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# Bjørnsholm. A Stratified Køkkenmødding on the Central Limfjord, North Jutland

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## INTRODUCTION

The Bjørnsholm shell-mound, or *køkkenmødding*, is located in the central Limfjord area in Northern Jutland (fig. 1). Today it is our largest *køkkenmødding* with levels of occupation from the Late Mesolithic Ertebølle and the Early Neolithic Funnel Beaker Culture. From 1985–1992 a series of excavations were undertaken, partially in the shell-mound and partially in the area behind it.[1] The following is a survey of the preliminary results of these new investigations, with special emphasis on the structure and stratigraphy of the *køkkenmødding*.

## HISTORY OF RESEARCH

Denmark is one of the classic areas for prehistoric studies of shell-mounds – a tradition which goes back to the 1850's. One of the main areas in Denmark for *køkkenmødding* research is the central Limfjord in Northern Jutland. The oldest records in the National Museum are from 1837 and report on excavations in the Krabbesholm shell-mound. From 1893 to 1897 the large *køkkenmødding* at Ertebølle was investigated (fig. 2). It later became the type site, *locus classicus*, of this culture (Madsen *et al.* 1900; S. H. Andersen & E. Johansen 1987).

The Bjørnsholm site was partially excavated in 1931 by the National Museum (unpublished).[2] Subsequent to this investigation, an area of the best preserved southern and southwestern part of the *køkkenmødding* measuring 30×30 m was protected by law. The excavation produced a large number of artefacts, but the record lacks information as regards stratigraphy, etc. The site therefore only played a minor role in descriptions and discussions of the Ertebølle Culture and was only mentioned briefly in the literature (Brøndsted 1938:98, 333; Mathiassen 1940:40–41; Mathiassen *et al.* 1942:54–56; Becker 1947:99, 145, 149).

In the 1950s, two Neolithic graves, one from the Middle Neolithic and one from the Late Neolithic, were excavated by the National Museum to the west and southwest of the *køkkenmødding*.[3] Finally an Early Neolithic grave with a timber construction was found and investigated in 1988–89 (S.H. Andersen & E.Johansen 1992; S.T. Andersen 1992).

The main aims of the new investigations at Bjørnsholm were to get an up-to-date sample of the artefact assemblage, together with faunal remains in association with a well-defined stratigraphy and a cultural and chronological context, to obtain information on the site itself with regard to stratigraphy, structures, size and type of midden, the timespan it covered, and to determine the character of the settlement. A secondary aim was to compare Bjørnsholm with Ertebølle in order to answer the question whether there was any relationship between the two sites – the two largest Danish *"køkkenmøddinger"* – and if so, what the nature of this relationship was.

## EXCAVATION PROCEDURE

The investigation started with a 1 m wide and 28 m long trench running through the thickest part of the shell-mound (the protected area) and perpendicular to the prehistoric beach. Later, additional squares and smaller sections were investigated, but it was not possible to open up larger squares within the protected area. Outside the protected area, to the rear of the *køkkenmødding*, c. 800 square metres were excavated in order to find traces of habitation (S. H. Andersen & E. Johansen 1992, fig. 17).

Most squares of the midden were excavated by following the stratigraphy and recording everything in a three dimensional coordinate system and with plans drawn for every 1–2 cm. Other squares were dug in 5 or 10 cm

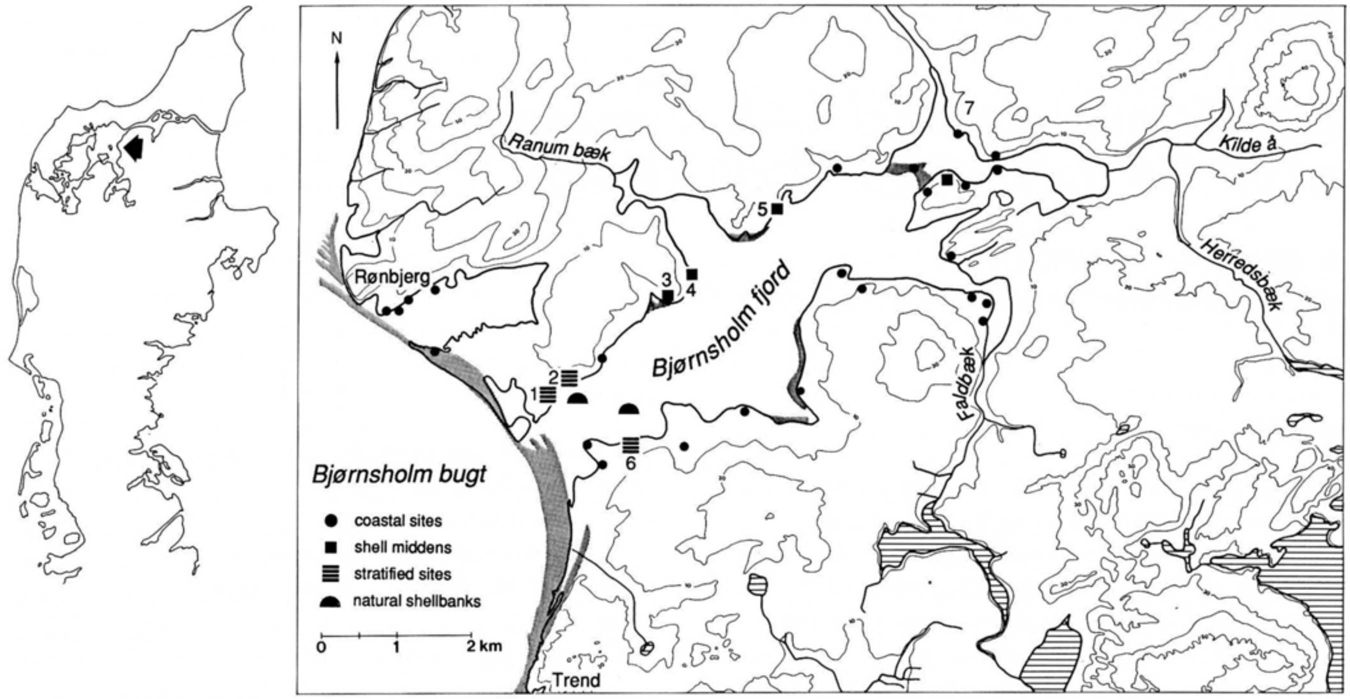



Fig. 1. The location of shell-mounds and other coastal sites in the Bjørnsholm Fiord: 1) Bjørnsholm. 2) Åle. 3) Siggård. 4) Østergård. 5) Egsminde. 6) Lundgård. 7) Trindbjerg.

horizontal layers. Finally a few square metres through the shell-mound were taken back to the laboratory as large column samples for later excavation and laboratory analysis by various specialists in Aarhus. All excavation was performed with extreme care and all the debris was sieved through a 2–3 mm mesh. Both wet and dry sieving were used, and flotation was used to retrieve charred materials from around the fireplaces for analysis. Samples for dating, scientific analysis, etc. were taken at several different locations, and in all excavated areas sections were measured and drawn.

As was the case with other Danish *køkkenmødding* excavations, the new investigations were performed by a group of archaeologists and scientists, *i.e.* a quaternary geologist, a botanist, palynologists, zoologists, icthyologists, and a specialist in marine molluscs and foraminifera. The present paper is a preliminary account of the results of this joint project.

### *The Bjørnsholm køkkenmødding*

The *køkkenmødding* is situated on a headland facing south along the northern shore of a former fiord, which opens up into the modern Limfjord (figs. 1–2). Today the site lies between the contours for 5–6.5 m above present sea level, thus giving an impression of the geological uplift in this region since the Atlantic – Subboreal periods (K. S. Petersen 1985b:19). In the Stone Age the fiord was c. 8.5 km long, between c. 0.7 and 2.5 km wide and oriented NE–SW (fig. 1).

The shell-mound has the shape of a narrow rectangle c. 325 m long (NE–SW), c. 10–50 m wide (E–W), and up to 1.2 m thick. The greatest dimensions are at the southern end, where the various excavations have taken place (the protected area). From here, the mound gradually becomes thinner and narrower towards the north. The actual settlement area (as defined by flint scatter on the modern surface) is, however, much larger – c. 4–500 m long and c. 30–50 m wide, and it continues to the northeast in form of the Åle *køkkenmødding* which is c. 150 m long and c. 25 m wide (fig. 3). The Bjørnsholm complex (the Bjørnsholm and Åle *køkkenmøddinger*) is, therefore, the largest preserved shell-mound area in Denmark today.

The Bjørnsholm *køkkenmødding* is one of the *stratified* shell-mounds which are characterized by a series of lower, Mesolithic levels, belonging to the Ertebølle Culture, capped by Neolithic levels from the Funnel Beaker Culture. In this respect it is of the same type as Krabbesholm on the Limfjord (unpublished, but mentioned in S. H. Andersen 1991:25 and fig. 12), Norsminde in East Jutland (S. H. Andersen 1991), and Sølager on Zealand (Skaarup 1973:61–67).

Such sites are of special importance for the study of the Mesolithic-Neolithic transition – not only in Denmark, but in the whole South Scandinavian area. Because they are characterized by thick, stratified formations of shells with a rapid accumulation rate, they allow more detailed analyses of stratigraphy and chronology than other contemporaneous settlements. It is therefore possible, within the same controllable environment, to describe and "measure" the different types of changes from a hunting/gathering to a farming economy. The rapid accumulation rate also "seals" surfaces representing very short occupational phases. Activities which on other settlement sites are "blurred" by secondary habitation-phases, are preserved in the shell layers of the *køkkenmøddinger*, thereby offering the possibility of intra-site analysis such as refitting.

### *The Ertebølle settlement system in the Bjørnsholm area*

The investigations have not concentrated on the Bjørnsholm *køkkenmødding* exclusively. On the contrary, the site has been studied *both* in its prehistoric, environmental context and as part of a larger Late Mesolithic/Early Neolithic settlement complex incorporating the fiord and the surrounding area (figs. 1–2).

Parallel with the new excavations, a large-scale survey of the whole coastal region of the northwestern part of Himmerland was initiated in order to obtain information about the Late Mesolithic and Early Neolithic settlements and settlement pattern. This survey has now been going on for several years and it is planned to continue for some years yet.

Today about 30 Late Mesolithic/Early Neolithic coastal sites have been registered along the shorelines of the former Bjørnsholm Fiord and the nearest surroundings. Of these, only 7 sites are *køkkenmøddinger* (fig. 1). The settlements are distributed all along the coastline, most sites being found in the fiord and along the north coast on promontories facing south and at river outlets.

Based on their topographical location several different types of coastal sites could be distinguished: 1) Settlements on beach ridges facing an exposed coast; 2) settlements on capes facing south – near the opening of the fiord; 3) as type 2 settlements, but in the central area of the fiord; 4) settlements at river outlets; 5) settlements on islands – either in the fiord or in more open waters. The largest site in this area is the Bjørnsholm *køkkenmødding* (fig. 1).

The fact that several of the *køkkenmøddinger*, including the largest of them, are located close to the mouth of the fiord is not accidental. It most probably reflects the position of the largest and richest natural shell-banks which were dependent on fresh, nutrient-rich water. As several of these sites show clear evidence of secondary marine erosion it is to be assumed that the number and size of the coastal sites (including *køkkenmøddinger*) and their size could originally have been greater.

A number of these settlements have been investigated, for example the three shell-mounds at Åle, Siggård, and Lundgård, and the Trindbjerg site (fig. 1). At three of these settlements stratigraphic sequences from the Late Mesolithic to the Early Neolithic were recorded, *e.g.* Bjørnsholm, Åle, and Lundgård – all of which are located close to the mouth of the fiord. All of the shell-mounds have been radiocarbon dated:

At Bjørnsholm the Ertebølle layers have been dated to 5050–4050 B.C. (K-5304, K-5068) – while the Early Neolithic phase is dated to 3960–3530 B.C. (K-5516, K-5721).

The Lundgård *køkkenmødding* has been dated to 4500 B. C. (K-5522).

The Åle *køkkenmødding* is dated to 4650–4580 B.C. (lower Mesolithic level) and 4230–4170 B.C. (upper Mesolithic level) (K-5061 and K-5060); the Early Neolithic level at this site has been dated to 3990 B.C. (K-5303).

The Siggård *køkkenmødding* is dated to 4890–4850 B.C. (lower Mesolithic level) and 4340 B.C. (upper Mesolithic level) (K-5521 and K-5520).

The large number of finds from the latter three sites have not yet been analyzed, but it is obvious that all the sites are smaller than Bjørnsholm and that they clearly reflect variations in both size and artefact composition.

Long-distance contacts between this area and the Continent are indicated by new discoveries: An Early Neolithic grave at Bjørnsholm containing, *i.a.* a stone axe-blade imitating a Central European copper axe (S. H. Andersen & E. Johansen 1992:46) and a new find of a typical Danubian shaft-hole axe at the Åle shell-mound is the first of this type from Northern Jutland (*cf.* Fischer 1982:10 and fig. 3). These finds clearly underline the importance of the settlements in this region compared to other Ertebølle – Early Neolithic settlements in Northern Jutland.

*Environmental analysis: Geology*

The geology of this area has been described by H. Gry and K. Strand Petersen (Gry 1979; K. S. Petersen 1976, 1985a and b, 1986 and 1987).

The subsoil consists of chalk which is covered by morainic clay (especially towards the north), while smaller, local areas particularly to the south are characterized by glacial meltwater sand and gravel (S. H. Andersen & E. Johansen 1992, fig. 2). The topsoil closest to the Bjørnsholm site is sandy humus (leached morainic clay). To the east the meltwater deposits also dominate around the fiord. It is probable that the fiord was originally a large freshwater lake (in the Late Glacial and Early Postglacial periods). Later – in the Early Atlantic c. 6800–5500 B.C. – the sea inundated the area and transformed it into a part of the Limfjord, the Bjørnsholm Fiord. From the Limfjord to the north there was access through the Hanherred out into the Skagerak and the North Sea. The region has risen at least 6 m since the Stone Age (Mertz 1924; K. S. Petersen 1979). Today the fiord is a relatively dry meadow, c. 3 m above modern sea level, filled by thick marine deposits, which to the east are covered by younger freshwater levels. The marine deposits contain shells of oyster *(Ostrea edulis)*, cockle (*Cardium* or *Cerastoderma edulis)*, mussel *(Mytilus edulis)*, and periwinkle *(Littorina littorea)*, even in the narrow easternmost parts of the fiord. At two locations, natural shell-banks have been found and radiocarbon dated (fig. 1). 1.25 km east of the Bjørnsholm *køkkenmødding,* a natural shell-bank has been investigated by K. Strand Petersen and dated to 2920 B.C. (K-5863), and on the seaward side of the Åle *køkkenmødding,* a shell-bank has given a date of 3250–3100 B.C. (K-5354). Food may very well have been collected on these banks in the Stone Age. Both in the Atlantic and Subboreal periods water in the fiord had a salinity and nutrient content such that oysters could live relatively far into it.

The entrance of the fiord and the whole beach region towards the Bjørnsholm Bay is characterized by a c. 0.5–2.5 km wide system of beach ridges running from Trend in the south to Rønbjerg in the north (figs. 1–2). Finds of *in situ* settlement sites from the Ertebølle Culture in these beach ridges indicate that they formed during the Atlantic period.

Towards the north, the area has a "natural" topographical limit at the narrow passage of the Limfjord at Aggersund situated 11–14 km away. Towards the south, at a distance of c. 4 km, the Trend river valley (also a fossilized Stone Age fiord) forms a natural topographical border (fig. 2).

Towards the west lie the waters of Bjørnsholm Bay and Løgstør Bredning, which together form the largest area of open sea in the Limfjord, with water depths ranging from 7 to 10 m. Here lies the island of Livø (7 km) with the reef Livø Tap (5 km), and further to the W-SW is the larger island of Fur (11 km).

In an easterly direction, the catchment area is naturally delimited by a hilly area c. 10 km away (fig. 1).

The *køkkenmødding* is located only c. 600 m from the entrance of the fiord and c. 300 m from the open sea (as the crow flies). The distance from Bjørnsholm across the fiord to the opposite shore is c. 1.25 km (fig. 1).

The shell-mound stretches NE–SW along the edge of a flat morainic hill which slopes gently downwards to the fossil fiord, and ends in a low slope – the prehistoric coastline, which lies between 4.00–5.50 m above sea level.

The *køkkenmødding* lies just above and follows this shallow cliff; its deepest part is between 4.80–6.50 m.a.s.l., while the surface is 5.40–6.60 m.a.s.l.

The area adjacent to the midden is a level plateau (7 m.a.s.l.) which gradually rises towards the N–NE (15 m.a.s.l.). It is first c. 2 km further to the north that the terrain becomes more hilly and reaches heights of c. 30–50 m. East of the fiord the surrounding areas are also level and flat; the surface rises very slowly to c. 10 m and it is first 5 km to the SE that the terrain becomes more hilly and reaches altitudes of c. 40–50 m. The transition from raised marine floor to dry land is gradual everywhere, but at some places marine erosion has formed steeper cliffs.

In the immediate neighbourhood of the *køkkenmødding* there are no river outlets today; the nearest is c. 2.5 km to the northeast (Ranum Bæk). Further to the east there are several larger rivers, Kilde Å, Faldbæk, and Herreds Bæk, of which Faldbæk (6 km to the east) and Herreds Bæk (9 km to the east), have connections to freshwater lakes (4–5 km SSE). However, this part of Himmerland is very poor in freshwater lakes, and they are all very small. Within a c. 10 km radius there is only one lake area (to the SE) (figs. 1–2).

There was ready access to good quality flint; in the immediate vicinity of Bjørnsholm, chalk bedrock with large nodules of flint is frequently found at the surface.

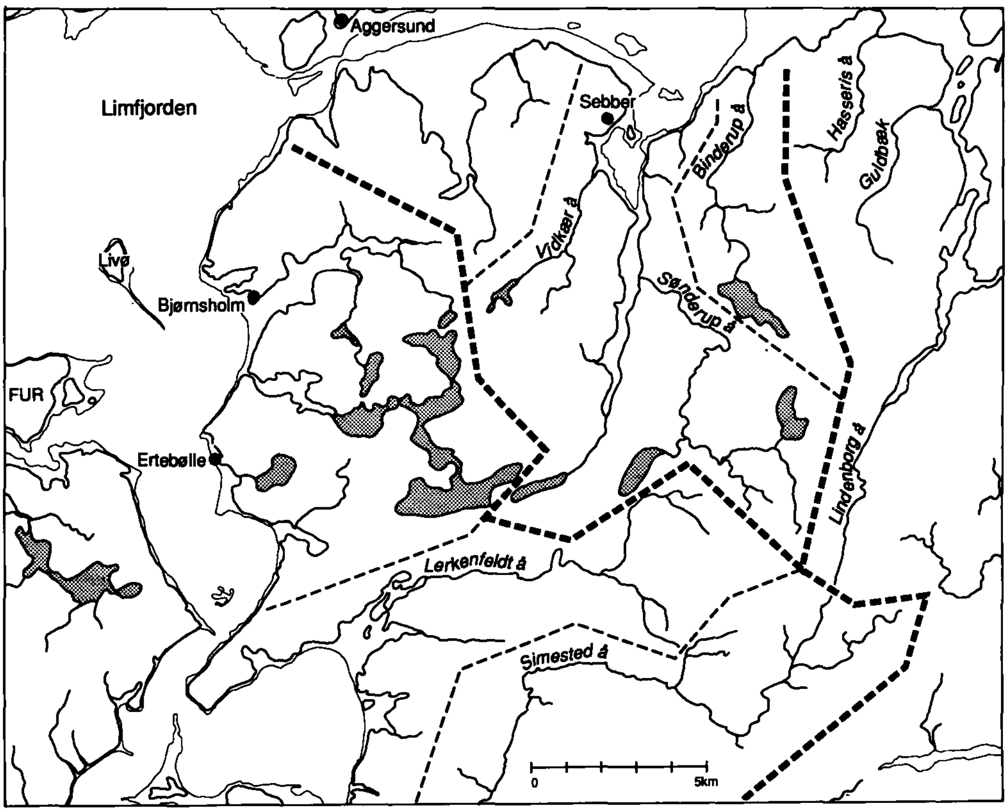



Fig. 2. The Bjørnsholm and Ertebølle *køkkenmøddinger* in relation to the freshwater drainage system in the northwestern part of Himmerland. Modern and Mesolithic coastlines are marked by a thin and a broad line, respectively. The larger water sheds are marked by a dotted line. – Elsebeth Morville *del.*

*The environment during the Late Mesolithic*

During the Atlantic period, c. 50% of the area within a 5 km radius of the Bjørnsholm site was open sea, c. 9% fiord and c. 40% was dry land (S. H. Andersen & E. Johansen 1992, fig. 1).

