

'Køkkenmøddinger' (Shell Middens) in Denmark: a Survey

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This paper presents a review of prehistoric shell midden sites ('Køkkenmøddinger') in Denmark. The form and structure of these sites, their contents, distributions, cultural associations, and chronology are discussed. It is concluded that they are not a unique type of coastal settlement but represent coastal, homebase settlements characterised by a dominance of shellfish in the cultural deposits. This is the only aspect by which they differ from the rest of the coastal habitation system. Shell midden sites seem to flourish in periods characterised by a rich marine biotope and coastal habitation can be seen as a direct reflection of variations/changes in the marine biotope.

HISTORY OF RESEARCH

The archaeological investigation of *Køkkenmøddinger* (shell middens) has a 150-year long tradition in Denmark. Already by 1837 artefacts from a midden in Northern Jutland (Knabbesholm) were sent to the National Museum in Copenhagen and, together with other similar finds, this material gave rise to a discussion as to whether they were natural phenomena or humanly created sites/settlements. A multi-disciplinary working group was set up in 1848, comprising an archaeologist, a zoologist, a botanist, and an expert on molluscs, in an effort to clarify the question (*The First Kitchen Midden Commission*). It was the first time such an inter-disciplinary group was established to work on a prehistoric issue in Denmark (and northern Europe), and it formed the starting point of a research tradition which has continued up to modern times, and which has always been a very characteristic aspect of Danish *Køkkenmødding* research. In 1851 these finds were placed in their correct context – as settlements – and the term *Køkkenmødding* was used to characterise these sites.

At the close of the 19th century an excavation was carried out of part of the large midden at Ertebølle (*locus classicus* – *The Second Kitchen Midden Commission*), a name which later became synony-

mous with the Late Mesolithic of Northern Europe as it gave its name to the Ertebølle Culture (5400–3900 cal. BC). The purpose of this excavation was, first, to recover a large assemblage of artefacts from one big settlement site and, secondly, to try to date the period more precisely in relation to the Postglacial forest succession in Denmark. After both these targets were met (Madsen *et al.* 1900), the remaining part of this midden, and others, was scheduled for protection – an act of crucial importance because it has provided us with the possibility of carrying out revising excavations of the classical sites using modern techniques in order to investigate new questions and theories (Andersen & Johansen 1987; Andersen 1993).

Since the first excavations, about 150 years ago, other kitchen middens have been excavated from time to time and in the first half of the 20th century the first regional study of shell middens and their relation to the topography of the Atlantic coast around Roskilde Fjord was published (Mathiassen 1919). However, larger inter-disciplinary excavations involving both archaeologists and scientists were not resumed until the 1970s and 1980s. Among the sites excavated at that time were the middens at Meilgaard, Norsminde (Andersen 1991), Ertebølle (Andersen & Johansen 1987), and Bjørnsholm (Andersen 1993).

The shell midden excavations of the 19th century covered only small sections or areas and the deposits were excavated in metre-square grids in 0.20 m thick

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layers. Gradually the predominant field technique changed towards the three-dimensional recording of all cultural objects combined with measured profiles and, today, we are now excavating large areas of the middens as well as radiocarbon dating whole middens and 'systems' of middens in topographically well-defined regions (*ibid.*). In recent years the attention of research has been broadened. In the late 19th century the excavations were primarily aimed at solving chronological issues but, gradually, the focus of investigations has turned to questions of intra-site patterning, formation processes, and function. In addition, the excavations have been concentrated not only in the middens themselves but also, more importantly, to the area beneath, to the 'rear' and 'in front' of the middens in order to recover synchronous living floors, activity areas, and other features below and within the middens. This development could be described as a *trend from objects to contexts and from chronology to site formation and function.*

One other important advance of recent years has been the wet sieving of excavated material, which has made it possible to demonstrate that fishing was the main economic activity at these sites and that shellfish gathering, though providing the main bulk of the *Køkkenmøddinger*, was not the essential subsistence activity. Finally, there is also a growing recognition of the possibility of using ethnographic information (descriptions and pictures) with major significance for the interpretation of the Danish kitchen middens.

Why are shell middens essential for Mesolithic studies?

Primarily, the generally good preservation condition for organics provides excellent information on subsistence and seasonality – aspects which are especially important in regions where organic materials otherwise are not preserved. Secondly, the organic content also provides the potential for radiocarbon dating (shells, charcoal, and bones).

In addition, the middens have a stratigraphical resolution which is unmatched by other types of Mesolithic settlements, which makes it possible to follow typological and economical developments over very short time spans and within a well defined biotope. The shell layers can also be separated into a number of horizontal layers which makes it possible to investigate surfaces – 'living floors' – from individual occupations, reflecting short term activity

episodes which otherwise would have been blurred/destroyed by later activities on other, more ordinary, settlement sites.

