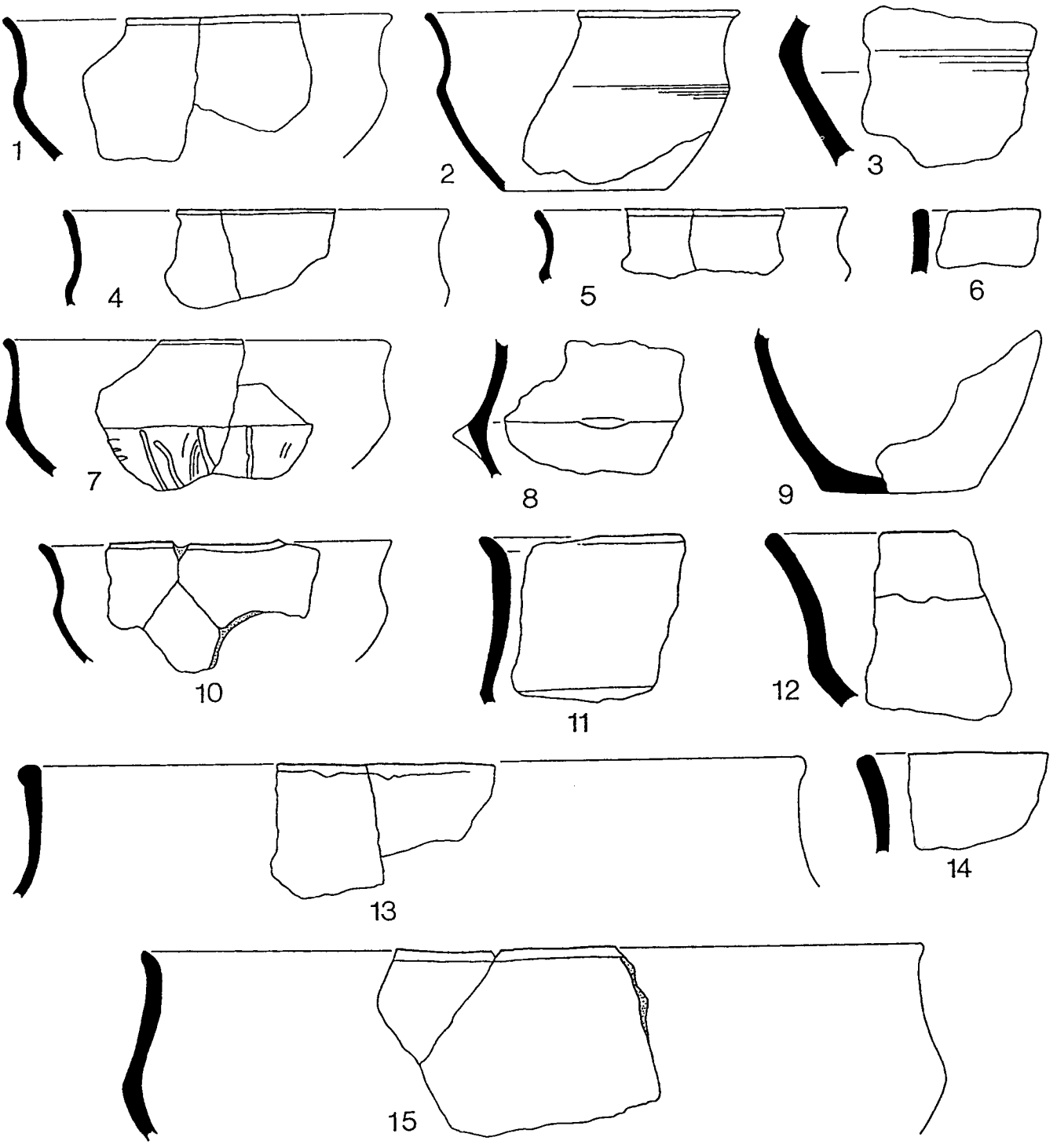

Fig. 13. Pottery from "Middle" site Occurrence C. Scale 1:3.

with rounded sand grains, but angular grains occurred also. Surfaces were fairly smooth. Firing tended to produce a fairly hard, dark brownish black ware.

Bowls and jars were almost the only forms present, with bowls considerably outnumbering jars. They were of the sharply carinated form (Fig. 12: 1, 3 and 6), or had slightly more rounded carination (Fig. 12: 2, 4 and 15), and some had markedly concave necks (Fig. 12: 1-3). Fig. 12: 4 shows a bowl with soft carination fitted continuously from rim to base.

The jars were fewer and less could be reconstructed of them. The rim sherds show an inward slope without the outcurving upper part characteristic of Bodbjerg. Fig. 12: 7 looks as though it flowed smoothly from neck to body. Fig. 12: 10-11 and 14 are further rim sherds from jars. The last is slurred externally right up to the rim.

Eight sherds were noteworthy for coming from small, thin-walled vessels of finer black ware, one of which could be reconstructed on paper as a miniature bowl (Fig. 12: 16), while the others could also have been bowls, but were slightly larger (e.g. Fig. 12: 17). Sherds of two handles (Fig. 12: 9) were found. The handles were rather thick, one with raised edges (Fig. 12: 12), the other joining the rim and shoulder of a little bowl (Fig. 12: 13). The lugs were tongue shaped (Fig. 12: 9).

Details of rim form are important. The commonest were simple rounded (Fig. 12: 3 and 11) or rounded-flattened (Fig. 12: 2 and 4). The latter is like one of the rim treatments common at Lyngby North. On the other hand the internal facet resulting from running a finger around the inside to evert the rim does not occur at all (cf. Fig. 4: 1, 3 and 6), and appears to be a later trait only.

From Occurrence C were recovered no less than 2239 sherds with a combined weight of 27.35 kg. There were many large sherds, but they did not fit as well as hoped.

The technology and typology were similar to those at Occurrence B, but there were a few differences. Bowls were commoner than jars. Nearly all were of a standard shape with concave neck and a distinct carination (Fig.13). The ratio between width and height seems to have varied considerably. Fig. 13: 9 suggests a decidedly deep bowl, while the large vessel Fig. 13:15 would have had much shallower proportions. Fig. 13: 12 seems unusually strongly splayed. The most typical form is represented by Fig. 13: 1-5, 7 and 10). Another variable is the sharpness of the carination, with Fig. 13: 2 and 8 at the sharp end of the range and the much more rounded Fig. 13: 1 and 15 at the blunt end. On the whole the carinations are less sharp than at Occurrence B, and the necks less concave.

Jar rims are recognisable from their inward slope, but important features of jar form are uncertain, as there are not enough fits. Fig. 14: 2-4 and 7 can perhaps be compared with a broad category of ovoid jars with slightly upbent top of profile. The form is best seen in Fig. 20: 2 from Lyngby North and Fig. 12: 7, but it is hard to distinguish sherds of such jars from those of jars with conical inward sloping neck with out-turned rim as represented by Fig. 14: 1 (cf. Baudou's form XXVIII C 1). A more marked out-turn of the rim is seen in Fig. 14: 5, 6 and 9 which leads on to a common type at Bodbjerg (see below).

A quite different jar profile is indicated by Fig. 14: 8. The form was barrel-shaped rather than necked. In this particular case there was an offset upper part, whose smooth surface contrasted with the heavily slurried body. Fig. 14: 11, shows some resemblance to it. Bucket-shaped profiles of this or any other kind were rare at this site.

An interesting feature of the assemblage was sherds of a small number of fine, dark, miniature vessels (Fig. 14: 12-14 and 18-21). Some sherds were as thin as 4 mm. Though smoother than the other wares, they were not polished or extremely fine, and the tempering and forms were essentially like those of the larger and coarser pottery, though finer. The small angled sherds Figs. 14: 12-13 must be from small carinated bowls. The rims Fig. 14: 18 and 20, as well as a few others, could also have come from such bowls. Miniature vessels of other shapes are already indicated by Fig. 14: 19 and 23, of which the latter was an unusual barrel shaped miniature and the former perhaps the same. The rims of the fine black ware were treated the same way as those of the material as a whole. We may therefore suppose that these small, thin-walled vessels were made locally or at any rate in the region. Their function is a little unclear as they seem too few and often too small to be a better class eating ware, and Fig. 14: 23 had been used for cooking as there are patches of burnt crust on its inner surface.

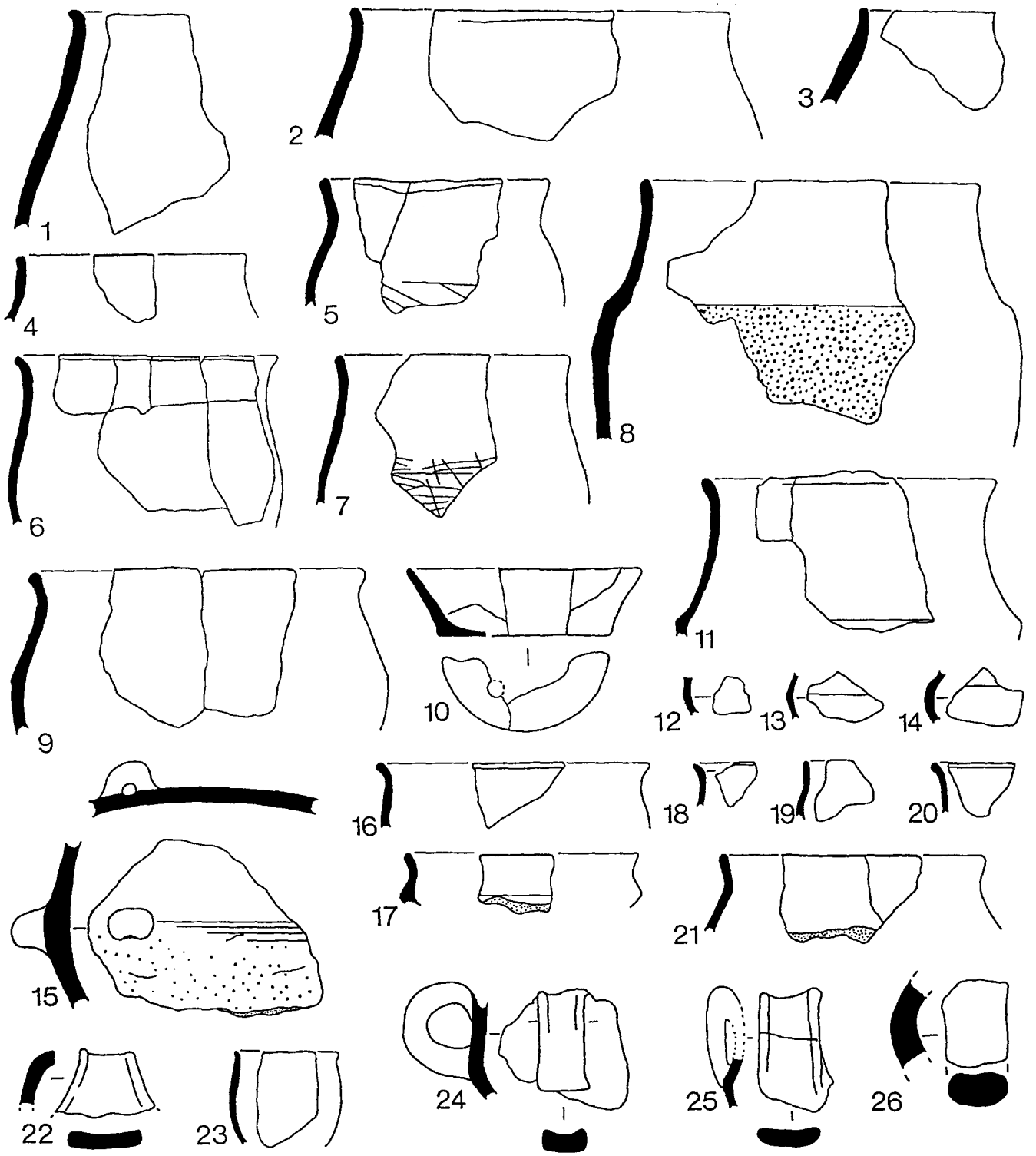

Fig. 14. Pottery from "Middle" site Occurrence C. Scale 1:3.

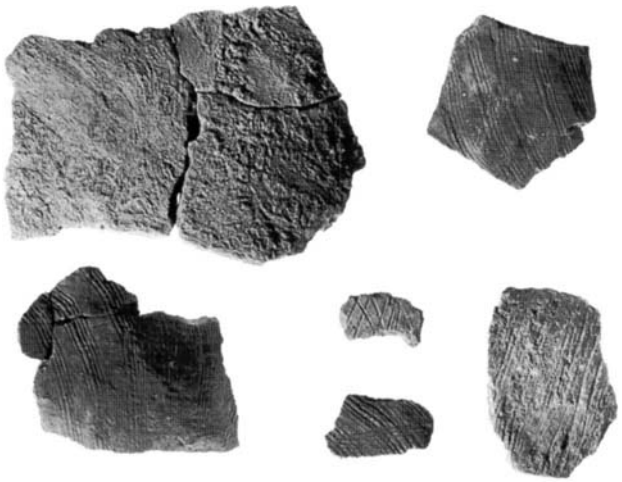

Fig. 15. Pottery decoration at "Middle" site Occurrence C.

A few bowls and jars of intermediate size and better than average technology also occur. Fig. 14: 10 was a sieve shaped as a small conical bowl with at least one hole through the bottom. Sieve sherds were not common at the "Middle" site.

A greater variety of rim shaping was present at "Middle" site C than at B. Squared off but still somewhat rounded rims, as at Occurrence B, are not uncommon (Fig. 13: 1 and 13; Fig. 14: 5, 7, 9 and 16), and there is a variant where more has been made out of the flat rim by making it really flat and more sharply set off from the sides of the pot (Fig. 13: 12 and 14). Simple rounded rims are also present (Fig. 13: 2 and 7; Fig. 14: 2 and 8). These tend to protrude slightly on the outer side without really being thickened. Attention may be called to the rims that have been shaped by running a finger around inside, thereby pressing them out a little and causing a facet (Fig. 13: 4, 10, 11 and 15; Fig. 14: 6). The facet can be rather distinct (Fig. 13: 4 and 15) or suppressed (Fig. 13: 11). It is a characteristic feature of pottery from much of the Late Bronze Age.

There are a small number of handles. Fig. 14: 25 shows a strap handle with raised edges and 'horned' top joining the rim and shoulder of a bowl. It is especially characteristic for having been pressed inwards when the clay was still wet. There is a parallel from Fragtrup (Draiby 1985, Pl. V, 1-2). The others are flat handles with raised edges (Fig. 14: 22, 24, of which 22 widens strongly towards the ends), and a thick handle (Fig. 14: 26). Lugs were not common. The only ones were Fig. 13: 8, a very small lug placed on a sharp carination, and Fig. 14: 15, a vertically perforate lug at the widest diameter of a pot with slurried lower part.

Decoration is very rough and not common, and has more the character of a surface-covering roughening than an embellishment underlain by even simple geometric ideas. We find surface-covering scoring with a narrow comb-like implement with multiple points (like Fig. 21), and rough parallel or cross-hatching applied with a single point (Fig. 14: 5 and 7; Fig.15), or with a blunter implement (Fig. 13: 7).

The small typological difference between the pottery from Occurrences B and C was not recognised until the ceramics were studied in detail for publication. The technology is similar and both assemblages are dominated by a very characteristic form of carinated bowl, which unites the two sites in contrast with the others. However the carinations at Occurrence B show a tendency to be sharper and the necks to be more concave, while faceting of the inside of the rim was common at Occurrence C but absent at Occurrence B. Though some of the details can be a question of representativity, there are so many differences that the two middens can hardly be exactly contemporary. The radiometric datings however suggest a much larger age difference than is believable.

Bodsbjerg

At this site (Sb 32, Lodbjerg parish) settlement may well have lasted as long as at Stenbjerg North or the "Middle" site, if we may judge from the depth of the midden and the presence of postholes, but the evidence was not so clear. The extent of the surrounding area with scattered pottery supported that it had a surrounding territory as at those sites. Unfortunately Bodsbjerg cast no further light on agricultural practices.

The Younger Bronze Age midden at this locality was discovered in 1976 and excavated on various occasions until 1990 as the cliff retreated. It is not known how many meters of land were washed away, as all markers disappeared. The Bronze Age material came

from a midden built up of many greyer, browner, and paler lenses, containing a good deal of pottery that fitted relatively well. The thickness of the midden as exposed in 1978 was 40 cm, but in 1982 the thickness was about a meter. It showed in 1976 as a deposit thrown down a northward facing slope, but in 1982 as one thrown down a southward facing slope. In 1978 two postholes were observed. Charcoal from the bottom of the midden was C-14 dated (K-3535: 2590 ± 125).

It was naturally wished to follow the horizon out to the sides, especially in hope of finding traces of cultivation. However it was found that it could not be followed northwards at all because the surface had been deeply denuded by a recent blowout, but a few sherds found at the bottom of the blowout implied that traces of occupation had originally continued northwards. In 1982 an attempt was made to follow the horizon southwards, but the first 6 m were blocked by a sandslip, and beyond that the occupation horizon was picked up again only in an inconclusive way.

A further attempt was made in 1990, but by that time funding was very short and the investigation had to be carried out in a great hurry and yielded little new information. The result is that we have a site with a good collection of pottery, some interesting archaeobotanical samples it has not been possible to have identified, some detailed stratigraphy of no value, but very little other information.

In 1967 an occurrence of pottery was investigated about 150 m away to the NE. Some of it was sandblasted and lay on the bottom of old blowouts. It could not be dated more closely than to the Bronze Age, but could well be from the same period as the midden. On the other hand some sherds acquired in 1967 from a local informant could from their appearance have come from the midden itself, when this was earlier accessible in a blowout. In 1976 Harald Holm found some coarsely decorated sherds rather like those from the settlement about 50 m to the south. Thus there are various indications of settlement in the territory around the midden, and there is no reason why the territory should not have been as big as at the "Middle" site. In 1986 many carbonized seeds and grains were sieved out of the occupation layer by the Hirsch family and the author.

Pottery: This was more interesting. About 726 sherds were uncovered with a total weight of 16.5 kg. The sherds were on the whole large, and many fitted together giving substantial parts of relatively many profiles. The temper consisted of quartz sand with occasional mica suggesting the grit had been processed from granite. The temper and clay had not been very thoroughly mixed and little concentrations of grits could be observed in the biscuit. Firing however was hard, and the material seemed to lack nothing in utility.

The pottery was dominated by the larger "kitchen" wares, which had often been thrown into the midden in large connected pieces, but there were sherds of both small and middle-sized vessels of rather better, smooth, evenly dark ware, so the importance of the large, coarse wares should not be stressed unduly. A primary division can be made into jars and bowls, with the jars the more numerous. Most of them were plain with no sign of either slurry or decoration. Some have burnt organic material on the outside or inside, showing they were used for cooking. The most distinctive form element is the short everted neck (Fig. 16: 4, 5; Fig. 17: 2-5). A variant with short, upturned rather than out-turned rim is also present (Fig. 16: 6 and 8; Fig. 17: 6). The conical neck is less common, but an example is illustrated as Fig. 16 9, and the same form is implied by some shoulder sherds, none of which are illustrated.

A minority of jars is of a quite different shape. They have evenly bowed sides ("barrel shaped", Fig. 16: 10) or straight sides ("bucket shaped", Fig. 16: 1, 2). They are further characterised by having a cordon, ridge, or row of impressions a few centimetres below the rim (Fig. 16: 1, 2, 3 and 7), and normally the pot exterior is smooth above but roughened by slurry below this feature (Fig. 16: 1-2), a trait which is regarded as characteristic of period VI (Jensen 1967). A variant is the division of the pot into a smooth zone a few centimetres wide below the rim while the rest of the pot is slurried, with no cordon to mark the transition (Fig. 16: 4). The very large bowl, Fig. 17: 9, shows that the motif of a slurried body with smooth zone under the rim can also occur on bowls.

The form with short everted rim continued and became more universal in the earliest Iron Age (Beck-

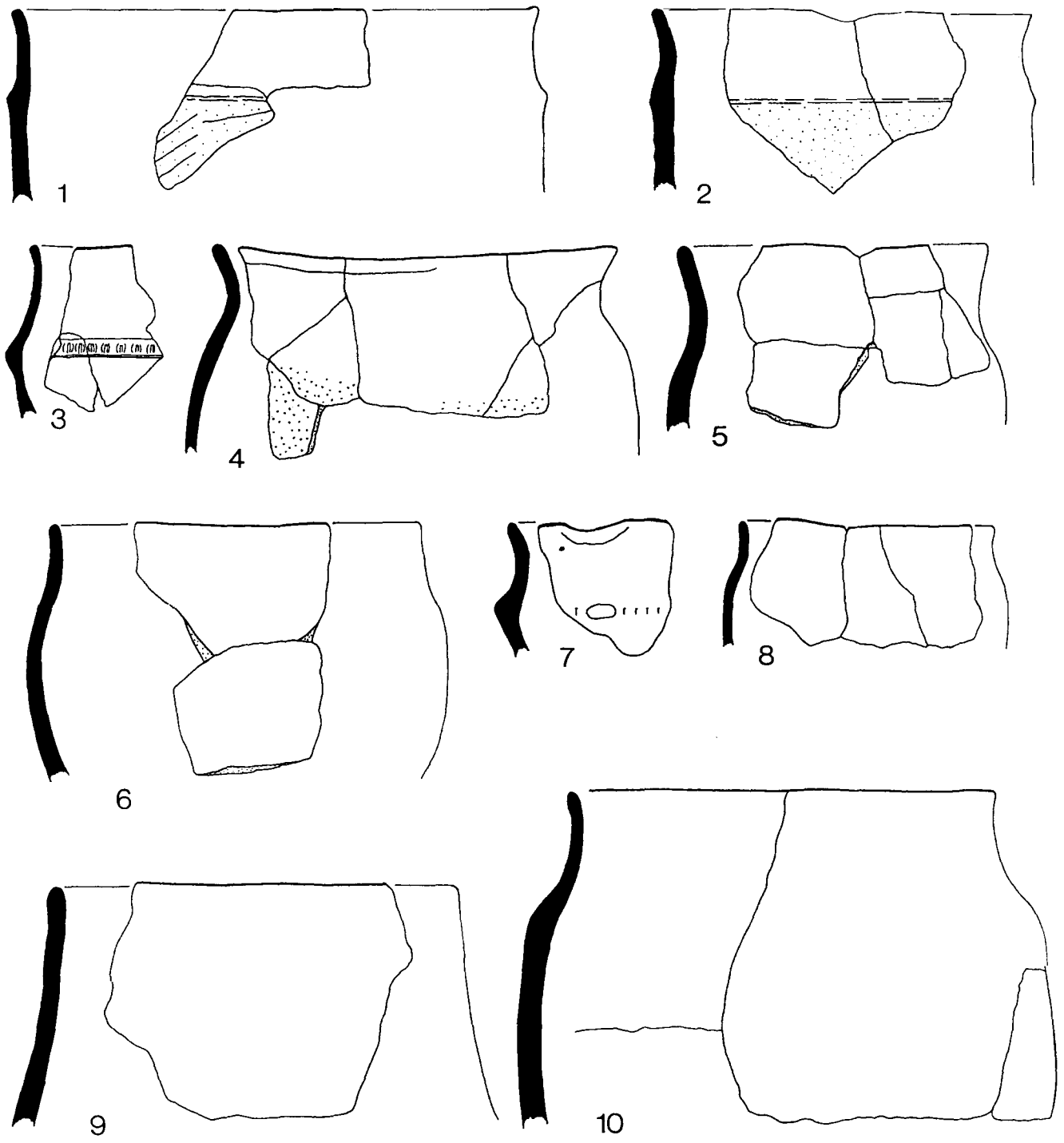

Fig. 16. Pottery from Bodbjerg. Scale 1:3.

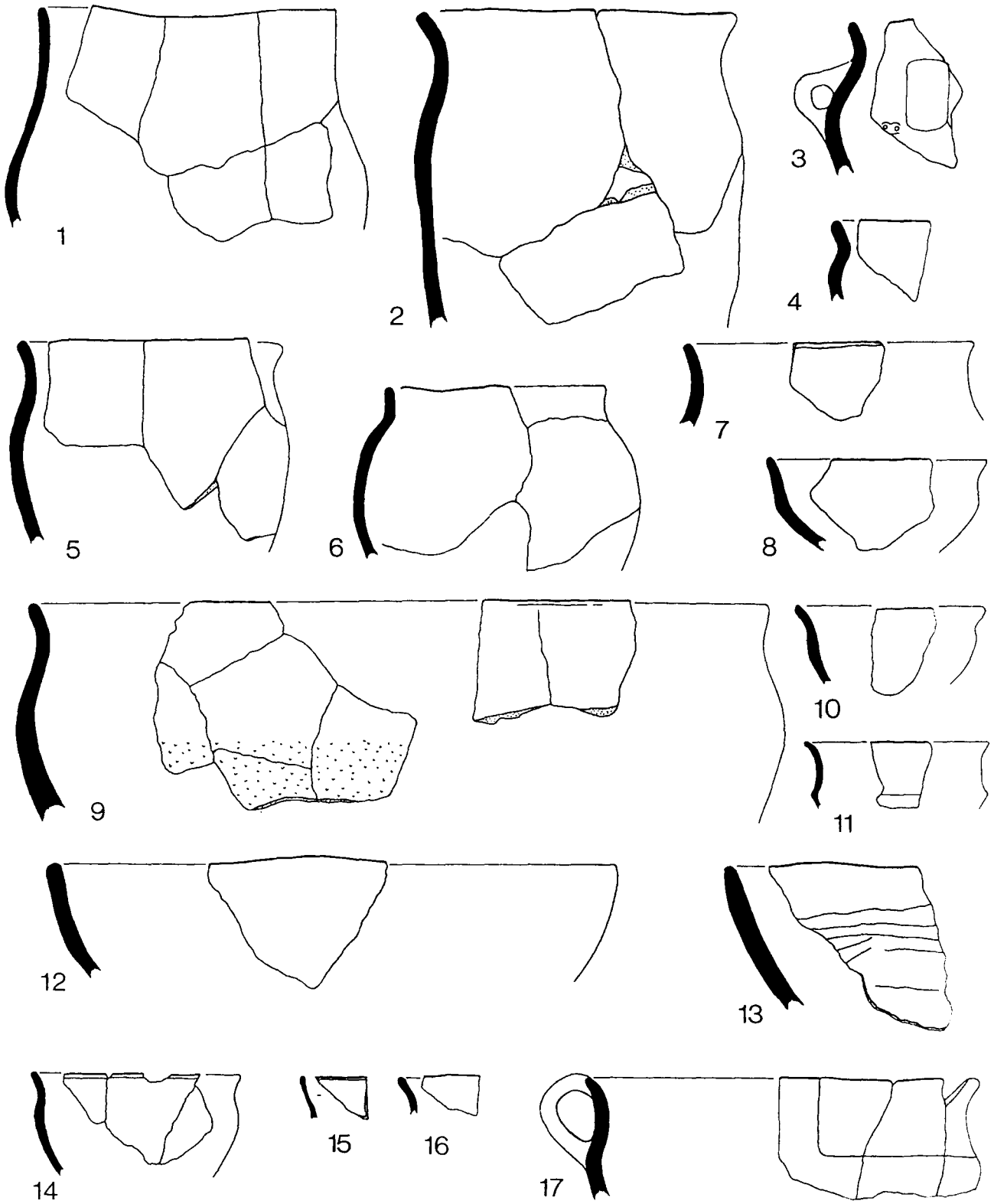

Fig. 17. Pottery from Bodbjerg. Scale 1:3.

er 1961). Fig. 17: 3, for instance, with its short everted neck and shoulder with parallel-sided handle would be quite at home at the beginning of the Iron Age.

The bowls were fewer than the jars. They are more varied in form than at the earlier sites in the dunes, and can be regarded as falling into the three subclasses of large bowls (presumably for household purposes), better bowls with concave neck bridged by a handle joining the rim to the shoulder, and small, usually fine bowls which it can be conjectured were intended for dipping into the common platter and eating from. Of the large housekeeping bowls, Fig. 17: 9 was of very thick ware and had a rounded shoulder below which it was slurried, while Fig. 17: 12-13 were wide open bowls with simple convex sides, the second with coarse, horizontal finger fluting on the body. Fig. 17: 17 represents the second subclass.

The small possibly eating bowls are represented by Fig. 17: 8, 10, 11 and 14-16, some of which are of very thin, black ware. Fig. 17: 11 is carinated as at the "Middle" site, but the others have only unemphatic shoulders.

Lugs appear as Fig. 16: 7 and handles as Fig. 17: 3 and 17, but were decidedly uncommon.

The rims were usually rounded (Fig. 16: 9-10; Fig. 17: 9-11). but the rounded flattened form also occurs (Fig. 17: 2 and 7). The rim with internal facet made by smoothing with a finger does not occur at all, and the rounded rims do not give the same impression of being a thickened lip that they do at the "Middle" site. Decoration is somewhat commoner than at the other sites, but is still not common. It is confined to surface-covering scraping, fluting, or brushing (Fig. 18) except when a cordon or ridge is notched as in Fig. 16: 3 and 7. Slurry is also present, which is another form of surface roughening decoration.

Lyngby North

In 1973 and succeeding years pottery was found by the Hirsch family at odd places along a 400 m stretch of coast, north of Lyngby (Sb 84, Hvidbjerg parish). The richest site was the northerly one given the name Lyngby North. The area has the special interest that the finds appear to be from a little-known phase of the EarlyBronze Age.

The best finds were made before contact was established with the National Museum, and included part of a flint dagger blade and a flat-flaked arrowhead (Fig. 22), which are important as dating indicators, and some pottery beautifully fitted together by the finders.

In 1978 and some years preceding the main occurrence was accessible at two points about 35 m apart. Conditions are documented by the photograph, Fig. 19, which shows a section through the find layer in 1978. There was a thin, somewhat streaky layer which contained occasional pieces of charcoal, stones (usually burnt), irregular small flint flakes, and pottery.

At the other exposure 35 m further south the layer had much the same character, but was in the process of being eroded from above by the wind.

There were signs that the total settlement area was much larger than the part of it most of the finds came from. Small amounts of pottery that appear to be from the Early Bronze Age were found by the Hirsch family at various places south of Lyngby North, the remotest being about 400 m away (Sb 86, 87 and 88 of Hvidbjerg parish). Early Bronze Age material has not been observed anywhere else along the 12.5 km cliff in the investigation.

Pottery: There were recovered 512 sherds with a combined weight of 2.5 kg. Compared with the Late Bronze Age material the technology differed in that the grits were more irregular in size and distribution and were angular pieces of quartz and/or flint with very little mica. A few of the largest grits were as much as 5 mm across. There was probably also organic temper. With exceptions the ware was rather softly fired and the surface was often rather poorly smoothed. In form, colour, firing, and smoothness this material called to mind Late Bronze Age much more than earlier Late Neolithic and earliest Bronze Age ceramics.

As most of the sherds were small and could not be fitted, our knowledge of the forms is very limited. The impression is that average pot size was smaller than at the Late Bronze Age sites, but large pots did exist, as shown by the thickness and curvature of some of the unillustrated body sherds. Bowls and jars were both present. Fig. 20: 2 was a small ovoid jar with slightly upbent mouth, and Fig. 20: 1 was a small, soft-profiled, necked bowl. Other sherds show that handles

Fig. 18. Pottery decoration at Bodbjerg.

on inward-sloping necks were not uncommon (Fig. 20: 3, 4 and 6), but complete neck profiles were not preserved. The handles were parallel-sided with raised edges, like those in use later in the Bronze Age.

There is fuller information about rim treatment. The top centimetre or two of most pots bend outwards (Fig. 20: 8, 9-11 and 14). This part can be tapered or rounded (fig. 20: 10 and 12), but is most commonly squared off in a blunt way (Fig. 20: 7-9 and 14), which is a characteristic potting trait in this material.

More unusual finds were the straight-walled jar or bowl (Fig. 20: 13) and Fig. 20: 12, which recalls a common rim form from the end of the Neolithic and the earliest Bronze Age (Rasmussen 1993, Fig. 28, 30), from which it differs however in its smooth surface and relatively fine ware.

A little crude decoration is present (Fig. 21), respectively swept with a brush and with a comb-like implement. Both sherds were found at an early stage of the investigations and are not parallelled in later finds. Fig. 20: 15 and 16 recall fine decorated pottery from period V, but at the same time their ware, and especially colour, fits in well with the rest of the material from Stenbjerg North so it is unsure whether they represent later pottery or not. A little period V pottery was found a few hundred meters to the south, so we cannot with our present knowledge exclude that these sherds could be some kind of contamination.

Other finds: The early date of this site is confirmed by the association with a flat-flaked arrowhead and a flint dagger blade. The arrowhead (Fig. 22 right) was leaf-shaped with a small semicircular notch at the base, but is damaged. The dagger blade (Fig. 22 left) is not type determinate. Flat flaked flint artifacts continue to occur until the end of Bronze Age Period II according to Rasmussen (1993), or into Period III according to Rønne (1989).

The material included also a small deposit of carbonized cereal grains recovered by the Hirsch family and identified by G. Jørgensen as six-rowed barley, indeterminate as to whether naked or hulled. In 1978 a glass bead with large hole (Fig. 20: 17) was picked up where it was weathering out of the occupation horizon. It was 7 mm in diameter and 6 mm long of matt, translucent, bottle-green glass. Unfortunately it is not much help for dating, as glass beads occur sporadically in Denmark through most of the Bronze Age (Thrane 1963, list note 29; Jensen 1965, 70-71). However Late Bronze Age beads are usually opaque and often cobalt blue, which gives some marginal support to an Early Bronze Age dating.

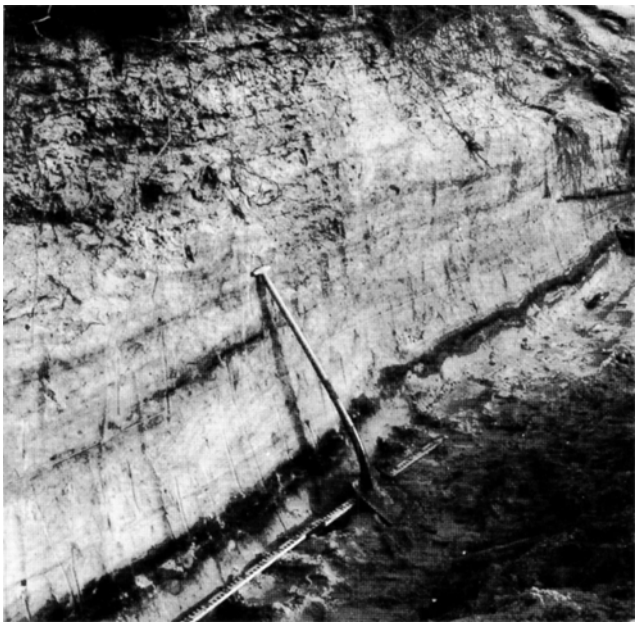

Fig. 19. View of the find layer at Lyngby North, 1978.

Fig. 20: 18 is a strange chalk pendant or amulet with grooved point which could have been meant to take a suspension cord.

Other sites

The realization that even the smallest sign of human activity was important for understanding the pattern of land use only came at a late stage of the investigation. Three minor sites have been omitted from the above survey. One was wind-blasted sherds from a refilled blowout found by the author, another was pottery found by Klaus Hirsch at a place that could not be relocated for closer study (it may have been buried by moving sand), and the last was a site discovered by Kersten Hirsch and later excavated for a few hours, showing that it was connected with a small undisturbed part of a well-consolidated original surface. These three sites all show localised small-scale settlement, but their close dating is problematical because the pottery seems to have been lost in the changes taking place at the National Museum. It was however identified as Bronze Age when it was found.

RESULTS

Development of pottery

One of the uses of the investigations has been the study it made possible of the changes in domestic pottery over seven or eight centuries in a small area, perhaps all of it made by the same local community. In Bronze Age Denmark pottery style seems to have been a matter of habit more than of deliberate choice, and was not used to emphasise cultural identity or show awareness of the passage of time as much as in some other periods. The result is that the pottery of different parts of the Bronze Age is rather much alike, and the features, which make chronological differentiation possible, are not particularly obvious, though they do exist. It should be added that our sequence is local or possibly regional, and without further study it would not be possible to say which features were of supraregional importance for dating.

The Bronze Age began with very coarse ceramics in Egehøj style, representing the nadir of Danish prehistoric potting. This style is represented in the dune transect at a site at Gjævhul, which will be dealt with elsewhere.

Some time in the Older Bronze Age a revolution took place in potting style and technology, and a new kind of pottery appeared. The Late Neolithic "beaker" and "bucket" tradition and fondness for cordons under the rim gave way to a style characterized by a more varied repertory of jars and bowls, which were more carefully shaped out of better prepared clay.

An early stage of the new style is seen at the site Lyngby North. One of the characteristic features was a fondness for flowing forms. The profiles recall shapes found in dated EBA contexts at Ordrup in NW Zealand (Rønne 1989, Fig.2: 1, 3, 4), and Lusehøj on Funen (Thrane 1964, Figs. 55f, 61c, 64a). Some of the features characterizing LBA pottery begin here, like the unartistic roughening of the surface by stroking, brushing, scraping etc. seen in Fig. 23. In M. Rasmussens dating system for pottery of the Early Bronze Age (1993) Stenbjerg North would be placed in phase 4, the Oxholm phase, but it is difficult to make satisfactory comparisons so long as no Oxholm site is properly illustrated. This change in potting may well have

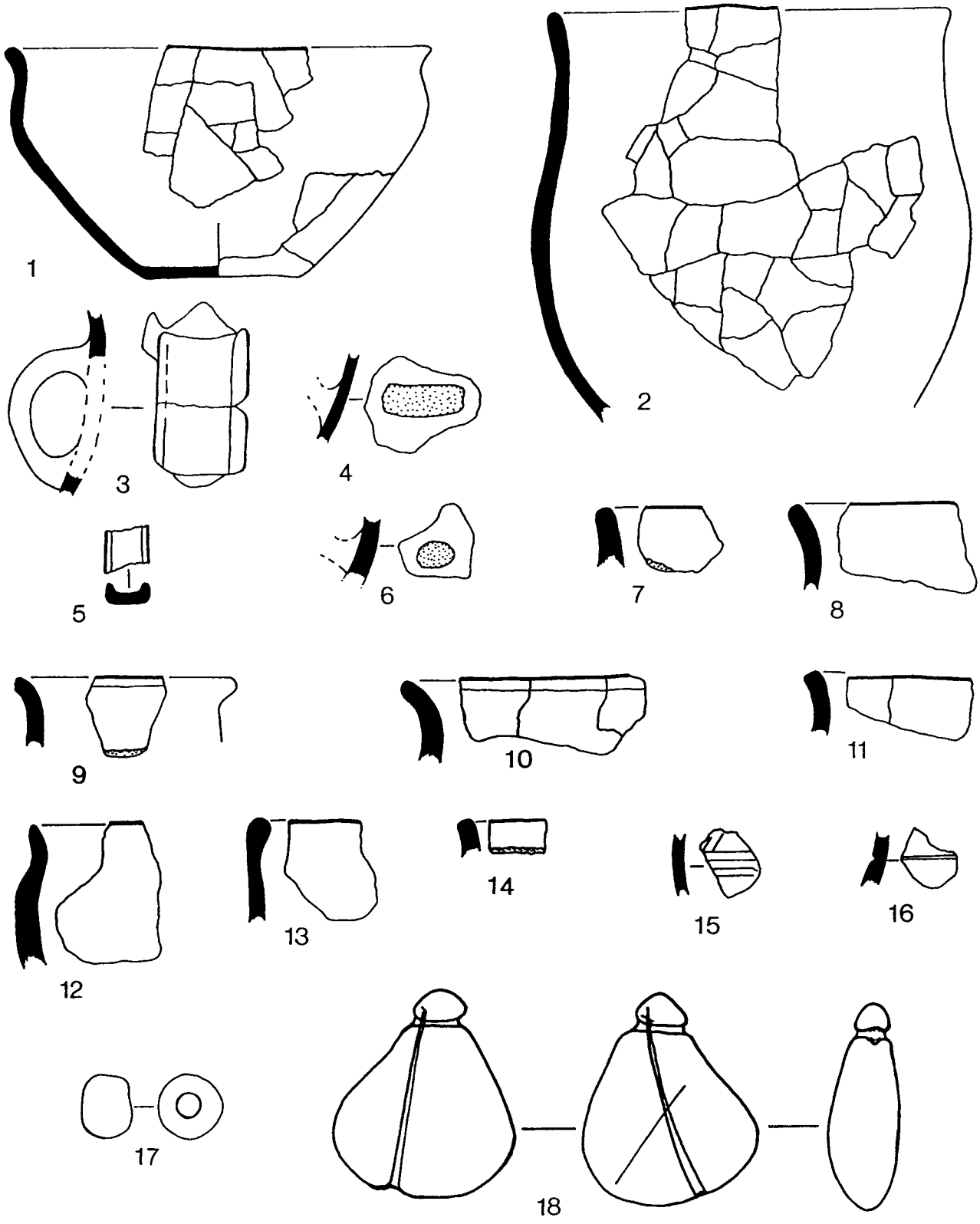

Fig. 20. Pottery from Lyngby North. 1-16 scale 1:3; 17-18 natural size.

Fig. 21. Pottery decoration at Lyngby North.

Fig. 22. Flint arrowhead and part of dagger from Lyngby North.

signalled a profounder realignment of society at this stage (see Vandkilde 1996, *passim*).

Period IV is represented in our material by the "Middle" site, where two large similar but not identical assemblages were found. It is difficult to accept the radiometric datings, which separate the two occurrences far too much for two sites with such similar pottery. Bowls were more numerous than jars, and had as most characteristic feature a sharp carination recalling that of the so called "bicone" urns. Fine ware makes its first appearance at this stage. It took the form of small, thin-walled vessels of smooth blackish ware and was not at all common. Jørgen Jensen (1966) has shown that the carinated form was particularly characteristic of Period IV.

Chronologically the next settlement was the one called Stenbjerg North, which may be assigned to Period V. The fine blackish ware continued, but a second fine ware was added in the form of somewhat larger bowls of a fine brown ware with a characteristic decoration of neatly incised horizontal lines and chevrons. Similar fine decorated ware was found in period V contexts at Fragtrup in Jutland and Voldtofte on Funen. (Draiby 1985, Pl. III, 1,2,4,5; Jensen 1967, Fig. 5, 1,3,4), which date it. Fine black ware was in use throughout the LBA, but the fine, incised, brown ware in our material occurs only at Stenbjerg North. At this site, in contrast to the "Middle" site jars were commoner than bowls, but the question whether this was a general stylistic trait or only showed that different economic activities were carried out at the sites in question must remain open. The jars often had conical necks, sometimes tall ones. A common way of smoothing the rim resulted in an internal facet, and a certain tendency to thicken the rim is also met at this stage.

The next stage, represented by the midden at Bodbjerg, can be assigned to Period VI. It is found that the internally facetted rim has been abandoned and there is now a stronger tendency to evert the rim; as this trait cannot easily be combined with the conical neck, the latter fell increasingly out of fashion. The range of forms became more varied, with new kinds of bowls not seen earlier, but not the carinated Period IV form. There are now new bucket and barrel shaped forms, some with a cordon a few centimetres below the rim separating a roughed body from a smooth rim. This is a characteristic trait of period VI pottery (Jensen 1967).

The everted rim led on to the pottery of the Pre-Roman Iron Age, when a curved profile with outbent

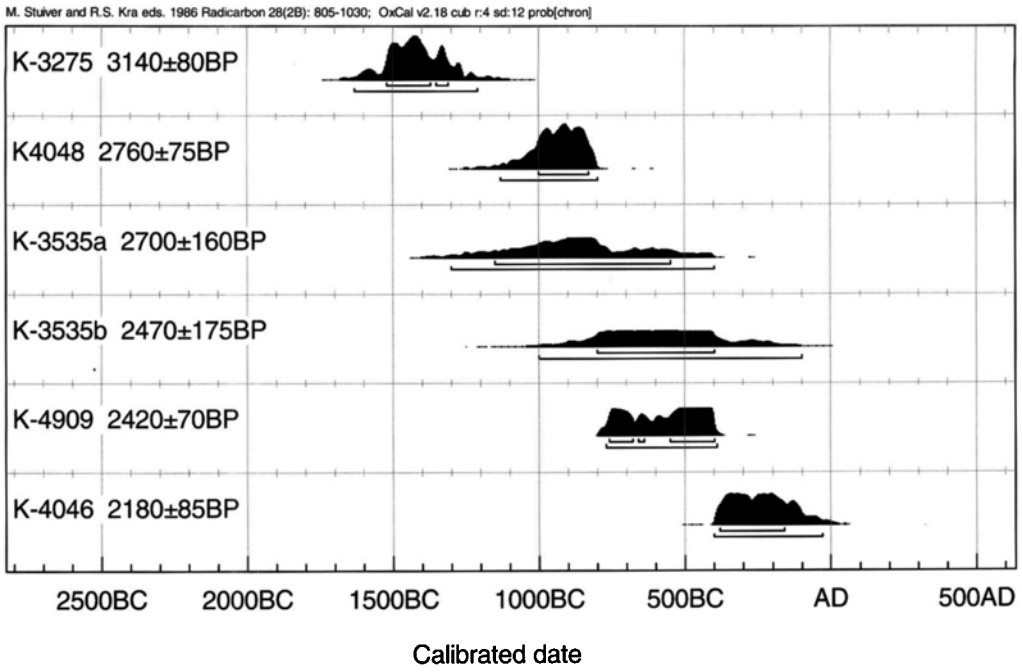

Fig. 23. Overview of relevant radiocarbon dates calibrated as probability areas according to Stuiver *et al.* (1993) using the OxCal calibration program. K-3275 = "Middle Site B", charcoal from midden; K-4048 = "MiddleSite C", charcoal from bottom of midden; K-3635a-b = Bodbjerg, two separate charcoal streaks at bottom of midden; K-4909 = Stenbjerg North, twigs in peat sealing plough layer; K-4046 = "Summerhouse Site", humus from uncultivated surface outside field.

or upbent rim above a now more rounded shoulder than before became almost universal. There is a continuous development in pottery style from the LBA to the early Pre-Roman Iron Age, and this suggests cultural continuity in a wider sense. The jar/bowl dichotomy continued, but the forms were more standardised in the Iron than the Bronze Age. Despite certain changes of potting technology the continuity is quite clear in the broader perspective.

It is hoped that this presentation will be of some use to practical archaeologists in the field. It is primarily a local sequence, and no doubt other regions had some individual features of their own.

Pattern of Settlement

In Denmark forty years ago Bronze Age settlements were a rarity and dwelling structures virtually unknown. This invited the hypothesis that the Bronze Age inhabitants led a fleeting, nomadic type of existence leaving little archaeological trace except for graves and hoards. Opinions changed rapidly in the 60's when new excavation techniques began turning up post-built long houses from the Bronze Age not greatly different from those of the Iron Age, but not quite so solid and fewer in number (Becker 1968, 1972, 1980; Thrane 1985; J. Jensen 1988).

The new archaeological evidence seemed to show hamlets with the plans of several houses close together. Further research however showed that the house plans sometimes overlapped and the buildings were often consecutive rather than contemporary, so that what might at first seem to be a hamlet of several dwellings could on the sum of the evidence be seen as different constructional phases of the same isolated farmstead. Settlement was therefore stationary for even longer than at first supposed. On occasion there is evidence that different buildings stood at the same time, as at Højgård in south Jutland (Ethelberg 1987;

1993) or Vadgård South (Rasmussen 1995), but this only confirmed that Bronze Age settlement was not shifting or nomadic, but was characterised by a high degree of locational continuity.

Some interesting observations on settlement structure have been made by Mikkelsen (1996), based on a pipeline transect excavation, especially the part of it along the Ås ridge in eastern Thy, and they confirm points made earlier by the present author (see below). It was found that stretches of line with posthole structures and Bronze Age pottery alternated with longer stretches where no Bronze Age material was found at all. Mikkelsen's Fig. 3 shows four stippled areas on the Ås ridge with smallest short dimension about 150 m and largest large dimension about 500 m. The criteria allowing an area to be shown as stippled are not fully explained. We assume that they were areas in which thinly scattered Bronze Age pottery and/or postholes occurred, but it is unclear how reliably such areas could be determined in the field and by what methods. Mikkelsen suggested that each settlement lay in a larger territory measuring 1 to 1½ square km, which is described sometimes as a "resource area" and sometimes a little confusingly also as a "settlement area". These outer territories are regarded as being the grazing land of the community they surrounded and to which they presumably belonged. The inner settlement areas made up less than 10% of each total territory. Mikkelsen reports that altogether thirteen Bronze Age settlement areas were struck along the full 23 km of pipeline.

The studies along the coast also led to the conclusion that there existed areas up to a very few hundred meters across with scattered pottery, and in small parts of them house remains and abundant pottery, surrounded by much larger, archaeologically sterile "outer" territory. (Liversage *et al.* 1987, 79ff.; Liversage 1993, 31ff.). Settlement was thinner in the dune belt and the individual settlement areas in shorter use than on the Ås Ridge, but in both areas the overall land use pattern was the same. There were inner territories, which were directly inhabited, and outer territory, which was not. Researches along the coast have given the added the information that the inner territories were ploughed and indeed kept under cultivation for periods measureable at least in decades. The outer territory must have been used for grazing, and provided whatever other resources might be obtained from heath, rough pasture, scrub, and woodland. This model can provide a starting point for further analysis of land use in the Bronze Age.

But first it should be noted that quite different conclusions were reached by another school that tried to approach the question from the point of view of soil fertility, unfortunately without collaborating with experts in the subject. Poulsen (1980) based a model on the principle that land could not be cultivated for more than "a couple" of years without long fallow, and that Bronze Age land use was therefore extensive rather than intensive. Hedeager & Kristiansen (1988) saw the Bronze age as a long period of deterioration caused by over-cropping and over-grazing under a system of shifting clearance farming, leading to crisis and restructuring of the productive system at B.C. 500.

Unfortunately it is a basic misunderstanding that land could only be cultivated for short periods. In reality settlement areas became not depleted, but nutrient enriched, which is the reason why phosphate mapping can be one of the best ways of finding ancient settlements (Tesch 1980). Long-term continuous cropping was quite possible when properly combined with manuring. This is backed up by written historical fact. According to Christian V's tax survey (1688) a method of cultivation was practised in several parts of Denmark called *alsæde.* Alsæde land lay close to the villages and was cropped continuously without ever being fallowed (Begtrup 1808-12; Frandsen 1983). It was copiously manured and a certain amount of crop rotation was practised on it. In a parallel system found in parts of Holland and NW Germany the continuously cropped land close to the village was called *Esch* or *ess* and the manure is specifically described as sods that had served already as litter in the byres. Continuous cultivation of the "infield" is also recorded in Scotland, where the occasionally cultivated "outfield" and the permanently cultivated "infield" were contrasted with one another. Yet another version was Norwegian *reitbruk* (see Kulturhistorisk Leksikon for Nordisk Middelalder), which again was an agricultural system involving enclosed, continuously cropped land close to the houses in historical times. The question of soil exhaustion in archaeological context is also discussed by J. Lüning (1980), whose conclusions were similar. There is no doubt, with all re-

spect to Poulsen and Kristiansen, that continuous cropping was widely practised in our part of Europe in early times, and the recent infield systems probably had roots going far back in prehistory.

An interesting point is that when "alsæde" at the turn of the 18th and 19th centuries was ceasing to be regarded as an appropriate farming method, it was criticized not for exhausting the soil, but for encouraging excessive weed growth (Knud Aagaard 1802). The longer land remains in cultivation, the more species of weeds will establish themselves (Groenman-van Waateringe 1979), and we should seriously consider that what mobility we find in prehistoric agriculture may have been a result not of soil depletion but of fleeing from too rich a weed flora in old fields.

However manuring was certainly necessary, and there is no reason why crop rotations of various kinds could not also have been practised in combination with it, though there is no archaeological evidence. Manure must have been plentiful in the Bronze Age. The proportionally large outfield, which on pollen analytical evidence was largely deforested, implies that grazing land was plentiful and large herds of livestock could be supported. It is hard to follow Hedeager & Kristiansen's view that manuring was something that began suddenly in the early part of the Iron Age, when the first earthfast stall partitions appear. They envisage that manure was taken manually from the byres to the fields, but this seems intrinsically unlikely, as there was a much easier way of getting it there. Furthermore the appearance of earthfast stalls in the long houses was hardly so revolutionary, for cattle can be brought indoors without stall partitions at all, or without partitions inserted deeply enough to be detected in archaeological excavations. Nor do stalls, when they do appear, really establish that full winter stalling took place, which is the supposed background for the whole theory of manual spreading. The most obvious other way to use the byre would be for bringing the stock in at night. Winter nights are long and cold, and mortality in the herd could no doubt be substantially reduced this way. The indoor wintering hypothesis was a hasty over-interpretation originated by Hatt, and a variety of objections and alternatives have been proposed by Liversage (1980, 128).

The application of manure where and when it was needed would of course be a matter of farming technology, and we may suppose that the inhabitants knew what methods were the most suitable; but cattle have only to be penned or tethered in the fields for a few hours daily and manure will appear spontaneously, so to speak, and indeed be trampled into the ground. Begtrup was concerned that manure should be ploughed in and not be allowed to *bortdunstre* on the surface! We may suppose that the stock grazed in the rough pasture and woods of the outer territory for a good part of the day, probably under surveillance, but at some point were brought into the fields or byres. As plenty of outfield grazing was available, we may suppose it was no problem to keep herds large enough to provide in this way the full amount of manure needed to keep the infield in semi-permanent use. A necessary precondition would of course be that the pastures were properly looked after and not impoverished by overgrazing.

This is another question. We may suppose the people had the knowledge necessary to maintain their grazing land; but to be able to do so society had to function well and be able to enforce the rules. Hedeager and Kristiansen's proposed degradation of the rough pasture, if and when it came, should be seen as a socio-political rather than a purely economic or technical problem. The Bronze and Pre-Roman Iron Ages in Denmark were in reality one continuous upward trajectory of success. If there really was a crisis resulting from deterioration of the grazing and arable land along the lines proposed by these authors, it ought rather to be connected with a possible population maximum in the Roman Iron Age, when there is indeed evidence of a slow crisis with a profound restructuring of the agricultural system to follow (Liversage 1977).

In all events as far as the Bronze and pre-Roman Iron Ages are concerned the model which best suits the evidence is that long-term infield cultivation was made possible by the possession of large herds of livestock, which grazed in the outfield and brought nutrients back to the infield. The system gave a fine ecological balance and one would think could have lasted much longer. It may have been destroyed by its own success in the form of the population growth it provided the conditions for.

This brings us to a different question. It has often been observed that the houses stood in the cultivated

areas (J.Aa Jensen 1974; Draiby 1985; Boas 1993; further cases summarised by Liversage 1980, 127). We will now briefly turn our attention to the cultivated areas, but in a different perspective. The remains of prehistoric fields were once common in the Jutland heaths as systems of surviving low banks, but nearly all have by now been ploughed up. G. Hatt saved some of the last from oblivion by survey and excavation (Hatt 1949). In this country one of the most remarkable discoveries of the second half of the twentieth century has been that patterns of colour caused by the transport by the wind of dust from the fields surfaces to their surrounding hedges often survive and are visible from the air. They are apparently very resistant to destruction even by modern farming and they must be what remains of the "infields" of prehistoric times.

The history of research into prehistoric fields in Denmark after Hatt is quickly told. In 1963 N.R. Jeansson published a list of 54 sites in Himmerland (Jeansson 1963). Further studies by Newcomb increased the number in Himmerland to 480 sure and further uncertain cases of field systems (Newcomb 1971). Some more occurrences were described by Sørensen (1973), who later published a distribution map of field systems visible from the air in Vendsyssel, giving detailed plans of three of them (Sørensen 1982).

Thus the basic facts about the visibility of old field systems from the air in Himmerland and Vendsyssel have been known since 1971 and 1982 respectively, but have not been followed up (renewed interest was shown very recently by J.N. Nielsen, 1998). This contrasts with for instance Holland, where detailed maps of all the known systems were published more than twenty years ago (Brongers 1976). Considering how important field systems are for understanding settlement patterns and land use, it is astonishing that so little has been done to follow older research up. This is all the more deplorable as they are a monument type under continual threat from farming and wind erosion, and the least one could expect in a country supposedly proud of its archaeology would be that an effort was made to find out how important they are as a historical source, and how fast they are really being destroyed. One would suppose they contain an enormous potential for further insights into the development of the cultural landscape.

CHRONOLOGY

The probability areas of the six radiocarbon dates from the sites dealt with in this paper are given in Fig. 23. They show what a radiocarbon date really means and imply that a larger number of datings would be needed to give a dependable fine chronology. This is a general fact with ^{14}C datings. Beware of short series!

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Food Remains from the Gut of the Huldremose Bog Body

by Timothy G. Holden

INTRODUCTION

The Huldremose body was recovered from a peat bog at Ramten, Djursland, Denmark in 1879. Although it has never been subject to conservation methods, over the years it has gradually dried out and apparently stabilised. An initial radiocarbon date of 1920±100 bp (K-1396, uncalibrated) based on samples of textile associated with the body was in good agreement with a more recent one from body tissue (1910±110 bp uncalibrated, OxA 2826). However, there are evidently problems associated with the pre-treatment of the samples for dating purposes and an earlier date in the pre-Roman period, as suggested by the textile technology, remains a possibility (Brothwell, Liversage & Gottlieb 1990).

Detailed studies of the body have been made by Liversage (1982), and Brothwell, Liversage and Gottlieb (1990) who reported a number of interesting observations. Despite the lacerations to her legs, amputation of one of her arms and injuries to her hands at, or close to, the time of death, the condition of the body is remarkable. The abdomen and chest had not collapsed onto the vertebral column as in many of the other bog bodies, and there was therefore a strong possibility that areas of gut had also remained intact. In view of this, arrangements were made for the body to undergo a C.T. (Computed Tomography) scan. With the aid of this equipment it was possible to identify accurately the position of the remaining gut material in the body which showed up as a dense area in the lower abdomen. In consultation with the conservation department at the Nationalmuseet, Copenhagen, it was decided that it would be possible to sample the dense area with minimal damage to the body and approximately two grams of material were later extracted for analysis. A detailed report of the location and extraction of the samples is presented in more detail by Brothwell *et al.* (1990).

THE ANALYSIS OF THE FOOD DEBRIS

Two samples of food debris from the gut, weighing 0.35 and 0.95 grams, were taken for analysis. The desiccated samples were then rehydrated using an 0.5% aqueous solution of trisodium phosphate. This method is routinely used in the analysis of desiccated human coprolites (see, for example, Callen & Cameron 1960 and Holden 1990; 1994). The resultant wet organic material was then sieved and all identifiable remains in the greater than 0.5 mm fraction separated for analysis and quantification. The remaining fraction of less than 0.5 mm was scanned in detail and any identifiable elements not encountered in the larger fraction removed. Four main categories of material were removed:

a) *Cereal debris* - This consisted of cereal bran (i.e. testa and fragments of pericarp). Where the pericarp had survived in a reasonable condition clearly defined thickenings could be observed in the end cell walls of transverse cell layer. These thickenings are indicative of rye (*Secale cereale* - see Fig. 1 and Winton & Winton 1932; Dickson 1987). Preservation of the bran was, however, such that the

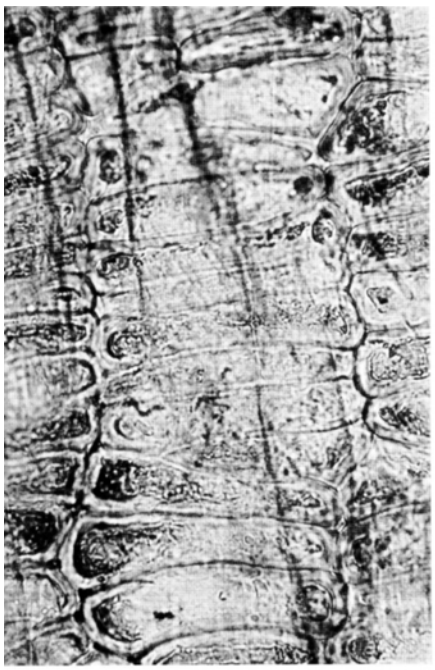
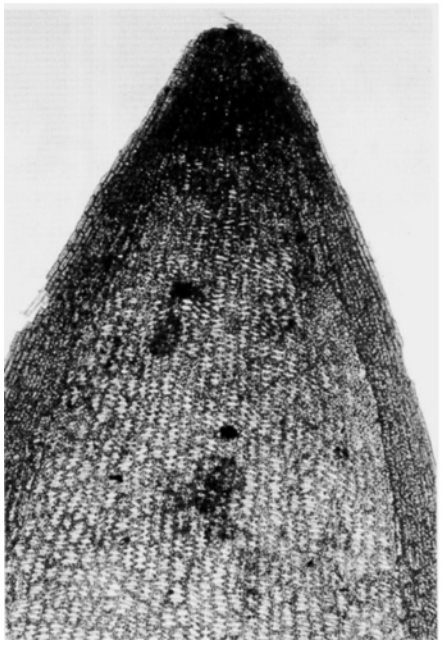


Fig. 1. The transverse cell layer of the pericarp of rye x 325.

fig. 2. The cell patterns of the testa of corn spurrey x 325.



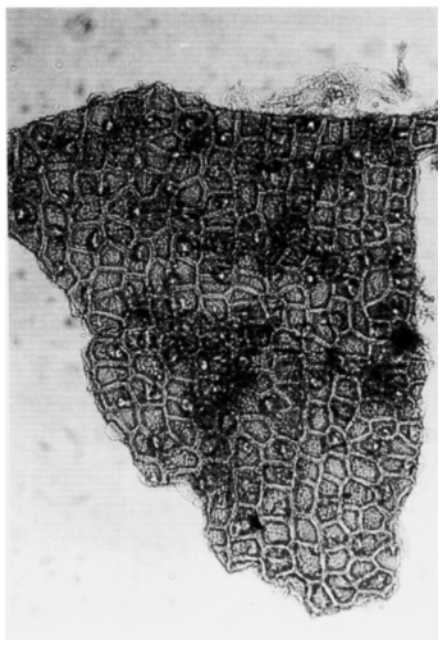


Fig. 3. One of the capsule teeth of the corn spurrey x 50.

Fig. 4. The testa of *Camelina* cf. *sativa* (gold of pleasure) x 85.

distinctive cells of the pericarp did not always survive and in these cases they could not be distinguished from wheat (*Triticum* sp.) which is anatomically very similar.

b) *Weed seed component* (used here to include items which are strictly speaking fruits as well as seeds) - This was overwhelmingly dominated by the testa fragments of corn spurrey (*Spergula arvensis*) although other species were also present (Table 1). These were identified on the basis of their gross

Species	English name	Plant part	Sample 1 **0.35 g**	**Sample 2** 0.95 g
Camelina sativa (L.)Crantz	gold of pleasure	testa fragment	+	
		siliqua fragment	+	
Spergula arvensis L.	corn spurrey	testa fragment	++++	++++
		seed without testa	+++(26)	+++(68)
		calyx teeth	+++	+++
		capsule base	++	++
		stem/axil	++++	++++
Polygonum cf. lapathifolium	pale persicaria	nutlet	+(2)	
		nutlet fragments	+	++
Fagus sp.	beech	wood fragment	+	
Dicotyledonindet.		leaf fragments	+	+
Secale cereale L.	rye	testa fragments	++	++
Setaria viridis (L.) Beauv.	green bristle grass	floret	+(1)	
Triticum/Secale	wheat/rye	testa fragments	++++	++++
Gramineaeindet.	indeterminate grass	light "chaff"	++	++
Indeterminate		testa fragments	+	
Charcoal fragments			++	++
cf. Animal connective tissue			+	+
Animal hair				+
Mineral fragments			+	+
Key + = rare, ++ = occasional, +++ = common, ++++ = abundant				

Table 1. The composition of the gut samples from the Huldremose Woman

morphology and cellular characteristics. (see Figs. 2 - 3).

c) *Other plant tissues* - This comprised a mixture of dicotyledon stem and capsule fragments (Fig. 3) that matched well with comparative examples of modern corn spurrey. Other fragments of vegetative plant tissue including a small piece of beech wood were also present in much lesser quantities.

d) *Animal and mineral elements* - Trace amounts of animal connective tissue and mineral material were also recovered.

Quantification of the debris

The quantities and state of preservation of most of the debris was such that a four point subjective esti-

mate was considered to be the best method of representing the results. This is presented in Table 1. The fragment size, and the abundance of both the cereal bran (primarily testa) and the corn spurrey seeds from these two samples were, however, such that they could be further quantified on the basis of their dry weights. To this end the greater than 0.5 mm fragments of cereal bran (which for the purposes of quantification was assumed to be rye bran) and corn spurrey seeds which had been consistently picked from the samples were dried, weighed and an attempt made at crudely calculating the equivalent dry weight of undigested food (e.g. Holden 1994).

Values given for the percentage by weight of vegetable fibre in rye grain (i.e. the undigestible part), taken from four different dietary studies (Winton & Winton 1932: 260), give an average value of 1.99%. For the purposes of this project, however, this value is probably too high. It is a notable feature of cereal bran that the outer layers of the pericarp (the longitudinal and transverse cell layers) degrade significantly on passing through the human gut. Few examples of the longitudinal cell layer remain attached to the testa in the Huldremose sample and the transverse cell layer was often considerably reduced. In view of this, the percentage of dietary fibre in rye used for this project has been reduced by approximately a third, to 1.3%. This is, however, probably a conservative estimate of the loss in weight of the fibre component of the grain and this figure may need to be reduced further if more accurate data become available.

Data relating to the dietary fibre component of corn spurrey is not readily available and an estimate of the percentage by weight of the fibre component has had to be made on the basis of other similarly sized seeds. Fat hen (*Chenopodium album*) was given a value of 14.63% fibre by Spinner and Bishop (1950) and Winton & Winton (1932 citing various authors) give values for wild radish (*Raphanus raphanistrum*) – 10.13%, amaranth (*Amaranthus retroflexus*) – 10.92% and various cabbage/mustard species (*Brassica* sp.) between 6.42% and 14.74%. The seeds of fat hen have, however, thick seed coats relative to those of corn spurrey and a value closer to most of the other, similarly sized seeds with thinner testas of 11% would therefore seem to be more suitable. These amended percentage fibre values for rye grain and corn spurrey seed have been used as the basis for conversion factors to give a more reliable estimate of their relative importance in the last meal of the Huldremose woman. The calculation of equivalent weights of undigested food based upon these conversion factors is presented in Table 2.

DISCUSSION

The calculation of equivalent weights of undigested foods indicate that a mixture of approximately 3 parts rye grain (possibly with some wheat) to 1 part corn spurrey seed made up the bulk of the "last meal".

The antiquity of rye in Northern Europe has been a point for discussion for a number of years but there is now evidence for its introduction before the Roman period (Chambers 1989; Chambers & Jones 1984; Van Zeist 1981). Chambers does, however, believe that

Sample	Weight of sample sorted	Species	Weight of identified debris in grams dry weight	Fibre content (approx.)	Conversion factors ($^{100}/_{\text{fibre}}$)	Equivalent weight of undigested food	Equivalent weight of undigested food per gram of gut contents
1	0.35 g	rye	0.004 g	1.3 %	76.9	0.31 g	0.89 g
		corn spurrey	0.011 g	11 %	9.1	0.1 g	0.29 g
2	0.95 g	rye	0.013 g	1.3 %	76.9	1 g	1.05 g
		corn spurrey	0.033 g	11 %	9.1	0.3 g	0.32 g

Table 2. The conversion of the major classes of food debris into equivalent values of undigested food

rye was not of great importance in Denmark and the Low Countries until the early first millennium A.D. If this is the case, the Huldremose sample represents an early find in this area.

In addition to the seeds of corn spurrey, other parts of the plant were also present in the sample including fragments of the capsule and stem. This might imply that parts of the plants had been eaten green although the presence of so many of the black seeds indicate that the plants must have been harvested close to maturity. It would seem more likely that it was the seeds that were the main focus of attention and that the presence of other parts of the plant represent residual unwanted fragments in a poorly cleaned product.

Some ethnohistorical data is available, relating the use of corn spurrey in the past. Salisbury (1961: 246), refers to it being grown and used as human food in the Shetland Isles. From Denmark itself, Steensberg (pers. comm. citing Hansen 1921: 114 in translation) gives an example from the last century from Brejning in West Jutland. In this area the people were poor and the children only had dry bread to eat at school, "the bread was even partly made from Spergula arvensis, because rye was so sparse".

This combination exactly mirrors that represented by the food debris in the Huldremose samples. The relatively large fragments of cereal bran and seed testa suggest that this same combination was probably eaten as gruel or as coarse bread although other preparation techniques such as roasting or crushing of the grain are possible alternatives that might also produce similarly sized fragments.

The example given by Hansen above, not only shows how corn spurrey seed was used but also links it with rye. Corn spurrey is an aggressive competitor on light and lime deficient soils (Watson & Moore 1962: 118) while rye can tolerate low fertility, acidic and dry soils (Jones 1981: 108). These two species will therefore be expected to produce well on similar soils. They may have been growing together, or, possibly in close association such as first year and second year crops in a system of shifting agriculture (see below).