The coastline was relatively even; only in the central area were there larger bays. Nothing indicates the presence of islands, but maybe the shallow bank "Holmen" in the centre of the fiord was originally an island; which later was eroded. This was also the case at Ertebølle, where a similar topographic situation has been recorded (S. H. Andersen & E. Johansen 1987:33).

In the Stone Age the opening of the fiord was c. 1 km wide, but already in the Atlantic period it gradually became closed off by a large system of N–S running beach ridges (Gry 1979). It is clear that this gradual closing off of the fiord must have had effects on the local environment, but at present it is not possible to give a closer description of these conditions.

Erosion by the Littorina Sea is evident at several positions along the prehistoric beaches, but the cliffs are generally low compared to the more exposed coastal areas in the central Limfjord. The fact that some beach ridges are also found far into the fiord, especially where the coasts have been exposed towards the longest free distance (towards SW and W), is a good illustration of how strong wave action and currents were in this fiord, which was most probably also strongly affected by tidal action. It is not possible to determine the prehistoric water depth. As the whole region has risen c. 6–7 m since the Stone Age it is reasonable to assume a depth equal to, or exceeding this.

The many river outlets in the eastern part of the fiord open up the possibility for seasonal movement of ana- and catadromous fishes. The fact that all these rivers had their outlets in the fiord must have caused a mixing of the sea water with, and dilution by, freshwater from land drainage. This must have influenced the environment, such that sea-water was more brackish to the east. This hy-

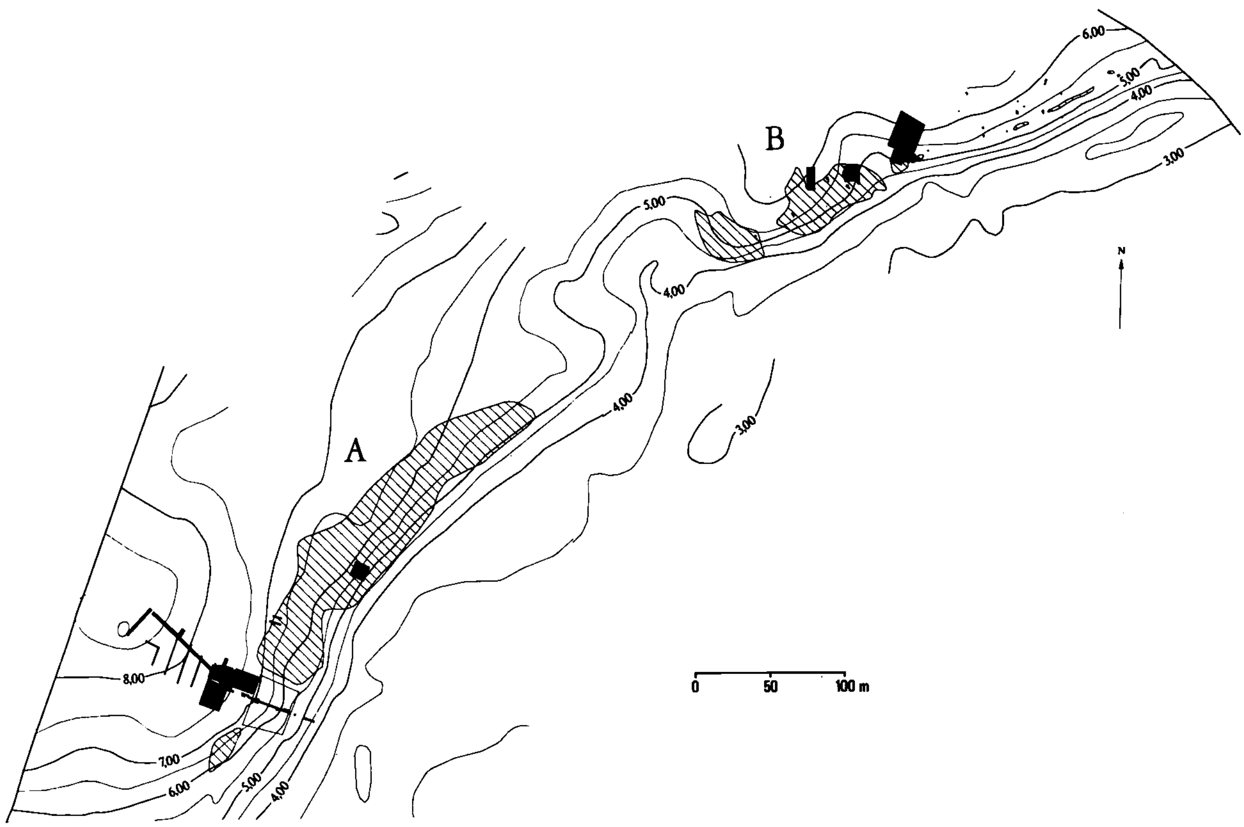



Fig. 3. Contour map showing the Bjørnsholm (A) and Åle (B) *køkkenmøddinger* situated along the prehistoric coastline. Areas on dry land with worked flints are shaded. Excavated areas are shown in black. – Jan S. Carlsen *del.*

pothesis is supported by investigations of oyster shells from the *køkkenmøddinger* at Bjørnsholm and Siggård. The oyster shells from the Siggård site, which is located c. 2.5 km further into the fiord, are both substantially smaller and thinner than the contemporary oyster shells from Bjørnsholm – an indication of less favourable living conditions for this species at Siggård.[4]

The Bjørnsholm fiord was an estuary during the Atlantic period. Estuaries are regarded as being the coastal habitat type having the highest biomass production (Paludan-Müller 1979:124). This probably explains why there were so many settlements in these areas in the Atlantic and Early Subboreal periods, and why the settlements were so large. We may thus assume that the Bjørnsholm fiord in the Stone Age was an estuary with a high biological productivity. The numerous layers and banks with marine shells – even at the far eastern end of the fiord – demonstrate that there was an ample exchange of fresh sea-water with the open Limfjord.

The coastal climate in the Atlantic period is generally described as moist and temperate with a mean summer temperature of 20°C and a mean winter temperature of 1°C, which is higher than today (Iversen 1967:407). The higher temperature and the greater salinity of the sea-water due to stronger tides, created very favourable living conditions for components in the marine food chain. The local wind conditions have also played a role in determining the local habitat. The area around Bjørnsholm is exposed to the Limfjord and the North Sea to the west and north, and this area must have been much more exposed to storm and wind than for example the east coast of Jutland.

As for vegetation, pollen analysis has not yet been completed. However, the analysis of charcoal from the Mesolithic *køkkenmødding* suggests a landscape covered by oak *(Quercus)*, hazel *(Corylus)*, apple family (apple, rowan, thorn) *(Pomoidea)*, willow *(Salix)* , elm *(Ulmus)*, and birch *(Betula)*, with oak as the absolutely dominant species (c. 70%).[5] This vegetation reflects an environment and climate which may have been similar to the modern assemblage seen today around this part of the Limfjord.

Animal life is also well represented, as documented by the list of fish species from the 1931 excavation (Rosenlund 1976:29)[6] and by the new lists of species by B. Bratlund (1993, this volume) and I. B. Enghoff (1993, this volume).

The position of the Bjørnsholm site was ideal. Within a 10 km radius of the settlement several different resource types were present: Open coast, islands, beach ridges, narrow straits, freshwater, river outlets and dense forest.

*Investigations behind the køkkenmødding*

Due to the large numbers of artefacts recovered, earlier Danish *køkkenmødding* excavations have concentrated exclusively on the shell deposits themselves, while the surrounding areas were not investigated. It has not, therefore, been possible to determine whether a shell-mound was to be regarded as the actual settlement site or whether it was simply part of a settlement, being the waste area or "midden".

In order to shed light on this question, it was decided that the area behind the Bjørnsholm *køkkenmødding* should be investigated. This area was chosen because the flat plateau just behind the shell-mound seems well suited for habitation (fig. 1), and because surface reconnaissance revealed Mesolithic flint on the surface up to c. 15 m behind the shell-mound. The latter indicates that activities *had* taken place, although the frequency of finds was not very high.

After scraping away the plough soil from an area of c. 800 m$^2$ it was clear that a primary cultural layer was present in the area immediately to the rear of the central and thickest part of the shell-mound (the protected area). It was possible to follow this layer continuously from the edge of the shell-mound up to c. 10 m west of the mound and over a distance of 20 m N–S. Outside this area two smaller clusters with flint and potsherds of Early Neolithic origin were recorded (S. H. Andersen & E. Johansen 1992:55, fig. 17). The layer was c. 20 cm thick and consisted of black sandy earth with charcoal, shells lying scattered and in heaps, some fire-cracked stones, many flint tools and flint debris, pottery, and a few animal bones. It was evident that this thick cultural layer represented several occupations, but it was not possible during excavation to distinguish any separate units. However, the vertical distribution of typical artefacts clearly demonstrated that the lower part of the layer was dominated by Ertebølle artefacts, while the upper level was characterized by Early Neolithic material. In the topmost level of

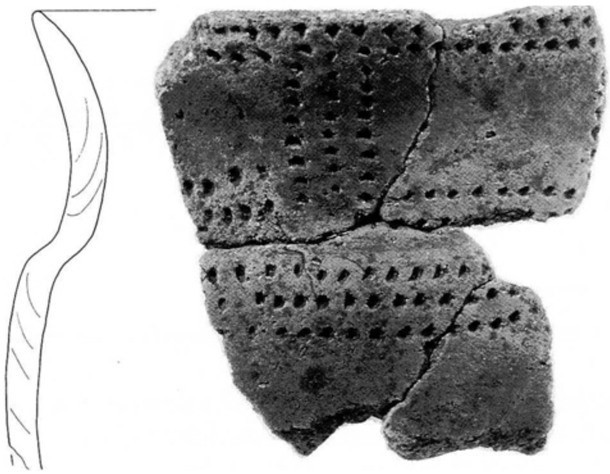


Fig. 4. Fragment of an Early Neolithic funnel beaker from the cultural layer to the rear of the *køkkenmødding*. 1:2. – Photo P. Dehlholm.

this layer, some scattered finds from the early Middle Neolithic Funnel Beaker Culture also appeared. After removing this cultural level, several postholes and some small pits were observed in the subsoil, but unfortunately they formed no recognizable pattern.

In terms of the horizontal distribution, the finds reflect diffuse flint concentrations measuring 3–4 by 3–4 m. At present this material has not yet been sufficiently analyzed as to reveal the true nature of these clusters. However, it is reasonable to assume that this cultural layer represents occupation of the site – first by people of the Ertebølle and later by people of the Funnel Beaker Culture.

Among the many potsherds found in the Early Neolithic level in this area was a fragment of a funnel beaker decorated with series of dots forming a chequered pattern (fig. 4). A small funnel beaker with a similar type of decoration is known from the Early Neolithic level in the nearby shell-mound (fig. 30). Such ornamentation is very rarely found on Early Neolithic funnel beaker vessels in Denmark; a related sherd is known from the Early Neolithic site Siggeneben Süd in Holstein (Meurers-Balke 1983, taf. 23 no. 8).

As regards the Ertebølle occupation, it is very difficult to ascertain the nature of this cultural layer. Both its vertical and horizontal extent (and its thickness) seem very restricted. This is contrary to what one would expect, when taking the size and thickness of the midden layers into account. A similar situation was observed at Ertebølle. The excavation behind the Ertebølle *køkkenmødding*

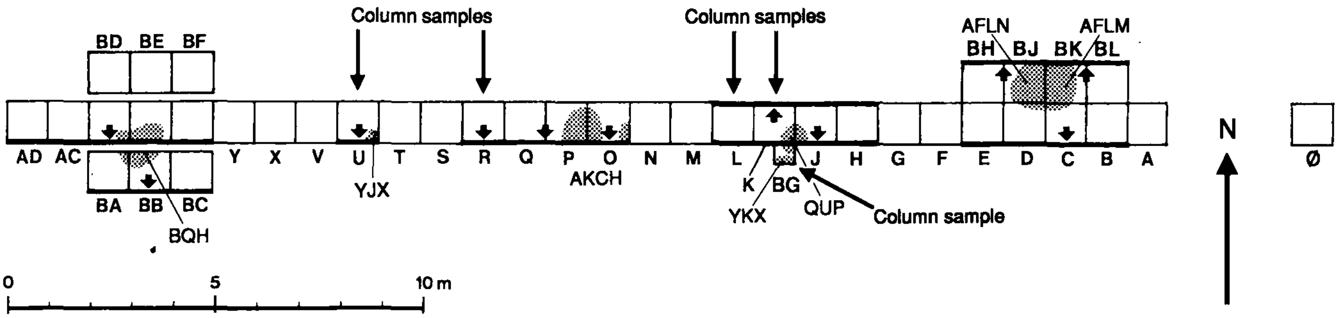



Fig. 5. The excavated trench through the *køkkenmødding*. Hearths in the Mesolithic shell layer are marked by shading. – Sv. Kaae *del.*

revealed only few sporadic traces of habitation, one of which was a flint knapping area measuring 15 by 6 m (S. H. Andersen & E. Johansen 1987:35–40).

Marine erosion could be an explanation for the lack of substantial settlement structures from the *Ertebølle period* to the rear of the midden, these having been washed away during the Late Atlantic transgression. Such heavy erosion *is* possible but does not fit observations made at the shell-mound, which has an undulating surface and is not covered by any marine sediments, despite the fact that it was situated 1–2 m lower than the plateau behind it.

It is more likely that traces of structures are absent, either because no large scale activity took place there, or because activities were simply of a type which were not preserved in the archaeological record.

As regards the *Early Neolithic* habitation, the pattern of finds at the Bjørnsholm site indicates a settlement area with an associated *køkkenmødding* situated c. 20–40 m away at the seashore.

At the Norsminde shell-mound, where no marine erosion has taken place, the same observations were made: No traces of Ertebølle occupation outside the area of the shell-mound were documented. On this site – just like at Bjørnsholm – an Early Neolithic habitation area was discovered on higher, drier ground c. 50 m from the midden on the beach (S. H. Andersen 1991:17).

Fig. 6. Section SPH through the *køkkenmødding*. South section of square K. Compare with the section on fig. 9. – Photo E. Johansen.

### *Stratigraphy of the køkkenmødding*

The base and surface of the midden is plane and slightly curved and follows the sloping subsoil towards the east. The delineation of the *køkkenmødding* is well defined in all directions – especially to the east, where it is abrupt and bears clear evidence of secondary marine erosion.

In the excavated section, the maximum thickness of the *in situ køkkenmødding* is c. 1.2 m, and the cross-section (E–W) is lenticular/semi-circular (fig. 7). The greatest thickness is in the centre and the eastern end of the trench (down towards the prehistoric beach). To the west the midden gradually fades out, and over large areas it is only 10–20 cm thick; the shell layer finally disappears 5–6 m west of the protected area (fig. 7).

The subsoil (layer 6) consists of chalk with a covering layer of 1–3 m of chalky morainic clay – of which the top level (0.5 m) is more sandy because of secondary outwash of the clay particles. The western part of the *køkkenmødding* is deposited upon this sandy morainic clay, while the central and eastern part rests upon marine sand and

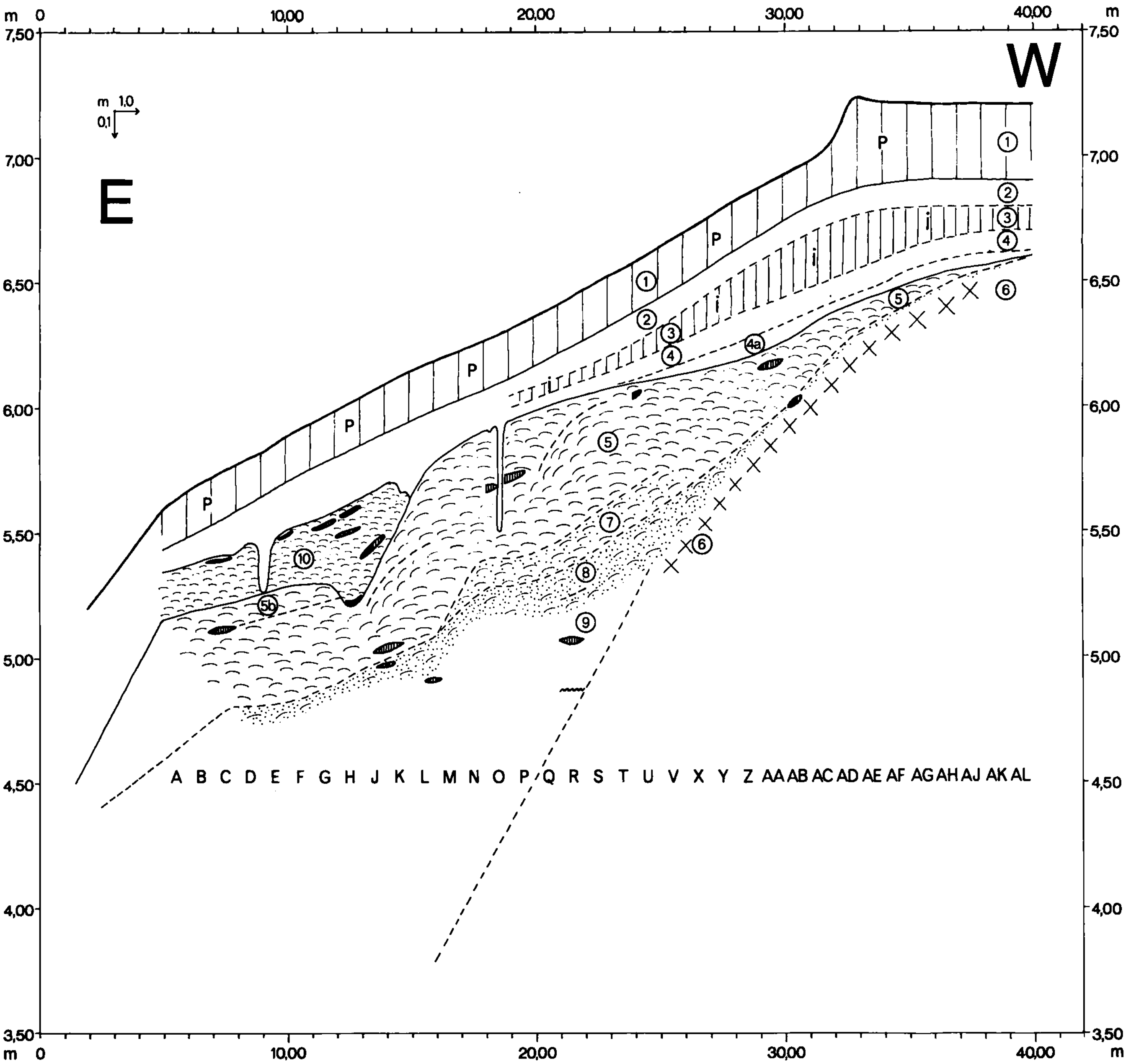



Fig. 7. Section (E–W) of the Bjørnsholm *køkkenmødding*. – 1) Modern plough soil. 2) Brown earth. 3) Iron Age cultural layer. 4) Brown, sterile sand. 4a) Black sand with gravel, flints, and pottery. 5) Mesolithic/Ertebølle *køkkenmødding*. 5b) Ertebølle shell-mound with sand and crushed shells. 6) Subsoil, morainic, sandy clay. 7) *Køkkenmødding* with many marine molluscs. 8) Black sand with cultural remains, i.e. flints and bone. 9) Marine sand with marine molluscs and water-rolled flints and bone. 10) Neolithic *køkkenmødding*. Metres are given above modern sea level; hearths are shaded. Elsebeth Morville *del.*

gravel (layer 9), formed after an erosion of the morainic deposits. In square U it is possible to follow this marine sand up to a level of c. 5.4 m above present sea level, where a small slope is to be found. Compared with other observations from the Limfjord area, for example at Ertebølle, it is most likely that this erosion took place during the Early Atlantic or at an early stage of the High Atlantic transgression (S. H. Andersen & E. Johansen 1987:41–

42). The same sea level has also been documented at another, more northernly position in the Bjørnsholm midden, and at the Lundgård site on the opposite shore of the fiord (fig. 1).