Furthermore, there is a particular group of shell middens, known as 'stratified shell heaps', which is still the best source for studies of the transition from the Mesolithic to the Neolithic and thus also for testimony about the first Early Neolithic living conditions.

DEFINITION

The Danish *Køkkenmøddinger* are a special type of coastal settlement in which shell refuse is a dominant part but which is mixed with cultural debris such as flint, bone, antler, charcoal, ceramics, ash, fire-cracked stones ('potboilers'), and features such as hearths, pits, stake-holes and graves, etc. In Denmark a *shell midden* is a sediment of which at least 50% of the volume must consist of shells or fragments of such: in addition, the area of the shell deposits must exceed 10 m² and the layer must form a continuous horizon. A *shell midden site* is a shell midden on whose surface(s) daily life activities took place and which was of importance to its users. The Danish *Køkkenmøddinger* are generally very 'compact' in their structure and shells and shell fragments normally make up to 70–80% (or more) of the cubic content. The amount of cultural debris is large.

The most famous type of Danish shell midden is the Late Mesolithic *Køkkenmøddinger* from the Ertebølle culture (5400–3900 cal. BC), however, middens are also known from the Early and Middle Neolithic (4000–2400 cal. BC) and from the Early Iron Age (500 cal BC–cal. AD 100).

DISTRIBUTION

Distribution of shell middens

In Scandinavia *Køkkenmøddinger* are – with a few exceptions situated on the west Swedish coast – known only in Denmark, where c. 500–550 are recorded (Figs 1 & 2). This is a fairly small number compared to an Atlantic coastline of c. 7300 km! In the rest of Northern Europe they are found only in Scotland, especially in the West Scottish archipelago (Mellars 1987).

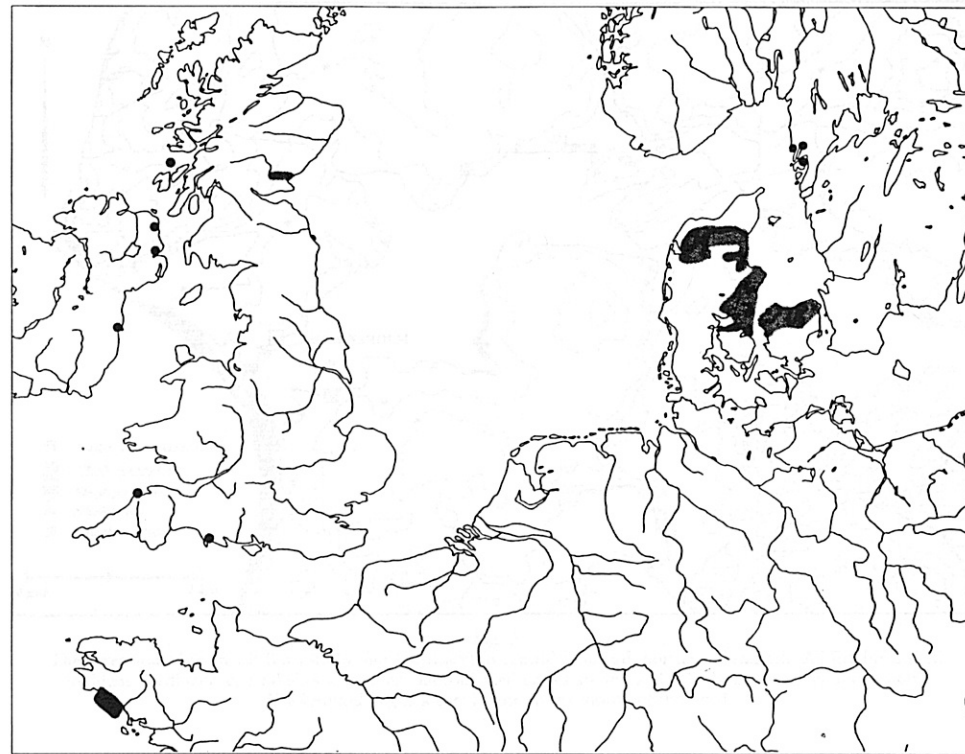


Fig. 1

The general distribution of Mesolithic shell middens and shell midden groupings in north-western Europe (shaded)

In Denmark the distribution is closely connected with the occurrence of prehistoric, 'natural' shell banks. Only in the north and north-eastern parts of this region was the Atlantic Sea warm, saline, and rich enough in nutrients to permit the formation of natural mollusc banks which could be exploited.