A few fragments of the testa and siliqua of *Camelina* cf. *sativa* (gold of pleasure – Fig. 4) have also been identified from these samples. *C. sativa* has been recovered in quantity from a number of Iron Age sites (eg. Helbæk 1954: 255; Korber-Grohne 1988: 393; van Zeist 1981: 183) and the evidence indicates that it was most likely cultivated in the past for its oil rich seeds. It is also a weed of corn, lucerne and flax fields (Clapham *et al.* 1962). Although it seems likely that these seeds were deliberately included in part of the Huldremose woman's food the small quantities recovered from the samples indicate that they were not an important part of the meal.

It is clear from the reports of Brandt (1950) and Helbæk (1950; 1958) relating to previously discovered bog corpses, and from other reports (eg. Helbæk 1954), that a number of predominantly segetal weed seeds (ie. weeds of crops) played an important part in the domestic economy of Iron Age Denmark. The combination of a cereal component and an abundant weed seed element in the Huldremose samples therefore conforms to an already recognised pattern. Helbæk (1950; 1958) reported that the Grauballe man had eaten a meal in which corn spurrey, pale persicaria/redshank (*Polygonum lapathifolium/persicaria*), black bindweed (*Polygonum convolvulus*) and fat hen together with a number of grass caryopses had made up the weed seed element. The Tollund man (Helbæk 1950), on the other hand, had eaten barley with a substantial amount of corn spurrey, pale persicaria/redshank, fat hen, gold of pleasure, flax (*Linum usitatissimum*) and field pansy (*Viola arvensis*). Finally, the Borremose corpse (Brandt 1950) had been eating corn spurrey, pale persicaria/redshank, and fat hen with the addition of sheep's sorrel (*Rumex acetosella*). No cereal element was noted in this last case. In comparison with these earlier Danish finds, the results presented in this paper are unusual in respect of the lack of diversity in the weed seeds represented. The Huldremose sample contained a substantial weed seed element; this was, however, dominated by the seeds of only one species – corn spurrey.

These seeds must represent more than mere accidental inclusions in the meals of the Grauballe, Tollund, Borremose and Huldremose people. At the very least, they must have been a tolerated component of recognised nutritive value but were, more probably, included deliberately. Steensberg (citing Hansen 1921: 114; 1941: 122 in translation) gives two examples where weed seeds (corn spurrey, common sorrel (*Rumex acetosa*) and black bindweed) were mixed with

cereal grains in order to make bread. More recently, British prisoners reported being fed on pearl barley and cakes of weed seed during the last war (Blythe 1969: 46). Thus, in respect of the Huldremose sample, it is reasonable to suggest that the mixture of rye and corn spurrey represent a deliberate attempt to stretch dwindling supplies of cereal. The literature indicates that there are three ways in which these weed seeds could possibly have been procured for consumption:

a) *Collection from field and other environments* – Helbæk (1958: 114) suggested that these would have been collected from areas of fallow or waste land. "In the poorer districts of Jutland, the land had to lie fallow for long periods, and, arable land being thus restricted, the peasants could not afford to disregard the food value of the wild plants which sprang up on otherwise unproductive land".

b) *Recovered from the waste fraction of crop processing* – Hillman (1986: 102) suggests that both the weed seed component and the cereal chaff fragments are typical elements in the composition of the "waste" fraction from crop processing. This, he comments, could have been saved from the previous year and used as a means of stretching out meagre supplies during years of scarcity in much the same way as Maurizio 1927 (cited by Hillman 1986) recorded ethnographically.

c) *Deliberate cultivation* – As Professor Axel Steensberg has pointed out, (pers. comm. citing Hansen 1939: 75) crops of corn spurrey were grown separately in Denmark even as late as the 1850s. He again translates Hansen (1959: 110) with regard to the a system of shifting agriculture in the area of Kolkær, South of Herning, that "when they had burned the heather and taken one or two crops of rye, they used to sow corn spurrey the next year."

They also grew common sorrel in this way. Unfortunately, however, it is not clear with a number of these references whether the crops were planted with the intention of it being for human or animal consumption. It is probable, however, that distinctions between what was considered to be fit for animal and human food, or what was a fallow field and what was a secondary crop, were not clear cut and must have become further blurred in times of food shortage.

Most probably, all three of these methods of procurement were important during the Iron Age. The presence of certain chaff elements such as those recovered from the Grauballe sample (i.e. even whole spikelets of wheat) would, however, tend to support Hillman's (1986) suggestions in that case. With the Huldremose Woman, however, the case is less clear. The rye/corn spurrey mixture could represent a rye crop that had been heavily infested with corn spurrey which was then consumed before being thoroughly cleaned. The absence of rye chaff and presence of vegetative parts of corn spurrey, on the other hand, imply that the two elements were collected or possibly just processed separately only to be combined during food preparation. In any event all the evidence suggests that the seeds represented deliberate inclusions in her last meal and they must therefore have had some specific significance in the story surrounding her untimely death.

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Hedegård – a rich village and cemetery complex of the Early Iron Age on the Skjern river

An interim report

by Orla Madsen

INTRODUCTION

The Hedegård complex in the parish of Ejstrup in eastern Mid-Jutland is one of the many archaeological sites that were discovered in advance of the construction of Denmark's natural gas network. The site was found during survey work in the summer of 1986, and that part of it which was directly affected by the engineering work was excavated. This involved a strip 450 m long and about 8 m wide running more or less north-south through the complex. The investigation showed that the site comprised a large village of the late pre-Roman and Early Roman Iron Age enclosed by a fence, with a group of contemporary graves to

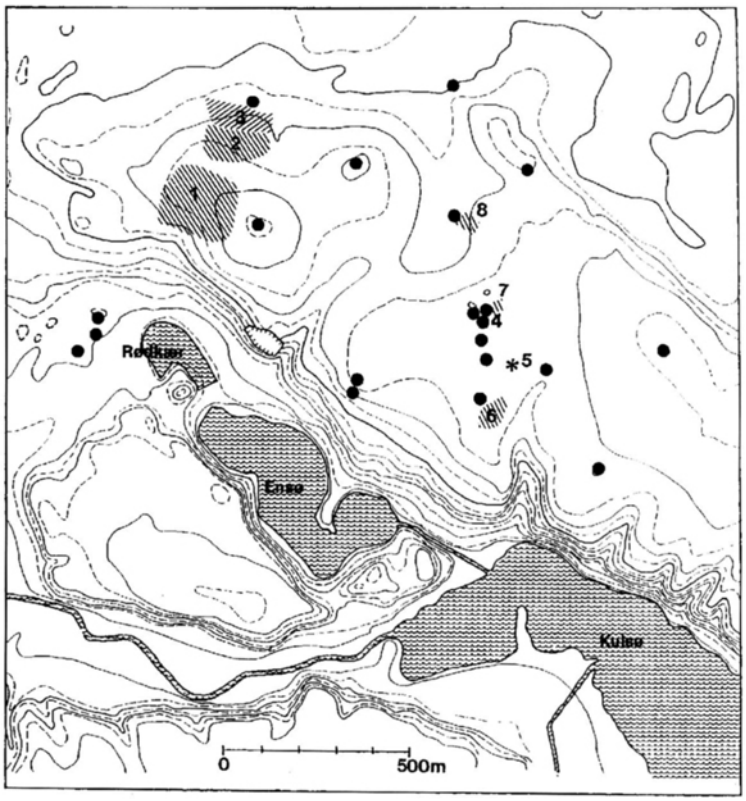


Fig. 1. The Hedegård complex and known Bronze Age and Iron Age sites in the surrounding area. Drawing Ina Holst.

Solid circle - burial mound

1 The Hedegård village from the late Pre-Roman Iron Age/ early Roman Iron Age.
2 The Hedegård cemetery from the late Pre-Roman and early Roman Iron Age.
3 Settlement from the early and late Germanic Iron Age. Extends over 2.
4 The Storhøj/Rønslunde find.
5 Inhumation grave from the late Roman Iron Age
6 Cemetery with small burial mounds from the Pre-Roman Iron Age period I.
7 Cemetery from the late Bronze Age period IV.
8 Pithouses from the late Iron Age/ Viking Age.

Fig. 2. Section through the thick culture layers in the centre of the village area.

the north, several of which were richly furnished (Madsen 1986; 1987).

The investigations continued with funding from Rigsantikvaren and Horsens historiske Museum (j.nr. HOM 151). In 1987 trial trenches were dug in both the village and the cemetery area with a view to establishing something of the extent of the complex, its state of preservation and its archaeological potential. The excavations showed that the cemetery was under particular threat, and that the whole site, to judge by the size and structure of the village and the rich associated burials, would probably be able to contribute important new information about social and settlement structures around the beginning of the Christian era.

From 1989 onwards the excavations therefore proceeded by means of regular area stripping, initially with a view to the complete excavation of the cemetery, which was under severe threat from cultivation. This work was completed in 1993, since when the large quantity of finds have been under conservation and processing with a view to a final publication of the whole cemetery. This, therefore, is an interim report.

TOPOGRAPHY

The Hedegård complex is situated on a relatively high and slightly undulating plateau which is sharply delimited to the south by a steep bank running down to a relatively broad part of the Skjern river valley. Here lie the lakes Ensø and the somewhat overgrown Rødkær as relicts of a presumably once much richer system of rivers and lakes. The Skjern river now runs about a kilometre to the south of the village, but it appears that in dry summers an earlier river course can be discerned immediately below the village site. To the east, west and north the terrain falls gradually to flatter and slightly lower-lying areas. The composition of the natural soil varies from gravel over fine sand to sandy clay.

THE VILLAGE

At the highest point of the plateau, at its southern end, lies the village (Fig. 1). The remains of the village take the form of post holes, fences and pits run-

Fig. 3. The southern section of the fence enclosing the village.

ning over an area of at least 180 m x 200 m which was apparently enclosed on all sides by a massive, post-set fence. During the trial excavation of 1987 an attempt was made to follow the fence right round the village by means of extended trenches. This proved impossible, however, and it was in fact necessary to use the last building plots discovered to define the limits of the village. Its extent to the east and west is therefore uncertain.

To the north, the village is bounded by two fences. The fence furthest north is the stoutest, with a trench 70-80 cm wide and 87 cm deep. In the middle of the trench are traces of vertical, closely spaced posts, each 22 cm in diameter. The other fence trench is only 30 cm wide and 50 cm deep. In the middle of this trench are the remains of posts 20 cm in diameter. These two fences can hardly have been contemporary. Behind the fences there is a large number of post holes from buildings and other large structures, plus a number of pits.

While the northern part of the village area is found immediately underneath the ploughsoil, some sections of the central and southern zones are covered by culture layers up to a metre thick and rich in finds (Fig. 2). These layers, which contain large quantities of slag and pottery, were deposited during the period of occupation. This shows that the village had at least two phases: an earlier phase beneath the layers and a later phase which cut into them.

The southern fence of the village is situated near the steep bank facing Rødkær and the Skjern valley (Fig. 3). Its trench is from 0.7 to 1.2 m wide. During the excavations of 1986 and 1987 the posts within the fence were difficult to distinguish in several places both on the surface and in section. In a long section, however, there were clear traces of closely spaced posts, each 20 cm in diameter and set 60-70 cm deep in the ground (Fig. 4). In the lower, relatively narrow

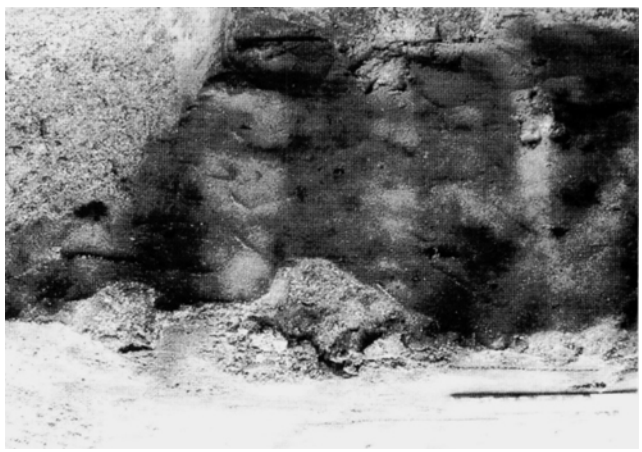


Fig. 4. Longitudinal section through the southern fence.

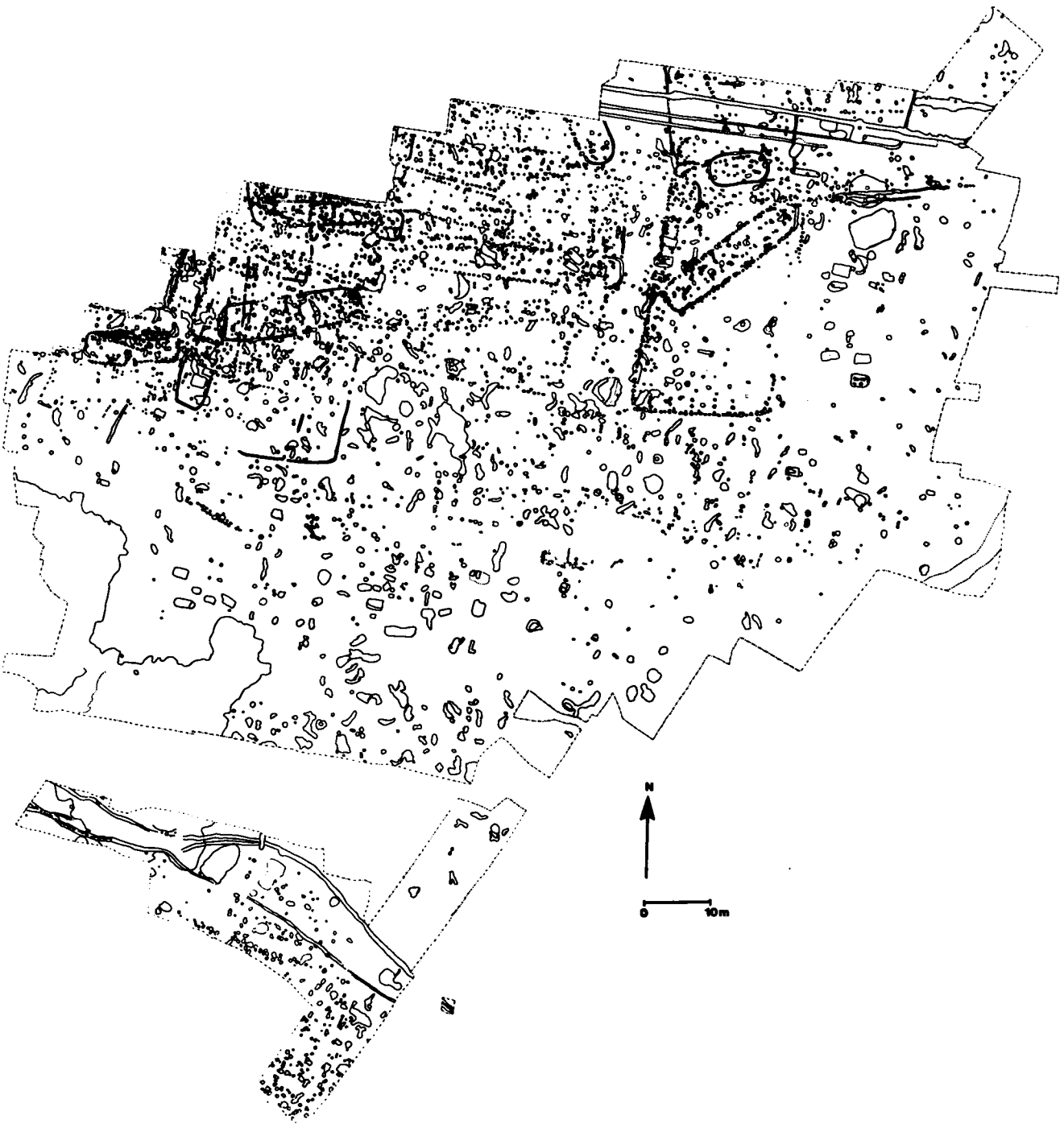


Fig. 5. All the features in the fully excavated cemetery. The many postholes form fences and houses from several phases of a village from the early and late Germanic Iron Age. Furthest to the south, two fences from the settlement contemporary with the cemetery can be seen, and behind these are the postholes and other features from the settlement. Drawing Ina Holst.

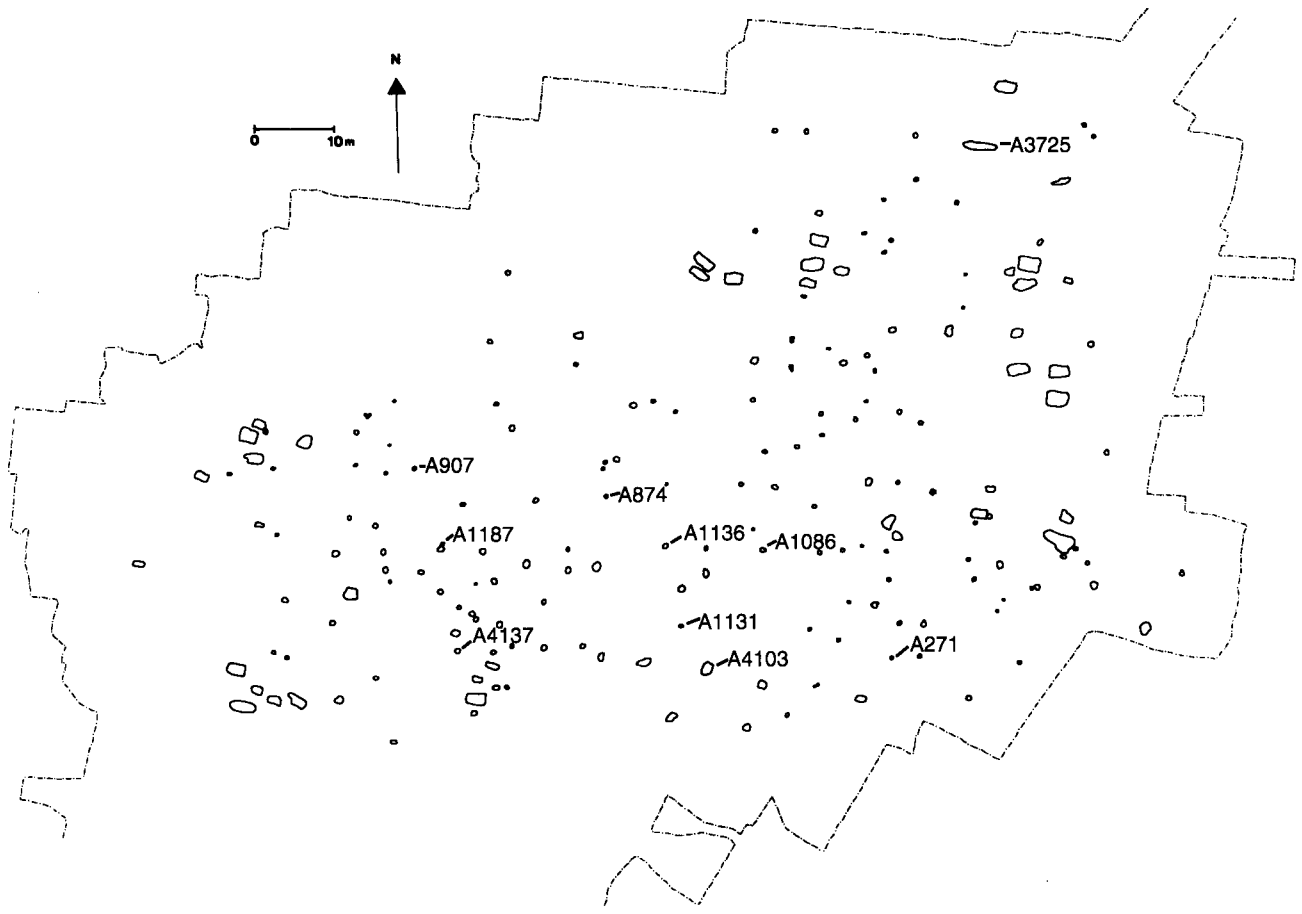


Fig. 6. All the datable graves and grave-related features from the late Pre-Roman and early Roman Iron Ages. Drawing Ina Holst.

area that runs diagonally across the southern part of the village the fence is missing. There appears to have been quite a wide opening here where either the fence did not continue or it was not dug into the ground.

In the middle of the village area beneath the thick culture layers were found two parallel ditches with layers of water-deposited sand and clay (Madsen 1986, 21). These ditches may be directed towards the opening in the fence and thus have served as a drainage system for part of the area. The thick culture layers which may have been used more or less deliberately to regulate the ground level make it very difficult to get an idea of the original ground surface).

In constructional terms, the northernmost fence and the southern one could well be contemporary. More excavation will be needed, however, before this can be proved. There are also settlement remains in the form of post holes and pits behind the southern fence, in many places covered by culture layers 30-40 cm thick.

In 1987, Olfert Voss excavated a well-preserved iron-smelting furnace of the Skovmark type 16 m south of the southern fence (Voss 1989). Whether or not this furnace was an isolated feature is not known, but a plateau south-east of the village fence may have served as a work area for, *inter alia*, iron extraction.

There are also traces of the inhabitants' activities north of the village fences. North-west of the village, and immediately west of the westernmost graves, there is, for instance, a very large pit, dug to a depth of 2 metres. This pit was unquestionably dug for the ex-

Fig. 7. One of the secondary graves during excavation. To the left the frequently occurring stone packing above and around the vessels. To the right the vessel exposed in the pit. Feature seen from the south.

ceptional clay that occurs in this area. It was then refilled with waste which included a great deal of pottery, many fragments of furnaces and forge-stones, and a very large amount of iron-smelting slag.

THE CEMETERY

The cemetery is situated 30-40 m north of the enclosure fence of the village in an area measuring 90 x 120 m that slopes gently to the east (Fig. 5-6). Here there is a mixture of cremations, inhumations, and secondary graves from the same period as the village. Many of the graves have been either entirely or partly destroyed. This is due both to modern cultivation and to a settlement of the Early and Late Germanic Period which is found scattered across the north-western part of the cemetery. The buildings can be dated typologically and by the pottery to the Early and Late Germanic Iron Age. A metal-detector sweep of the excavated areas by Ove Madsen produced a well-preserved bronze beak brooch. In 1992 a N-S inhumation grave A4261 was excavated which also relates to the later settlement. This grave contained a coffin in the form of a halved trough and the following grave gooods: 3 gold-in-glass beads, 2 spindle whorls, 1 bronze ring brooch and 1 iron knife. There remain about 200 more or less well-preserved graves and associated features. The best preservation is found in the eastern part of the cemetery, where the graves are both covered by a layer of blown sand and protected by the soil which has slipped down here over the course of time from the higher western part of the hill.

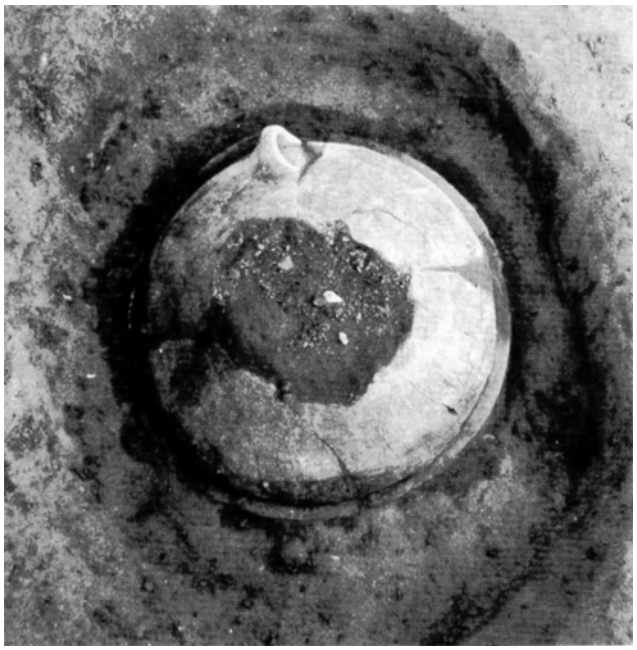


Fig. 8. The pottery dish over the bronze urn in A1136 exposed. Along the northern edge of the dish the rim of the underlying bronze dish can be seen as a lighter stripe.

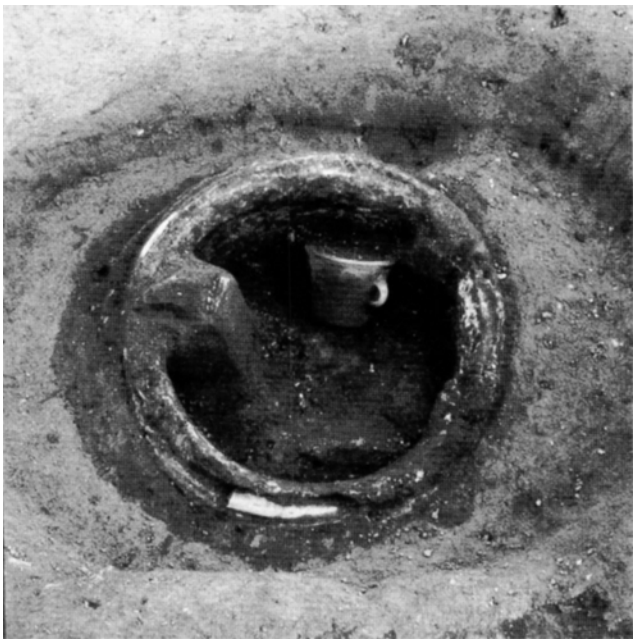


Fig. 9. The bronze dish in A1136 partially exposed and emptied. In the dish the small straight-sided beaker can be seen and amongst the calcined bones, approximately in the centre of the picture, a gold finger ring can be perceived.

The cremations include urned burials, cremation patches and urn-pits, although the former two are clearly predominant. All of the datable cremations can be assigned to an earlier phase of the cemetery, Periods IIIb of the pre-Roman Iron Age and B1 of the Early Roman Period. The datable inhumation burials examined so far are, by contrast, all from Period B2 of the Early Roman Period, especially from the earlier half of the period. Amongst the burials are 18 secondary graves with from one to seven complete pots placed in what is often a stone-lined and stone-capped pit (Fig. 7). These vessels are empty, except for a few that contain small stones. In a small number of cases the secondary graves seem to be associated with individual graves, as has been seen at other cemeteries in East Jutland (Fischer & Jensen 1985, 7), but in the majority of cases they appear not to be linked to any particular grave.

The graves at Hedegård are different in a wide range of ways from what we normally expect of burials of this date. There are, for instance, generally several artefacts in each grave; there are several weapon graves, several graves with precious metal, and generally many more foreign and – according to our archaeological perception of the period – rare or unique objects. It is particularly the earliest graves, the cremations, which display the widest variety of furnishing and wealth. There are also relatively rich inhumation graves (Madsen 1986; 1987), but these lack the outstanding and distinctly foreign artefacts.

Four of the burials at Hedegård stand far apart from the others in terms of furnishing. These four graves were found relatively close together approximately in the middle of the cemetery (Fig. 6), possibly indicating some relationship between those buried there. They share a unique and rich range of grave goods including Roman bronze vessels.

Graves with Roman bronze vessels

Grave A1136

After the removal of the ploughsoil, grave A 1136 appeared as a circular feature of sandy clay with a

light admixture of soil, 60 cm in diameter. A large ceramic urn 48 cm in diameter at the rim had been deposited base upwards to cover the burial urn itself (Fig. 8), a very badly preserved bronze vessel (Fig. 9). This contained the cremated bones of a juvenile, 12 or 13 years old, a finger ring of thin and smooth gold wire, a decorated bronze socket (Fig. 10,2) which is probably the terminal of a knife handle like the better preserved bronze socket from A1086 described below, fragments of a small iron knife (Fig. 10,2), a little powdered silver of unknown provenance, and a small, undecorated, straight-sided beaker (Fig. 10,5). Around the bones and the artefacts there was preserved textile – presumably remains of a garment that the cremated bone and artefacts were wrapped in. Two very long knives had been placed in a V around the foot of the vessel.

The bronze vessel is of Eggers's Type 94, known as an early vessel with a pedestal and a fixed handle with vineleaf-shaped attachments, also known as the Dobbin Type (Eggers 1951) (Fig. 10,1). Vessels of this type are extremely rare in Germania Libera. Eggers counted only three examples in 1951. The specimen which gave its name to the type is a wetland find from Mecklenburg (Asmus 1938, 78, 267). The second find, which lacks the foot, is from the Weddel cemetery near Braunschweig (Willers 1900,121ff.), while Eggers also assigns a profiled pedestal from Jægerspris in northern Sjælland (Liversage 1980, 40) to this type. The latter parallel is uncertain, however, as the pedestal could be from a vessel of a different type. Vessels of the Dobbin Type are Italian products made in Capua between 100 and 50 B.C. or a little later (Kunow 1983, 21, 60 with refs.). The Hedegård grave can hardly be much later. A dating to Period IIIb of the pre-Roman Iron Age is thus probable. This dating is supported by the straight-sided beaker in the grave (Bech 1980,145).

The two large knives by the foot of the vessel are quite identical (Fig. 10,3-4), 45 cm long with a wide, hanging edge, and a strongly marked back and a tang offset from the line of the back. There are signs of bronze rivets on the tang. One of the knives had been covered by a thin layer of bronze which probably comes from the much decayed bronze vessel above it. In spite of their impressive length, these knives are not to be regarded as one-edged swords. They are knives, probably Celtic or in any event typologically influenced by that culture. Similarly outsized knives are known in rich Celtic graves (Jahn 1916, 31; Penninger 1972, plates). In the weapon graves at Hedegård long knives with winged socket occur relatively frequently – presumably some form of slashing weapon. These knives are of a quite different type to those in A1136.

Grave A1131

Grave A1131, which was positioned 6 metres southwest of A1136, appeared as a circular feature of sand with a slight admixture of earth 90 cm in diameter. In the middle of the feature was a large domestic pot face downwards as in A1136 (Fig. 11). This vessel was the bottom, coated section of a large storage jar, the rim of which, 57 cm in diameter, was bevelled in a wavy manner. Beneath the pot was a bronze vessel (Fig. 12) with the burnt bones of a 4- to 5-year-old child and a gold finger ring which is practically identical to that from grave A1136. In this grave too, the contents of the urn were wrapped in textile. Beneath the bronze vessel were the remains of the lining of the grave pit, consisting of well-preserved fern fronds on the inside, surrounded by a cowhide. On the sloping western side of the pit lay the other iron and bronze grave goods.

The bronze vessel is an early straight-sided vessel of Eggers's Type 67 (Eggers 1951). Together with bronze cauldrons with an iron rim (Eggers types 4-8), vessels of this type are the most common types of bronze vessel of the late pre-Roman Iron Age, although some straight-sided vessels are dated to the Early Roman Iron Age (Eggers 1951). An equivalent vessel was found at Try Skole in Vendsyssel (Becker 1958, 54), and three other vessels of this type are known from the rest of Scandinavia. A total of nineteen early straight-sided vessels are known from Germania Libera. Seven of these are from a single cemetery: Körchow in Mecklenburg (Eggers 1951, 114).

The grave goods lying to the west of the urn consisted of several severely damaged bronze and iron artefacts. Amongst the bronze objects one could distinguish, on the basis of the amount of bronze, the melted remains of yet another, smaller bronze vessel. Two very small bronze hooks of unknown function and a heavy bronze ring which had evidently sat up-

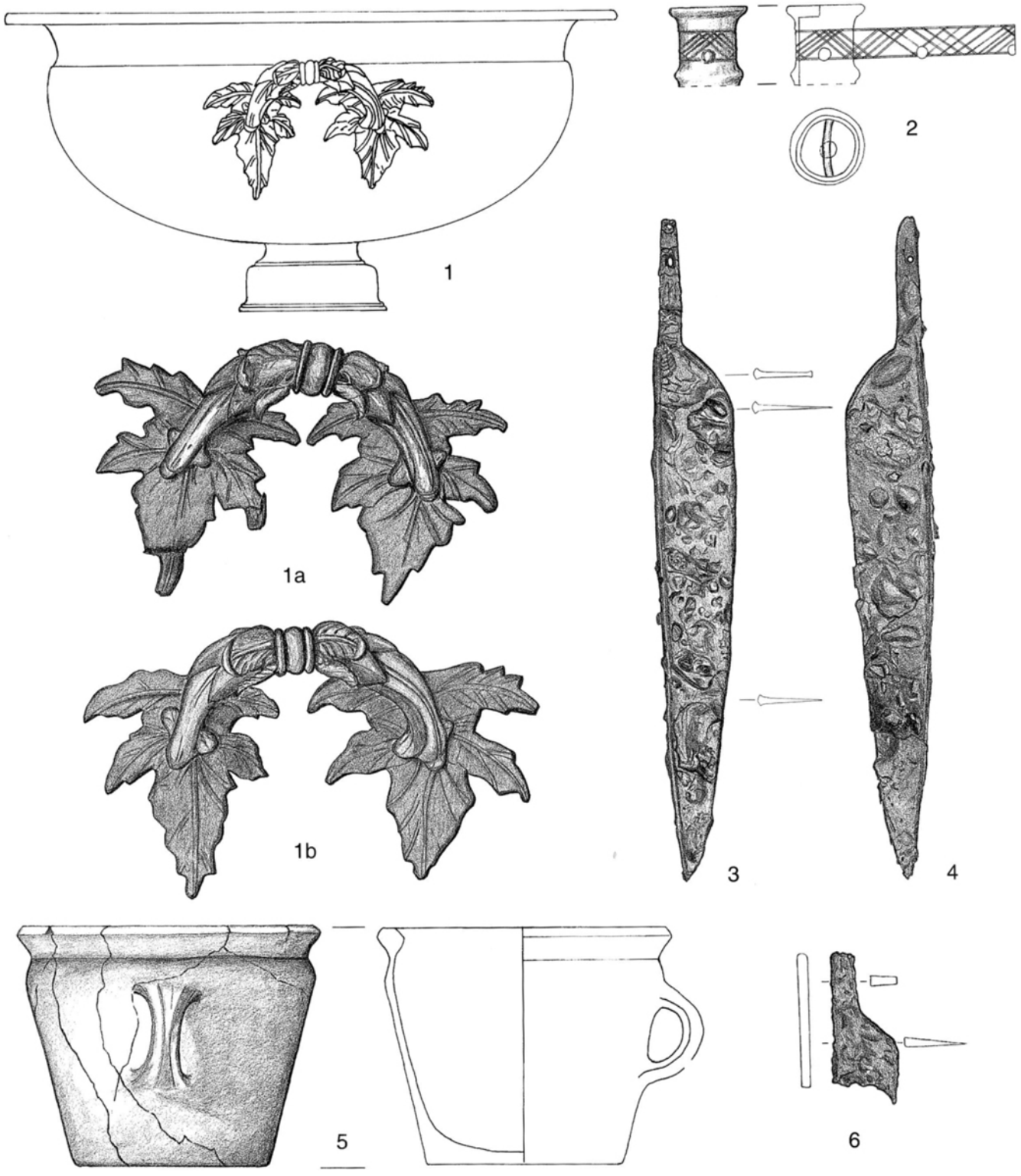


Fig. 10. Grave A1136. 1: Bronze dish (1:4) with detailed drawings of the handles (1:2). 2: Bronze socket with ornamentation (1:2). 3-4: The two long knives found under the bronze dish (1:4). 5: Straight-sided beaker (1:4). 6: Fragment of an iron knife (1:2). Drawing Lizzi Nielsen.

Fig. 11. The large upturned settlement vessel from grave A1131 exposed. Most of the very degraded gravegoods can be seen at the edge of the excavation to the west of the large vessel.

Fig. 12. The pottery vessel has been removed and the bronze dish exposed in grave A1131.

on an object made of thin sheet bronze were also found here (Fig. 13,4). The bronze ring may be part of a bronze vessel but other possibilities cannot be excluded.

Most of the iron objects are practically as difficult to identify as the bronze ones. One indentifiable item, however, is a straight-backed knife with a decorated sheath (Fig. 13,1). The sheath was made of a folded sheet of iron which terminated in a moulded chape. The front of the sheath is decorated with a fine wavy line immediately above the chape. The grave goods also included a pair of shears (Fig. 13,3). The bow of these shears was decorated with four very substantial grooves on the outer side. A great rarity this far north is a spear ferrule (Fig. 13,2). This ferrule was formed of a heavy, composite piece of sheet iron, with a nail running through at the top. Remarkably, the other end of the spear, its head, is absent from the grave goods. While ferrules are extremely rare in Scandinavia, they are little more common in German cemeteries of the late pre-Roman and Early Roman Iron Age, in several cases also without a spearhead (Weski 1982, 13).

The remaining items in grave A1131 have defied identification so far. Apart from one or two small iron ring-brooches, which may have belonged to the costume of the deceased or to some other items, the 'problem' is an iron object (Fig. 13,5). This object, which is now 14-15 cm across, consists of a relatively heavy piece of iron which at the bottom – or the top, depending on which way up it goes – has a cut rectangular plate. In this plate there are six small, regular, paired rectangular notches. Four "legs" run out from the corners of the plate, two long ones curving sharply back to one side, and two slightly shorter ones, less bent than the others. The two long legs terminate in flat hammered heads with a rivet- or nail hole. Some form of nail went through these, to be fastened on

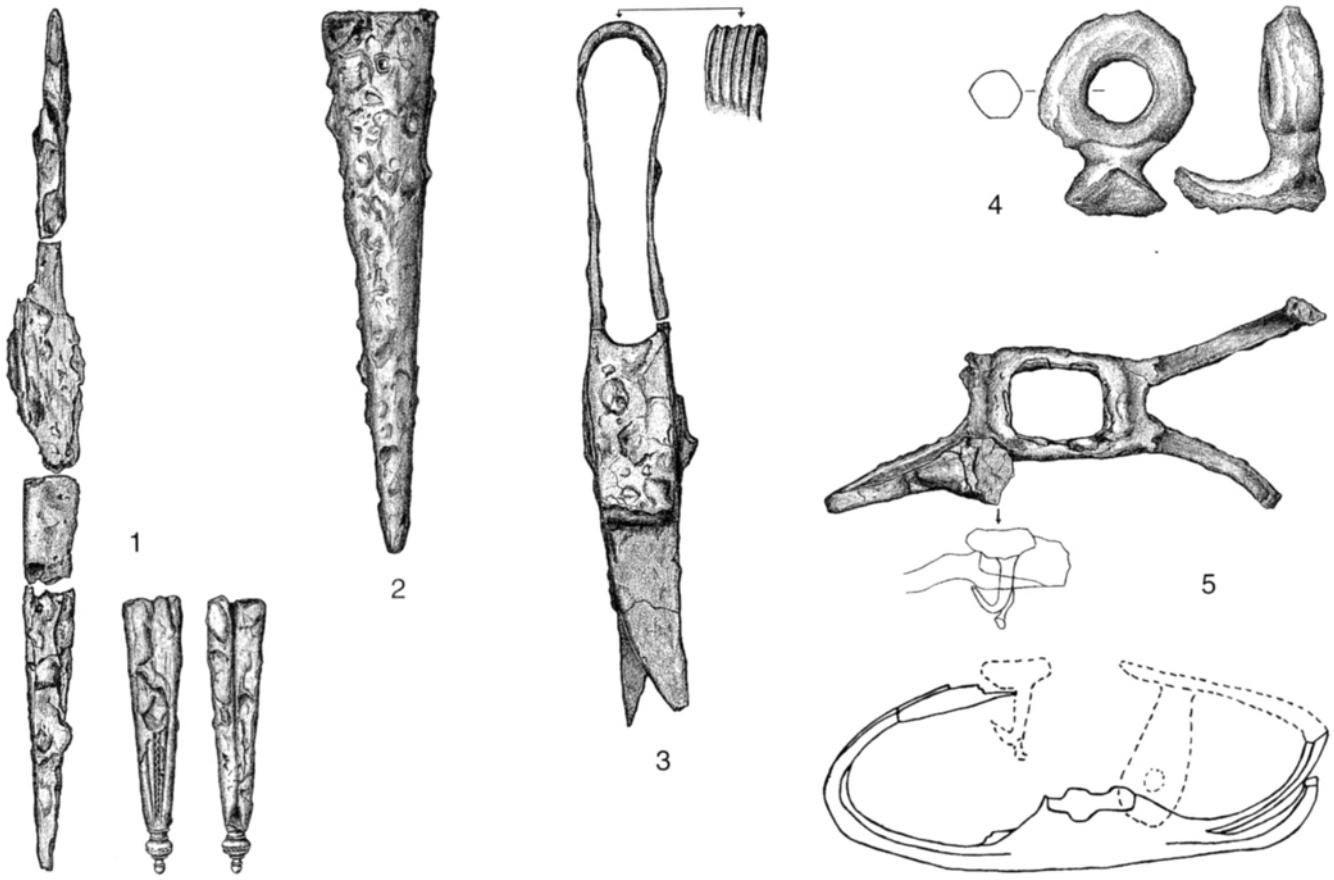


Fig. 13. Grave A1131. 1: Knife and sheat (1:2). 2: Lance socket (1:2). 3: Iron scissors (1:2). 4: Heavy cast bronze ring (1:1). 5: Unidentifiable iron object seen from above as it now appears and drawn from the side from an X-ray photograph (1:2). Drawing Lizzi Nielsen.

the inner side simply by being split into two halves, each of which was bent back on its particular side. These nails passed through another loose, square head, probably to strengthen the thin sheet at the end of the leg. The two other legs were probably shorter and terminate in similar flat, oval heads. Here there is a very strong iron rod with a rivet hole and a bronze nail at one end.

The function and use of this object is a complete mystery. It must be part of some larger item, possibly of wood. But what? A few other pieces of iron with holes and a couple of small iron loops could possibly be parts of the same thing.

Grave A1086

Grave A1086 was positioned about 12 metres east of A 1136. When the soil was removed from over the grave a diffuse feature measuring about 2.5 x 1.5 m was found immediately underneath the ploughsoil (A 840), with a quantity of pieces of melted bronze, a couple of square bronze pieces from the belt described below, a slightly shaped bronze horse head (from the zoomorphic handle described below), a fragment of an iron fibula, a few very small fragments of burnt bone and some charcoal. Immediately to the south-east of this layer, which was 4-10 cm thick, a nearly circular pit 50 cm in diameter appeared. This

Fig. 14. The urn in grave A1086 during excavation.

contained urn-grave A1086 (Fig. 14), where the grave goods described below were found beneath the urn, a large wavy vase, showing that the objects in A840 derived from this burial. Since there is no sign of any disturbance either in or around the urn and the iron and bronze artefacts below it (A1086), it is possible that A840 is the site of the funeral pyre. If this were the case, the melted bronze pieces can be interpreted as items that were overlooked during the burial itself. No features of this kind have been observed beside other graves at this cemetery. Since A 840 was quite well protected in the lower-lying part of the cemetery, however, we cannot reject the possibility that other similar pyre-sites have been removed by cultivation.

The cemetery was swept with a metal detector several times after the excavations. Apart from one shield boss nail, only a Late Germanic Iron-age beak brooch was found. This therefore does not suggest that many pyres were ploughed to bits. It must, however, be noted that the metal artefacts were generally so poorly preserved at this site that ploughing would hardly leave much of any hypothetical metal behind.

The urn in A1086 is a 36 cm high, wavy vase with a markedly thickened, out-turned rim, and a vertical handle with greatly expanded fixing points on the upper side. This vase is undecorated apart from narrow, vertical lustrous gooves on the coated underbody of the vessel leading up from the base to the polished upper body. The vessel was full of burnt bone and the following objects:

1) 2 identical massive gold beads.
2) 1 unravelled, punchmarked, gold spiral bead.
3) 2 nearly identical bronze balls measuring 5 mm (perhaps melted drops).
4) 1 very thin piece of sheet bronze, possibly from the bronze sieve referred to below.
5) 1 unidentifiable piece of sheet bronze with gold- or brass-like plating.

The large vase had been put down upon a large quantity of iron and bronze objects. At the top of this group and virtually surrounding the base of the urn was an iron ring. Beneath this were the other finds, consisting of about 55 pieces which can be reconstructed as the following artefacts:

6) A straight-backed iron knife with a grip socket and a bronze suspension ring.
7) A massive cast bronze belt of square and rectangular plates connected by bronze rivets and with a fastening in the form of a belt hook and ring. In the front of the belt is a free-hanging loose end of gathered rings and acorn-shaped connecting pieces which terminates at the bottom in an almost triangular pendant.
8) Two iron fibulae.
9) An iron sewing needle.
10) An awl-like iron object with a crooked point.
11) The remains of a bronze sieve.
12) Possible remains of another bronze vessel.
13) A fragment of a large translucent green glass bead.
14) An animal-shaped bronze handle.
15) A quantity of unidentifiable heat-distorted bronze fragments.

The majority of the large number of pieces of bronze in A1086 are from the massive cast bronze belt (Fig. 15). The total length of the belt and the exact number of its constistuent parts in both the belt itself and the section that formed its free end hanging down in front

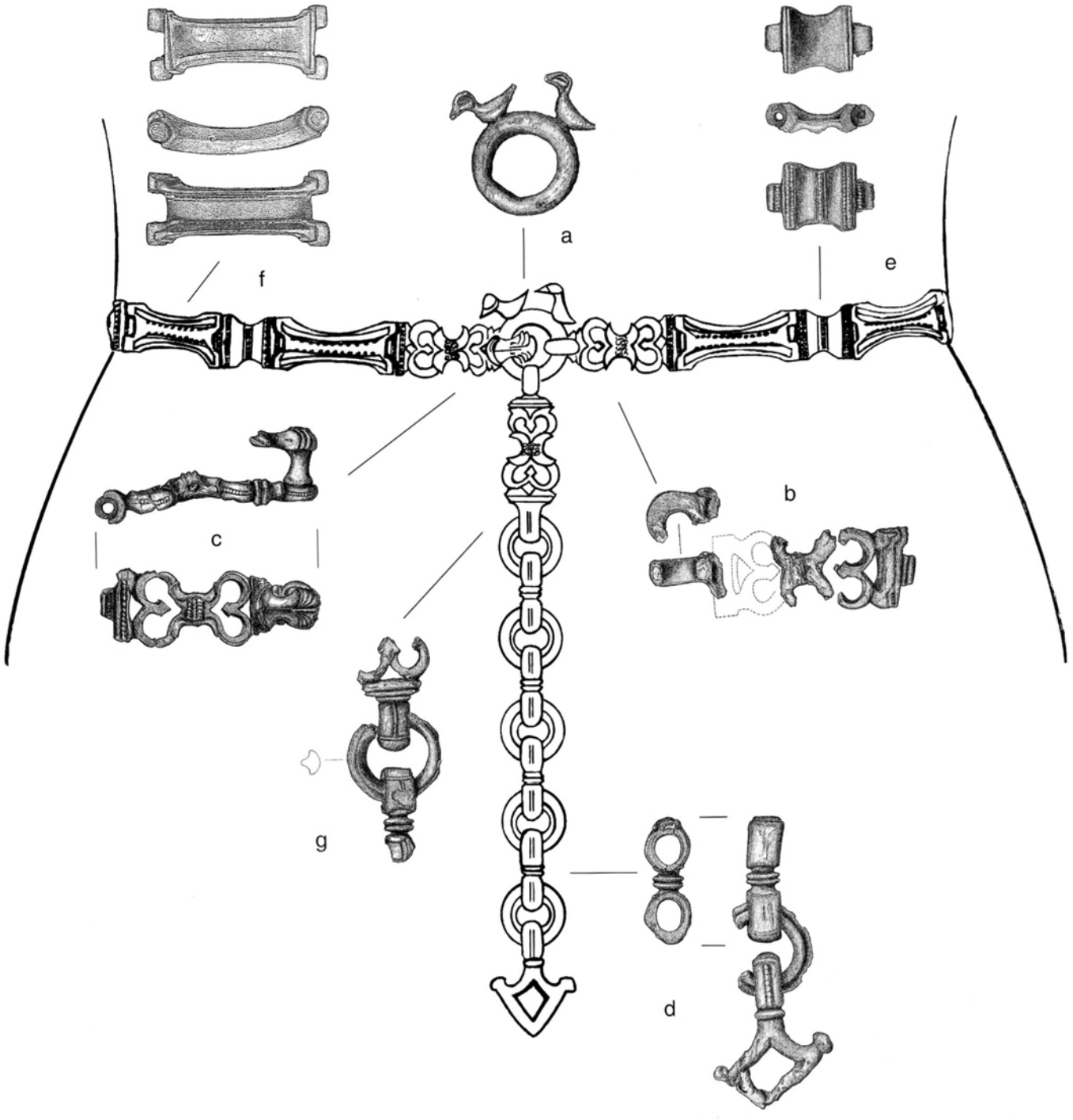


Fig. 15. Drawing of some of the best preserved parts of the bronze belt from grave A1086, together with a reconstruction of the belt. a: belt ring, b: "belt clasp", c: belt hook, d: the free end of the belt together with a reconstruction of the lowermost suspension, e: quadratic bronze link, f: rectangular bronze link. All in 1:2. Drawing Lizzi Nielsen.

cannot be determined because of the effect of the heat on many of the pieces. The belt is closely related to what are known as massive case North-Jutlandic bronze belts (Müller 1900, 130; Werner 1952, 133ff.; Klindt-Jensen 1953, 54ff.; Becker 1958, 49ff.), but it nonetheless differs from the other seven known Danish belts in several respects. The belt is more complex and more detailed in its construction than any previously known specimen. If the belt is compared with the best preserved examples, from Søder Skjoldborg and Karby, and the somewhat more fragmentary specimens from Rævebakken, Try and Oplev, the same basic feature can be seen: namely a metal belt of massive, individually cast, decorated bronze parts, connected by bronze rivets and fastened at the front by a belt ring and belt hooks. The belt hooks are formed more or less naturalistically as animal heads. Down from the belt ring hangs a free end of rings of faceted cross-section, connected by acorn-shaped pieces. The free end on the Hedegård belt terminates in an unfortunately much distorted triangular attachment, while the Søder Skjoldborg belt, for instance, terminates in two or three small bronze chains each with an almost anchor-shaped attachment.

The belt hook on the Hedegård specimen is located on a plate which has been shaped as two opposed hearts in cast openwork. In profile, the plate is slighly curved along its length and has traces of a hole between the two hearts through which a hook or something similar may have been fastened, possibly for the suspension of the knife described below. The belt hook has the shape of an animal or human head with a mass of hair parted in the middle, slightly marked eyes, an obtrusive lower jaw, and a long, concave neck. The head and neck are cast in a separate piece which was subsequently added to the heart-shaped base. The belt hook catches on to the central part of the belt, a heavy bronze ring with two swimming ducks on the upper side. The heart-shaped mounts recur in the three sections that form the central fastening and suspension area. The different state of preservation of the pieces means that there are some uncertainties in the reconstruction of this central area of the belt. While the North-Jutlandic belts previously known evidently consist only of rectangular plates, the Hedegård example consists of both rectangular plates (mostly of the same type as those of the North-Jutlandic belts) and nearly square ones which seem not to be paralleled in any previous finds. As has been observed several times in the past, the massive cast bronze belts were produced in Germania under strong Celtic influence (e.g. Müller 1900, 138; Werner 1952, 136; Klindt-Jensen 1953, 57). This is probably equally true of the Hedegård belt, although it is more complex and better made than the other examples from Denmark.

The three gold beads (Fig. 16,1) do not, as far as we know, have any exact parallels in Scandinavia. They probably represent a composite neck ornament, the main element of which was formed by the now partly unravelled spiral bead made of 23-carat gold thread of almost triangular cross-section (von Szemerey 1990, 59). The outer side of the bead is divided into three areas, a blank one to either side and one in the middle decorated with fine triangular punchmarks. Similar spiral beads of gold, silver, bronze and iron have previously been found (Norling-Christensen 1954, Pl.59 no.17; Klindt-Jensen 1953, 57). The closest parallel is a smooth spiral gold-wire bead from the Store Skindbjerg cemetery at Skjern. This bead is smaller, however, and undecorated (Hansen 1990, 54).

The two smooth round gold beads are 11 and 12 mm in diameter and 7 and 8 mm high, and of 20-carat gold (von Szemerey 1990, 59). They were originally fully identical but one of them has been slightly affected by the fire. The beads are solid, smooth and have the string hole marked by a straight, cut ridge. As far as we know these beads have no exact parallels, but two similar beads were found in Juellinge grave 1 (Müller 1911, Pl.III no.3). The Juellinge beads, however, are smaller, and lack the ridge by the string hole.

The massive cast belt makes up the majority of the grave goods beneath the urn. There are, however, several other artefacts here which confirm the exceptionally rich and rare charater of the grave furnishing.

The iron ring found at the top of the pile is 6 mm thick and fully square in cross-section. The ring was originally completely closed, with an outer diameter of 26 cm. The ring bears no traces of other metals or of anything having been broken off. The item thus appears to be complete. Analysis of the iron has shown that it was made of phosphous-free iron with a little copper and thus not of metal produced from Danish

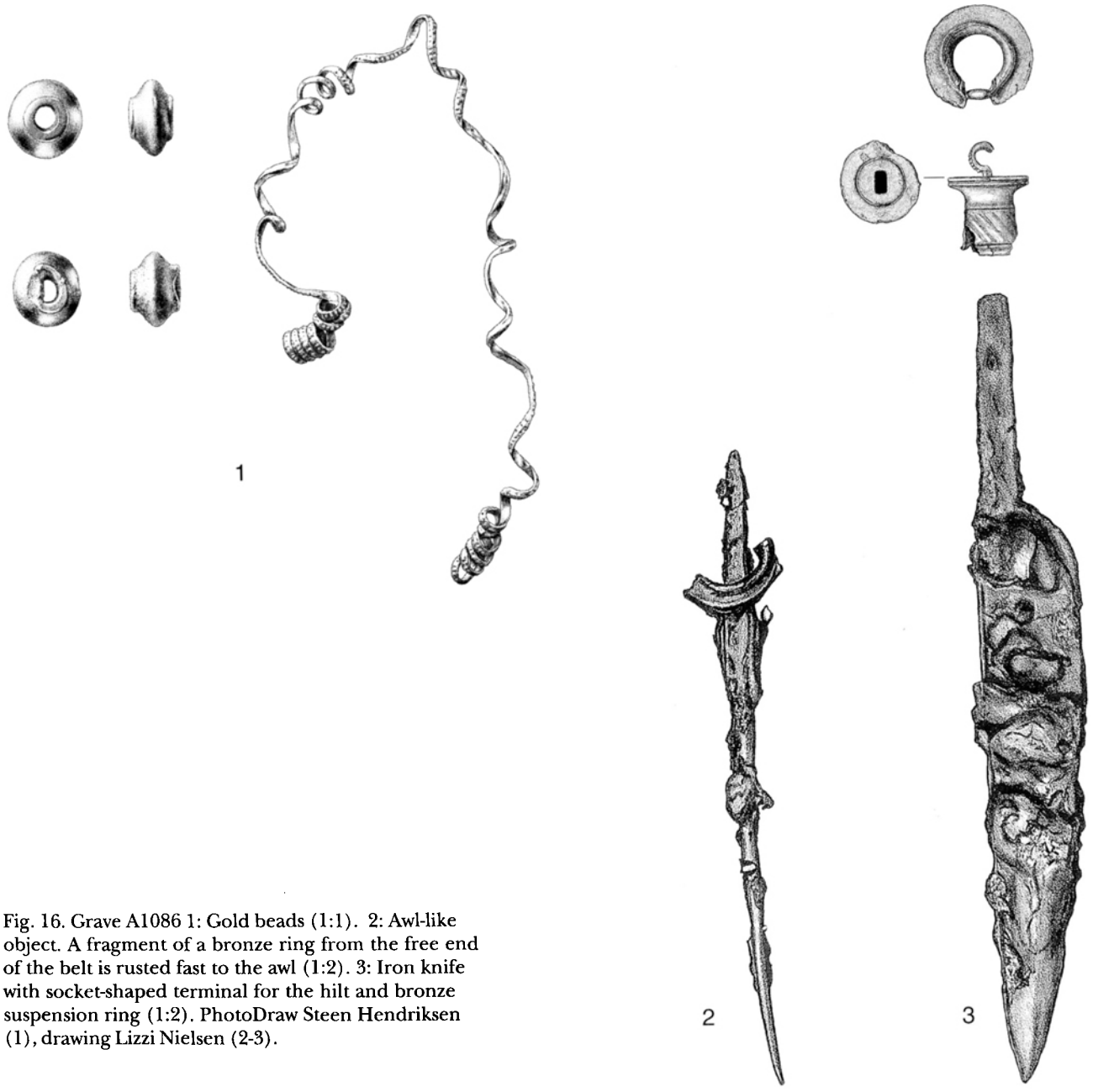


Fig. 16. Grave A1086 1: Gold beads (1:1). 2: Awl-like object. A fragment of a bronze ring from the free end of the belt is rusted fast to the awl (1:2). 3: Iron knife with socket-shaped terminal for the hilt and bronze suspension ring (1:2). PhotoDraw Steen Hendriksen (1), drawing Lizzi Nielsen (2-3).

bog ore (von Szemerey 1990, 34). It is not known whether it was the raw material or the finished article that was imported.

The function of the iron ring is unknown. Iron rings are known from the large bronze cauldrons of the late pre-Roman Iron Age (Eggers 1951, Types 4-6), but the Hedegård ring is simply too small to have been attached to one of these. It is nevertheless probable that it was some part of a bronze cauldron. A similar ring is known from a find from Poland, attached to an early Roman situla (Wielowiejski 1985,158), and in 1989 a small bronze cauldron with a rather similar iron ring was found at the cemetery of Wilhelmslyst on Langeland (AUD 1989, no.165). Whether there were something similar in the Hedegård grave, we do not know, and other possibilities

must be considered too. With reference to the other finds in the grave, however, the idea of a Roman bronze vessel is not improbable. There is indeed a quantity of melted sheet metal from at least one bronze vessel, probably, in fact, from two. In one case the object was undoubtedly a sieve, the holes in which can be seen in an X-radiograph. This object is too fragmentary for any closer identification, but it is in any event one of the earliest finds of a bronze sieve from Germania Libera (Kunow 1983, 27).

The zoomorphic handle (Fig. 17) was probably attached to one of the bronze vessels, though we do not know which. This handle has no precise parallels, although it clearly belongs to the same group as two other Danish finds of vessels with secondarily added Germanic handles. These are the small silver cup from Hoby (Friis Johansen 1923, 150) and the bronze beaker from Mollerup (Eggers 1951, no.167; Klindt-Jensen 1953, 59; Kaul & Martens 1995, 129). The handle of the Mollerup cup has been quite differently reconstructed by Eggers (1951, no.167) and Klindt-Jensen (1953, 59). The handles have most recently been discussed by Kaul & Martens (1995, 129). Klindt-Jensen's reconstruction is followed here.

At the top of the Hedegård handle there is a finely shaped horse's head with an open mouth, ears pointing backwards, and large circular eyes which take the form of a hole through the head. The horse's mouth had been biting on to the presumed rim of the bronze vessel. Behind the horse's ears can be seen the uppermost part of the handle itself, which was formed of two tightly joined bronze rods of circular cross-section. These continue to approximately the middle of the handle where they are gathered in a knob-like projection. To this is attached a ring, the upper side of which is shaped as a wild boar with a snout, fangs, bristles on its back, and a curly tail. Immediately below the body of the boar can be seen an opening 5 mm wide with some dark material which may be the remains of some organic stuff.

In between this ring and the head were one (or two) horse's legs. The best preserved of these is slightly twisted along its length and has a clearly marked hoof, knee and thigh. The hoof may have been fastened to the side of the vessel. The other end is hammered flat to form a circular plate which was probably attached to the handle. An X-radiograph appears to show a second horse's leg. This, however, is so poorly preserved that it is quite uncertain how the object, on its own, would originally have looked. There was also a small bronze object amongst the many severely fire-distorted bronze fragments which has traces of rivets on the back and decoration on the front. This piece may belong to the handle, and could be a small animal head that, as with the handle on the Mollerup cup, was a connecting piece between the handle and bronze vessel.

The reconstruction of the handle proposed in figure 25 is somewhat doubtful and should only be regarded as a suggestion. Most certain is the placement of the horse's head and the boar ring's association with the knob-like projection, where it fits precisely. Although the size of the handle is uncertain, it must have been attached to a relatively small vessel. As with the other two known handles from Hoby and Mollerup, the Hedegård handle is probably Germanic. Its style, however, is clearly Celtic. This is particularly the case with the wild boar (see e.g., Penninger 1972, Taf.34 no.1).

Amongst the other artefacts within the grave was a long, straight-backed iron knife 24.5 cm long, with a fine, worked, socket-shaped cap to the handle with a suspension hook, all of bronze (Fig. 16,3). The socket is decorated on the side with slightly angled grooves, while the upper side with the decorated hook has two concentric circles. The end of the handle is also associated with a bronze ring of faceted cross-section with a marked central area to which the hook on the handle was fastened. The presumably organic haft of the knife has not survived, but it was attached with bronze rivets. Whether or not the object was fastened to the belt, and, if so, how, we cannot tell. As noted above, there are traces of a bronze nail or rivet, possibly the top of a now lost hook, in the centre of the plate with the belt hook.

A 20 cm-long awl-like artefact with a slightly crooked point was also found in the grave (Fig. 16,2). A half-ring from the free end of the belt is now rusted on to it. Its identification as an awl is uncertain in view of the large size of the item. It may rather be a firesteel or have had some quite different function. There was also a 9 cm-long iron sewing needle amongst the tools.

The two iron fibulae in the find, and a fragment of

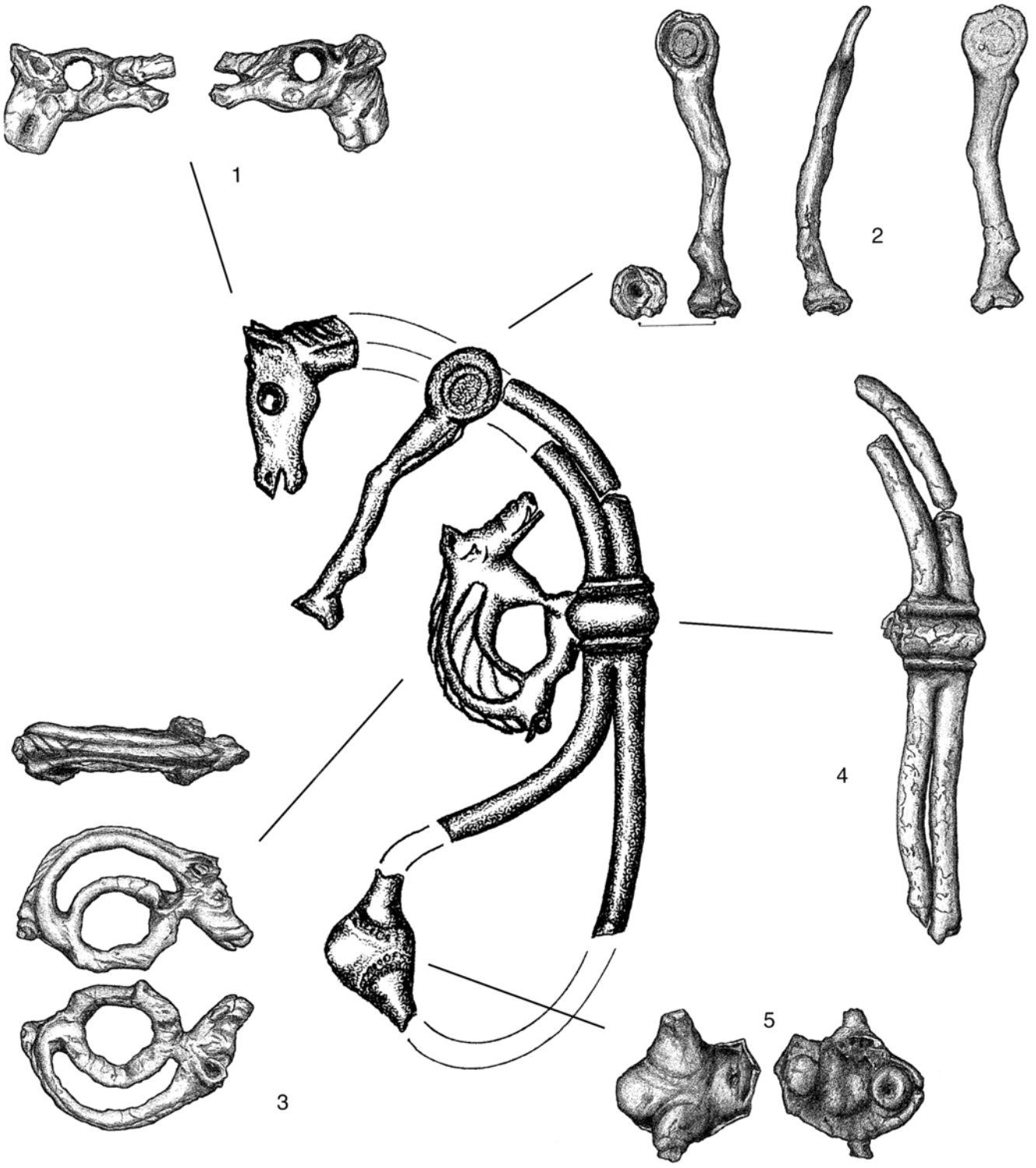


Fig. 17. Reconstruction of an animal-formed handle from grave A1086/840, and its best preserved parts: 1) The horse's head, 2) the best preserved leg, 3) the "wild boar ring", 4) handle fragment with bud-shaped extension onto which the "wild boar ring" fits exactly, 5) The presumed lower terminal. 1:1. Drawing Lizzi Nielsen.

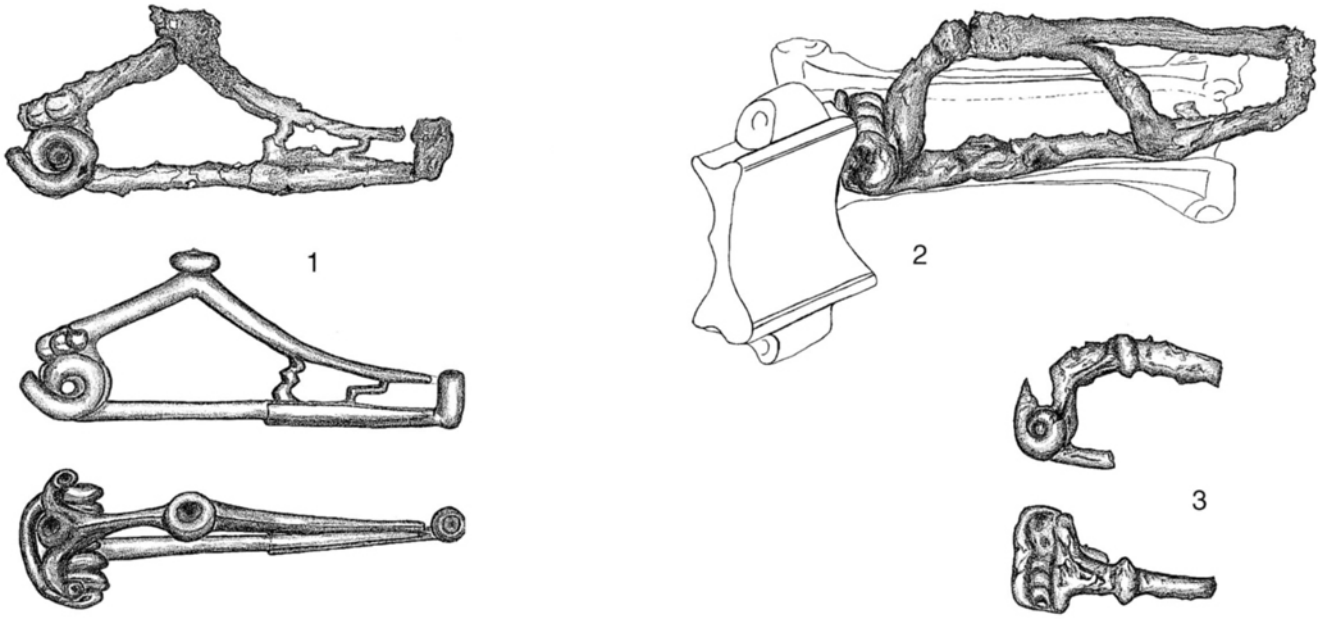


Fig 18. The three iron fibuli from grave A840/1086. 1 and 2 are from the heap of artefacts under the urn in grave A1086, while 3 is the fibula fragment, which was found in the burnt layer A840. 1 has been drawn partly as it now appears, partly from an x-ray photograph (lowermost). 2 is rusted together with two parts of the belt, a rectangular and a quadratic bronze link respectively. 1:1. Drawing Lizzi Nielsen.

a third (Fig. 18) from the overlying burnt layer (A 840), are extremely important as they provide an answer to an old debate about the dating of the massive cast belts (Klindt-Jensen 1953, 56; Becker 1958, 59). The two fibulae in the group of artefacts beneath the urn are a Kostrzewski variant D/E and a late Kostrzewski variant K fibula respectively (Kostrzewski 1919), and the grave can, in consequence, be dated to Period IIIb. The fibula fragment from A 840 supports this dating. This consists of the head and spiral probably from an Almgren 65 fibula (Almgren).

The final artefacts to be noted are a bronze tube of unknown function with a central, torus-like projection, and a fragment of a large translucent green glass bead.