A radiocarbon date for shells from the highest level of the marine sand was 5050–5000 B.C. (K-5304) probably a *post quem* for the final stage of this sea level. Intermixed in this marine sand layer are several 2–5 cm thick horizontal layers of more coarse grained sand, gravel and small stones, water-rolled and patinated flint debitage and flint tools, a few animal bones, shells, and fragments of marine molluscs – predominantly oysters, cockles, and mussels. One of these levels is a c. 10 cm thick layer characterized by many shells and shell fragments of marine molluscs – most probably a redeposited shell-mound; this layer (layer 8) has been radiocarbon dated to 4770–4730 B.C. (K-5071). Collectively, this material demonstrates that these layers are either part of an older *køkkenmødding* redeposited by the sea or "waste" from a nearby site.

In squares L and R two small hearths built of stones were encountered in the sand – indicating that the layer was periodically dry enough for habitation. Artefacts from the marine sediments which belong to the Early Ertebølle Culture, are in accordance with the radiocarbon dates which demonstrate that the deposition took place during the High Atlantic transgression.

After this time the sea gradually receded to a level of c. 4.3 m.a.s.l., which is the basal level of the lowest part of the shell-midden. During this process more sand was deposited (layer 7) – black sand with a high content of charcoal powder and mixed with scattered shell fragments, flint debris and tools and fire-cracked stones. This level (10–20 cm thick) is only found in the central area of excavation and measures c. 9 m (E–W). It is obviously a cultural layer – still very close to the sea-shore. The stratigraphic position clearly indicates that it represents the oldest *in situ* occupation level at Bjørnsholm; it is radiocarbon dated to 4670–4620 B.C. (K-5070).

Similar cultural layers below the shell-mounds have frequently been observed at other Ertebølle sites; they always represent the first habitations which are without shell deposits, *e.g.* the *køkkenmøddinger* at Ertebølle (S. H. Andersen & E. Johansen 1987: 41–42) and Norsminde (S. H. Andersen 1991:20).

In the central part of the section there then follows a c. 10 cm thick sand layer, which is a mixture of shells and fine sand with flint tools, flint debris, and animal bones. The content is clearly dominated by shells and fragments of shells and is very similar to a "normal" *køkkenmødding*. The presence of relatively large quantities of sand in this layer may either be explained by the fact that the sea was still very close to the settlement or it may be due to secondary wind and water transport of sand from higher ground to the west.

On top of this layer the accumulation of the *køkkenmødding* took place – both in an eastern and western direction (layer 5). The midden was deposited on dry land; no levels of marine sand and/or gravel and water-rolled shell material were observed in the shell-mound – as was the case at Ertebølle (S. H. Andersen & E. Johansen 1987: 41–42).

The shell-mound seems to have expanded from the central area (*i.e.* around square R), where the deepest level is dated to 4650–4580 B.C. (K-5069). In the squares AB (towards the west) and L (towards the east) the deepest levels of the *køkkenmødding* are younger, 4350 B.C. (K-4689) and 4340 B.C. (K-4945) respectively.

The *køkkenmødding* could be divided in two main sections, layer 5 constituting the lower, and layer 10 the upper shell-mound (fig. 7).

The lower *køkkenmødding* is found through the entire excavation area and has a thickness of c. 70 cm in the central area from where it becomes thinner towards the east and west. Based on topographic and stratigraphic criteria the shell-mound layer could be divided into at least three fairly well-defined areas centred around hearths.

The shell-mound consists of a mixture of shells and fragments of shells of marine molluscs, mainly large oysters *(Ostrea edulis)*, cockles *(Cerastoderma edulis)*, mussels *(Mytilus edulis)*, periwinkles *(Littorina littorea)*, and *Nassa reticulata*. The most frequent type of mollusc is the oyster (up to 60–80%). Marine shells are the dominant component of the shell-mound, which also contains sand, flint debris, flint tools, fire-cracked stones (cooking stones), animal bones – in particular fish bones, charcoal, some potsherds, and many natural stones of varying sizes. The flints are not water-rolled, having sharp edges and being unpatinated.

The large number of natural unworked stones (normally 3–8 cm in diameter) in the layers is difficult to interpret, but they may be sinkers for fishing nets or they may indirectly reflect activities such as the collecting of seaweed.

During the excavation it was observed that the oyster

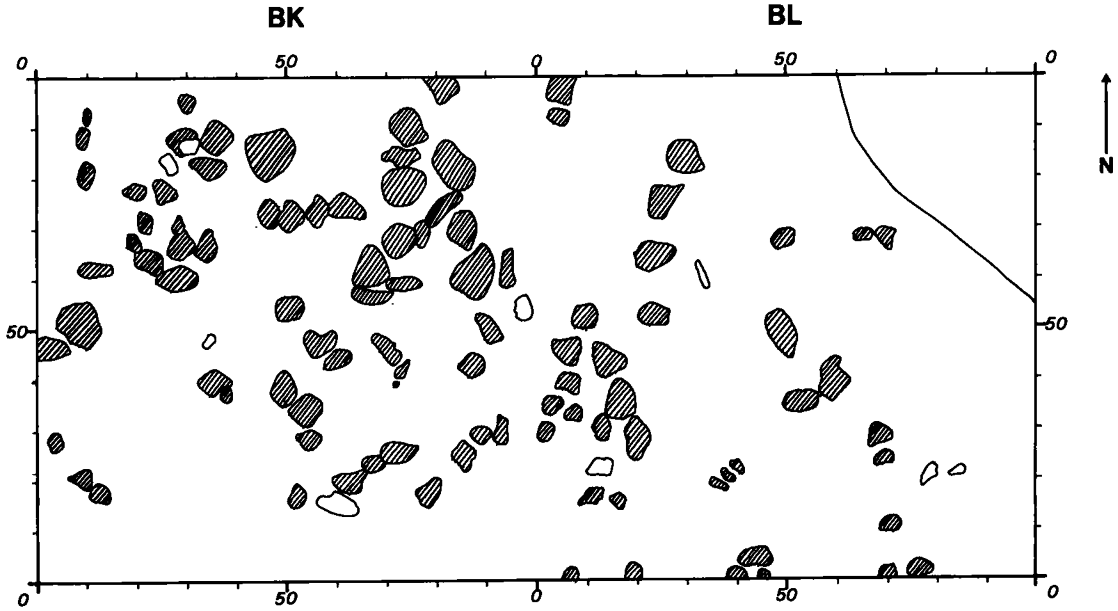



Fig. 8. "Dump" of cooking stones in the Early Neolithic level.

shells became smaller from bottom to top through the sequence in several squares (K and BH-BJ).

Hearths, layers of ash, and a few larger stones were also found.

In the eastern squares the shells of the uppermost 10–20 cm of the lower *køkkenmødding* are more crushed than those which lie below, and they are not so uniformly deposited in a horizontal manner (fig. 7, layer 5b, and fig. 10 left, layer 14, section AFZJ). In addition, the shells are mixed with more sand than in the lower levels of the shell-mound. This level could be an erosion level, or it may represent a surface of the shell layer which was exposed for a period.

The upper shell-mound is situated directly upon the lower levels in the central and eastern part of the section where there is a distinct boundary. This observation suggests that the layers must have been deposited at a steady, continuous rate. However, it is impossible to prove that there was no hiatus between the lower and upper shell layers. If such a hiatus existed, it must have been a very short break in deposition.

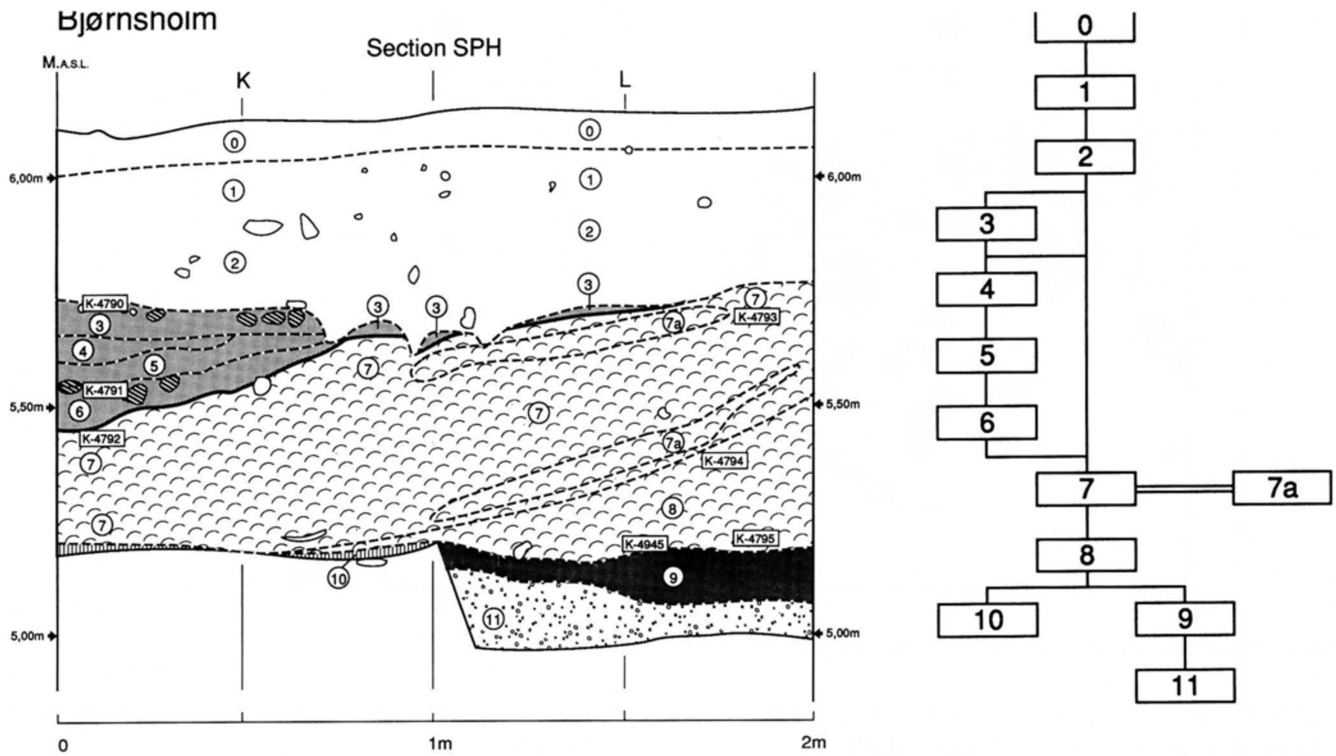
The upper shell-mound (fig. 7, layer 10) is only observed in the eastern and central part of the trench. Therefore, the width of this level is only measured as being 10–12 m in an E–W direction, the thickness being 20–40 cm. However, the layer extends horizontally over a long distance along the prehistoric coastline. Towards the NE, c. 100 m from the trench, an identical stratigraphy was recorded.

This younger shell-mound consists of a series of thin, alternating horizontal layers of black, sandy material, divided by layers of grey ash regularly intermixed with levels of shells, abundant shell fragments, charcoal, many burnt shells and fire-cracked stones (cooking stones). All these layers are only 1–5 cm in thickness. They contain some flint tools and debris (but less than in the lower layers), abundant fire-cracked flint, many potsherds, and some animal bones. The flints are not water-rolled and unpatinated. This layer of the shell-mound is also an undisturbed and *in situ* deposit.

The number of ash layers lies between 3 and 5, probably representing a similar number of occupational episodes. At Norsminde the number of ash layers was between 5 and 6 (S. H. Andersen 1991:23).

The cooking stones can be divided in three classes: Sandstone, quartzite, and granite. They clearly differ from the fire-cracked stones in the lower part of the shell-mound in being smaller and much more cracked. The cooking stones are very often found in heaps, usually measuring c. 1 m in diameter, and are most likely "dumps" from cooking activities (fig. 8).

In contrast to the lower shell-mound, the layers of the upper mound are generally dominated by shells of (small) cockles (*Cerastoderma edulis*), mussels (*Mytilus edulis*), and




| | Layer no. | Sample lab no. | C-14 age b.p. |
|---|---|---|---|
| EARLY NEOLITHIC | 3 | K-4790 | 5050±90 |
| | 5 | K-4791 | 5040±90 |
| LATE MESOLITHIC | 7 | K-4792 | 5410±90 |
| | | K-4793 | 5380±90 |
| | | K-4794 | 5560±90 |
| | | K-4795 | 5310±90 |
| | | K-4945 | 5440±90 |

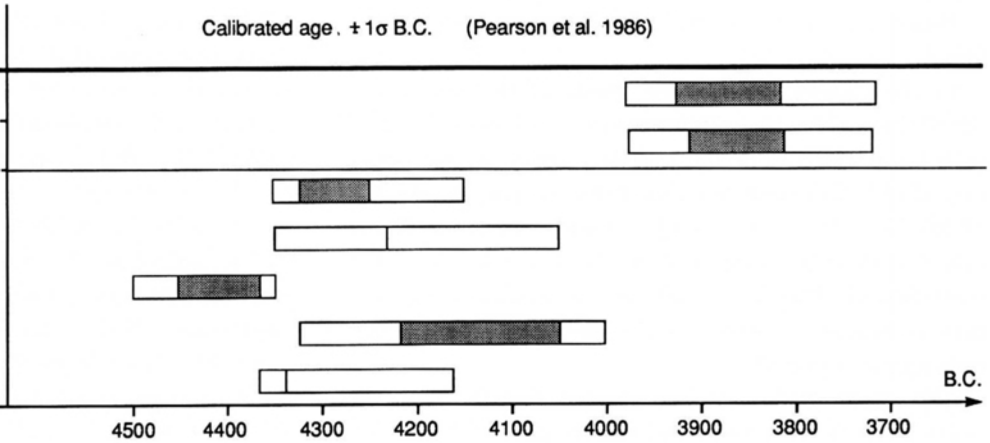



Fig. 9. Left: Section SPH; south section of squares K-L. Laboratory numbers of radiocarbon samples are marked. The Early Neolithic level is shaded. – Right: Harris matrix of the section. – Bottom: Radiocarbon dates of section SPH. All dates are for oyster shells. – Elsebeth Morville *del.*

periwinkles (*Littorina littorea*). Because many of the cockles are very small (obviously too small for eating), it is highly possible that some of the components in these levels could be natural deposits in the form of beach ridges of shells. However, the content of oysters is also very high, and in several squares the layers are dominated by this species, like in the lower shell-mound. The content of oyster shells in the upper part of the Bjørnsholm shell-mound is clearly higher than in the contemporaneous, Early Neolithic *køkkenmødding* at Norsminde (S. H. Andersen 1991:23, 28 and fig. 23), where the cockles show absolute dominance.

The top level of the shell-mound sequence is a 1–1.5 cm thick level of compressed oyster shells.

The oldest part of the Neolithic shell-mound seems to have been located towards the west from where it grew towards the east where it has been secondarily eroded by the sea.

Above the Neolithic shell-mound there follows to the west a c. 10 cm thick layer of black sand rich in charcoal with many small stones (gravel), flint tools, flint debris, and potsherds (layer 4a). This layer could be followed up to c. 6.6 m.a.s.l. and probably represents a marine transgression after the deposition of the upper shell-mound. A layer of this kind, situated at this level, may have been deposited due to the Subboreal transgression, an interpretation which is in accordance with observations at Ertebølle (S. H. Andersen & E. Johansen 1987:39,43), Aggersund (S. H. Andersen 1979a:8–9), and other locations in the Limfjord region (K. S. Petersen 1979). Above this layer lies a 10–30 cm level of brown, fine-grained sterile sand – most probably windblown sand and humus from the higher areas to the west (layer 4).

Above this sand layer there is a 10–20 cm thick cultural level of black, fine-grained sand with abundant pottery, charcoal, and occasional layers of yellow clay (layer 3). The finds and features associated with this layer indicate that it is a cultural level with house floors belonging to a village from the Late Pre-Roman Iron Age. The Iron Age level is stratigraphically separated from the lower *køkkenmødding* by the sand layers 4 and 4a. From this Iron Age level several postholes penetrate the lower sand and shell layers and continue down into the subsoil. These later intrusions in the shell-mound were easily recognizable during the excavation, and did not cause any problems.

The top layer (layer 2) is a brown, fine-grained sterile sand level with a high humus content, which gradually becomes thicker towards the west.

Layer 1 is the modern plough soil.

### *Interpretation of the stratigraphy*

The Bjørnsholm site is characterized by the following stratigraphy from bottom to top: The subsoil is a sandy morainic clay which has been eroded by the Early or High Atlantic transgression. During the regression, marine sand with redeposited cultural material belonging to the Early Ertebølle Culture was deposited. This sand forms the base under the central and eastern part of the midden. After the sea receded and the sand became a dry beach, intense activity took place, as indicated by a high concentration of charcoal, flints, bone, ash, and cooking stones. Shortly after, c. 4600–4500 B.C., the *køkkenmødding* started accumulating. About 4400–4200 B.C. the *køkkenmødding* increased rapidly both horizontally and vertically.

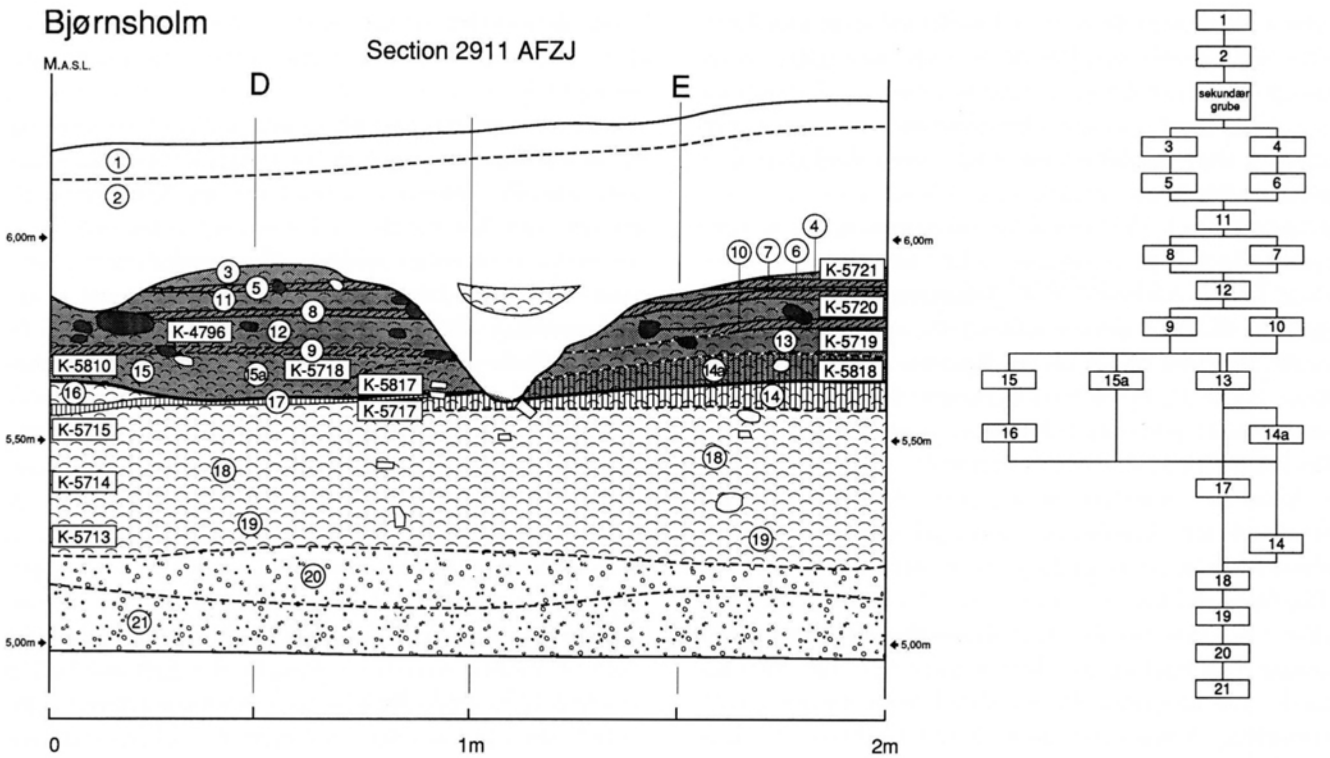
The *køkkenmødding* is made up of a lower series of shell layers, dominated by oysters, capped by an upper midden dominated by cockles, black sandy earth, and cooking stones. The lower shell-midden was deposited during the regression between the High and Late Atlantic transgressions, but we only find few traces of flooding of the lower midden. After the deposition of the upper shell layer the sea again flooded the site, thereby causing erosion on the plateau behind the midden. This resulted in the black sand and gravel layer covering the western part of the *køkkenmødding*. This transgression layer is followed by brown, sterile sand. Later, the sea withdrew and eroded the eastern edge of the midden. Finally the sea floor in front of the settlement gradually became transformed into a brackish bog. On dry land a cultural layer belonging to an Iron Age settlement was deposited, and finally, the site was buried under a thick deposit of sandy earth.