Local distribution

Mesolithic shell middens always lie directly on, and along, prehistoric coastlines; in contrast, the Neolithic middens are sometimes found up to c. 400 m from a coastline – a fact which clearly reflects different attitudes and behavior towards the marine molluscs in

this period than in the Late Mesolithic (Madsen *et al.* 1900, 147–8).

The distribution of shell middens within a Danish fiord

The Danish shell middens are found in estuaries, calm bays, or lagoons. A location on an exposed coast is the exception. In limited areas such as fiords, bays, etc., only one of the middens will be large and there is a tendency that this site will be centrally positioned in the region or close to the mouth of the inlet (Fig. 3).

Køkkenmøddinger are only one of a varying number of utilised sites situated in the estuaries and,

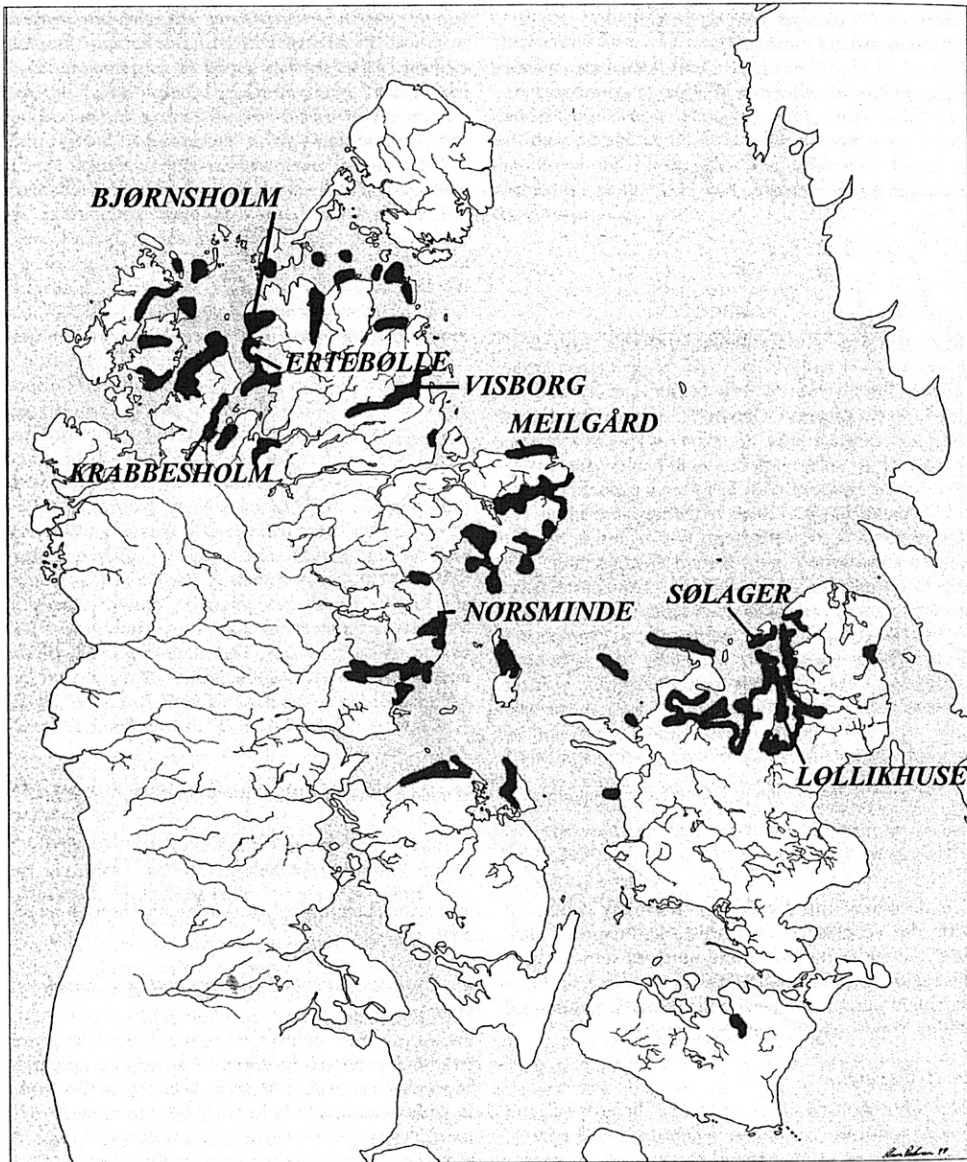


Fig. 2

The Distribution of *Køkkenmøddinger* in Denmark (shaded). This type of settlement is restricted to the north-north-eastern part of the region while Ertebølle coastal settlements are found along all the prehistoric coastlines