The bones from A 1086 have kindly been identified by lic. med. Pia Bennike (von Szemerey 1990:65), who reached the following conclusion: "The skull fragments appear rather thick and the other bones imply a relatively strong individual, perhaps a man. The open aveolae in the lower jaw with no traces of tooth-loss, and the open skull seams, indicate that this was a young adult, i.e. less than 35/40 years old."

The osteological sexing is uncertain, therefore, and far from likely in view of the grave goods. The grave furnishings, which include beads, three fibulae and a sewing needle, are distinctly female. This holds for the belt too, as in Celtic graves, the belts of which are the models of the Scandinavian types, these occur in women's graves (Werner 1952, 135). If the grave is sexed by archaeological means, it is most probably a woman's grave.

Grave A4103

This grave was sited 10-15 metres south of the three graves already described (Fig. 6) and, like these, is an urn-grave. The grave appeared in the ground as a feature aligned north-south, 1.48 m long and 1.12 m wide (Fig. 19). Within this feature there were two further layers, one to the north and one clearly cut through its southern end. About half a metre south and north

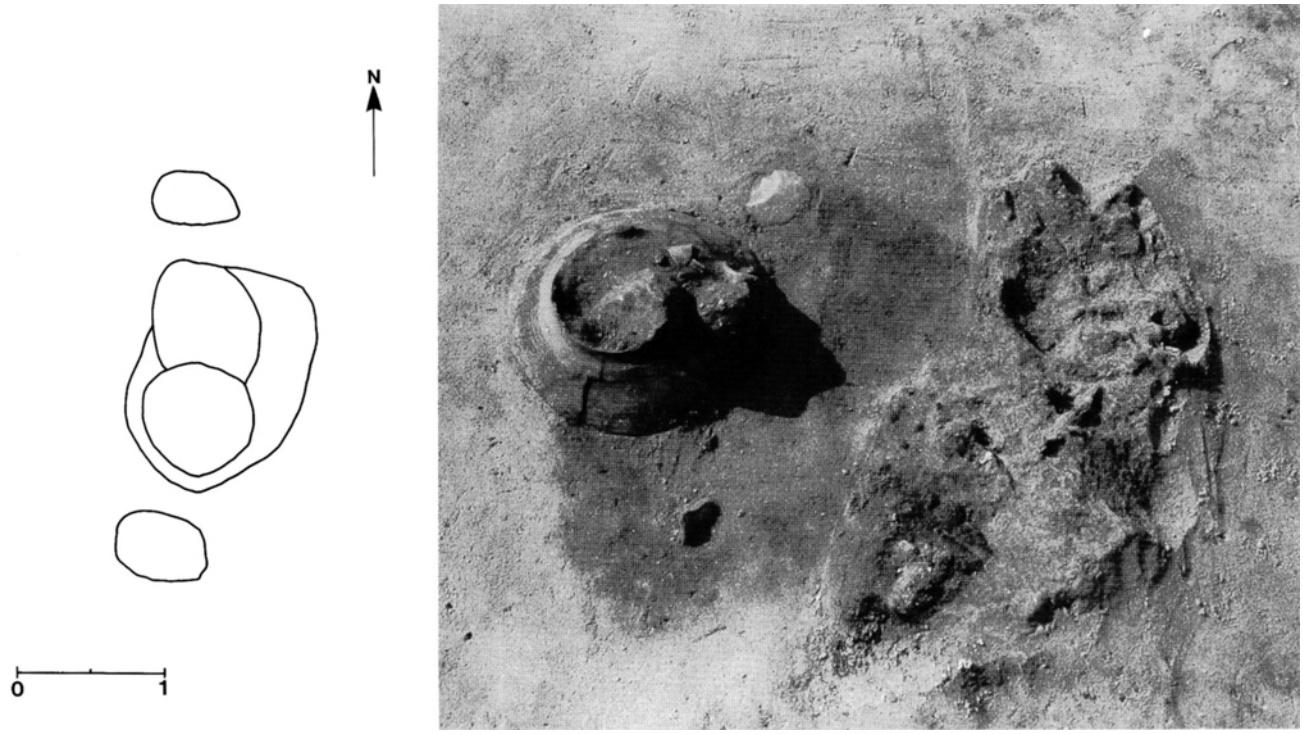


Fig. 19. Plan of grave A4103 together with a photograph of the feature seen from the east during excavation. To the north of the exposed rim of the urn lies the melted bronze vessel and the other gravegoods.

of the grave (measured from its edge) there were two features resembling post holes. It is not clear whether or not these relate to the grave, as some form of grave marker, or are only coincidentally associated with it.

In the southern feature within the grave there was a black-burnished meander-decorated vase (Fig. 20) containing a small quantity of burnt bone (only 6 g in all), a small amount of powdered silver, a somewhat uncertain and relatively small fragment of glass and a thin bronze disc 2 cm in diameter. The urn was surrounded by three smaller black-burnished pots, a bowl and a handled vessel to the west, with the bowl placed upside-down over the handled vessel as a lid, and fragments of a pedestal beaker to the east.

In the earlier layer north of this collection of pots there was a large quantity of melted bronze and a number of iron artefacts that had rusted together (Fig.

Fig. 20. The urn of grave A4103 seen from the west with meandering ornamentation and the surrounding secondary vessels exposed. To the north of the group of vessels melted bronze and iron can be seen.

20). How far apart in time these two deposits are we do not know. It does not appear that any finds were removed from the earlier deposit when the later intervention was made, and the fact that both cuts are within the same larger feature indicates some form of connection between them. The idea that this is a single burial is supported by the fact that burnt bones were found only in the large urn and not amongst the bronze and iron artefacts. At Hedegård it is not uncommon for some of the grave goods to lie beneath or alongside the urn, although the whole grave assemblage usually lies within a single cut.

Lying both over and under the artefacts was organic material which proved to come from a woven or bound net of reed. It is clear that all of the grave goods were packed into this net for burial.

The great majority of the bronze derived from a fire-damaged vessel. On the basis of its well-preserved foot and fragments of the handles (Fig. 21,1) this can be identified with reasonable confidence as of Eggers's Type 100 (Eggers 1951). Although bronze vessels are far from common in this early phase of the Early Roman Iron Age this is a relatively familiar type. It is known from five or six Scandinavian graves and is a type which, with minor changes, was a long-lived one both in the Roman Empire and in Germania Libera (Lund Hansen 1987, 463).

The other bronze objects in the grave consisted of three rivets and a small rectangular decorative mount (Fig. 21,2) which had apparently been attached to a leather belt, together with a fragment 2.5 cm long, possibly the foot end of a fibula (Fig. 21,4). The fibula fragment is not classifiable, but it is apparently from a specimen with an openwork catch piece and a foot of triangular cross-section.

At the south-eastern edge of the bronze finds lay a quantity of iron rusted together, in which only a pair of shears could be recognised during excavation. An X-radiograph allowed a dagger with its sheath, a knife and a small spearhead to be identified (Fig. 22). The shears are relatively small, only 16.6 cm long. The knife, which was partly covered by the shears, is long, thin, straight-backed, and has a rolled-up haft. It is 18 cm long and 2 cm wide. Close beside the knife lay a spearhead 16.2 cm long with a short socket measuring 3.4 cm that has three collars towards the head alongside a massive mid-rib of rhomboidal cross-section which runs up to a flat point. Spearheads of this type are rare. A similar spearhead is known from Kalkriese (Franzius 1997, 78) and relatively few others are known from the area of Denmark (pers. comm. M. Watt). From the same grave, but amongst the melted bronze from the vessel, came a more common type of spearhead 10.2 cm long (Fig. 21,5) and a D-shaped iron belt buckle (Fig. 21,3).

What particularly makes this grave assemblage stand out is the dagger with its sheet-iron sheath. This is what is known as a *pugio* (Latin for "dagger"), a type of weapon that was common amongst the Roman legions and which, with decorated sheet-iron sheaths, is known in relatively limited numbers from the 1st century A.D. *Pugiones* continue in use in the Roman army into the 2nd and 3rd centuries, but without decorated sheet-metal sheaths (Hermann 1969:132; pers. comm. W. Zanier). Leather and wooden sheaths were far more common in the 1st century too. Luckily, the dagger had been pulled up out of its sheath upon burial so that both pieces can be studied in their entirety (Fig. 22). The dagger is fully preserved. It is 35.2 cm long, including a grip of 10.6 cm. This ends, towards the blade, in a 7 cm long hilt guard which is made of two pieces of strip iron on the front and back of the hilt respectively. The grip is made of three layers making it 2.5 cm thick (Fig. 23). The middle plate is a continuation of the blade. In between this and the two outer plates there was some organic inlay. This material has not been identified although horn is used here in other cases (Ypey 1960-61, 347). The front and back sides of the grip are made up of two practically identical iron plates which expand in the middle and at the top. The back is almost completely smooth while the front has some characteristic rivet heads in several places, all of them with a central cavity to receive some material. Similar rivets occur on the hilt guard and there may also have been a rivet in the small hole in the projection in the centre of the grip. We know, from better preserved finds, that the rivets carried inlays of red or green enamel (e.g. Thomas 1971, 48ff.). The X-radiograph reveals two further rivets in the hilt guard and three in the central axis of the grip. These were presumably also meant to hold the composite grip together. The front side of the grip has a further sheet-iron plate of practically animal-head shape on the expand-

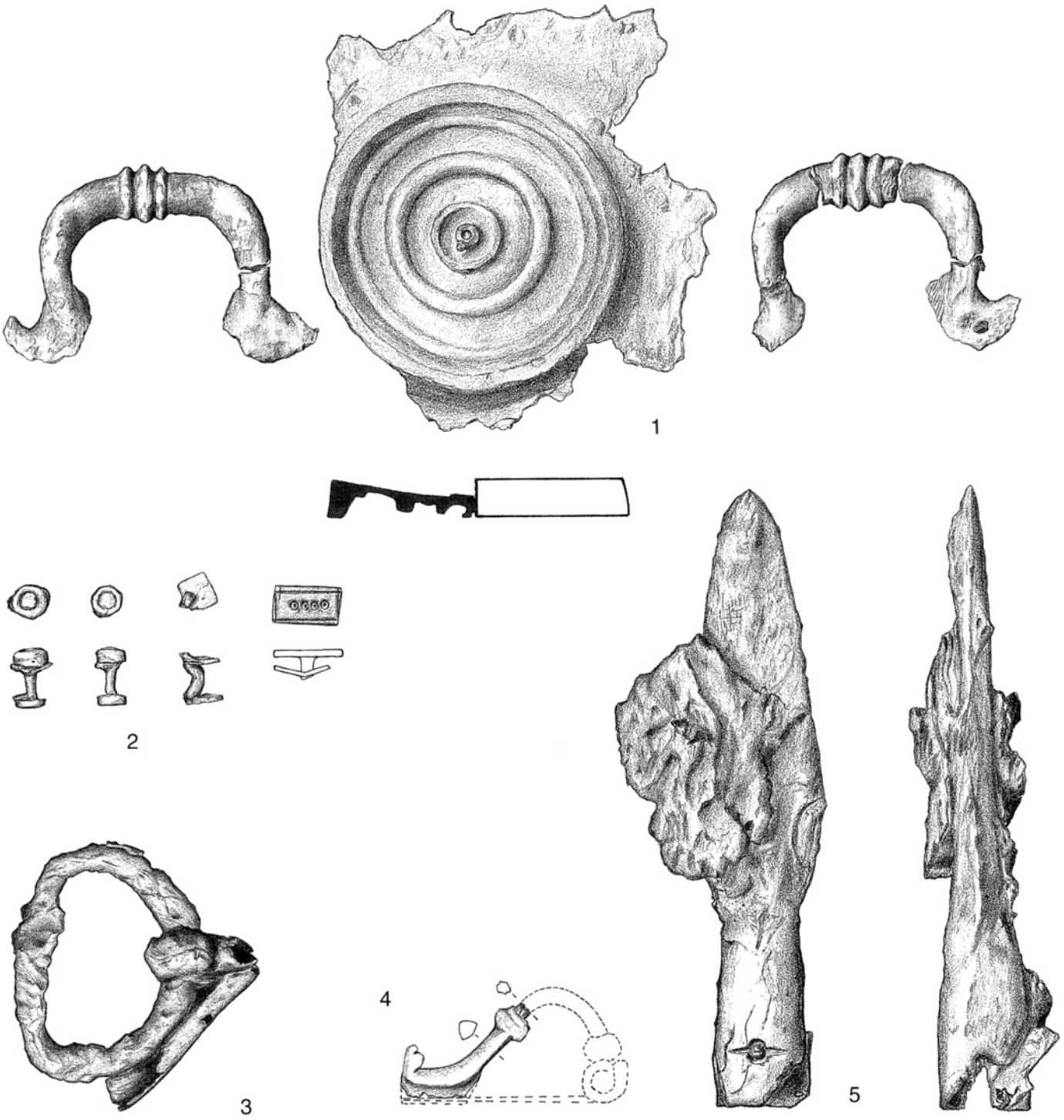


Fig. 21. Grave A4103. 1: Handle fragments and a foot from a melted bronze dish (1:2). 2: Circular decorated bronze rivets and a decorated rectangular bronze plate. The bronzes lay together at the base of the bronze dish (1:1). 3: Iron belt buckle (1:1). 4: Foot of a bronze fibula from. The stippled parts have been reconstructed (1:1). 5: Lance point (1:1). Drawing Lizzi Nielsen.

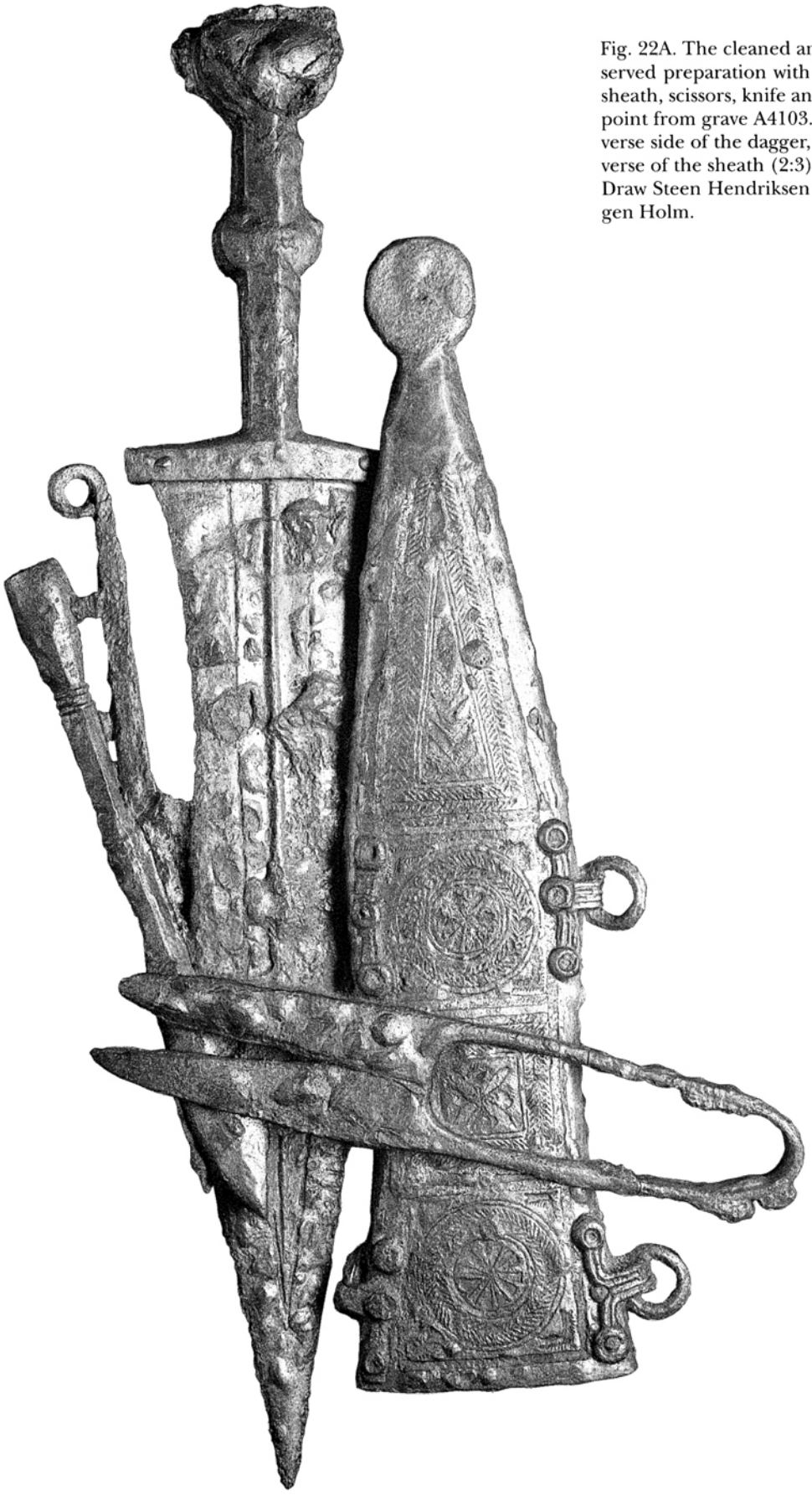
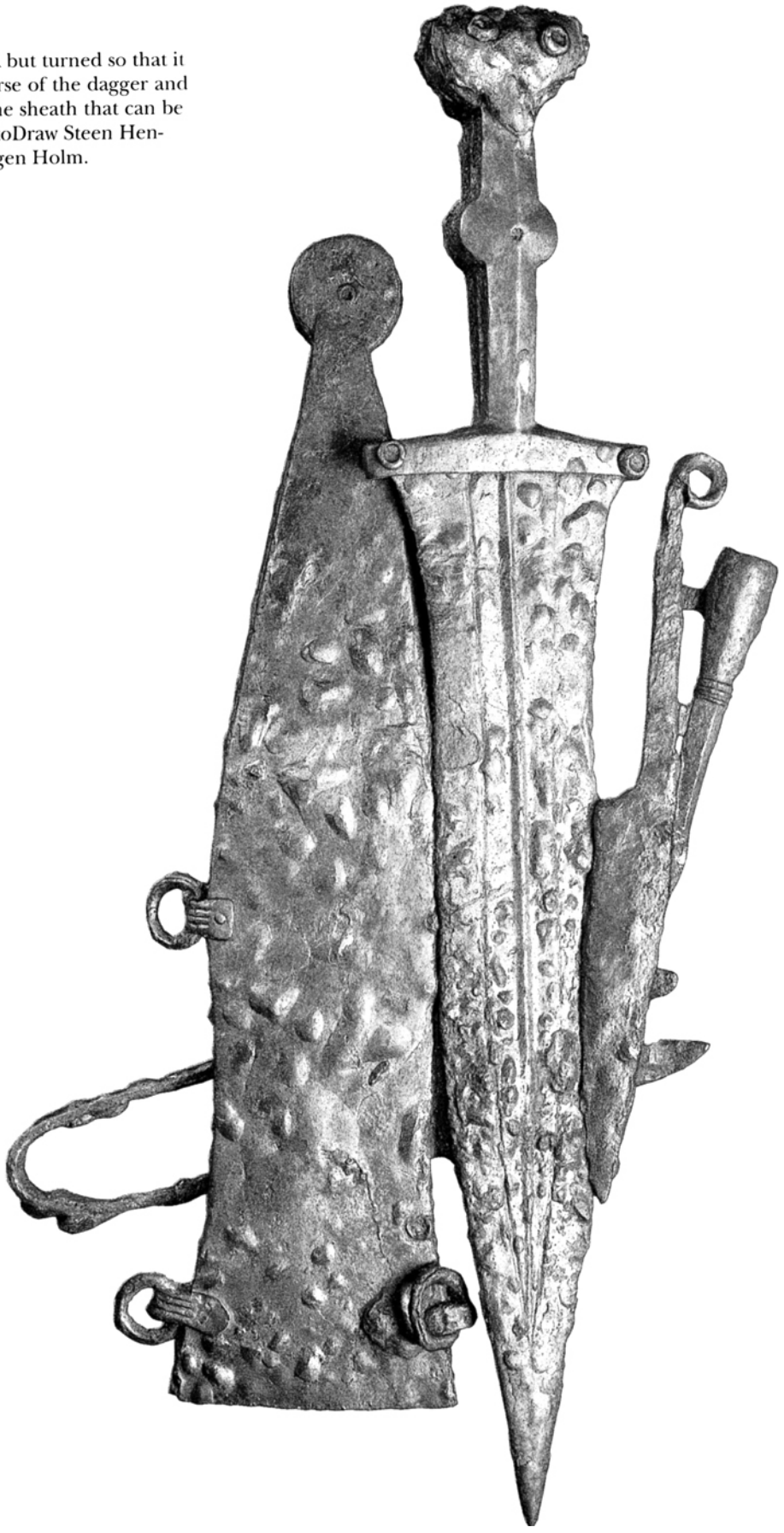


Fig. 22A. The cleaned and conserved preparation with dagger, sheath, scissors, knife and lance point from grave A4103. The reverse side of the dagger, the obverse of the sheath (2:3). Photo-Draw Steen Hendriksen and Jørgen Holm.

Fig. 22B. As 22A but turned so that it is now the obverse of the dagger and the reverse of the sheath that can be seen (2:3). PhotoDraw Steen Hendriksen and Jørgen Holm.



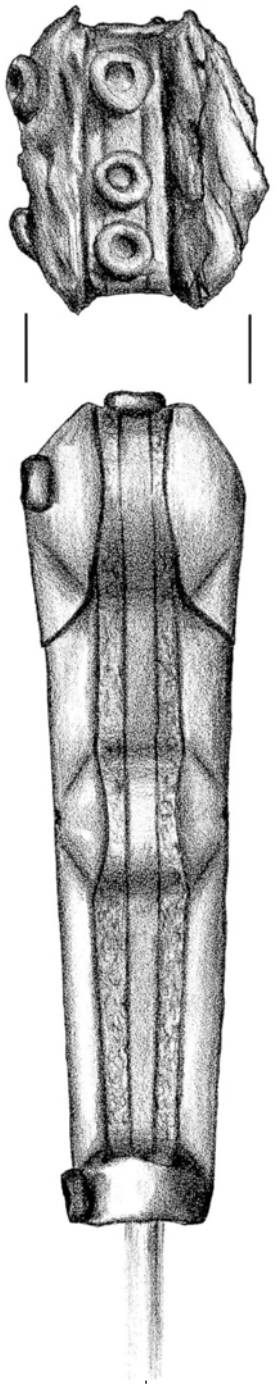


Fig. 23. The dagger hilt from grave A4103 seen from above and from the side (1:1). Drawing Lizzi Nielsen.

ed area at the top. At the end of the grip there is an iron strip which holds its parts together (Fig. 23). This strip also carries three rivets with cavities for enamel inlay.

The dagger blade, which is 24.6 cm long, has curved sides and is sharply pointed. The blade has a prominent mid-rib surrounded by two blood furrows. The furrows and mid-rib run together and end 4.2 cm above the sharp point.

The dagger's sheath is 27.3 cm long, and at its mouth, which is its widest part, 6.7 cm wide. The sheath has a front and a back side, both of them made of thin sheet iron, the front side being convex and the back flatter. Apart from the four suspension mounts along the sides of the sheath the back is smooth, so the account here will concentrate on the richly decorated front side (Fig. 22; 24).

Along the sheath there are four suspension mounts, placed symmetrically in pairs on either side. The two uppermost mounts are 2 cm below the mouth. Each mount is 3.5 cm long and formed of four thin iron wires, welded together, with a carrying ring at the end. Upon the sheath itself the four wires are divided into two strands which are bent at a right angle in opposite directions. These strands are attached to the sheet iron of the sheath at the top, in the middle and at the bottom by a rivet like those described above in connection with the grip. The two uppermost mounts are of a single form, although that to the right is less well preserved than that to the left, which lacks its central rivet. The two lower suspension mounts are located in the middle of the curved outline of the sheath. The suspension mount to the left is complete, with all its rivets and the whole surface preserved, while that to the right has lost its suspension ring. This was missing before the deposition of the item as grave goods as both the ring and the projection it was attached to were removed and the area gradually worn down. On the back of the sheath the four suspension mounts end in a flat, hammered projecting area with a small central rivet. This feature is completely absent from the modified mount referred to above, corroborating the idea that the suspension ring and parts of this mount were removed while the dagger was still in use. In connection with this it is interesting that although the majority of sheaths have the same method of suspension as that from Hedegård, i.e. four symmetrically placed suspension mounts along the sides, normally only the two uppermost ones are used (Morel & Bosman 1989, 183).

Fig. 24. Sketch of the ornamentation on the dagger sheath from grave A4103 (1:2). Drawing Lizzi Nielsen.

The sides of the sheath follow a curved outline which ends at the bottom in a circular chape. This chape is 2.4 cm in diameter and undecorated. Apart from the chape and a small part of the end of the sheath, the decoration on the front side of the sheath is largely intact. This is virtually surface-covering decoration, divided into four fields, of which the uppermost and the third fields are practically identical. All the decoration is formed by inlay. The metal which was hammered down as an inlay has kindly been examined by civ. ing. Arne Jouttijärvi, whose analyses are the basis of the account presented here. It must be noted, however, that the results of the metallurgical study are uncertain as the dagger was affected by heat both in antiquity and during conservation, and this may have affected the chemical composition of some of the materials.

The four fields of decoration are framed by a rather broad groove inlaid with an alloy of tin and bronze with a high admixture of silver, giving the alloy a brass-like colour. In the two almost identical patterns the brass frame encloses a rosette which is surrounded at all four corners beside the frame by an angular cavity. Analyses of the material in these angles have produced no secure results, but to judge by their form it is likely that the inlay here was enamel. Inside of the angles there is a rosette surrounded by a copper alloy. Within this there is a leaf border with a completely black fill, probably niello but which as a result of the effects of heat has been converted into metallic silver. In the sample from the sheath there was 75% silver and 13% copper. This is probably the remains of niello, as that would provide the greatest contrast to the otherwise blank "silver-like" surface of the iron sheath. Inside this leaf border there is a leaf pattern in which every second leaf has been inlaid with a bronze that was redder than the brassy-yellow inlay of the surrounding frame. The alternative leaves are empty. They presumably originally carried enamel.

Thus the decoration of the uppermost and the central fields. The second field from the top is slightly different. The frame around the field and the internal niello border are the same, but here are square in shape and there is a pattern consisting of four confronted, diagonally placed pointed-oval cavities inside the niello border. Between these cavities there are four identical hearts, meeting at their points. There are traces of bronze within the ovals and the hearts presumably carried enamel inlay.

The decorative field at the bottom is triangular and somewhat damaged towards the chape. There was originally decoration here, and we have to assume that the outermost decorative strip ended in a point alongside the circular chape. The frame here too consists of a brassy-yellow bronze, again with the black niello border on its inside, now describing a triangle. Inside this there is chevron pattern made up of angled, engraved fields which carried a reddish bronze-

alloy or enamel inlay alternatively, beginning at the top with enamel. It is not known whether or not the chape was decorated. It may have been entirely blank, but could also have been decorated with a silver or bronze/brass disc.

The analyses have unfortunately not been able to provide information about the colour of the enamel inlay which undoubtedly adorned the rivet heads and large parts of the pattern on both the dagger and its sheath. From other, comparable finds, red is particularly familiar, although there is also one example of green as well, which may well have been the case here (Thomas 1971, 48).

Complete *pugiones* are known in only a small number of cases from the Roman area within Europe. Only 70 more or less complete decorated sheaths, with or without their daggers, are known and some 60 complete daggers (Scott 1985, 160). If we add to these fragments of grips, blades and sheaths the number grows somewhat to 196 pieces (Thiel & Zanier 1994, 60), but given the size of the Roman Empire and the considerations discussed below, this remains a very rare ancient artefact.

Outside the Roman Empire *pugiones* are even less common. In fact only three specimens have been found north of the Empire. Only the area of the Continent north of the limits of the Roman Empire is included here. Apart from the three *pugiones* noted in the text, the other examples found north of the Rhine or the Danube come from Roman camps or sites related to them. Only two of the daggers, Hedegård and Ilischen, are from Germanic features (graves). One example comes from a Germanic grave from Ilischken near Kaliningrad in what is now Russian territory (Nowakowski 1983, 80), another was found in Ocnita in Romania (Thiel & Zanier 1994, no.138), and the third is the Hedegård find. The remainder are all from the Empire, especially along the Limes (Thiel & Zanier 1994, Abb. 5-6).

Inside the Roman Empire the number of finds is strikingly low when one considers that the *pugio* was an integral part of a Roman legionary's equipment. Some scholars believe, partly on the basis of studies of military graves, that auxiliary soldiers also carried the *pugio*. This should mean that there were always at least 150,000 such daggers in use in the Roman army (Scott 1985, 181 no.1). Not all of these would have had decorated sheaths. Most specialists agree that these, even at the time of use, were rare in the Roman area, and that relatively few sheaths of this type were made. This effectively means that these de luxe weapons were possessed only by relatively few, distinctly high-ranking officers who had been given the daggers as a reward for long service or something similar, rather like medals of later times (Morel & Bosman 1989, 187).

The Roman army only used *pugiones* in decorated sheet-metal sheaths in the 1st century A.D. In this period the type underwent a series of changes. The earliest daggers are those of the Dunaföldvar Type (Thomas 1971, 52; Scott 1985, 176) with side plates around the central grip plate, rivet holes in the shoulder of the blade to fasten the hilt and a curved blade with a central rib between blood furrows. This was followed by another type with a much more simple grip tang, no rivet holes and a narrower and straighter-sided blade (Scott 1985, 164).

The associated decorated sheet-iron sheaths change too. The earliest match the Hedegård example very closely, with the inlays consisting of brass, bronze, silver/niello and red or green enamel, and the curved outline of the dagger mirrored by the sheath. The pattern on the sheath is divided into four fields comprising rosettes, chevrons, hearts and ribs of various kinds. The inlays used later change, with enamel disappearing and the brass and bronze being partly superseded by silver. The motifs also change, through temples, lilies etc, to more abstract patterns in which the division into fields so characteristic of the earlier sheaths is completely lost (Thomas 1971, Taf.LXXX; Scott 1985, 165ff.).

None of the sheaths found so far are obviously identical. The sheat which is immediately most similar to the Hedegård example is from Dunaföldvar, a dagger that was unearthed in the Danube a little south of Budapest in 1967 (Thomas 1971, 47ff.). Although there are many similarities, the Dunaföldvar dagger does not have the hearts in field 2, a motif which is, however, also found on a dagger from the Abte Ladiner valley in the southern Tyrol (Thomas 1971, Taf.LXXVI:2). The other daggers of what is known as the Dunaföldvar Type also carry motifs and other features resembling the sheath from Hedegård (Thomas 1971, Tafn.LXIX-LXXX).

Within the Roman Empire the Dunaföldvar Type is dated relatively early, but there is some disagreement over exactly how early. Scott, for instance, considers that the distribution of the type along the Danube and the Rhine means that it should be dated to within the first twenty years of the Christian Era (Scott 1985, 170). According to Scott, the daggers came into use in the decade following the birth of Christ amongst the Roman legionaries on the Danube border in Noricum and Illyria. The production of these early daggers presumably took place in what is now northern Italy and Austria with the then famed trading town of Aquilaia as the centre for their distribution. The presence of the type in the Rhine area is connected by Scott directly with the disaster that befell the Romans in 9 A.D. The three legions that were annihilated in the Battle of Teutoburg were in fact replaced in the same year by three legions from the Roman provinces of Illyria and Noricum (That Roman legionaries used the *pugio* in the West Germanic provinces before or in the year 9 A.D. is shown by, *inter alia*, the fact that a fragment of a *pugio* is included in the Kalkriese find (Franzius 1997, 78)).

Other scholars, such as Thomas and Zanier, date the daggers a little later, namely to the middle third of the 1st century (i.e. 30-60 A.D.) (Thomas 1971, Taf. LXXX; pers. comm. W. Zanier).

The Hedegård dagger can thus with some care be dated to the Early Roman Iron Age, possibly close to the year 9 AD. and scarcely later than about the year 50 AD., and thus clearly in Period B1 of the Early Roman Iron Age – a dating which is also supported by the other finds in the grave. This dating also accords very well with the bronze vessel, a type which, however, was also a long-lived one, and which therefore could just as well come from the second half of the 1st century.

DISCUSSION

The four graves just described can all be dated to the earlier phase of the cemetery's use. In the case of A1086, the fibulae indicate a date in Period IIIb of the pre-Roman Iron Age. The same dating is implied for graves A1131 and A1136 by the bronze vessel-types and the straight-walled beaker. In the case of A1131 a dating to the very beginning of the Early Roman Iron Age cannot be absolutely excluded. On the evidence of the dagger, A4103 is of the Early Roman Iron Age.

The three late pre-Roman Iron-age import graves can be aligned with a very small group of early graves from Denmark with imported Roman bronze vessels in terms of their type and richness. These are the graves from Langå, south-western Fyn (Albrectsen 1954, 29), Kraghede (Klindt-Jensen 1949, 201) and Try Skole (Becker 1958, 54) in Vendsyssel, and Simblegård on Bornholm (Bjørnvad 1989, 7). The wagon grave from Husby near Flensborg also belongs to this set of burials (Raddatz 1967).

Although the import graves at Hedegård – A4103 excepted – are broadly contemporary with these graves and belong to the same high social sphere, there remain certain clear differences between them. The late pre-Roman Iron-age Hedegård graves lack the traditional weapons (spear, shield and sword) which have otherwise been emphasized as typical of such early Germanic import graves (Hedeager 1990, 120). In respect of the other grave goods, the import graves are also very varied with virtually the only similarities being that they contain artefacts that are extremely rare, in so far as other grave assemblages can tell us, and required a lot of material and material of exceptional artistic quality: artefacts which manifestly distanced these individuals from their fellow-villagers buried alongside them.

Weapon graves

While the amount of traditional weaponry in the four rich import graves is very small, such items are found in quantity in the surrounding graves. Only the earlier graves, the cremations from Periods IIIb and B1, contain weapons. About a quarter of these graves are weapon graves, a very high proportion compared with the "normal" picture for the area of Jutland and Fyn. In the Early Roman Iron Age, for instance, only 7% of the graves in the old *amter* of Skanderborg and Århus are weapon graves. On Fyn in this period there are weapons in 8.9% of the graves and in one German cemetery, Hamfelde, there is weaponry in 6% of the graves (Madsen 1984, 92ff.; Hedeager 1990, 114). One should also note that the frequency of weapon graves varies enormously, governed both by chronological and regional factors although method-

Fig. 25. Hilt of the La Tène sword from grave A1187 (1:1). Drawing Pernille Kristensen.

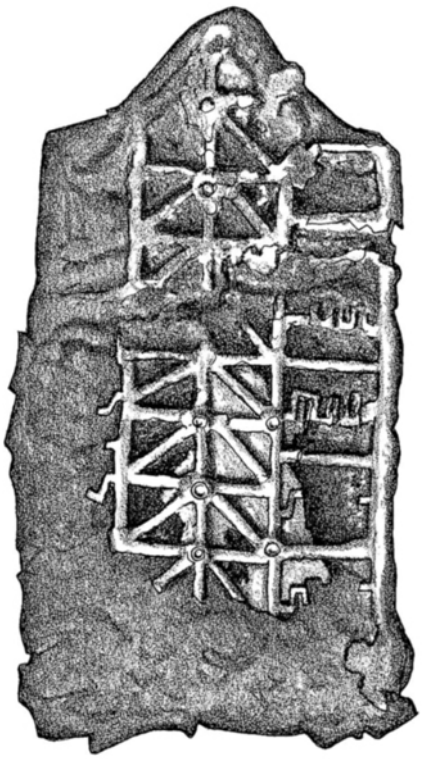


Fig. 26 Iron sword with "Opus Interassile" of bronze from grave A907 (1:1). Drawing Pernille Kristensen.

ological factors are also relevant: e.g. whether all the graves from a cemetery have been examined, or whether some of the isolated weapon graves in an area actually come from larger but not as yet fully investigated sites. The weapon-grave frequencies cited here must also be taken with one further, important qualification, namely that the late pre-Roman Iron-age graves are not included, while these, especially if they lack metal artefacts such as weaponry or brooches, may be difficult to distinguish from Early Roman Iron-age graves. The number of weapons grave could thus be either higher or lower in the late pre-Roman Iron Age than in the Early Roman Iron Age.

Most of the weapon graves at Hedegård contained a full weapon-set of spear, sword and shield, thus distinguishing them from the weapon-grave milieu as hitherto described (Bjørnvad 1989, 19; Hedeager 1990, 117). Two-edged La Tène swords are predomi-

nant amongst the swords (Fig. 25). We shall not discuss here which of these are imported and which are local reproductions, but it can simply be noted that many of them appear to be imported items if one uses the length and the form of the sheath as determinative criteria. One of the swords, for instance, is in an iron sheath with openwork in bronze at the mouth (Fig. 26) – an example of what is known as *Opus Interassile*, which is usually found in Noricum (Werner 1977, 367ff.).

In the present report, just one of the weapon graves will be described in detail, cremation patch A 4137 (Fig. 27). This grave contained, *inter alia*, an iron ring mail-shirt, a one-edged sword, two long knives with winged socket 42 cm long, a spearhead, two ring brooches and a number of mounts which probably belong to the mail-shirt. The deceased appears to have been cremated in his mail-shirt which was then buried, partly folded up and partly cut up. The rings of which the mail was made are incredibly fine (Fig. 28). Each ring, measuring only about 5 mm in diameter, is made of iron wire 0.9-1.0 mm thick. The mail-shirt consisted of tight rows of rings of which each alternative row consists of rings fastened with a rivet or whole rings respectively. Each ring interconnects with four others. The total weight of the mail-shirt is now 10.36 kg. This weight also includes a small amount of burnt bone, charcoal, etc, which is rusted fast on to the remains of the mail-shirt. In Denmark otherwise, pre-Roman mail-shirts are known only from the Hjortspring find, where the excavator saw traces of at least 20-24 examples (Rosenberg 1937, 47), and possibly a loose find from Kastentov in Hellum parish, North Jutland. This mail-shirt is undated, but technically, in size and chemical composition, it fully matches the Hedegård mail-shirt and could even come from the same workshop. In relation to the later, and better known, Late Roman Iron-age mail-shirts from, for instance, Brokær, Vimose and Thorsbjerg, the rings of the Hedegård mail-shirt are somewhat smaller in diameter (Jouttijärvi 1995, 102). It also differs from those examples by having the rivets which every second ring is fastened with considerably longer, thus making the mail-shirt very tight.

As of yet the Hedegård mail-shirt is the earliest known securely dated, grave find of a mail-shirt in Denmark. Provisional analyses of the iron in the rings indicate that it was made either in central or in western Jutland (possibly at Hedegård itself) or in northern Germany/Poland, and thus is not, as one might have thought, Celtic work.

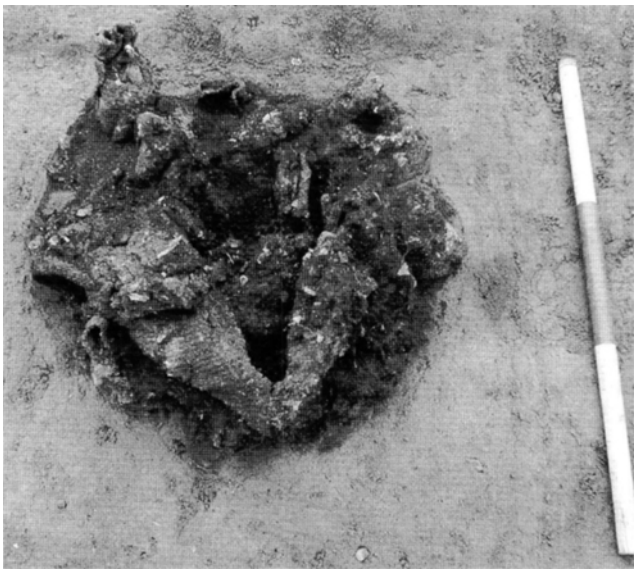


Fig 27. Cremation patch A4137 with the chain mail exposed.

Graves with tools

At least three graves in the Hedegård cemetery contain tools, although the total will probably grow when all of the grave assemblages have been more meticulously examined. In urn-grave A271 four small iron objects were found with almost chisel-like edges at one end and a hole with a clamped termination at the other (Fig. 29). These may be graving tools for fine engraving of metal (Lønborg 1992, 80). The whetstone which the graving tools were sharpened on is also in the grave group. So too was an awl and a couple of unidentifiable iron fragments. In another cremation grave (A1187) there were two small gouges or spoon bits with a narrow and a wide edge respectively, together with a tool with a double, angled, chisel-like edge, possibly a turning tool and an awl (Fig. 30). In addition to these small tools the grave contained a La Tène sword, a large knife with winged socket, a small knife, pieces of a shield boss, the sock-

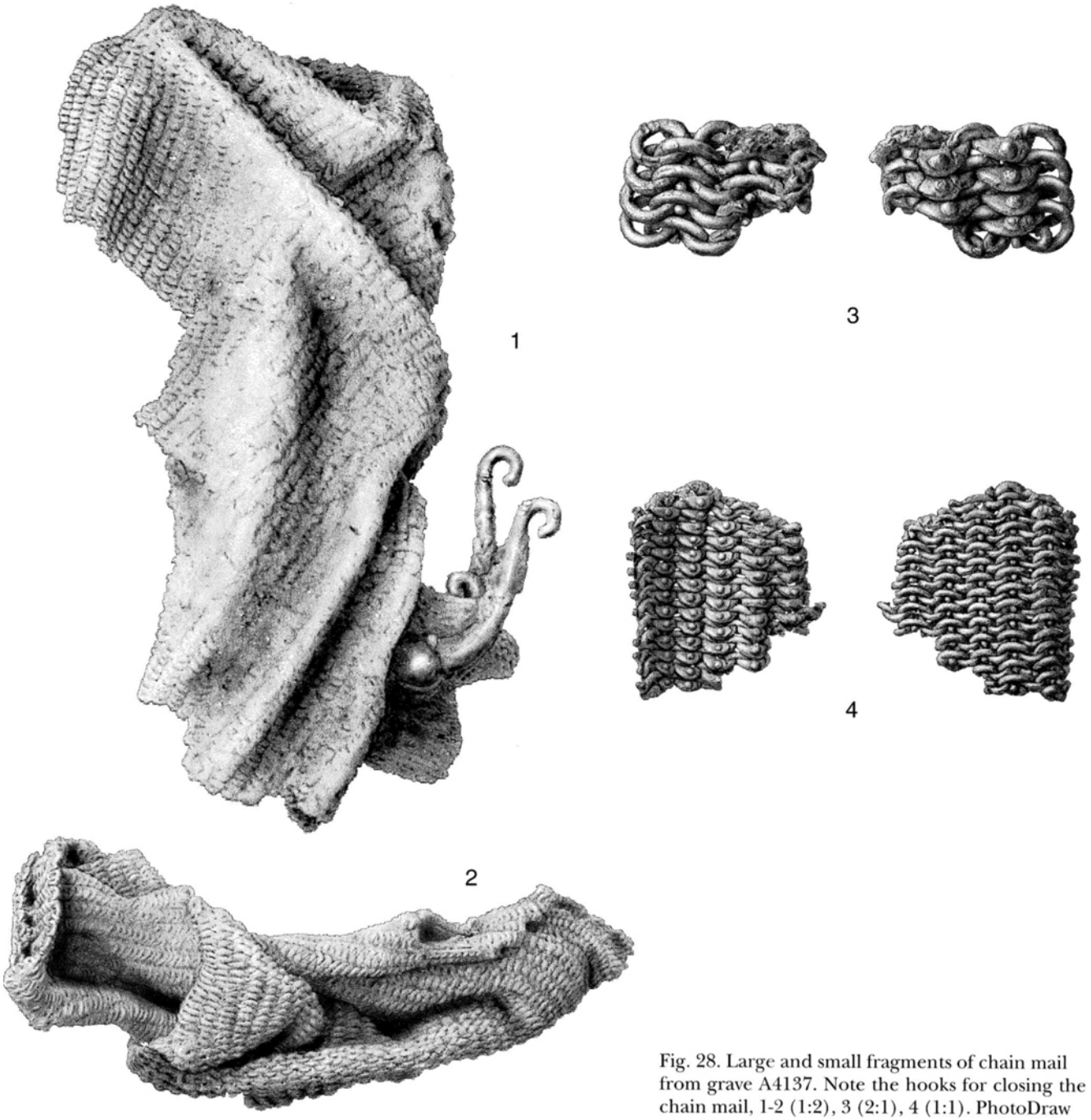


Fig. 28. Large and small fragments of chain mail from grave A4137. Note the hooks for closing the chain mail, 1-2 (1:2), 3 (2:1), 4 (1:1). PhotoDraw Steen Hendriksen.

et from a spearhead, an iron brooch, and potsherds from several vessels. The gouges, the "turning tool" and the awl were probably used for fine woodwork.

The last grave to be noted here is grave A874 with a full weapon-set and an object looking like a pair of tongs (Fig. 31). These tongs are very fine, with the two arms bent slightly backwards. As of yet it is not certain that this was their original form.

It is anticipated that more small tools will be discovered during the future study of the graves.

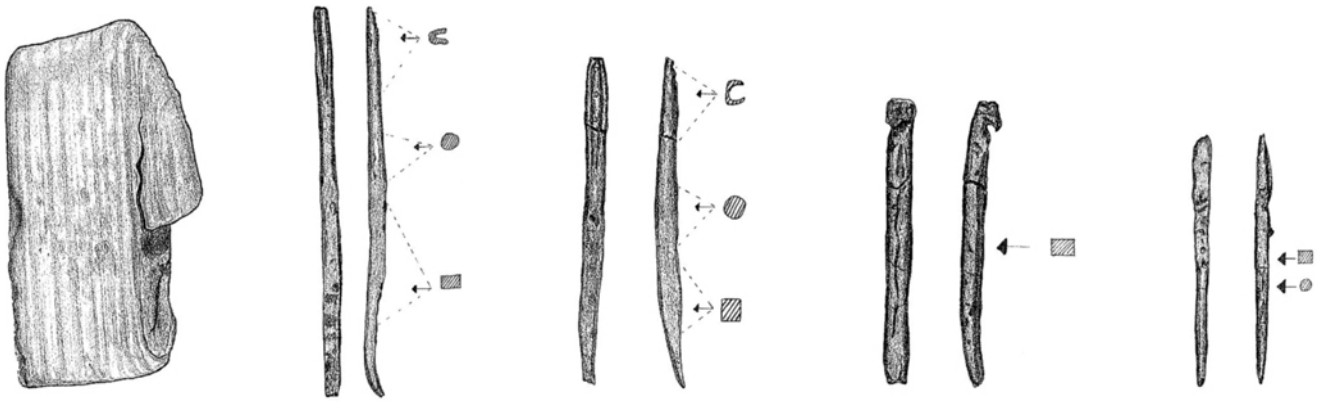


Fig. 29. Whetstone, three of the tools with a chisel-like edge and the awl from grave A271 (1:2). Drawing Lizzi Nielsen.

Graves containing small tools are an extreme rarity in the Iron Age. From the late pre-Roman and Early Roman Iron Age only a few smiths' graves with hammers and tongs are known. These graves are concentrated in the same local group as Hedegård, in the western part of the former Skanderborg *amt* (Levinsen 1984, 202). No standard smiths' graves have been found at Hedegård.

Graves containing tools show that the craft practised by the deceased during his life was of considerable importance in respect of status and so should also be marked in the grave. Whether or not this also indicates that the deceased were specialized craftsmen is another matter.

The foreign streak

In the import graves the foreign material is conspicuous and unambiguous. However many of the other graves at Hedegård also bear signs of foreign influence. The four extremely rich individuals thus appear to have had some impact on those around them, in terms of both wealth and external contacts. This foreign streak can be found both in the artefacts and in the more ideological sphere. It is a matter of diverse contacts, with the Romans and the Celts, and, more locally, with other Germanic "tribes". The bronze vessels from the Roman area have already been noted. To these we can add the *pugio*, possibly the ferrule, and certainly the glass beads. The numerous La Tène swords presumably come from the Celtic area, and one very long spearhead (61 cm) and the long knives in A 1136 seem very probably also to come from this source. There are also signs of contact with closer Germanic areas. The evidence for this includes a bronze fibula with long false spirals (Madsen 1987, 328). Similar "T-fibulae" are known from Vendsyssel in Period IIIa, although there they are of iron (Bech 1975, 82), and are not, as the Hedegård piece is, attached to a developed K-fibula. The long false spirals of this fibula are rather typical of Gotland. The massive cast bronze belt and the zoomorphic handle ought also to be viewed as signs of internal Germanic

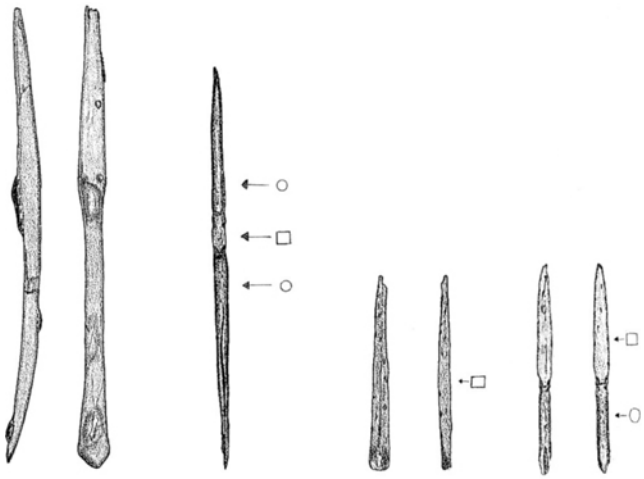


Fig. 30. Turning tool, two gouges and an awl from grave A1187 (1:2). Drawing Lizzi Nielsen.

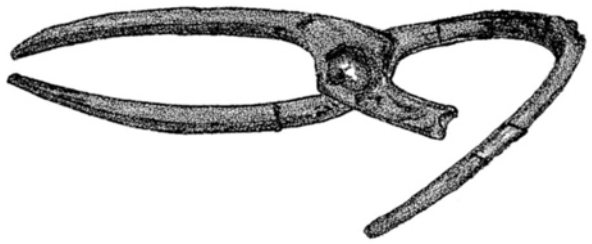


Fig. 31. The tongs from grave A874 (1:1). Drawing Lizzi Nielsen.

contacts reflecting Celtic craft influence. On the evidence of the iron analysis, the mail-shirt apparently points in the same direction. Typologically, however, it is unquestionably Celtic.

The network of contacts was thus both large and diverse, as will probably appear all the more clearly when all of the graves have been studied in greater detail.

The boat grave

Very close to the northern limit of the cemetery, a feature 4.65 m long and 0.6 m wide running east-west (A 3725) was found in 1991, with the sherds of a small pot at the western end and a small handled vessel at the eastern end (Fig. 32). the fill of this feature was highly reminiscent of the slightly loamy natural soil that is usually found in the inhumation graves at Hedegård, although in comparison with these this feature was excessively long and narrow. A few centimetres down into the feature, however, the explanation was found. This feature was in fact a boat grave: the first and so far the only one at Hedegård, and the earliest in Denmark apart from on Bornholm.

The form of the boat can be largely reconstructed from its impression. Since the boat was preserved only in the form of an impression, it posed seriously problems in respect of excavation technique. Via cand.phil. Jørgen Dencker a message was passed to Ole Crumlin-Pedersen, Skibshistorisk Laboratorium, who had both excavated several of the boat burials at Slusegård and had just published the boat graves of that cemetery. The boat grave was then excavated according to his directions. The boat was excavated in perfectly horizontal spits which were drawn at the scale of 1:10 at every 2 cm level. Near the bottom of the boat the technique was modified to leave a section in the middle of the boat in order to reveal, if possible, any keel or the like. There was none present. The method of excavation meant that the form of the boat can now largely be reconstructed. It is what is known as a extended log boat, 3.65 m long at the gunwales and now 0.6 m wide (Fig. 33). The massive stem post was almost beak-shaped. The stern post was less easy to follow as part of the grave goods – a black-burnished bowl – was unluckily placed in such a way here as to obscure the form of the boat. To make a guess on the basis of the few sections that could be seen, it appears likely that the stern post was rounded. The side of the boat, the gunwale, was 1-2 centimetres thick.

The grave goods in the boat were relatively sparse (Fig. 33). In addition to the two pots placed on top of the grave at either end of the boat the small bowl was found at the stern, as mentioned, while a dish was found in the bows with a bowl lying on its side immediately in front of it, right up in the curve of the prow. Roughly in the middle of the boat there was finally a small, curved iron knife with the remains of a wooden haft. Altogether this was a rather humble assemblage, which cannot be more closely dated than to the Early Roman Iron Age. Since, however, this is an inhumation grave, and such graves at Hedegård date to Period B2, the boat grave is presumably also to be assigned to this period.

In the bottom of the boat, close to the prow, five absolutely identical iron clamps were found, laid in a straight row at exactly 14-cm intervals (Fig. 33). These probably represent a repair to the boat. The iron salts in the clamps had preserved some of the oak from the boat. As far as we know, this repair using iron clamps is the earliest known example of the use of iron in a boat in Scandinavia. A similar repair is known from a Swedish boat of the Early Germanic Iron Age (Humbla 1949, 11).

The Hedegård boat has its nearest parallels, both typological and chronological, at the Slusegård cemetery on Bornholm. Here the boats could be divided into three types, of which the Hedegård boat clearly belongs with the extended log boats of size-group 1: the short type, with the form of the prow most like type 6 (Crumlin-Pedersen 1991, 168, 171, Fig. 91:6).

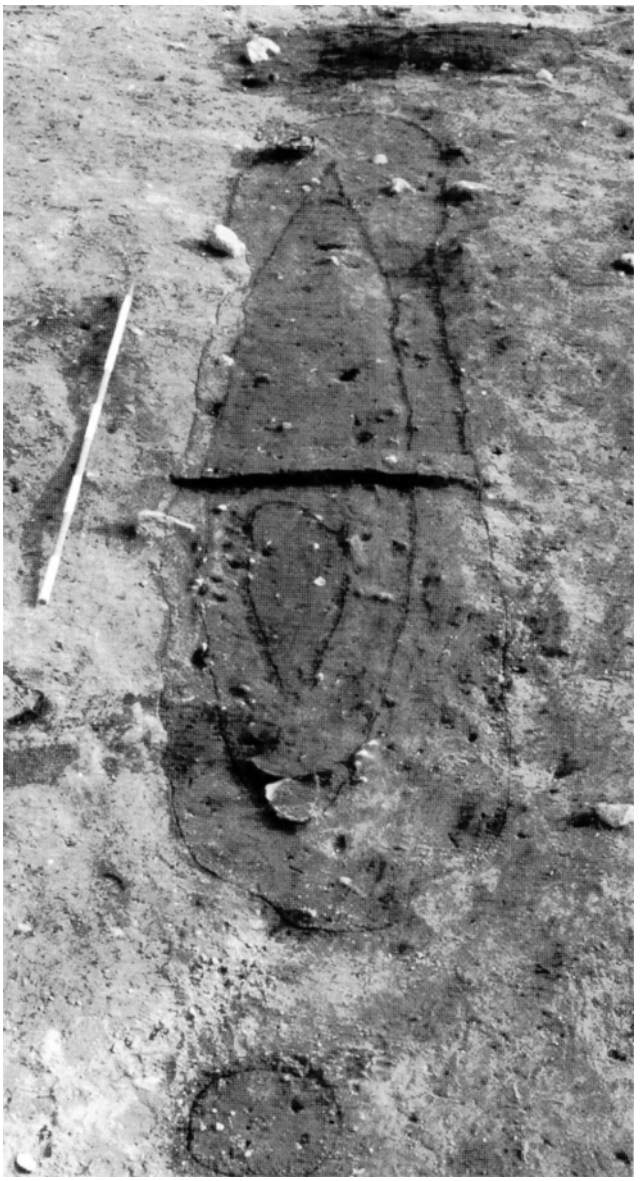


Fig. 32. Boat grave A3725 seen from the west during excavation. The outline of the boat in the surrounding fill has been highlighted.

There was no trace of struts in the Hedegård boat, but, as in the Bornholm boats, these were probably removed before the boat was used as a coffin.

The similarity with the boat graves of Bornholm is, therefore, striking, and the greatest difference, apart from the iron clamps, is that the Hedegård boat grave was aligned east-west with the prow to the east while those on Bornholm were most commonly aligned north-south (Crumlin-Pedersen 1991, 206). This can probably be explained in terms of the general differences between the two areas in terms of the normal orientation of inhumation graves.

The Hedegård boat grave is, as noted, the earliest and as yet the only Early Roman Iron-age boat grave in Denmark west of Bornholm. Two other boat graves are known from Jutland, the prow of an extended log boat from Foulum near Viborg and a clinker-built boat from Brokjær near Ribe. The Foulum grave is dated to the Early Germanic Iron Age and the Brokjær one to the transition between the Late Roman and Early Germanic Iron Age (Crumlin-Pedersen 1991, 232ff.).

The Slusegård boat graves are interpreted by Crumlin-Pedersen as the burials of an especially powerful priesthood (Crumlin-Pedersen 1991, 221). This is not the place to discuss this proposition in detail, nor can a single boat grave from Hedegård make any fundamental contribution to the question. The Hedegård boat grave is, however, an extremely important ele-

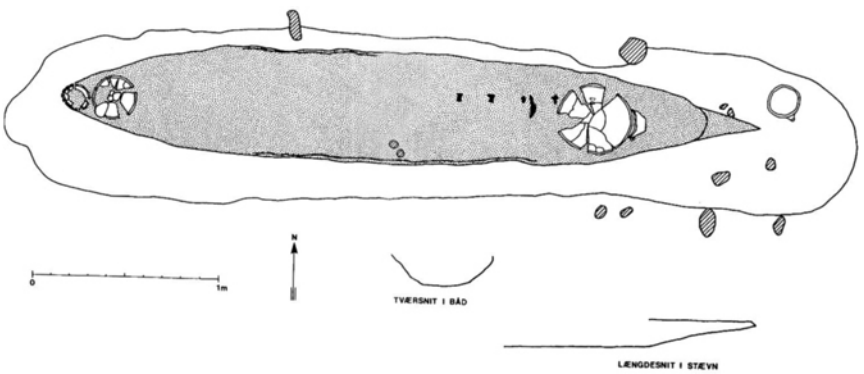


Fig. 33. Plan of grave A3725 showing the cross-section and bow profile of the boat. The boat impression has been emphasised by shading (half tone), iron artefacts are drawn in with black while the pottery vessels have been left untouched. Drawing Ina Holst.

ment of the cemetery as it is an example of the site's extensive and diverse cultural connections, which comprised not only material but also ideas.

The subsequent development of the complex

The Hedegård cemetery seems to have been founded with the rich horizon containing the Roman imports, the large quantities of weaponry, the tools and the generally rich international connexions. After this phase the wealth diminishes. This may, of course be due to the site losing some of its importance, but there may also be another explanation. An old find may shed some light on the matter.

In 1860, one or two sets of horse harness were unprofessionally excavated in the barrow Storhøjen, Rønslunde, at the farm of Højgård only about 800 m east of the Hedegård cemetery (Fig. 1) (Klindt-Jensen 1949, 80ff.; Ørsnes 1993, 192). Storhøjen is now protected, with a massive cavity in its centre. The excavation of the finds was an unscholarly undertaking and it is reported that the harness lay between the top and the base in the eastern side of the barrow to the south of two horse's skeletons that were buried here, side by side, both of them with their head turned to the north. No human grave was found. Its absence is striking, and rather improbable when this is compared with other similar finds. Five graves with horse-harness mounts of the Early Roman Iron Age are known. In all of these cases the horse gear is an element of very rich grave finds which, to judge by the other grave goods, are often women's graves (Hedeager & Kristiansen 1984, 182; Madsen 1984, 136ff.). In light of the other Danish finds there ought to have been a grave in Storhøjen too, and the possibility that one was missed in 1860 has to be considered a real one. The horse harness from Storhøjen may also indicate that there is a cemetery of the Early Roman Iron Age in this area. A Late Roman Iron-age inhumation grave was excavated in the nearly Højgård cemetery (NM j.nr. 86/55, C 27026-27028), and surface finds of glass beads, a bronze ring and sherds show that there are one or more Iron-age sites in the area. In 1989 a trial excavation was conducted south of Højgård after the terminal of a cruciform brooch was found here. Rather unexpectedly, a small-barrow cemetery of pre-Roman Iron Age Period I was discovered (AUD 1989, 178 no. 331). Even more surprising was the result of a small excavation immediately to the north of Storhøjen in 1993. In this area urn-graves of Late Bronze Age Period IV were found (AUD 1993, no. 364), while further south a sunken hut of the Late Iron Age/Viking Period was excavated in 1994 (HOM j.nr. 738). Thus both earlier and later sites are situated in the fields around the farm of Højgård, and all in all Hedegård can probably be regarded as representing a labile Iron-age community like Vorbasse (Hvass 1984). For the time being, however, these suggestions must wait upon further investigations in the area around Hedegård and Højgård.

Although only a very small segment of the Hedegård complex's settlement has been excavated, it is tempting to compare it with the fully excavated village of Hodde. At Hodde, the village was founded by the family in the chieftainly farm (Hvass 1988, 58), which thus held the central, leading position in the pattern of village movement that subsequently appears to be detectable in most Iron-age settlements. If the same were the case at Hedegård, it is possible that the chieftainly family in the village at Hedegård in or just after Period B1 moved to the area by Storhøjen, where one member of the family was eventually buried. If this were the case, there is both continuity in settlement and also a possible explanation of the decrease in wealth in the Hedegård cemetery from Period B2 onwards.

CONCLUSION

The Hedegård complex provides new information about several aspects of social organisation in the Early Iron Age. The combination of a contemporary village and cemetery is, despite the large amount of Iron Age evidence from practically every corner of the country, still relatively rare. It is clear that the presence of both types of site provides optimal scope for the direct comparison of the cemetery structure with that of the village, and thence to tease out information about both the structure of the settlement and the organisation of the community in this period of the Iron Age.

Although only small trial excavations have been carried out in the village area at Hedegård, these have

provided vital information. As of yet, Hedegård is the largest known settlement of the late pre-Roman and Early Roman Iron Age in Denmark. The village was surrounded by heavy, post-set fences which, in addition to marking the bounds of the village, probably also had some protective function. The culture layers and the many traces of ironworking, together with the craftsmen's graves, indicate that iron-production, if not craft in general, played a central role in the economy of this settlement, and thus also, presumably, in the wealth and power of the leading individuals. As the tools were included on an equal basis with other artefacts in the graves, and thus were attributed with equally high symbolic value in the funerary ritual as, for instance, weaponry, it is evident that craft played a central role in the marking of personal status. The analyses of the mail-shirt show that it could have been made at Hedegård. So specialised and complicated a piece of handicraft as this must have been made by an extremely well-trained smith. In the marsh settlement of Feddersen Wierde, admittedly from a slightly later period, it can be seen how the different crafts were directly associated with the chieftainly farm of the village (Haarnagel 1979, 305; 1983, 79ff.). Here, then, there was a relationship of social dependency, possibly a form of servile relationship, between the leader/chieftain of the village and the craftsmen. It is not yet known whether this was also the case at Hedegård. That the craftsmen were buried so close to the graves of the elite may suggest this. When the large number of well-furnished weapon graves are also brought into the picture, the interpretation must be that this is the burial place of a chieftainly family and some of the people who helped to create and perhaps to maintain and enhance the site's (and the leading family's) social and economic position.

Compared with other known settlements the Hedegård village can be classified as a central village (Lund 1988, 147ff.). These very large and manifestly rather rare types of settlement were the central places of the settlement pattern of their time, in respect of the economy, the leadership structure, external contacts both political and trading, and possibly innovation in a wider sense (Lund 1988, 149). As of yet, unfortunately, only one of these settlements has been fully excavated, namely the site of Hodde referred to above. Here one of the most striking characteristics is the separate, fenced-off chieftainly farmstead, which is clearly different from the remaining farmsteads in the village in respect of construction, size and the number of internal divisions.

Typologically, the Hedegård village is apparently comparable with Hodde. As yet, of course, we do not know whether there was a chieftainly farmstead at Hedegård, although to judge from the graves there ought to have been one. These graves show that the central villages, in some cases at least, were the residences of the absolute leaders of society – the individuals buried with Roman bronze vessels.

Hedegård is one of the key sites for the understanding of social development in its entirety, not only in the century around the birth of Christ but throughout the first millennium A.D. The great archaeological potential of the site means that future investigations into the complex should be approached vigorously. Of fundamental importance is that the graves in the cemetery should be studied and related to the other grave finds of this period. Only then can the village study be properly taken up. The large culture layers here mean that excavations will be extremely difficult and very expensive. On the other hand these layers will probably contain information about the productivity of the settlement and thus, perhaps, the background to the many rich graves.

Translated by John Hines.

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The dynamic of the Iron-age village

A technique for the relative-chronological analysis of area-excavated Iron-age settlements

by Mads K. Holst

This article presents a technique for the analysis of relative-chronological relationships within area-excavated Iron-age settlements. A system of relational descriptions is built up, which demonstrates the feasibility of inferring relative-chronological relationships between features from a variety of observations made during excavation, and translating these into formal logical expressions. The logical expressions make it possible to construct a detailed diagram of the temporal structure of the settlement under investigation. The application of this method is illustrated in relation to a small segment of the 3rd- to 7th-century settlement at Nørre Snede, Mid-Jutland. Finally the potential of this technique for analyses of the temporal structure of settlements is discussed.

INTRODUCTION

The use of machines to strip the sites of Iron-age settlements with no surviving culture layers was a methodological revolution when first introduced around 1960, and one which yielded a body of data of hitherto unseen character. The exposure of very large areas and a sharp focus on the constructional entities of the settlements made it possible to achieve a comprehensive image of the settlements and to follow their development over periods of several centuries.

In connection with the very extensive area excavations in Jutland in the 70's and 80's, settlement mobility became very much a central research topic, primarily as a result of the studies at Vorbasse (Hvass 1979; 1983a). At a micro-level a continuous change in the appearance of the individual farmstead could be observed, but even more revolutionary was the indication of clear structures in the course of development even at the general village level. These observations gave the Vorbasse excavations a very prominent role in the characterisation of the "shifting village", a term which C. J. Becker had introduced in connection with the investigations at Grøntoft (1972).

The image that an area excavation presents us with initially, however, is static. It is very much like a photograph taken with an extremely long exposure time, and the job of reconstructing the dynamic original development is a large and complex one. A huge quantity of observations has to be transformed, by various processes, into a body of data, which can be processed using logical principles, and subsequently used to build a model of the development of the village. The purpose of this article is on the one hand to present some theoretical considerations relating to the dynamic of area-excavated Iron-age villages, and on the other to develop a technique based upon these points. This technique results in a detailed relative-chronological sorting of the entities of the settlement and will be capable of contributing to our understanding of the character of the mobility of the Iron-age village. It is primarily applicable to settlements at which the quantity of relationships between the different entities of the site is large, which in practical terms means settlements with preserved fence-lines. A limited segment of the Mid-Jutlandic settlement at Nørre Snede of the later Iron Age will be used to demonstrate this,

and the informative potential of the method will be discussed to conclude with.

THE CHARACTER OF THE DATA

Both the method of excavation and the post-excavation analyses of area-excavated Iron-age settlements lacking preserved culture layers are directed first and foremost at exploiting the information potential of the structural traces. In the absence of find-bearing cultural layers the artefactual evidence is often limited in range, highly fragmentary, and rarely representative, all of which seriously reduces the scope for analysis based upon the finds. This tendency is particularly marked on late Iron-age sites, a period in which the pottery both reduces in quantity and loses formal and ornamental characteristics, significantly reducing the information potential of the excavated artefactual finds. As a result there are still major problems for the establishment of a ceramic chronology that can be employed with the settlement finds of the later Iron Age, putting limits to the level of detail in which the temporal development of the settlements can be illuminated by the finds. On the other hand, the best preserved settlements are characterised by a very large and often only partially exploited body of relative-chronological evidence in the form of a substantial body of documented observations of the structures' relationships with one another. The constant movement of the entities of the settlement means that the structural traces intercut extensively, that openings in fences and doorways are blocked by earlier or later features, buildings and fence-lines are joined together, and so on.

The sheer quantity of data, however, renders it very necessary for the analyses to be conducted with a consistent and explicit method (Madsen 1995). This consistency is an essential prerequisite for the use of digital data processing, without which it is in practical terms impossible to comprehend the basic data and thus to exploit its information potential to the full. We end up reducing the level of detail and merging a series of complex temporal observations to some general and simplified term. The most important reason to develop a formal technique of relative-chronological analysis, however, is that the temporal sorting of a village excavation is, like any other analysis of archaeological evidence, a process of interpretation, the end result of which is based upon a wide range of preconditions. By formalising the methodology and formulating it explicitly one can ensure that these preconditions are absolutely clear. In this way it is possible to measure both any uncertainties that reside within the results obtained and the degree to which the latter can be used in further analyses while avoiding circular arguments. The development of the method itself thus comprises a far from insignificant element of epistemology.