In an attempt to gain an impression of the stratigraphy and to locate a "waste" area in front of the site – something which is common at many Danish Mesolithic sites, both inland and coastal, *i.e.* Ringkloster, Tybrind Vig (S. H. Andersen 1975, 1985), etc. – a 19.4 m long (E–W) trench was excavated in the sediments in front of the site. However, all that was found were scattered animal bones and water-rolled and patinated flints of younger Ertebølle types, imbedded in marine sediments of sand and gravel. Above this there was freshwater peat with potsherds and the remains of a stone-built road dated by potsherds to the Early Iron Age.

The explanation for the lack of such a "waste" area at Bjørnsholm is most probably to be found in the topographic position of the site, which is very close to the opening of the fiord and in front of a long free stretch of open sea (towards the southwest). The site has therefore been exposed to wave action and sea currents etc., all of which would have washed away any waste dropped into the sea in front of the site.

The stratigraphy of the Bjørnsholm *køkkenmødding* is in most aspects similar to the sequence at Ertebølle, but we lack clear traces of The Late Atlantic transgression, and no marine layers were observed in the Bjørnsholm shell-mound such as was the case at Ertebølle. This is probably a reflection of the different topography at the two sites: The Ertebølle site was located on a lagoon facing a more exposed and open coast than that at Bjørnsholm, which lay in a more sheltered estuary/fiord.

Another difference is the Early Neolithic level present at Bjørnsholm but absent at Ertebølle, where only one – or maybe two – radiocarbon dates indicate an Early Neo-




| | Layer no. | Sample lab no. | C-14 age b.p. |
|---|---|---|---|
| EARLY NEOLITHIC | 4 | K-5721 | 4760 ± 90 |
| | 12 | K- 5720 | 4840 ± 95 |
| | | K-4796 | 4960 ± 90 |
| | 15a | K-5718 | 4860 ± 95 |
| | 15 | K-5810 | 5210 ± 95 |
| | 13 | K- 5817 | 5100 ± 95 |
| | | K-5719 | 5070 ± 95 |
| | 14a | K- 5818 | 5080 ± 95 |
| LATE MESOLITHIC | 14 | K- 5717 | 5360 ± 70 |
| | 18 | K- 5715 | 5360 ± 100 |
| | | K- 5714 | 5380 ± 70 |
| | 19 | K- 5713 | 5320 ± 75 |

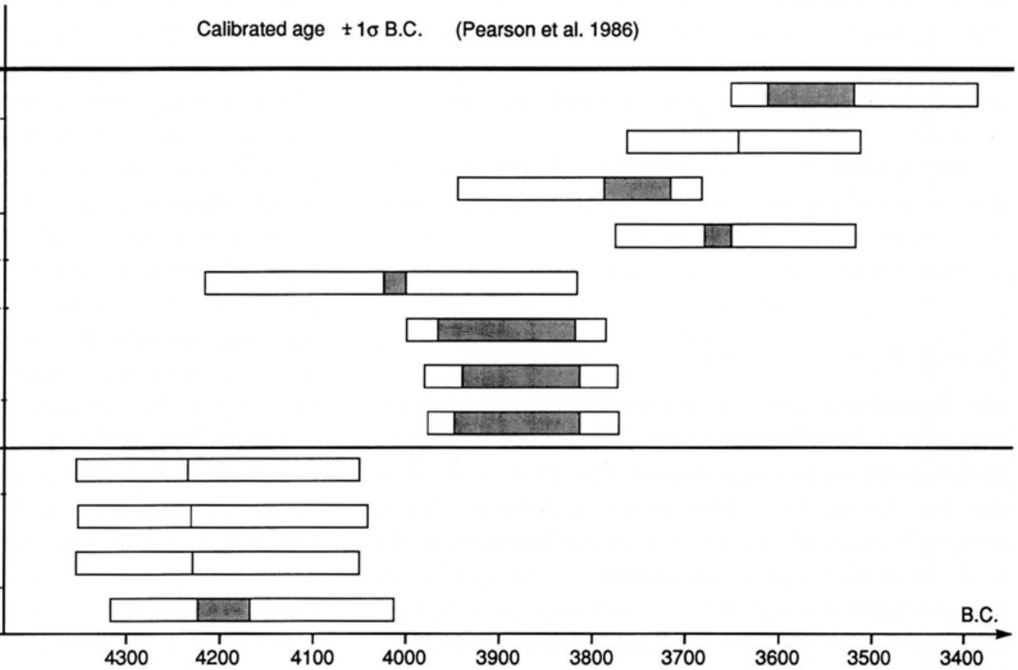



Fig. 10. Left: Section AFZJ. South section of squares D–E. Laboratory numbers of radiocarbon samples are marked. The Early Neolithic level is shaded. – Right: Harris matrix of the section. – Bottom: Radiocarbon dates of section AFZJ. All dates are for oyster shells. – Elsebeth Morville *del.*

lithic occupation (S. H. Andersen & E. Johansen 1987: 50–51). An explanation for the lack of a substantial Early Neolithic level at Ertebølle may be sought in the fact that this *køkkenmødding* was covered by one, or maybe two transgressions, which could easily have eroded such a sequence.

### *The composition of the shell-mound*

In the *køkkenmødding* the shell composition of the deposits varies. Oysters dominate in the lower midden (up to 80%), followed by cockles, mussels, and periwinkles. In some areas of the upper midden oysters dominate, in other squares it is cockles and mussels that are most common. Over smaller areas, any one of these species may dominate completely – most probably representing waste from individual meals made up of a single species (fig. 6).

The distribution of cultural remains also varies. Some levels are characterized by numerous artefacts. The areas around the hearths are normally richer in finds than the rest of the midden. The richest level is the "black cultural layer" below the midden.

The content of artefact material in the shell-heaps is very uniform throughout the midden, suggesting that activities continued unchanged throughout the long occupation period.

Using differences in the micro-stratigraphy, *i.e.* the composition of shells, colour, density, and degree of decomposition, it was possible to divide the lower midden into between 5 and 25 sub-units. The stratigraphic analysis, the number of shell levels and the radiocarbon dates all indicate that the occupations at Bjørnsholm were probably few, but extensive. This opinion is also supported by the fact that the shell formation is rather loose. The shells generally lie horizontally, however, at three positions the layers are "dome-shaped" or make up "heaps". Just west of – and bordering – the hearths in squares O–P is a clear "heap", which obviously is connected with the nearby fireplaces. Also in the squares K–L there is a "heap" sloping in a westerly direction; finally the layering in square G also indicates a "heap". Maybe this heap is also associated with the previously mentioned hearths in the squares O–P, so that these hearths have functioned as the focal points for domestic activities with shell-heaps accumulating all around them.

The surface of the lower *køkkenmødding* is generally very flat and even, but in squares G, H and J there is a c. 4 m broad depression, which marks a border between two large shell-heaps, to the east and west of the depression, respectively.

The stratigraphy and radiocarbon dates demonstrate that the Mesolithic part of the *køkkenmødding* seems to have started in the central squares P–T and from there expanded both horisontally and vertically. This expansion was very rapid – the main part of the shell-mound was deposited within 100–200 years. The most intense accumulation took place about 4300 B.C.

There is a noticeable difference in sediment types between the lower and upper levels. Apart from differences in the types of sediment, the nature of accumulation must also have changed. The collection and deposition of molluscs decreased in the upper *køkkenmødding*; the shell layers are much thinner, more compressed, and very confined. Despite the fact that there are many hearths in the upper shell-mound these hearths do not seem to have influenced the way the shell-mound accumulated, as was the case in the Mesolithic (see later). Generally the shell material in this part of the *køkkenmødding* is more crushed and compressed than in the lower shell-mound, probably because of more activities on the surface during accumulation.

There are other significant differences between the two main levels in the Bjørnsholm *køkkenmødding*. No concentrations of fish bones are observed around the hearths in the upper layers. This may be a question of preservation, but bad conditions should also have affected small bones of other species in these layers, which nevertheless turn out to be well-preserved. The lack of fish bones seems rather to be a reflection of differences in economic activities.

Also the quantity of flint tools and debitage is noticably less in the upper level, suggesting that flint knapping did not normally take place on the shell-mound, as was the case in the lower layers. The only really abundant artefact type in the upper level is pottery. No structural remains, *i.e.* pits, house floors, postholes or graves were found in this level.

### *The archaeological sequence*

An investigation of the vertical distribution of a series of characteristic artefacts, especially pottery, clearly indicates that the material of the lower midden belongs to the Ertebølle Culture (ETBK) (Early, Middle, and Late), and the upper part is associated with a very early stage of the Early Neolithic Funnel Beaker Culture (TRBK).

It is of special interest to define exactly the stratigraphic borderline between the Late Mesolithic and the earliest Neolithic. At other, contemporaneous and similarly stratified *køkkenmøddinger*, *e.g.* Norsminde, the transition was easily recognisable as a clear stratigraphical division between an oyster-dominated and a cockle-dominated part of the shell-mound (S. H. Andersen 1991: 20–23, 38 and fig. 23).

The transition from the Mesolithic to the Neolithic is most easily defined by plotting potsherds and other characteristic Ertebølle and Funnel Beaker types on the sections. In analogy with the similar stratigraphy at Norsminde, it was expected that the cultural transition at Bjørnsholm would also be congruent with the stratigraphic border between the oyster- and the cockle-dominated parts of the shell-mound. This *was* the case in some squares, but it was also evident, that in most squares Neolithic artefacts were found somewhat *deeper* than the change from the oyster-dominated to the cockle-dominated layers. This indicates that the typological transition took place *before* the change in deposition of molluscs. Thus, the change in artefact composition is not associated with a specific geological level, but is partially found in the previously mentioned layer of crushed shells in the upper part of the oyster-dominated shell-mound (layer 5b on fig. 7, and layer 14a on fig. 10). The earliest Neolithic artefacts occur below, and are older than, the cockle-dominated levels.

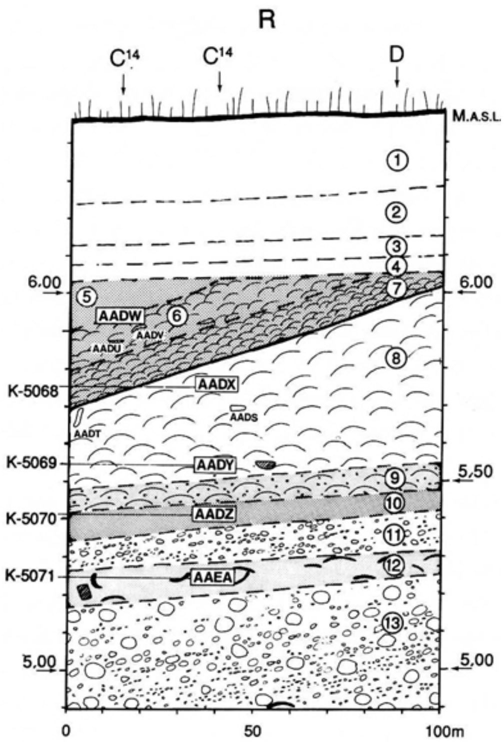
This sequence is firmly supported by the radiocarbon dates which show that the stratigraphically earliest Neolithic finds at Bjørnsholm are contemporaneous with the oldest Early Neolithic assemblages known from other sites in northern and eastern Jutland (and obviously older than the main part of the Early Neolithic assemblage at Norsminde). Compared with Norsminde, the stratigraphy at Bjørnsholm seems to be more complex.

It is also evident from the Bjørnsholm investigations – as was the case at Norsminde – that there is no "transitional" level, *i.e.* a layer with both ETBK and TRBK artefact types. On the contrary, at Bjørnsholm the two complexes are sharply divided.

## *Chronology*

Twenty-eight samples from the *køkkenmødding* have been radiocarbon dated (see K. L. Rasmussen, pp. 93–96). All dates are based on oyster shells, and the samples have mainly been taken in stratigraphic series through the midden deposits, *i.e.* in squares D–E, K–L, and R or as scattered samples (figs. 9–13).

In general, the radiocarbon dates support the stra-




| | Layer no. | Sample lab no. | C-14 age b.p. |
|---|---|---|---|
| LATE ERTEBØLLE | 8 | K-5068 | 5300 ± 90 |
| | | K-5069 | 5720 ± 95 |
| | 10 | K-5070 | 5770 ± 70 |
| EARLY ERTEBØLLE | 12 | K-5071 | 5840 ± 95 |

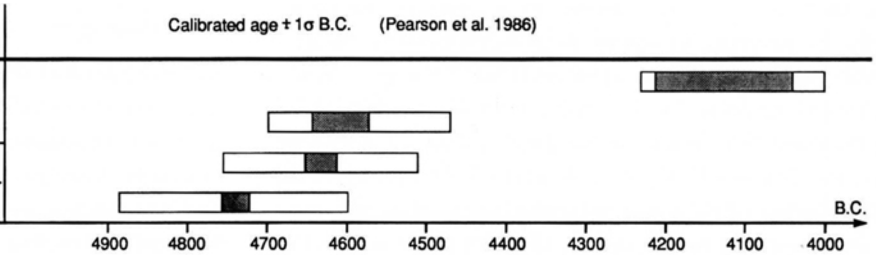



Fig. 11. Left: Section AADR; south wall of square R. Laboratory numbers of radiocarbon samples are marked. The Early Neolithic level is shaded. – Bottom: Radiocarbon dates of section AADR. All dates are for oyster shells. – Elsebeth Morville *del.*

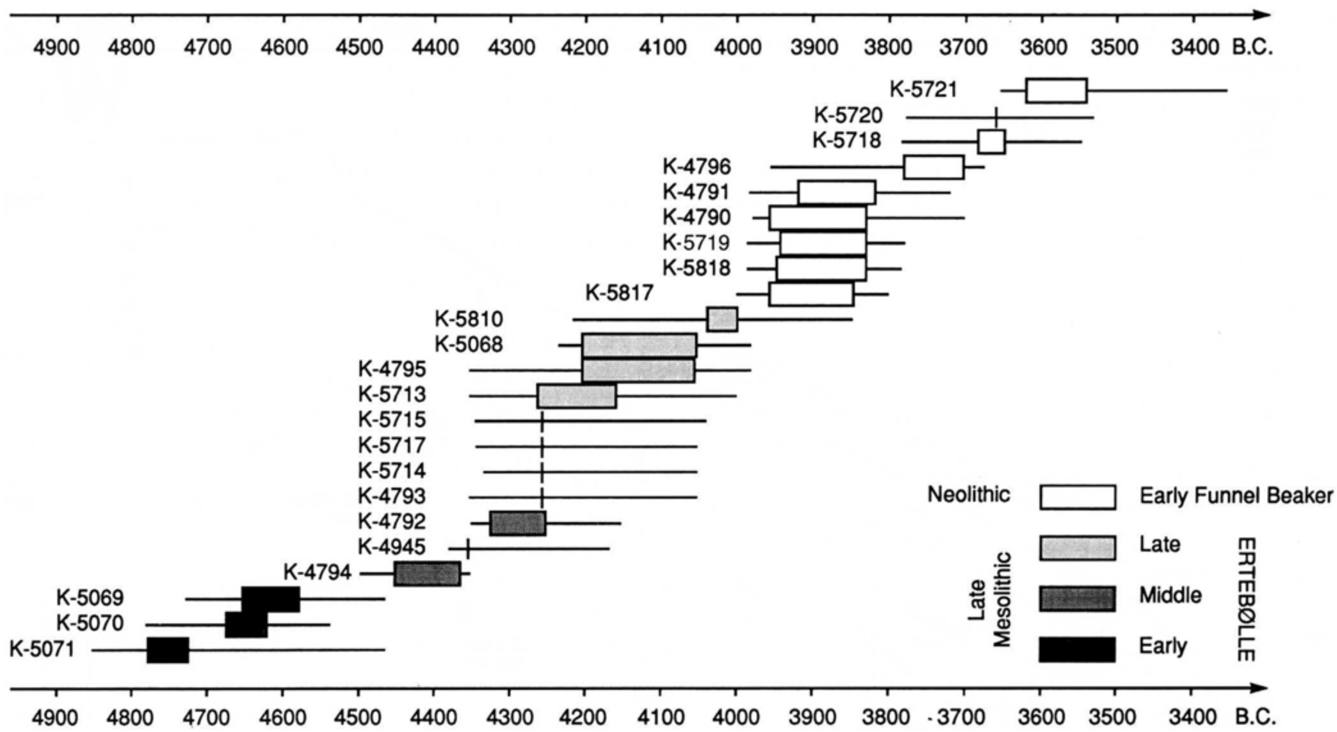



Fig. 12. All radiocarbon dates from the squares R, K–L and D–E given in calibrated ±1 standard deviation (Pearson *et al.* 1986).

tigraphical observations and reflect a gradual accumulation on the site from bottom to top. Only in two instances are the dates older than expected from the stratigraphy. They can best be explained as being due to disturbances or being the results of accumulation at high water level of older material in younger deposits.

The oldest dates are obtained from the marine sand under the midden: 5050–5000 B.C. (K-5304), and for the top level of this horizon 4770–4730 B.C. (K-5071).

The main part of the *køkkenmødding* belongs to the period 4400–4200 B.C. Within this timespan the dates indicate a rapid accumulation. At several sections through the *køkkenmødding* the layers seem to have been deposited contemporaneously from bottom to top., *e.g.* in square L (fig. 9).

In general the dates seem to become younger towards the east, following the sloping subsoil. The dates correspond well with those from the Ertebølle shell-mound, where the main part of the occupation also falls in the same period, *i.e.* 4400–4200 B.C. (S. H. Andersen & E. Johansen 1987:49–50) and the nearby Aggersund site (S. H. Andersen 1979a:42). All together these dates illustrate the richness of the marine biotope on the central Limfjord in the Atlantic period and the intense Mesolithic gathering activity on the shell-beds along the coasts.

At three positions (separated from each other) the toplayer of the Mesolithic section is dated to 4350–4240 B.C. (K-4688, K-5717) – indicating that the top level is contemporaneous over large parts of the section. The youngest Ertebølle level is found at two positions in the trench, in squares D and R, and is dated to 4240 B.C. (K-5717) and 4220–4050 (K-5068). These dates are the youngest from the section, however, they do not necessarily reflect the total duration of the Mesolithic occupation at the site.

All dates from the Early Neolithic level are very consistent and fall within a short timespan: 3960–3830 B.C. (K-5817) – 3620–3530 B.C. (K-5721), thereby placing it in the very earliest Neolithic and indicating that this level is a very short and intense depositional phase, although the layer is only 20–30 cm thick.

The stratigraphy may be interpreted as evidence of a continuous occupation of the Bjørnsholm site from the Late Mesolithic to the earliest Neolithic. However, when we look at the diagram (fig. 12), the dates seem to group

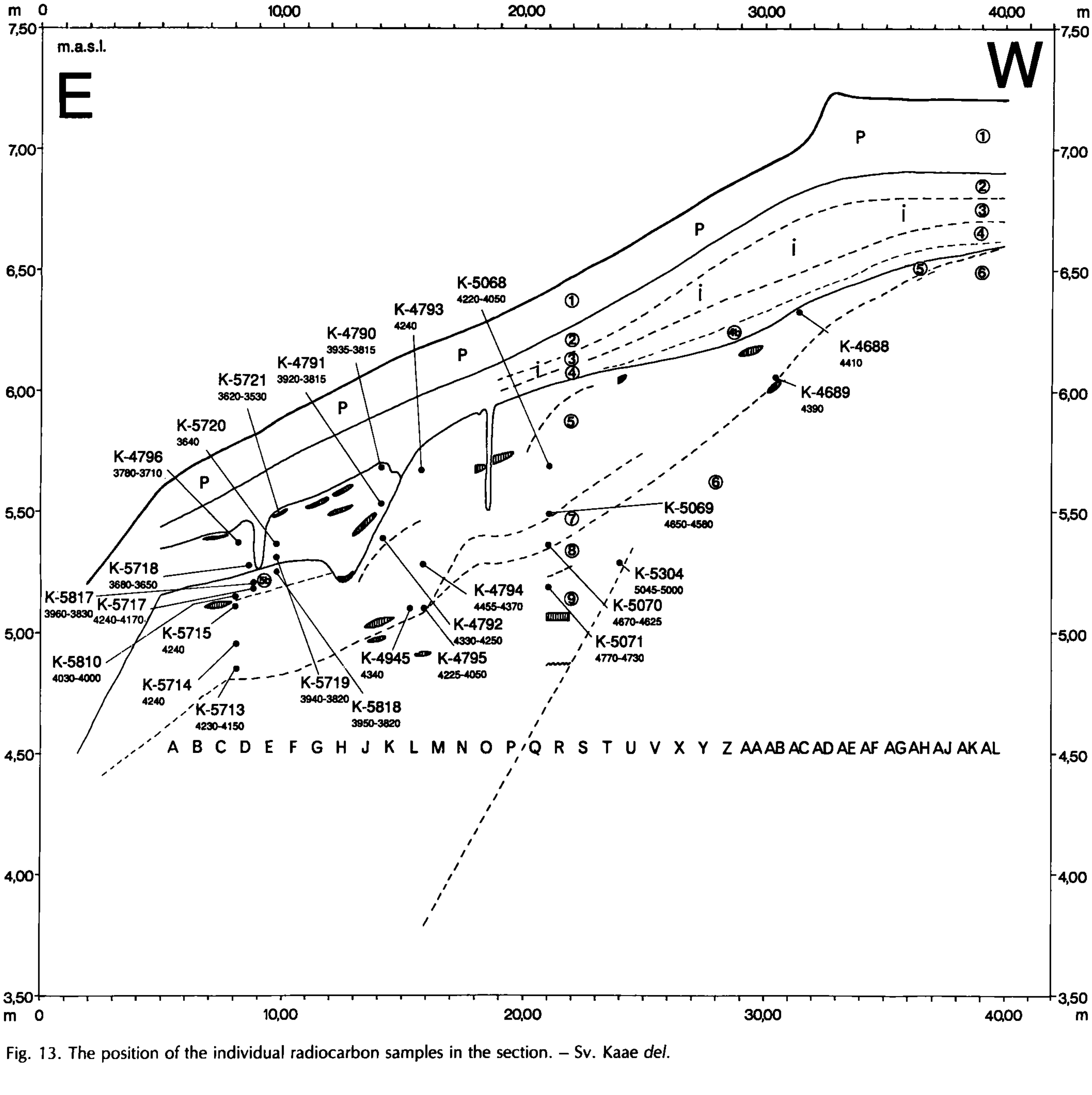



Fig. 13. The position of the individual radiocarbon samples in the section. – Sv. Kaae *del.*

in two clusters, one in the Late Mesolithic and one in the very Early Neolithic, perhaps indicating a short "hiatus" in the occupation of the site about c. 4000 B.C. The explanation for this could either be a *real* stop in habitation during the Late Ertebølle – or a break in sedimentation where this section is positioned – or a level of the shell-mound could have been eroded away by a rise in sea level (during the Late Atlantic transgression). When looking at the graph of the dates (fig. 12), it must be borne in mind, however, that the number of dates is also a reflection of the thickness of the layers. From this we must conclude that continuity of habitation seems to be the most probable.

It is of special interest to define the exact date of the

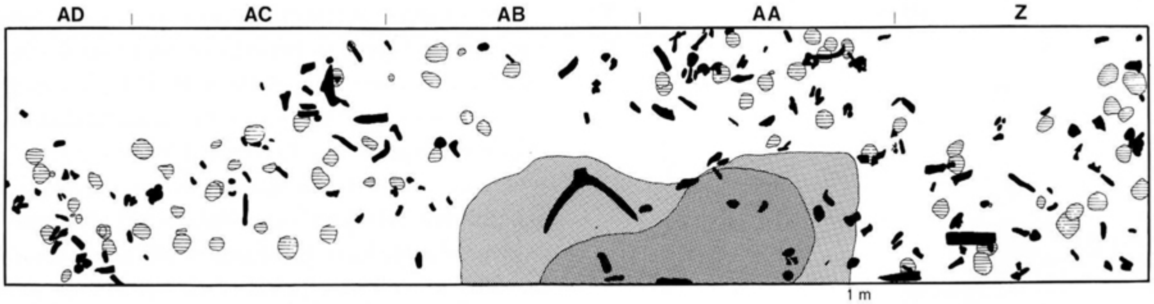



Fig. 14. The hearth (hatched) in squares AA-AB surrounded by animal bones (black) and small clusters of fish bones (shaded).

transition from the Late Mesolithic to the earliest Neolithic, from the Ertebølle to the Funnel Beaker Culture. It can be deduced from figs. 9–12 that this transition must have been of very short duration, occurring at c. 4000–3950 B.C. Perhaps this means that the transition took place over a period of less than a century.

The very early date of the Funnel Beaker level at Bjørnsholm is further supported by an AMS-date of 4040–3690 B.C. (AAR-802) from the timber construction at the east end of the Early Neolithic grave just west of the *køkkenmødding*. The grave contained pottery of the same type as was found in the Neolithic levels of the shell-mound (S. H. Andersen & E. Johansen 1992:52).

### *Hearths*

In the *køkkenmødding* only hearths consisting of circular layers of a grey, greasy substance (burnt shell material and charcoal) have been found; they occur in all levels of the shell-mound. In the Mesolithic layer such hearths have been observed at 7 positions – evenly distributed through the shell-mound (fig. 5). Compared with Ertebølle there are many more hearths in the Bjørnsholm *køkkenmødding*, but the type is the same, circular, 1–1.5 m in diameter and dome-shaped. They consist of a grey substance mixed with very small grey-blue flakes of burnt shells. The centre is always of a light, yellow-grey ash and is surrounded by an up to 0.5 m wide brim of grey ash, followed by an outer black border c. 20–30 cm wide, rich in charcoal powder. The different colours reflect the different temperatures in the hearth. The thickness at the centre is 5–10 cm. Chemical analyses reveal that these hearths consist of pure chalk originating from flakes, small pieces, and powder of burnt shells. Modern experiments with oyster shells burnt in an open fire produce exactly the same type of grey-bluish powder which has turned out to be the main component of these hearths. Therefore, these "hearths", which were only found in the shell-mound, are not hearths in the usual sense, but they are obviously the *loci* where the shellfish were put onto the fire – to open them in an easy manner. Such a procedure is well known from ethnographic sources, *e.g.* from Australia (Meehan 1982:87–89, 102 and 108).

Around these hearths are concentrations of flint debris and animal bones, normally found c. 0.5–1 m from the periphery of the ash layer (fig. 14). In contrast to Ertebølle, no levels of fish bones have been observed in the Bjørnsholm *køkkenmødding* (S. H. Andersen & E. Johansen 1987:47).

Hearths of a different type are the stone hearths, probably with a more permanent function. They were not found in the shell-mound proper but are recorded from the subsoil (in square AB) and in the marine sand below the *køkkenmødding* in squares L and R (fig. 15). Also in square R – but at a somewhat higher level – a 2–4 cm thick level of charcoal was observed – probably indicating a hearth somewhere nearby.

These hearths are small, with a diameter of c. 0.50 m, built of a single layer of small, flat stones, and have a high charcoal content. None of these hearths are surrounded by concentrations of artefacts, flint debris, animal bones, or other types of "waste" – as is the case with all the other hearths in the shell-mound proper.

Within the shell-mound the hearths are found in groups (fig. 5) spaced horizontally within a few square metres – often in stratigraphic sequences – for instance in squares O–P, BG K–L, and C–D–BK–BL. Such a concentration

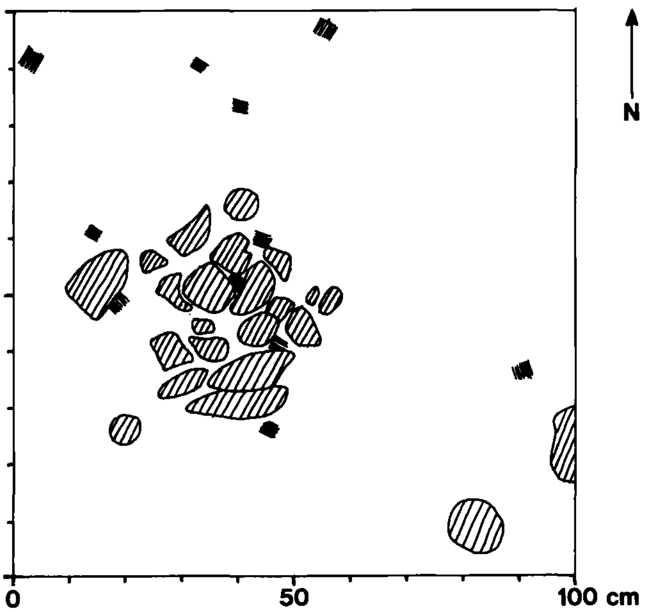



Fig. 15. Stone hearth (square R) in the marine sand below the *køkkenmødding*. Stones are shaded; charcoal marked by thin parallel lines.

of several hearths within a restricted area – a hearth *locus* – is most distinctly observed in squares K-R, where the hearths are surrounded by dome-shaped shell heaps. A similar pattern was also observed at Ertebølle (S. H. Andersen & E. Johansen 1987:47–48) and Norsminde (S. H. Andersen 1991:25). This observation must indicate that the position of the hearths has been fixed through time (in some cases through 2–300 years).

The continued use of these hearth *loci* may be due to local factors such as wind, growth of trees, etc., or it may reflect an organization of the shell-mounds as dump areas with some form of structure.

Also in the upper Neolithic shell-mound, hearths with burnt shells have been found in several cases, but they are much smaller and only 2–5 cm thick, and not always circular in outline as the Mesolithic ones are. In addition, they are not found in stratigraphic sequences as is the case in the Mesolithic levels, but are more evenly distributed horizontally and vertically. These hearths appear to have been more cursory than the Mesolithic ones and in contrast to the latter they are not surrounded by a great amount of debris.

At Ertebølle similar types of "grey" hearths of burnt molluscs were recorded (S. H. Andersen & E. Johansen 1987:47–48). However, the "cooking pits" observed at this site have not been found at Bjørnsholm.

The change in type of hearth from stone fireplaces in the bottom layers to hearths of burnt shells in the later phases took place at c. 4600–4700 B.C. A similar change in the type of hearth is frequently observed at many other *køkkenmøddinger* of the Ertebølle Culture, *e.g.* at Ertebølle, where two stone-lined hearths were recorded underneath the midden (Madsen *et al.* 1900:25–28). The stone hearths may originally have belonged to old living floors situated outside the area of an early shell-mound formation. After being abandoned, the hearths were covered by the accumulating shell-mound.

*Other structures in the shell-mound*

At Ertebølle a division of the midden in two areas was observed: One area close to the seashore which was characterized by domestic activities, and another area further away from the shore with shell-dumps (S. H. Andersen & E. Johansen 1987:44–45), but this was not documented at Bjørnsholm.

Layers of ash and charcoal were found around the hearths. In some areas the ash layers extended out 1–2 metres. Such layers enable us to connect contemporaneous surfaces within the midden. Furthermore, the extension of such ash levels clearly prove that the hearths were situated in the open air. If they had been inside huts, the ash would have been more confined.

In no case is there more than 4–5 m between the hearths. The hearths in squares O-P are surrounded by steep-sided shell-heaps within a distance of 1–1.5 m. The radiocarbon dates demonstrate that these shell-heaps are contemporaneous from bottom to top despite the fact that they are 60–80 cm in thickness. Such shell-heaps probably represent single, short episodes. The fact that they hardly contain any debris supports this assumption.

Only in one case are there indications of what may have been an open surface of longer duration in the *køkkenmødding* (layer 14a on fig. 10 and layer 5b on fig. 7). A similar surface was observed at Ertebølle (S. H. Andersen & E. Johansen 1987:44–45). Apart from this, both the stratigraphy and the radiocarbon evidence indicate that the main part of the Bjørnsholm *køkkenmødding* represents continuous accumulation.

Scattered human bones may be the remains of disturbed graves. In 1931 a burial with a skeleton was found lying in an extended position and oriented NE–SW.[7] The presence of Neolithic and Iron Age pottery in the grave fill as well as the stratigraphic observations indicate that this grave is considerably later than the Ertebølle occupation.

*Finds from the Ertebølle layers*

Artefacts occur throughout the midden. Activity areas are indicated by horizontal and vertical concentrations of artefacts. In terms of horizontal distribution, the material around the hearths is highly concentrated – there are not only tools, but also debris and animal bones. However, the densest concentration is found below the shell-mound, on the surface of the marine sand (the "black layer").

The majority of artefacts in the shell-mound are found in connection with the ash layer from the fireplaces, indicating that occupation took place for some time on the open surfaces.

Changes in the artefact inventory can be observed in relation to the stratigraphy. Some are gradual, minor changes, while others, such as the first appearance of ceramics, are more abrupt.

The tools are made of two different types of flint: 1) Small flint nodules with a grey, hard cortex probably extracted from the morainic deposits. 2) Flint nodules with a soft chalky primary cortex. This type of raw material must have come from areas where there is direct access to limestone or chalk bedrock with flint. Such

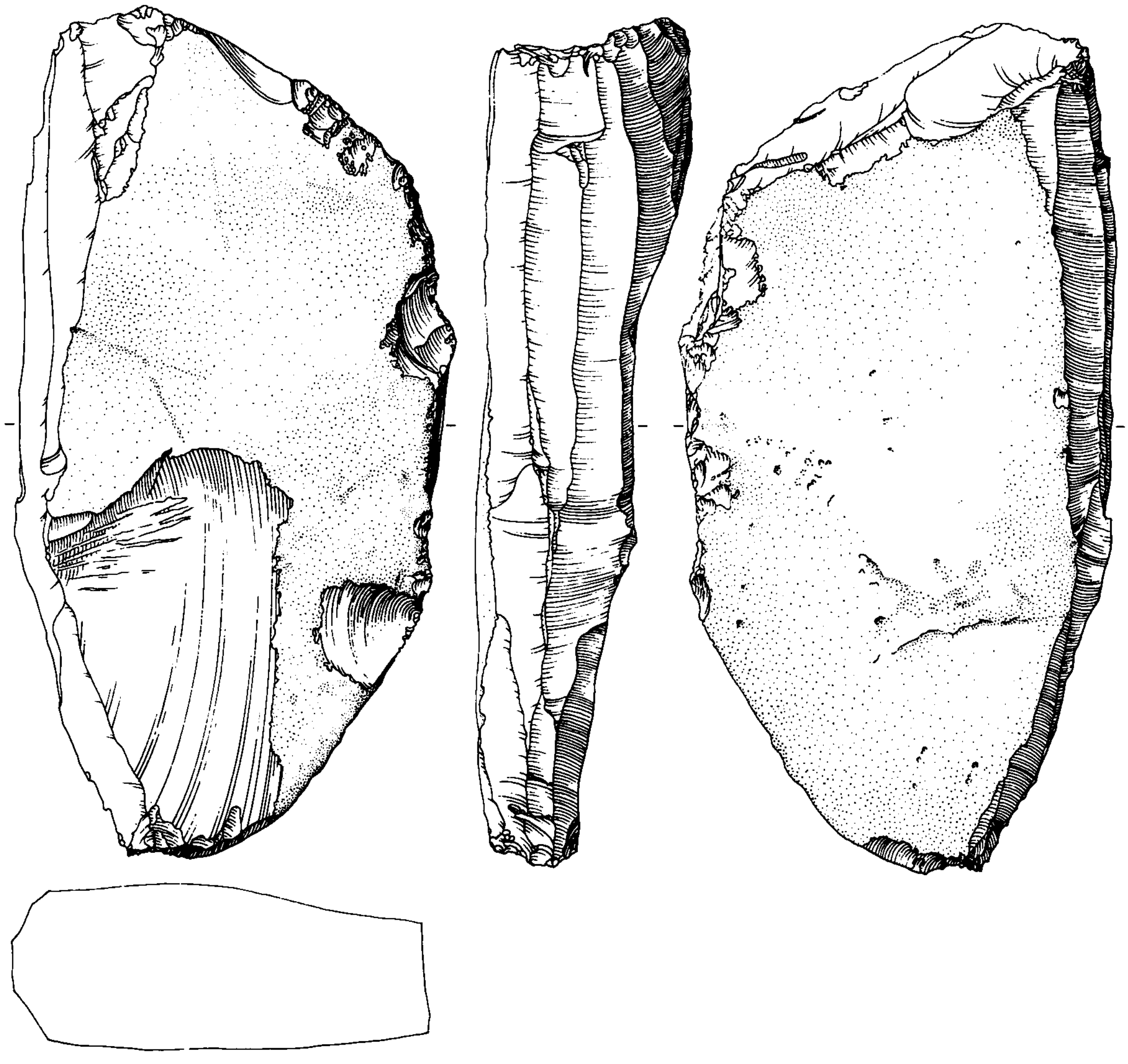


Fig. 16. Blade core from the Ertebølle layer. 2:3. – J. Mührmann-Lund *del.*

layers are common in the immediate neighbourhood of Bjørnsholm and in the area around Aggersund where the chalk bedrock very often is found on the surface.

The flint tools are very regular and well made compared to other contemporaneous Ertebølle sites on the Limfjord. These characteristics seem to be constant throughout the occupation.

From the contemporaneous, nearby Ertebølle site (fig. 2) there was access to the same types of raw material, but the tools differ stylistically. This may indicate that the two

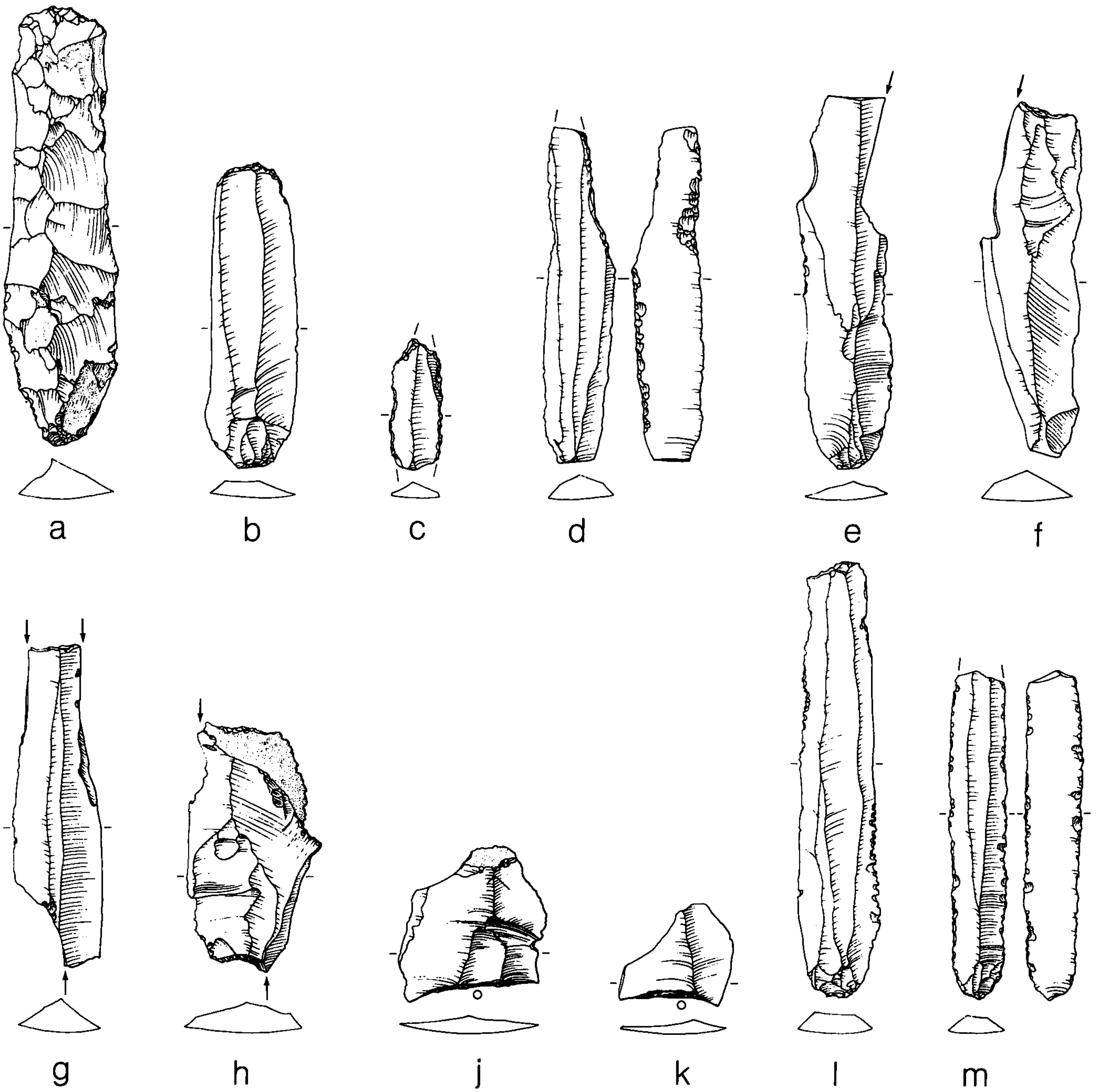



Fig. 17. Flint artefacts from the Ertebølle levels: a–b) Blade scrapers. c–d) Borers. e–h) Burins on a break (e) and truncation (f–h). j–k) Flakes with truncation, preproduction for transverse arrow-heads. l) Blade saw. m) Denticulated blade. 2:3. – J. Mührmann-Lund *del.*