An Iron-age settlement can be treated as a form of system of relations. There is a set of basic entities: the buildings and fences, which are linked together in relative-chronological relationships on the evidence of, for instance, the cutting of one feature by another. The intercutting structural traces of area excavations can thus be equated to the sequences of layers in stratigraphical excavations, where we have already worked for a long time with a stringent, graph based sorting system, the so-called Harris matrix (Harris 1975; 1989, 120ff). In this, each stratigraphical event constitutes an element, whose temporal relationship to another element can be described in terms of one, and only one, of three possible relationships: "earlier than", "later than" or "contemporary with". Portraying the individual entities as boxes that are connected by lines graphically represents this: horizontal for contemporaneity and vertical for earlier-/later-than relationships. There are now several computer programmes available that can produce such graphs (e.g. Herzog 1993). The Harris matrix method was developed in 1973 and has since then occupied an important place in the continuing discussion of the archaeological treatment of stratigraphy (Harris *et al* 1993). To develop a method for the relative-chronological sorting of Iron-age settlements, it is appropriate, therefore, to start from the debate over stratigraphical analysis.

THE SORTING METHOD

The starting point for any work on patterns within Iron-age settlements is, as already determined, the individual structures: buildings and fences. Since the

identification of these entities is of such fundamental importance, it ought for the most part to be carried out even while the excavation is still in progress, where, self-evidently, we have the optimal opportunity to test hypotheses (Hvass 1983b). The farmsteads of the village are, consequently, divided into a wide range of entities: longhouses, minor houses, fence-lines, granaries, etc. All of these entities are included in the temporal sequence and are normally regarded as each constituting a temporal unit, with a clear-cut starting date and end date. A particular line of fencing is assumed to have been constructed, in practical terms, at a particular moment and likewise physically ceased to exist at another precise moment. The same, in general terms, holds for the farmstead as a whole. The earliest features are assumed to have been created to all intents and purposes at the same time, and when the farmstead ceases to exist it is the whole complex, fences and buildings, that disappears together. The situation is quite different with farmstead phases, which are dynamic combinations of entities that do not necessarily share a common start and end point.

The unambigous start and end dates are, self-evidently, both approximations and assumptions. In purely physical terms it is clear that the "moments" must have had some extent of their own, although in the relative-chronological sorting of the Iron-age settlements the duration of at least the period of construction is taken to be so slight that it can simply be ignored. The end date is somewhat more problematic. It is well known that the abandonment of a structure can be a drawn-out process. The cessation of use of a building for occupation is not the same as the end of its physical existence. It may collapse slowly and be part of the landscape in one form or another after abandonment (Cameron 1991). It must therefore be emphasised here that what we use in the relative-chronological sorting is observations of traces of the physical features and not of their function. The start date for a structure is consequently the point at which it appeared in physical terms. Similarly the end date is the point by which an element, in physical terms, must have disappeared or been so reduced that it no longer had any physical influence on new entities. Even though the concept of end date is most appropriate in respect of the deliberate demolition of structures, there is in principle no objection to using the end date as an abstract, purely functional concept, relating to the gradual decay of buildings.

On the basis of the above, we can treat it as an acceptable generalisation, that Iron-age settlements consist of a series of entities: fence-lines, buildings and, somewhat less certainly, farmsteads, all of which are characterised by unambigous start and end dates.

Starting from the Harris matrix model, the relative-chronological sorting can be understood as a representation of the temporal relationships between the entities of the village distinguished. Here it is of the greatest importance that the entities are temporal unities. If this is not the case, logical inconsistencies will emerge sooner or later, which will prevent the systematic treatment of the evidence that is absolutely essential with the huge quantities of data from area-excavated settlements.

It is not, however, possible simply to use the same principles of description that can be used in stratigraphical excavations. In the later the individual entities function as if they were *moments in time*, while with the often very large number of more or less contemporary entities from Iron-age villages it is of great importance to be able to work with the fact that the structures cover a *span of time.*

If one understands a span of time as the period between a start date and an end date, it is possible to describe the life-span of the entities by using two moments in time, with the start date and the end date being linked in an earlier-/later-than relationship. It is then possible to describe every element's temporal relationship to any other element in terms of the relationships between the two entities' start and end dates. These points, to which the relationships refer, are called *relata.* One can thus distinguish on the one hand between an expression such as "X is earlier than and of a different period than Y" (end of X is earlier than start of Y), and "X is earlier than and immediately succeeded by Y" (end of X is contemporary with start of Y) on the other. At the same time it will be possible to describe a situation in which a fence is built on to an earlier fence and both fences are decommissioned at the same time (start of X is earlier than start of Y and end of X is contemporary with end of Y). In a formal description of these expressions, "earlier than" is represented by the symbol \ and "later than" by /, while contemporaneity is represented by =.

It must be noted, that in principle the start and end dates which define the entities' life-span cannot be counted in the life-span, as that would imply that two successive entities existed together at the point at which one element comes to an end and the other begins. Even though this is insignificant in terms of the archaeological problem, it is in logical terms important to understand that the life-span of the entities includes only the open interval between the start and end dates.

It is only a very small proportion of the originally colossal volume of relationships that can now be inferred from the archaeological evidence, and so with the majority of the entities it is not possible to detect the exact temporal relationships between the start and end dates of the entities. All the same we may have observations that indicate or demonstrate that two such "floating" entities either cannot both have existed at the same time or conversely that they must have co-existed in at least some of their respective life-spans. In logical terms it is still possible to describe the temporal relationship between the two entities by relating their start and end points alone in terms of the relations "earlier than", "later than" and "contemporary with", but it is necessary to link these relationships with logical operators, i.e. "and", "or" and "either/or" expressions for which AND, OR and XOR is used. The expressions "younger than or contemporary with" and "earlier than or contemporary with" can be abbreviated to /= and \= .

The temporal relationship between two entities about which we know only that they existed concurrently at some time can thus be described as *start of element X is earlier than end of element Y and end of element X is later than start of element Y*, or, more formally:

$$X(\text{start}) \setminus Y(\text{end}) \text{ AND } X(\text{end}) / Y(\text{start}) \qquad (1)$$

Similarly, the temporal relationship between two entities which definitely did not exist at the same time can be described as *either start of element X is later than or equal to end of element Y or end of element X is earlier than or equal to start of element Y*, which appears formally as:

$$X(\text{start}) /= Y(\text{end}) \text{ XOR } X(\text{end}) \setminus= Y(\text{start}) \qquad (2)$$

The use of the AND expression is unproblematic as it only means that an observation involves two or more relationships between the relata of the compared entities. On the other hand OR and XOR expressions are problematic in respect of the production of a graph showing the temporal relationship between entities as it is not possible to represent this uncertainty. The problem can partly be solved by including the new relationships \= and /=, but a series of other expressions are impossible to represent without one element appearing in several places in the graph, an undesirable situation for several reasons. It has therefore been necessary to accept that we can have observations from an excavation which imply relationships that can influence how the individual entities are placed in the relative-chronological sorting but which are not represented in the graph based presentation of this scheme.

In order to achieve optimal exploitation of the potential information from major area-excavated Iron-age settlements and a precise description of the temporal relationship between the entities of the village, it is thus necessary to establish a far more complex descriptive system than that which has traditionally been used for the relative-chronological sorting of stratified excavations. If one sticks to the simple method of description one at best gets a simplified image. Large groups of entities will appear to have been demolished or constructed at the same time, even though in reality they represent gradual replacement. The account thus loses some of the dynamic that the evidence embodies. Finally it will be more difficult to measure the weaknesses in the sequence of development one produces as, for example, a relationship of contemporaneity will lock two entities together in respect of both their start and end dates, while the entities with the extensions presented above are only aligned just as much as there is evidence for in the observations made in the course of excavation.

It needs finally to be noted that the principles presented above can not only be used in connection with area excavations of Iron-age sites but also for the temporal sorting of any group of entities with a diachronic dimension that are linked together by relative dating.

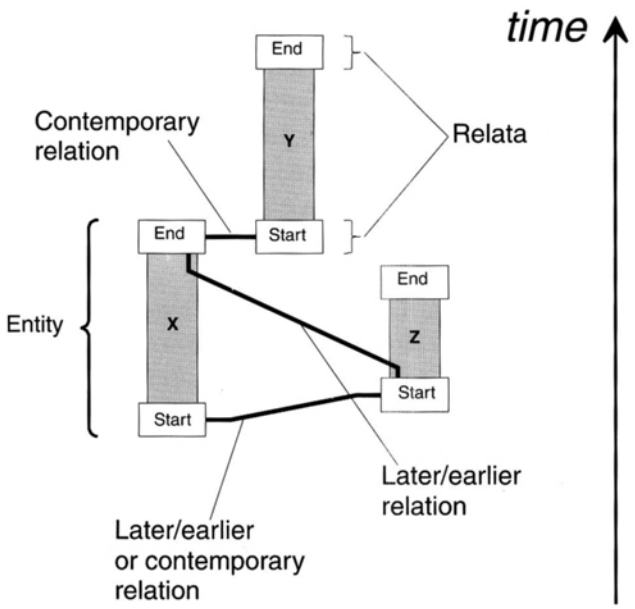

Fig. 1. The main components and terminology of the graphical representation of the relative chronological sorting.

THE PRODUCTION OF THE RELATIONSHIPS

From the above survey we can distinguish three levels in the process of relative-chronological sorting:

1) A level of observation, in which the significant relative-chronological facts from the excavation are recorded. At this level one works with *entities*: in other words the unambiguously temporally discrete structures such as buildings and fences.
2) A level of logical operation, in which the observations are reformulated in terms of formal relationship expressions which are collated and reduced to the shortest possible logical terms. At this level each element is represented in terms of two *relata*: the start and end point of the entity. Relata are connected by *relationships* and the sum of the relationships between two entities is the same as the *relative-chronological relationship* between the entities in question.
3) Finally, a level of graphic modelling, in which a graph of the relative-chronological sorting is produced on the basis of the inferred relationships (Fig. 1).

The following section focuses on how we move from the one level to the next; in other words on how the various observations from the excavation are translated into relationships, and how the relationships can be used to construct a graphic image of the relative-chronological relationship between the entities of the settlement.

It is rare for the field records relating to the temporal position of the structures to be immediately interpretable in terms of relationships between the start and end dates of the entities. It will often, in fact, be necessary first to clarify what degree of continuity there is in the replacement of structures, and the earliest and latest phases of the farmsteads have to be identified, before it is possible to deduce the precise relative-chronological relationships between the two entities: i.e. a number of observations have to be linked together. In a typical excavation situation where only a limited part of the settlement area is open at any time it is often very difficult to get a clear view of all of these observations in the field, and a direct relative-chronological sorting of the entities of the settlement is consequently only rarely possible. Finally a range of information about the temporal relationship between entities is not deliberately collected but can be discovered later by examining the composite excavation plans and with the help of parallels from other area-excavated Iron-age settlements. The basic evidence for the relative-chronological sorting of the Iron Age settlement thus takes the form of a range of more or less deliberate, formulated or unformulated observations, about the temporal relationship between the entities.

It must be emphasised that the production of relative-chronological observations involves a great deal of interpretation, and is based on a number of principles and presuppositions, which can rarely be explicitly formulated. During the area excavations with many overlapping construction traces the model is based primarily on an assumption, well-supported by the more thinly spread settlement, that the settlement consists of a number of well-defined, autonomous farm units, the central structure in which is the longhouse. An absolute rule is that a farmstead at any one time comprises one and only one longhouse. Something similar is assumed to be the case for the fences, which delimit the farmstead area: we do not have sev-

eral contemporary parallel rows of fencing bounding the farmyard. These assumed principles of architectonic composition are highly influential in directing the inference of relative-chronologically significant observations, and the temporal importance we attribute to a variety of our excavation records presupposes that the principles enunciated here are valid for the lifetime of the structures.

The observations relevant for relative chronology can be sorted into five groups: asynchronic, synchronic, diachronic, implicitly continuous, and implicitly discontinuous observations. We can also talk about two types of observations: on the one hand those that are simple and direct, and on the other those that are complex and derivative.

The asynchronic evidence is characterised by yielding information about what cannot have been contemporary, while the synchronic observations, by contrast, demonstrate contemporaneity. The diachronic observations provide information about the temporal sequence of features in the settlement. The implicitly continuous evidence indicates which entities can be regarded as being linked in a temporally coherent sequence while the implicitly discontinuous observations conversely separate phenomena in time.

This classification of the evidence or indications from the excavation concerning the temporal relationships between structures naturally constitutes a systematisation and clarification of the large number of observations made during area excavations. But by far the most important reason for this systemisation is that these five groups have different implications for the deduction of relationships between relata.

The difference between the simple, direct observations and the complex, derived observations covers the fact that certain relative-chronological relationships can be drawn directly from one simple field observation, while others require a wide range of single observations to be put together. The latter, complex observations can be difficult to deal with systematically, and to allow for checking of the relative-chronological sorting it is important that an account is given of the character of the complex, derived observations every time they are used.

There is one final distinction amongst the observations that should briefly be introduced. This concerns the difference between what we can call symmetrical and asymmetrical observations. With symmetrical observations the temporal expressions will be the same, irrespective of which entity one takes as the base line, while the temporal expressions with the asymmetrical observations will vary according to the reference point. For instance, an observation, which states that two entities were in existence at the same time, is a symmetrical observation, while one that states that one element is earlier than another is asymmetrical.

It is important to stress that the difference between the symmetrical and the asymmetrical here refers to the structures' temporal position at the level of observation and not to the relationships at the logical-operative level. We can indeed talk about symmetry and asymmetry at the logical-operative level. Thus = is a symmetrical relationship, while / and \ are asymmetrical and the inverse of one another. At the logical-operative level, however, the difference between the symmetrical and the asymmetrical refers to relata, while that at the observational level refers to the entities or structures. As a result, an observation can be asymmetrical while its relational expression is symmetrical. For instance, an observation that shows that one element succeeds another will be asymmetrical at the observational level. If the earlier feature be X, the relationship will be:

$$X(\text{end}) = Y(\text{start}) \tag{3}$$

while the expression of the inverse situation in observational terms, with X now the later feature, will be:

$$X(\text{start}) = Y(\text{end}) \tag{4}$$

At the logical-operative level these are two symmetrical relationships, each with its own relata.

The logical asymmetry is important in the context of recording in a database, where both the relationship and the inverse relationship have to be registered. This is, however, of less importance in connection with the translation of observations into formal logical relationships, which is the subject of the following sections.

Asynchronic observations

Asynchronic information (Figs. 2-3) indicates which phenomena cannot have been contemporary, with-

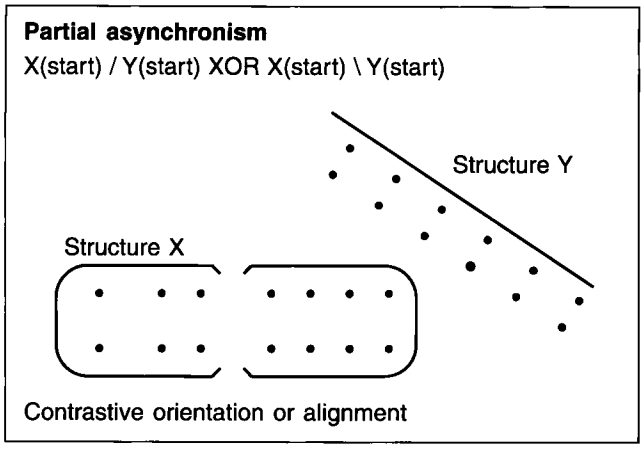

Fig. 2. Partial asynchronism. Example of observation and the logical expression.

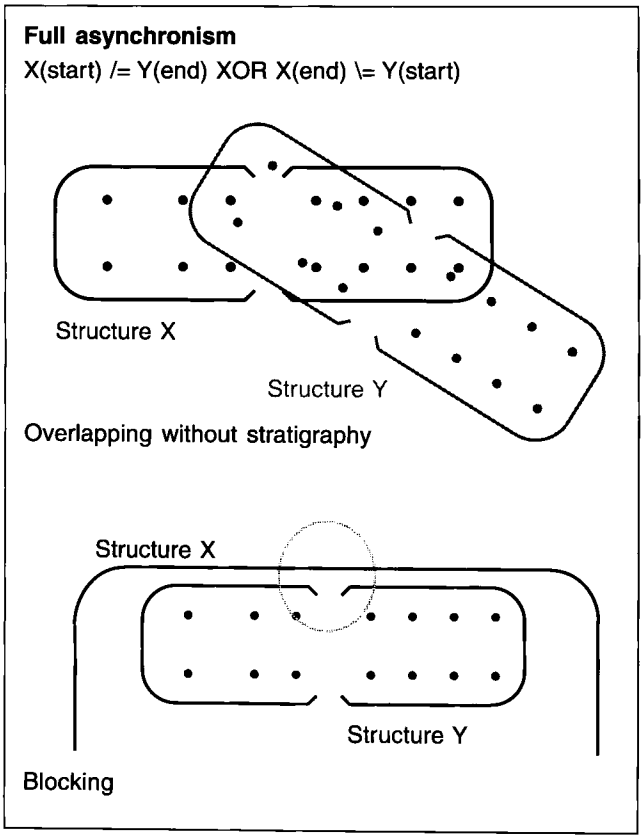

Fig. 3. Full asynchronism. Examples of observations and the logical expression.

out being able to identify which is/are older or younger. It is possible to have partial asynchronism, where the observations only allow one to say that the entities cannot have existed simultaneously for at least part of their lives as for example when two structures cannot have been founded at the same time. In this case the result is the following relationship:

X(start) / Y(start) XOR X(start) \ Y(start) (5)

To this class of observations belongs the temporal differentiation of structures on the basis of contrastive orientation or alignment, which, according to how great the difference is, may be more or less reliable as evidence. Markedly different alignments between buildings within the same, otherwise regular farmstead make it at least doubtful that the buildings were constructed at the same time.

There can also be examples of complete asynchronism, where two structures undoubtedly never existed at the same time, giving the relationship:

X(start) /= Y(end) XOR X(end) \= Y(start) (6)

Observations that reveal full asynchronism include overlapping without stratigraphy, and features that block one another. Both of these observations, like the observation of difference in alignment, belong to the group of simple, direct observations. A complex, derived indication of asynchronism is the identification of what one can call functionally identical structures within the same farmyard, such as longhouses and the boundary fence of the yard. Here one can assume that only one of the structures within each functional assemblage can have been in use at any one time.

Synchronic observations

Diametrically opposed to the asynchronic observations, evidence of synchronism provides information about contemporaneity (Figs. 4-7). One can distinguish between several different forms of synchronism, of which the most frequently encountered is what is referred to here as general synchronism. This means that two features existed simultaneously for some part

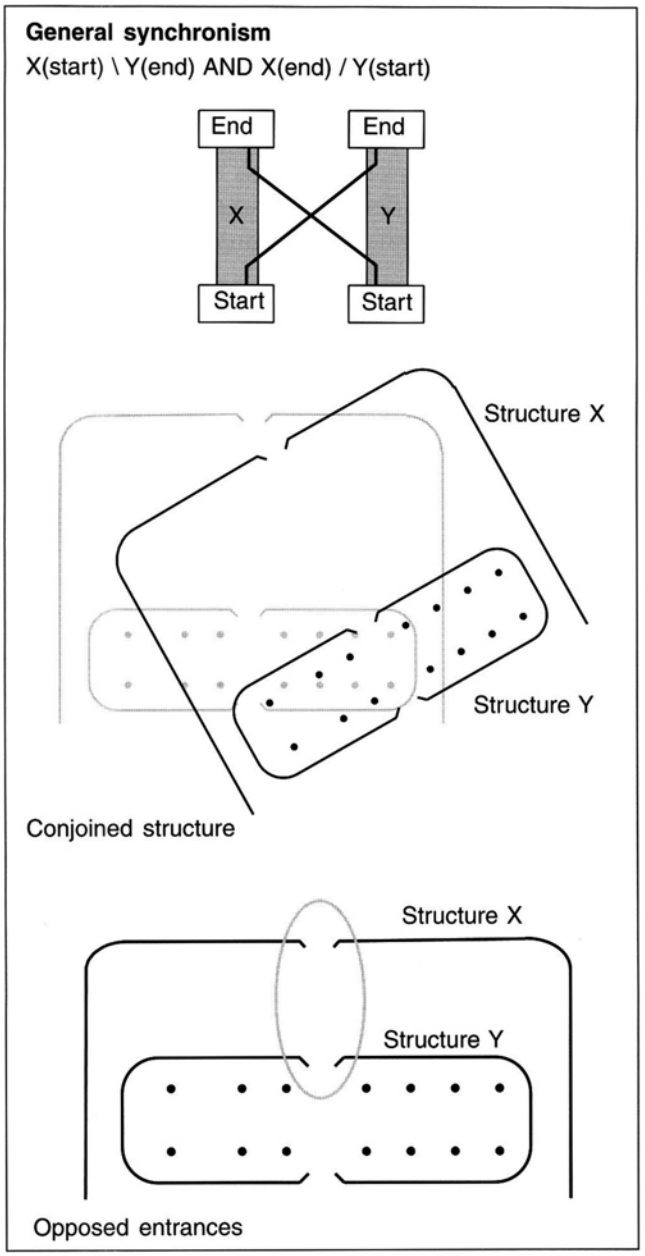

Fig. 4. General synchronism. Examples of observations, the logical expression, and the graphical representation.

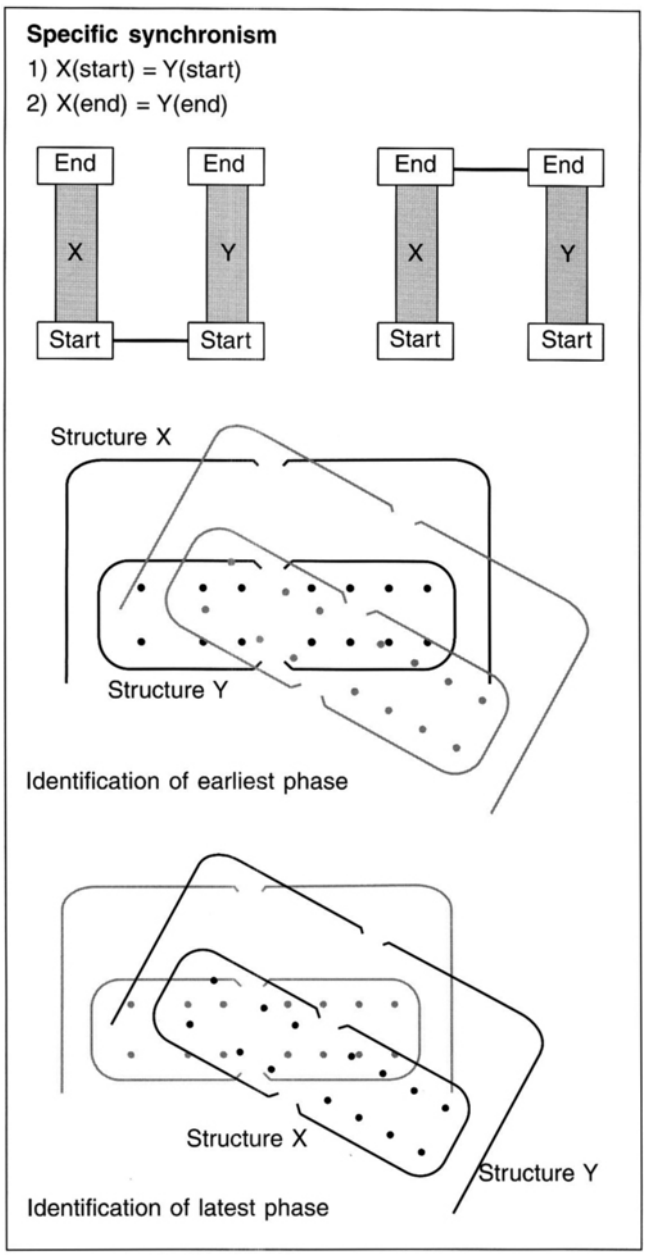

Fig. 5. Specific synchronism. Examples of observations, the logical expression, and the graphical representation.

of their life-span but no more precise information is available. This involves the relationship:

$$X(\text{start}) \setminus Y(\text{end}) \text{ AND } X(\text{end}) / Y(\text{start}) \qquad (7)$$

As examples of the simple, direct observations, which involve this type of relationship, we can cite conjoined structures, and entrances in fences and small buildings directly opposite the doorways of longhouses. In some cases agreement in alignment is found as an argument for the concurrent existence of the entities, although this evidence is very uncertain. Where a fence is shared by two farmsteads, there is general synchronism, on the basis of the fence, between the two farmsteads. Amongst the more complex, derived ob-

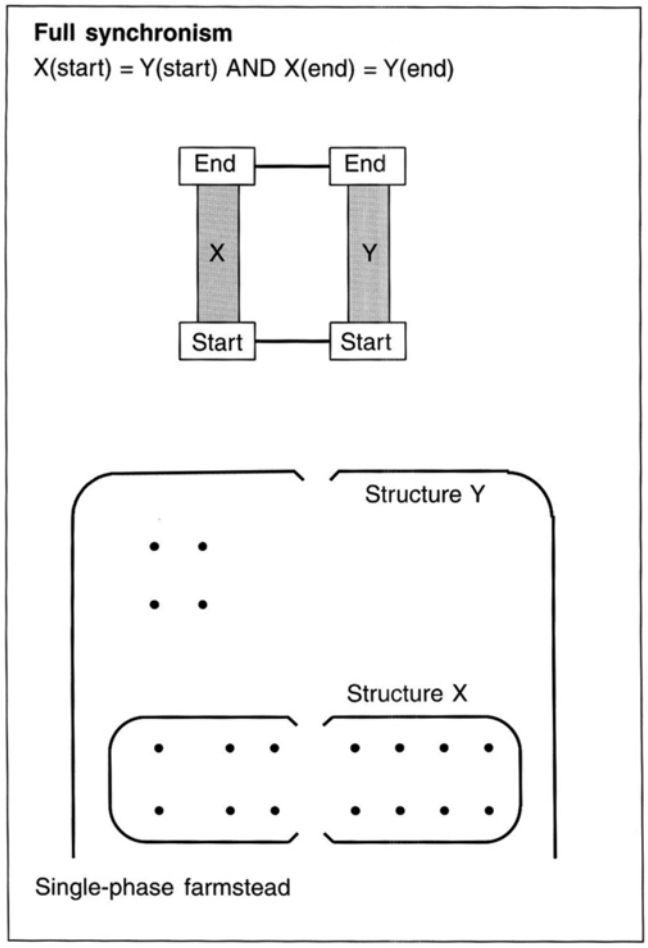

Fig. 6. Full synchronism. Example of observation, the logical expression, and the graphical representation.

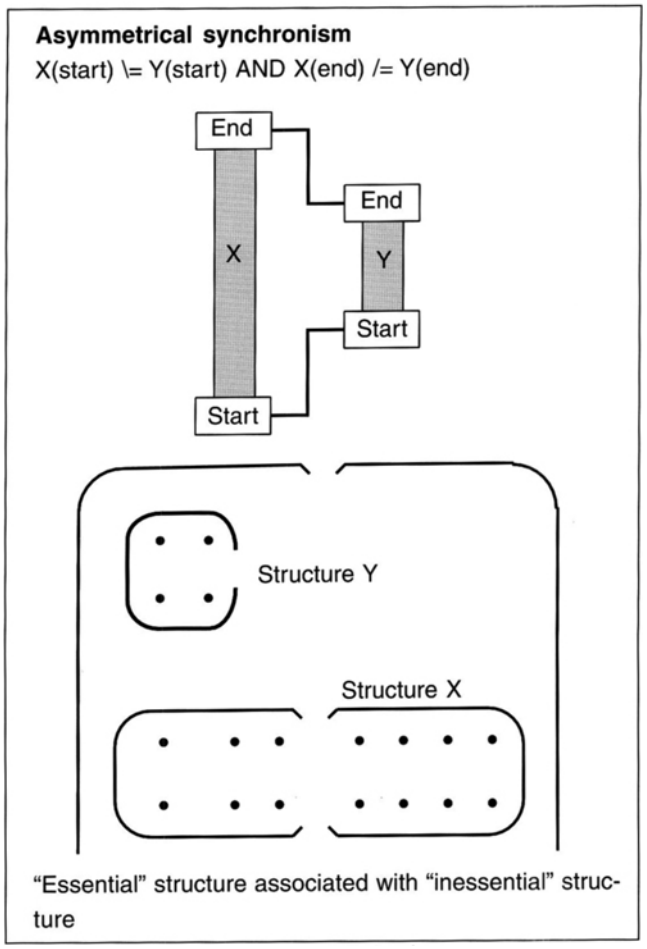

Fig. 7. Asymmetrical synchronism. Example of observation, the logical expression, and the graphical representation.

servations, the association of several entities with a particular phase of a farmstead is by far the most important of the indications of contemporaneity. This involves the interassociation of a large number of minor observations, which in methodological terms is an extension of the identification of the entities. If the farmsteads exist as single-phase phenomena without later disturbances, free of earlier structures and well preserved, both the identification of entities and the interassociation of fences, longhouses and minor houses inside the farmyard is a relatively simple process. The situation is quite different, however, in areas with many overlapping settlement traces, where it is often difficult to assess which fences are to be associated with which longhouses. In these cases the identification of both entities and farmsteads frequently ends up based upon references to the image of Iron-age farm structures and buildings that has been created during the last 35 years' area excavations.

If there are indications that all the structures were either raised or demolished at the same time it is possible to be more precise about synchronism, and one can then operate with a specific synchronism represented by the relationships:

$$X(\text{start}) = Y(\text{start}) \tag{8}$$

for structures raised at the same time, and:

$$X(\text{end}) = Y(\text{end}) \tag{9}$$

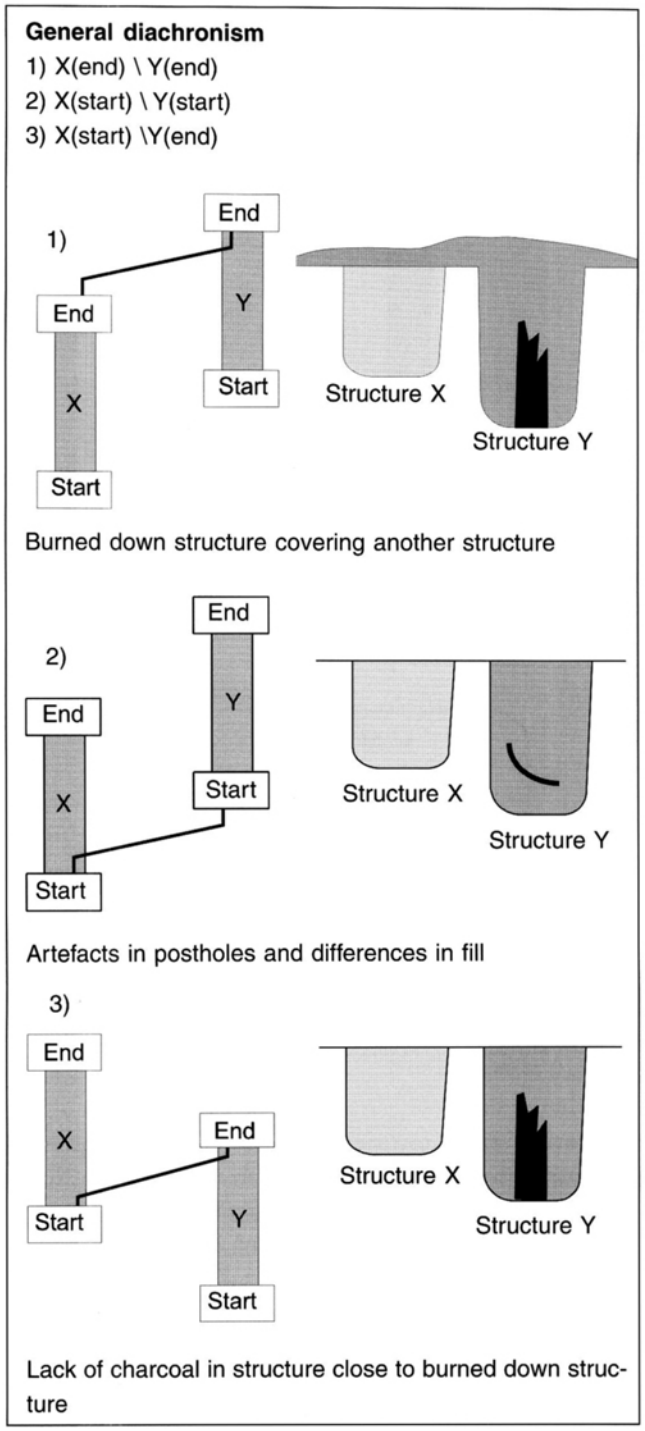

Fig. 8. General diachronism. Examples of observations, the logical expression, and the graphical representation.

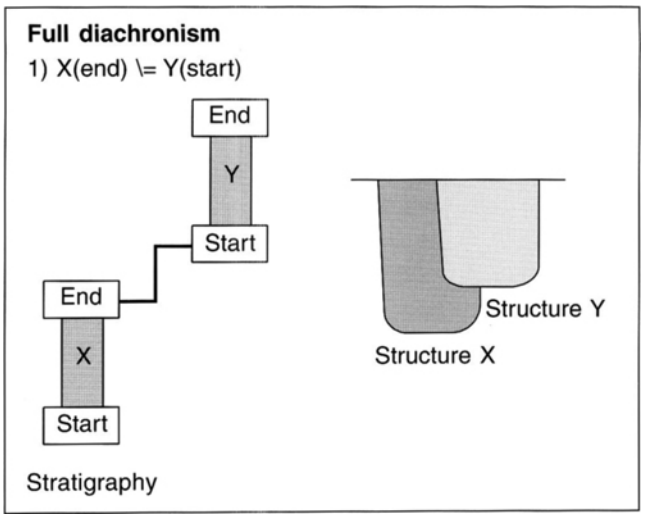

Fig. 9. Full diachronism. Example of observation, the logical expression, and the graphical representation.

for structures demolished at the same time. Observations which imply relationships of this type will often be of the complex, derived type, such as the identification of the earliest and the latest phase of structures in the history of a farmstead. In the intermediary phases of the farmstead there can, of course, be no certainty that longhouses and fences were replaced at the same time.

Where the structures were both raised and demolished at the same time, we have full synchronism, giving the relationship:

$$X(\text{start}) = Y(\text{start}) \text{ AND } X(\text{end}) = Y(\text{end}) \qquad (10)$$

Full synchronism is found between what we can call "essential" structures within a single-phase farmstead. By "essential structures" is understood those structures which define the farmstead and which can be assumed to have existed throughout its life-time, i.e. the longhouse and the boundary fence.

The final form of synchronism to be treated here is called asymmetrical synchronism. This form of relationship occurs when the life-span of one feature lies within that of another feature but does not necessarily extend over the whole of that period. Formally, this involves this relationship:

$$X(start) \leq Y(start) \text{ AND } X(end) \neq Y(end) \quad (11)$$

Asymmetrical synchronism is, as the name implies, an asymmetrical observation. It typically arises where a supposedly "essential" structure is found in association with an "inessential" one. For example, a stack barn may be found within the farmyard of a single-phase farmstead. In this case the barn can be assumed to have existed within the life-span of the longhouse and the farmyard fence, but not necessarily throughout the whole of that period. When a farmstead has several phases, features, which cannot necessarily be related to specific structures, can similarly be assumed to have had a functioning life, which at least does not fall outside the life-span of the farmstead. It must be emphasised that the "inessential" structures have to be unambiguously associated to some specific "essential" element for asymmetrical synchronism to be invoked. In general, the observations, which lead to asymmetrical synchronism, have to be classified as complex and derived.

Diachronic observations

With the information they provide about the temporal sequence, it is the diachronic observations that add movement to the settlement picture (Figs. 8-9). Traditionally, a diachronic relationship between two entities is described as either an "earlier than" or a "later than" situation, but just as in the survey of asynchronous and synchronous observations it is also necessary here to sharpen up and subdivide the terms in question.

General diachronism comprises those cases in which the observations indicate that one feature was either raised or destroyed before or after another one, but without the temporal sequence between the two being revealed in any other way, and with a degree of overlap remaining possible. In principle this involves three different types of observation. One results in relationships between the end dates of the structures:

$$X(end) \setminus Y(end) \quad (12)$$

Another leads to relations between the start dates:

$$X(start) \setminus Y(start) \quad (13)$$

And the last type of observations result in the start date of one structure being linked to the end date of another structure:

$$X(start) \setminus Y(end) \quad (14)$$

Diachronism implies relationships of the earlier-than/later-than type, and thus asymemtrical observations.

A burned down structure whose charcoal layer covers another structure is an example of diachronic observations which concerns the end dates of features, as the structure covered must have ceased to physically exist before the other structere was destroyed in the fire.

As an example of diachronic observations which concern the start date of the features, one could point to particular differences of fill. If the fill in the postholes of a structure contains higher concentrations of artefacts and dark culture-layer material while another structure in the same area has a light fill with no finds, this can be used as evidence that the structure with the light fill was built first, especially if it appears probable for some other reason that the two structures are temporally close to one another.

Differences of fill can also be used as an example of observations, which yield diachronic relationships between start and end dates. If one has traces of a building that had burnt down, while another structure in the same area, ideally one similar in date, does not have any charcoal in the postholes, one can infer with some reservations that the structure without charcoal was erected before the other structure was burnt.

Another form of diachronism is what we can call full diachronism, when two features have not existed simultaneously at all. Fundamentally, this is a matter of a combination of the general diachronism just discussed with full asynchronism, but since a very important and extensive group of observations from excavations, namely the cutting of one feature by another (often called stratigraphy), involves relationships of this type, it is distinguished here as a separate type. Since the actual start and end dates, as noted above, do not in logical terms belong to the life-span of the entities, the formal expression of "earlier than" is:

$$X(end) \leq Y(start) \quad (15)$$

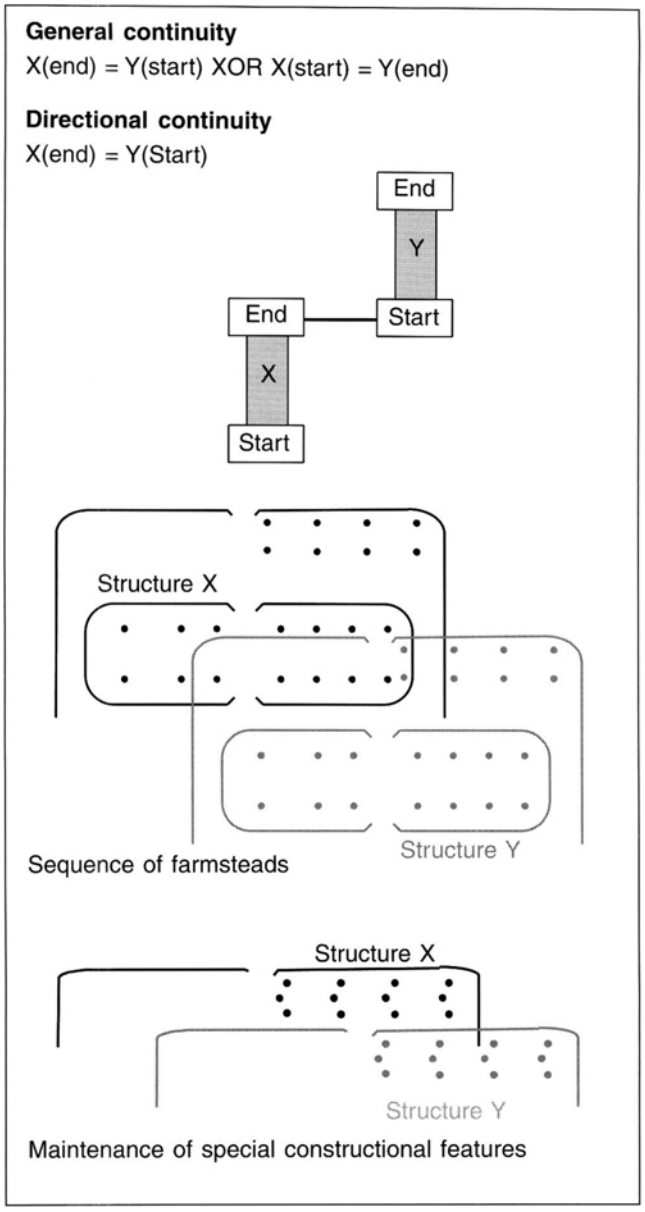

Fig. 10. Continuity. Examples of observations, the logical expression, and the graphical representation.

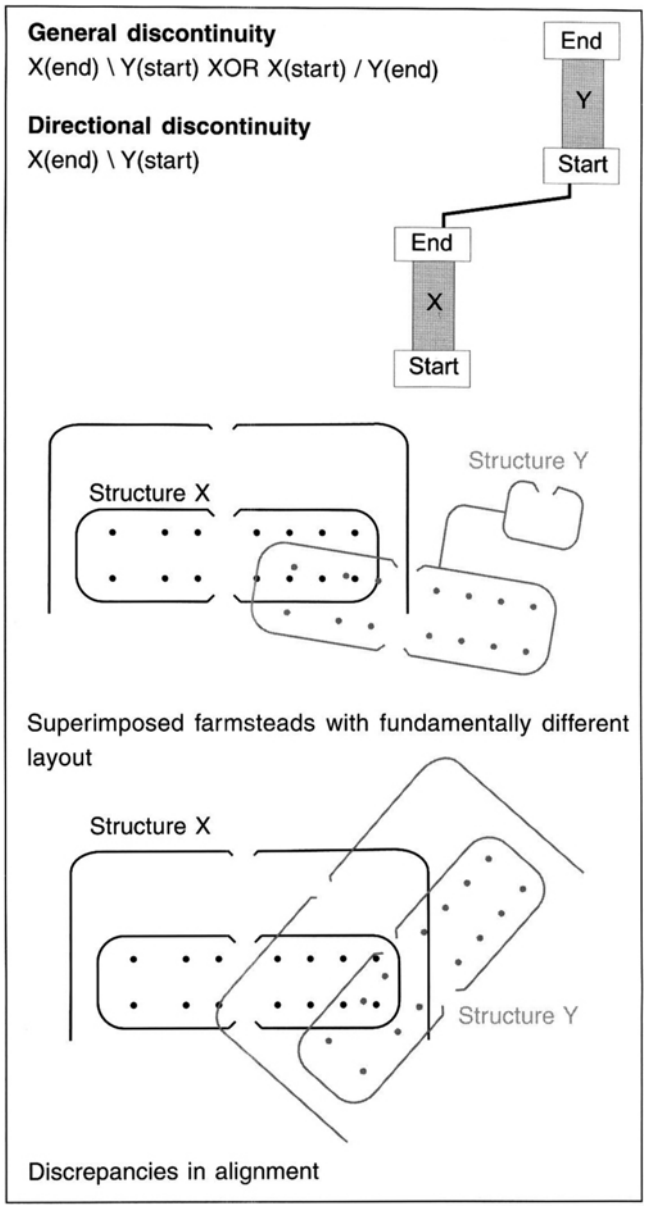

Fig. 11. Discontinuity. Examples of observations, the logical expression, and the graphical representation.

Observations implying continuity

It is the identification of continuity, which practically by definition validates the cohesion of the model of development produced (Fig. 10). *Continuity* is here understood as that one feature follows immediately after another without any temporal overlap. Where the temporal sequence between the two features is not known, the relationship appears as:

$$X(end) = Y(start) \text{ XOR } X(start) = Y(end) \qquad (16)$$

Indicators of continuity can be the maintenance of special constructional features in structures, which can be assumed to supersede one another, for instance a

fence with a particular buttressing post construction, which is maintained through two phases. Continuity can often also be inferred within well-defined farmstead complexes. Here the different "essential" structures within each function group, i.e. the longhouse and the farmyard fence, can be assumed to be part of a continuous sequence. There was no time where the farmstead did not have a longhouse, for instance. Where temporal neighbours amongst the different types of "essential" structure can be identified one can also, in consequence, assume continuity. Generally, continuous relationships will be founded on complex, derived observations, as the identification of continuity presupposes a sort of genetic connection between the features. We try, one might say, to find the descendants of abandoned structures.

When indicators of continuity are combined with evidence about the temporal sequence between two features one can talk about continuity with a definite temporal direction. When X is succeeded by Y we obtain the following formula:

$$X(\text{end}) = Y(\text{start}) \qquad (17)$$

This definitely directional continuity will normally only be used when the entities in a farmstead have already been placed in a temporal sequence. Stratigraphically, however, it can also be demonstrated as a general rule, that when an earlier farmyard fence is replaced by a new one, the farmyard area is extended. If a high level of uncertainty is tolerated, successive extensions of fences can thus be treated as evidence of continuity with a definite temporal direction.

Observations implying discontinuity

The final category of observations comprises indicators that the life-spans of two or more features were separated from one another by a certain amount of time, which here is referred to as discontinuity (Fig. 11). In formal terms, this temporal separation produces the relationship:

$$X(\text{end}) \setminus Y(\text{start}) \text{ XOR } X(\text{start}) \;/\; Y(\text{end}) \qquad (18)$$

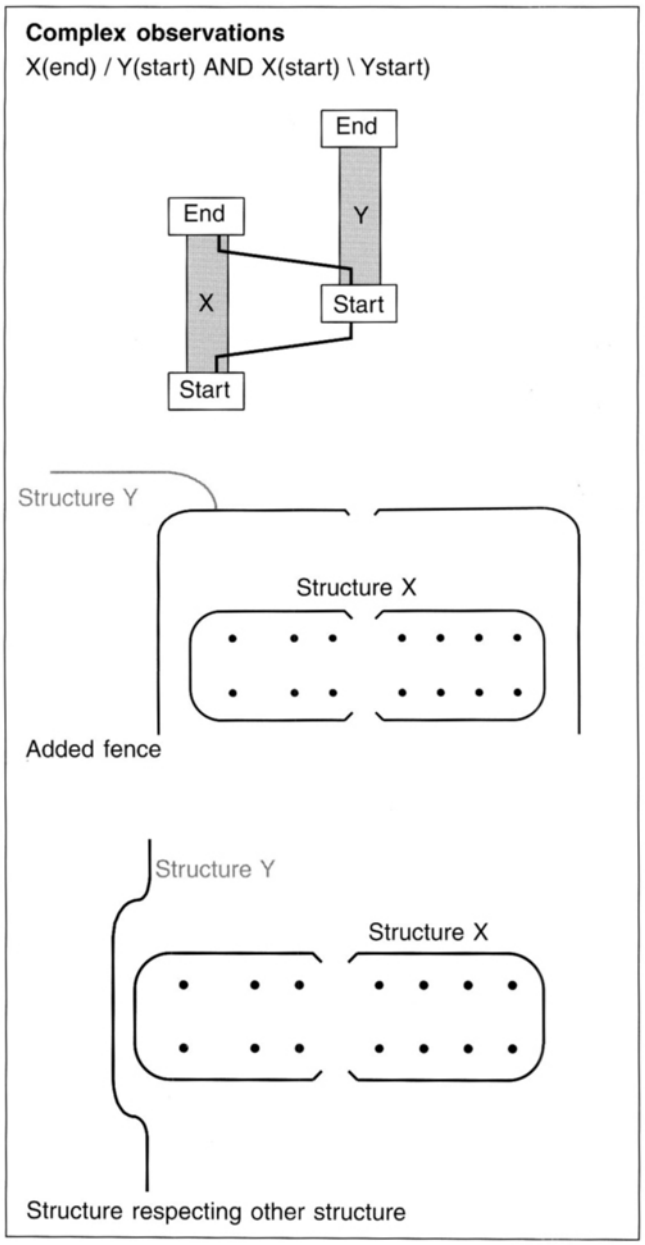

Fig. 12. Complex observations. Examples, the logical expression and the graphical representation.

In certain cases, discrepancies in alignment can be used as indicators of discontinuity, while amongst more complex, derived observations one can note the identification of superimposed farmsteads with fundamentally different layout. Both of these situations must normally be regarded as uncertain indicators.

Just like continuity, discontinuity is of especial significance when it is combined with diachronic observations, making it possible to sharpen up a /= - \= relationship produced by diachronic observations into a / - \ relationship:

X(end) \ Y(start) (19)

Composite and complex expressions

In the preceding sections the various principle observations have been surveyed. Some observations, however, contain information of a more complex character, as their evidence of the temporal relationship between two entities is best described as the product of the adding together of the types of relationship presented above (Fig. 12). This is the case, for instance, when fence lines clearly show that a fence has been joined on to a structure already in existence. In this case it is clear that the added fence was built after the structure to which it has been joined, but it is also clear that both structures existed at the same time. This, then, is a case of a combination of general synchronism and general diachronism. Formally, this situation can be expressed by chaining the logical expressions for general synchronism and general diachronism respectively with an "and" expression — a conjunction. The resultant expression is written thus:

X(start) \ Y(end) AND X(end) / Y(start) AND X(start) \ Y(start)

but since it is also necessarily the case that:

Y(start) \ Y(end)

the expression:

X(start) \ Y(end)

is logically implicit when we have the expression:

X(start) \ Y(start)

so that the formal expression can be reduced to:

X(end) / Y(start) AND X(start) \ Y(start) (20)

A similar situation arises in those cases in which one feature manifestly respects another one. It is clear that the features are contemporary, but it must also be regarded as likely that the respecting feature often was constructed after the feature it respects — this is, just as in the case of an added-on fence, a case of a combination of general diachronism in respect of the features' start dates with general synchronism.

In principle, it is also a matter of conjunctive chaining when two features are linked by several different observations. In this case too, all of the relational expressions must be given, and a composite expression of the relationships between the two entities in question is produced by linking the individual relationships with the conjunction "and". In certain cases it may be advantageous to reduce the often lengthy expressions thus produced.

Another problem which yields rather complex expressions results from the fragmentary and partial nature of the archaeological evidence. In several cases it is not possible to identify exactly which structure a given feature stands in a particular relationship to. For instance, minor houses may occur within the farmyard area of a multi-phase farmstead. It is not possible, in this case, to state which structures the minor houses in question are contemporary with, although it is at the same time obvious that the life-span of the minor houses lies within the whole life-span of the farmstead. If we do not view the farmstead as a discrete entity this is, in formal terms, an example of a disjunction: the minor houses existed at the same time as Structure X *or* Structure Y *or* Structure Z, and so on. Referring to our assumption that the longhouse is the principal structuring entity, it is most appropriate to formulate relationships to the longhouses. This, then, will involve the chaining of a series of expressions of general synchronism with "or" expressions.

THE TEMPORAL SORTING

With the above guidelines for translating excavation observations into formal, relative-chronological relationships, a foundation for working through a formalised relative-chronological sorting of the Iron-age settlement has been laid. In practice, the sorting is done by recording which observations link which features. Such recording can be done in a symmetrical matrix with all the identified structures listed on both axes and the identified, linking observations recorded in

the boxes of the matrix. As was explained in the preceding sections, the excavation observations that are significant for relative chronology are then translated into totally unambiguous formal logical relational expressions, which in turn are able to form the starting point for the construction of a graphical model of the temporal development of the settlement.

In practice, there will often be several observations that link any two features. In such cases the relative-chronological implications of the different observations have to be compared. This sort of comparison can lead to four possible results:

1) The different observations may be of the same relative-chronological significance, i.e. they translate into exactly the same relational expressions. Such a situation will only corroborate the relationship between the two features.
2) The different observations may be contradictory. At the logical-operative level this will produce inconsistency, and the observations will therefore need to be re-assessed. If one of the observations proves to be significantly more trustworthy than the other, the dubious observation can be ignored. If this is not the case, both observations must be omitted.
3) One observation may have more detailed but not contradictory temporal implications than another. For instance, a case of general synchronism in which the two features concerned can move in relation to one another is a less exact expression than complete synchronism, which locks the two features firmly together. In such cases the formal relational expression for the less informative relationship can be omitted in further sorting.
4) Finally, discrete observations can supplement one another and sharpen up the temporal relationship between the features. In these cases the relational expressions of all of the individual observations must be retained in the further sorting.

Just as several relationships can appear between each structure, one can of course also encounter features whose mutual temporal relationship is not documented by any observations. In fact far the majority of features will appear unrelated. This partial character of the archaeological evidence means that the relational network that is built up over the temporal structure of the settlement does not issue in a completely interlinked model. There will be some flexibility in the network. Some features will be movable in relation to others, and there will often not be a unified network for the whole settlement: rather several smaller networks that remain unrelated to one another will exist. These are called "sequences" in the following.

It is clear that the individual sequences have to be dealt with on their own, both in the construction of the relational model of the temporal structures of the settlement and in the subsequent analyses of these structures. Later, with the aid of pottery chronology, building typology, or other external chronological systems, one may try to correlate the different sequences, but because of the lengths of the periods in the chronological systems this will always only be a matter of a relatively coarse relative dating compared with the very detailed sorting that is produced by the relative-chronologically significant observations from the excavation.

The problem of the flexibility of the system can be dealt with in various ways. We can modify some of our analyses so that we investigate the question of how far a concrete temporal structure is consistent or inconsistent with the relational network as it appears on the basis of the documented observations. These analyses take account of the flexibility in the relational network, and it is therefore unnecessary to modify the network.

In other cases we want our network to be the most probable image of the temporal structure of the settlement. Here it may be necessary to build in certain supplementary hypotheses to "shore up" the network. Examples may be assumptions that different longhouse phases will be of approximately the same duration, as also fences and perhaps other structures too. In the graph of the temporal structures of the settlement, this can be put into effect by attempting to give the longhouses the same extent, and likewise a consistent extent can be sought for the fences. It is obvious that these assumptions may introduce false temporal structures into the settlement or may hide real ones. It is important, therefore, that the assumptions used are explicitly formulated, and that their consequences are evaluated in the context of the resultant analyses.

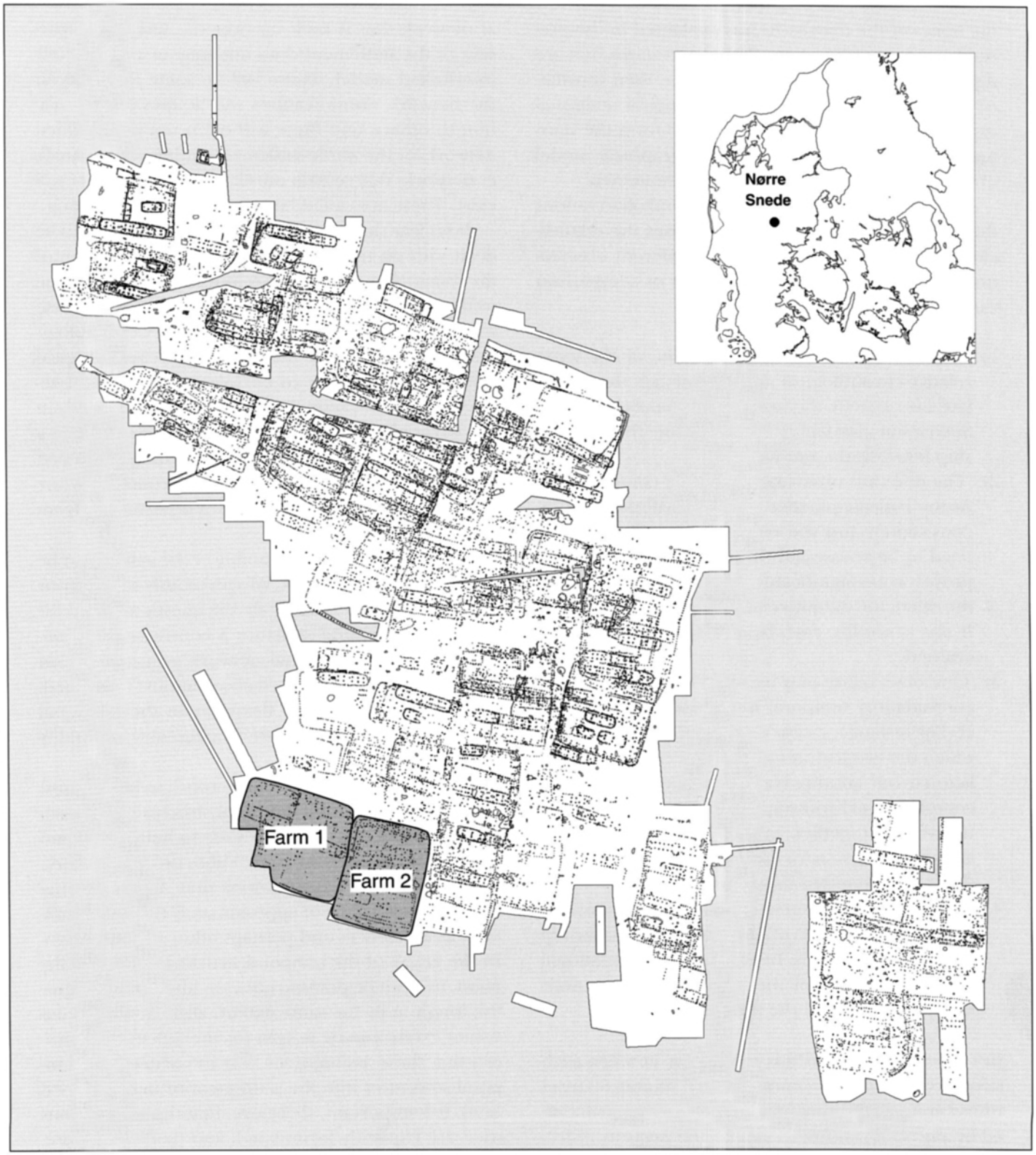

Fig. 13. Excavation plan of the Nørre Snede settlement with the two analyzed farmsteads marked. Scale: 1:2500

Fig. 14. Excavation plan of the analyzed segment of the Nørre Snede settlement with accentuation of the identified structures. Scale: 1:500

AN EXAMPLE OF APPLICATION IN PRACTICE

So far, an account has been given of a technique of relative-chronological sorting of the machine-stripped, area-excavated, Iron-age settlements with no preserved culture layer. In the following section the method will be demonstrated in practice, using part of the extensive excavations at Nørre Snede in Mid-Jutland (Figs. 13-14). The excavations of the settlement at Nørre Snede took place in the years 1980-86 under the direction of Torben Egeberg Hansen. During these seven years a total area of 80,000 m^2 was excavated, in which it is possible to trace the settlement in a temporally unbroken sequence from the 3rd centu-

Observation	Code	Relation
Contrastive orientation or alignment	a	X(start) / Y(start) XOR X(start) \ Y(start)
Overlapping without stratigraphy	b	X(start) /= Y(end) XOR X(end) =\ Y(start)
Blocking	c	X(start) /= Y(end) XOR X(end) =\ Y(start)
Functionally identical structures within the same farm	d	X(start) /= Y(end) XOR X(end) =\ Y(start)
Identification of farm phase	e	X(start) /= Y(end) XOR X(end) =\ Y(start)
Opposed entrances	f	X(start) \ Y(end) AND X(end) / Y(start)
Conjoined structure	g	X(start) \ Y(end) AND X(end) / Y(start)
Identical orientation	h	X(start) \ Y(end) AND X(end) / Y(start)
"Inessential" structure associated to several "essential" structures	i	X(start) \ Y(end) AND X(end) / Y(start)
Identification of earliest phase	k	X(start) = Y(start)
Identification of latest phase	l	X(end) = Y(end)
Single-phase farmstead	m	X(start) = Y(start) AND X(end) = Y(end)
"Inessential" structure associated with "essential" structure	n	X(start) =/ Y(start) AND X(end) \= Y(end)
"Essential" structure associated with "inessential" structure	o	X(start) = \ Y(start) AND X(end) /= Y(end)
More artefacts in posthole and darker fill	p	X(start) / Y(start)
Less artefacts in posthole and lighter fill	q	X(start) \ Y(start)
Charcoal in structure in or near burned down structure	r	X(start) / Y(end)
Burned down structure in or among structures with charcoal	s	X(end) \ Y(start)
Burned down structure in or among structures without charcoal	t	X(end) / Y(start)
Structure without charcoal in or near burned down structure	u	X(start) \ Y(end)
Cuts	v	X(end) /= Y(start)
Is cut by	w	X(end) =\ Y(start)
Temporal neighbour in farm sequence	x	X(start) = Y(end) XOR X(end) = Y(start)
Maintenance of special constructional features	y	X(start) = Y(end) XOR X(end) = Y(start)
Successor in farm sequence	z	X(start) = Y(end)
Predecessor in farm sequence	A	X(end) = Y(start)
Succesive extension of fence	B	X(start) = Y(end)
Fence succesively extended	C	X(end) = Y(start)
Superimposed farmsteads with fundamentalle different outlay	D	X(start) \ Y(end) XOR X(end) / Y(start)
Discrepancies in alignment	E	X(start) \ Y(end) XOR X(end) / Y(start)
Fence with addition	F	X(end) / Y(start) AND X(start) \ Y(start)
Added fence	G	X(start) \ Y(end) AND X(start) / Y(start)
Respects	H	X(start) \ Y(end) AND X(start) =/ Y(start)
Respected by	I	X(end) / Y(start) AND X(start) =/ Y(start)

Table 1. List of observations and the formal expression of their chronological implications used in the analysis of the Nørre Snede settlement. Also so-called inverse observations are listed.

ry A.D. to the 6th or 7th. In the course of this period of four centuries there is a general tendency for the settlement to move from the south-east to the north-west, and in a provisional discussion of the whole site the village is divided into five main phases (Hansen 1988).

The segment, which will be analysed in this section, lies in the south-western corner of the excavated area within the second main phase of the settlement. This segment constitutes a well-defined unit consisting of two farmsteads with no physical or relational overlap with any structural traces that can not be assigned to these two farmsteads — in other words, this is a discrete sequence, and the area thus offers a highly suitable object of analysis. The state of preservation of the features within the area concerned can be described as averagely good. There are few disturbances, the roof-bearing posts have been found in all of the buildings, but the building walls and the fence-lines were found in more varied states of preservation, from completely preserved to seriously fragmented.

Within the area under consideration, seven long-houses have been identified (Longhouses I to VII) of

	Longhouse I	Longhouse II	Longhouse III	Longhouse IV	Longhouse V	Longhouse VIa	Longhouse VIb	Longhouse VII	Fence 1	Fence 2	Fence 3	Fence 4	Fence 5	Fence 6	Fence 7	Fence 8	Fence 9	Fence 10	Fence 11	Fence 12	Fence 13	Fence 14	Fence 15	Fence 16	Fence 17	Other 1	Other 2	Other 3	Other 4	Minor 1	Farm 1	Farm 2
Farm 2	.	.	.	o	o	o	o	o	.	.	.	.	.	i	o	o	o	o	o	o	o	o	o	o	.	.	.	o	o	.	..
Farm 1	o	o	o	.	.	.	.	.	o	o	o	o	o	i	.	.	.	.	.	.	.	.	.	.	o	o	o	.	.	..	
Minor 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	..		
Other 4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	..		
Other 3	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	..			
Other 2	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	..				
Other 1	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	..					
Fence 17	.	.	.	.	.	.	.	.	.	.	.	.	.	d	bd	.	g?	.	.	.	.	.	.	..						
Fence 16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	g			p	..								
Fence 15	.	.	.	.	.	.	k	.	.	.	.	.	.	.	.	.	.	d	d	d	d	d	..								
Fence 14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	d	d	d	Cd	..									
Fence 13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	d	d	Cd	..										
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Fence 11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C?d	..												
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Fence 9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	d	qwCd	..														
Fence 8	.	.	.	f	.	.	.	.	.	.	.	.	.	.	yqd	..															
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Fence 1	mg	.	.	.	.	.	.	.	..																						
Longhouse VII	.	.	.	Aqd	qd	qd	qd	..																							
Longhouse VIb	.	.	.	d	vd	zvd	..																								
Longhouse VIa	.	.	.	d	zvd	..																									
Longhouse V	.	.	.	zpd	..																										
Longhouse IV	.	.	.	..																											
Longhouse III	d	Awd	..																												
Longhouse II	Abd	..																													
Longhouse I	..																														

Table 2. Matrix of the relative chronologically significant observations linking the structures of the analyzed segment of the Nørre Snede settlement. The letters refer to the codes listed in table 1.

which one was subjected to total replacement of the roof-bearing post-sets (Longhouse VI(a+b)). Seventeen pieces of fence-line have been identified, while there are four stack barns including one special type, and finally a single minor building. The structures are distributed, as noted, between two farmsteads: Farm 1 to the west with three partially overlapping longhouses in a line along an east-west axis, and Farm 2 to the east with four longhouses and a relatively high degree of stability in the structure and position of the farmstead.

The observations which link the features of the farmsteads are presented in Table 1. The table illustrates extremely well the highly varied range of basic observations produced by area excavations, with virtually all of the types of observation described above being represented.

On the strength of the gradual shift that took place with Farm 1, each farm-phase can be treated as a single-phase structure, meaning that the majority of the fences can be assumed to have the same start and end date as the longhouses they are associated with. Exceptions, however, are Fences 3 and 4 pertaining to Longhouse III, where there is no certainty that both of them existed throughout the whole life-span of the building. The temporal sequence of the three farm-phases is demonstrated both by stratigraphical relationships between Longhouse I and Fence 2 of Longhouse II and also by the observation of hearth material in the one posthole from a roof-bearing post of Longhouse II which is located in the hearth area of Longhouse III. In general the structures of Farm 1 are clear, and their sorting unproblematic. The only observation which needs a little explication is indeed the chaining of Fences 1, 2 and 4 into a continuous sequence on the basis of a shared and peculiar constructional feature. The fences represent the so-called half-roof fence with two rows of roof-bearing posts of

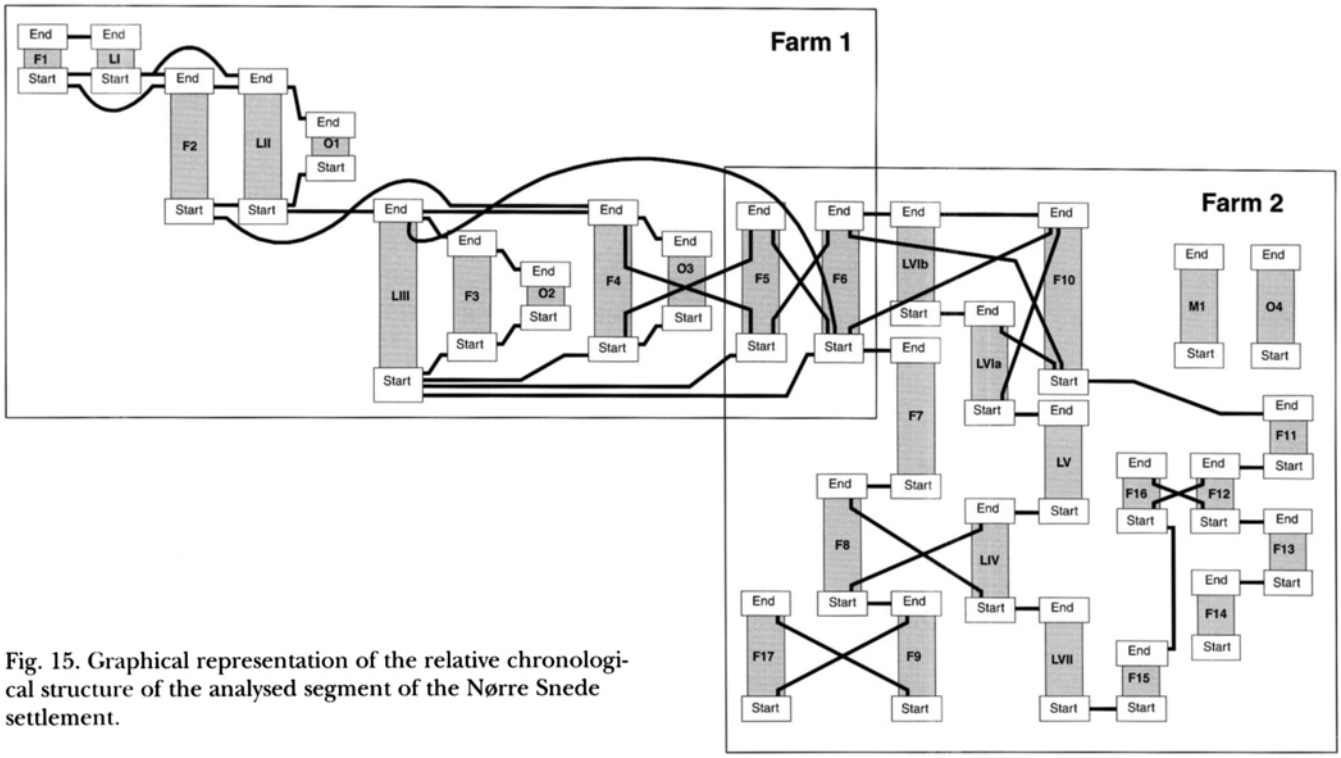

Fig. 15. Graphical representation of the relative chronological structure of the analysed segment of the Nørre Snede settlement.

which the inner and outer posts are equally deeply rooted, when by far the most common construction of this sort of fence has the inner roof-bearing posts dug deeper than the outer ones. One can argue whether this is really evidence for continuity, but the feature unquestionably indicates some genetic connection between the three fences.

Farm 2, with its greater locational stability and consequent high level of overlap of features, is significantly harder to deal with than Farm 1, especially in respect of sorting out the sequence of fence-lines as many of the fences are only partially preserved. Stratigraphy and differences of fill constitute the most important basis for sorting, although entrances aligned with one another and structural similarities also play a significant part. It has not been possible to place Minor house 1 and the special Stack barn 4 precisely within the sequence of development of the farmstead.

Farm 1 and Farm 2 are linked by a somewhat doubtful observation concerning Fence 6, the roof-bearing post-set of which shows that it must belong to Farm 2 although at the same time the fence appears to make a minor detour around Longhouse III of Farm 1, suggesting that it respects that building. This deduction is also supported by the fact that Fence 4 of Farm 1 was apparently built together with or joined on to Fence 6, and that fence 5 and Fence 6 may be seen as a conjoined structure.

After collecting the significant relative-chronological observations in this way, one can produce a matrix of the formal relationships between the structures identified on the basis of the principles formulated in the foregoing sections (Table 2). This matrix may then, in turn, provide the starting point for the construction of a graph of the development within the segment of the settlement under examination, as in figure 15.

A number of things can immediately be read from this graph. It is evident that the two farmsteads have quite different temporal structures. Farm 1 presents clear, well-defined phases, in which the structures are unambiguously associated with one and only one of the farmstead's three longhouse-phases. This pattern corresponds to the farmstead having been moved in each phase, involving the rebuilding of all the structures. Farm 2, in contrast, remained in the same place through all of its rebuilding phases. Here, as a result, the graph shows a far more intricately intertwined

picture of the gradual, dynamic replacement of features, without clear, unitary phases.

POTENTIAL APPLICATIONS

The area analysed constitutes only a very limited segment of the Nørre Snede settlement, which is taken, furthermore, from an area of relative clear and uncomplicated structures. The real potential of the method, however, evidently lies in the analysis of larger and more complex sequences with extensive overlap of features, where it is in practical terms impossible to grasp all of the observations and their implications. The model in figure 15 can be regarded as the end result of a condensation and structuration of the relative-chronological entities of the complex and extensive data produced by area excavation. Here we have obtained a tractable graphic presentation and model of the temporal relationships between the entities of the settlement with a systematic method that facilitates work with much more extensive collections of data.

On the other hand, the sorted relative-chronological model can also be regarded as merely an intermediary result: a starting point for further analyses of the spatial and temporal structures of the settlement. In this regard, the observations implying continuity are of particular importance, as they render it possible to identify what we can call continuous sequences of development. These sequences are constituted of entities which are firmly tied relationally to other entities by being linked to them through observations of synchronism, by being in a relationship of contemporaneity, or by having both earlier-than and later-than relationships with other entities which are themselves related amongst themselves by relationships of contemporaneity. This means that all entities in such a continuous sequence of development are located within an unbroken span of time, with important consequences for the interpretation of the structures of the village. It is in fact the case that one must assume that there was a certain historical as well as some functional or semantic connection and mutual influence between the different entities in these sequences of development as reflected by the expressions farmstead-sequence (diachronic connection) and village phase (synchronic connection). This means that within each of these sequences of development there is the possibility of identifying connections that were genuinely meaningful for the prehistoric population, and it is these connections which are essential to us when we attempt to reveal the human aspects of the prehistoric sequence. A clarification of the structures in the village is an account of the character of and background to these "human" connections. The sequence of development discussed here is a simple continuous sequence.

To obtain the full and true benefit of the relative-chronological sorting, however, one needs a really thorough understanding of how the diagrammatic representation is to be read so that possible interpretations and uncertainties are not ignored. In the following sections, therefore, an attempt will be made to go through some of the problems that reside in the interpretation of the graphs, with particular focus on two potential applications: phasing; and analyses of the pattern of movement of the settlement.

Phasing

It is an absolutely fundamental precondition for studies of the spatial structure of Iron-age settlements that the occupation evidence accumulated through the centuries can be distributed amongst a series of temporal phases, ideally of as limited duration as possible, so that one can produce plans of more or less contemporary structures. It is telling that the more and the shorter phases it is possible to distinguish, the more detailed the analyses of the structure of the settlement one can, in principle, carry out. In practice, however, one quickly faces a conflict between the desire for short phases and the increasing uncertainty that a higher level of detail involves.

In the full or partial phasings of Iron-age settlements that have been produced up to now, one can distinguish between two methodologically different approaches. One takes its starting point from an established chronological system to sort the settlement entities into temporally well-defined periods. This method can be seen in practice particularly in respect of the extensive excavations in northern Germany (e.g. Schmid & Zimmermann 1976). The other meth-

Fig. 16. Phasing of the analysed segment of the Nørre Snede settlement. Scale 1:1000

od starts from the observations concerning the relative-chronological relationship between the entities of the settlement in question, on which basis a temporal sorting of the features is undertaken. In this case, a phase is understood as a group of entities that existed at the same time, and Danish archaeology has produced several exemplary applications of this method, most clearly in the analysis of the village of Hodde (Hvass 1985).

It is significant that if one starts from the ceramic evidence, one is obliged to have a very well-developed chronological system with short pottery phases in order to have any hope of catching a glimpse of spatial structure. On the other hand, the method based upon the observations from the excavation itself concerning the relative sequence of the features relies upon a good state of preservation and a large number of relationships between individual structures. It does, however, make it possible to achieve an extremely detailed image of the development and structures of the settlement.

The method presented here is manifestly closely associated with phasing based upon the observations during excavation. The relative-chronological sorting, however, is not truly a phasing, rather a detailed picture of the dynamic development of the settlement. It is a phase-less image, emphasising gradual development. It is, however, a relatively easy matter to use the graph of the relative-chronological sorting to construct both temporally extensive phases and "momentary phases": i.e. "phases" which offer a snapshot of simultaneous entities, as a horizontal section through the graph should in principle produce such an image. Those structures that are cut through were standing at the same time. A temporally extensive phase can, consequently, be understood as consisting of those structures which are present in the space between two such horizontal sections.

In practice, however, phasing is not such a simple and unambiguous process. The problem resides in the flexibility of the graph referred to above. There will often be quite significant uncertainties, particularly in the case of sequences with large numbers of entities. The use of supplementary hypotheses is, as a result, often a vital precondition for a phasing. As for loosely located entities, the most valid solution will be not to assign these entities to a definite phase.

With these guidelines, the phases can now be identified by placing horizontal lines across the graph (Fig. 15). In principle we have complete freedom as to where we place the lines. For the analysed segment of the Nørre Snede settlement, five lines were drawn through the graph resulting in five phases as shown in figure 16.

It must be emphasised that a phasing following the guidelines suggested here can only be undertaken in respect of each sequence individually, so that several different continuous sequences of development within a sequence can cause problems. If one is to establish phases across sequences other dating methods have to be introduced and attempts to establish momentary phases abandoned. The value of momentary phases thus resides first and foremost in revealing the development of individual farmsteads.

The pattern of movement

The relational treatment of the observations from area excavations results, as already noted, in a relative-chronological sorting of a very high level of detail and with the potential to catch the dynamic replacement of entities of the settlement. With this, it also becomes a realistic proposition to undertake systematic analyses of the movement of the settlement itself, and thus to approach closer to a solution of the problem of how and why the villages shifted. It is, for example, still relatively unclear how far this affected whole villages or whether it was solely a matter of a gradual relocation of the individual farmsteads. An answer to this question is obviously of great importance to our understanding of the organisation of agrarian settlements, and will give some indication of how well developed the village community was.

Another crucial question, which it may be interesting to consider, is that of to what extent the Iron-age farmstead actually is to be perceived as a unilinear phenomenon. The traditional discussion of Danish Iron-age settlements seems to assume, more or less explicitly, that it is the same farmsteads, in other words the same discrete families, that functioned throughout the life-time of the village. This presupposes a definite pattern of inheritance through which the farmstead is passed down a direct line. In this explan-

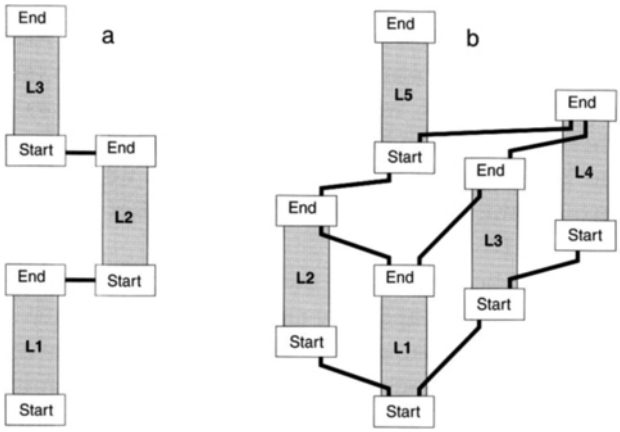

Fig. 17. Graphical representations of the basic structures in a) a unilinear and b) a multilinear sequence of development.

atory model we lack any explanation of the mobility of the farmstead. A possible alternative interpretation could be that it was the inheritance rules themselves that caused the high level of mobility within the settlement. If, for instance, at the point of inheritance, there were a division of the land between several heirs, this would serve to explain the construction of new farmsteads, and the high degree of dynamism within the settlement at the same time. The construction of a new farmstead for one of the children of the family could even take place before the death of the parents, for instance when the son married. If this model is correct, the unilinear concept of the farmsteads has to be dropped.

The production of an accurate picture of how the farmsteads move would thus offer very important information on Iron-age society, and with the relative-chronological sorting model presented here it should — as long as the basic evidence available is of sufficiently good quality — be possible to determine which patterns of movement we are faced with. This principle is based upon the idea that we can view the relational graph as a sort of legible text. What we are seeking to identify is the presence of particular "sentences" or compositions. In figure 17 an example is shown of how both a unilinear and a multilinear sequence of development will appear in the graph of the relative-chronological sorting of the entities of the settlement.

It is impossible to get any closer to an answer to these questions from the segment of the Nørre Snede excavation discussed here: the sample is simply too small. To reveal the character of mobility within a settlement would probably require a virtually complete analysis of a village, both because there would otherwise be no certainty that the patterns identified were representative, and because the observations that link the different farmsteads together are often seriously uncertain, so that a large body of data is essential for the results to be regarded as statistically significant.

The analyses of the temporal structures can of course be extended and formalised, while there may also be other questions that it would be interesting to explore. It is hoped, however, that the examples presented here will have shown what sort of prospects reside in undertaking such very detailed relative-chronological sorting of the evidence from machine-stripped area-excavated Iron-age settlements.

CONCLUSION

With the introduction of area excavation, a body of data of quite new character was also produced. Now that the major excavation campaigns of the 60's, 70's and 80's are beginning to be worked upon, the need has arisen for new methods that can cope with and make use of this new type of body of data. The above is an attempt to establish a method for the first stage of post-excavation analysis, the relative-chronological sorting.

As with many other archaeological objects, it is particularly spatial and temporal structures that are the focus of attention in respect of the Iron-age settlements. In the case of these sites, spatiality is already dealt with in the recording phase. The chronology is a more difficult matter, and it is this problem which the technique presented here is aimed at. The technique is capable of producing a very detailed graph of the relative-chronological relationships between the structures identified as it is possible to translate any conceivable observation about the temporal relationship between two features into a logical expression, which can then form the basis for a systematic sorting of the entities of the settlement. This, then, is not just a formalised reproduction of the excavation observations but also an analytical tool.

The most interesting prospects, however, reside in the scope for undertaking detailed analyses of the temporal structures of the Iron-age settlements after the relative-chronological sorting. Through total analyses of the larger, area-excavated, shifting villages, the method is probably capable of giving a more accurate view of the mobility of the settlement and thus, possibly, also of shedding some new light on to vital aspects of Iron-age society.

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Shards for Beads ?

by Tine Gam Aschenbrenner

Shards of blown vessel glass found in Scandinavian settlement contexts can be interpreted in several ways. Do the pieces mirror an assemblange of whole, unbroken glass vessels brought to the site? Or should they be seen as cullet imported for a local glass bead production? Is it at all possible to produce beads from broken vessel fragments? In the light of archaeo-experiments these questions are discussed below.

INTRODUCTION

A glass vessel found in a grave is ... a glass vessel; and if only a single fragment is discovered, a *pars pro toto* interpretation is often suggested. A simple explanation to a simple phenomenon. When a number of fragments from the same beaker or vessel are found at a settlement site, even within the same house, it is usually assumed that these fragments represent a whole beaker broken due to unfortunate circumstances. One examble is the house from Dejbjerg, which probably contained a minimum 15 beakers, mainly found in the central and eastern part of the house (Egeberg Hansen 1996, 228). Another example is the glass finds from house I at Borg, Northern Norway, dated to the later half of the the first millennium AD (Henderson & Holand 1992). Despite the fact that the fragments from Borg did not come from a closed find such as Dejbjerg (the Dejbjerg house had burnt down), a number of fragments from the same beaker, supported by an analysis of the batch composition, made it possible to establish the grouping of the glass vessels from Borg. This was interpreted to indicate that the vessels had been imported as complete items (Henderson & Holand 1992, 33).

In more datable settlement contexts such obvious explanations do not always account for the glass fragments found. Sorte Muld on Bornholm is one such example. In 1986 and 1987 excavations on this site uncovered 267 hollowware glass fragments, and a large number of beads. The most famous finds from the site must be the 2300 gold foil figures, but also traces of different crafts (such as iron, bronze, gold and amber working) should be mentioned. The glass fragments have been interpreted as possible raw material for bead making (Watt 1991, 100), although Margrethe Watt also points to the possibility that they represent luxury trading goods. However, in a later reference to the find, it is again suggested that the fragments could possibly be viewed as raw material (Jensen & Watt 1993, 198). As a permanent settlement for several centuries and because of the rich finds uncovered there, Sorte Muld has been characterized as a central place (Watt 1991).

Why has glass bead making been suggested, despite the fact that no production waste or other indications of the craft have been found at Sorte Muld? Part of the answer is found in the trade and exchange connections of which Sorte Muld have similarities with other Scandinavian market places. Another part of the answer may be found at sites with strong evidence that bead making took place. To what extent bead manufacture can be assumed at Sorte Muld will be discussed later in this paper.

When characterizing a location as a market, trading center, or an ordinary habitation site, it is impor-

tant to establish to what degree glass fragments from broken, blown hollow-ware can be regarded as an indication of local bead production. The difference between mere trading with goods and the actual production of them is crucial for the understanding of the activities in and around a settlement. As with crafts the presence of the finished goods is in itself no evidence for a local production, no matter how many items are found. Even if two different find categories are identified it does not follow that manufacturing took place, but somehow the phrase 'bead making' often pops up when glass beads and vessel fragments are found at the same site.

The focus here is on the category "raw materials", as glass shards almost inevitably are regarded as raw material for glass beads. Vera I. Evison has summed it up thus: "....the use of glass fragments to melt down into small baubles like beads is, of course, a possibility on any site" (Evison 1982, 53). It was to test this possibility that the experiment described below was carried out.

BEADFORMING TECHNIQUES

The type of bead most frequently found in Scandinavia in the 8th and 9th centuries is the "wound" bead. It was made by winding hot glass around a solid core. The technique has been the object for archaeoexperiments (Gam Aschenbrenner 1997 with references) and a few of the main results are listed because they lay the foundation for the actual experiment.

- First of all, it turns out that crucibles for bead making consume too much glass and fuel.
- Secondly, it has been stated that crucibles are necessary for the bead-making process. But if we assume the use of crucibles, we should expect them to show up in greater numbers, especially at sites with many craft identifying artifacts. In reality, only very few crucible fragments have been found.
- Finally, the development of an alternative method for making beads without crucibles seems very convincing, the so-called "fragment gathering method".

A few more words about crucibles

For the interpretation and understanding of glass fragments as raw material for beadmaking it makes a difference whether the use of the crucible or the fragment gathering method is presumed. The indirect heating of glass in a crucible leads to a considerable fuel consumption, compared with directly heated glass, when the fragment gathering method is used. The advantage of using a crucible is that the glass can be cleared of embedded air bubbles by heating it for some time, but this will inevitably imply an even higher fuel consumption. Furthermore, the crucible theory assumes that fragments were used as a basic glass to which tesserae could be added for colouring. The idea that only vessel fragments were used can be totally disregarded due to the discrepancy between the majority of transparent pale green(ish) vessel glass fragments and the often strongly coloured opaque beads.

Henderson & Warren have analysed an opaque yellow glass inside a crucible fragment from Ribe (1983). Compared with six other analyses of opaque yellow glass from Ribe (two of which were made on rods), the glass in the crucible fragment has a lower content of silica oxides, whereas the content of tin oxides is very much higher. Furthermore, this fragment does not derive from the beadmaker workshop layers (Näsman pers.comm.), making it more than questionable if it should be linked to the production of glass beads.

At the Funen site Lundeborg two fragments of crucibles "with fused glass on the inside" have been found (Thomsen 1995, 24), but an analysis of the exact batch composition from one of the fragments has shown that the content of copper, tin and zinc oxides makes it unlikely that the fragment should be linked to glass working (Thomsen forthcoming).

Outside Scandinavia we have a possible exception from York, where about 300 crucible sherds were found at 16-22 Coppergate and more than 1300 sherds at 22 Piccadilly, dated to the 11th century AD. The glass inside the crucibles was of a high-lead type with added copper to colour it green, like some beads from the site. One can hardly ignore the connection between beads and crucibles here, but an alternative interpretation is that the high-lead glass was primari-

ly for enameling, leaving the bead making as a minor activity. An interesting phenomenon is that "nearly 10% of the sherds [from the site] are not strictly parts of crucibles but are potsherds roughly chipped into discs about 50mms across. These have small pools of melted translucent blue glass on them, most of which has then been scraped off while still soft. There are drips and rods of similar glass as well as mis-shapen and complete beads, suggesting that blue glass fragments were being melted down and beads made from them" (Bayley 1997, 4). Unfortunately it is not specified what kind of blue fragments these were, but the manufacturing description is very close to the fragment gathering method. From the short note published it is difficult to discuss the finds in more detail here, but both methods could have been practiced, in parallel, at the same site. The geographical and chronological differences make it difficult to draw direct comparisons with the Scandinavian material.

As stated above, previous archaeoexperiments have stressed the fragment gathering method as the most likely for local bead production in Scandinavia. Only if future archaeological material should be enriched with a variety of crucible fragments – undoubtedly for bead making – will the archaeoexperimental results have to be reconsidered.

Original test glass

Using original archaeological material for a destructive experiment has been a way of gaining new knowledge before experimental archaeology was developed as a science. To test the bronze alloy from an English carnyx, found in 1768, the experimentator George Pearson "melted the old implements and cast them in the same ingot mould." (Coles 1979, 13). Fortunately this method was not generally accepted and almost all fields of experimental archaeology today use modern material. However, when an archaeological artifact is commonly found, and the total amount required for an experiment is tiny, we can ignore the importance of every single object. In this specific case it was also interesting to use the original glass compared with a glass replica, because of the difficulties in making an exact batch copy.

The working properties of glass differ according to glass type and to limit the experiment only one glass type was tested. Since the art of glass blowing was invented in the 1st century BC, a soda type glass was used. Caroline M. Jackson has recently published a study of the change from Roman to early medieval glasses, and an important result was that "while styles of glass change from the Roman into the early medieval period in Northern Europe, and visually the glass appears to deteriorate in quality and design, generally appearing to be technically less sophisticated, the composition appears to stay remarkably the same" (Jackson 1996, 291ff.)

During the 8th century AD the first signs of a shift from a high soda glass to a mixed alkali glass occur (Henderson & Holand 1992, 36). Therefore, an appropriate test material would be a soda glass from which it would be possible to use a small amount of approximately 200 g. Roman hollow-ware glass seemed to be an acceptable choice. The possibility arose to use glass from the excavation at Blake Street in York, which can be dated to 1st - 3rd century AD. The actual fragments derived from mouldblown bottles, which is the most common type of container found in Britain (Cool *et al.* 1995, 1580). They were broken into pieces measuring from 10 to approximately 80 mm in size, with an average thickness of 2 - 3 mm. Some base fragments reached a thickness of 6 mm. The colour was very pale greenish, sometimes with a bluish tinge. The quality seemed to be good, with very few seeds and bubbles. The glass composition was probably a soda glass, as is typical for Roman glass. An iridescent layer covered the fragments (Fig. 1).

It can be argued that Roman bottle glass is poorly suited to match the Scandinavian finds some 500 years later, as only very few bottles have been found in Scandinavia. These include a few smaller Frankish bottles, like the one from Hopperstad (Hougen 1968:101). Some are with trails, like the bottle from Stenum (Ekholm 1958, Abb.2), and additionally a few fragmentary larger pieces, like those from Dejbjerg (Egebjerg Hansen 1996, Fig. 10.4) have been found. From Herlufmagle, Zealand, we have an unbroken cylindrical mouldblown bottle from the 1st century AD (Lund Hansen 1973, Fig.5; 1979, Fig.1), but so far this bottle is unique and no (mouldblown) bottles of the Roman kind are known from Sweden or Norway.

From a practical viewpoint the differences between fragments from bottle glass and fragments from other vessel glass are in the shape and size of the fragments. The Roman bottles are mostly mouldblown straightsided, cylindrical, square or prismatic, with a rather thick base, which makes up a comparatively great part of the whole item. The vessel glass from Scandinavia consists of more or less conical beakers, bowls and cups and for these vessels the somewhat thicker base only make up a limited part of the whole glass. This means that the fragments for the experiment had a somewhat greater thickness, than if Frankish glass fragments had been used. Another factor which should be taken into account is that thicker fragments tend to withstand breakage, but on the other hand they were more likely to be retrieved, thereby not appearing in the archaeological register. This compares with smaller and thinner pieces, which break easily, and then into small bits which may disappear into the soil and subsequently be excavated.

THE EXPERIMENT

Finds from the 8th century workshop layers in Ribe, Denmark (Näsman 1979), formed the basis for the test workshop conditions. The bead making process was carried out using a small open fireplace with an inner diameter of c. 40-50 cm, and a pair of bellows to raise the temperature. Charcoal was used as fuel. The tools consisted of a gathering iron (solid iron rod), bead mandrels, a pair of metal tongs, a pair of wooden tongs with grips of antler, a knife, an iron pan, and an iron tong.

To prepare the fragments the white ink museum numbers were removed with spirit and rinsed off with water. The fragments were then placed for pre-heating on the iron pan near the heat centre in the fireplace. The gathering iron was heated until yellowish orange in colour, after which a tiny fragment of glass could be melted onto the gathering iron. Having heated this fragment to the melting point it was easy to gather a greater fragment, and heat it until melting, and then gather a new fragment ... and so on, until it was possible to make beads from the lump of molten glass achieved. Only the most simple kinds of beads were made, plain globular and melon beads.

Fig. 1. Roman bottle glass fragments (Blake St., York, 1st-3rd c.AD) and beads made from the fragments. Photo: M. Schreiner, ALM.

After each bead had been made it was carefully placed in a jar filled with ashes. The jar stood inside the fireplace, but opposite the heat centre. Within an hour the temperature in the jar rose from 150° C to 550° C which was regarded as an acceptable upper temperature for the following annealing period. After the last bead had been made, the fireplace was left to cool down over night, and some red-hot charcoal was arranged around it to ensure that cooling did not happen too quickly.

Results

All the beads turned out to contain a large amount of bubbles, and many also had some darker streaks. The bubbles often burst during production leaving big scars in the surface of the beads (Fig. 2); or causing a very uneven annealing of the beads, i.e. they broke easily.

Three possible sources for the bubbles can be listed:

- Glass quality.
- Air trapping during melting process.
- Iridescent surface.

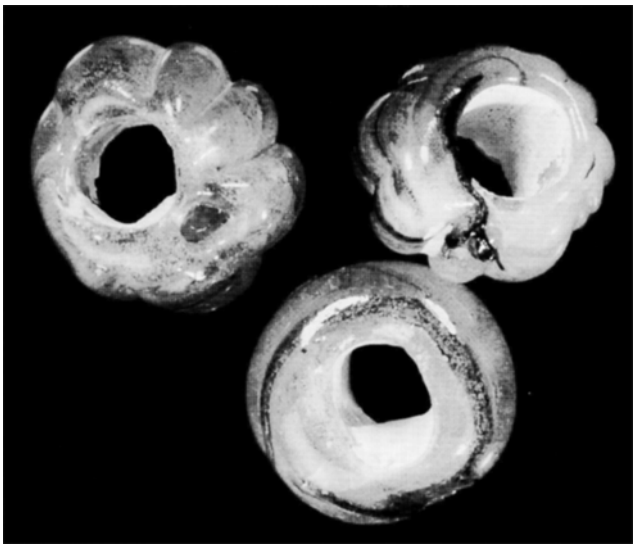

Fig. 2. Replica beads made from Roman bottle glass fragments. Photo: M. Schreiner, ALM.

A common characteristic of all ancient glass is the presence of bubbles, or glass seeds, which appear in many different sizes and numbers according to the glass quality. For most blown items the seeds only form an aesthetic problem, but for the beadmaking process they are also a physical problem, as the amount of glass for each bead is much less, and so the glass seeds expand more easily when heated, leading to bursting bubbles and eventually scars. As mentioned before, the Roman glass used for the experiments contained very few seeds, but occasionally larger bubbles, and both led to bursting bubbles. It is worth noticing, that Frankish and Carolingian glass generally contains more bubbles, than Roman glass, i.e. beads made from a such poor quality fragments would contain great amounts of bubbles or scars.

That air became trapped happened because a hollow ware (body) glass fragment has a rather large surface area to volume ration and when turning the mass into a more massive lump of molten glass the fragment will fold down in various ways. Depending on the size and shape of the fragments it is almost inevitable that air will become trapped in the foldings. At least, this was what happened during the test, causing some very large bubbles.

The iridescence is the result of devitrification, where the alkaline has been washed out causing a laminated surface. The darker streaks of 'polluted' glass, which can be seen on some of the beads probably derive from the lamination, but this need to be verified. Additionally it has to be checked to what extent the streaks only formed an aesthetic problem, or if they also caused uneven annealing. It is worth noticing that for this experiment the fragments were approximately 1700 years old, so a similar problem probably did not arise for the bead makers in for instance Ribe, unless it could be proved that they used fragments which were about 500 years old, and that such an iridescence was present at the time.

The inevitable conclusion

It is difficult to estimate to what exact degree the three categories of possible problems listed above have influenced the beads. The only category which is dependant on the craftman's skills is the folding process. The result from this experiment would probably turn out slightly differently with more experience, but this will not eliminate the fact that glass with a rather large surface area to volume ratio forms a bad raw material for bead making, when the fragment gathering method is used.

The inevitable conclusion must be, that hollow ware glass fragments form a rather inconvenient basis for glass bead making. It is possible, but using the fragment gathering method, the result will turn out to be somewhat poor. Ulf Näsman has put it in a nutshell when writing that: "...that some [glass] fragments were probably remelted in the bead making workshops, but for bead making there were better raw materials like tesserae and raw glass" (Näsman 1984, 36). The following example shows the accuracy of the description.

Fragment-made beads? Ribe, once again

A curious fact is that fragments so often are interpreted as a raw material, but only seldom has that argumentation been put forward in the light of the beads themselves. Few beads or other glass items are described as being made from fragments. Ulf Näsman

mentions a bronze pendant with a mounted piece of yellow glass, covered of a layer of opaque reddish brown glass from the settlement fort Eketorp II, Öland (Näsman 1984, 24). A poorly formed spindle-whorl made of transparent green glass derives from Treby, Segerstad, Öland (Näsman 1984, 24). From a grave at Dømmesmoen, East Agder, Norway, comes a yellow and blue glass bead which has been interpreted as being made from a fragment of a cased glass (*Überfangglas*) (UOT, 1982:66-72, Fig.11).

Ribe, too, seems to provide a relevant example, represented by some beads from one of the workshop layers (layer A 330) at "Posthusfeltet", dated to AD 740 - 770. The possibility that these beads were imported is disregarded here. The beads (ASR X 513) were made from bluish green glass (two with yellowish streaks) as simple wound beads without any decoration. The glass quality is very bad with numerous bubbles, some scars and grains of sand melted into the surface (Fig. 3). Lene Lund Feveile has suggested that they were made from fragments; possibly from polychrome fragments with cable decoration, judging from the two beads with yellow streaks (Lund 1993, 54, note 156). Indeed, the test beads and the Ribe beads share the same characteristics: many bubbles and contaminated glass. Both must be regarded as low quality products. Taking the colour(s) as an indicator, it would also be reasonable to regard the beads as a local product made from hollow-ware fragments, as the dominant colour for the hollow-ware fragments found in Ribe is bluish green.

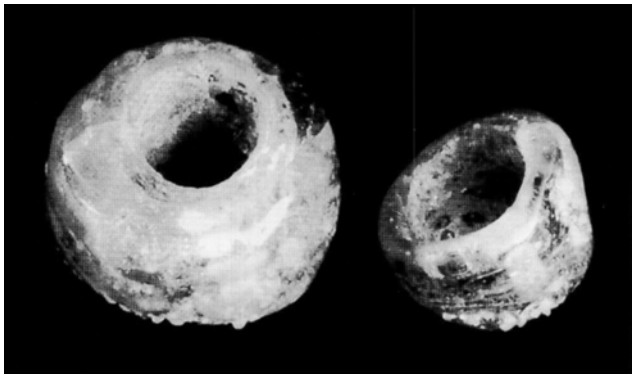

Fig. 3. Beads made from hollow-ware glass fragments? (ASR X513, Posthusfeltet, Ribe, 8th c. AD). The large bead measures 11 mm. Photo: M. Schreiner, ALM.

APPROPRIATE RAW MATERIAL

What, then, is the optimal form of the raw material ? The answer lies indirectly in what was said above. The ideal form is cubic with a side length of about 10-15 mm.

This brings us to the mosaics or tesserae. These little dices, in many colours, have been found almost exclusively at sites with other indicators of the bead making craft, and are themselves taken as an indicator of the craft (e.g. Näsman 1979, 127; A. Lundström 1976, 5 with references). In Ribe they have been found in their thousands and the correspondence between the colour of the mosaics and the beads makes it more than probable that the mosaics acted as a raw material in the bead production. This pattern is partly paralleled by the glass finds from Paviken, Helgö, Åhus and Kaupang.

The other raw material is "raw glass", characterized as non-blown glass, i.e. with arbitrary form and thickness, and possibly containing air bubbles with no clearly direction. The finds from Ribe leave the impression that the bead makers were not short of raw materials. In Åhus, cobalt blue raw glass made up 48% of the total glass finds (Callmer 1982, 224). This cobalt blue colour is very typical of many of the plain globular beads, melon beads and rod-band decorated beads at both sites. Likewise, a certain amount of white raw glass from Ribe can be paralleled in a selection of white beads. The presence of small splinters of blue raw glass could indicate that the raw glass was imported in a form (as cakes ?), which was awkward to handle for the bead making process, and which required breaking up. Näsman has expressed this idea for the Ribe glass (Näsman 1979, 128), and concerning the raw glass from Åhus Johann Callmer writes that "many, if not all [raw glass], have been struck from rounded glass cakes...not unlike the round glass smoothstones.." (Callmer & Henderson 199, 2). The breaking-up process could also be supported by the experiments, which made it clear that there is an upper limit for the size of the raw material. This limit is closely connected to the size of the heat centre, i.e. larger pieces of raw glass demand a larger heat cen-

tre to melt, which again leads to a greater fuel consumption. It would seem only logical that the bead makers in Ribe and Åhus also had an economic work attitude.

Supply and trade

Within Scandinavia there is not much to add to the impression of itinerant beadmakers bringing with them the necessities of the craft. However, an exclusive trade in tesserae could have supplied not only this activity, but also the related work of enamelling. Still, it is difficult to estimate to what degree the makers and their material were separated. A short digression to the widespread Roman transport system shows that it was no problem to move even greater amounts of raw glass, as long as the transport route was water. We get an impression of the actual volume from those ancient misfortunes which are so beneficial to the archaeologists. A shipwreck from the 1st century AD found at Mljet on the Croatian coast has been investigated, and among the commodities were 100 kg of bluish green raw glass, in lumps. As there were no traces of containers, the authors believe that the glass was packed in organic material (Radic & Jurišic 1993, 113). In the Mellieha Bay on Malta, some lumps of brown glass and blue pellets of frit from a shipwreck can be dated to the 3rd century AD. The excavator suggested that the brown glass was transported to be cut as tesserae (Frost 1969, 13). Further east, along the present Israeli coast, several Roman wrecks or cargoes, dated between the 1st and the 3rd century AD, have been located, some of which contained raw glass, either as "blocks of crude yellow glass" or as "broken ingots of glass" (Galili *et al.* 1993, 71). Almost a millennium later a ship capsized at Serçe Limani, in present day Turkey. The cargo of raw glass weighed almost 2 tonnes. In addition there was a huge quantity of blown glass waste fragments – around 1 tonne (Bass 1984, 64; Lledó 1996, 9ff.).

From these few examples it is obvious that within the Mediterranean blown glass producing area raw glass was a well-known commodity. Additionally, the finds from Serçe Limani show that waste glass definitely was a trade object.

Waste, cullet, scrap and fragments

Waste glass, in modern terms "cullet", can be broken hollow-ware, or workshop debris such as failed items, cut-offs from the blowing iron, drops and blobs – all kinds of finished glass. When raw materials for glass are melted together, a certain amount of cullet added to the batch will shorten the melting period. So, it makes sense to regard fragments as a valuable material which there would be no reason to export outside the blown glass producing areas. Therefore, it would be more precise to use the term "cullet" about glass fragments found in or near the glass producing zones, provided that they are not the poor remnant of a complete glass. Glass fragments found in Scandinavia should first of all be defined as ... fragments.

The transport has been referred to as "scrap-import", but the negative value of the word 'scrap' indicates a useless waste material, which was not the case, in either Scandinavia or further south on the Continent. A single glass fragment could be integrated into a ceramic vessel, adding to the value of the whole item. At the site of Lundergård, Northern Jutland, a green glass sherd was integrated into the bottom of a ceramic jar (Fig. 4) found in a grave from the 4th-5th century (Nilsson 1999)[1]. A similar piece has been found in a grave near Nørbæk in Central Jutland (Stidsing 1996, 118ff. Fig. 10)[2]. This 2 cm^2 greenish fragment is faceted and has been placed into the wet clay before the whole jar was fired. Such jars (*Fenstergefäße*) are known from a wide area of Northern Europe (Häßler 1993 with references). Glass fragments could also live a second life as beads or pendants. The most simple way to reuse glass fragment is to string it through a hollow part of the original vessel; for instance a hollow rim. This had happened

1. Vendsyssel Historiske Museum 26/1997, Lundergård, Jetsmark parish, Hvetbo district, Nordjyllands county. Grave no. A 13; the ceramic jar no. x 16. The grave has been excavated during summer 1997 by Torben Nilsson, Vendsyssel Historiske Museum.
2. Kulturhistorisk Museum Randers j.nr. 0807, "Ved Ålehøj", Nørbæk parish, Sønderlyng district, Viborg county. Grave no. A1. The jar is 9.4 cm high. The grave is dated to AD 250 - 320.

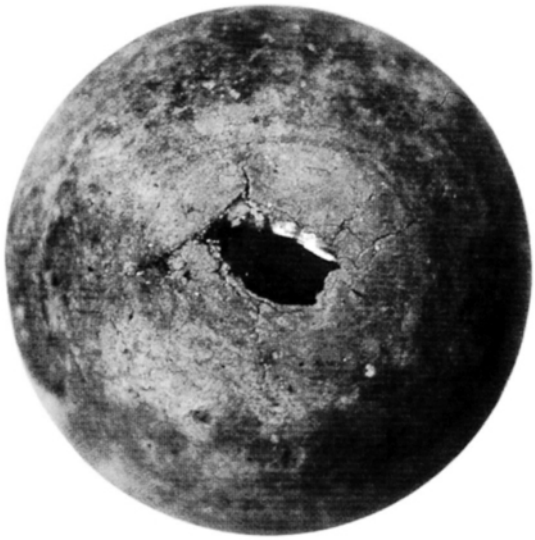

Fig. 4, Bottom of ceramic jar with green glass fragment inserted. (VHM 26/1997, Lundergård, 4th-5th c. AD)
Photo: T. Nilsson, VHM.

to the 'bead' from Slaum, Sweden. Another example is a 'bead' found at Brista, Sweden, which was in fact the middle part of a claw from a claw beaker. Drilling a hole through a glass shard would also be a method of stringing, as can be seen on a 'bead' from Tingvollheimen, Norway (Henricson 1995 with references).

SCANDINAVIAN BEAD MAKING SITES REVISITED

The discussion about the glass fragments, and their way to Scandinavia is first of all firmly connected to sites with a glass bead production. To elucidate the connection, or lack of connection, some well-known sites where bead manufacture generally is postulated are re-examined in the following.

The discussion is not new. In 1937 Holger Arbman expressed the idea, that hollow-ware fragments found in Haithabu should be seen as an import of scrap from the south (Arbman 1937, 68 note 2). Although the only firm 'evidence' for a local bead manufacture, the bottom of a furnace or fireplace (Schwantes 1932, 243), does not exist anymore, there are some production waste and semi-finished products in the glass finds which point to some kind of local work. However, the majority of the more than 7000 beads, together with all (at that time whole) vessels must be regarded as a natural import to this town-like site. In saying that it must be remembered that only a minor percentage of the area has been excavated, and therefore it would be no surprise if a bead workshop should come to light some day.

The far more ambiguous material from Helgö, with 1600 hollow ware fragments and 1100 beads (including items from burials) covering a period of about 800 years, is more difficult to interpret. Wilhelm Holmquist did not believe there was any scrap trade (Holmquist 1964, 259). Agneta Lundström has tried to elucidate all possible interpretations, where the glass finds are related to three different building groups and given alternative value according to the overall interpretation of the (function of) the houses. Her interesting result is that "in Building Group 3 the sherds may be considered to be raw material for bead making. In Building Group 2 they may be explained as broken vessels in ware houses. In Building Group 1 it is difficult to reach a decision as there is much which also shows it to be a beadmaking workshop" (P. Lundström 1981, 21). Concerning the chronological variation Lundström concludes that "complete vessels were imported during the Roman iron age whereas in the migration period/Vendel period the glass was brought in as raw material for the beadmaking workshops". This is perhaps too simplified a conclusion as one could ask why there should be a lacuna in the import of whole vessels, and Holmquist was probably more correct in his judgment. One of the most intriguing finds is still the bead stuck to the tip of an iron rod (A.Lundström 1976, Fig.2), a last greeting from an unlucky bead maker.

In his interpretation of the huge glass finds from Åhus Johan Callmer does not believe that the 856 glass shards should be associated with the bead manufacture (Callmer & Henderson 1991, 2). It would also seem superfluous, because of the overwhelming amount of cobalt blue raw glass at the site. According to the chorological and chronological similarities between Åhus and Ribe, it is tempting to imagine the same crew operating at both sites.

Concerning the glass from Kaupang, Ellen Karine Hougen supposed that the c. 250 vessel fragments

were (partly) imported as scrap, but she is cautious about the bead making material (Hougen 1969, 125). After a personal look through the material at Oldsaksamlingen in Oslo, I found strong indications that beads were made locally at Kaupang, – only not from fragments. Many blue and white beads compared with rods and tweezermarks in the same colours, green beads were mirrored in green waste material and more green and blue pieces have an iron (?) scaling, which could derive from the beadmaking iron.

About 80 vessel fragments were excavated at Paviken, together with 200 whole and misshapen beads, 39 tesserae, and c. 30 pieces of raw glass and bead production waste. The importation of scrap is suggested by the smallness of the shards (P. Lundström 1981, 97), but there is more congruity in colour between beads and some tesserae, raw glass and tweezer marks. The proposed bead mandrel from Paviken must be regarded as a mistake. It is hollow which must be seen as incompatible with bead making.

During the excavations in Birka the following categories have been found: a few tesserae, some lumps (raw glass?), and a few rods (Ambrosiani *et al.* 1974, 58). In her analysis of the glass from Birka, Greta Arwidsson suggested a connection between shards and beads and she also interpreted the fragments as scrap import (Arwidsson 1984, 210). Excavations carried out between 1987 and 1989 uncovered ten finds listed as waste from bead production: eight rods, one lump and one tweezer mark, and Lars Henricsson has pointed out that "this waste can be directly linked up with the bead material" (Henricson 1993, 146). However, I do not agree with Henricson "that native production using crushed glass vessels must be anticipated" (Henricson 1993, 146). During excavations in 1990 and 1991 in the Black Earth Area a lot of beads, a few tesserae, rods, raw glass and some fragments were found by water sieving. There were also signs of a division into lots, just as in Ribe (Ole Nielsen & Björn Ambrosiani pers.comm.).

Investigatinons have been carried out at Slöinge, Halland, since 1992 (Lundquist 1996; 1997 with refrences). The site has been designated as a chieftain's farm. Luxury goods and traces of specialized crafts were concentrated in the central room in the main building. The site has been partly excavated and some of the deposits watersieved. 69 glass shards, 86 beads (some misshapen), 3 tesserae and 225 pieces of bead making waste (rods, melted lumps, droplets, and tweezer marks) were found, and this material can be dated to the 8th century. One interesting fact is the presence of manufacturing within a building, the only other parallel being Helgö. Another is the great similarity with the bead material from Ribe. There is a striking resemblance concerning melon beads, polyedric beads with eyes, trail decorated beads (with a combed pattern), and mosaic beads from the two sites. The hollow-ware fragments should be regarded as what they are: fragments of glass vessels.

Herrebro in Östergötland was excavated in 1988 and 1989 and turned out to be a market place (Lindeblad & Nielsen 1992; Lindeblad 1996). Among other remains from different crafts were two mosaics, a few whole and misshapen beads, and some glass droplets. If the finds do not seem too convincing, it must be stressed that the excavated material is derived from the outermost part of the culture layer, which was not watersieved. More will very likely be found, – even fragments of blown glass.

Lundeborg on Funen represents the oldest site with c. 140 glass sherds, 360 beads, and 37 pieces of bead making debris (a few widespread rods, one tweezer-mark, and some lumps) all dated to the 3rd - 4th century AD (Thomsen 1995). In his examination of the finds Per O. Thomsen discussed the fragments as possible raw material for bead making. When it comes to the colours he stressed that this connexion is only supported by the beads to a certain degree: "Most of the glass sherds are greenish, while the majority of the beads are made of opaque, coloured glass. However, several beads with colours that correspond to the colour on the glass sherds are found at Lundeborg and in the cemeteries of the area" (Thomsen 1995, 23). Nevertheless, the crucial point is that the technical view is ignored. As a result it is immaterial whether the sherds originate from vessels broken on (the way to) the site, brought there as fragments, or collected there for redistribution.

Last, but not least and certainly not less numerous, are the hollow ware fragments from Ribe, more than 2000 fragments from several excavation campaigns, which also revealed different bead makers' workshops (Näsman 1979; Jensen 1991). The amount of hollow-ware fragments is not only the greatest

among the sites mentioned here, they also accumulated over a shorter period than, for instance, the approximate number from Helgö. A detailed publication of the glass is still awaited, but Lene Lund Feveile has based a thesis on the hollow-ware fragments from 'Posthusfeltet' (Lund 1993) and she also discusses the scrap import theories. Lund Feveile highlights the important fact that scrap glass could be reused in the glass-producing areas, leaving no reasons for export (Lund 1993, 54). This argument seems to have been ignored totally by other researchers, but its logic should not be underestimated. Per Lundström, for example, refers to Gregor of Tours as an example of a trade in cullet being documented in the written sources (Lundström 1981, 98), but he seems to overlook the fact that this trade took place within the glass producing areas.

That Ribe also revealed some beads which in all likelihood were made from fragments does not contradict this theory. On the contrary, taking into account the massive indications for beadmakers, operating in different places at the market, combined with the significant amount of hollow ware fragments at hand so to say, it is tempting to imagine how one beadmaker made use of an apparently suitable material, – and to imagine the dissatisfaction which followed. Certainly not a beau idéal to follow.

CRAFT IDENTIFICATION

The previously mentioned sites all share the common characteristic of being defined as market places with many indications of trade and exchange – some with a permanent settlement area. They could also be classified as central places, not necessarily in any value-laden respect, but simply because they grew up at localities which were central with regard to transport of people and commodities. Another common phenomenon is the remains of different crafts, which were carried out at these sites. This once again brings into focus the Bornholmian site of Sorte Muld, mentioned at the beginning of this paper, which has so much in common with these market places, resulting in the glass fragments being interpreted as a raw material for a, yet, unproven bead making activity. Indeed it would come as no surprise, if bead making was carried out at Sorte Muld, but glass fragments alone must not be taken as an indicator of the craft, no matter how many other non-bead-making similarities two sites may share.

The only way a local production can be rendered probable is by (a combination of, if not all) the categories:

1. Raw materials
2. Prefabrication
3. Production waste
4. Failed items
5. Tools
6. Other craft-identifying phenomena
7. Finished items

Applying these categories to the craft of glass bead making, the finds could be:

1. Raw glass or tesserae
2. E.g. polychrome twisted cables (reticella) or plates of mosaic for the two types of beads respectively.
3. Melted lumps or tool-marked pieces of glass
4. Failed beads
5. Bead making mandrel or a pair of tongs
6. Fireplace or furnace
7. Beads

What the actual archaeological remains really look like does of course depend on the kind of beads being produced including the technology used in the period in question.

CONCLUSION

From the outcome of the archaeoexperiment I would conclude that hollow-ware glass fragments form a bad raw material for glass beads. However, the possibility exists that fragments can be used, and bad quality beads from Ribe might be such an examble. So, from a bead maker's point of view, there would be no argument for importing glass fragments; – and since glass waste, or cullet, is almost a necessity in batch making, there would be no reason to export fragments from the glass producing areas. From this it must be evident that glass fragments found in Scandinavia are

first of all related to the trade or exchange in whole vessels. They all reached their final resting place as whole, unbroken, beautiful, fragile containers, unless they, regrettably, broke during transport. The logical consequence is that fragments are no indicator of a bead making activity. To identify the craft it would be more sensible to search for raw glass and tesserae, production waste, tools and working place debris.

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Riding gear from Late Viking-age Denmark

by Anne Pedersen

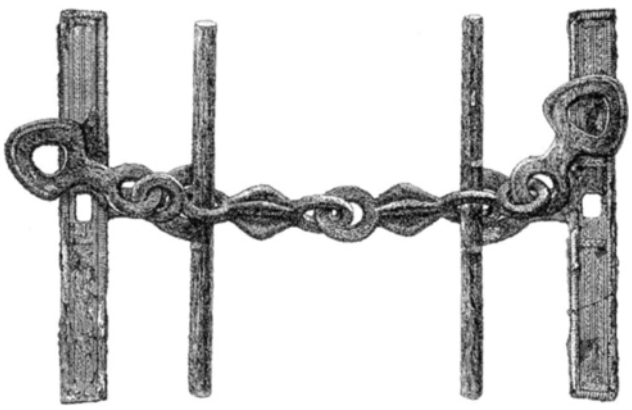
In Denmark, grave finds containing iron stirrups and horse harness are a well-known phenomenon clearly linked to the 10th century AD. During one short phase, men were buried with (*inter alia*) horse gear and spurs; in many cases also with a horse. Most, if not all, of the metal fittings from this equipment were made of iron and they are often decorated with silver and copper. The burial custom appears to have been followed mainly in western Denmark and gradually died out towards the end of the century (cf. Pedersen 1997a). Riding equipment was then no longer deposited in graves, and it becomes far more difficult to gain a definite impression of any typological development based on secure find combinations. In recent years, however, intensified metal detector scanning and excavations on settlement sites have yielded new finds that cast some light on the later developments.

Whereas most of the equipment in the 10th century was made of iron, harness fittings of cast copper alloy appear in the following century. The objects most easy to recognize are cheek-pieces for snaffle bits and decorated copper-alloy stirrups. Such objects have been known for a long time, but have rarely been discussed in detail as a group (see Paulsen 1937; Fuglesang 1980; Graham-Campbell 1992). With the increasing number of metal detector finds, not only cheek-pieces but also stirrup-strap mounts of copper alloy are beginning to appear in larger numbers, although unfortunately often as fragments that may be difficult to identify. Another group of mounts, the so-called stirrup terminals, has only recently been identified in England (cf. Williams 1998), but a preliminary survey has shown that these terminals are in fact present in Denmark amongst the single finds discovered with metal detectors. Without attempting to present complete surveys of all four groups of horse trappings, mounts as well as stirrups, the aim of this article is to draw attention to these characteristic objects from the transition period between the Viking Age and the Medieval Period in Denmark.

CHEEK-PIECES OF COPPER ALLOY

Horse-bits with long cheek-bars and matching rectangular plates are well known in Scandinavia, especially in Denmark. The horse-bits included in the Danish equestrian burials of the 10th century are almost exclusively of this type (Brøndsted 1936 and find list no. 2 in Pedersen 1997b). Variations occur in, for instance, the length of the bar and plate, and towards the end of the 10th century and in the following century we see examples with curved rather than straight bars or

Fig. 1. Iron horse-bit from Stengade grave 3, Langeland, Denmark (after Brøndsted 1936). Scale ca. 1:3.



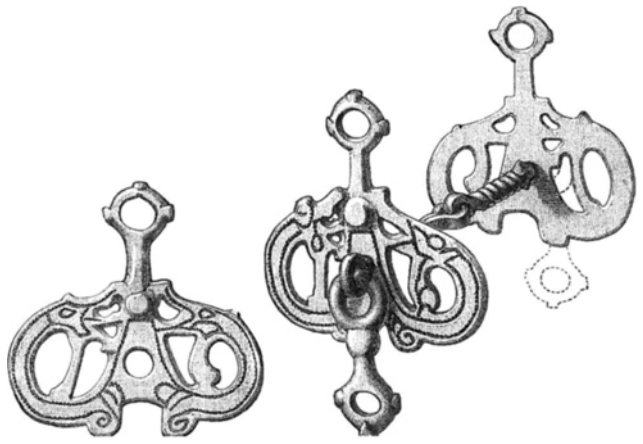
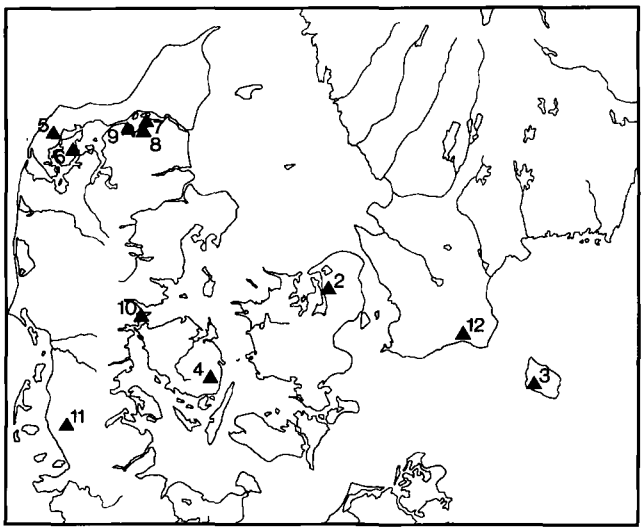


Fig. 2. Iron horse-bit with copper-alloy cheek-pieces from Lundby, Södermanland, Sweden (after *Fornvännen* 4, 1909). Scale ca. 1:3.

bars ending in animal heads such as on a well-preserved horse-bit of iron from Lund in Skåne, dated to AD 1000-1050 (Kulturhistoriska Museet i Lund inv.no. KM 59126:751; *Vikingarna* 1989, 108). Here stylized bird's heads with curved beaks terminate the ends of both bars. Curved bars are found on a horse-bit from a burial uncovered at Næsby in northern Jutland (Ranum parish, Ålborg county; Vesthimmerlands Museum Aars inv.no. VMÅ 867/C226). Close parallels to this bit are known from burial finds in Norway where they are dated to the early 11th century (Petersen 1951, 21ff.).

Fig. 3. Distribution of copper-alloy cheek-pieces in Schleswig, Denmark and Skåne (cf. find list no. 1).



In spite of the variety of shape and size, these iron horse-bits all belong to the same basic type, a two-link horse-bit with two eyes set at right angles to each other at either end, the inner eye for a single cheek-bar or a bar with an attached decorated plate, the outer eye for the rein strap (Fig. 1). The mouth-piece may have a square, circular (a twisted bar), or rhombic to cross-shaped cross-section, the latter probably being required for a well-trained horse (cf. Forsåker 1986, 115, note 1).

A small group of horse-bits dated to the 11th century have a slightly different construction and are fitted with copper-alloy cheek-pieces instead of decorated iron bars and plates. The two-link mouth-piece was made of iron, and each end passed through a decorative plate cast of copper alloy to which the bridle-straps were fastened (Fig. 2). The ends of the iron mouth-piece therefore have only one eye for the rein strap, instead of the two typical of the bits with bar and plate. This construction is not an entirely new development, appearing, for instance, in two identical iron bits from the Ladby ship burial in Denmark, dated to the first half of the 10th century (Thorvildsen 1957, 56). A more elaborate example from the early 9th century is a pair of copper-alloy cheek-bars of Carolingian origin from the Haithabu ship burial (Müller-Wille 1976, 84ff., Abb. 38-39; Wamers 1994, 19ff.).

Until now twelve finds of copper-alloy cheek-pieces have been recorded from Viking-age Denmark, including Schleswig and Skåne (Fig. 3). Further examples are known from Sweden and Norway (type Rygh No. 568), as well as from England, where the number of finds is steadily increasing (cf. find list no. 5). In many cases the cheek-pieces are broken and thus difficult to identify, especially fragments with a rounded cross-section which have been wrongly classified, for instance as strap buckles depending on the break. The breaks usually occur down the central axis of the plate, i.e. through the hole for the bit, or horizontally, in which case the eye for the harness-strap is missing.

It is generally accepted that the copper-alloy plates are cheek-pieces for horse-bits, although some of them, such as a fragment from Sebbersund in northern Jutland (Fig. 4c), appear small and very slight.

Fig. 4. Danish finds of copper-alloy cheek-pieces. a. Dueholm Mark, Mors. b. Unknown provenance, Denmark. c. Sebbersund, Ålborg county. d. Bøgeskov Strand, Vejle county. e. Græse, Frederiksborg county. f. St. Myregård, Bornholm. g. Gärarps church ruin, Skåne. h. Sønderholm, Ålborg county. Scale 1:1. Photo: National Museum, Henrik Wichmann; Museet Færgegaarden; Trelleborgs Museum, Skåne.

Fig. 5. Cheek-pieces from Leck, Schleswig, Germany. Scale 1:1. Photo: Archäologisches Landesmuseum der Christian-Albrechts-Universität, Schleswig.

This interpretation is supported by two Swedish burial finds, a cremation burial from Lundby, Fors parish in Södermanland (cf. Fig. 2), and a disturbed boat grave (grave III) excavated at Tuna, Alsike parish in Uppland, in which the bits are combined with stirrups and a pair of spurs (cf. find list 5, no. 5 and 8).

Based on the shape of the cheek-piece and the composition of the animal motif, it is possible to distinguish two main types:

1 A cheek-piece consisting of a thin (c. 3-6 mm) copper-alloy plate with a hole at the centre for an iron bit and an eye for the bridle-strap with three ornamental projections. The plate is decorated with two animal heads, one at each side or end. The heads are depicted with a stylized mane and may stand freely or be joined to the centre of the cheek-piece (cf. Fig. 4).

2 A cheek-piece of roughly the same shape as type 1 but with slightly rounded cross-sections in the animal ornament and apparently depicting only a single animal instead of the two heads on type 1. An animal's head with open jaws is set opposite a tail-end resembling a fleur-de-lis. No mane is evident, but tendril extensions emphasize the lower jaw and the tail. Two cheek-pieces from Leck in Schleswig are mirror images of each other (Fig. 5); the pair from Lundby in Södermanland on the other hand consists of two identical cheek-pieces (cf. Fig. 2). In both pairs the two sides of the ornament are slightly different, and it is evident that only one animal was intended on each cheek-piece.

On both main types, the two heads or head/tail normally face each other, but an unusual cheek-piece from Edsvära in Västergötland, Sweden depicts two heads turned outwards (cf. find list 5, no. 3). This mount, with its attached iron bit, was found in 1906 next to the skeleton of a horse.

Apart from the cheek-pieces from Leck, there is one other example of type 2 from the Danish area, a fragment from Sønderholm in northern Jutland (Fig. 4h). The proportions of the animal head are almost identical to the heads on the set from Leck, and it is possible that they were fashioned over the same model. Most of the present Danish finds belong to type 1, showing variations over the main theme, animal heads with a more or less elaborate mane. However, one from Gudme on Fünen is atypical, carrying what seem to be very debased versions of the animal ornament and a mask-like figure above the hole for the mouthpiece (Fig. 6).

The most complete examples of type 1 from Den-

Fig. 6. Cheek-piece from Gudme, Svendborg county, Denmark. Scale 1:1. Photo: Weiss & Wichmann.

mark are a cheek-piece from Dueholm Mark on the island of Mors and a stray find picked up on the beach at Bøgeskov in Vejle Fjord (Fig. 4a and 4d). The surface of the cheek-piece from Bøgeskov is very worn, whereas the decoration on the piece from Dueholm stands out clearly. This latter find is reported to have been found together with the fragment of a sword not far from the site of a burial mound. It is, however, uncertain whether the two objects represent one or possibly two burials or rather stray finds from a settlement site. Equestrian burials are not unknown on Mors, and one grave, most likely a burial from the 10th century according to the description of the contents published in the local newspaper at the time, was uncovered in 1857 on Dueholm Mark (J. Nielsen 1991).

A third group of cheek-pieces made of iron, not copper alloy, may be added, although as yet no examples have been recorded in Denmark. The disturbed boat grave (grave III) at Tuna, Alsike parish in Uppland, contained a horse-bit with iron cheek-pieces combined with *inter alia* two different iron stirrups, a pair of spurs and a heavy spearhead as well as a second snaffle-bit and a harness-bow mount (Arne 1934, 26ff., Taf. VI). A similar horse-bit with very stylized cheek-pieces of iron was found together with two strap-mounts, a broad-bladed iron axe and an iron spearhead with silver inlay in a burial mound at Göksbo in Altuna parish, also in Uppland (Paulsen 1937, Abb. 17). A third example is a single find of unknown provenance from Sweden (cf. find list 5, no. 1). All three horse-bits are very simple and stylized versions compared to the more elaborate bits with copper-alloy cheek-pieces.

A copper-alloy mount from Lund in southern Sweden has been interpreted as yet another version of decorated cheek-piece (Fig. 7). It has an eye at either end but instead of the central boss typical of strap-links, it is decorated with an animal figure. The back-turned animal's head forms a hole above the animal's back and a strap fixture corresponding to the eye on the animal-head cheek-pieces joins the two legs. The hole is placed slightly off the central axis of the object and the diameter, only 5 mm, appears too small for a mouth-piece when compared with the cheek-pieces. The object therefore is most likely a decorative strap-link with a fixture for a third strap-end. The archaeological context gives an approximate date of AD 1020-1050 (Kulturhistoriska Museet i Lund inv.no. KM 66166:711; Bergman & Billberg 1976). Also from Lund comes a roughly T-shaped, triangular mount of copper alloy with a rhombic eye at either end of the bar (one missing) and a projecting ornamental part with

Fig. 7. Copper-alloy bridle-mount from Lund, Skåne. Scale 1:1. Photo: Lunds Universitets Historiska Museum.

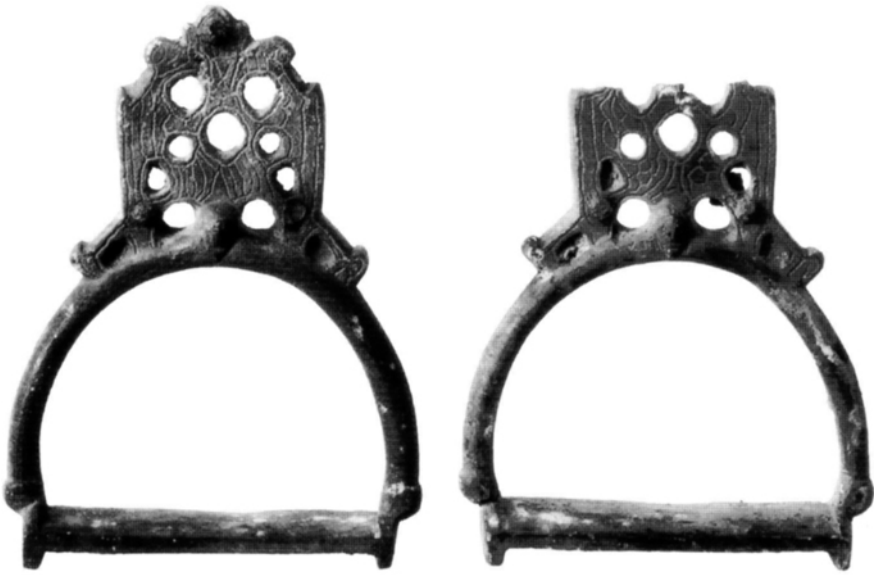


Fig. 8. A pair of copper-alloy stirrups from Lundby, Södermanland, Sweden. Scale 1:2. Photo: ATA Stockholm.

a hole in the centre (Strömberg 1961 II, Taf. 67.3a). A function as a cheek-piece is not obvious, although the object doubtless comes from a bridle or harness.

The cheek-pieces from Leck in Schleswig and the horse-bit from Lundby, Södermanland as well as one from a burial (grave III) uncovered at Årsunda in Gästrikland, Sweden were found with strap-mounts of copper alloy for the reins. A circular eye at one end of these mounts was attached to the iron mouth-piece, and at the opposite end the rein strap was drawn through an eye with three ornamental projections giving it a rhombic or square appearance similar to the eye terminating the cheek-pieces (cf. Fig. 2). Årsunda grave III also contained two cross-shaped strap-mounts with four such rhombic eyes. Similar mounts or fragments of mounts with one, two opposite or four eyes turn up as single finds and are most likely part of a bridle or horse harness.

STIRRUPS

The horse-bit from Lundby in Södermanland was found together with a pair of copper-alloy stirrups characterized by a low, almost semi-circular hoop with a flat, slightly raised rectangular tread-plate (Fig. 8). The basic shape of these stirrups also occurs in iron and may be seen as a further development of the triangular stirrups typical of the Viking Age. The hoop is, however, significantly shorter than the ones on the triangular stirrups which usually measure between 15 to 20 cm, in some instances up to 25 cm as on an ornate pair of iron stirrups from Nr. Longelse on Langeland (Brøndsted 1936, Pl. V-VI; cf. Pedersen 1997a). The width of the tread-plate and thus the space for the rider's foot is narrow, only about 9-10 cm, and

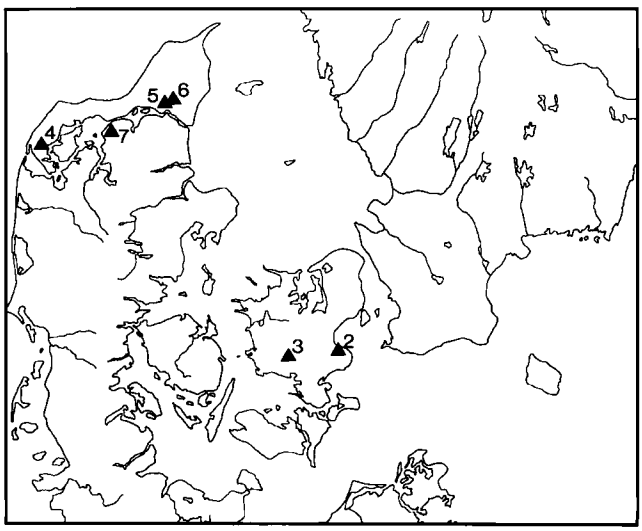


Fig. 9. Distribution of copper-alloy stirrups in Denmark (cf. find list no. 2).

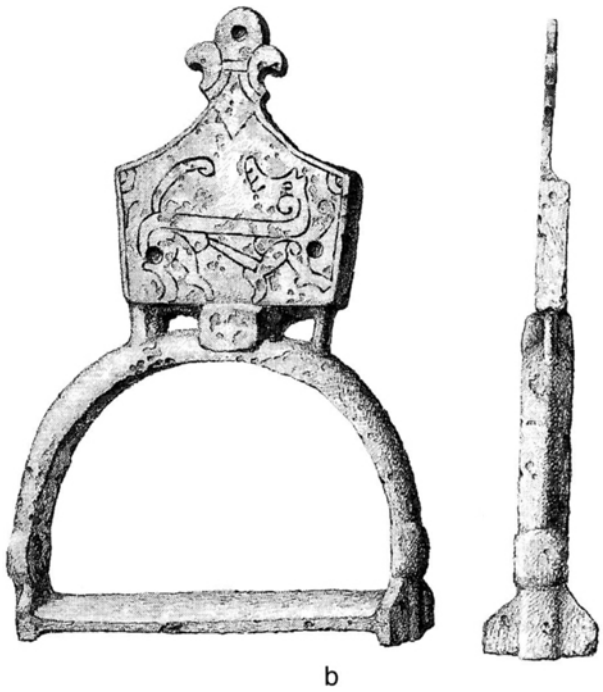


Fig. 10. Copper-alloy stirrups from a-b. Hammer, northern Jutland and c. possibly Stevns, Zealand. Scale 1:2. (Mejborg 1877 del., Petersen 1904 del.).

instead of the usual rectangular eye at the top through which the stirrup-leather would be passed, the cast stirrups from Lundby and their counterparts have a decorated strap-plate to which the stirrup-leather was riveted.

Six copper-alloy stirrups are known from late Viking-age Denmark (Fig. 9), although unfortunately three of these have so far only been identified in drawings and photographs. Two of them came from a bog in Hammer parish, Ålborg county. They appear in the Danish National Museum archives in two detailed drawings by Mejborg from 1877 (Fig. 10a-b). At that time it was noted that they were owned by a Mr. Ahlmann. In 1889 both stirrups were shown in the archaeological section of the Danish contribution to the World Exhibition in Paris[1], and one of them is published as the type example No. 588 in Sophus Müller's *Ordning af Danmarks Oldsager* Vol. II from 1895. In spite of this, there is no record of the two stirrups having been included in the collections of the National Museum and their present location is unknown.

The third stirrup was apparently returned to the owner after a drawing had been made for the National Museum by Magnus Petersen in 1904 (Fig. 10c).

1 Photograph of the Danish archaeological exhibition in the archives of the Prehistoric Dept. of the National Museum, Copenhagen. The exhibition was organized by Sophus Müller and included c. 400 objects, about half of which were from private collections.

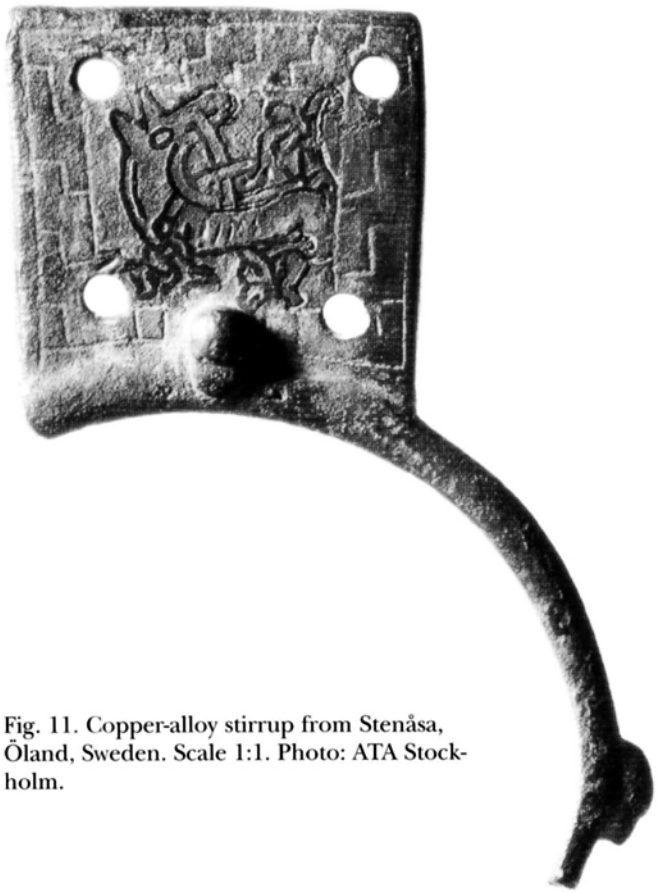


Fig. 11. Copper-alloy stirrup from Stenåsa, Öland, Sweden. Scale 1:1. Photo: ATA Stockholm.

According to the drawing it was purchased at an auction in 1904 and on 27th June of that year it belonged to a mechanic H. Petersen of Strøby on Stevns, eastern Zealand. The stirrup is mentioned in a compilation of local legends referring to burial mounds on Stevns (Boberg 1931). It appears that a burial mound at Strøby beach was removed around the year 1880. A copper-alloy stirrup was later found in one of the gardens in Strøby to which soil had been carted from the beach, and it is very likely that this stirrup is the one sold at the auction in 1904, in which case the provenance for the stirrup drawn by Magnus Petersen is Strøby.

The three preserved stirrups are also single finds, one of them without provenance. This latter stirrup has only a simple strap-plate whereas the other two are typical of the decorated copper-alloy stirrups. One is a single find from Trollegab Mose, a bog in northern Jutland; the other is from Bavelse on Zealand. It is reported to have been found during marl digging in Bavelse Mark at a depth of c. 1 metre. A later inspection of the site provided no further information, and it is doubtful whether the stirrup came from a burial[2].

Apart from the Danish examples, copper-alloy stirrups have been found in Sweden, Iceland and England (one example), but none are mentioned from Norway (cf. find list no. 6). These stirrups are all similar to the ones recorded from Denmark apart from slight variations in the ornament such as the number and shape of the animals depicted on the plates as well as the general outline of the plate. Only the two stirrups from Lundby in Södermanland constitute a definite pair. All the others are single finds like the Danish examples are. The two stirrups recorded from Hammer in Jutland may of course have been used together; on the other hand they are not identical. In nearly all Viking-age burials with stirrups in Denmark, the two stirrups form a pair, and although wealthy burial finds may not be the best source of information for common everyday behaviour, it does appear that mis-matched pairs were avoided if possible.