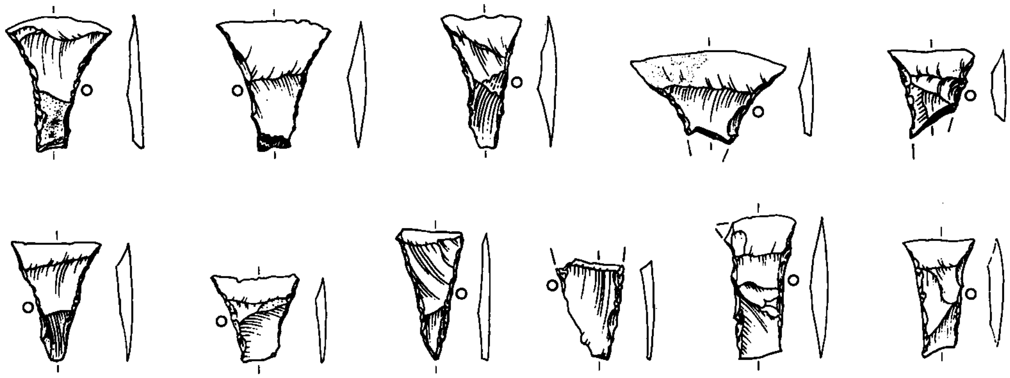
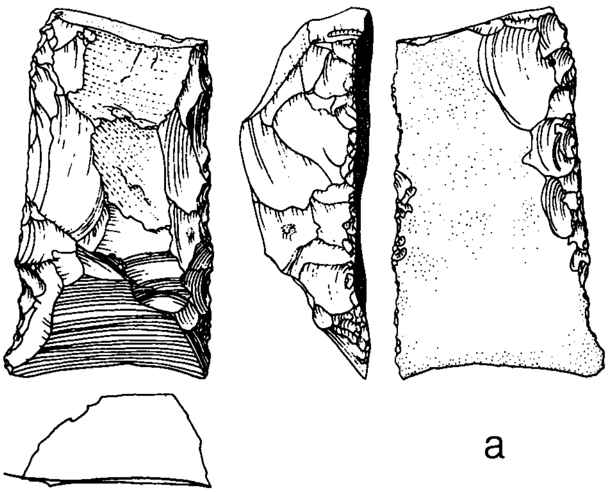


Fig. 18. Transverse arrow-heads from the Ertebølle levels. 2:3. J. Mührmann-Lund *del.*



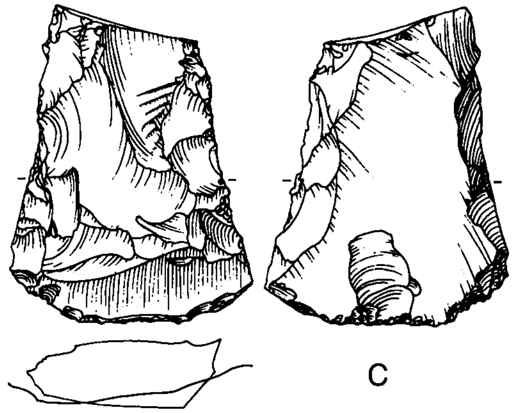
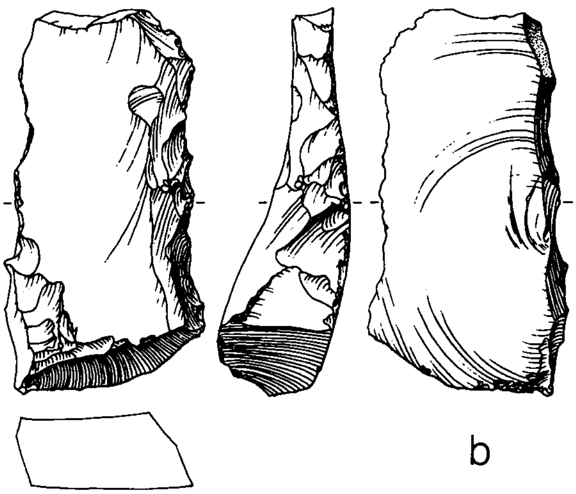




Fig. 19. Flake axes from the Ertebølle levels: a-b) Edge-trimmed. c) Flat-flaked. 2:3. – J. Mührmann-Lund *del.*




sites were inhabited or used by two groups of people with different flint tool traditions.

The Mesolithic flint inventory from Bjørnsholm displays types and type compositions characteristic of the Limfjord area and belonging to a regional group within the Ertebølle Culture in Jutland. This regional group is characterized by many tools made from regular blades made by "soft technique" used on large, flat cores with two opposing platforms (fig. 16). A number of tools are based on blades, such as scrapers, borers, burins, truncated pieces, saws, denticulated blades (fig. 17), and transverse arrow-heads (fig. 18). In addition, there are flake (fig. 19) and core axes (fig. 20, top). In the Danish Late Mesolithic, the core axe dominates in the early phases, the flake axe in the later phases. In the Bjørnsholm *køkkenmødding*, the two forms are evenly represented. In the vertical distribution of the subtypes of the flake axe,

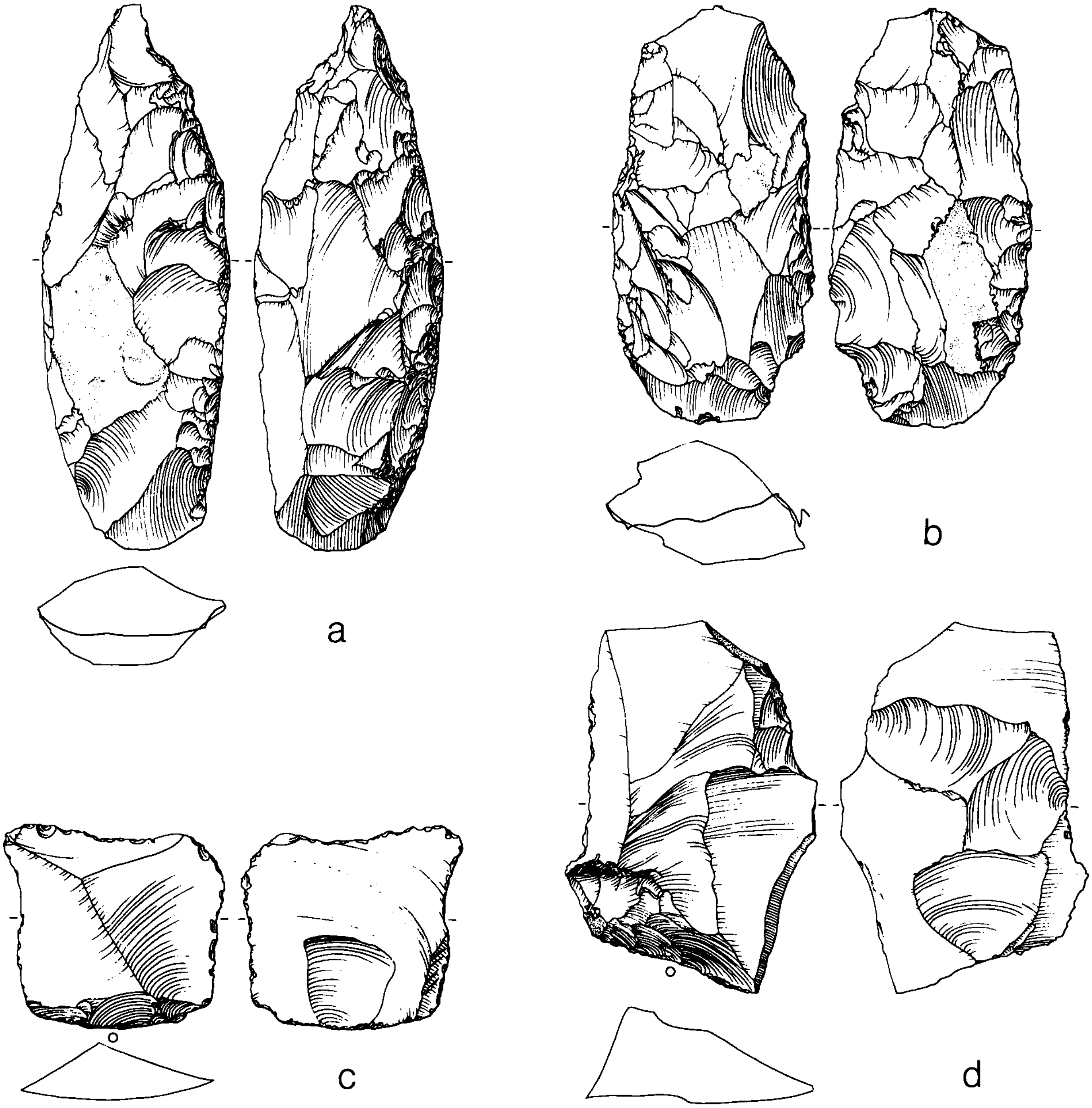



Fig. 20. Flint artefacts from the Ertebølle levels: a-b) Symmetrical core axes. c-d) Scale-worked flakes from the marine sand below the shell-mound (c) and from the black cultural layer (d). 2: 3. – J. Mührmann-Lund *del.* 2:3.

the edge-trimmed variant is very common (fig. 19a–b) in contrast to the flat-trimmed flake axe, which is numerous in Eastern Jutland and on the Danish Isles but more sparsely represented in Northern Jutland (fig. 19c). No axes of greenstone (diabase) were found.

The same types of flint tools were found in the sand layers below the shell-mound, but slight differences in technique and relative proportions can be observed. For instance, there is an increase in the number of burins and a decrease in scrapers and borers.

Among the tools made from flakes, there are several scale-worked flakes (S. H. Andersen 1979b). These flakes, which are significant for the earliest Ertebølle phase in Jutland, are found in the marine sand below and within the deepest layers of the *køkkenmødding* (fig. 20, bottom).

Tools of antler and bone belonging to the Ertebølle

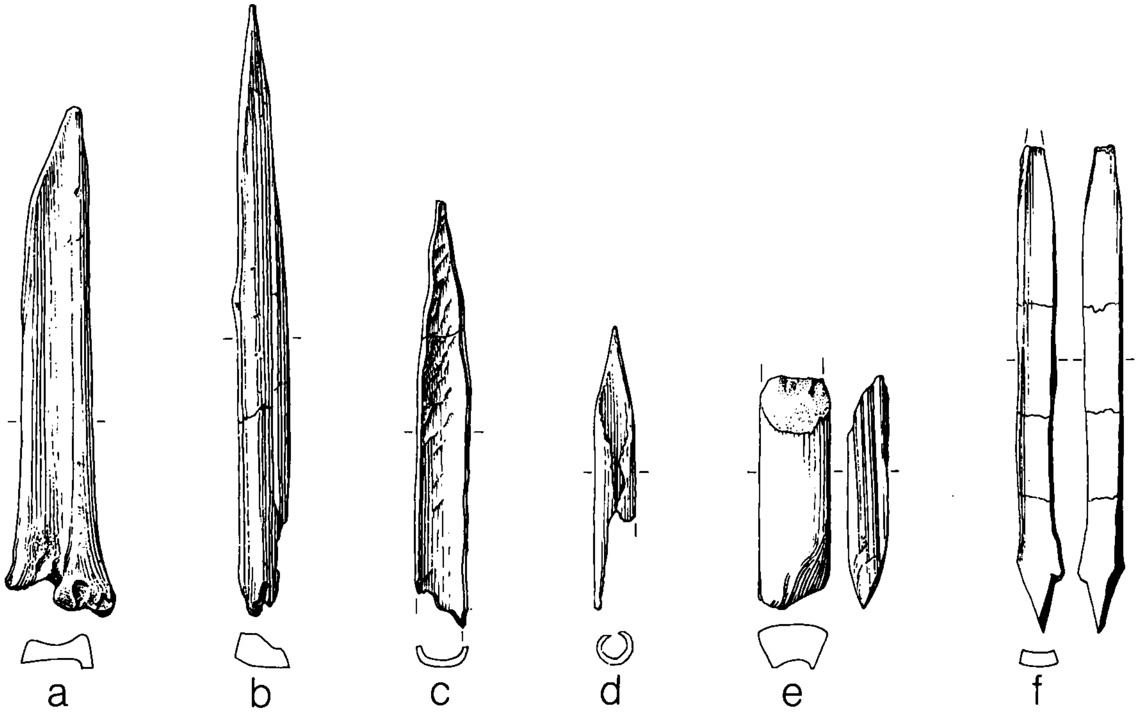



Fig. 21. Bone points from the Ertebølle levels: From roe-deer metatarsus (a), bird bone (c-d), a bone splinter (f), and with round section (b). e) Broken-off base of a bone point. 2:3. – J. Mührmann-Lund *del.*

tradition were also found. A red deer antler axe with the shaft-hole on the stem where a tine has been sawn off, a so-called T-shaped axe, was found in the top layer. The antler implements include several sawn-off tines, two pieces of red deer antler with traces of groove- and splinter technique which are obviously waste from the production of harpoons[8] (S. H. Andersen 1972:105–106), four sawn tines for pressure-flaking, and one short pick with a shaft-hole made of a tine of red deer antler (fig. 25). There are 21 simple bone points – either round-sectioned (fig. 21b) or flat, made of roe-deer metatarsus (fig. 21a). Four points are made from bones of large birds, probably swans (fig. 21c–d), a type characteristic for the Early and Middle Ertebølle Culture in Jutland. Seven small fish-hooks and 3 unfinished examples are made of bone (fig. 22). In the bottom layer of the *køkkenmødding* an ornament consisting of the front teeth of the lower jaw of a young red deer was found (fig. 23). Four beads of red deer teeth with an incised groove around the root were scattered in the shell deposit. There are also two ornaments made of wild-boar tusk (the outer side of the tusk) (fig. 26). Similar pendants are known from the early excavations at Ertebølle (Madsen *et al.* 1900, Plate VII lower row).

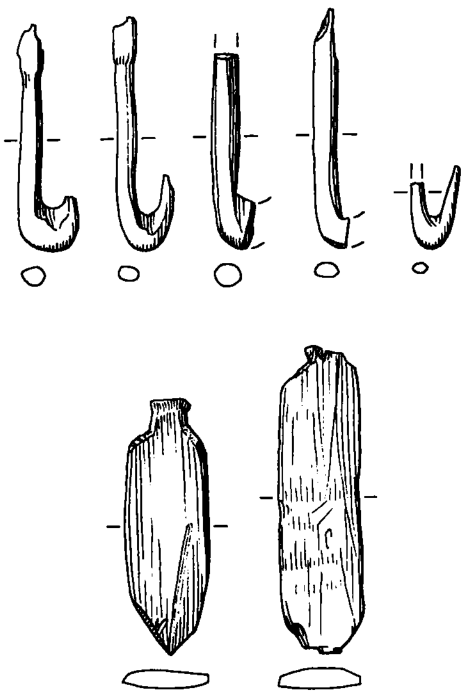


Fig. 22. Bone artefacts from the Ertebølle levels. Above: Fish-hooks of bone. Below: Flat pieces of bone, probably rough outs for fish-hooks. 1: 1. – O. Svendsen *del.*

Fig. 23. Ornament of red deer teeth. All the front teeth of the lower jaw have been cut out of the jaw – probably still attached to the tissue. 1:1. – Photo P. Dehlholm.

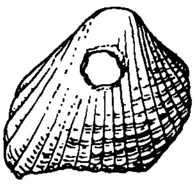


Fig. 24. Shell of *Cerastoderma* with perforation. 1:1. – J. Mührmann-Lund *del.*

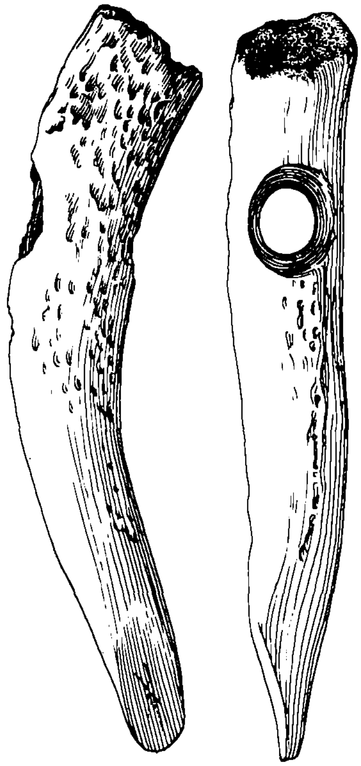


Fig. 25. Small pick with shaft-hole. 2:3. – J. Mührmann-Lund *del.*

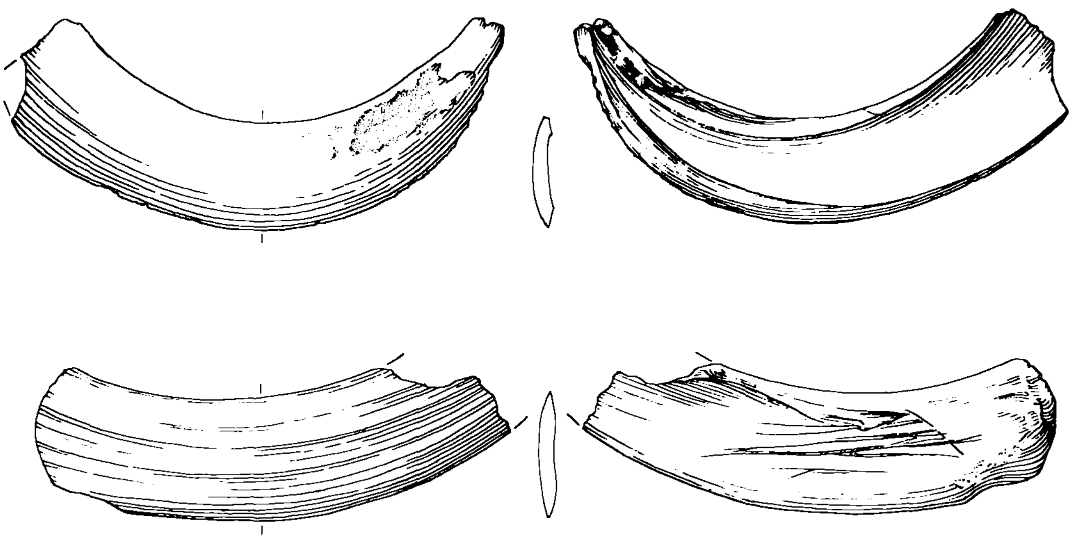


Fig. 26. Ornaments made from the outer side of wild-boar tusks. 2:3. O. Svendsen *del.*

Finally, a shell of *Cerastoderma edulis* has a perforation and was probably also an ornament (fig. 24).

Ertebølle pottery is not found in the deepest levels of the *køkkenmødding* but appears abruptly in the layers later than c. 4600 B.C. Pottery is frequently found in small concentrations around the hearths, but is very seldom present in the shell layers. The ware is 1–1.5 cm thick and is clearly thicker than pottery found at contemporaneous sites further to the south in Jutland (S. H. Andersen 1975: 56–64). The vessels are undecorated. Only sherds from simple, pointed-bottom vessels are found.

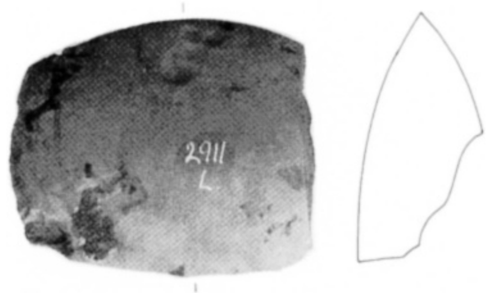


Fig. 27. Fragment of a thin-butted, polished flint axe. 2:3. Photo P. Dehlholm.

### *Finds from the Neolithic layers*

The flint artefacts from the Early Neolithic are very few and restricted in type – mainly because of the small amount of flint in these levels, and also because of the small areas of excavation. The Neolithic flint tools are only slightly different from the Mesolithic ones. The Neolithic assemblage is characterised by both blade and flake techniques. Blades are fewer than in the deeper layers of the shell-mound, and more tools are made from flakes. As we are dealing with the same site there is no reason to suppose that this difference has anything to do with access to raw material; it must, indeed, be a change in "style". Generally there are the same types and type groups as before, but in other relative frequencies.

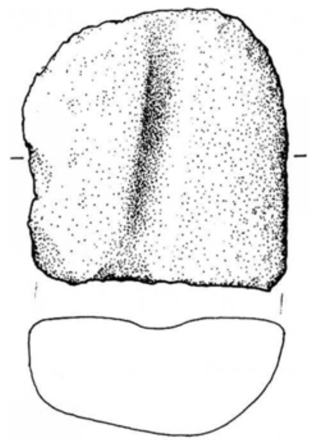


Fig. 28. Arrow-shaft straightener of sandstone. 1:1. – J. Mührmann-Lund *del.*

Only a few axe types are documented from this level. Core and greenstone axes are completely absent and only a few flake axes are found. The dominant axe type is now the polished, thin-butted axe – probably of type IV (possibly also type I) (fig. 27) (Nielsen 1977:72–74 and 77–78, 106). Transverse arrow-heads are also found, but these have slightly convex sides and a pointed butt. In addition, there are several round flake scrapers, some borers and knives, while burins and truncated pieces are few. From the Early Neolithic comes a fragment of a sandstone arrow-shaft straightener with a grooved channel (fig. 28).

Tools of bone and antler are very few in number; only some simple bone points and sawn off tines for pressure flaking are present. A simple bone point has its articular end preserved as a handle (metatarsal of a sheep) (fig. 29, left). A small oval bead of mother-of-pearl with a central perforation is also recorded from this layer (fig. 29, right).

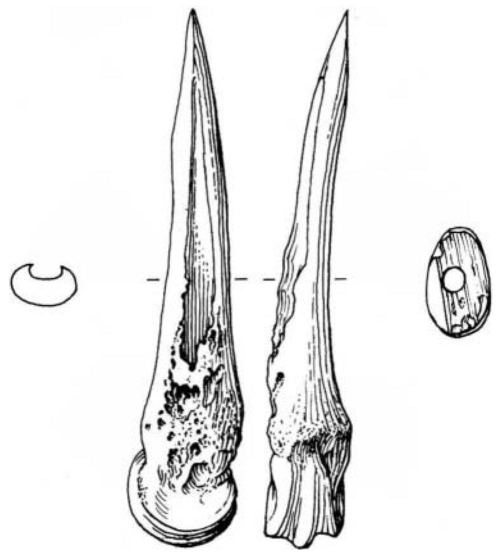


Fig. 29. Left: Simple bone point from metatarsus of sheep. Right: Bead of mother-of-pearl. 1:1. – J. Mührmann-Lund *del.*

The most abundant artefact group is pottery, normally found in large fragments – very often in the ash and stone layers. In comparison to the Ertebølle level, ceramics play a more important role in the inventory. With regard to

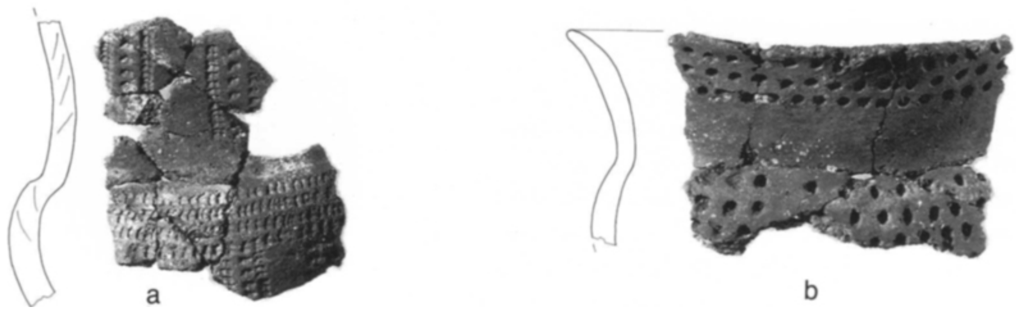


Fig. 30. Decorated funnel beakers of Volling type. From the top of the Early Neolithic level in the *køkkenmødding*. 1:2. – Photo P. Dehlholm.

shape, technique, and ornamentation the Early Neolithic pottery is fundamentally different. Hybrids between the Ertebølle and Funnel-Beaker ceramics have not been found.

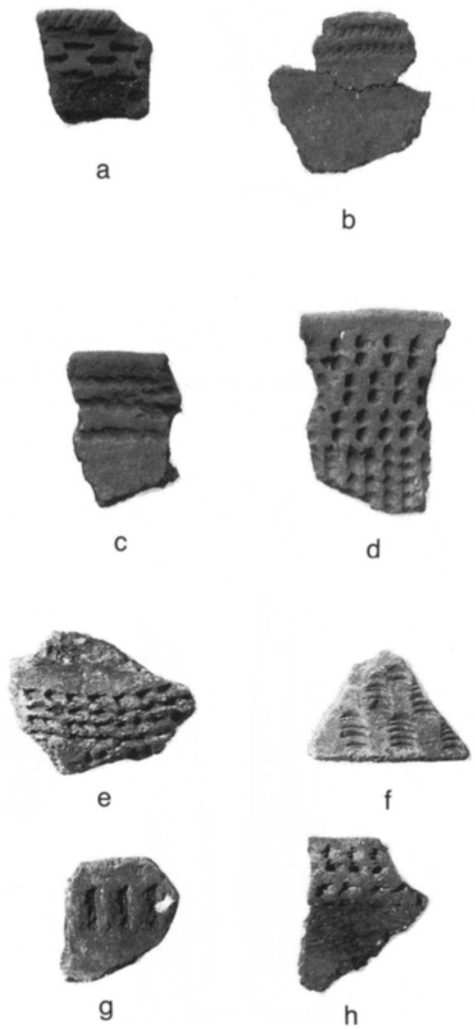


Fig. 31. Rim-sherds from the Early Neolithic level. 1:2. – Photo P. Dehlholm.

The ceramic inventory comprises simple funnel-necked beakers, lugged beakers, and large lugged jars. The dominant form is simple funnel-necked beakers, which are present in two size groups. The largest group is made up of rather small vessels with a height of c. 15–20 cm and a smaller group of larger pots c. 30–40 cm in height. The majority of the vessels display a very characteristic profile with a relative high, concave neck, separated from the convex belly by a distinct angle (fig. 30). The base is always round or rounded. The pottery is generally without ornamentation. If decoration is found, it is usually confined to just below the rim. A frequent ornamentation consists of 2–3 horizontal cord impressions on the rim (fig. 31). Some vessels also display single or double rows of horizontal stabs or short strokes (fig. 31). Within this ceramic group a small number differ from the rest in that they are of a finer and thinner ware and that the entire surface is covered with decoration in stab-and-drag technique in a chequer composition (fig. 30).

The large group of funnel beakers corresponds to the so-called B-beakers, while the finer vessels belong to the "non-megalithic C-Group" (Becker 1947). Both groups have recently been incorporated in the Volling Group (Madsen & Petersen 1984). The Bjørnsholm (and Norsminde) stratigraphy clearly demonstrates that the two types of funnel beakers are contemporaneous in northern and eastern Jutland, and that these types of pottery should be dated to 4000–3800 B.C.

Of special interest is a thin-walled and undecorated vessel of a different type with a short, concave neck and a long belly. Unfortunately, the bottom is not preserved, but from the outline of the belly it is evident that the vessel must have had a very narrow bottom, which was either rounded or pointed (fig. 32). Typologically and

Fig. 32. Funnel beaker from the deepest level of the Early Neolithic level of the *køkkenmødding*. 1:2. – Photo P. Dehlholm.

technologically it is clearly a funnel beaker and shows clear affinity to the A-group (Becker 1947), but it is also typologically related to the pointed-bottomed Ertebølle pots. The vessel is different from the rest of the Neolithic pottery at the site. It was found at the very bottom of the Early Neolithic level *below* the material belonging to the Volling Group. A radiocarbon date for oyster shells in direct association with this vessel gave a date of 3960–3830 B.C. (K-5516) which is in accordance with the stratigraphic position of the vessel. It is not possible to determine whether this funnel-beaker represents a variation within the Early Neolithic pottery assemblage, or whether it is diagnostic of a separate phase of Early Neolithic occupation in this area. However, sherds from similar funnel beakers were frequently found in the oldest Early Neolithic levels during the excavation (fig. 33).

Although the sample size is small, the pottery seems to cluster stratigraphically, so that the earliest level is mainly characterized by non-decorated vessels similar to the above mentioned, while funnel beakers, like fig. 30 – beakers of the Volling Group, belong to a *higher* level in the sequence. Undecorated pottery is also known from the Norsminde shell-midden. Unfortunately this is only dated by its stratigraphical position (S. H. Andersen 1991:34, fig. 21) at the very bottom of the Early Neolithic sequence of this site, which is a strong indication of the very early date of such vessels. The results from Bjørnsholm and Norsminde demonstrate therefore, that this type of beaker is characteristic of the very earliest Funnel Beaker Culture in Jutland.

### *The economy of the Mesolithic occupation*

Subsistence was based on hunting, fishing, and gathering. This is well documented by the types of artefacts found associated with large numbers of animal bones and shellfish. The list of species reveals a wide range of mammals, birds, fish, and reptiles (see Bratlund 1993 and Enghoff 1993, this volume).

The only domesticated animal is the dog. A tooth of man was also recorded. It was found in the body of the shell-mound and probably came from a grave destroyed by later activities.

It is interesting that the bones in the shell-mound are generally small splinters, less than c. 10 cm in length, much smaller than the ones found in the waste dumps

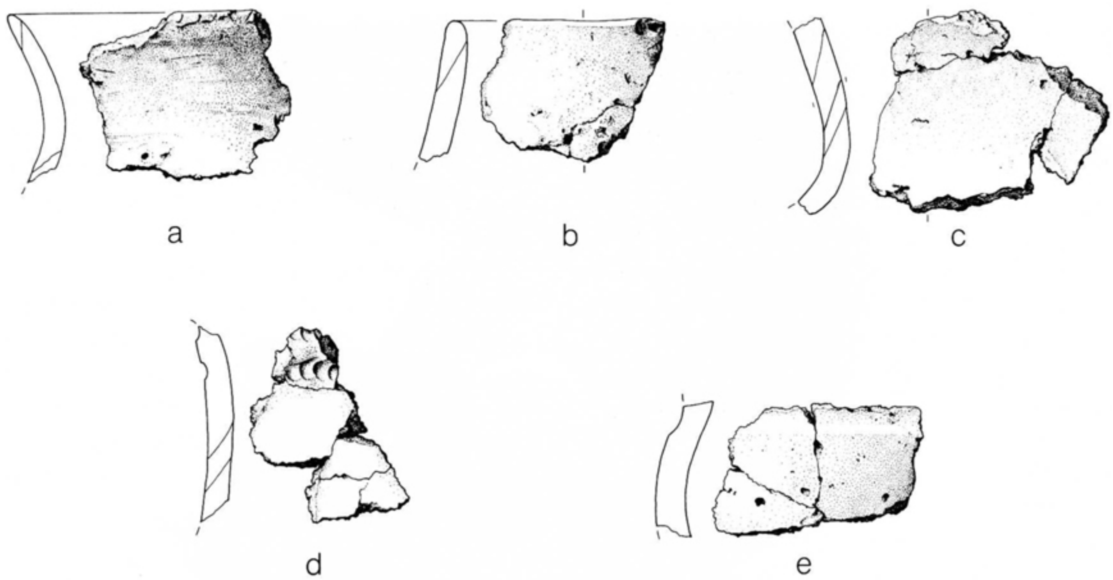



Fig. 33. Undecorated rim-sherds from the bottom of the Early Neolithic level of the *køkkenmødding* (a–b) and belly-sherds from the same level (c, e). d) Rim-sherd decorated with two lines of horisontal cords. 1:2. – J. Mührmann-Lund *del.*

(lake and sea deposits) at for example Ringkloster and Tybrind Vig, where the bones have been deposited in wet muddy layers outside the habitation area (S. H. Andersen 1975, 1985). This difference may be explained by the fact that the bones from the *køkkenmødding* have either been exposed to many different taphonomic factors such as dogs, weather, and trampling, or that the bones were intentionally crushed for making soup (Binford 1983: 149–159). The latter interpretation is supported by the fact that many of these bone splinters are found close to the hearths and very often in small concentrations (fig. 14).

The vertical distribution of animal bones follows the same patterns as described for the flint debris. There is a close correlation between the ash levels around the hearths and the higher concentrations of bone; many of these bone splinters show traces of burning, which is in contrast to the bones in other layers of the shell-mound.

The bones from mammals and birds are in most cases found individually or in small heaps, while fish bones occur in small concentrations (10–15 cm in diameter) for which we do not have any interpretation at present. They display a similar distribution pattern to the other animal bones and are also concentrated around the hearths.

In a few cases, bones of mammals, including bones from animals killed for their fur (*i.e.* pine marten, wildcat), are also found in small clusters – a well known phenomenon at other Ertebølle sites such as Ringkloster (S. H. Andersen 1975) and Tybrind Vig (S. H. Andersen 1985:57).

Among the larger animals, wild pig, red deer, and roe-deer, were the most common species. All of these were hunted without any age class restrictions. Auroch is represented by only a few bones. One scapula of a red deer displays a distinct, unhealed hunting lesion (Bratlund, this volume, p. 102).

Animals such as red fox, badger, wildcat, lynx, common otter, wolf, pine marten and western polecat were killed for their fur.

Grey seal and porpoise were hunted at sea and along the coast.

A substantial number of birds, especially swans and ducks, were captured. The majority of these birds could have been taken on or near the water, but two species indicate forest hunting: Capercaillie and the ural owl.

The fact that fishing was of great importance is confirmed by the many fish bones (found in concentrations and as single bones), the wide range of species, and the tools used for this activity (see Enghoff 1993, this volume). At Bjørnsholm the freshwater species amount to 15%, the marine species to 22%, and migratory species to 63% of the total sample. The fish bone material found at Bjørnsholm is surprising because of the many bones of eel and roach. Just like Ertebølle itself, fishing at Bjørnsholm was directed towards eel. This characteristic separates the two Limfjord sites from contemporaneous settlements such as Norsminde (S. H. Andersen 1991; Enghoff 1991) and Tybrind Vig (S. H. Andersen 1985; Trolle-Lassen 1984).

Marine species are also represented, such as mackerel, herring, and garpike. Also Cyprids like roach, tench, and rudd are frequently found, followed by cod, three-spined stickleback, and greater weaver.

Freshwater species like perch and pike add to the diversity. The explanation for this interesting aspect of subsistence is to be found in the habitat at the time of occupation. The estuary with its many river outlets within easy reach of the settlement, must have offered excellent possibilities for eel fishing.

The number of bones from eel at Bjørnsholm is far greater than normally found at Ertebølle sites. One reason for this is the high content of fat in eel which makes this fish much more attractive than most other fish species. Everything points to the fact that eel fishing was of great importance in the diet of the inhabitants, and that this type of fishing was one of the decisive factors in positioning the settlement.

Eel bones were found throughout the shell-mound layers, thereby demonstrating that this type of fishing was carried out during *both* the Mesolithic and the Neolithic occupation phases. Such great numbers of eel bones have previously only been documented at Ertebølle (Enghoff 1987). The existence of this stable resource may explain why these two sites grew to become amongst the largest of the Late Mesolithic sites.

Of special interest is the occurrence of southern fish like black seabream, European seabass, and smoothhound, indicating a warmer sea than today.

The species and size of the fish give some information as to fishing techniques. Fishing must have taken place in shallow, coastal waters with stationary equipment, *i.e.* fishtraps near the river outlets and along the coastline. This technique probably also explains the more numerous marine species at Bjørnsholm, where the large fiord with access to the Limfjord, opened up for more marine species than the lagoon at Ertebølle (Enghoff 1987:64). However, the relatively numerous small fish-hooks of bone indicate that other fishing techniques were also employed at Bjørnsholm.

Gathering is documented by the many shells of oysters, mussels, cockles, and periwinkle.

Some information on seasonality is available. The bone sample of the larger mammals points to an occupation period from late winter (January–February) to late summer (July–August), the presence of mackerel and garfish indicates summer fishing, and the eels were caught in August. The animals used for fur were most probably hunted in the winter months. This is also the case with the swans and some species of ducks.

At present, we have indicators of spring, summer, autumn, and winter activities, but it would be premature to argue that there was permanent year-round occupation.

One of our future tasks is to analyze the bone content and the seasonal indicators of the different stratigraphic units of the shell-mound, to see whether these indicators are restricted or found throughout all the units.

### *The economy of the Early Neolithic occupation*

As would be expected with such a mixture of habitats as is the case in the Bjørnsholm area, hunting, fowling, gathering, and fishing played important roles in the economy. Bones of wild-boar, red fox, pine marten, red deer, roedeer, gannet, and whooper swan were found in the *køkkenmødding*. The domesticated animals include sheep, cattle, and pig (Bratlund 1993, this volume).

Fishing also took place and the species are largely identical with the Mesolithic ones. Eel is the most common species, followed by fish from the cod-group, mainly cod, but also mackerel, flatfish (plaice, flounder, dab), and garpike were caught. Stingray was also found in this layer (Rosenlund 1985:23–24). In contrast to the contemporaneous shell-mound at Norsminde, fishing seems to have continued into the Early Neolithic period, although the number of fishbones in these levels is noticeably lower than in the Ertebølle layers (Enghoff 1993, this volume).

Shells of cockle dominate the Early Neolithic level, but oyster, mussel, periwinkle, and whelk were also collected during this occupational phase.

The change from oysters to cockles is interesting. This may be explained in several ways. In the preliminary article on the Norsminde *køkkenmødding*, where a similar change was observed, it was presumed that it reflects a general change in the marine biotope (S. H. Andersen 1991:37), and a similar development could have taken place in the Bjørnsholm area.

The animal bones from the Early Neolithic levels also point to occupation during most parts of the year (see Bratlund 1993, this volume).

Soil samples from the mound and the fill of the two vessels 2911 AAVT and AAVW from the Early Neolithic grave were investigated for pollen (S.T. Andersen 1992). This analysis demonstrated that birch *(Betula sp.)* woodland was growing in the neighbourhood, and that the birch woodlands were exploited using swidden cultivation.

Traces of agriculture are indicated by the presence of pollen of wheat *(Triticum sp.)* and pollen likely to belong to barley *(Hordeum sp.)*. Wheat and club wheat *(Triticum compactum)* have also been identified from impressions in a potsherd from the Early Neolithic level of the *køkkenmødding* (Mathiassen 1940:41. H. Helbæk *det.*).

The available information clearly points to a very mixed economy based on farming, hunting, fishing, and gathering, but it is not possible to say anything about their relative importance. It seems that *the economy of the Early Neolithic in all essential aspects continued the Mesolithic way of living* – adding only a few domesticated animals and arable agriculture.

The settlement continuity on this location must have been based on the stable resources. In the Early Subboreal there were still sufficient resources available to make this and several other locations, such as the sites at Åle and Lundgård, favourable for habitation. The Early Neolithic settlement at Bjørnsholm was of the same size as Mosegården in eastern Jutland (Madsen & Petersen 1984:71).

A similar contemporaneous settlement is the small shell-mound at Aggersund – also with a mixed economy comprising both pastoral agriculture, hunting, fishing, and collecting. From this site bones of aurochs, domesticated ox, wild-boar, domesticated pig, roe-deer, red deer, sheep/goat, dog, swan, duck, and vertebrae of cod as well as man have been recorded (S. H. Andersen 1979a: 13–14 and note 16).

In contrast to the rapid sharp transition in aspects of material culture from the Ertebølle to the Funnel Beaker Culture it is striking here to see the gradual continuous change in economy.

### *Bjørnsholm and Ertebølle*

The two large *køkkenmøddinger* are located on the same stretch of the Limfjord – only c. 8 km apart. Surveys of the surrounding territories demonstrate, that these two sites are not only the largest in the area, but that they are surrounded by several smaller, contemporaneous settlements. Topographically, Ertebølle is in a more exposed location in a lagoon area, close to the open waters, while Bjørnsholm is positioned on a large estuary with calmer, protected waters, but still within easy reach of open waters. The Bjørnsholm *køkkenmødding* is longer and wider than the Ertebølle, which is the thickest of the two.

The main Mesolithic occupation at the two sites falls in the same period. At both sites the earliest habitation started during the regression after the Early Atlantic transgression. We find marine sand with a mixture of shells and rebedded cultural material from the Early Ertebølle Culture. After the retreat of the sea the middens began to accumulate around 4600–4700 B.C. and then continued through the following centuries – until 4200–4100 B.C. At both settlements the intensity of shell deposits culminated around 4300 B.C.