The actual number of preserved copper-alloy stirrups is limited, but they appear to fall into three main groups, characterized by differences in the strap-plate:

1 Stirrups with a four-sided or trapezoid plate.
2 Stirrups with a four-sided plate ending in a top ornament similar to a „fleur-de-lis".
3 Stirrups with a plate showing a curved outline; in this group the plates are usually attached directly to the main hoop of the stirrup.

As yet, it is not clear whether the variation in the shape of the strap-plate is of geographical, chronological or possibly symbolic significance, and there does not appear to be any definite relation between the shape of the strap-plate and its ornament or between the plate and the way it is attached to the main hoop of the stirrup, either with a single joining "neck" (Fig. 10a) or several (Fig. 10b).

2 National Museum inventory from 1853, inv.no. 13308. In 1991 L. C. Nielsen apparently considered the stirrup to be a burial find (cf. L.C. Nielsen 1991, Fig. 5), but this is uncertain.

The strap-plate provides room for ornamentation, usually in the form of sketchily engraved animals. Single beasts are found on, for instance, one of the stirrups from Hammer (Fig. 10b) and a broken stirrup from Stenåsa on Öland, Sweden (fig. 11). On the latter the main motif is surrounded by a frame with a stepped pattern. Two ribbon-shaped animals are depicted on the second stirrup from Hammer (Fig. 10a) and the one from Bavelse Mark, as well as on a stirrup from Romsey, England and one from Merkihvoll, Iceland, none of them identical (Read 1887; Eldjárn 1956, Fig. 189). A single ribbon-shaped animal is seen on the stirrup from Stevns (Fig. 10c).

Niello was used to emphasize the animal figure on the strap-plate of the stirrup from Stenåsa, and according to the information given on the drawings, traces of niello were evident on the two stirrups from Hammer. Silver wire was apparently used to trace the design on the stirrup from Romsey (Read 1887, 532), but as the silver had almost entirely disappeared leaving only the empty lines, this may be a mis-interpretation. Whether the inlay was of silver or niello can no longer be verified. The sketchy designs suggest inlay, but where no traces are preserved, it is possible that, as suggested by Holger Arbman, the intention was to create a contrast between a matt line decoration and the surrounding polished surface (Arbman 1937, 268).

The foot plates on two stirrups from Vidafjell and Klóarfjell on Iceland have a decorative moulding at the lower edge (Eldjárn 1956, Fig. 190, 191). This is even more pronounced on a single find from Vindblæs in northern Jutland, kept in the National Museum in Copenhagen (Fig. 12). The foot plate is curved downwards and has small plant-like ornaments along the edge resembling the ornaments on some medieval stirrups. The strap-plate on the other hand is very similar to the plates on the copper-alloy stirrups with semi-circular hoop, and the attachment of the plate to the main hoop is not unlike that on the two stirrups from Lundby in Södermanland (cf. Fig. 8). The stirrup from Vindblæs probably represents the final stage in the development of the type and is as yet a unique find in Denmark.

STIRRUP-STRAP MOUNTS

The copper-alloy stirrups have a fixed strap-plate. Similar, decorated plaques occur as single objects. They have often been classified as book-mounts or clasps, as box-mounts or as strap-ends, even though the characteristic bottom flange set at an angle to the plaque itself renders the last interpretation unlikely or unpractical (Roes 1958, 96). The number of mounts alone is an argument against an interpretation as book-mounts; books were still very rare and precious objects (cf. Margeson 1997, 33). Similarities in the design of some of the types to the strap-plates on the decorated stirrups as well as a few find combinations provide a definite link between these single mounts and iron stirrups. On one iron stirrup, a recent detector find from Chalgrove, Oxfordshire in England,

Fig. 12. Copper-alloy stirrup from Vindblæs, Ålborg county. Scale 4:5. Photo: National Museum.

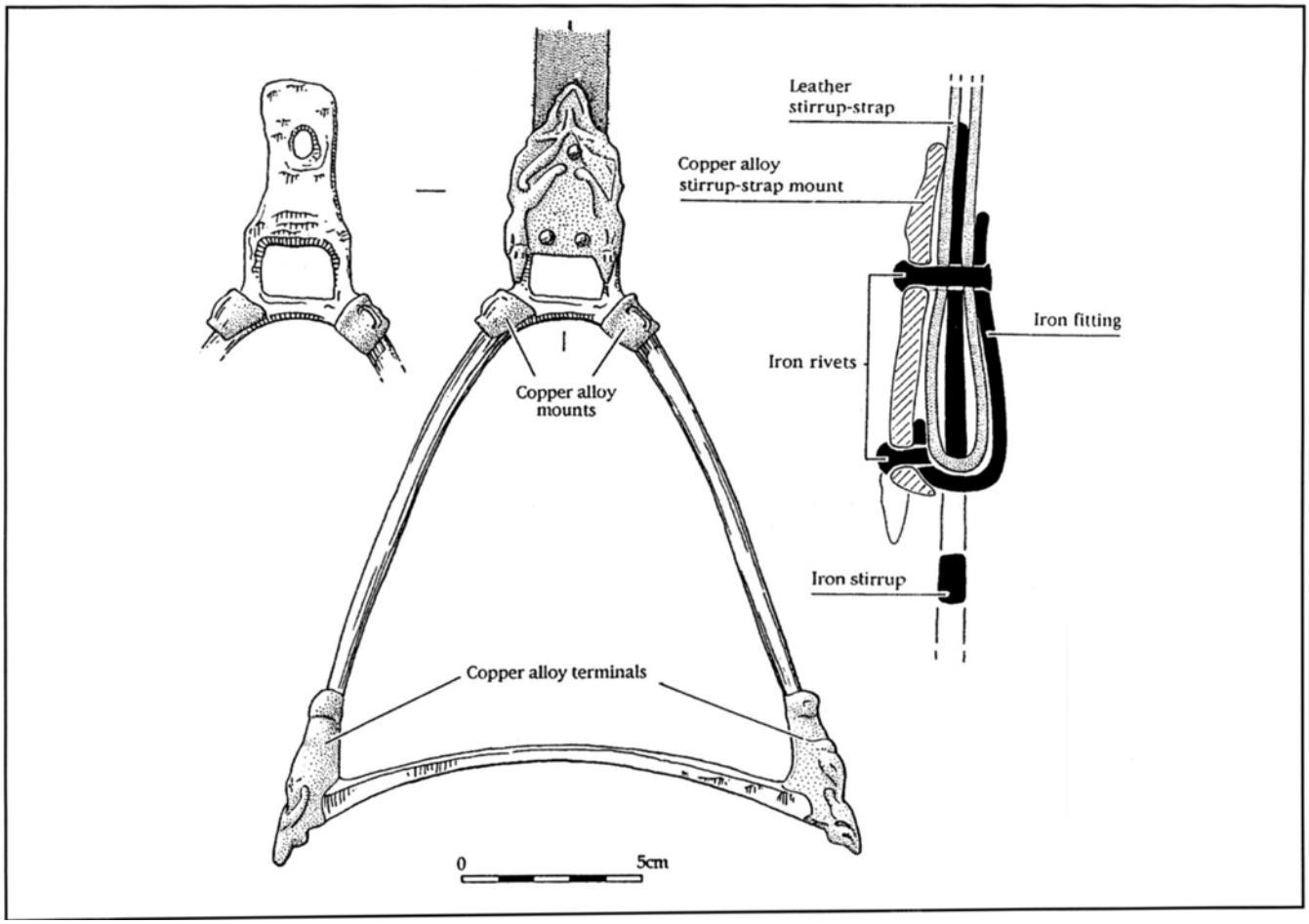


Fig. 13. Iron stirrup with copper-alloy mounts from Chalgrove, Oxfordshire (after Williams 1997a). The position of the strap-mount and stirrup-leather is indicated in the reconstruction.

a strap-mount of copper alloy is still in place. The leather of the stirrup-strap is partly preserved, enabling a reconstruction to be made (Fig. 13).

The mount from Chalgrove belongs to a type that has not yet been recorded in Denmark, and there are no parallels to its shape among the fixed strap-plates on the copper-alloy stirrups. A Swedish find from Kvalsta in Västmanland provides a closer resemblance to the stirrups. At Kvalsta a decorated mount of copper alloy was found together with tall iron stirrups fitted with a broad rectangular eye for the stirrup-leather (Arbman 1937, 270ff, Fig. 7). Most of the stirrups of this basic type were apparently used without metal mounts or with strap-mounts consisting of narrow iron bands or rectangular decorated iron plates of about the same width as the stirrup-leather (cf. Brøndsted 1936, Figs. 5-6, 71, Pl. IX), but the Kvalsta find indicates that this stirrup-type may also have been combined with decorative copper-alloy mounts similar to the strap-plates on the cast stirrups. The find circumstances at Kvalsta are not very accurately documented and several burials may have been mixed up, but the objects found together with the stirrup and published by Holger Arbman as a group, among them several copper-alloy strap-mounts, suggest a date in the 11th century (Arbman 1937).

Considering the number of mounts that are now coming to light with the aid of metal detectors, it is very likely that iron stirrups with copper-alloy strap-mounts were far more common than the cast stirrups.

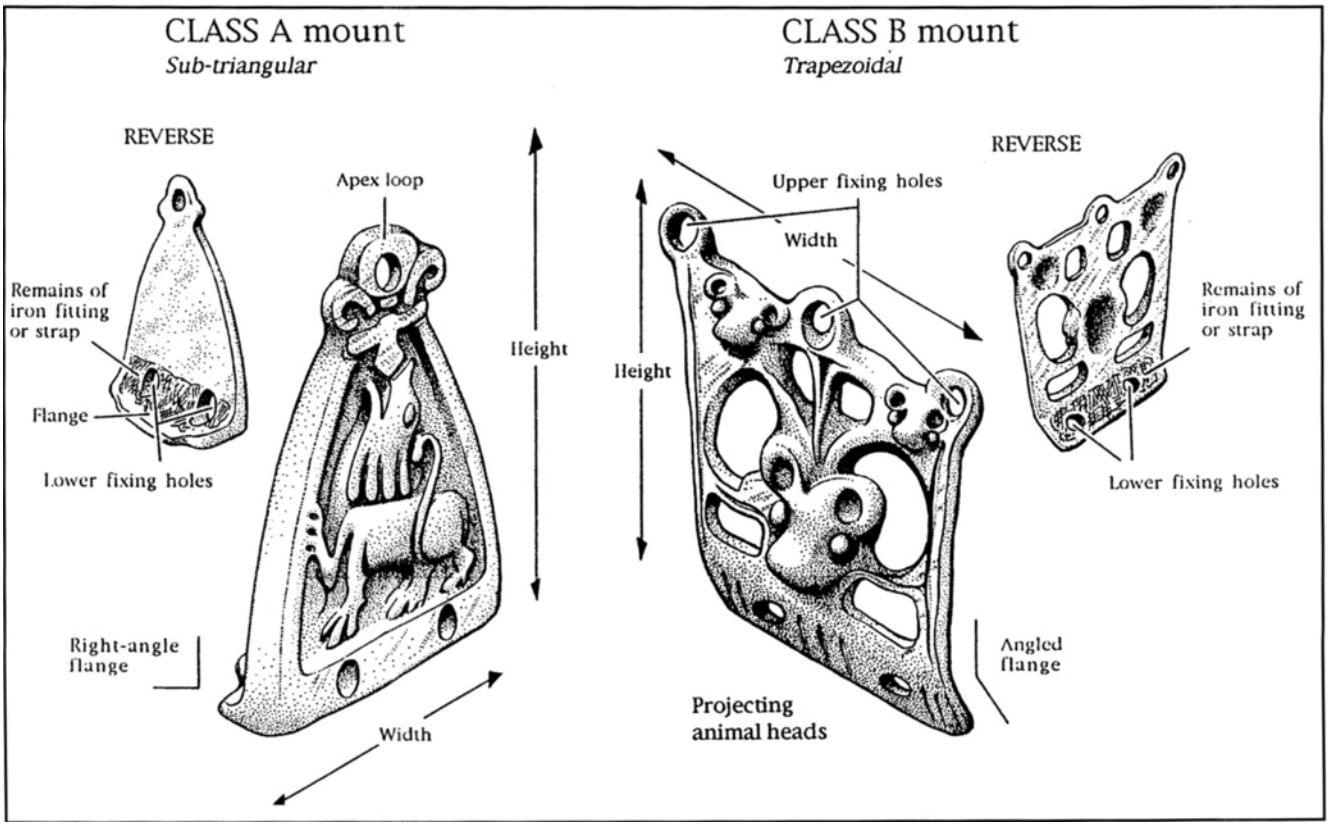


Fig. 14. Construction principles for strap-mounts of Classes A and B (after Williams 1997a). No scale.

The Anglo-Saxon mounts have recently been studied in detail by David Williams, and his catalogue numbers just over five hundred. The widespread distribution in rural and urban areas supports the interpretation as horse-equipment rather than book mounts (cf. Margeson 1997, 34). Based on the shape and decoration the strap-mounts are grouped into three main classes with sub-types (Williams 1997a). Most of them fall into class A (Fig. 14). They are most often triangular and have a single rivet-hole at the top or the upper part and one or two rivet-holes at the base. Class B is less numerous (Fig. 14). These mounts tend to be trapezoidal or sub-rectangular with rivet-holes placed at the top and in the angled flange at the bottom. The decoration is often openwork. Class C covers a small group with projecting side-lugs.

A preliminary survey has revealed fourteen finds from Viking-age Denmark (Fig. 15). Nothing like all

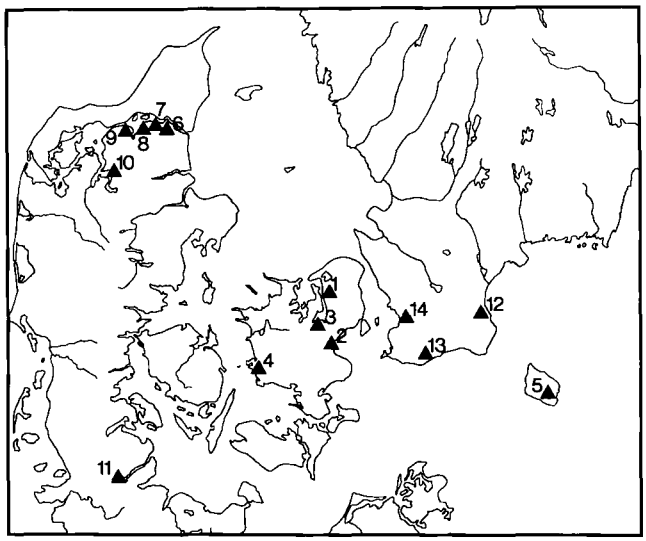


Fig. 15. Distribution of stirrup-strap mounts in Schleswig, Denmark and Skåne (cf. find list no. 3).

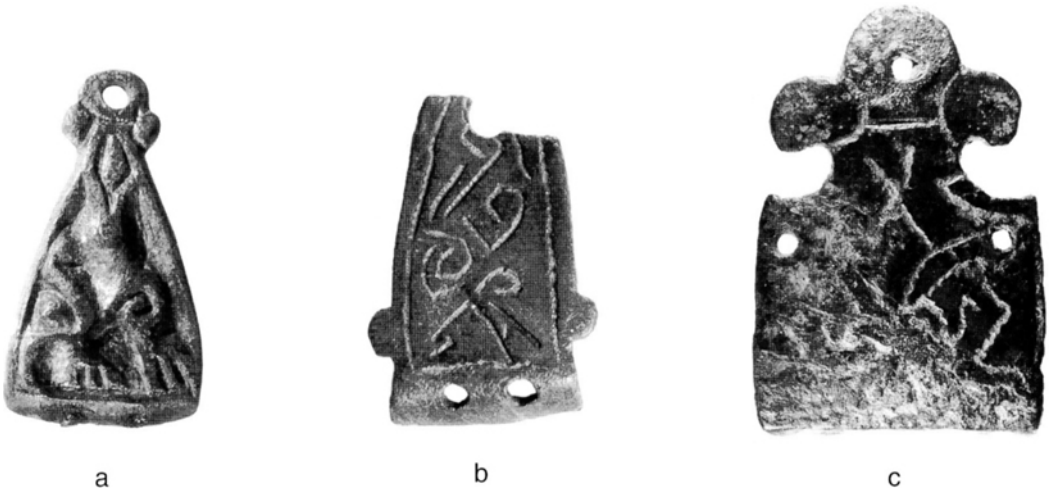


Fig. 16. Stirrup-strap mounts from a. Græse, Frederiksborg county, b. Langetofte, Sorø county, c. V. Klagstorp, Skåne. Scale 1:1. Photo: Weiss & Wichmann; Lunds Universitets Historiska Museum.

of the types distinguished by David Williams are present, possibly due to the limited number yet recorded, but all three main classes have been identified.

Eight strap-mounts belong to William's Class A. A sub-triangular mount with slightly curved sides and two rivets at the base from Græse, northern Zealand, is very similar to a type common in England depicting a four-legged leonine animal. The known finds range from very well-made examples with a clearly defined animal figure to debased versions. The animal on the Danish mount looks to the right (Fig. 16a). The tail at the left curls up over the animal's back, and the head with open jaws is turned upwards, reaching for an object at the top of the mount. The animal lacks the raised front paw seen on better versions. Another broken triangular mount with two rivet-holes at the base from Langetofte, western Zealand, has a more uncertain design consisting of straight borderlines and comma-like figures in the centre field, possibly a very debased version of a sketched animal motif (Fig. 16b).

A four-sided mount with a fleur-de-lis ornament at the top from V. Klagstorp in Skåne also belongs to

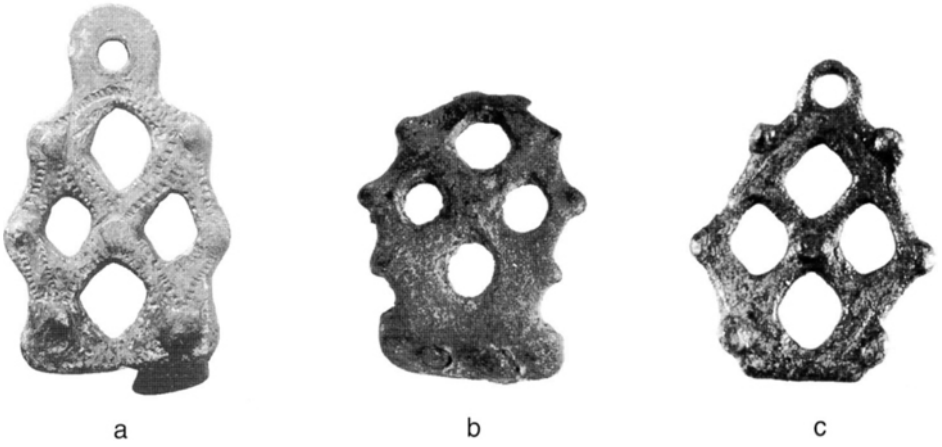


Fig. 17. Rhombic strap-mounts from a. Sebbersund, Ålborg county, b. Hjulmagergård, Bornholm, c. Postgården, Ålborg county. Scale 1:1. Photo: Aalborg Historiske Museum; National Museum, Henrik Wichmann.

Class A (Fig. 16c). The front is very worn, but the motif appears to have been a rough sketch of an animal. The shape of the mount comes very close to the strap-plates on the copper-alloy stirrups with a fleur-de-lis ornament at the top, and a function as a stirrup-mount was suggested by Märta Strömberg in 1961 (Strömberg 1961 I, 146). The sketchily engraved lines are similar to the technique employed in the decoration on the stirrups.

Openwork mounts of roughly rhombic shape with two rivet-holes at the base and a circular terminal with a central rivet-hole at the top (William's Class A, type 12) are at present the most common type in Denmark and are recorded in five finds, three from northern Jutland, one from Skåne, and one from Bornholm (cf. find list no. 3). Two further examples of this type are known from the island of Öland off the east coast of Sweden (Strömberg 1961 I, 146f.; Williams 1997a). These mounts have been described as strap-ends (cf. Strömberg 1961 I, 147), but considering their similarity with other strap-mounts and the often slightly oblique base with two rivet-holes, the latter identification is the most likely.

The rhombic mounts are very similar but vary in details such as the decoration and the number of bosses on the frame (Fig. 17). A well-preserved mount from Hjälmeröd in Skåne has a boss at the centre and three bosses or slight projections at either side where the central cross-shaped figure joins the frame (Strömberg 1961 II, Pl. 72.3). Double rows of dots decorate the framework. On a mount from Sebbersund in northern Jutland, the bosses are situated more directly on the frame without forming actual projections (Fig. 17a).

A very distinctive mount from Flengemarken in Roskilde, Zealand, belongs to William's Class B, type 4, which appears to be most common in East Anglia (Williams 1997a, 95ff.). These mounts are characterized by a staring human mask with a very marked nose and two prominent eyes. The background for the mask from Flengemarken is difficult to determine but may be interpreted as waving hair or some kind of headdress (Fig. 18a). The mount has a single rivet-hole at the top in the hair or headdress of the mask and two rivet-holes at the base, which is set at an oblique angle to the front.

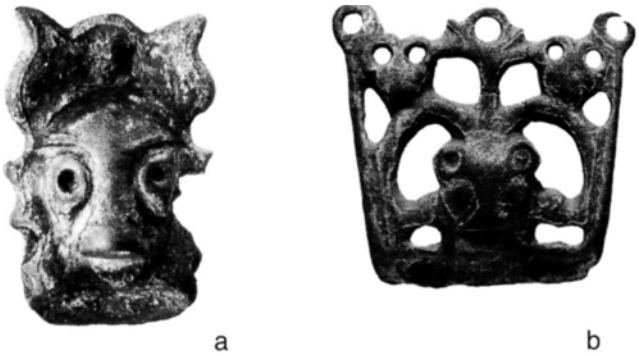


Fig. 18. Stirrup-strap mounts from a. Flengemarken, Copenhagen county, b. Gl. Køgegård, Copenhagen county. Scale 1:1. Photo: National Museum.

Many of the types of stirrup-mount distinguished by David Williams have no direct parallels in the strap-plates of the copper-alloy stirrups, but the link is evident when, for instance, the mount from V. Klagstorp (Fig. 16c) is compared with the stirrup-plates. The similarity in outline and ornament is also very close in a small group of four-sided openwork mounts with animal motifs of William's Class B. Three examples are preserved from Haithabu in Schleswig, Gedsted in northern Jutland and Lund in Skåne (Fig. 19). They are surprisingly alike and were probably fashioned over the same or almost identical models. The mounts depict a four-legged animal with one raised front paw and a curved tail over its back. The jaws are open, and the head seen in profile is dominated by a large round eye. The motif has been interpreted as an animal with a male rider, but this seems rather doubtful in view of the example from Lund on which the tail appears to pass down between the two hind legs of the animal and curl up over its back.

A rectangular openwork mount from Dingtuna in Sweden is very similar to the ones from Denmark, but the animal is shown in greater detail (Ekegård, Dingtuna parish, Sweden; Statens historiska Museum Stockholm inv.no. SHM 9170:1235) (Fig. 20). Whereas these mounts depict the whole animal, another openwork mount (William's Class B, type 1) is decorated with stylized cat-like heads within a four-sided frame. One such mount has been found near Ellehalen/Gl. Køgegård, Køge parish on eastern Zealand (Fig. 18b), but several are known from England, and a similar

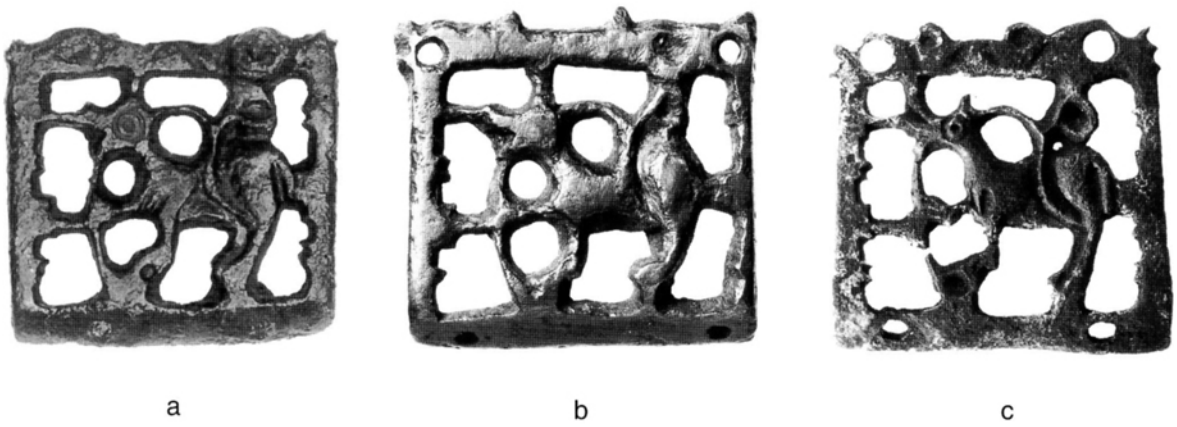


Fig. 19. Stirrup-strap mounts from a. Haithabu, Schleswig, b. Gedsted, Viborg county, and c. Lund, Skåne. Scale 1:1. Photo: Archäologisches Landesmuseum der Christian-Albrechts-Universität, Schleswig; National Museum, Copenhagen; Kulturen, Lund.

mount comes from Büderich in Nordrhein-Westfalen, Germany (Williams 1997, 85ff.; *Das Reich der Salier* 1992, 36).

Finally a stirrup-mount of William's Class C from Sønderholm in northern Jutland (Fig. 21) resembles the strap-plates of stirrups on which the plate is attached directly to the main hoop as on one of the Danish examples (Fig. 10c) or on two stirrups from Iceland (Eldjárn 1956, Fig. 190, 191). The ornament appears to consist of at least one very degenerate animal head (Fuglesang 1980, 134). A strap-buckle acquired together with this stirrup-mount and presumably of the same provenance indicates that the stirrup-leather or other harness-straps were fitted with buckles decorated in a style correponding to the mounts next to the stirrups. However, we lack secure find combinations that may confirm this connection (cf. Graham-Campbell 1992, 87).

All the Danish strap-mounts, like most of the English and Swedish examples, are single finds. A comprehensive survey of Norwegian and Swedish collections would probably reveal further mounts and could confirm whether only certain types are present in Scandinavia in comparison with the many types from Anglo-Saxon England.

Fig. 20. Stirrup-strap mount from Dingtuna. Scale 1:1. Photo: Statens Historiska Museum, Stockholm.

ANIMAL-HEAD TERMINALS

A second group of attachments for iron stirrups has recently been identified in England (cf. Williams 1998). Apart from the copper-alloy mount for the stirrup-leather, the stirrup-iron from Chalgrove, Oxfordshire mentioned above has decorative copper-alloy fittings at the top of the hoop as well as at the treadplate (cf. Fig. 13). The lower fittings or terminals are shaped as stylized animal heads. Similar objects are known as single finds and they appear most often stylistically related to the Ringerike/Urnes style, thus belonging to the late Viking Age/early Medieval Period (Williams 1998). Whether all examples were at-

Fig. 21. Stirrup-strap mount and buckle from Sønderholm, Ålborg county. Scale 1:1. Photo: National Museum.

tached to stirrups is uncertain. Some of them appear very slight, and more than one purpose may be possible, although at present an interpretation as stirrup terminals seems the most likely (cf. Margeson 1997, 36).

A damaged stirrup of approximately the same basic shape as the one from Chalgrove is kept in the National Museum in Copenhagen. It is a single find uncovered at a depth of c. 75 cm in a meadow south of the river Rævså (Odder parish, Århus county; National Museum inv. no. D11408). The front of the stirrup is decorated with brass sheet, and the joints between the hoop and the tread-plate are hidden under copper-alloy mounts of "strange hoof-like shape" according to the inventory (Fig. 22). These mounts are very simple in comparison with the elaborate animal heads, but fulfil a similar function.

Confirmation of the connection between stirrups and animal-head terminals is also provided by a stirrup from Farstorp in Skåne, Sweden (Strömberg 1961 II, Pl. 67.1). This stirrup is made of iron with a decorative brass band wound around the hoop. Two animal heads attached with a lead solder decorate the sides of the hoop just above the tread-plate. Both heads have prominent eyes, small triangular ears and an upturned nose. An almost identical stirrup has been found in the River Ray near Islip in England (Seaby 1950; Strömberg 1961 I, Fig. 18). It is also wound with brass bands and a stylized animal head is preserved on one side of the hoop. The almost semi-circular hoop of both stirrups provides an approximate date in the first half of the 11th century. Very similar stirrups with a small rectangular eye for the strap but no animal heads on the hoop have been found in grave VIII at Tuna, Uppland in Sweden, which has been dated to the first half of the 11th century (Arne 1934, 71, Taf. XIII.11-12).

Up to now twelve animal-head terminals of copper alloy have been identified in Viking-age Denmark (Fig. 23). Some of the animal heads are not unlike gold or silver animal-head terminals for chain ornaments. A

Fig. 22. Detail of iron stirrup decorated with brass sheet from Odder parish, Århus county; front and inside view. Scale 1:1. Photo: National Museum.

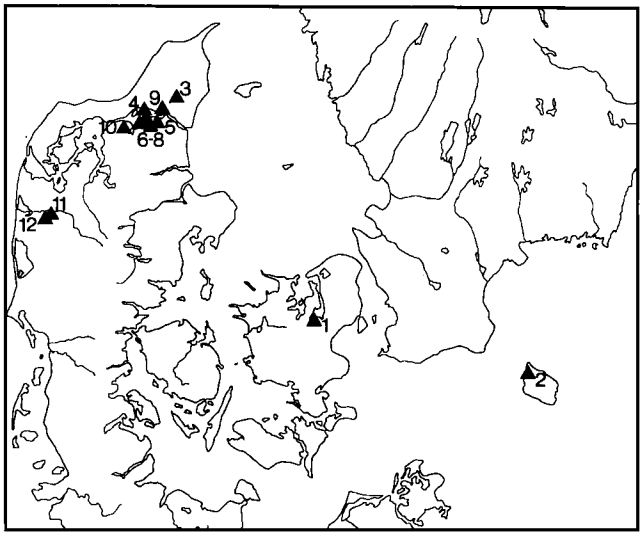


Fig. 23. Distribution of stirrup-terminals in Denmark (cf. find list no. 4).

function as supports for, for instance, candle sticks has also been suggested, although one feature is very typical. The terminals are hollow-backed (i.e. on the underside of the animal head) and the hollow may contain remains of a lead solder which secure the terminal to another object, the lower part of the stirrup-hoop. There may also be a projecting ledge which could support the end of the tread-plate, and the upper part of some terminals ends in a simple or decorated collar.

More than eighty terminals have come to light in England (as of 1997), and a preliminary study by David Williams has revealed several different groups distinguished by variations in the details of the heads such as the snout, the eyes and ears, and the tendrils or crest above the brow (Williams 1998). Similar variety is evident in the Danish finds.

One group of terminals is characterized by snub-nosed animal heads with prominent bulging brows, eyes and ears, lobe-ended tendrils and in some cases flaring nostrils (Williams 1998, Fig. 2). A well-preserved terminal from Nørregård in Ringkøbing county falls into this group and a second example with traces of iron at the top and the lower end of the back was recently found at Nørholm in Ålborg county (Fig. 24).

A second group comprises more or less simple zoomorphic terminals of various shapes without such details as the marked tendrils of the first group (Williams 1998, Fig. 4). A terminal from Flengemarken in Roskilde, Zealand (Fig. 25a) belongs to this group. It is not very long, but has a marked collar at the top and the typical hollow back. Deep lines indicate two elongated eyes and a pair of nostrils at the base of the mount. A very similar but poorly preserved mount has come to light on Bornholm. Another is known from Nørre Felding in northern Jutland, and a small fragment from Nørholm, only 1.4 cm long, has been identified as the snout end of a simple animal head.

A terminal from Gjøl Mark in northern Jutland is more massive and the open mouth of the animal head is unusual (Fig. 25b). It has a parallel in a very short, possibly broken terminal from Stentinget, Hjørring county. Another unusual terminal with a pointed snout below two bulging eyes was found north of Lindholm Høje in northern Jutland. It is very slight, but has the characteristic hollow back and a protruding ledge indicating that it was used used for the same purpose in spite of its size.

These terminals are about 3 to 3.5 cm long, the one from Lindholm only 2.5 cm long. A highly stylized terminal found at Skelagervej near Ålborg in Jutland, is slightly longer, 4.2 cm, and shows more clearly distinctive traits of the Urnes style than the other mounts. The elongated eyes resemble those on Urnes-style jewellery (Fig. 25c).

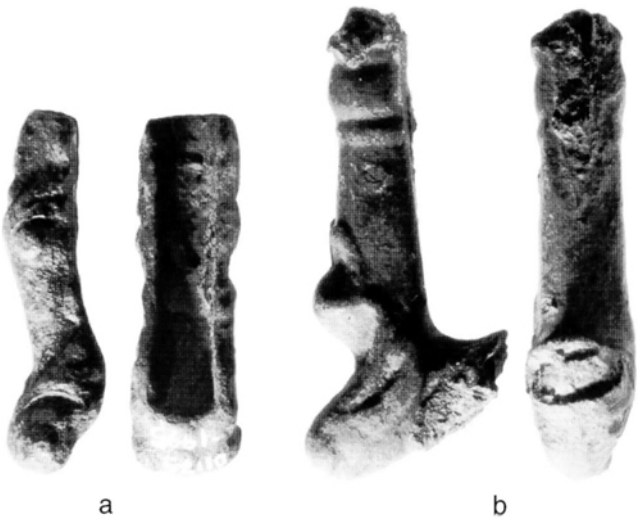


Fig. 24. Stirrup-terminals from a. Nørregård, Ringkøbing county, b. Nørholm, Ålborg county; side view and back. Scale 1:1. Photo: Henrik Wichmann.

Fig. 25. Stirrup-terminals from a. Flengemarken, Roskilde county, b. Gjøl Mark, Hjørring county, c. Skelagervej, Ålborg county, d. Nørholm, Ålborg county; side view and back. Scale 1:1. Photo: Henrik Wichmann.

Most of the animal heads face downwards on the stirrup, but one group is characterized by a crested animal head curled round to face upwards on the stirrup, not unlike the animal heads on the cheek-pieces of copper alloy. Some terminals recorded by Williams enclose the stirrup arm completely (cf. Williams 1998, Fig. 3), although the one example as yet found in Denmark at Nørholm in Jutland has an open hollow back (Fig. 25d). It does not have the elaborate crest of David Williams's type example but is otherwise very similar.

The number of identified terminals from Viking-age Denmark is still limited when compared to the many from England, but in view of the definite stylistic connection with Scandinavia these objects may be expected to turn up in larger numbers along with the strap-mounts[3].

DATING EVIDENCE

Most of the Danish copper-alloy fittings for horse gear are single finds, and the archaeological evidence for a precise dating of these objects is limited. Significantly, none have yet been located in a secure burial context, although it cannot be ruled out that the cheek-piece from Dueholm Mark on Mors came from a destroyed grave. A copper-alloy strap-mount from Aggersund in northern Jutland, similar to those linked with the cheek-pieces, is reported to have been found in a mound, albeit without definite reference to a burial context (Aggersund, Aggersborg parish, Hjørring county; National Museum inv.no. C23296). These objects apparently came into use in late Viking-age Denmark after the end of the burial custom involving deposition of weapons and horse trappings in male graves. Finds from Norway and Sweden where such furnished graves continue well beyond AD 1000 support this interpretation.

Cheek-pieces and decorated stirrups of copper alloy occur together in the Swedish grave find from Lundby in Södermanland. Apart from the horse-bit and stirrups, this burial contained a pair of copper-alloy spurs, an iron spearhead, a knife and strap-mounts. The spearhead is not readily classifiable, but it resembles Jan Petersen's type M which has been dated to the 11th century (Petersen 1919).

Datable objects have been found in two other Swedish burials containing horse-bits with cheek-pieces, i.e. the disturbed boat grave (grave III) from Tuna in Alsike, Uppland, and a burial uncovered at Göksbo, also in Uppland (cf. find list 5, no. 8 and 9). In both cases the cheek-pieces are made of iron in a simplified design compared with the copper-alloy versions. The objects from Tuna grave III include *inter alia* a spearhead of iron and two different iron stirrups characterized by a low, almost semi-circular hoop. The broad blade and short socket of the spearhead are typical of Jan Petersen's type G, which is dated to the second half of the 10th century and the early 11th cen-

3 Since this article was completed two further terminals have come to light south of Nørholm, Nørholm parish, Ålborg county. National Museum inv.no. D87/1999 and D102/1999, the latter of the same type as Fig. 25.d.

tury (Arne 1934, 61). The horse-bit from Göksbo was found together with a broad-bladed axe of Jan Petersen's type M and a silver-inlaid spearhead decorated in the Ringerike style (Paulsen 1937, Abb. 17; Fuglesang 1980, 29ff., pl. 12A). Both objects support a date in the 11th century.

Complete horse-bits with copper-alloy cheek-pieces are known from two other finds, but in this case the accompanying objects do not permit a definite dating (cf. find list 5, no. 11 and 12). The Norwegian type find, horse-bit Rygh No. 568, from Vestby in Sørum, Akershus, came to light in 1862 not far from a burial mound. It was found together with a spearhead, a knife of iron and a small, crudely ornamented oval brooch (Rygh 1885). The objects and the site suggest a destroyed burial; the brooch possibly coming from a second grave. Apart from a horse-bit, grave III at Årsunda in Gästrikland, Sweden, included an axe, according to the photographic records of Statens Historiska Museum in Stockholm. Two axes are preserved from the site, but it is uncertain which one is from grave III and the presence of an axe is not confirmed in the museum inventory.

The stirrups from Lundby and Tuna grave III are typologically late forms, different from the tall triangular stirrups typical of the Danish equestrian burials of the 10th century. Although very much alike, these latter iron stirrups may be divided into three main groups distinguished in terms of single features and general proportions (Pedersen 1997a, 128f.). As a whole they show a gradual change from a fairly simple stirrup without marked traits towards the well-known tall stirrups with clearly defined details such as the boss on either side of the hoop and the extensions of the hoop below the foot-rest. This type was reduced in height towards a more compact stirrup, in some cases with very pronounced features. A similar development is seen in Norway and Sweden leading to types with very low triangular hoops that do not occur in Danish burials (cf. Braathen 1989). These short stirrups are related to the forms with a semi-circular hoop, and Tuna grave III contained one of each type. The stirrup with a semi-circular hoop from Tuna has the rectangular loop for the stirrup-leather typical of the triangular iron stirrups, but is covered with thin copper-alloy sheet, leading T.J. Arne to compare it to the copper-alloy stirrups, and the resemblance between the two types is clear (Arne 1934, 65, Taf. VI 8,9).

Two graves containing iron stirrups with short, almost semi-circular hoops as well as weapons (axe and spear) excavated at Åsta in Västmanland in Sweden confirm the typological development and the late date of this stirrup-type (Simonsson 1969). In Åsta grave 7 a single stirrup was found with *inter alia* an axe of Jan Petersen's type M and a spearhead possibly of Jan Petersen's type H. Åsta grave 8 contained a pair of stirrups, an axe, and a spearhead of Jan Petersen's type G. These weapons indicate a date for both burials in the early 11th century.

The fittings in Åsta grave 7 include a broad sheet-iron band that was fitted to the stirrup-leather immediately next to the stirrup. A pair of stirrups with similar iron bands are known from a cremation burial uncovered at Raglunda in Västmanland, Sweden, and G. Westin compared these iron bands to the copper-alloy strap-plates for a pair of heavy stirrups recovered in 1851 from a burial mound at Velds in northern Jutland (Westin 1941, 97; cf. Brøndsted 1936, 104, fig. 11). The Velds plates, dated to the early 11th century, are decorated with animal ornament and were rivetted to the strap-leather in much the same way as the copper-alloy strap-mounts. Although earlier stirrup-types were often fitted with decorative plates for the stirrup-leather, these plates were made of iron, and the decoration does not appear to include animal figures, thus differing from the motifs used on the copper-alloy stirrups and strap-mounts as well as on the plates from Velds (cf. for instance Brøndsted 1936, Figs. 5-6). The Velds plates may be linked to the development of the decorated stirrup-strap mounts, although they are over twice the usual size of these mounts (cf. Williams 1997a, 6).

The similarity between some of the stirrup-strap mounts and the strap-plates on the copper-alloy stirrups supports the interpretation of the single mounts and indicates that the two groups of objects are contemporary. Two strap-mounts may be given an approximate date. One is an openwork rhombic mount found in a sunken hut at Sebbersund in northern Jutland. Pit-houses appear to have gone out of use on this site around AD 1000 and a date in the late 10th century or

very early 11th century is suggested for the mount by the excavator Peter Birkedahl. The openwork mount depicting a four-legged animal from Lund was excavated from a pit in a cultural deposit with dendrochronological dates at AD 1060-70 (Mårtensson 1982), and activity at Lund as such does not appear to have commenced much before c. AD 990. The few English mounts associated with datable material also point to a date after c. AD 1000, and there appears to be no evidence for an earlier date (Williams 1997a, 8).

The strap-mount from Kvalsta in Västmanland in central Sweden was found together with several iron stirrups. To illustrate the function of the mount, Holger Arbman attached it to one of the stirrups from the site (one of an identical pair), commenting that the combination of the two objects of different metals was not what one would expect (Arbman 1937, 272). The stirrup is characterized by a triangular hoop to which the rectangular loop for the strap-leather is joined by a narrow and rather long neck. It has been suggested that this type could be an Insular form (Seaby and Woodfield 1980; cf. Williams 1997a, 4). However, the type occurs in several Swedish finds as well as in Norway and may in fact have been made in Scandinavia although possibly some time before the strap-mount[4]. A pair from Birka grave 708 was found together with weapons and an iron horse-bit with cheek-bar and plate typical of the 10th century (Arbman 1940-43). The Kvalsta site was unscientifically excavated, and the wide variety of objects are most likely from several disturbed graves. It is therefore uncertain how many burials are represented and which objects belonged to each individual burial. Holger Arbman does not state whether the strap-mount was actually found *in situ* on the stirrup, thus, although the Kvalsta find provides a probable link between mounts and stirrups, it does not supply an exact date for the mount.

The stirrup from Chalgrove in Oxfordshire provides evidence that the stirrup terminals and strap-mounts of copper alloy are roughly contemporary, and it is possible that the inspiration and prototypes behind the use not only of mounts but also of elaborate terminals lies in the development of the iron stirrups in the Viking Age.

Many of the triangular iron stirrups of the 10th century bear a boss on the arms of the hoop immediately above the tread-plate. These iron bosses were hammered out in the hoop or attached separately, and none of them has a definite animal shape, which appears to be a later development. On the stirrups from Velds in Jutland the bosses were apparently made of a lead alloy covered with gilt copper alloy (Brøndsted 1936: 104). A similar pair from Loose in Schleswig is fitted with lead-alloy bosses decorated with silver (Müller-Wille 1977, 70, Abb. 8.6-7). Other stirrups with copper-alloy bosses on the hoop as well as a copper-alloy boss at the "neck" are known from Norway and Sweden, one of them a short iron stirrup from Tuna grave III, mentioned above[5]. The decorative use of copper alloy on these typologically late stirrup-irons may be inspired by the copper-alloy stirrups or *vice versa*, and the stylized animal heads on a few iron stirrups such as the two from Farstorp in Skåne and the River Ray in England typologically dated to the first half of the 11th century may provide a background for the use of the more elaborate terminals.

To sum up, the archaeological and typological evidence points to a date for the copper-alloy fittings in the 11th century, and the forms employed show definite links to the typological development of stirrups and iron fittings characteristic of the 10th and the early 11th century.

4 The stirrups from Kvalsta correspond to a pair from Birka grave 708, Uppland (Arbman 1940, Taf. 36.2); two stirrups of unknown provenance, Närke (Örebro Läns Museum 4701); three single stirrups from Vänsta, Kolbäck parish, Västmanland (Västerås Museum 5796), Boberg, Fornåsa parish, Östergötland (Statens Historiska Museum Stockholm 11390:22), and St. Lundby, Lids parish, Södermanland in Sweden (Statens Historiska Museum Stockholm 8640:322); and a pair from Hennum, Buskerud in Norway (Universitetets Oldsaksamling Oslo C.4622a-b).

5 The finds include two burials from Bryni and Finstad Söndre, Hedmark in Norway (Universitetets Oldsaksamling Oslo C.21812 and C.11323); Tuna grave III in Alsike parish, Uppland, and a burial from Svaneholm in Ås parish, Småland, Sweden (Statens Historiska Museum Stockholm 10035:3 and 9116).

STYLISTIC EVIDENCE

Apart from the archaeological and typological indications, the dating of the four groups of horse trappings relies on stylistic information. It is not possible to group all objects within one of the Viking art styles, but they doubtless belong to the late Viking Age and early Medieval Period.

The horse's heads depicted with a curling mane such as on the cheek-piece from Dueholm Mark may be grouped under the Ringerike style, even though many of the mounts are crudely executed and the stylistic traits appear rather debased (Fuglesang 1980, 133). The Ringerike style emerged in Scandinavia at the end of the 10th century and flourished in the first half of the 11th century (Fuglesang 1980, 43ff; Wilson 1995, 153ff.). Characteristic elements are the flared terminals of the mane and tail as well as the round eyes of the animals. The cheek-pieces from Leck in Schleswig as well as the almost identical fragment from Sønderholm and the pair from Lundby in Sweden are slightly different but still show Ringerike traits. The elongated eyes and fine proportions of other cheek-pieces bring them closer to the Urnes style, which emerged around the middle of the 11th century and continued in use into the 12th century (Wilson 1995, 217).

The decoration on the copper-alloy stirrups and some of the strap-mounts is linked to the late Viking-age art styles as well, although the animal and plant motifs often appear as rough sketches when compared with the more typical examples of each style. The strap-plate of the broken stirrup from Stenåsa on Öland (Fig. 11) depicts a four-legged animal within a stepped pattern-frame. The animal has been described as a debased animal of the Jelling type, whereas the tendril pattern or tail above its hind quarters in the top right-hand corner of the strap-plate points to the Ringerike style (Klindt-Jensen & Wilson 1965, 83f.). The stepped border of the strap-plate is very similar to the border of a large silver brooch from a silver hoard dated to the middle of the 11th century, uncovered at Äspinge, Hurva parish in Skåne (Holmqvist 1951, 48ff.). The four-legged animal engraved in the centre-field of the brooch is typical of the Ringerike style and far more detailed than the animal on the stirrup (Klindt-Jensen & Wilson 1965, 105). However, the same constituent elements, the knotted front and hind legs, the curled tail and pointed snout, are evident in both animals. The combination of a stepped border and animal ornament is also found on a copper-alloy buckle from Lund dated to the first half of the 11th century (Mårtensson 1982, 162). The width of the buckle, 6.2 cm, indicates that it was fashioned for a broad strap possibly a harness strap.

The animal figures and the plant-like ornament on the other stirrups as well as the single strap-mounts from Sønderholm in northern Jutland (Fig. 21) and V. Klagstorp in Skåne (Fig. 16c) show elements that may also be associated with the Ringerike style (Fuglesang 1980, 133f.).

Torsten Capelle considered the four-legged animal in the rectangular openwork mounts (Fig. 19) to be in the Mammen style (Capelle 1968, 59). The head of the animal resembles the bird's head on the silver-inlaid axe recovered from the Mammen chamber burial, but the composition of the animal motif as such has close parallels amongst the four-legged animals of the Ringerike style. It is very similar to the animal on the openwork mount from Dingtuna (cf. Fig. 20), on which the Ringerike elements are more evident. The archaeological context for the mount from Lund suggests a date around the middle of the 11th century (Mårtensson 1982), a date which is supported by another object from Lund, a small circular brooch found in grave 17 excavated on the Thule site (Mårtensson 1963, 58ff.). The brooch depicts a bird/griffin with a head dominated by a single round eye with a dot at the centre very like the head on the mount. The grave is one of the earliest in the cemetery and has been dated to the second half of the 11th century.

Like the strap-mounts, many of the stirrup-terminals may be associated with the Scandinavian Ringerike and Urnes styles, although some of the small animal heads such as the ones from Gjøl Mark (Fig. 25b) and Lindholm Høje are stylistically uncertain (cf. Williams 1998, 1).

An elaborate flying mane formed of tendrils in the Ringerike style is found on an animal-head terminal from Gooderstone in Norfolk, and another very fine example in the British Museum is from Lincolnshire (Margeson 1997, Fig. 41.b; Williams 1998, Fig. 3). The

Danish terminal from Nørholm (Fig. 25d) is a simpler version of this type, and shows similar features, albeit more suggestive of the Urnes style.

The round eyes under curling eye brows and the corresponding bulging nostrils and flared whiskers on the terminal from Nørregård as well as the tendrils on another terminal from Nørholm (Fig. 24) may be assigned to the Ringerike style. Viewed from the side they are not unlike some of the two-dimensional animal heads on the copper-alloy cheek-pieces. The elongated eyes on the stylized animal head from Skelagervej in Ålborg, on the other hand, are definitely indicative of the Urnes style (Fig. 25c), and the terminal from Flengemarken (Fig. 25a) shows similar traits.

The evidence as a whole suggests that the copper-alloy fittings for stirrups and horse-bits belong to the 11th century, possibly with an early beginning in the very late 10th century. The presence of stylistic traits related to both the Ringerike and the Urnes styles indicates that these objects were made over some time, i.e. from the first half of the 11th century continuing into the second half of the century and possibly beyond AD 1100. At present it is difficult to be more precise about the chronological development of the types. It is to be hoped that new finds in datable contexts may provide more detailed information.

The stirrup from Vindblæs adds a new element to the decoration. The main motif on the strap-plate is a rough sketch of a single four-legged beast turned to the left (Fig. 12). It is similar to the four-legged animal turned to the right on one of the stirrups from Hammer (Fig. 10b), but a cross is clearly seen above the animal. The significance of the cross is uncertain but it may reflect an addition or change in the known motif, like that occuring in small circular openwork brooches some of which depict an animal in the Urnes style whereas others of the same shape and size incorporate an "Agnus Dei" with a cross above its back within the circular frame (Bertelsen 1991).

ORIGIN

The copper-alloy stirrups and related horse-bits have been considered to be of Anglo-Saxon origin but from areas with close contacts to Scandinavia. This interpretation was based on the typological difference between these objects and the traditional Viking-age riding gear known from burials, as well as the difference in technique and style and the choice of raw material, i.e. copper alloy rather than iron.

In his publication of the cheek-pieces from Leck, Peter Paulsen suggested that the stirrups originated in southern England and were made at the beginning of the 11th century (Paulsen 1937, 22, 34). Similarly, Holger Arbman proposed England or possibly Jutland as the place of origin (Arbman 1937, 268). Arbman based his argument on the geographical distribution and the technique of some of the copper-alloy horse-trappings which appeared foreign in a Scandinavian context. Instead of having a cast ornament, the ornament on some strap-mounts and stirrups was incised after the casting process and often seemed sketchy and crudely executed, although the contrast between rough, matt lines and polished surfaces in Arbman's opinion could have been intentional, and the niello inlay on some of the stirrups would hide a rough surface in the incised grooves. This style of ornament apparently became popular, especially for horse-trappings, at the beginning of the 11th century, and production under craftsmen in areas of Anglo-Saxon and Scandinavian contact seemed probable. To Arbman at the time, England was most likely, with Jutland as an alternative.

The copper-alloy stirrups have been compared with the very ornate set of gilt copper-alloy strap-plates from Velds in Jutland. The lightly incised decoration on the front of these plates depicts birds and floral ornaments in a style which has been linked with southern England (Brøndsted 1936, 102ff.). Holger Arbman believed the whole set of riding gear from Velds to be imported (Arbman 1937, 268ff.) but although it is true that it differs from most of the equipment in the Danish equestrian burials, there are, as mentioned above, a few related finds from Scandinavia which indicate that the objects are not all foreign. Stirrup-plates of this type do not occur in England, and the stirrup-irons are not Anglo-Saxon, but rather Scandinavian in type. On the other hand, Leslie Webster describes the ornament as an amalgam of Late Saxon acanthus and bird decoration and Scandinavian Ringerike tendrils, probably made in an Anglo-Scandinavian milieu (Webster 1984). She suggests that the strap-plates may have been made in southern England for a Scandina-

vian follower of King Cnut, or that a set of Anglo-Saxon motifs were adapted by a Danish craftsman for the Scandinavian-type stirrups. In either case, the set of stirrups and strap-mounts testifies to the close contacts between England and Scandinavia and not least the possibility of cultural influence as reflected in ornaments and objects passing both ways.

Märta Strömberg pointed to a link between Scandinavia and England for the copper-alloy cheek-pieces (Strömberg 1961 I, 145), and similarly the nature of the Ringerike ornament on cheek-pieces, strap-fittings and stirrups suggested to Signe Horn Fuglesang the possibility of these objects representing an innovation in Scandinavia based on Anglo-Saxon prototypes (Fuglesang 1980, 135). However, the semi-circular hoop of the stirrups is not without parallels in Scandinavia; on the contrary, the basic shape of the stirrups corresponds better to the Scandinavian typological development than to the stirrup-types found in England (cf. Seaby & Woodfield 1980; cf. Pedersen 1997a). The present distribution of the copper-alloy stirrups strengthens the argument in favour of Scandinavia, most likely Denmark, and it is very probable that cheek-pieces and strap-mounts were fashioned in this country as well.

Strap-mounts and stirrup-terminals have now been identified in museums and are beginning to appear on the so-called metal-detector sites along with the cheek-pieces, indicating that these objects were much more common than the old finds lead us to believe. Many of the cast stirrup-strap-mounts were probably made in England. But the similarity between certain types and the strap-plates on the copper-alloy stirrups suggests a Scandinavian origin for at least some of them. The rhombic openwork mounts may have been produced in Denmark, and there are as yet no direct counterparts in England for the three openwork mounts from Haithabu, Gedsted and Lund depicting a four-legged animal. The closest parallel is an openwork mount found near Kemsing in Kent, England, which David Williams considers to be a debased copy of the design on the Danish mounts (Williams 1997a, no. 472). The apertures are arranged identically, but details of the original motif have not been transfered.

The present distribution in Denmark of the four groups of horse-trappings shows a predominance in the area from northern Jutland across Zealand and Skåne towards Bornholm, an area where we may expect evidence of strong influence from Anglo-Saxon England. Whether this is a true picture of the area in which horse-gear with copper-alloy mounts was in actual use in the 11th century or rather a result of different factors such as the local conditions for the preservation of copper-alloy objects and, a possibly much more relevant factor, the involvement of enthusiastic amateur archaeologists and metal-detector users working in close co-operation with the local museums, is still uncertain. Preliminary inquiries to museums in southern Denmark i.e. Den Antikvariske Samling in Ribe, Langelands Museum Rudkøbing and Svendborg og Omegns Museum, have not revealed new finds, which would seem to confirm that the distribution of these objects in Denmark may reflect regional differences in cultural orientation and influence irrespective of the definite bias caused by the varying intensity of metal-detector use across the country. A detailed survey of the related copper-alloy strap-links and cross-shaped mounts may reveal more information on the geographical distribution and use of these objects.

CONCLUSION

Copper-alloy horse-trappings form a much larger group of objects in Denmark of the Late Viking Age and Early Middle Ages than hitherto supposed, the limited number in part reflecting find circumstances in the past two centuries but also the changing burial customs of the late Viking Age and the resulting lack of secure grave finds containing horse gear. Most of the horse trappings from Denmark are single finds, and the recent addition to types and numbers is, as noted, mainly a result of intensified detector scanning on settlement sites.

Typological and stylistic evidence from the finds indicates a development of riding gear in the early 11th century in which copper-alloy details were used to decorate objects made of iron, thus replacing the silver and copper inlay used in the previous century. The new types of horse-fittings have been linked to influence from Anglo-Saxon objects and art in Scandinavia, although as the evidence of Scandinavian tradition in the use of Ringerike and Urnes style elements shows, this was not one-way influence. At least some

of the objects that have been seen as products of Anglo-Saxon workmanship may equally well have been made in Scandinavia.

Other objects testify to the close contacts between Viking-age Denmark and Anglo-Saxon England during the reign of King Cnut the Great. Coins are an obvious group. Not only do we find many Anglo-Saxon coins in Scandinavia, but Anglo-Saxon moneyers were employed by the Danish king, a number of them working in Lund. The decorated lid of a pen case, a well-known object from Lund, is often cited in this context. The ornament depicts elements typical of the Winchester style influenced by the Ringerike style, and the inscription on the lid has been interpreted as Leofwine, the name of a known moneyer from England working in Lund (Cinthio 1990, 49).

One of the most magnificent objects from the early 11th century representing the wealth and status of its owner is a sword with silver-gilt guards decorated with birds and snakes in high relief found at Dybäck in Skåne (Strömberg 1961 II, Taf. 65.2). The style of the decoration is mainly Anglo-Saxon in character with close parallels within the Winchester style, whereas the scabbard mount is a foreign element originating in Scandinavia. A silver-gilt sword pommel decorated with niello from Vrångabäck, also in Skåne, is very like the Dybäck sword but not identical (Strömberg 1961 II, Taf. 65.1). Whether these swords were made in southern Scandinavia under strong English influence or possibly in England and brought to Scandinavia has not been determined. However, they leave no doubt of Anglo-Saxon artistic trends present in Scandinavia (cf. Graham-Campbell 1980, No. 250; Webster 1984, No. 96).

Further evidence of close contacts may be found amongst small everyday ornaments, such as simple hooked tags of sheet copper alloy. Hooked tags have been excavated in 11th century contexts in England, and almost identical tags have appeared in Lejre and in Lund, here not only as finished products but also as semi-fabricata. Similar objects were thus fashioned and used on both sides of the North Sea.

Heavy iron stirrups were a technical innovation in the Viking Age providing support for the mounted warrior, and it has been suggested that the horse-bits with sharply profiled mouth-pieces were used for well-trained horses and thus also formed an important part of the mounted warrior's gear. The adaptation of this equipment in Denmark is to a large extent due to contact with the Carolingian and later Ottonian empires, where effective use of cavalry evolved as a response to intruders from the East. Born of military requirements, the horse and riding gear acquired a symbolic value similar to that of weapons, and elements of what was later to characterize medieval knighthood, including the importance attached to horsemanship, were already evolving in the 9th and 10th centuries (cf. Leyser 1994). Knowledge of rituals and ceremonies related to horsemanship was very likely transmitted to Denmark together with the actual objects, thus influencing values in this country. To judge from the equestrian burials of the 10th century, horse-gear including a saddle with decorated stirrup-irons and matching bit held definite symbolic meaning apart from its obvious practical function and was placed alongside weapons in the grave to emphasize the standing of the deceased and his family.

It is possible that the iron and copper-alloy trappings of the 11th century should be viewed in a similar context, i.e. that they too were objects intended for practical use at the same time as visually communicating the standing of the owner. On the other hand, the fact that many of the details seem poorly executed and the large numbers recorded from England suggest that, although of some value, these trappings did not necessarily belong to the social elite.

Recent studies indicate that the innovation and improvement in Anglo-Saxon riding equipment from the 10th and 11th century was largely influenced from Denmark (Graham-Campbell 1992). The overall distribution pattern of the copper-alloy horse-trappings combined with the many other examples of mutual contact support this view and suggest an Anglo-Scandinavian milieu in the 11th century across which similar objects and similar art styles were in use. The increasing number of small, surprisingly alike everyday objects turning up not only in England but also in Denmark thus provide a material background for the contact evident in the political development of this period, beginning with Svein Forkbeard and his son Cnut the Great.

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The find lists 1-4 for Denmark, Schleswig and Skåne are mainly based on published finds and information in the archives of the National Museum in Copenhagen, *inter alia* the treasure trove (*Danefæ*) records.
Find list 5 is the result of a preliminary survey and does not claim to be complete. New finds of cheek-pieces are coming to light, especially in England as a result of metal-detecting (cf. Graham-Campbell 1992, 84ff.; personal communication D. Williams), and museum collections may contain further unpublished examples.
Find list 6 covers published copper alloy stirrups from Sweden, Iceland and England. Signe Horn Fuglesang has not included any examples from Norway in her survey from 1980 (Fuglesang 1980, Appendix 5), and a recent check by the author in the database of Universitetets Oldsaksamling in Oslo did not reveal any finds.

Find list 1: Cheek-pieces

1. Unknown provenance, Denmark. National Museum D46. Fragment of cheek-piece, copper alloy; L 5.2 cm. Single find. Fuglesang 1980, pl. 79.B; Pedersen 1998, Fig. 3.2.
2. Græse, Græse parish, Frederiksborg county, Denmark. Færgegaarden MFG 41/91. Fragment of cheek-piece; L c. 6.5 cm. Single find. Unpublished.
3. St. Myregård, Nylarsker parish, Bornholm county, Denmark. Bornholms Museum BMR 1478x7. Fragment of cheek-piece, copper alloy; L 5.7 cm. Single find. Unpublished.
4. Gudme/Uhrenholtgård, Gudme parish, Svendborg county, Denmark. Odense Bys Museer FSM 7529x15. Fragment of cheek-piece, copper alloy; L 5 cm. Single find; trial excavation. Unpublished.
5. Tinggård, Sjørring parish, Thisted county, Denmark. Museet for Thy og Vester Hanherred 3471x746. Fragment of cheek-piece, copper alloy. Single find from settlement site; archaeological excavation. Unpublished.
6. Dueholm Mark, Nykøbing parish, Mors, Thisted county, Denmark. National Museum C23648. Fragment of cheek-piece, copper alloy; L 6.8 cm x W 7.7. The mount was found near the fragment of a sword, both objects near the remains of a burial mound; ? burial find. Fuglesang 1980; Pedersen 1998, Fig. 3.1.
7. Nørholm Skole, Nørholm parish, Ålborg county, Denmark. National Museum C32941. Fragment of cheek-piece, copper alloy; L 4.4 cm. Single find, metal detector. Pedersen 1998, Fig. 3.3.
8. Sønderholm, Sønderholm parish, Ålborg county, Denmark. National Museum D418/1990. Fragment of cheek-piece, copper alloy; L 4.9 cm. Single find, metal detector. Pedersen 1998, Fig. 3.5.
9. Sebbersund, Sebber parish, Ålborg county, Denmark. National Museum C31559. Fragment of cheek-piece, copper alloy; L 5.2 cm. Single find, settlement site. Pedersen 1998, Fig. 3.4.
10. Bøgeskov Strand, Vejlby parish, Vejle county, Denmark. National Museum D473/1994. Cheek-piece, copper alloy; L 9.7 cm. Single find from slope near beach. *AUD* 1994, 252; Pedersen 1998, fig. 2.
11. Leck, Kr. Nordfriesland, Schleswig, Germany. Archäologisches Landesmuseum der Christian-Albrechts-Universität Schleswig K.S. 14658 a-c. Two cheek-pieces and one strap-mount, copper alloy; cheek-piece (a) L 7.9 cm x W 7.9 cm, cheek-piece (b) L 8.2 cm x W 7.9 cm. Single finds from a bog near Leck Au between Leck and Kokkedal. Paulsen 1937; Müller-Wille 1977.
12. Gärarp church ruin, Tosterup parish, Skåne, Sweden. Lunds Historiska Museum 28674. Fragment of cheek-piece, copper alloy; L 5.7 cm. Single find. Strömberg 1961 II, 31; Taf. 67.9.

Find list 2: Copper-alloy stirrups

1. Unknown provenance, Denmark. National Museum, no reg.no. Stirrup with narrow rectangular strap-plate. Single find. Unpublished.
2. Uncertain provenance, Denmark; possibly Strøby, Stevns. Private possession 1904, not located; National Museum j.nr. 286/04 (drawing by Magn. Petersen). Stirrup; trapezoid strap-plate, single animal with snake-like hindquarters; L 15.5 cm. Single find, purchased at an auction. Boberg 1931 *passim.*
3. Bavelse Mark, Bavelse parish, Præstø county, Denmark. National Museum 13308. Stirrup with strap-plate ending

in a fleur-de-lis top ornament, two animals on plate; L 17.7 cm. Single find. Worsaae 1859, no. 481.
4. Trollegab Mose, Hassing parish, Thisted county, Denmark. National Museum 10849. Stirrup; L 14.0 cm. Single find from a bog. Unpublished.
5. Hammer, Hammer parish, Ålborg county, Denmark. Private possession 1877, not located; National Museum drawing no. 2214a (Mejborg 1877). Stirrup with strap-plate; top ornament of two animal heads on long necks, two animal heads and interlace on plate; L c. 16 cm. Single find from a bog. Müller 1895, nr. 588.
6. Hammer, Hammer parish, Ålborg county, Denmark. Private possession 1877, not located; National Museum drawing no. 2214b (Mejborg 1877). Stirrup with strap-plate ending in a fleur-de-lis top ornament, single four-legged animal on plate; L c. 17 cm. Single find from a bog. Unpublished.
7. Vindblæs Hede, Vindblæs parish, Ålborg county, Denmark. National Museum D12704. Stirrup; single four-legged animal with a cross over its neck on plate; L 14.1 cm. Single find, found close to an old trackway Nibe-Vitskøl. Unpublished.

Find list 3: Strap-mounts

1. Græse, Græse parish, Frederiksborg county, Denmark. National Museum C32653. Triangular mount, William's Class A, possibly type 11; H 4.6 cm, W 2.5 cm. Single find, metal detector. Williams 1997a.
2. Ellehalen/Gl. Køgegård, Køge parish, Copenhagen county, Denmark. National Museum D348/1994. Trapezoid mount with stylized animal heads, William's class B, type 1; H 3.7 cm. Single find, metal detector. Matthiesen 1994; *AUD* 1994, 245f.
3. Flengemarken, Roskilde Cathedral parish, Copenhagen county, Denmark. National Museum C30902. Mount with mask, William's Class B, type 4; H 4.4 cm, W 3.0 cm. Single find, metal detector. Unpublished.
4. Langetofte, Boeslunde parish, Sorø county, Denmark. National Museum C32676. Triangular mount, William's Class A, no type; H 4.3 cm, W 3.0 cm. Single find, metal detector. Williams 1997a.
5. Hjulmagergård, Åker parish, Bornholms county, Denmark. National Museum D119/1997. Rhombic, openwork mount, broken at the top and bent slightly out of shape, William's Class A, type 12; H 3.9 cm, max. W 3.1 cm. Single find, metal detector. Unpublished.
6. Postgården, Sønder-Tranders parish, Ålborg county, Denmark. National Museum C33414. Rhombic, openwork mount, William's Class A, type 12; H 4.4 cm, W 3.5 cm. Single find, metal detector. Williams 1997a.
7. Bejsebakken, Hasseris parish, Ålborg county, Denmark. Ålborg historiske Museum 961. Rhombic, openwork mount, William's Class A, type 12. Single find. Unpublished.
8. Sønderholm parish, Ålborg county, Denmark. National Museum D4929. Strap-mount William's Class C, no type; H 6.5 cm. Single find. Fuglesang 1980, pl. 79.B; Williams 1997a.
9. Sebbersund, Sebber parish, Ålborg county, Denmark. Ålborg historiske Museum 2863x4210. Rhombic, openwork mount, William's Class A, type 12; H 5.2 cm. Single find from the bottom of sunken hut A 635, archaeological excavation. Birkedahl & Johansen (in print).
10. Gedsted, Gedsted parish, Viborg county, Denmark. National Museum 7032. Rectangular openwork mount, single animal, William's Class B, no type: H 4.5 cm, W 4.2 cm. Single find. Roes 1958, pl. XVII.2; Williams 1997a.
11. Haithabu, Schleswig, Germany. Archäologisches Landesmuseum LMS Hb 1931. Rectangular openwork mount, single animal, William's Class B, no type; H 4.2 cm, W 4.4 cm. Single find from settlement site. Capelle 1968, Taf. 14.5; Williams 1997a.
12. Hjälmaröd 9:30, Vitaby parish, Skåne, Sweden. Statens Historiska Museum Stockholm, not located. Rhombic openwork mount, William's Class A, type 12; H 5.1 cm. Single find, late Viking-age settlement site. Strömberg 1961 II, Pl. 72.3; Williams 1997a.
13. V. Klagstorp 7, V. Klagstorp parish, Skåne, Sweden. Private ownership. Rectangular mount with top ornament, worn surface, William's Class A, no type; H 5.8 cm. Single find. Strömberg 1961 II, Pl. 67.2; Williams 1997a.
14. Lund, Kv. Färgaren 38, Skåne, Sweden. Kulturhistoriska Museet i Lund 71.075:689. Rectangular openwork mount, single animal, William's Class B, no type; L 4.6 cm. Single find from a pit, archaeological excavation. Dendrochronological dates 1060-70. Mårtensson 1982, Fig. 4; Williams 1997a.

Find list 4: Stirrup-terminals

1. Flengemarken, Roskilde Cathedral parish, Copenhagen county, Denmark. National Museum C30904. Short terminal with eyes and snout marked by simple lines; L 3.4 cm. Single find; metal detector. Unpublished.
2. Baggård, Klemensker parish, Bornholms county, Denmark. National Museum C31786. Short terminal, broken snout and corroded surface, features marked by simple lines ; L 2.7 cm. Single find; metal detector. Unpublished.
3. Stentinget, Hellevad parish, Hjørring county, Denmark. National Museum C31438 STT91 (Vendsyssel historiske museum 80/1989x171). Short terminal, upturned snout, eyes faintly marked; L 1.9 cm. Single find; metal detector. Unpublished.
4. Gjøl mark, Gjøl parish, Hjørring county, Denmark. National Museum D321/1993. Short terminal, cast features, open mouth; L 3.1 cm. Single find; metal detector. *AUD* 1993, 239.
5. South of Skelagervej, Hasseris parish, Ålborg county, Denmark. National Museum D37/1987. Long slender terminal, animal head with elongated eyes, pointed snout; L 4.2 cm. Single find; metal detector. *AUD* 1987, 214.
6. Nørholm, Nørholm parish, Ålborg county, Denmark. National Museum D514/1993. Fragment of terminal, snout end; L 1.4 cm. Single find; metal detector. Unpublished.
7. Nørholm, Nørholm parish, Ålborg county, Denmark. National Museum D48/1998. Terminal with head curled back-

wards to form a circle; L 3.4 cm. Single find; metal detector. Unpublished.
8. Nørholm, Nørholm parish, Ålborg county, Denmark. National Museum D282/1998. Long slender terminal, animal head with bulging eyebrows; traces of iron; L 5.4 cm. Single find; metal detector. Unpublished.
9. North of Lindholm Høje, Nørresundby parish, Ålborg county, Denmark. National Museum D298/1989. Slender terminal, animal head with bulging eyes and pointed snout; L 2.5 cm. Single find; metal detector. Unpublished.
10. Sebbersund, Sebber parish, Ålborg county, Denmark. Ålborg historiske Museum 2863x01712. Slender terminal with indistinct features; L 3.6 cm. Unpublished.
11. Nørregård, Nr. Felding parish, Ringkøbing county, Denmark. National Museum D1179/1995. Long terminal, animal head with bulging eyes and square snout; L 4.1 cm. Single find; metal detector. *AUD* 1995, 256.
12. Nr. Felding church, Nr. Felding parish, Ringkøbing county, Denmark. National Museum D53/1997. Fragment of short terminal, top end appears to be broken; L 2.7 cm. Single find; metal detector. Unpublished.

Find list 5: Cheek-pieces from Sweden, Norway and England:

1. Unknown provenance, Sweden. Statens Historiska Museum Stockholm SHM 29163. Broken horse-bit, one cheek-piece of iron and one bit-link preserved.
2. Gullbrandstorp 1:24, Harplinge parish, Halland, Sweden. Fragment of cheek-piece, copper alloy; single find. Lundborg 1970.
3. Svanhem, Edsvära parish, Västergötland, Sweden. Västerås Museum. Ced. 15-16. Cheek-piece, copper alloy, with iron bit; ? burial find, apparently found near the skeleton of a horse. Wideen 1955, 70; Fig. 123.
4. N. Åsarp, Västergötland, Sweden. Borås Museum 4316. Fragment of cheek-piece, copper alloy; single find. Wideen 1955, 69; Fig. 37.F.
5. Lundby, Fors parish, Södermanland, Sweden. Statens Historiska Museum Stockholm SHM 13703. Horse-bit with copper-alloy cheek-pieces; cremation burial containing a pair of copper-alloy stirrups, a pair of spurs, a spearhead and a knife. Tillväxten under år 1909, *Fornvännen* 4, 1909 [245-247].
6. Byringe, Husby-Rekarne parish, Södermanland, Sweden. Statens Historiska Museum Stockholm SHM 14207. Cheek-piece, copper alloy. Paulsen 1937, 28.
7. Ångsby, Lena, Uppland, Sweden. Uppsala Museum UMF 4573. Intact cheek-piece, copper alloy. Graham-Campbell 1992, Fig. 6.
8. Tuna grave III, Alsike parish, Uppland, Sweden. Statens Historiska Museum Stockholm SHM 10289. Horse-bit with iron cheek-pieces; boat burial with *inter alia* stirrups, spurs, spearhead, iron bit and harness mount. Arne 1934, Taf. VI.
9. Göksbo, Altuna, Uppland, Sweden. Statens Historiska Museum Stockholm SHM 18122. Bridle with iron cheek-pieces; burial find from a mound with an axe J. Petersen type M and a spearhead with silver inlay. Tillväxten under år 1926, *KVHAA Årsbok* 1927; Paulsen 1937, Abb. 17.
10. Öland, Sweden. Lunds Historiska Museum LUHM 14137. Cheek-piece, copper alloy. Paulsen 1937, 28.
11. Årsunda grave III, Gästrikland, Sweden. Statens Historiska Museum Stockholm SHM 17408. Complete horse-bit with copper-alloy cheek-pieces (one broken); burial find. Tillväxten under år 1924, *Fornvännen* 19, 1924.
12. Vestby, Sörum, Akershus, Norway. Universitetets Oldsaksamling Oslo C2748. Complete horse-bit with copper-alloy cheek-pieces; burial find including a spearhead, knife and copper-alloy buckle. Rygh 1885, 568; Petersen 1951, 16.
13. Cambridgeshire, England. University Museum of Archaeology and Ethnology Cambridge, Aug. 6. 1914. Fragment of cheek-piece, copper alloy. Bjørn & Shetelig 1940, Fig. 40.
14. Stoke Holy Cross, Norfolk, England. Fragment of cheek-piece, copper alloy. Graham-Campbell 1992, Fig. 5.
15. St. Martin-at-Palace Plain, Norwich, England. Fragment of cheek-piece, copper alloy. Margeson 1987, Fig. 39.
16. Near Tandridge village, Surrey, England. Cheek-piece, copper alloy. Williams 1997b, Fig. 1.A.
17. Henhaw Farm, South Nutfield, Surrey, England. Fragment of cheek-piece, copper alloy. Williams 1997b, Fig. 1.B.

Find list 6: Copper-alloy stirrups from Sweden, Iceland and England:

1. Stenåsa, Öland, Sweden. Statens Historiska Museum Stockholm SHM 1851:27. Stirrup with rectangular plate, single animal. Single find.
2. Lundby, Fors, Södermanland, Sweden. Statens Historiska Museum Stockholm SHM 13703. Two stirrups with open-work plate; sub-foliate ornament. Cremation burial. *Fornvännen* 1909 [245-247].
3. Skagershult, Porla Brunn, Närke, Sweden. Statens Historiska Museum Stockholm SHM 9170:1231. Single find.
4. Merkihvoll, Landsveit, Iceland. Reykjavík 332. Stirrup with rectangular plate, two animals. Single find from farm site, 1866. Eldjárn 1956, Fig. 189.
5. Viðafell, Reykjadalur, Iceland. Reykjavík 381. Stirrup with "rounded" plate, two animals. Single find c. 1867. Eldjárn 1956, Fig. 190.
6. Klóarfjall, Árnessýsla, Iceland. Reykjavík 3170. Stirrup with "rounded" plate. Single find c. 1888. Eldjárn 1956, Fig. 191.
7. Romsey, Mottisfont, Hampshire, England. Private possession 1887, not located. Stirrup with trapezoid plate, two animals. Single find from a bog. Read 1887; Seaby & Woodfield 1980, no. 9.

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Integrity and characteristics of the bones of the Danish King St Knud (II) the Holy (†AD 1086)

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INTRODUCTION

The Danish King Knud (II) the Holy, one of King Svend Estridsen's numerous children, was probably born about 1043, and was thus about 43 years of age when he was murdered in 1086 after a six year reign. The scene of the murder was St Alban's Church in Odense on the Danish island of Funen, where King Knud, his half-brother Benedict, and 17 housecarls had taken refuge, after a band of men conscripted for war revolted against the King. Part of King Knud's strong assertion of royal power was based on his eager support of the Church. This cause was carried further when King Erik (I) Ejegod, one of King Knud's younger brothers and Danish king from 1095-1103, secured his canonization in the year 1100. An early legend about St Knud, *Passio sancti Kanuti regis et martyris*, tells that the King's bones were tested before he was declared a saint, and that, among other things, they were exposed to violent fire without being damaged (Gertz 1907). The priest Elnoth from Canterbury, who, some twenty years later, wrote the legend of St Knud (*Passio Gloriosissimi Canuti Regis et Martyris*, cf Albrechtsen 1986), stated that St Alban's Church was in possession of two capsules ("*capsulas*") with relics of St Alban and St Oswald, the former having been brought to Odense from England by King Knud. King Knud, says Elnoth, was mortally wounded, struck by a lance through his side, while Benedict, who fought by his half-brother's side, was literally cut to pieces. Elnoth ends with a description of how the bones of King Knud were wrapped in silk and laid in a shrine made of golden metal and decorated with gems. The shrine was placed on the altar in the new St Knud's Church in Odense (Johannsen *et al.* 1995; Vellev 1986).

A Russian prayer from about 1135 (Lind 1990; 1992) and another legend dealing with St Knud, the anonymous *Passio sancti Kanuti regis et martyris* dated to 1220-50 (Gertz 1912), both mention Benedict as a saint. The Iceland chronicle of kings from ca. 1250, *Knytlinga-saga* (cf. Knytlinga 1925) notes that both King Knud and Benedict were enshrined. It reports nothing about any ill treatment of Benedict, but says that King Knud was murdered with a sword after he had been hit with a stone on the forehead. Relics of St Knud and St Alban are referred to in 1183, and at the beginning of the 16th century Queen Christine gave offerings to the shrine of St Knud, a separate reliquary for St Knud's head, and a reliquary for St Alban's arm (Dronning Christines Hofholdningsregnskaber 1904).

From then on and until 1582 the fate of the shrines is unknown. But around 1582 St Knud's Church was being rebuilt, and on 22nd January 1582 St Knud's shrine was brought to light, presumably from a hiding-place in the choir (Dania Chorographia 1591; Otonium (1597) 1981; Konninck 1603; cf. Gertz 1907). The shrine, which held a couple of inscriptions denoting it as St Knud's shrine, was described as an oak coffin with metal furnishings and rock crystals, lined by thin, brown silk. The bones were wrapped in costly clothes. Although many people saw the shrine, it is

uncertain when it was walled up again. Two Flemish monks who visited Denmark in 1622 asserted that they had seen the fragments of the skull of St Knud, but it is uncertain whether they also saw his shrine (Janssenius & Brouwer 1622; Wieselgren 1961). Around 1694, while the church was under repair, some artisans discovered a bricked-up cavity above a niche in the southern part of the eastern wall. Both shrines were concealed in this cavity (Forskellige stykker 1696; Bircherod 1743; Bircherod 1773; cf. Gertz 1907). This time, however, they were found robbed. Almost every bit of the furnishings had been torn off, one of the shrines had lost its lid completely, the other had lost part of its lid, and as both shrines were placed on end, bones and clothes from each had fallen out and were now partly intermingled. As there was no inscription left to identify St Knud's shrine, the scholars present at the event decided that the shrine with the partially preserved lid was that of the King.

In 1696 the shrines were once more walled in, and in 1833 they were brought to light for the last time (Paludan-Müller 1833). Since then they have had their place in the church, on public display. In 1874-75 the shrines were restored and their contents distributed between the two shrines by a committee set up to estimate the age and historical backgrounds of the skeletons (Helgenskrinene 1886). This sorting of the bones was not as complicated as might be envisaged because of the apparent age difference between the two skeletons (aged about 40 and 20 years respectively). Most of the committee members agreed that King Knud's shrine was the one without a lid. This had hardly any furnishings left, but – contrary to the shrine with a fragment of lid – it bore traces of having been lined with red-brown silk. Since 1875, the shrines have been kept in the crypt of St Knud's Church and the identities of the skeletons and the correctness of their distribution have occasionally been questioned and discussed ever since. Is it really King Knud who lies in the lidless shrine? Do all the bones in this shrine belong to the same individual? As to the other shrine, the essential question has been the identification of the skeleton. Several scholars have pointed out that it must be St Alban (Petersen 1886; Steidl 1908). One scholar has drawn attention to an English legend according to which the skeleton of St Alban had at one time been kept in Denmark, but parts of it were smuggled out again at a later time (Petersen 1886). Another group of scholars have adhered to the opinion that St Knud's Church originally only possessed a minor part of St Alban, and that the skeleton in the other shrine is that of Benedict (Jørgensen 1887; Damgaard 1891; Gertz 1912); an opinion consistent with the findings of this study. Benedict is known to have been King Knud's younger half-brother, which agrees well with the skeletal age determination (18-20 years) of the bones. A recent theory claims that the other skeleton could be that of King Erik (III) Lam born *c.* 1110, who died as a monk in the Monastery of St Knud in 1146 (Langberg 1992), a theory which is inconsistent with the present findings.

The shrine without a lid has been dated by dendrochronology (Bonde *et al.* 1994). Three samples were dated, but sapwood was not preserved in any of them. The results showed that the shrine had definitely been made after AD 1074 and probably before AD 1100, the year of King Knud's enshrinement. The shrine with remnants of a lid will have to be disassembled before it can be dated by dendrochronology, and it has therefore been decided to postpone this step until the shrine is to be restored some time in the future. Based on stylistic criteria, however, the shrine with a piece of the lid can be dated to about AD 1050-75. In the light of this, and based on the remnants of red-brown silk still visible inside the lidless shrine, it must be considered likely that this was the shrine made for the body of King Knud just before AD 1100. It is beyond any doubt identical with the shrine found and identified as that of King Knud's in 1582. What remains to be discussed is the question of the identity of the skeletons.

THE SKELETON

King Knud's shrine contains an almost complete, well preserved skeleton, which has been described in a previous study (Tkocz & Jensen 1986). The results of our re-examination are in general identical to the observations of Tkocz & Jensen (1986).

The skeletal remains can briefly be described as rather well proportioned, with an approximate stature of 178 cm, which is more than the average male stature in the Viking period (171 cm) and the Middle

Ages (173 cm). The relatively tall stature may be linked to a high social rank having provided optimal conditions for growth and development.

Two thoracal vertebral bodies are wedge-shaped, probably a congenital phenomenon (Morbus Scheuermann) which X-ray pictures seem to confirm, rather than the effect of osteoporosis. The bone mineral content of the femoral diaphyses, measured with a dual photonabsorption scanner, was very low indeed, 4.08 g/cm, compared to the average values in contemporary Danish men, 5.40 g/cm, and Viking Age/Medieval male skeletons, 4.88 g/cm (Bennike & Bohr 1990). King Knud's low bone mineral content value for the femoral bones could be an expression of little or no heavy physical exertion.

In the following, we have chosen to focus on the essential disparities between the results of the above-mentioned previous study and our re-examination and on clarifying: 1) whether the cranium and the rest of the skeleton belong to a single or two individuals, 2) whether so-called lesions on the cranium and on the sacrum were induced pre- or postmortem and 3) how the lesions were induced.

AGE DETERMINATION OF THE SKELETON

In general, ossification of the cranial sagittal suture begins posteriorly at the age of 20-40 years, and is completed anteriorly at 40-50 years. Ossification of the coronal suture begins centrally at 40-50 years and is only completed later in life. Both the anterior part of the sagittal suture and the whole coronal suture are clearly visible on the cranium, indicating an age of 30-50 years. Degenerative signs were found in the form of beginning osteophyte formations around the auricular surfaces and some of the costo-vertebral joints, which also indicates that the individual was between 30 and 50 years of age. Together with an examination of the costo-sternal end of the ribs and of the pubic symphysis, an estimation of the age (Bass 1987) can be summed up as:

Cranial sutures:	30-50 years m = 40 years
Costal ends (Phase V):	33-42 years m = 38 years
Pubic symphysis (Phase IV):	23-57 years m = 40 years
Osteoarthritis:	30-50 years m = 40 years

This points to an average age of 40 at the time of death; most likely the individual was between 35 and 45 years of age.

Fig. 1. a) Cranium of King Knud. Front view, b) Side view. Note the 6.6 cm long crack on the left side of the frontal bone.

THE CRANIUM AND THE CRANIAL DEFECTS

The surface of the cranium is slightly brown and has peeled off in places, which means that it has either been lacquered or treated with a preservative some time in the past. The remaining bones are the frontal bone, the left and right parietal bones and the occipital bone. The squamosal sutures delimit both the parietal bones. The internal lamina of the cranium shows distinct imprints of vessels, but without any traces of aneurysms, which are most common in elderly individuals. Although the external occipital protuberance (to which the muscles of the neck are attached) is not prominent, the well-developed brow-ridges and sloped forehead indicate a male cranium.

The few obtainable cranial measurements are listed below (Martin & Saller 1957):

M 29 nasion-bregma:	10.6 cm
M 30 bregma-lambda:	11.2 cm
M 9 min. frontal width:	9.1 cm
M 8 max. width:	13.6 cm
M 1 max. length:	18.0 cm
Width/length index:	75.6 (mesocephalic)

The cranial capacity could not be determined, but as all the measurements are smaller than the averages for Danish male skulls from several prehistoric periods, the capacity of this skull cannot have been very large.

In an earlier study of the skeleton, Tkocz & Jensen (1986) concluded that there is a lesion on the left side of the frontal bone, supposedly caused by a sharp weapon. Our re-examination of the left side of the frontal bone only revealed a 6.6 cm, slightly curved, vertical crack without sharp edges (see Fig. 1). No signs of bone reaction (healing processes) could be seen at the crack. In our opinion, this crack is hardly the result of an attack with a sharp weapon. If the crack is the result of an act of violence, it must have been caused by a blunt instrument. A stone, as claimed by the Knytlinga saga (1925), could possibly have caused such a lesion. From below, it runs from the edge of the sphenoid bone, almost straight through the temporal line and continues to approximately the middle of the coronal suture. An indentation caused by postmortem erosion surrounds the widest end of the crack. The right side of the frontal bone exhibits a similar, though less eroded indentation in the corresponding area. These particular areas of the cranium are often very thin, and it seems likely that the crack is a consequence of postmortem erosion. However, there are other less well-defined eroded areas on the cranium, e.g. a 1.2 x 1.5 cm area on the right parietal bone at the lambdoid suture, which we also assume to be due to postmortem erosion.

THE SACRUM AND THE SACRAL LESIONS

The well-preserved and intact sacrum has a slightly brown colour and has most likely been lacquered or treated with a preservative. Interestingly enough, it shows both male and female characteristics: a protruding promontory and a sharp curvature at the 3rd sacral vertebra. The sacrum is rather small and wide, which is atypical in the male, but it is also relatively massive.There is no doubt that the sacrum, the rest of the pelvic bones (ossa coxae) and the femora belong to one and the same individual, most probably a male. The uppermost articular surface of the sacrum is slightly larger than one third of the total width, but cannot be considered excessively large. The auricular surfaces of the sacrum are not symmetrical. The left surface is irregular with a small bone protuberance at the upper, forward articular edge and has a porous spot (2 x 1 cm) in the middle. For obvious reasons this area was not included in the skeletal age determination. The uppermost segment of the coccyx is fused with the sacrum at an angle of 145°.

The sacral measurements are:

Diameter (max.) of the upper joint surface of the 1st sacral vertebra (basis ossis sacri):	4.6 cm
Width of sacrum (max.):	11.3 cm
Vertical length (max.):	9.2 cm
Depth (max.):	3.3 cm
Length of auricular surface:	5.9 cm

(Definitions: W.Bass 1987, p.108).

On the ventral sacral surface of the 3rd sacral vertebra (Fig. 2), there is a 3.5 cm long horizontal fracture, most likely a lesion, with fractured surfaces that

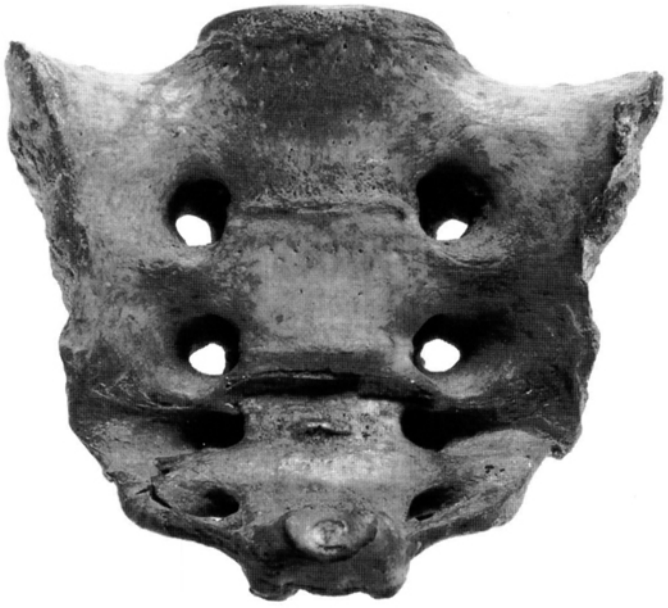

Fig. 2. Ventral surface of the sacrum of King Knud. Note the 3.5 cm long horizontal fracture on the ventral sacral surface of the 3rd sacral vertebra.

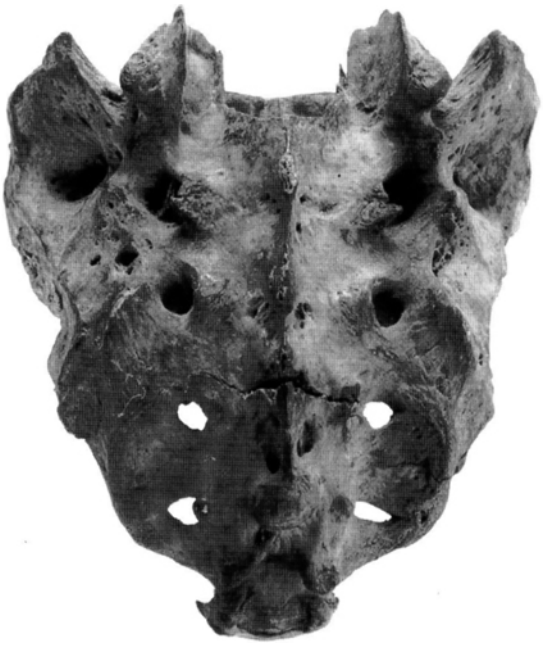

Fig. 3. Dorsal surface of the sacrum of King Knud. Note the vertical, wedge-shaped 4 mm wide and 15 mm long, horizontal crack in the median crest at the 3rd dorsal sacral foramen.

do not show any signs of bone reaction. The fracture line runs down to the 3rd right sacral foramen, continues to the 4th right sacral foramen and on to the right edge of the bone. In the centre of the fusion between the 3rd and 4th sacral vertebrae there is a small smooth bone formation. This is presumably a natural ossification and thus insignificant.

On the dorsal sacral surface (Fig. 3) there is a vertical, wedge-shaped 4 mm wide and 15 mm long, horizontal crack in the median crest of the sacrum at the 3rd dorsal sacral foramen. Fracture lines run in both directions to these foramina. To the right of and slightly below the 3rd sacral foramen one sees a 2 mm long fracture line with an aperture of 1 mm. This fracture ends 1 mm from the right edge, 22 mm above the fracture line on the ventral sacral surface.

It is very difficult to imagine how this lesion could have been caused by a frontal attack with a lance as proposed by Tkocz & Jensen (1986). The weapon would have had to enter the body from below, at an angle of 140° in relation to the axis of the body, and at an angle of 100° in relation to the axis of the two uppermost sacral vertebrae. The lance would thus have to have caused serious damage to the sacrum, leaving smooth but sharp marks on the bone, which, however, were not observed. Regardless of whether King Knud was standing, sitting, kneeling or lying down when attacked, the weapon could not have entered the body at the stated angles without producing lesions on the fused coccyx/sacrum or on the pubic bone, none of which are seen. The wedge-shaped crack on the dorsal sacral surface does not show any sign of having been induced by a sharp weapon. There is spongoid bone tissue along its edges and there is no evidence of bone reaction in the surrounding area. The most likely explanation is that the crack was due to a compression of the sacrum resulting in a 105° curvature. We therefore assume that the lower part of the sacrum was exposed to some kind of sudden and extreme pressure slightly left of centre, causing the sharp curvature, which in turn caused the wedge-shaped crack (Fig. 4). This could happen if the King was in a kneeling position, and as there are no traces of a sharp weapon, the lesion must have been the result of a blow with a blunt instrument, *e.g.* a club. A violent blow would probably crush the bone,

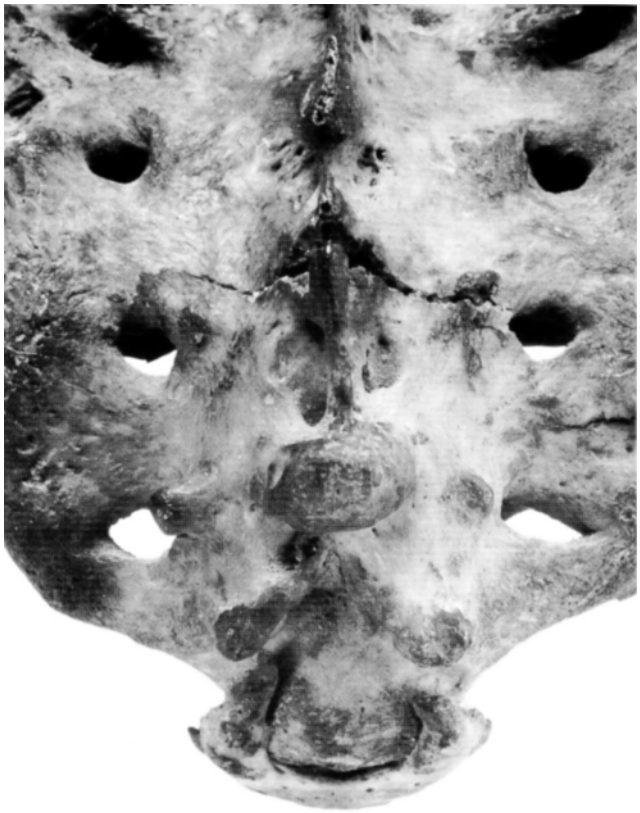

Fig. 4. Dorsal surface of the sacrum of King Knud. Note the wedge-shaped crack.

but posteriorly, soft tissue could have had a cushioning effect. Another, perhaps less likely, possibility is that the lesion could have been induced shortly before or after death by a fall from a certain height.

The King was interred after his death, but his skeleton was finally moved back to the church 30 years later, and one cannot completely exclude the possibility that the sacrum was compressed in the interim when the bones were displaced. In this case the sacrum would have to have been in an upside down position with the upper vertebra pointing downwards. However as the bone would have been dry by this time, it would more likely have been crushed.

CARBON-14 DATING

A 1.5 gram sample was taken from the posterior part of the tibia of King Knud for the purposes of trace element chemical analysis and radiocarbon dating. The bone was reconstructed in plaster, so that the sampling location is now barely visible. On Benedict a 1.0 gram sample of the left femur was taken for both radiocarbon dating and trace element analysis. The outer parts (~ 1 mm) of the bone samples were removed with a scalpel prior to further treatment.

Collagen was extracted from the bone samples in the standard way used in the Copenhagen Radiocarbon Dating Laboratory (Mook & Waterbolk 1985: 40). The carbonate and hydroxyapatite were dissolved in an excess of 1.8 M HCl. The samples were then washed in demineralized water, followed by hydrolyzation of collagen in 0.001 M HCl. Insoluble residues were removed by centrifugation, and the collagen samples were dried at 120°C for at least 50 hours.

Approximately 14 mg of collagen was then sealed in an evacuated quartz tube together with 0.3 g CuO and heated to 800°C for 10 minutes, thus converting the carbon in the collagen to CO_2. Constituents other than CO_2 were removed in our Accelerator Mass Spectroscopy (AMS) preparation line by freezing with dry ice and acetone, and a small sample was extracted at this stage for $\delta^{13}C$-measurements carried out on a Micromass double focusing mass spectrometer situated at the Geological Institute at the University of Copenhagen, Denmark. The rest of the sample was then converted to graphite at 650°C on a Co-catalyst placed in a quartz tube, which was subsequently evacuated and sealed. Prior to graphitation the Co-catalyst was preheated at 450°C in a H_2-atmosphere for 1 hour. The graphitation process was continued until more than 95% of the CO_2 had been converted to graphite. AMS measurements were carried out at the AMS-facility at Aarhus University, Denmark. The ^{14}C-activity of the sample was referred to the oxalic acid standard prepared in the same reactor of our AMS preparation line.

The results of the datings are listed in Table 1. The calibration into calendar years has been carried out with the 20 years averaged atmospheric calibration curve from 1998 using the University of Washington Calibration program Calib version 4.0 (Stuiver *et al.* 1998). The resulting distribution of calendar years is shown in fig. 5. It is apparent that both dates are in accordance with a death in AD 1086.

The radiocarbon dates exclude the possibility that

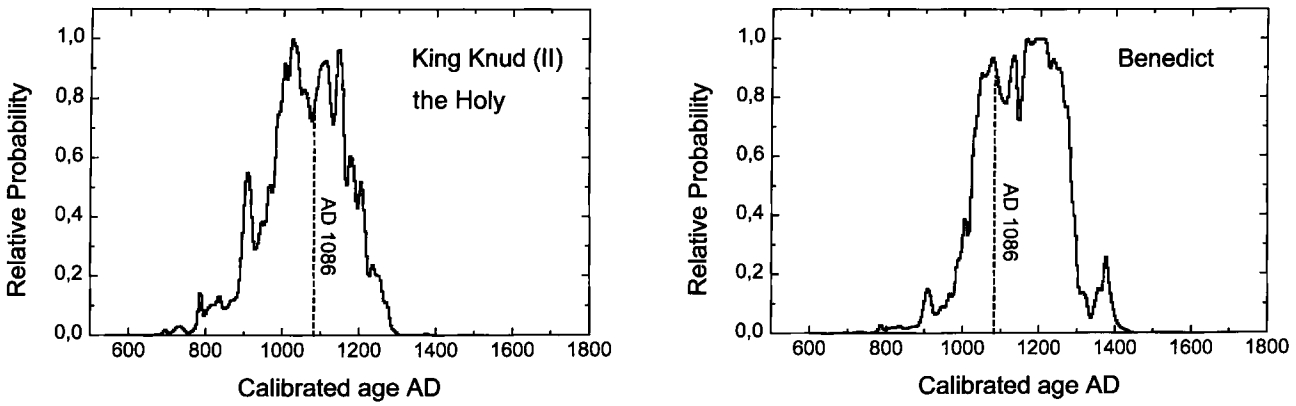

Fig. 5. Distribution of calibrated radiocarbon dates of King Knud and Benedict. The radiocarbon dates have been calibrated according to the 20 years averaged atmospheric curves given in Stuiver & Pearson (1998).

the bones could have belonged to either the Holy St Alban (died *c.* AD 305) or the Holy St Oswald (died *c.* AD 642). From the radiocarbon dates alone it cannot, however, be excluded that either individual could be from AD 1146, the year that King Erik (III) Lam died in the Monastery of St Knud in Odense. It is, however, not very likely that King Erik (III) Lam, who was a monastic scholar, could have received the lesions observed on both skeletons.

CHEMICAL ANALYSIS

In order to elucidate the question of the integrity of the skeleton of King Knud, a 0.5 gram sample was taken from the left basal part of the cranium. This sample, together with an aliquot of the sample from the tibia from King Knud and the femur of Benedict, was subjected to Instrumental Neutron Activation Analysis (INAA).

Two sub-samples were irradiated in the Danish heavy water reactor DR-3 at Risø in a neutron flux of 3 10^{13} cm^{-2} s^{-1} for 20 hours. Subsequently the samples were counted three times on a high purity Ge (germanium)-detector and the concentrations of Na (sodium), K (potassium), Ca (calcium), Sc (scandium), Fe (iron), Co (cobalt), Zn (zinc), Br (bromium), Sr (strontium), Ag (silver) and Au (gold) were determined. The analytical errors are typically within ± 10%. Two other sub-samples were irradiated in the Triga-reactor in Vienna in a neutron flux of 5 10^{12} cm^{-2} s^{-1} for 10-20 seconds and analyzed for shortlived elements. The concentrations of F (fluorine), Cl (chlorine), Al (aluminium), Mg (magnesium), V(vanadium) and Mn (manganese) were determined by short irradiations. The analytical errors for the elements

Lab. No	Other Id.	Material	δ13C o/oo VPDB	^{14}C-age (BP)	Cal. Date AD	Cal. Date at ±1 σ
K-6141	NNU A-7348 AAR-1494	Femur of Benedict	-19.0	860±120	1190-1210	AD 1020-1280
K-6142	NNU A-7348 AAR-1495	Tibia of St Knud	-18.3	985±100	1020	AD 980-1160

Table 1. Results of the radiocarbon dating. The samples were pre-treated and graphitized at the Radiocarbon Dating Laboratory in Copenhagen and measured by AMS at the accelerator facility at University of Aarhus. Preservative materials were removed prior to dating. The $\delta^{13}C$ analyses were performed at the Geological Institute, University of Copenhagen. Calibration was carried out using the 20 years averaged atmospheric curve (Stuiver *et al.* 1998).

determined by the short irradiations are typically within ± 15%. The results are given in Table 2.

Figure 6 shows the abundances normalized to the average of 40 historic and prehistoric Danish bones. The figure also shows the ± 2 standard deviation variation interval, which constitutes the interval of normal variation for each element for the 40 historic and pre-historic bones. It is evident from fig. 6 that all elements analyzed are within the ± 2 standard deviation intervals with only one exception, namely Au, which is significantly higher in the cranium than in the tibia. For the other elements the variational patterns of the cranium and the tibia are very similar. Excluding Au (gold), this implies that there is no reason to assume that the cranium and tibia belong to different individuals.

Gold is an element that is ubiquitous in both churches and laboratories, but even so, we consider the difference between the cranium and the tibia so large that a specific explanation is called for. The only plausible explanation we can offer for the increased Au-abundance in the cranium is that it stems from carrying the cranium of King Knud around the city of Odense in a reliquary in the Middle Ages. Such reliquaries were often gold plated on the inside, and it is known that Queen Christine did in fact donate a separate reliquary for King Knud's head (Dronning Christines Hofholdningsregnskaber 1904; Braun 1940). Even though we removed about 1 mm of the outer parts of the bone samples in order to avoid contamination, we consider it likely that particularly the back of the cranium, which was sampled for this study, was somehow contaminated with Au in the reliquary.

CONCLUSIONS

1 Trace element analyses imply that in all likelihood the cranium and tibia of the skeleton in King Knud's shrine belong to the same individual.
2 Based on the anthropological re-examination of the skeletal remains of King Knud, it can be stated that in all probability the remains are from the same individual, although the anthropological results alone are inconclusive. The suggestion that the skull is significantly younger than the rest of the skeleton (Tkocz & Jensen 1986) can however be repudiated.
3 Based on several age determination criteria, we conclude that King Knud was 35-45 years old at the time of his death.
4 The radiocarbon dates are in accordance with a death in AD 1086 for both skeletons, as would be expected for King Knud (II) the Holy and his half-brother Benedict.
5 The radiocarbon dates exclude the possibility that the bones could be the remains of either St Alban or St Oswald, but it cannot be excluded that either of the skeletons might be that of King Erik (III) Lam, who died in AD 1146. It does not, however, seem likely that King Erik (III) Lam could have received the lesions found on both skeletons.

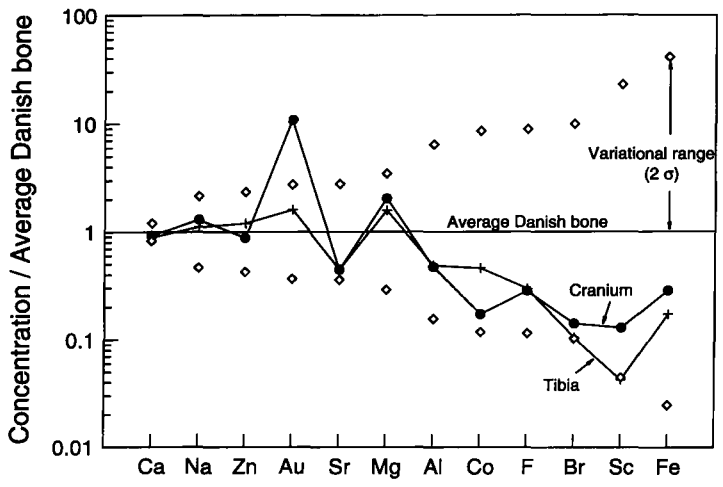

Fig. 6. Abundances of trace elements in the cranium and tibia of the bones in King Knud's shrine normalized to the average of 40 historic and prehistoric Danish bones. Also shown: the ±2 standard deviation variation interval for each element. Note the co-variance of the two samples, with the exception of Au (gold).

	Tibia	Cranium	Cra/Tib
	µg/g	µg/g	
F	494	470	0.95
Na	5110	5980	1.17
Mg	3450	4470	1.30
Al	206	200	0.97
Cl	679	2190	3.23
K	< 1470	1650	> 1.12
Ca	236000	246000	1.04
Sc	0.00148	0.0045	3.06
V	< 0.14	0.296	> 2.11
Mn	779	378	0.49
Fe	36.2	60.1	1.66
Co	0.136	0.0508	0.37
Zn	133	97.4	0.73
Br	2.47	3.33	1.35
Sr	118	118	1.00
Ag	< 0.14	0.476	> 3.40
Au	0.0114	0.0772	6.77

Table 2. Results of the INAA on the skeleton in the shrine of King Knud (II) the Holy, Odense. Both tibia and cranium were analyzed. The elemental ratios between cranium and tibia are listed as well.

6 Whether the lesion on the left side of the cranium is the result of a pre- or postmortem episode could not be established with any certainty. If the lesion was induced by an act of violence shortly before or after death, it must have been inflicted with a blunt instrument, as the cranial fracture shows no sharp edges. However, several thin areas of the skull exhibit signs of advanced erosion, indicating that the crack could be due to postmortem damage.

7 The fractured sacrum does not show any signs of bone reaction either. Even though it cannot be ruled out that the fracture was induced by a fall, pre- or postmortem, we consider it more likely that the fracture of the sacrum was caused by a blow with a blunt instrument shortly before or after death.

8 It is highly unlikely that the lesion of the sacrum was caused by a lance as proposed by Tkocz & Jensen (1986). The lance would have caused serious damage to the sacrum, leaving smooth but sharp marks on the bone, which was not observed. A lance entering at the required angle would also produce lesions on the fused coccyx/sacrum or on the pubic bone, none of which are evident.

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Debate

The debate on the Mesolithic-Neolithic transition in the western Baltic: a central European perspective

by Lutz Klassen

The Mesolithic-Neolithic transition has been one of the most intensively debated topics in the archaeology of southern Scandinavia for the last thirty years. From the area of the late mesolithic Ertebølle-culture (in the following EBK) and the early neolithic north group of the funnel beaker culture (in the following TBK), that is all of Denmark, southern Sweden, Schleswig-Holstein and Mecklenburg-Vorpommern in northern Germany, no less than about 50 contributions to the debate can be cited from the last 30 years alone. There is no common background or continuously conducted discussion behind this huge number of contributions. What we see is a debate that developed in several steps and in different directions, especially following the partial separation of research traditions in Denmark and Germany from the seventies onwards. This paper does not attempt to give a detailed descriptive survey of the extensive literature. Such surveys can be found in Pedersen (1982), Jennbert (1984), Rowley-Conwy (1986), Madsen (1987) and Price/Gebauer (1992). An acount of the contents of articles discussed is given only if required for the understanding of the first part of the paper. In this part an attempt is made to detect steps in the debate, to characterise these steps and to describe their background. In the second part of the paper the comments in the first part are taken as a starting point for an analysis of the factors leading to the present research situation, which is argued to be one of stagnation. Finally, a proposal is made suggesting how to progress from the present situation. This proposal is the basis of work on the Mesolithic-Neolithic transition presently being conducted by the author. To begin with, however, there is a brief discussion of the literature on this topic in the western Baltic that appeared before the sixties, because this is the basis for understanding the remarks that follow.

A discussion of the Mesolithic-Neolithic transition in southern Scandinavia began in the 1920s, more than 70 years after the separation of an older and younger Stone Age by J.J.A. Worsaae. O. Rydbeck was of the opinion that the TBK was an immigrant farming culture that lived side by side with the late mesolithic EBK without any significant interaction. Contrary to this diffusionist theory C.A. Nordmannn proposed an evolutionary explanation. He postulated that the TBK evolved from the EBK under strong influence from central Europe with chronological continuity between the two (for references, see Troels-Smith 1953, 6 ff.). In the fifties and sixties, the same opposition between theories of immigration and local development characterised the debate between C.J. Becker and Troels-Smith. Becker (1947, 286 ff.; 1955, 156 ff.) was of the opinion that the TBK, or more precisely the A-group, had immigrated as the first neolithic element in southern Scandinavia, and lived there side by side with the late mesolithic EBK for a long time. Troels-Smith on the other hand (1953; 1960; 1967) saw Becker's A-group, which was defined on purely typological grounds based on single finds from bogs, as an integral part of the EBK. Based on cereal impressions, the bones of domesticated animals and cereal pollen, the earliest traces of farming were associated with funnel beakers of the A-type. Consequently, Troels-Smith viewed the final phase of the EBK as a semi-form of agriculture that had slowly developed from the last hunting groups influenced by the neolithic cultures in the south. Immigration was postulated by Troels-Smith for the following B-phase of the early Neolithic only.

Parallel to this discussion, H. Schwabedissen began excavations in settlements of the late Mesolithic and early Neolithic in Schleswig-Holstein (Schwabedissen 1958a; 1958b; 1972). The results of these excavations formed the basis of a series of works on the Mesolithic-Neolithic transition in northern Germany (Schwabedissen 1967; 1969; 1979; 1981 and again 1994). These papers stress both the significance of influence from neolithic cultures in western, central and south-eastern Europe and the traces of neolithic economy in the EBK. In opposition to Troels-Smith, however, Schwabedissen did not consider Becker's A-group part of the EBK.

A development comparable to that in Schleswig-Holstein is seen in the neighbouring region to the east, Mecklenburg-Vorpommern. Here new small-scale settlement excavations of the local EBK (the so-called Lietzow culture, see Gramsch 1966; 1971a and 1976) resulted in another paper on the Mesolithic-Neolithic transition (Gramsch 1971b). This paper was the first to contain a whole series of new theoretical proposals that came

to dominate the subsequent intensive debate in Denmark and Sweden. In northern Germany, where Schwabedissen's traditional typo-chronological concepts were never disputed, no real debate about the neolithisation process ever took place.

Gramsch's paper (1971b) was influenced by the Anglo-American New Archaeology, where the incorporation of anthropological research and ecological reconstruction in archaeological theory was dominant, and traditional typo-chronological work of less importance. For the understanding of the Mesolithic-Neolithic transition, some recent anthropological research on hunting societies was considered to be of special importance. In traditional literature, such societies were often supposed to be more "primitive" than early agricultural ones. With this viewpoint, no special explanation was required to understand the introduction of a neolithic economy, for it constituted a natural form of advance. Thus a simple evolutionist explanation model could be applied. This situation changed drastically as it became apparent that allegedly primitive hunting societies could in fact have quite a complex social structure. It was also shown that the amount of subsistence labour per person per day required could be much lower in hunter-gatherer societies (with low population densities) than in agricultural ones. A simple evolutionist model of natural advance was now no longer sufficient to explain the transition from hunting and gathering to farming. Instead new models were developed, in which factors such as population pressure, ecological change and scarcity of natural resources were key issues. These theories were much inspired by a book of E. Boserup (1965) and were applied for the first time in archaeology in works dealing with Mesolithic-Neolithic transition in the Near East.

Gramsch (1971b) applied these new explanatory models to western Baltic archaeology for the first time, but his work did not provoke a renewed discussion on the subject of neolithisation. This only happened two years later in Denmark and Sweden following an inspiring paper by Andersen (1973). His work, and three other papers that were published in the proceedings of the same conference (Becker 1973; Stürup 1973; Salomonsson 1973), argued from new chronological information. Tauber (1971) published a number of C-14 dates making it clear that the chronological overlap between the early neolithic TBK and late mesolithic EBK must have been a very short one, if existing at all. Stratigraphic evidence for a succession of the two cultures was published by Skaarup (1973) soon afterwards, and was already known to Andersen from observations in kitchen middens when he published his important work in 1973. Consequently, Becker's postulate of a long coexistence of the two cultures as well as Troels-Smith's idea of the A group being part of the EBK were proven wrong. The C-14 dates from the A-group settlement of Muldbjerg in Åmosen in particular, which had been used by Troels-Smith in his arguments, turned out to be several hundred years younger than the EBK dates. As a result, most scholars abandoned conventional immigration theories (with the exception of Becker 1973 and Solberg 1989), and the foundations for a debate influenced by New Archaeology had been laid.

Typical of this discussion was the predominance of models based on ecological explanations of change (Fischer 1974; Paludan-Müller 1974; 1978; Rowley-Conwy 1984; 1986; Vang-Petersen 1982; Zvelebil/Rowley-Conwy 1984; 1986). All of these authors used almost the same explanation for the introduction of food production in the area. They assumed that a change of climate at the transition between the Atlantic and Subboreal pollen zones, followed by changes in seawater level, resulted in an emergency in the late Mesolithic that could only be resolved by introducing a farming economy. According to these authors, the spread of the primeval forest in the Atlantic period and the resulting reduction of the biomass available for hunting led to increased pressure on the available food resources. At the same time an assumed increase in population due to a settled way of life would have accentuated this development. In response, the late mesolithic population increased its reliance on aquatic resources. The regression of the sea at the beginning of the Subboreal period was assumed to lead to a drop in salinity in the fjord areas, followed by the disappearance of oysters and maybe also some species of fish. By then this would have been fatal for the Ertebølle population for whom these resources were vitally important, so that the adoption of a farming economy was now the only way out.

It is characteristic that all contributions to the discussion at this point were made by researchers who had their main field of interest in the late Palaeolithic and Mesolithic of southern Scandinavia. Heavy reliance on ecologically founded arguments, characteristic of the research in these main periods of prehistory, is very clearly visible in all the models proposed.

The influence of the research into the Mesolithic-Neolithic transition in the Near East at that time was also clearly present. In one case it was even proposed that the EBK was a kind of harvest-culture that developed its own form of agriculture on the basis of local resources and thus without the influence of the central European neolithic cultures - a concept taken directly from the Near Eastern Natufian (Horowitz 1973).

The publication of K. Jennbert's book *Den produktiva gåvan* in 1984 (Jennbert 1984; see also Jennbert 1988; 1994) started a new wave of contributions to the debate over the Mesolithic-Neolithic transition in southern Scandinavia (see *Journal of Danish Archaeology* 5 and 6). She published cereal impressions in Ertebølle ceramics and a stratigraphy of the coastal settlement of Löddesborg, where TBK and EBK finds occur together in layers, that, according to the author, were not mixed up after sedimentation. Her view was soon criticised by both Danish (Nielsen 1987) and Swedish (M. Larsson 1987) scholars. The most interesting aspect of Jennbert's book is that she used social factors as an explanation for the Mesolithic-Neolithic transition. That had been done before (Persson 1979; Mahler 1981; Jensen 1982; Mahler et al. 1983), but it was not until Jennbert's contribution that social explanations were given priority over ecological explanations (see Blankholm 1987; Madsen 1987; 1988). The types of social processes referred to by the different authors were very different. There was a Marxist-inspired claim of internal contradictions in late EBK society (Persson 1979); a claim for a decreasing standard of living in the late EBK (Jensen 1982); and a claim for an intensification of exploitation leading to overexploitation of resources and in consequence competition for territories (Mahler et al. 1983). Further, it was claimed that some individuals in the late

EBK strove for prestige and that this forced late mesolithic society to adapt to the new economy. Within the latter category, different views may be recognized. Blankholm (1987) suggests that some individuals in the late Mesolithic were integrated in exchange networks (the importation of shoe-last axes) and thus introduced the neolithic economy in order to increase the profits of production which they controlled and converted into prestige items. Madsen (1987; 1988), on the other hand, proposed that a few persons, striving for prestige, monopolised the exploitation of local resources in order to increase control with society. This should have led to over-specialisation and potential instability, where any change rather than being gradual would take the form of a 'catastrophe'. Finally Jennbert herself is of the opinion that domesticated animals and cereals were part of the very exchange of prestige goods and that their local production assured higher prestige for the persons involved.

A group of papers (Fischer 1981; 1982; Nielsen 1987; L. Larsson 1987) do not contain any specific model for the Mesolithic-Neolithic transition. They either stress the importance of imported prestige items in the late EBK (Fischer) or the social and ideological change clearly observable in the early TBK in comparison with the EBK. In this way these authors also turn away from explanatory models rooted purely in ecological determinism.

The emphasis on social factors while still using ecological factors for explanation at this point in the history of research is characteristic of Neolithic research traditions. It is thus no surprise to observe a considerable number of researchers with a principle interest in the Neolithic period taking part in the discussion along with those whose main interests lie in the Palaeolithic/Mesolithic. As in the former and partly overlapping stage of research, the influence of theoretical archaeology in Great Britain and North America was clearly felt at this second stage. This is especially true of the use of centre-periphery models (exchange of prestige items) and the implementation of both mathematical (Madsen 1987) and Marxist (Persson 1979) models of explanation.

The publications of the last ten years have continued to move away from ecological determinism and towards the greater application of socially and ideologically based models of explanation. The relevance of palaeo-ecological arguments is almost or completely denied in these papers (Thomas 1988; Hodder 1990: 178ff; Price/Gebauer 1992: 106ff; Hoika 1993; Klassen 1996: 315ff; Thorpe 1996: 92f; Tilley 1996: 70ff; Jennbert 1997). Only Andersen (1989) still uses purely ecologically-deterministic arguments, while Solberg (1989) even re-introduces immigration theories otherwise abandoned in the beginning of the seventies. The main reason for the development towards models giving more relevance to social explanations is in some cases at least (Price/Gebauer, Hoika, Klassen; partly Jennbert) new information about the early neolithic economy. In general, new excavations of settlements from this period and investigations of animal bones from these excavations have shown that food production accounted for a surprisingly small part of the overall amount of food consumed (e.g. Andersen 1993). This information comes mainly from coastal settlements and thus is not necessarily representative of the whole of the early neolithic TBK. Pollen analysis in fact shows increasing activity inland. Settlement continuity into the early Neolithic observed at most of the larger late mesolithic coastal settlements and the size of the early neolithic settlements at these locations nevertheless point to the very marked importance of coastal settlement at this time. On the other hand, continuity into the early Neolithic in respect of both location and economy at the larger inland Ertebølle settlements can also be demonstrated (e.g. Ringkloster: Andersen 1998), and the early neolithic component of the inland 'Gudenå' hunting stations should not be forgotten either. Even though farming activities occur inland from the beginning of the early Neolithic onwards, it appears for the time being that hunting, gathering and fishing still played a major role in the overall economy of the first phase of the early Neolithic. The facts that the introduction of food production is connected with a major change in material culture, which cannot be characterised as a functional necessity, and that new grave-types appear at the same time also point towards ideological rather than economic reasons for the introduction of food production. In summary this means that food production was not introduced to cope with problems of hunting and gathering at the end of the Atlantic period. The new data available are so unambiguous that even researchers at the forefront of the wave of research characterised by ecological determinism, have now changed their mind and allow social explanations to be relevant (Meiklejohn/Zvelebil 1991, 138). Thus, paradoxically enough, the consequent implementation of ecological research in settlement archaeology proved ecological determinism as employed in the seventies to explain the introduction of farming to be wrong.

In contrast to the authors referred to above, the rejection of palaeoecological explanations by Thomas (see especially Thomas 1991: 11ff), Tilley and Hodder reflects a fundamentally different definition of the term *Neolithic*, at least in the chronological horizon relevant here (see below). The theoretical topics of post-processual archaeology are clearly in evidence, as they are in the works of Jennbert (1997) and Thorpe (1996: 92f). The latter postulates a change in attitude, in the direction of active manipulation of the landscape as being of major importance for the introduction of food production. Thorpe considers this new attitude, allowing direct manipulation of the environment, to be responsible for the fact that the social control of exploited resources in the late EBK (as described by Madsen 1987) could no longer be maintained. In consequence, the previous rejection of food production would have to be given up.

In their survey of 1992, T.D. Price and A.B. Gebauer reached the conclusion that our empirical knowledge of both the EBK and the early TBK is very good and that it is possible to answer questions of "what" happened in a quite detailed matter. In contrast, the question of "why" still awaits an answer (Price/Gebauer 1992: 112). In my view this unsatisfactory situation has several causes, one of which is of a fundamentally methodological nature, as described by Madsen (1987: 235) in connection with his theory about the introduction of farming.

The reasons for the introduction of a farming economy cannot be traced with archaeological methods, as the under-

lying decision-making is an intellectual process that does not leave any traces in the ground. In this context it is irrelevant whether the transition is viewed archaeologically as a fast or a more smooth and subtle one, as postulated by Jennbert. Crucial in both cases is the intention to change. In the words used by Madsen, the process in question is best characterised as a black-box-problem. Of course this does not mean that archaeologists should give up working with the problem of the Mesolithic-Neolithic transition because they cannot reach any certain knowledge, and leave the field to cultural theorists instead. As mentioned above, the intensive settlement-archaeology and ecological research into the late Mesolithic and early Neolithic of southern Scandinavia has demonstrated that some theories could be proved wrong or at least improbable by archaeological methods.

In northern Germany, research into the Mesolithic-Neolithic transition has been restricted, in the main, to pure description of find materials with few attempts to explore the reasons behind the change. In contrast to archaeological research in the German-speaking area there has been an openness in the Scandinavian countries towards Anglo-American theoretical developments from the seventies onwards. Studies like those conducted in German archaeology have thus become less important while works dealing with local processes of cultural change gain influence. As a consequence, studies that deal with far-reaching cultural relations and models based on diffusion, as for example the classic works of Glob (1944) and Becker (1947), have become almost obsolete. One can observe a retraction of Danish and Swedish research to local source materials. Due to the restriction in the sources used, which was dictated by the theoretical models employed, a Scandinavo-centric picture of the Mesolithic-Neolithic transition emerged. As these restrictions have been maintained ever since the beginning of the seventies, a reader gets the impression that what was originally only a Scandinavo-centric picture of history has turned unconsciously into a Scandinavo-centric conception of history. This is a process that may also have been influenced by the political discussion on the integration of Denmark in the European Community (see Thrane 1997: 155 for an example). The fact that the power of resistance of the Ertebølle culture to far reaching neolithic influences from the south is directly or indirectly stressed in Danish research (see Erny-Rodmann/Gross-Klee et al. 1997: 52, note 107) may also be seen as an expression of this attitude. As a result the reasons for the introduction of farming are sought only in the global climatic change and its consequences for local ecological conditions (first step) or in local social developments (second step). Firstly, this means that people in the late Mesolithic are denied the ability to adapt socially and in a flexible manner to far-reaching European influences. Secondly, it means that the early and middle neolithic cultures of central and western Europe are degraded to supernumeraries that only fulfil their humble contribution of delivering cereals and domesticated animals after they have been asked for this by the main actors in southern Scandinavia. Thomas, who already in 1988 formulated similar thoughts, used the term of automates for the neolithic cultures of central Europe. Automates where the people of the late Mesolithic could get the agricultural products when desired (Thomas 1988).

Any more active and decisive role for the central European Neolithic is no longer even a matter for discussion in the Scandinavian literature since immigration theories in general have been dismissed since the beginning of the 1970s. The only exception that can be cited is the work of Solberg (1989), but this paper argues for immigration too. It is obvious that the development in the Scandinavian countries described above, leading to an intensification of local research, and including important work on palaeoecological problems, hampered the advance of research into the Mesolithic-Neolithic transition. Becker's remark (1973: 6f) at the same conference where Andersen (1973) gave the paper that became so decisive for subsequent developments, that the early TBK occurred in huge areas of Europe in a very similar form, was largely neglected. That super-regional influences thus must be considered very important for the understanding of local development in southern Scandinavia have been totally neglected in recent Scandinavian research. Only very recently has it been made the starting point of renewed work on the Mesolithic-Neolithic transition (Klassen 1996: 315ff; 1997).

The narrowing of the territory in which Scandinavian researchers have been looking for the causes of the Mesolithic-Neolithic transition has gone further yet. The area of research is often reduced to that of modern national states, see, thus, the titles of papers by Madsen 1987; Becker 1985; Fischer 1981 and 1982; Jennbert 1986; M. Larsson 1987; Pedersen 1982; Rowley-Conwy 1984 and 1986; and Stürup 1973 (see also Rudebeck 1997: 66 for this). The attempt to deal with Stone-age cultural history in the framework of the then non-existant national borders is dangerous, even though there are obvious regional differences in the EBK and TBK between Sweden, Denmark and northern Germany. These doubts get even more pronounced when it is realised that there are not only restrictions of a national-geographic nature involved, but also of a cultural-chronological character. This means that no attempt was made to consider both the Mesolithic and the Neolithic points of view and thus the different traditions of research linked with them. Instead the view chosen is often one-sidedly either Mesolithic or Neolithic (Andersen 1973; Blankholm 1978; M. Larsson 1987; Rowley-Conwy 1984; 1986; Vang-Petersen 1982; Zvelebil/Rowley-Conwy 1984; 1986). The use of the far reaching Continental connections of the EBK and the high priority given these in almost all explanatory models of the Mesolithic-Neolithic transition appears almost paradoxical in this situation. A closer examination shows that almost no attempt has been made to examine these connections any closer and that their use in the argumentation is mostly very superficial, the paper by Andersen (1973) being the only exception. The imported Danubian stone axes, for instance, play an important role in almost all contributions to the discussion without any attempts to find out their real region of origin or precise dating. Research in the earliest copper finds in the western Baltic has shown how misleading the application of the dating of a few finds in closed contexts can be in relation to the major part of the material, consisting of single finds

(Klassen 1997). In the case of imported stone axes it is consequently not possible to be sure about their dating at all.

Even a cursory look at the dating of a few crucial artefacts of the EBK shows how unpropitious to the advance of research it is to work in a modern national framework, especially where relations between the EBK and central European neolithic cultures are concerned. There are indications that some of the EBK artefacts appear up to 500 years earlier in Schleswig-Holstein than in Denmark and Sweden. This mainly concerns Ertebølle pottery. These ceramics obviously owe their existence to influences from neolithic cultures and are regularly used to demonstrate EBK contacts with these. Taking the differences in dating into account it becomes clear that the appearance of these finds in Denmark and Sweden is due to contacts with the EBK in northern Germany and not with unknown neolithic cultures in unknown locations. This fact is very important for understanding the Mesolithic-Neolithic transition in Denmark and Sweden, but has been practically ignored up to now.

Only a few works by non-Scandinavian researchers take a wider geographical and cultural perspective into consideration. From the first phase of research, an investigation by Zvelebil and Rowley-Conwy (1986) has to be mentioned. These authors compared the Mesolithic-Neolithic transitions in different regions in order to be able to distinguish relevant parameters of super-regional importance. This is a very meaningful procedure, but the way in which Zvelebil and Rowley-Conwy chose their regions of study is open to criticism. They took only geographical and climatic factors into consideration and ended up with the Atlantic fringe from Portugal to Finland as the research area. In doing so they excluded the possibility of finding factors relevant for the understanding of the Mesolithic-Neolithic transition which were not ecological but cultural in nature and located outside their research area. The choice of research area in a study like that of Zvelebil and Rowley-Conwy should therefore comprise at least all those areas in which the appearance of the TBK (in its broader definition, i.e. including the North Alpine region) is connected with the transition from the Mesolithic to the Neolithic, as is the case in parts of northern Poland and southern Germany. This is especially important if we remind ourselves of the remark by Becker (1973), cited above, that the early TBK appears, in a related form, over wide areas of Europe, which indicates that the problem in question cannot be understood without a wider cultural perspective. Such a perspective has been adopted by the author and has resulted in the recognition of some factors of super-regional importance. Apart from the often-cited ceramics and stone battle-axes the first appearance of copper is of importance here. Just like stone battle-axes and ceramics, copper does not appear absolutely simultaneously, but is connected to the emergence of the different regional groups of the TBK. Obvious elements from the cultures where these copper finds originate, can be detected in the emerging TBK-groups. It seems fair to assume that the copper finds and the development of a semi-industrial metal production in south-eastern Europe was relevant to the emergence of the TBK complex and the Mesolithic-Neolithic transition in southern Scandinavia (Klassen 1996, 315ff; 1997).

Related results have been achieved by two works of the post-processual archaeology which also make use of a wider chronological and geographical interpretative framework (Thomas 1988; Hodder 1990). Both authors see the reasons for the Mesolithic-Neolithic transition in southern Scandinavia in the cultural and economical change of the central European Neolithic, but argue on purely theoretical grounds to a much higher degree than the present author. Most clear is the statement by Thomas (1988: 63), who argues that economy and magic got connected with each other at the beginning of the *Jungneolithikum* (in the southern German terminology) in central Europe. As the ideological part of this package was of special interest to the hunters, they had to take over food production too when they adopted the ideology. This theory explains both the sameness of material culture of the early TRB in wide parts of Europe and the minor importance of food production in early neolithic southern Scandinavia. The theory of the importance of metallurgy in south-eastern Europe for the Mesolithic-Neolithic transition is compatible with Thomas' approach. Early metallurgy was without doubt closely linked to the magical and ideological sphere, and the knowledge of this may very well have been part of the attraction of the earliest metallurgical products and have spread with them. For the time being, however, this theory resides almost completely built on hypotheses and demands much further research.

In summary it may be said that the survey of the literature on the Mesolithic-Neolithic transition in the western Baltic of the last 30 years shows a changing and regionally differentiated picture. Remarkable is the separation of the German and Scandinavian research traditions in the 1970s, which led to very different strategies. The German contributions to the debate are purely descriptive and deal with far-reaching cultural relations of the southern Scandinavian late Mesolithic and early Neolithic. What is seen in Denmark and Sweden, on the contrary, is an intensive discussion that developed under influence of the Anglo-American theoretical archaeology in different, partly overlapping steps. Whereas the beginnings are marked by pure ecological determinism there is an opening towards socially based explanatory models in a second stage of research. The conception of history mirrored in this discussion is Scandinavo-centric, as the reasons for the Mesolithic-Neolithic transition are sought only within the boundaries of the modern states of Denmark and Sweden. In my eyes this is one of the main reasons for an advance in research that at best can be called moderate when the intensity of the debate is taken into consideration. Other reasons for the lack of progress are that the relationship between EBK and neolithic cultures further south and west has not been sufficiently investigated, and that the problem of the Mesolithic-Neolithic transition in general has been dealt with one-sidedly from either a mesolithic or a neolithic point of view. This led Danish and Swedish research into a blind alley and resulted in a breaking off of the discussion at the end of the 1980s. The latest move in research is thus almost completely dominated by works of the English post-processual archaeology. These contributions are, in contrast to the Scandinavian ones, based on a much wider chronological and cultural framework. The results of these investigations, however, have a hypothetical char-

acter with a severe reduction in the use of empirical source material. My own model is both in accordance with the English post-processual theories and much more based on empirical studies, but it is still quite one-sided because the basis of this model is an examination of only one category of finds.

From these remarks, some conclusions relating to future research in the Mesolithic-Neolithic transition may be drawn. One general demand is that work be orientated towards the whole distribution area of EBK and TBK. The meaningless approach of writing Stone-age cultural history within the boundaries of modern national states has to be dropped. It is necessary to consider a much wider geographical area than so far done in most works, in order to be able to judge the significance of super-regional influences in the western Baltic. The local conditions must of course be considered to the same degree as Tilley (1996:72f) claimed in a critical comment on Thomas' (1988) paper. This means that the relationship of the EBK to neolithic cultures in western, central and southeastern Europe has to be investigated in detail. This work is presently being done by the author and involves attempts to find out both where imported finds such as shoe-last axes come from and when they were imported. For this purpose the material has been collected and compared with European finds from about 35 museums in Denmark, Sweden and Germany. Other objects of research are those parts of the locally produced material culture of the EBK that owe their existence to influences from other parts of Europe, such as ceramics and parts of the bone and antler industry. As with the imports, the attempt is made here to detect the origin and age of influences from neolithic cultures on the EBK in the western Baltic based on comparisons across a huge body of European material. A further aim is to draw a picture of the social structure of the late EBK because this information is fundamental to understanding the Mesolithic-Neolithic transition, especially if this transition is to be explained by social and/or ideological change.

As far as the local factors are concerned, most attention will be paid to regional differences between northern Germany on the one hand and Denmark and Sweden on the other. This is because these regional differences are especially mirrored in those artefacts that show far-reaching connections to neolithic cultures. For the same reasons, the traces of cereals and domesticated animals in the EBK will be investigated.

The work described above on the Mesolithic-Neolithic transition covers only one part of the problem, the late Mesolithic. The same procedure has to be applied to the early TBK, with the connections between the northern group and the other regional groups as a main issue. As the copper finds already have been looked at, ceramics and stone battle-axes will play a major role here.

When all these points listed above are considered, a major advance in research in the Mesolithic-Neolithic transition should be possible.

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Where did all the farmers come from?

by Håkan Petersson

In this article I take up again a discussion in the Journal of Danish Archaeology, 1987, concerning the neolithisation of southern Scandinavia. In contrast to most scholars, but in agreement with a few others (Juel Jensen 1994; Price et al 1995), I consider neolithisation to have been a gradual transformation over a long period. I will also argue that it was a process with large regional differences. In this article I make an attempt to present a somewhat different view from that which represents the change as rapid and uniform. I also try to re-introduce the earlier European hypothesis of a slow and geographically varied shift to the neolithic way of life in southern Scandinavia. My opinion is that the change takes place almost simultaneously in western Norway, the Mälar region, western Sweden and Denmark. But the transformation varies from region to region and societies do not change according to unitary, defined cultural systems; rather in accordance with their own unique conditions. My aim is to discuss neolithisation in this light. Similar discussions of the change from the Mesolithic to the Neolithic have recently appeared (Nordqvist 1997; Zvelebil 1995; 1998; Whittle 1995).

History

In one way or another, theories of the eighties have considered neolithisation to be a rapid and homogeneous process. It produced new, regional groups of vast extent (Volling, Svaleklint-Svenstorp and Oxie; Svenstorp is another name for Svaleklint in Scania). The Ertebølle culture's relatively homogeneous territories disappeared in favour of new ones "...reflected by the local stylistic groups emerging during the EN" (Nielsen 1987, 242). The inland Ertebølle culture was transformed to the Volling/Svaleklint stylistic constructions and thereafter the coastal populations of the Ertebølle culture also changed, possibly with some people moving away from the settlement areas (Madsen 1987, 237). Several researchers considered the Oxie group to have been a development out of the coastal populations of the Ertebølle culture, with its origins still visible in the archaeological material. The theories were basically functionalist, even if many of the researchers modified their views (e.g. Madsen 1979; 1982; 1987; 1991). The shape of vessels was considered to be determined by methods of food production and storage, while stylistic and technical details were seen as specific cultural elements (see, for instance, Nielsen 1987, 242). The traditional chronology was overturned by C14 analyses. These also indicated that neolithisation occurred within a short period, and were considered to refute the previously popular migration theories.

The relatively small difference in time between the Ertebølle culture and the Funnel Beaker culture strengthened the view of the new local pottery groups as parts of a homogeneous system so that a mixed economy, with both mesolithic and neolithic elements, was impossible. Some archaeologists considered it to be solely the product of economic factors: the population of the Ertebølle culture had "...a modest capacity for the storage of food. The range of pottery types was limited..." (Nielsen 1987, 240). That cultural groups in a phase of transformation could maintain elements from both the Ertebølle and the Funnel Beaker cultures has never been discussed, since this has been considered incompatible with the differences in respect of social organisation that these two economic systems are supposed to involve. This, it was argued, was demonstrated in that the Funnel Beaker culture had a more advanced material culture than the Ertebølle culture (for instance the pottery).

The existence of cultural dualism in the transformation phase has been the subject of discussion in Scandinavian archaeological research for a long time. It has been categorically denied by most scholars in southern Scandinavia since the advent of the processual uniform system theory and the development of the radiocarbon dating method. This position may also be seen as dependent on the opinion that the changeover from the EBK to the TRB was very rapid. Economic variation has, however, been accepted, even if the degree of variation that researchers recognise varies considerably. Fishing and hunting are considered to have been important complements to farming throughout the Early Neolithic. On the other hand the view seems to be that the new economy, i.e. food production, changed society fundamentally, and the population is therefore to be seen as one of farmers (Kristiansen 1988; Larsson 1987; Madsen 1982; 1987; 1990; Madsen & Juel Jensen 1982; Nielsen 1985; 1987; Welinder 1982; Skaarup 1973). In the work of Welinder, the new economy is expressed by the populations of some sites preferring hunting and gathering while others preferred farming. His conclusion is that it is uncertain whether they belong to the same cultural system or consist of different groups but that they all used Funnel Beaker pottery irrespective of their different economic strategies (Welinder 1982, 159).