There are many similarities with respect to stratigraphy and features between the two large shell-mounds. In all essential aspects there is a high level of congruence, and the differences are to be ascribed to the different topographic situation.

The youngest *in situ* layers at Ertebølle are dated to c. 3900 B.C., after that time only few traces of Early Neolithic habitation are documented, while there is a continued and intensive habitation at Bjørnsholm until c. 3500 B.C., and finally there are scattered remains of habitation until the Early Middle Neolithic.

The economy of the Mesolithic levels is generally identical at both sites. It was based on fishing, hunting (both forest and at sea), and shell-fish collecting. It is interesting to observe the almost complete absence of large terrestial animals such as aurochs and elk, which are found at contemporaneous Ertebølle Culture sites further to the south, *e.g.* Ringkloster (S. H. Andersen 1975:84–89 and 94).

Eel fishing in particular was extensive during the *whole* occupation period. This activity is a very characteristic aspect of these sites, which separates them from other contemporaneous settlements. The fishing techniques also seems to be of the same type at the two sites: fishing in shallow, coastal waters with fishtraps and bone hooks. At Bjørnsholm there are more marine species than at Ertebølle.

Both sites were apparently occupied throughout the whole year.

The number of structures in the shell-mounds are few, mainly hearths of burned molluscs, which are surrounded by flint and bone debris from artefact production and food preparation.

Only few traces of habitation during the Late Mesolithic were found behind the two middens.

The flint inventory is of the same order and reflects a regional, Limfjord variant of the Ertebølle Culture in Jutland. All types of flint, bone, antler, and ceramics are present and demonstrate that the same types of production and consumption – home base activities – took place at both sites.

A difference is observed in the style of the flint artefacts. The flint tools from Bjørnsholm are generally much more regular and carefully made than at Ertebølle. This feature is characteristic for the whole period of occupation and may reflect the presence of different groups with different traditions of flint making. Such a hypothesis is supported by the complete lack of Ertebølle sites in the fiord at Trend Å (fig. 2). Despite intensive surveys, no Ertebølle sites have been recorded in this fiord, which is approximately of the same size and with a similar habitat as the Bjørnsholm fiord. If we take all reservations with regard to source criticism and representativity into consideration, this lack of settlements is quite surprising. The Trend fiord is located half-way between the Bjørnsholm and Ertebølle sites, and an explanation for the absence of sites *could be* that this area was lying too close to the two other settlements, such that there were not enough resources to sustain a third system of exploitation.

## CONCLUSION

The Bjørnsholm *køkkenmødding* is a stratified shell-mound with a lower Ertebølle series capped by an upper Early Neolithic section belonging to the Funnel Beaker Culture. The lower (Ertebølle) shell-mound is dated to 4700–4000 B.C. while the Early Neolithic level belongs to the period 4000–3500 B.C.

The main part of the Mesolithic occupation at Bjørnsholm is roughly contemporaneous with the Ertebølle site.

No extensive traces of occupation outside the *køkkenmødding* have been found belonging to the Ertebølle occupation phase. All finds reflect basic home base activities without any trace of specialization. The material culture of the lower midden reflects the whole range of Ertebølle flint, bone, and antler types. From the Mesolithic to the Neolithic the main types and type groups continue, but in a slightly different style, reflecting that the same types of activities took place in the two periods. Indeed, the Early Neolithic shell-mound shows indications of being a real dump – most probably being peripheral to the habitation area on higher dry ground to the west of the shell-mound area.

The explanation for the continuous habitation at Bjørnsholm is to be found in resource stability – mainly in the marine biotope. Fishing – especially of eel – was of major importance.

The economy of the Early Neolithic continues in "the Mesolithic way" and is made up of a mixture of hunting, gathering, fishing (although on a smaller scale than in the Mesolithic), farming based on the cultivation of wheat and barley, and animal husbandry probably represented by a few domesticated animals.

The presence of a habitation area and a rich grave behind the shell-mound (S. H. Andersen & E. Johansen 1992) indicates that this site must have had a high economic and social importance in the Early Neolithic. Therefore, it could not have been a short term seasonal catching site, a term which has hitherto been ascribed to the Neolithic coastal sites (Madsen 1982:203–205). The Bjørnsholm site should rather be considered as a *typical* Early Neolithic settlement with a mixed economy.

The greatest change in material culture is found in the ceramics, where a new technique, new types and decoration motifs appear. At Bjørnsholm the earliest Neolithic level is characterized by undecorated funnel beakers (related to Becker's A-pottery), which are found in a stratigraphic position below pottery belonging to the Volling Group. The lower Neolithic level at Bjørnsholm is the earliest well-dated settlement find of the Funnel Beaker Culture in Northern Jutland.

The transition from the Mesolithic to the Neolithic in this region of Denmark was a very short episode which took place in less than a century, radiocarbon dated to c. 3950 B.C.

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NOTES

1. The new excavations at Bjørnsholm are part of a joint research project by the Department of Prehistoric Archaeology, University of Aarhus, and Aalborg Historiske Museum. The scientific aim is to investigate the Late Mesolithic and Early Neolithic settlement systems and subsistence basis in the northwestern part of Himmerland. The Bjørnsholm *køkkenmødding* has Central Register no. 20 of Ranum parish, Ålborg County. The project has been sponsored by Aalborg Historiske Museum, The State Antiquary, *G.E.C. Gads Fond*, The Danish Research Council for the Humanities, *Dronning Margrethe II's Arkæologiske Fond*, and *Aarhus Universitets Forskningsfond*.
2. The excavation by the National Museum in 1931 was conducted by H. C. Broholm. Report in the archives of the National Museum, file nos. 356/30 and 361/31. An area of c. 77 $m^2$ was investigated.
3. The excavation by C. L. Vebæk was positioned c. 90 m from the western border of the *køkkenmødding*. Later smaller excavations have been performed west and southwest of the Bjørnsholm *køkkenmødding* by C. L. Vebæk: A Late Neolithic grave (National Museum file no. 1107/57, Central Register 26 of Ranum parish, catalogue no. A 48150) and an Early Middle Neolithic grave (National Museum file no. 1107/57, Central Register no. 25, catalogue nos. A 48151–59 og C 27501).
4. Information by Dr. Jørgen Hylleberg, Institute of Genetics and Ecology, University of Aarhus.
5. The charcoal samples were identified by Claus Malmros, The National Museum, Natural Sciences Research Unit, Copenhagen. Letter and report of 20.2.1990.
6. Report by U. Møhl of 22.5. and 28.5.1975 in the archives of the Zoological Museum, Copenhagen.
7. Report in the Museum of Natural History, University of Aarhus. Letter of 12.9.1954.
8. In the collections from the 1931 excavation in the National Museum is the base of an Ertebølle harpoon of type A (S. H. Andersen 1972: 108 and fig. 42a).

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# Radiocarbon Datings from the Bjørnsholm Site, North Jutland

by KAARE LUND RASMUSSEN

*Sample treatment*

The conventionally dated samples were cleaned by dilute HCl prior to analysis in order to remove the outer surface. At least 10% of the sample mass was removed this way. The cleaned samples were converted to carbondioxide ($CO_2$) by acid treatment. The $CO_2$ was purified by freezing out other compounds. Subsequently the samples were dissolved in ammonium hydroxide and precipitated as carbonate. The samples were then kept in sealed flasks for at least 21 days in order to let the bulk of the radioactive $^{222}$Rn decay. After that the samples were reconverted to $CO_2$ and purified in a CaO-oven in order to remove the remaining $^{222}$Rn. Finally the samples were counted for at least 20 hours in a 2 litre 1.5 atm. conventional proportional counter equipped with a guard counter.

Stable isotope fractionation ($\delta^{13}C$) was measured on all samples. The determined ages for the samples have been corrected for isotopic fractionation to the marine value ($\delta^{13}C$ = 0 ‰ PDB) for all samples. The dates are thus directly comparable with dates for terrestrial material, i.e. no further correction is needed for reservoir effects.

The results are reported below as conventional radiocarbon ages (based on the Libby half-life) ± one standard deviation.

All samples have been calibrated into calender years using 20 years averages of the terrestrial curves in Radiocarbon (1986) with the aid of the University of Washington program. The interval of calibrated ages corresponding to ± 1 standard deviation (method A) is also reported.

*Sample description of datings from Bjørnsholm*

Samples were submitted by Søren H. Andersen unless otherwise stated.

K-5810 5210±95 BP $^{14}$C y

Shells (*Ostrea ed.*). Oysters taken from face of section, field D, co-ordinates 00/20, level 5.25 m. Expected age: Ertebølle – Early Neolithic Funnel Beaker Culture. Sample 2911 AKFK: Hg 27031. NNU A 6442.

Calibrated (Pearson *et al.*, 1986): 4030–4000 BC Cal.
Calibrated ± 1 stand. dev.: 4220–3830 BC Cal.
$\delta^{13}C$ = −0,1 ‰ PDB.

K-5817 5100±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section, field D, co-ordinates 00/90, level 5.15 m. Expected age: Early Neolithic Funnel Beaker Culture. Sample 2911 AKFL; Hg 27032. NNU A 6442.
Calibrated (Pearson *et al.*, 1986): 3960–3830 BC Cal.
Calibrated ± 1 stand. dev.: 4000–3790 BC Cal.
$\delta^{13}C$ = +0,3 ‰ PDB.

K-5818 5080±95 BP $^{14}C$ y
Shells (*Ostrea*). Oysters taken from face of section, field E, co-ordinates 00/90, level 5.25 m. Expected age: Early Neolithic Funnel Beaker Culture. Sample 2911 AKFN; Hg 27033. NNU A 6442.
Calibrated (Pearson *et al.*, 1986): 3950–3820 BC Cal.
Calibrated ± 1 stand. dev.: 3990–3780 BC Cal.
$\delta^{13}C$ +0,2 ‰ PDB.

K-5713 5320±75 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field D, co-ordinates 00/10, level +4.82 m. From the deepest part with artifacts from Middle Ertebølle Culture. Sample 2911 AENO; Hg 26933. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4230–4150 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 4320–4010 f. Kr. Cal.
$\delta^{13}C$ +1,2 ‰ PDB.

K-5714 5380±70 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field D, co-ordinates 00/10, level +4.92 m. From the lower part of the midden with artifacts from Middle Ertebølle Culture. Sample 2911 AFZZ; Hg 26945. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4240 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 4340–4050 f. Kr. Cal.
$\delta^{13}C$ +1,1 ‰ PDB.

K-5715 5360±100 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field D, co-ordinates 00/10, level +5.07 m. From the middle part of the midden with artifacts from Late Ertebølle Culture. Sample 2911 AFZY; Hg 26944. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4240 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 4340–4040 f. Kr. Cal.
$\delta^{13}C$ +0,5 ‰ PDB.

K-5716 5450± 100 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field BH, co-ordinates 100/50, level +5.13 m. Expected age: Late Ertebølle Culture. Sample 2911 AENP; Hg 26935. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4340 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 4370–4170 f. Kr. Cal.
$\delta^{13}C$ +0,7 ‰ PDB.

K-5717 5360±70 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field D, co-ordinates 00/90, level +5.17 m. From the uppermost part of the midden with artifacts of Early Neolithic Funnel Beaker Culture. Expected age: Late Ertebølle Culture – Early Funnel Beaker Culture. Sample 2911 AFZX; Hg 26943. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4240 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 4340–4050 f. Kr. Cal.
$\delta^{13}C$ +1,0 ‰ PDB.

K-5718 4860±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field D, co-ordinates 00/70, level +5.22 m. From the uppermost part of the midden with artifacts of Early Neolithic Funnel Beaker Culture. Sample 2911 AFZW; Hg 26941. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3680–3650 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 3780–3530 f. Kr. Cal.
$\delta^{13}C$ +1,5 ‰ PDB.

K-5719 5070±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field E, co-ordinates 00/100, level +5.32 m. From the uppermost part of the midden with artifacts of Early Neolithic Funnel Beaker Culture. Sample 2911 AFZU; Hg 26939. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3940–3820 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 3990–3780 f. Kr. Cal.
$\delta^{13}C$ +0,9 ‰ PDB.

K-5720 4840±95 BP $^{14}C$ y
Shells (*Cardium, Mytilus*). Shells taken from face of section in kitchen, midden field E, co-ordinates 00/100, level +5.37 m. From the uppermost part of the midden with artifacts of Early Neolithic Funnel Beaker Culture. Sample 2911 AFZT; Hg 26938. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3640 f. Kr. Cal.
Calibrated±1 stand. dev.: 3770–3520 f. Kr. Cal.
$\delta^{13}C$ +0,1 ‰ PDB.

K-5721 4760±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field E, co-ordinates 00/100, level +5.50 m. From the very top of the midden with artifacts from Early Neolithic Funnel Beaker Culture. Sample 2911 AFZS; Hg 26937. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3620–3530 f. Kr. Cal.
Calibrated ± 1 stand. dev.: 3650–3380 f. Kr. Cal.
$\delta^{13}C$ +1,1 ‰ PDB.

K-4688 5500±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field AC, co-ordinates 50/50, level 6.79 m. From the top of the shell layer. Expected age: Ertebølle Culture. Sample 2911 DAA; Hg 25945. NV VIII A 6442.

Calibrated (Pearson *et al.*, 1986): 4350 BC Cal.
Calibrated ± 1 stand. dev.: 4460–4250 BC Cal.
$\delta^{13}C$ +1,4 ‰ PDB.

K-4689 5470±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field AB, co-ordinates 10–15/35–45, level 6.61 m at the bottom of the shell layer. Expected age: Ertebølle Culture. Sample 2911 QR; Hg 25946. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4350 BC Cal.
Calibrated ± 1 stand. dev.: 4450–4240 BC Cal.
$\delta^{13}C$ +1,5 ‰ PDB.

K-4790 5050±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from top of the kitchen midden, profile 2911 SPH, field K, southern profile, co-ordinates 00,10, level 274. Early Neolithic Funnel Beaker Culture. Sample 2911 SPM; Hg 26115. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3930–3820 BC Cal.
Calibrated ±1 stand. dev.: 3980–3710 BC Cal.
$\delta^{13}C$ +1,0 ‰ PDB.

K-4791 5040±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from upper part of the kitchen midden, field K, southern profile, co-ordinates 00,10, level 290. Latest Ertebølle Culture – Early Funnel Beaker Culture. Sample 2911 SPN; Hg 26116. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3910–3810 BC Cal.
Calibrated ± 1 stand. dev.: 3980–3710 BC Cal.
$\delta^{13}C$ +1,4 ‰ PDB.

K-4792 5410±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from the middle part of the kitchen midden, field K, southern profile, co-ordinates 00,15, level 307. Middle Ertebølle Culture. Sample 2911 SPO; Hg 26117. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4330–4250 BC Cal.
Calibrated ± 1 stand. dev.: 4350–4150 BC Cal.
$\delta^{13}C$ +0,6 ‰ PDB.

K-4793 5380±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from the middle part of the kitchen midden, field L, southern profile, co-ordinates 00,85, level 275. Middle Ertebølle Culture. Sample 2911 SPP; Hg 26118. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4240 BC Cal.
Calibrated ±1 stand. dev.: 4350–4050 BC Cal.
$\delta^{13}C$ +0,5 ‰ PDB.

K-4794 5560±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from lower part of the kitchen midden, field L, southern profile, co-ordinates 00,75, level 305. Middle Ertebølle Culture. Sample 2911 SPR; Hg 26119. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4450–4370 BC Cal.
Calibrated ± 1 stand. dev.: 4500–4350 BC Cal.
$\delta^{13}C$ +1,1 ‰ PDB.

K-4795 5310±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from lowermost part of kitchen midden, field L, southern profile, co-ordinates 00,85, level 335. Ertebølle Culture. Sample 2911 SPS; Hg 26120. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4220–4050 BC Cal.
Calibrated ±1 stand. dev.: 4320–4000 BC Cal.
$\delta^{13}C$ +1,3 ‰ PDB.

K-4796 4960±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from kitchen midden, plan 2911 LZZ, field D, co-ordinates 30,30, level 304–306. In direct contact with sherds from Early Neolithic Funnel Beaker Culture. Sample 2911 PLA; Hg 26121. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3780–3710 BC Cal.
Calibrated ±1 stand. dev.: 3940–3690 BC Cal.
$\delta^{13}C$ +0,8 ‰ PDB.

K-4945 5440±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from kitchen midden, profile 2911 SPH, field L, co-ordinates 00,50, level 330–338. Middle Ertebølle Culture. Dated as control for earlier date K-4795 (see above). Sample 2911 OSX; SHg 1824. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4340 f. Kr. Kal.
Calibrated ±1 stand. dev.: 4360–4170 BC Cal.
$\delta^{13}C$ +0,8 ‰ PDB.

K-5068 5300±90 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from a kitchen midden, field R, co-ordinates 00,20, level 225–230. Transition Middle/Early Ertebølle Culture. Sample 2911 AADX; Hg 26363. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4220–4050 BC Cal.
Calibrated ±1 stand. dev.: 4240–4000 BC Cal.
$\delta^{13}C$ +1,8 ‰ PDB.

K-5069 5720±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from a kitchen midden, southern profile of field R, co-ordinates 00,20, level 245–250. Middle – Early Ertebølle Culture. Sample 2911 AADY; Hg 26362. NM VIII A 6442.
Calibrated (*Pearson et al.*, 1986): 4650–4580 BC Cal.
Calibrated ±1 stand. dev.: 4720–4470 BC Cal.
$\delta^{13}C$ +0,5 ‰ PDB.

K-5070 5770±70 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from kitchen midden, southern profile of field R, co-ordinates 00,20, level 255–260. Early Ertebølle Culture. Sample 2911 AADZ; Hg 26361. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4670–4620 BC Cal.
Calibrated ±1 stand.dev.: 4770–4530 BC Cal.
$\delta^{13}C$ +1,0 ‰ PDB.

K-5071 5840±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from kitchen midden, southern

profile of field R, co-ordinates 00,20, level 275. Early Ertebølle Culture. Sample 2911 AAEA; Hg 26360. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4770–4730 BC Cal.
Calibrated ±1 stand. dev.: 4890–4590 BC Cal.
$\delta^{13}C$ +0,1 ‰ PDB.

K-5515 4890±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field BJ, co-ordinates 100/35, level 5.50 m. Originates from the uppermost layer of the midden with artifacts from Early Neolithic Funnel Beaker Culture. Sample 2911 UAM; Hg 26741. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3700 BC Cal.
Calibrated ±1 stand. dev.: 3780–3540 BC Cal.
$\delta^{13}C$ +1,0 ‰ PDB.

K-5516 5110±95 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from face of section in kitchen midden, field BH, co-ordinates 100/85, level 5.40 m. In direct contact with a large fragment of an Early Neolithic Funnel Beaker. Sample 2911 UAS, Hg 26742. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 3960–3830 BC Cal.
Calibrated ±1 stand. dev.: 4030–3790 BC Cal.
$\delta^{13}C$ −2,8 ‰ PDB.

K-5304 6090±100 BP $^{14}C$ y
Shells (*Ostrea ed.*). Oysters taken from kitchen midden, field U, layer 2, level 5.24–5.30 m on the highest point of a beach ridge. Early Ertebølle Culture. Submitted by C. Malmros and S.H. Andersen. Sample FHM 2911, Bjørnsholm 1988; Hg 26474. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 5050–5000 BC Cal.
Calibrated ±1 stand. dev.: 5210–4900 BC Cal.
$\delta^{13}C$ +1,3 ‰ PDB.

K-5306 5440±95 BP $^{14}C$ y
Shells (*Cardium, Litorina*). Shells taken from field Ø, layer 6, level 4.29–4.51 m, in marine sand layer at the foot of the kitchen midden. Expected age: Early Ertebølle Culture. Sample FHM 2911; Hg 26590. NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4340 BC Cal.
Calibrated ±1 stand. dev.: 4360–4160 BC Cal.
$\delta^{13}C$ +0,9 ‰ PDB.

K-5307 5850±95 BP $^{14}C$ y
Shells (*Ostrea, Cardium, Mytilus and Litorina*). Shells found in field Ø, layer 2, level 3.08–3.28 m, in the deepest marine sand layer at the foot of the kitchen midden. Layer contained flint. Sample FHM 2911; Hg 26588 NM VIII A 6442.
Calibrated (Pearson *et al.*, 1986): 4770 BC Cal.
Calibrated ±1 stand. dev.: 4890–4600 BC Cal.
$\delta^{13}C$ +4,0 ‰ PDB.

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