Discussions concerning cultural dualism, i.e. whether the EBK was replaced by the TRB or if the two cultures existed side by side in the beginning of the Early Neolithic, have taken place since twenties and thirties. The debate was especially intense during the forties and fifties, even if Rydbeck, for instance, argued for this as early as 1938. C. J. Becker argued that the EBK continued to exist throughout the EN. This view was accepted as the TRB was seen as an immigrant culture that could coexist with EBK as long as the resources were not scarce. The geological dating of the EBK in the 30's and 40's supported this hypothesis. In the 50's Troels-Smith argued that the younger part of the EBK had an economy that was partly agrarian, and that it continued to exist in the Early Neolithic side by side with the TRB, an immigrant population whose economy was based on animal husbandry. Troels-Smith's case was based on pollen analyses, and stratigraphical observations of EBK pottery and TRB A-pottery in Aamosen, along with the simultaneity of these two types of pottery and agreement

in technical features on two other sites. Several intermediary forms bridged the extremes in his view. After this, Becker accepted that the investigations in the Aamosen bog had proved that the A-pottery was the oldest. Elements of this pottery type were nevertheless seen as alien features (Becker 1954).

When finds from the EBK were radiocarbon dated, however, support for a cultural dualism in the Early Neolithic disappeared. At the same time during the seventies the idea of the introduction of farming due to migration became less popular, in favour of interpretations involving internal conditions, i.e. that the Funnel Beaker culture was a development out of the Ertebølle culture.

Since the theoretical resurgence of the 70's a Scandinavian form of processual system theory, influenced, *inter alia*, by traditional empirical diffusion and migration theories, has dominated archaeological research. The famous population model of Esther Boserup, where population pressure is the cause of all technological development, has frequently been used to interpret archaeological evidence. The more nuanced version of the theory later presented has never been taken into consideration (Boserup 1965; 1981a; 1981b).

Altogether this created a view that the structural changes were simultaneous all over Scandinavia. In accordance with processual theory they were the result of two competing technologies and external pressure, such as ecological changes and population pressure (see, for instance, Larsson 1984; 1987; 1992; Madsen 1982; 1987; Nielsen 1987; 1993). Other scholars considered these arguments to be unlikely, but that did not affect the praxis of interpretation (see, for instance, Jennbert 1985; Persson 1980; 1981). Estimates showed that population pressure alone could hardly have caused development towards a neolithic society (Persson 1981). At the same time some scholars argued that the population could never have reached its highest theoretical level. Logical estimates and anthropological research also rejected any essential connection between population pressure and the development of food production (Persson 1980; 1981).

The later works of Torsten Madsen and those of Kristina Jennbert represent one section of the research establishment which has reflected upon the critique of post-processualism. They both consider the shape of vessels to be symbolic, and to constitute people's perception of the world. An understanding of the relationship between changes in material culture and changes in social structure is therefore essential (Jennbert 1984; 1985; Madsen 1987; 1995). Madsen does not abandon systems theory or the idea of rapid cultural change in his social categorisation of the Early Neolithic, but he considers social factors to be of crucial importance in the process of change. However, he dismisses the theory that the earliest phase of the TRB constituted one single cultural group in southern Scandinavia (Madsen 1987; 1991, 490), a view with which I fully agree and which is supported by radiocarbon dating (see, for instance, Persson 1998). There is also a group of archaeologists who claim, supported by anthropological studies and analyses of economic change, that there are not necessarily any marked differences between the EBK and the earliest part of the Neolithic in respect of social structure, economic strategies, land use and material culture (Jennbert 1985; Persson 1987b, 52ff). Other presentations may also imply this (Andersen S. H. 1993a, 1991; Andersen & Johansen 1987; Fischer 1993; Larsson 1987). Modern theories thus seem to consider the transformation from Mesolithic to Neolithic to have been less dramatic (Ahlfont et al 1995; Bonsall et al 1997; Fisher 1993; Juel Jensen 1994; Olsen 1992; and others).

However, most researchers seem to stick to the idea that neolithisation saw a rapid introduction of farming to southern Scandinavia. This view is largely based on stratigraphical observations in shell middens (Andersen S. H. 1991; 1993), and on a general idea of how certain archaeological phenomena should be interpreted.

Mixed cultural layers and prehistoric cultural systems

Rapid neolithisation is said to be proved by the sharp stratigraphy of the shell middens (Anderssen S. H. 1991; 1993a). This, in turn, is based on the basic view of archaeology, under which the archaeological cultures EBK and TRB have been regarded as objective and truly existing groupings, reflected in two separate and observable systems of material culture. These represent separate societies, which are *a priori* discernible from each other. Cultural layers containing pottery from both the Ertebølle culture and the Early Neolithic have therefore been interpreted as mixed, irrespective of whether any arguments for a mixture such as geological factors have been presented. It is also due to archaeological methods, which have led the discussion to focus on accumulated, sealed settlement layers. So far only the stratified shell middens, in which it is claimed that EBK and TRB appear in separate layers, have been considered to fulfil these conditions. However, mixed and sealed accumulated layers are found at some settlements, such as Åkonge and Siggeneben Süd (Fischer 1993; Meurers-Balke 1983). It is therefore logical to presume that more open accumulated settlement finds may represent remains of settlements where culturally definitive material of both the EBK and the TRB was contemporary. Accordingly, I suggest that the idea that the two cultures represent two different societies has guided archaeological research to consider all stratigraphical settlement layers to be mixed until the contrary is proven. The result is that sites with material from both the early phase of the TRB and the late phase of the EBK cannot be regarded as undisturbed although the two are usually impossible to separate stratigraphically. That archaeological cultures such as the EBK and TRB are simplified constructions, fulfilling our need for a visible and understandable structure of prehistoric development, is not discussed. We construct archaeological cultures and decide to which culture the archaeological material belongs. But there seem to be some archaeologists who believe this construction to be a reflection of the actual course of events in the past. It is more likely, however, that our archaeological cultures are a considerable simplification of the actual way of life in that past. I argue that these constructions have been produced without allowing for the possibility of complexity and heterogeneity in societal development. In our concept of homogeneous systems and a defined cultural categorisation of the archaeological material there is no room for "cultural overlaps" and therefore no possibility that in periods

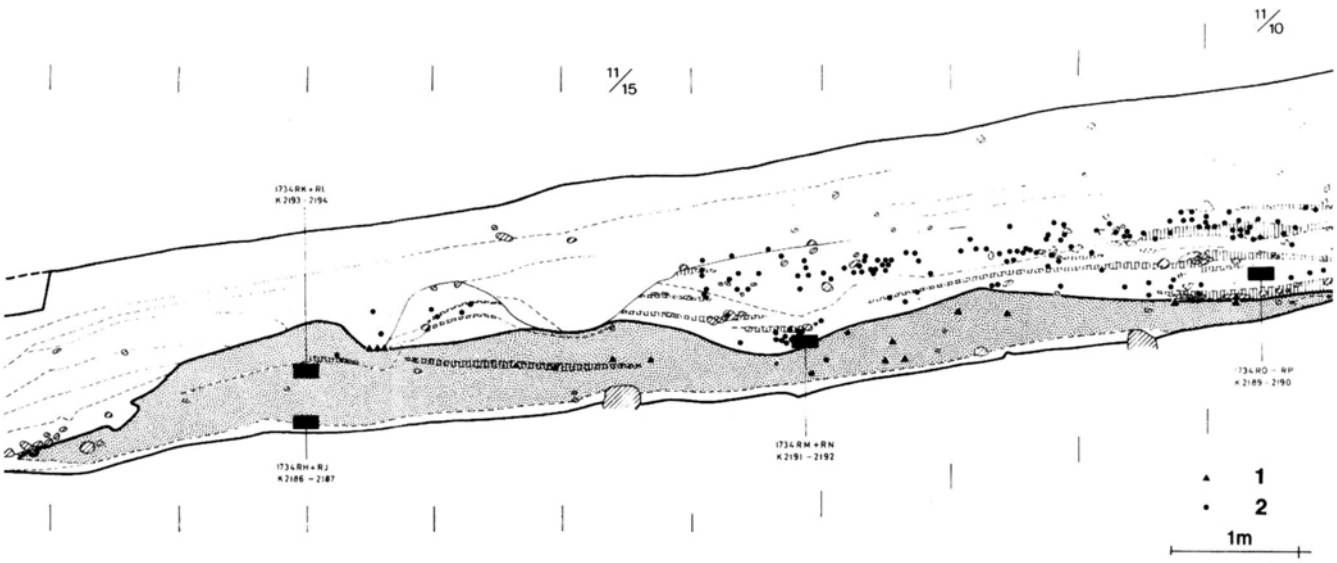

Fig. 1. Section from Norsminde midden. 1. EBK sherds; 2. TRB sherds (from Andersen 1991, 24, fig. 11).

of change the material may be a composition of two different "cultures". Such assumptions are controlled by the fact that archaeological research sees the marked change in pottery as a basis for defining culture, while the flint material, which indicates continuity, is explained functionally. There are on the whole no archaeologists who support the idea of different regional patterns of change where the contextual relationship of different material categories varies between different regions. The background to these circumstances is probably to be found in the paradigm of the 1970's and 80's, which was led by a belief in general laws and that change in the archaeological material reflected change in functional needs. A marked break in social organisation was considered a cultural change resulting from changed economic strategies, technological innovations and other external factors such as ecological ones.

It is plausible that one single social group produced and used both TRB and EBK pottery. This scenario is supported by ethnographic examples, where hunter-gatherer groups have intensive contacts with farming populations (e.g. Nicholaisen in Kristiansen 1988; Turnbull 1993). Under previous theories the two types of pottery have been taken to represent two completely different social systems. As I see it, however, different social groups used the same type of flint artefact and consequently may also have used the same type of pottery. But if this period of overlap is quite short, we will not be able to identify this short episode in the archaeological material.

Sites with cultural overlapping have been described as "mixed", even when there is no stratigraphical evidence. Methodological principles or ideas about various transformation processes might explain this. The conclusion is possible, but not necessarily the only possible scenario. Everyone agrees that at stratified sites one should always observe the stratigraphy, but some archaeologists do not seem to agree that a presentation of mixed sites ought to contain observations of transformation processes. My opinion is that in no other way can a mixture be established, although such sites are probably represented in the archaeological material as well. The term "mixed cultural layers" is often used where no discernible stratigraphy has been observed. Often there have been no observations of any transformation processes. The material is simply assumed to be mixed, since the artefacts cannot be stratigraphically separated.

The conclusion must be that a layer containing artefacts from different cultural systems, which are entirely our construction, can be original, although this can seldom be proved. It is also quite probable that societies during a period of change continue their old habits side by side with the innovations. Sealed settlement sites with both mesolithic and neolithic material have been observed at, for instance, Siggeneben Süd and Åkonge in Aamosen (Fischer 1993; Meurers-Balke 1983). However, as has been claimed by Persson, both cultures are mainly defined by their pottery, and the C14-analyses that have been undertaken indicate that there was a cultural overlap between them (Persson 1998, 162).

Examination of the stratigraphy of the shell middens

The perception of neolithisation derives mainly from C14-analyses of shell middens in Jutland. The transition from a mesolithic to a neolithic way of life is seen as an extremely rapid process in archaeological terms. Some archaeologists claim that it only lasted for c. 50 years. This conclusion is based on The sequence of datings associoated with the materiales in the middens (S. H Andersen1993a, 74ff.). Only a few scholars have suggested a different view (Juel Jensen 1994; Jennbert 1984; 1985; Persson 1979; 1987a, 113f; 1987b; 1998). There

are two sites of extraordinary importance in these circumstances: the shell middens at Bjørnsholm by Limfjorden and Norsminde south of Århus. A strict examination of the observed stratigraphical change at Norsminde shows that it was mainly due to a change of climate, from oysters to cardium shells (see fig. 1). According to S. H. Andersen, the stratigraphical change is the result of the human use of resources. This is probably a correct conclusion, but at the same time the economic change at Norsminde is taken to be accompanied by an archaeological cultural change, since the mesolithic and the neolithic pottery are claimed to be confined to the lower and upper layers of the kitchen midden respectively (Andersen 1991, 24, fig 11). This conclusion is logical since it is based on the dominant processual theory, according to which cultural change is a change of systems, created by external influences, such as ecological factors. But there are objections to this presentation of cultural change. If the small segment of the published section of Norsminde is examined (see fig. 1) one can see that a third (4/13) of the pottery material presented in the mesolithic layer of the profile is in fact Early-neolithic. But the contextual relationship is missing in the publication. There is therefore no information on the distribution of the material in the profile. How wide is the area in front of the profile from which the pottery originates? If this area were a metre wide, for instance, the discrepancies in the relative artefact levels might have been substantial. On the other hand it is claimed that the archaeological change is associated with a stratigraphical change from oysters to cardium shells. These possibilities seem therefore to have been taken into consideration when the archaeological material was projected into the profile. But if the area outside the profile, from which the projected material originates, had undulating layers, the material could have been projected into the wrong layer of the profile. This would imply that a totally misleading profile has been constructed. The solution would in this case have been to select a smaller area or an area with less difference in level for the projection. But one has to assume that the excavator did not document in a misleading way and that the published part of the profile is representative. Unfortunately there is no such stratigraphical presentation of Bjørnsholm. Furthermore, a detailed presentation of the entire material from both sites, with all sections fully presented, is wanting. It is noteworthy that a geological correspondence between EBK and TRB is discernible in the shell midden at Kolind (Mathiassen et al. 1942, 37), though the presentation of the evidence in this case is primitive.

The view of a rapid neolithisation at both Norsminde and Bjørnsholm is based on C14-analyses. All these analyses except one were extracted from oyster and cardium shells and there was no C14-analysis of artefactual material. This implies that the material analysed does not necessarily connect the ecological stratigraphy with the archaeological material. The fact that the neolithic material was found partly in the mesolithic oyster layer might of course be due to natural formation processes. But these are not discussed and there can therefore hardly have been any observations of such natural formation processes. Nonetheless, the profile from Norsminde cannot be used as a proof of a rapid neolithisation. A detailed discussion of how the neolithic pottery got in the "mesolithic" layers is lacking. Consequently, the archaeological material from the EBK and TRB in the transitional area between the layers could originate from the same period or settlement phase and the changeover from oyster to cardium shells might simply be the result of a change in climate. This view is supported by the fact that the transition to cardium shells at Bjørnsholm actually takes place before the cultural change (Andersen 1991, 74). Thus there are no necessarily functional or economic conditions for cultural change. The available resources affect the economy, but the economy is also a result of the needs and beliefs of the society.

If neolithisation was a rapid process at some sites, it does not automatically follow that all sites in that region underwent the same process at the same time. The radiocarbon dating of Norsminde in comparison with Bjørnsholm allows for a difference in time of 200 years, at a carbon14 probability of 10-90%. Similar transition phases of 200-250 years are possible when dealing with radiocarbon dates on TRB material in east central Sweden.

The exact time delay in the transition at Bjørnsholm is hard to calculate since the transition from oysters to cardium shells precedes the cultural change in archaeological artefacts, and, as has previously been discussed, it is not the archaeological material that has been dated, but the ecological change. However, the so-called rapid transformation in southern Scandinavia can be said to take place 200 years later at Norsminde, which is situated 110 km south of Bjørnsholm. This is an argument against the view of systems theory, of a large-scale, rapid and homogeneous transformation from EBK to TRB all over Scandinavia. According to this view neolithisation is an influence coming from the south and there should be no difference in time between the introduction of farming at the two sites. There had been contacts with the European Continent already in the late Mesolithic and it is thus hardly likely that the difference in time is due to social isolation of certain groups.

In Aamosen, Sjælland, Fischer has examined several settlement sites, all with sealed layers situated in bogs. The earliest is dated to 4000 BC and contains finds exclusively from the EBK, while sites that are later than these contain material from both the EBK and TRB. Then there is a younger group of sites, dated to approximately 3750 BC, which only contain TRB material. At all sites the flint shows marked continuity with the technology of the EBK. Bones from domesticated animals appear only at the youngest sites. At one site, Å-konge, the stratigraphy was divided into two sequences. The lower layers contained EBK pottery together with smaller amounts of Oxie-group pottery and bones from domesticated animals. The upper layer contained pottery from the EN and large amounts of bone from domestic animals. The excavations showed that the settlements had been used at the transition from the Mesolithic to the Neolithic, and radiocarbon dating indicates a gradual transformation (Fischer 1993; Persson 1997, 381).

Siggeneben Süd is another site with sealed accumulated layers. This has also been an object of discussion in respect of "mixed cultures" (Meurers-Balke 1983). A vessel that was found

at Bjørnsholm at the borderline between EBK and TRB deposits reveals the possibility of a morphologically intermediate form (S H Andersen 1993a, 86). Another intermediate form with a mesolithic morphology and neolithic ornamentation, has been found at Kotedalen, Norway (Olsen 1992). Koch Nielsen has also encountered an intermediate form, which she calls type 0 (Koch 1998). It is thus plausible that material from the EBK and the TRB can appear together in intact layers, irrespective of whether these can be stratigraphically determined to be sealed accumulations or not. The argument for the division of the archaeological material in stratified shell middens can also be criticised.

There is consequently no substantial proof that neolithisation was a rapid, homogeneous process. The archaeological material indicates that there was an intermediate phase before the development of a "homogeneous" neolithic culture. There is no proof that the so-called mixed settlement layers are really disturbed. The process may therefore have been slow, with a cultural transformation phase. It is also noteworthy that the nature of economic changes is considerably more long-term and is not necessarily connected to what we interpret as social and cultural markers.

Sites with observed stratigraphy may indicate a general stratigraphical difference between the EBK and the TRB. But this is hardly possible without a diffuse intermediate phase, and even if it were, no such single observation can be regarded as indicative of a general phenomenon. Such a diffuse phase is present in the profile of Norsminde, which has always been said to be the strongest indication of a marked break at the beginning of the EN. I therefore argue that the archaeological facts that we possess cannot be understood as reflecting incommensurable social systems in the way that the EBK and TRB have been regarded. Furthermore, many sites, e.g. the shell middens, show that the change of economic strategies was limited. In several cases there was only a small change in hunting and gathering strategies.

Is it likely then that people produced vessels using two different technologies, related to different pottery types, for more than a century? The pottery of the EBK is characterised by thick wares in H- or U-technique. Later the ware gets thinner and the N-technique is also used. The TRB pottery has thinner wares and is made in the N-technique. It is likely that the differences in technology are due to functional factors. The H-technique is suitable for a thick ware, while the N-technique is better for thin ware. Both EBK and TRB pottery have parallel Continental forms. But the N-technique is also used for thin EBK pottery, which shows that the choice of technology is not socially determined (Hulthén 1977, 205ff).

"The manufacture of Early Neolithic Funnel Beakers compared with a late phase of Ertebølle pottery methods is, for instance, one example of a continued development of pottery craft. The same applies to Middle Neolithic TRB pottery compared with Early Neolithic pottery." (Hulthén 1977, 205)

Furthermore, many small pottery sherds are classified as belonging to the EBK or TRB just by their thickness. There might thus be a large source of error because of the difficulties of definition. But even if the choice of technology and shape was not due to functional factors it is still plausible that the population stuck to the technique they were used to for producing a certain type of vessel, while concurrently using another technology for new types of pottery. That different types of vessels were produced during a same period is possible because of the functional reasons for technological differences. As has already been noted, there are also indications of intermediate forms of pottery.

One should not forget that neolithisation concerns more than just the production of pottery, even though this is of crucial importance in this discussion since it has been seen as socially constituted. My hypothesis is therefore that neolithisation was an extended process, both in terms of groups and in the relations between groups in a region, but that the phenomenon appeared at roughly the same time all over Scandinavia (cf. C14-datings; Persson 1998, 82f, 222ff). This will form the basis for the further discussion, where I shall argue for the plausibility of such a development at the transition from the Mesolithic to the Neolithic in southern Scandinavia.

Economic strategies

The hypothesis of a richly varied economy in the late Mesolithic and early Neolithic has recently become increasingly popular. It implies a more gradual and varied transformation to the Neolithic. But the archaeological material from this period is scarce and it is therefore hard to come to any conclusion concerning the economy. There is evidence of farming from the EN, but it can hardly have been crucial to the economy.

Analyses of sickles indicate very limited use from the EN to MNA I, and show that only flint blades were used (Juel Jensen 1994, 129ff.; pers. comm.). The spikes could, however, have been harvested by hand, so there is a chance that farming was more extensive than the evidence indicates. The material from a vessel at Bjørnsholm together with dated grains, e.g. from Mossby, are the most important indications of farming in EN I. But the sample from Bjørnsholm does not indicate farming until c. 3800 BC, i.e. approximately 150 years after the introduction of the Neolithic. In east central Sweden there are direct indications (bone material) of farming dated to 500 years later than the transition to TRB (Andersen Th. 1992; Persson 1998, 104).

"...the evidence for bare-soil plant communities is certainly sparse, compared to other vegetation types such as secondary woodland and pasture." (Juel Jensen 1994, 151)

This applies to both Sweden and Denmark. There is a certain difference in the Swedish evidence for the human effect on woodland in the Mälar region and southern Sweden, even though the development is not linear but shows great regional variation (Ahlfont et al 1995; Andersen 1993a). There is a possibility of pasture existing in Skåne already before the elm decline, which would in that case also be true of Sjælland. But the pollen evidence supporting this hypothesis is weak. Grains exist in Sweden from as early as the final phase of the EBK, but the indications from the pollen analyses are weak. Criticism of the methods of sampling and dating, which is general to all Neolithic pollen analyses, can certainly in this case cause

doubt whether the results are correct (Ahlfont et al 1995; Jennbert 1984; Göransson 1991; 1994; 1995). The pollen material from the Neolithic has been interpreted as indicating slash and burn agriculture (e.g. Th. Andersen 1992; 1993a; 1993b), while the same phenomenon from the Mesolithic has been interpreted as different types of burning. Clearance by burning is, in ethnographic terms, a kind of forest management. Burning causes a favourable sprout forest, but can also be used to manage certain types of forest. Recent investigations from Denmark show extensive manipulation of the woodland during the EBK to achieve a greater growth of willow. Evidence shows that willow was used for extensive fishing traps (Christensen 1997, 147ff; Petersen 1997, 124ff). In terms of C13 isotopes there is marked break between the Mesolithic and the Neolithic, but this may be misleading due to the reservoir effect. Samples from Dragsholm, Ertebølle, Vængesø and Norsminde have been dated to the Late Mesolithic and have a lower C13 content than those from an earlier phase of the Mesolithic, but the reservoir effect on marine material is not known. If we reckon with a reservoir effect, Late-mesolithic samples close by the shores might be from the Early Neolithic. This would give us a transition phase from the Mesolithic to the Neolithic of approximately 500 years. This is supported by the burials from Dragsholm where the two burials seem to be constructed together, but the radiocarbon dates separate them by approximately 500 years. This discrepancy is what one would expect when taking the reservoir effect into account. But there are very often remains of land mammals in the mesolithic graves as well. On the other hand, compared with material from central Västergötland, the skeletons from southern Scandinavia show that many individuals may have had a partly marine diet, irrespective of whether they lived at coastal or inland settlements. At the same time the decrease in the C13 content cannot be dated more closely than to the period between 4000-3500 BC (Persson 1997; 1998, 55ff, 93). Another problem is that one cannot determine whether a high C13 content is the result of a diet consisting of products from the natural flora and terrestrial animals or from domesticated animals and plants. This implies, if the decrease of the C13 content is correctly dated, despite the reservoir effect, that it might be the result of changed hunting and gathering strategies, without any farming going on.

There are bones from possibly domesticated animals of the EN, but they are few and there are other possible explanations than indigenous domestication (Mathiassen 1940, 17; Nielsen 1985; Persson 1998, 45ff). Sites dated to the earlier parts of the Neolithic with bone material show a marked dominance of wild species and all these sites are situated close to the shore (Persson 1998, 76). There are, however, important sites where bones of domesticates dominate, but which have not yet been dated. It is noteworthy that Havnelev and Sigersted, for instance, which have now been dated (Koch 1998) are not very early (4840 (K-3629) and 4780-4600 bp (Koch 1998: 87; NMI j.nr. 2103/77) respectively). Some of the earliest dated neolithic bone material comes from Gotland: sheep (5070 bp – Ua-4952), cattle (4935 bp – Ua-3248) and pig (4800 bp – Ua-3247). On Gotland there was no big terrestrial game so there is no doubt that these bones originate from domesticated animals (Jonsson 1986; 1988; Lindqvist 1997, 369ff). Recent radiocarbon dating of animal bones has revealed that bone material that previously was dated to the EBK is considerably younger (Jonsson pers. comm.). It has long been well known that grains and grain imprints on pottery can be dated to the earliest phase of the Neolithic. From Bornholm there are two dated grains, one from Vasegård (5250 bp – AAR-2438) and one from Limensgård (5000 bp – OxA-2895), which might indicate the existence of grain before, as well as after, the beginning of the EN.

The archaeological evidence of the EN is very scarce and indicates a varied economy, with a small element of farming activity at the transformation from the EBK to the TRB. S. H. Andersen has noted an economic continuity in the shell middens and this supports the idea that farming was a complementary activity, of secondary importance to a hunting and gathering population at the beginning of EN.

Did it start in the Mesolithic?

There are indications that a more varied economic strategy also existed at the end of the Mesolithic. Pollen analyses and paleobotanical examinations, together with archaeological artefacts from all over Europe and Scandinavia, have been interpreted as the products of a slash and burn economy with forest management, with so-called plant husbandry taking place in pre-neolithic contexts (see the discussion in Zvelebil 1994). This created favourable conditions for big game, which made hunting easier, although it is of course impossible to prove this scenario. Clearances of this kind would also have created advantageous conditions for hazel, which seems to have been highly desired in the late Mesolithic because of its nuts, and it is a fact that hazel nuts formed a large part of the diet in this period. Thus, the clearances might indicate that wild plants were of greater importance than has previously been supposed. The lack of fine-meshed nets for water sieving at most excavations might explain why plant remains are not often discovered (Göransson 1994; 1995; Persson 1980; 1987a; Zvelebil 1994).

It is in this mesolithic context that the earliest pottery appears, and this applies both to Scandinavia and to northern Europe in general (Persson 1998, 183). Several archaeologists today also claim that the tools made from bone and antler had a another function than was previously argued for. It is suggested, for example, that the T-shaped antler adze was used for processing the soil rather than woodworking. However, the results of studies of these adzes are contradictory. There are studies that show them to be suitable for woodworking (Jensen 1991), while other studies show them to be badly balanced for cutting wood (Smith 1989; for a further discussion see e.g. Chapman 1989; Zvelebil 1994). There are also ethnographic studies of soil processing among gathering populations which use wild plants (Harris & Hillman 1989).

The reports on neolithisation in Iron Gates indicate that "mesolithic" hunting and gathering populations lived side by side with "neolithic cultures", with a highly differentiated economy, but with fishing as the main resource. At one site possible grains from cultivated plants have been encountered in

both mesolithic and neolithic contexts. Isotopic analyses from mesolithic skeletons (Lepenski Vir) indicate a change in economic strategy in the Mesolithic, from freshwater fishing as the main resource to an increasing use of terrestrial hunting. An alternative view is that there was increasing exchange with the farming populations in the area or even an introduction of farming to these "mesolithic cultures" (Bonsall et al. 1997, 78)

Excavations in central Europe have revealed that the empirical data that we define as mesolithic and neolithic respectively seem to appear in both mesolithic and neolithic times (Bonsall et al. 1997; Budja 1996; Zvelebil 1994). These indications thus appear both in central European and Scandinavian material. But what impact do these indications of farming have on the hypothesis of a distinct change in social organisation in southern Scandinavia during the EN compared to the EBK?

Sedentary hunter-gatherers and a reconstruction of neolithisation

Theories of a sedentary "neolithic" settlement structure in the late Mesolithic and at the transition to the Neolithic in Scandinavia were put forward by several scholars during the 80's (Jennbert 1984; Paludan-Müller 1978; Persson 1980, 137; 1981; Wigforss 1983). A slow process of neolithisation could, by this theory, be due to the development of a more sedentary pattern and an appropriate social structure. Socially adapted and conservative groups thus made the introduction of farming a slow process, or adopted only a few elements that were commensurable with their cultural system, values or ideas. The existence of advanced and socially complex hunting and gathering populations is supported by ethnographic examples (e.g. Hayden 1994). There is also archaeological material to support this, such as neolithic hunting stations in Norway (Olsen 1992; for further examples see the discussion about late mesolithic plant breeding in Zvelebil 1994; 1998 and Göransson 1994; 1995, and the discussion of late mesolithic forest management and fishing constructions in Christensen 1997 and Petersen 1997). Osteological analyses indicate the risks of interpreting the lack of bone material from a certain season as being a result of seasonal settlement. Naturally, our indicators of different seasons, which make up a minimal part of the total bone material, are unevenly distributed in different times of the year. Mature individuals can be hunted throughout the year and some species can be stored from good years to bad years. The evidence from Skateholm reveals that that site was probably occupied throughout the year (Jonsson 1988, 85). The differences between coastal and inland settlements in respect of C13 levels, together with the previous argument for a permanent or semi-sedentary settlement, is further underlined by stylistic variations in the archaeological material (Andersen 1998, 48ff; Noe-Nygaard 1983; 1988; Persson 1998, 92f; Vang Petersen 1984).

During the 80's and 90's revisionist anthropological theory has claimed that modern hunter-gatherers have fundamentally changed their "original" lifestyle as a result of contacts with modern civilisation, and that they have often been forced to move from their area of origin (see e.g. Burch 1994; Burch & Ellanna 1994; Headland & Reid 1989; Kent 1992; Wilmsen & Denbow 1990). In spite of this crisis in anthropological research in respect of potential ethnographic analogies, the latter might still be useful in the construction of a plausible hypothesis. Such studies show, for instance, that there is no necessary isolation between hunter-gatherers and farming populations, as we often assume in our archaeologically constructed cultures. It is also noteworthy that there are no rules for how the relationship is formed: the farmers may be more dependent upon the hunter-gatherers than vice versa, and the hunter-gatherers may be more complex than the farmers (e.g. Burch 1994; Hayden 1994; Headland & Reid 1989; Turnbull 1993).

Norwegian research implies a stable and relatively sedentary hunting-gathering society from the Mesolithic, with a settlement structure that reminds us of the EN in southern Scandinavia. This structure continues into Neolithic times, and the Norwegian changeover from the Mesolithic to the Neolithic is marked by changes in artefacts and stone technology. Pottery appears at 4800-5000 bp and shows, as has previously been noted, various influences. There are sherds with ornamentation reminiscent of the TRB while the morphology is typical of the mesolithic. A marked economic change also took place at the transition to the EN, from heavy terrestrial dependency with the hunting of big game to an almost total dependency on sea fishing (Olsen 1992, 128 ff, tab 17). This Norwegian example reveals that changes in economy and material culture are not always accompanied by changes in social organisation. In Norway the hunting-gathering populations seem to have kept to their way of life, in spite of contacts with a farming population, for several hundred years (Olsen 1992, 231ff). Some archaeologists claim that a stable social organisation was established as early as late Mesolithic times among these hunter-gatherers, who knew of farming as a result of their contacts but who, economically defined, remained "mesolithic" (Bergsvik in Olsen 1992; Olsen 1992, 93, 141, 232ff). There is thus a possibility of higher complexity in mesolithic society than has previously been assumed, of a kind which is normally connected with the EN (Andersen 1991; 1993a; Bonsall et al 1997, 58, 75; Olsen 1992; Persson 1987a; Paludan-Müller 1978; Zvelebil 1994).

Social and ideological factors behind the introduction of farming?

Social and ideological factors provide plausible explanations of a regionally varied economy in southern Scandinavia. This would imply a regionally more varied social organisation and thus also more varied modes for the change to take place than the homogeneous view held in the research of today (Ebbesen & Mahler 1980; Larsson 1984; 1987; 1992; Madsen 1987; 1991; Nielsen 1985). The results of archaeological research indicate that social and ideological change may take place irrespective of, or with only slight changes in, the economy.

Our paucity of information on the EN cultures in respect of the economic factors of that period makes it difficult to try to discern the relationship between economic strategies and social differentiation, symbolically manifested in the decora-

tion of the pottery. The mesolithic lifestyle was not abandoned at the beginning of the EN in southern Scandinavia, but was supplemented by new strategies to a minor degree. The essential question is whether the impact of these new strategies on social organisation, settlement structure, relations of production and so on was in proportion with their relatively minor significance in the economy as a whole.

Cultivation may have been of importance in the creation of social status and for the manifestation of the relations of power in society. Bread and beer may have functioned as social capital and in ritual activities. We find, for instance, collections of grains at some causewayed enclosures, which may indicate that grains were deliberately brought there for some particular reason. The quantity of flint sickles present is also notably high at these sites (Juel Jensen 1994, 151, 203ff). It is also tempting to suggest that pigs were of ritual importance in the Neolithic. This is supported by osteological analyses and Neolithic finds from Gotland (Jonsson 1986; 1988). The same may also apply to cattle in the MN, while in Sweden finds of cattle are concentrated in areas with megaliths (Ahlfot et al. 1995, 166). The role of domesticated animals such as cattle and pigs as symbols of status or important elements in ritual activities, feasting, the perception of the world etc., are well documented by anthropologists among primitive farmers or pastoral groups (Dwyer 1990; Evans-Pritchard 1940; Keesing 1981, 335ff; Rappaport 1984).

Stylistic variations in the archaeological material in Europe are probably due to social and ideological factors rather than to time differences and differences of economic nature. I attach secondary importance to external factors and population pressure as causes of change. Instead I argue that change was created in a kind of successive, evolving interplay between societal actions in terms of "trial and error" and the constant transformation of the social regulations and ideological structures of power in the society. This process probably took place at a regional scale, even though changes may take place simultaneously on a wider scale. The development was probably based on previous experiences within the local community and should be seen in relation to local or regional conditions.

"...neolithisation of Denmark was a slow process, which began in the EBK with the introduction of certain non-subsistence related technologies, and was ended in MN AII, with the appearance of a manipulating full Neolithic economy...that the duration of this economic and ideological restructuring was more than 1000 years." (Juel Jensen 1994, 173 – my translation)

This implies that the introduction of new economic strategies is a determinative factor in social change. I argue that social and ideological changes in the societal structure of power were considerably more complex, and that in the period of transformation the "neolithic" economic elements probably constituted a small part of the process of change as a whole. But they may have caused marked social changes and started a slow economic development towards another way of life in a conservative society.

Continuity from the end of the EBK to the beginning of EN is, in the light of the foregoing discussion, a possible solution. My aim has been to show that economic, social and technological changes can take place independently of one another, as was the case in Kotedalen, and in a way that our constructions of cultural groups (EBK and TRB) does not take into consideration. Instead of establishing imaginary homogeneous archaeological cultures we should spend our time studying change in the light of how human behaviour changes.

My view is that neolithisation meant a gradual change of the social mode of production: i.e. the mutual relationship between people, their relations to their tasks and their relation to the system of legitimisation of power. In the EN the societal change led to what has often been interpreted as increased ritual activity - at first in connection with long mounds and later also in connection with megalithic graves and causewayed enlosures. The introduction of new economic strategies can be viewed as a part of the legitimisation of power, through political control of new factors of prestige. Even though these new elements were primarily symbols of prestige they had probably also some significance for the economy. They might also have been a vital part of social or ritual feasting in connection with the reproduction of social bonds, alliances, obligations and so on (see e.g. Dwyer 1990; Mauss 1990; Rappaport 1984).

It is tempting to see the ritual activity which is held to increase within the course of the EN as a result of the social, ritual and legitimising nature of the new economic strategies. This rituality is held to diminish or change nature at about the same time as the indications of cultivation and stock breeding become so evident that one may assume that these elements had become a general, basic part of the economy. This indicates a more fundamental change in relation to the TRB in southern Scandinavia during MN I/II than the almost invisible transition at the end of EN II and the beginning of MN I. The archaeological material indicates that the Neolithic can be divided into three parts: TRB I (5080-4710 bp), with earthen graves, long mounds and continuity from the Mesolithic, but also new elements and strategies; TRB II (4750-4450 bp), characterised by megalithic graves and a marked increase in rituality; TRB III (4450-4190 bp), when the building of megaliths ceases and ritual activities decrease or completely change character, when neolithic strategies become a basic part of the economy and the size of settlement sites increases.

History is not an objective subject; it is a product of our time. Has the time come to revise our view of the Neolithic? The view of the EBK and TRB as two incompatible cultural systems was a result of the theories of the 70's and 80's: a mixture of functionalism, neo-evolutionism and processualism. The function of social institutions as well as social actions is, according to this view, to keep the society in a state of *equilibrium*. Archaeological cultures have therefore been analysed as large-scale, homogeneous systems. The human being is seen as an anonymous and passive part, which only responds to external factors, not as an active factor in societal change. The interpretations of neolithisation have mainly been based on rational reasoning in terms of "cost and benefit". This kind of discussion is almost exclusively based on the economic aspects

of society, which are taken to be the product of external factors that are seen as the primary cause of cultural change. When societies get into a temporary phase of *disequilibrium* and the cost of maintaining the *status quo* exceeds the cost of reorganising society, a change of society as a whole takes place. Thus, rapid societal reorganisation has been assumed at every change of archaeological period, with a constant effort to restore *equilibrium*. Studies of the history of archaeological thought both by archaeologists and by historians of science (Kjørup 1996; Young 1973) provide quite similar views, although many archaeologists may not agree with this.

The transformation from the Mesolithic to the Neolithic, which was principally seen as an economic change with the introduction of farming, and which has been described as a "black box" phenomenon by Madsen, can now be seen as a gradual process. My hypothesis is that this process started in the later phase of the EBK, with the introduction of pottery and forest management, as well as plant husbandry, and that there was a gradual development into Neolithic times.

Thus, the earliest phase of the Neolithic comprises the introduction of farming: "the black box" which, according to Madsen, is to be seen as a process were we can see what goes in and what comes out, but not how it happened. The economically defined transformation from the Mesolithic to the Neolithic is rather a diffuse issue in the archaeological literature. The question is how marked and how fast the transformation was, with the change of material culture and use of artefacts. And how did it influence the social and ideological change? Are changes in material culture a safe indication of such a change? As has been argued by Zvelebil (1998, 23), there seems to be a certain continuity between the late Mesolithic and the early Neolithic.

I argue that the development was a slow process, to a large extent not in accordance with our construction of different periods. Social and ideological change nonetheless took place. The transformation was the result of the social and ideological constructions of the population rather than new economic impulses. *The homogeneous economy* all over Scandinavia is noteworthy, and a characteristic of the Late Mesolithic as well as in the Early Neolithic. My answer to the questions stated above is that "neolithic" elements may have caused a change of social organisation and the organisation for power in the mode of production (i.e. the relations between individuals and their access to the means of production). Currently, the TRB period as an ideological change may have implied a changed mode of production. But what was produced seems not to have undergone a marked change until later, in the Middle Neolithic.

The transition to the TRB is thus primarily to be seen as the result of social and ideological factors, which include the introduction of new economic strategies (see also Price et al. 1995; Tilley 1996). In these circumstances it is hard to separate cause from effect, but there was probably a dialectical relationship between the two. In my opinion, new economic strategies indicate that the legitimating structures for power were undergoing slow, but radical change. This change was probably considerably regionally varied, developing both divergently and gradually.

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Reviews

Michael A. Jochim: *A Hunter-Gatherer Landscape. Southwest Germany in the Late Paleolithic and Mesolithic.* Interdisciplinary Contributions to Archaeology, Plenum Press, New York and London 1998 (16 chapters, 233 pp, 115 illustrations [86 figures, 29 tables], multiple references [9 pp] and index [13 pp]). Available in cloth ($49.50) and paperback ($24.50).

In his latest book Michael A. Jochim takes us back to late glacial and early postglacial Southwest Germany. For many years the rich archaeological remains of this area has attracted numerous foreign (European as well as non-European) scholars working in hunter-gatherer archaeology. Jochim's own research in the area goes back to the early 1970's. His first book on the Mesolithic of the region (Jochim 1976) is a paramount example of the application of methods inspired by culture ecology and it was normative to theoretical approaches in prehistoric hunter-gatherer behavioural studies far beyond the boundaries of early postglacial Southwest Germany. As very correctly stated by Robert L. Bettinger in his foreword to the present book, this seminal study (Jochim 1976) on prehistoric hunter-gatherer subsistence and settlement was "startlingly radical at the time". This is most probably the reason why it never won renown in Germany where a more rigid form of materialistic archaeology has always ruled. The problems of matching the real data with Jochim's model were simply too severe to inspire German archaeologists to work along the same lines.

The present book represents an attempt to combine a somewhat de-emphasised theoretical approach (which is still heavily inspired by culture ecology) and an explicitly stated materialist approach presenting and discussing a new set of archaeological data unveiled by Jochim and his crew during the past two decades. In the light of the tremendous influence that the first book have imposed on hunter-gatherer studies ever since it was published, this new book absolutely deserves a detailed presentation and discussion.

The book is divided into four coherent parts. It is well set out and very well-written. Both data and theoretical framework is presented to the reader in a readily accessible language (given the geographical focus of the case study this is actually quite important).

In a brief *Introduction* (chapter 1) Jochim (re)introduces the reader to the general problems pertaining to hunter-gatherer archaeology as well as the more specific problems concerning the European Mesolithic. He also provides a brief introduction to ecological approaches, which is then considerably expanded upon in the following chapter (2) on *The Changing Theoretical Landscape.* In this chapter Jochim thoroughly discusses "certain dominant themes and problematic issues that must be addressed by archaeologists interested in prehistoric hunter-gatherers". It is highly recommended reading to anybody interested in the ecological approaches. Jochim convincingly argues that we should leave the much too detailed quantitative calculations (well known from Optimal Foraging Modelling) and seek a more general understanding of the structure of variations in resources through time and space and its implications for past hunter-gatherer behaviour. The ecological approach used by Jochim is thus one favouring simplistic modelling "to create a subsistence landscape reflecting the structure of variability". Chapter 3 completes this generally introductory part by giving a brief overview of *The Natural Landscape* of the region with respect to the present as well as the late glacial and early postglacial situations. This chapter also presents a very useful subdivision of the study area with respect to eight major geographic subregions.

Following this introductory part, the chapters 4-6 present an overview of the archaeological record and a 'Stand der Forschung' concerning the *Sites on the Landscape* in *The Late Palaeolithic, The Early Mesolithic* and *The Late Mesolithic* respectively. These chapters primarily review previous research carried out by German archaeologists in the area. I am sad to have to characterise this review as being superficial and not exactly flawless. A Danish journal may not quite seem the place to go into particulars on Southwest German archaeological findings, but such an allegation obviously must be accompanied by at least a few examples:

Regarding the Late Palaeolithic it should be remarked that organic artefacts are not just rare (p.43) they are generally absent or at least unknown. This holds for the portable art objects and ornaments as well. In fact the Late Palaeolithic of the region is in almost every respect far less well preserved and accordingly far more problematic than one should think from reading Jochim's chapter 4. There are immense prob-

lems pertaining to the absolute dating of these finds (Eriksen 1996, 1997), and these issues are not adequately dealt with in the book. On the contrary it is asserted that the Late Palaeolithic is securely fixed within the Allerød and Younger Dryas chronozones. The distinction between the Late Palaeolithic and the Magdalenian is not precisely drawn – as correctly mentioned by Jochim – still it does not make sense to assign a Magdalenian age to a questionable lithic inventory purely on the presence of a "small mammal fauna indicating cold conditions" (p.53). Based on these speculations a series of excavated finds are thus left out from the comparative analysis while other finds of a definitely more dubious quality, i.e. mixed collections of surface materials, are included (p.47). The following chapters 5 and 6 are not much better. There is a general lack of discussion of geochronological issues. C^{14}-datings are supplied when appropriate (more or less), but always without laboratory numbers or further references. The reader is thus prevented from checking out the context of the datings or pursuing any of these questions further. I miss a lot more care and thoroughness in the presentation. It is, for example, not even made clear to which extent Jochim has been able to examine any of the primary archaeological assemblages.

While this overview is essentially based on a literature survey of published research, the following part (chapters 7-11) presents the results of a long-term research (survey and excavation) project featuring *Sites on the Landscape* in the Federsee area. This project was motivated by the "lack of well-published excavations" (p.183) from the study area, and it was designed partly to investigate the role of the Federsee in Mesolithic land use patterns in Southwest Germany and partly to test the predictive model presented by Jochim in 1976. Chapter 7 presents the results of the *Survey*, while the chapters 8-11 present the results of the excavations of the sites *Henauhof Nordwest* (followed by a summary of the *Change through Time at Henauhof Nordwest*), *Henauhof West* and *Henauhof Nordwest 2.*

To a large extent these chapters merely seem to represent an English version of the German publication of Henauhof Nordwest (Jochim 1993) and I regret that neither of these two versions really does make up for the all too familiar lack of well-published excavations from the area. The artefact inventory is presented in a few sketchy tables and a handful of mediocre drawings. The faunal inventory is discussed extensively, but without any element of source criticism. I would at least have expected a critical discussion of the presence of wild boars in Younger Dryas faunal assemblages. There are few factual details and no listing of element representations or bone measurements and again the reader is prevented from pursuing any matters of specific interest. It may well be that these long known surface collected, but only recently excavated Federsee sites, are too problematic to deserve a more detailed presentation and publication, but then at least the reader should be given the possibility of asserting this through a set of proper illustrations, tables and appendices.

In all fairness it should be mentioned that the discussion generally pay due attention to several of the methodological problems inherent in the material, yet I must also add that some interpretations (especially when including palimpsests and accumulated settlement sites) still appear rather imprudent. I much regret that these observations also holds for the concluding part of the book: Chapter 12 discuss *Henauhof and the Federsee in the Regional Landscape* and the discussion continues in chapters 12-15 on *The Late Palaeolithic Landscape, The Early Mesolithic Landscape* and *The Late Mesolithic Landscape* respectively. The concluding chapter 16 finally deals with *Southwest Germany in the West European Landscape.*

Again I shall confine my remarks to a single example. Throughout the book (and especially in chapter 13 on *The Late Palaeolithic Landscape*) it is evident that Jochim adheres to the common supposition that sub-arctic hunter-gatherers subsist on meat to a considerable degree. However, in a highly recommendable paper on "The use of plants in the Upper Palaeolithic of Central Europe" Linda Owen demonstrates (Owen 1996) how plant resources have been neglected in most reconstructions of Upper Palaeolithic nutrition. It is established that even the Eskimos collected and preserved considerable amounts of plant foods. The archaeological case study concerns the Magdalenian of Southwest Germany, and Owen concludes that the possible importance of plants during this period should not be underestimated. Needless to say this conclusion must also hold for the Late Palaeolithic, tentatively fixed to the warmer and latter part of the late glacial. Thus I find absolutely no support for Jochim's assertion that "the overwhelming majority of human foods were animals, just as they had been in the preceding steppe-tundra" (p.194) – especially if we believe that the forests were sufficiently dense and warm to sustain boreal species like roe deer and wild boar (which I highly doubt).

I agree with Jochim (and others) that the importance of plant foods probably increased notably in the early postglacial, but here our agreement ceases. I am not convinced that the potential plant foods were relatively "expensive" in the early Mesolithic (p.202), rather I consider that the nutritional costs by not eating plants (e.g. for anti-scorbutic reasons) would have been considerably more marked.

As evident, e.g. from the discussion of "currencies of choice" used in the ecological approaches (p.20f), Jochim is in general very concerned that the data should not be pushed beyond their limits, but this concern does not prevent him from over-interpreting the data from a number of sites and inventories. I am especially concerned with the way that surface collected sites and palimpsests are used in the comparative analysis.

Much of the book consists of presentations of sites, but again there are too many shortcomings or even blunders. Jochim is well informed and the list of references is quite extensive. However, the relevant literature is generally just referred to. There is no significant discussion of the works by other scholars. Some of the data discussed by Jochim obviously derives from personal communication with the late Professor Wolfgang Taute, but too many data are discussed at length without proper referencing. Accordingly it is rather difficult for many readers to detect the occasional blunders – as for instance in the presentation and discussion of the head burials

from Große Ofnet. This is one of the most fascinating Mesolithic finds from Southwest Germany.

At Große Ofnet a total of 33 heads (4 adult males, 9 adult females and 20 children or juvenile females) were found in two pits (Schmidt 1912). Almost all heads were lavishly adorned with ornamental molluscs or perforated canines of red deer. The quantity of ornamental molluscs, mostly tiny gastropods, from Große Ofnet is truly impressive: There are 4000 *Lithoglyphus naticoides* probably originating from eastern Central Europe, 160 *Gyraulus trochiformis* from Steinheimer Basin on the Swabian Alb, 50 *Theodoxus gregarius* probably from Mainzer Basin, and 5 *Columbella rustica* from the Mediterranean Sea (Rähle 1978; Schmidt 1912; Strauch 1978). According to Jochim there were 4000 molluscs from the Mediterranean Sea (p.213), a rather inaccurate statement. Further according to Jochim there were 4000 perforated fish-teeth at Große Ofnet (p.220), but there are none. Unperforated fish-teeth from Black Sea roach (*Rutilus frisii meidingeri*) do occur in connection with a female skull from Hohlenstein Stadel, but in much smaller numbers (Wetzel 1938).

Michael A. Jochim's book and the present review represents a classical example of inherent discrepancies between an Anglo-American and a European approach to prehistoric hunter-gatherer studies. Our different approaches are rooted in highly different research traditions and despite the most genuine attempts to combine a theoretical and a materialist approach there always will remain a certain bias due to these different scholarly traditions. The present review may in some instances seem unduly rigid. However, the reader should remember that this is merely an example of different schools of thought. From an Anglo-American point of view Jochim might very well represent a "rather materialist theoretical orientation" (as stated by himself in the Preface), but from a European point of view the empirical part is negligible. Obviously, this does not make his approach less valuable or less inspiring to the more rigid empirical materialists – on the contrary. For these reasons and because it is so extremely important to keep an open mind to different analytical approaches and variant perspectives on the archaeological data I sincerely recommend this book to anyone interested in studies of past hunter-gatherer behaviour.

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Viborg Søndersø 1000-1300. Byarkæologiske undersøgelser 1981 og 1984-85. Edited by J. Hjermind, M. Iversen & H. Krongaard Kristensen. Jysk Arkæologisk Selskabs Skrifter XXXIV, 1998. 372 pp, richly illustrated, large format in cloth (Dkk 395), ISBN 87-7288-594-7.

In 1981 and 1984-85 Viborg Stiftsmuseum carried out a large number of trial excavations in an area on the western shores of Viborg Søndersø that between 1000 and 1300 AD had housed a settlement of craftsmen. To Scandinavian standards these excavations yielded extremely rich find deposits and well preserved parts of buildings. The reason for this is that the water table of the lake was raised at the beginning of the fourteenth century by damming, making the conditions for the preservation of organic material superb. The book, jointly published by Jutland Archaeological Society and Viborg Stiftsmuseum, is the product of no less than 20 authors.

The opening chapter by H. Krongaard Kristensen provides an introduction to the topography of the Viborg area and the history of the town as seen from the archaeological sources. The area at Viborg Søndersø has seen much activity from around 1000 AD and onwards with traces of building activities, house remains and leftovers from handcraft activities. Some of the oldest houses were raised in 1015 and 1018 AD according to dendrochonological dating. Due to the damming

around 1300 AD the whole area became uninhabitable and was left to flooding. The town itself, however, continued to grow, and from the medieval period the names of no less than 12 parish churches are known. To day only the cathedral and the Dominican monastery church are preserved.

H. Krongaard Kristensen starts out in chapter two to describe the background for the excavations at Viborg Søndersø. The planned building of a hotel was the direct cause. He then continues to describe the different excavated areas and trenches using detailed plan and section drawings. A number of Harris matrices provide excellent information on layer sequences and phasing of the layers in the different areas. High quality photos provide the reader with clear impressions of the find conditions. Dating of layers and constructions is mentioned in the text, and important artifact types are summarized for the different contexts. Based on the pottery, three horizons have been separated. Horizon I: Ca. 1000-1000 AD. Horizon II: Ca. 1100-1200 AD. Horizon III: Ca. 1200-1300 AD. In a couple of areas Horizon I probably reach back into the tenth century.

In chapter three H. Krongaard Kristensen describes the settlement, its house-types and constructions. In the eleventh century there seems to have been a rather dense settling within a limited space. In the twelfth century the settled area expands to a larger area, while already in the thirteenth the settlement has begun to decline, as it seems. Due to the limited size of the excavated areas only parts of houses were uncovered. One such house had an arched long-wall, while all others were rectangular. Most houses had wattled walls, but two houses with stave-built walls were also noticed. Finds of bole-planks shows that houses with bole walls had also existed. The youngest house found during excavation, from around 1300 AD, had buried posts in between which was a footing mostly consisting of bricks. Several houses had earth floors, open fireplaces, ovens and external pathways paved with planks or wickerwork. The individual lots had often been lined with wickerwork fences. Two-three wells build with wickerwork and horizontal planks were also uncovered.

Chapter four deals with conditions of preservation and conservation (by H. Krongaard Kristensen and E. Andersen), while chapter five, the largest of the book, document the huge artifact material through the works of a number of specialists. A number of good photos and drawings support this documentation. Coins, pottery, bone, antler, leather, metal objects, patrix, casting material, wooden objects, carriage parts, flax shirt and textiles, rope, querns, glass, decorated objects, whorls, steatite, brush, whetstones and stone mortars are objects or object groups dealt with in this chapter. If one section should be especially mentioned it must be J. Hjerminds' on the pottery, where he deals with a total of 13.000 shards. The thorough treatment of the pottery has shown chronologically conditioned differences in form and composition allowing for a division into three ceramic horizons. In large tables the domestic and imported pottery is presented in an easy to see format. A good number of photos and drawings show the different types of pots, and these are referenced to their respective horizons. Semispherical pots, spherical pots, swallows' nest pots, dishes, bowls, lamps, lids, etc. are treated thoroughly. Decoration on the pottery is also discussed, and the imported ware shows that there are direct – or perhaps rather indirect – contact with northern Germany, the Rheinland, Holland, Belgium northern France and England. Among the domestic pottery there is an ever-increasing regionalisation from 1000 to 1300 AD. The domestic pottery in Viborg clearly belongs to an east and central Jutlandic local group. M. Fentz's section on the flax shirt from the eleventh century is also a good example of the thorough treatment of an object / group of objects so richly present in the book.

T. Hattings section in chapter six on animal bones is based on an analysis of ca. 11.000 fragments from mammals. To this should be added bones from birds and fish. Cattle and perhaps especially sheep have had paramount importance for the economy of the settlement. Pig is also fairly frequent in the material, whereas horse and goat plays a minor role. Among the domestic birds fowls are dominant followed by geese. Game is only sporadically present and has been of no significance to the economy of the settlement. Fish are sparsely present in terms of fresh water fish from the local area and cod and flatfish from salt water further away. The other sections of chapter six deals with archaeobotanical analyses of forty samples, fish remains in human faeces, analysis of nails and fibre investigations of shoe seams, ropes and cords.

H. Krongaard Kristensen summarizes in chapter seven the results of the Viborg Søndersø excavations. The structure of the settlement, house types, trade and exchange, handcraft, nourishment, hygiene and material culture are issues that are rounded off in this chapter. Nice color photos from the excavations and of the best of the artifacts are presented here. Especially the color photos of the pottery are worth mentioning, as far too often colorful pottery is shown in black and white.

In chapter eight H. Krongaard Kristensen goes through the topographical development of Viborg from 1000 to 1300 AD. Already in the 7-800 years a farmstead can be followed in four phases in the Store Sct. Peders Stræde area in Viborg. The finds from here certainly do not suggest a town-like settlement at this early stage. From late in the tenth century Viborg starts to develop towards something that looks like a town with dense settlement and clear evidence of trade and handcrafts. The town seems to have developed around a pagan cult place and a thing. From the middle of the eleventh century clear traces of a conscious town planning is seen in Store Sct. Peder Stræde among other areas. In 1065 AD Viborg becomes an episcopal residence, and shortly afterwards, it must be assumed, the building of the cathedral has been initiated. Until about 1100 AD Viborg seems to have consisted of a settlement at Søndersø, and a settlement on the higher lying area around Store Sct. Peder Stræde. In the following development these two settlements melted together. On fig. 5, p. 353 one can see that Viborg with time was marked by a very strong ecclesiastical dominance with twelve parish churches, one cathedral, six monasteries, one House of the Holy Spirit, and one leper hospital. In Medieval Denmark Lund only supersedes these counts. Viborg is fortified in 1151 AD with rampart and moat, and for the next 400 years these constituted the delimiters of the town, not least in an eco-

nomic sense. King Erik Menved started in 1313 the building of the castle Borgvold, in connection with which the lake was dammed. The castle seems to have been demolished again soon afterwards.

The ninth and last chapter is an English translation of chapter seven.

There is no doubt that the book will become a work of reference for the research into artifacts from 1000-1300 AD exactly as was its model *Århus Søndervold,* when it arrived years back. The many specialists contributing to the book has heightened its quality. It is well organized and hardly with any weak points. On can only hope that *Viborg Søndersø* will inspire other Danish towns with a huge unpublished archaeological material from the Viking and Medieval Ages to publish similar books. Danish Medieval Archaeology needs more of these thorough publications.

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Military Aspects of Scandinavian Society in a European Perspective, AD 1-1300. Papers from an International Research Seminar at the Danish National Museum, Copenhagen, 2-4 May 1996. Edited by Anne Nørgård Jørgensen & Birthe L. Clausen. Publications from The National Museum, Studies in Archaeology & History Vol. 2. Copenhagen 1997. 265 pp.

Research seminars focussing on the military aspects of prehistory have not been an especially common occurrence in Scandinavia in recent years. War, weapons and power as individual elements have been analysed in many other contexts, but attempts to take a collective view of military aspects as an integrated part of the social development as a whole have been much rarer. Military Aspects of Scandinavian Society is the product of a well-planned and executed international symposium in Copenhagen in May 1996. The overall intention was to present and discuss current research concerning military organisation as the cornerstone for the state-formation process. As the introduction to the book states, a discussion of the transition from a tribally- to a nationally-based military organisation is of vital importance to our understanding of prehistoric society. The sources with which historians and archaeologists respectively work provide different backgrounds and conditions. This is reflected in the analyses of both classical and medieval warfare by both professions. The symposium highlighted this and served in a positive way to stress and create an understanding of how far research has progressed and which problems remain unsolved.

The publication consists of 26 contributions divided up into four general themes: military organisation in the light of written and archaeological sources, military organisation of naval forces based on written and archaeological sources and the logistics of military activities. Six of the contributions are in German and the remainder are in English. I do not intend here to comment in detail upon the various contributions, rather to report the authors' most important comments concerning the respective themes.

The contributions dealing with written sources begin with Sigmar von Schnurbein who sketches the organisation of the Roman army and the defence structure along the Limes. He describes the national Roman army's uniform organisation as the reason for its success, stressing that the Roman uniformity was unique in classical times and would remain so for some considerable time into the future. No other European state was able to organise its military forces in a corresponding fashion before the Late Middle Ages.

Edward James' contribution focuses on the conceptually difficult but important phenomenon of the militarisation of society. He begins by underlining that this was actually not something which applied in Rome but rather characterised the early medieval German kingdoms. James defines parts of this problem and emphasises in his paper the importance of not mixing up terms such militarisation, military organisation and perpetration of violence in analyses of society. The subject is actually too broad to be compressed into a contribution such as this, but it is recommended as an invitation to immerse oneself in James' inspiring discussions to be found elsewhere.

Bernard S. Bachrach's contribution deals with the Roman inheritance which influenced Merovingian military organisation. This is a very candid and direct paper which possibly reflects the author's roots in the American research tradition. Even thought this is perhaps open to criticism, Bachrach makes a clean sweep and with refreshing keenness disposes of a number of earlier misconceptions. The central element in his paper deals with Late Roman military organisation with defence in depth and mobile units as the background for studies of late classical and early medieval warfare. According to Bachrach it was no longer the classical legions but the civitates of the period which constituted the framework for the military structure. His conception of the significance of fortified cities and of siege warfare appears somewhat exaggerated, but seen in conjunction with Edward James' discussion of the militarisation of the population and the civitates it is very interesting.

The recruitment of the early medieval armies is dealt with in Timothy Reuter's paper. He discusses the categories of household, mercenaries and followings, as well as conscription, from a position counterpoising how these could have been organised, relative to how they were organised in reality. From a critical standpoint Reuter argues that we should be careful in equating these different levels of knowledge, and we ought to remember this even though historians and archaeologists perceive their sources differently in this area.

Carroll Gillmor and Michael H. Gelting conclude the theme of the written sources. Gillmor's paper illuminates the Carolingian military hierarchy, specifically Charles the Bald's mobilisation of small free farmers as a workforce at the defences at Pont de l'Arche in AD 862. She bases this in part on texts in the Edict of Pîtres and sketches the changes in the traditional hierarchy and the consequences of these. Gelting's paper focuses on military organisation and the distribution of social power in Denmark in the 11th and 13th centuries. He

presents the historical-geographical situation and makes comparisons with European society. This contribution gives an interesting and rather detailed historical-geographical insight, even though the link back to the military organisation comes rather late in the text.

The evidence from Jutland's war booty deposits is Jørgen Ilkjær's contribution to the publication. It begins the section dealing with archaeological source material. In an informative summary he describes the extensive Illerup finds and discusses how these could reflect the hierarchical structure. Ilkjær interprets this first and foremost in terms of a well-developed south Scandinavian military organisation which was able to carry out co-ordinated operations already in the Roman Iron Age. At the same time he stresses the importance of waterways and naval movements, as the finds in the Illerup valley are in all probability the result of a conflict which involved sea-borne attackers.

Wolfgang Schlüter's and Georgia Franzius' respective papers are topical presentations of background and evidence concerning other finds directly from the battlefield, namely the battles of Kalkreise or Varus in the Teutoberger forest. Since professional excavations commenced after the location of the site in 1987, extensive finds, including Roman army equipment, has been registered. The nature of the finds has exposed a number of facts concerning this famous battle which are of great interest for military studies. For example, it was not just the regular forces which took part in the battle, even the Roman support train with its scribes, craftsmen and doctors was exposed to attack. It is maintained furthermore that the so-called battle comprised a number of skirmishes, something which was previously thought to have been the case, but which has now been positively demonstrated through the archaeological analyses.

Heinrich Härke, in a customarily well-formulated contribution, outlines the difficulties associated with comparing the archaeological material with what the written sources have to say and what the material remains really reflect. He presents a critical discussion of the early Anglo-Saxon weapon burials in England and emphasises that these do not reflect directly either the military organisation or the underlying intention behind this, as we have difficulty in distinguishing between ritual symbolism and actual function in the material. Härke's contribution is an inspiring insight into the research which otherwise occupies him and his thoughts should encourage similar analyses comparing weapon grave finds with social and military organisation.

The Alamannic cemetery Kirchheim am Ries is dealt with in a contribution by Lars Jørgensen, Kurt W. Alt and Werner Vach. Here we are presented with an attempt to reconstruct the biological and social structure in a specific society by way of archaeological and odontological methods. The results so far are extremely exciting and the paper accounts for a credible picture of a militarily-organised society, in the sense of Edward James' definition, which under a ruling family ensured the standing military forces. Symbolic and functional aspects of the archaeological material are paired with anthropological aspects which, with respect to the question of organisation, give promising support to the interpretations.

Anne Pedersen shares with us her knowledge concerning the chronology and geographic variation of Viking Age graves with weapons and riding equipment in Denmark. She stresses the need for caution when simplifying the significance of quantitative and qualitative methods with regard to interpretations of military organisation. The Danish grave finds from the 11th century do however reflect, with some certainty, just such a structure. Pedersen considers that the accumulated number of finds today does in fact make it possible to draw far reaching conclusions alone on the basis of the archaeological evidence. These must of course be regularly balanced against developments in research into written sources, but provides interesting support for the potential strength of the archaeological evidence.

Heiko Steuer, Flemming Kaul, Ulf Näsman and Michael Olausson, in their respective contributions, deal with archaeological traces of military camps and fortifications. Steuer discusses the question of possible Germanic military camps in the 4th and 5th centuries, which is thought provoking as it is normally considered that the Germanic military organisation during this period used camps and defences according to the Roman or Early Medieval definition. Steuer puts forward examples from southwestern Germany as possible Germanic military camps, even though they probably have had other functions. Kaul presents sensational results from the investigations at Priorsløkke which reveal that defences were constructed at the site at the cost of an already existing village which was destroyed, clearly for strategic reasons. He makes some interesting calculations with regard to the potential threats and links a plausible historical scenario with traces of organised measures to counter a gathering hostile attack from the sea. Ulf Näsman and Michael Olausson discuss defensive works from the Migration period in Sweden. Näsman focuses on the function of Öland's ringforts in an overall system of defences. Overriding aspects of military tactics, topographic exploitation and links to the general settlement pattern are also presented, providing a usable framework for the interpretation of both sites and finds from the island. Olausson's article deals with the hillforts in the area of the Mälar valley during the Migration period and he sketches an interesting picture of the political landscape. The introduction of a new type of fortified sites in the area, and the fact that no material traces of siege warfare have been found, means that at least parts of the Middle Swedish military organisation must in some respects be interpreted differently from that on the Continent.

Naval organisation constituted a separate session at the symposium and contributions to this were presented by Bjørn Myhre, Ole Crumlin-Pedersen, Niels Lund and Anne Nørgård Jørgensen. Myhre writes about the Norwegian boathouses as a reflection of political centres along the coast in the Iron Age. The presumed territorial and military organisation coincides well with finds of these structures. Crumlin-Pedersen's contribution is a summary of boat finds from the Iron Age, but shows interestingly how they can have been adapted constructionally for military purposes. Of special interest are the comparisons between the Nydam boat and the Roman river patrol boat found at Mainz. The leidang as a phenomenon

and a organisation is touched upon in most of the contributions on naval organisation and especially so in Niels Lund's article which draws attention to non-Nordic parallels. Naval defences in Denmark, in particular barrages and military finds associated with these systems, are dealt with in an illuminating way in Nørgård Jørgensen´s contribution.

The concluding theme is in my opinion one of the books greatest assets. No less than six of the publication's authors present their views concerning logistical aspects of Iron Age warfare. It is perhaps no coincidence that logistics and the supply services seldom attract such attention, either as part of actual military operations or as an area of historical-archaeological interest. Their function is though a crucial condition for the carrying out of military operations and should accordingly be of great interest also for scientific studies. Svend E. Albrethsen starts his contribution with the unusual approach of making comparisons with the Danish army's present-day definition of logistics. He then stops off at several historical events where he makes various calculations. Calculations such as these can be of general use in questions regarding the general situation, but should always be treated with a certain caution. In their contribution Flemming Rieck and Erik Jørgensen describe the non-military finds from Nydam, giving interesting insights into both personal equipment and find categories not primarily used for battle purposes. In a well-balanced contribution Claus von Carnap-Bornheim deals with the significance of naval transport in the Iron Age. The war booty finds in Nordic bogs support his interpretations and by way of an interesting comparison with, among other places, the Black Sea areas, he demonstrates a well-organised ability among the barbarians to co-ordinate and execute naval movements. In an appropriate development of von Carnap-Bornheim´s reasoning, Olaf Höckman deals with the Roman military's river-borne transport system and patrolling activities on the Rhine and the Danube. The Roman supply and surveillance system was to a great extent built around superior use of naval units on rivers. Johan Engström´s article on the Vendel chiefs and the warrior equipment of the period is more an account of tactical behaviour on the battlefield. It can also be perceived as an invitation to immerse oneself in studies, the aim of which is to investigate logistical aspects of the military organisation in the Mälar valley in the Vendel period. In the book's final contribution the naval historian Richard Abels discusses the system of military administration in England during the period when Vikings threats dominated.

Military Aspects of Scandinavian Society is a proceedings volume of great value. It consists of a majority of relatively short contributions which were presented during the symposium in 1996, but at the same time constitutes a good overview of the status of research in this area during the 1990s. The published papers give qualified and concentrated insights which invite further study in the various sub-themes and in the various authors' fields of research. Light is furthermore brought to bear both on the primary bonding elements linking the disciplines of history and archaeology and those elements which through developments in research create new methodological diversity. The book also exposes the breadth of the subject. Military aspects are not just to do with weapons technology and tactical strategies, but extend to include, for example, non-military functions which support military activities. Knowledge and interpretation of the archaeological sources has today progressed to a point where we are able to produce a cohesive picture of the development of military organisation in Europe during the first millennium after the birth of Christ. The archaeological evidence is now so extensive that, in many cases, it is possible to produce a credible reconstruction of the prehistoric and medieval organisation almost exclusively on the basis of this. In conjunction with research into written sources and theoretical analyses, archaeology has, with regard to military aspects, shown itself to be a valuable compliment to all our analyses of prehistoric society.

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1 Bennike, Pia 1990: Human Remains from the Grøfte Dolmen. *Journal of Danish Archaeology* 7, 1988, pp. 70-76.
2 Roesdahl, Else 1988: Vikingetidens befæstninger i Danmark - og hvad siden skete. In Torsten Madsen (ed.): *Bag Moesgårds maske,* pp. 203-216. Århus, Aarhus Universitetsforlag.
3 Hvass, Steen 1988: Jernalderens bebyggelse. In Peder Mortensen & Birgit M. Rasmussen (eds.): *Jernalderens stammesamfund. Fra Stamme til Stat i Danmark 1.* Jysk Arkæologisk Selskabs Skrifter 22, pp. 53-92.
4 Ørsnes, Mogens 1988: *Ejsbøl I. Waffenopferfunde des 4.-5. Jahr. Nach Chr.* Nordiske Fortidsminder, Serie B 11.
5 Aaris-Sørensen, Kim 1988: *Danmarks forhistoriske dyreverden. Fra istid til vikingetid.* København, Gyldendahl.

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