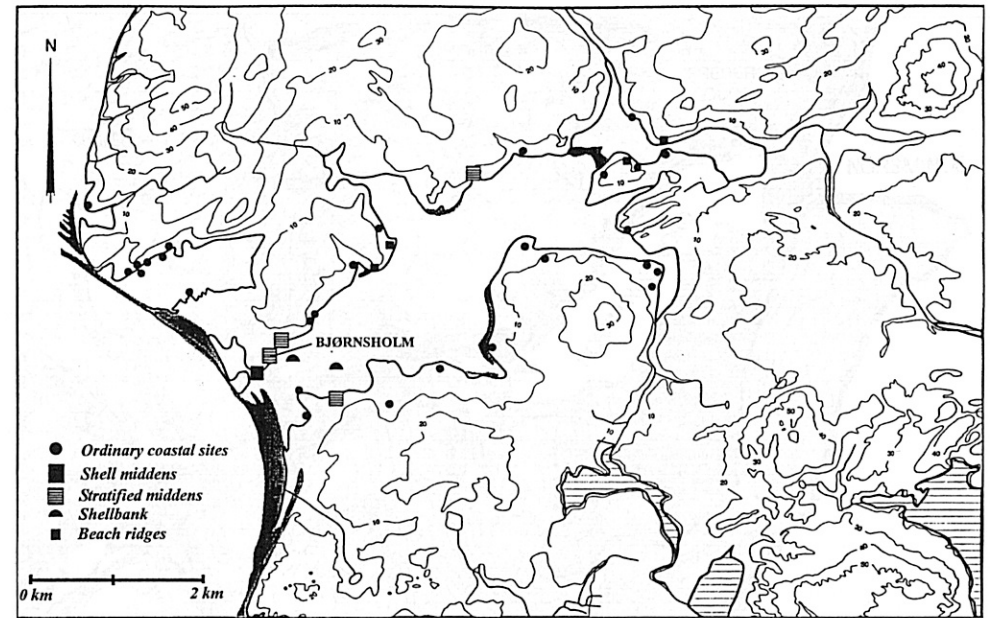


Fig. 3

The extension of the fossil Bjørnsholm fiord (estuary) in central Limfjord, northern Denmark. All Ertebølle shell middens, 'ordinary' coastal sites as well as 'natural' shell banks are marked. The largest site, the Bjørnsholm *Køkkenmødding* is located close to the mouth of the fiord

even in small fiords, the kitchen middens are always found together with coastal settlements sites without shell layers, the so called 'ordinary' coastal settlements (Andersen 1995, 48). Although there might be several shell middens in such a fiord, it is important to observe that the 'ordinary' sites generally comprise the majority of coastal settlements in the individual regions. Contrary to general opinion, several of the most famous Danish Ertebølle coastal settlements, such as Brabrand (Thomsen & Jessen 1906) and Dyrholmen (Mathiassen *et al.* 1948) are *not* kitchen middens, but 'ordinary' coastal settlements sites *without* shell accumulations.

The shell middens must not, therefore, be regarded in isolation; they were associated with a diversity of functions and should be put in their rightful place as parts of whole settlement units and not, as is frequently the case, be seen as individual, unique sites. Except for the presence of shell refuse, shell midden

sites appear identical to non-shell midden sites in function on the basis of the artefact inventories, activities, and faunal remains represented, and their location *always* follows the settlement patterns of the Ertebølle culture (Andersen 1995, 45–52). One of the essential factors for the location of Ertebølle coastal settlements was access to good fishing and it is evident that this economic aspect was one of, if not the, main localisational parameter(s) for this type of site. In other words, the 'non-molluscan' resources had greatest effect on the choice of site location (Fig. 18).

The *Køkkenmøddinger* were located close to places where mollusc banks developed during the Atlantic-Sub-boreal periods. Therefore, for a coastal settlement to become a *Køkkenmødding* depended on the presence of a natural shell bank within an 'economic' distance of the settlement. If that was the case, then it was exploited, and a kitchen midden accumulated on the settlement. If no special effort was made to collect

shellfish and transport them to the site, then we find 'ordinary' coastal settlements. This is nicely illustrated by the situation at Ertebølle itself (Fig. 4), where a natural shell bed, contemporary with the *Køkkenmødding*, was located 'in front' of the midden (Andersen & Johansen 1987, 33; Petersen 1987, 79). Here, contemporary coastal settlement along a 250 m stretch of coastline included three kitchen middens and an extensive 'ordinary' coastal site (*ibid.*, fig. 3).

If the marine biotope was especially productive there could be several contemporary kitchen middens, even in quite small fiords, and they could be located very close to each other. In several cases a distance of just a few hundred metres separated them: for instance, there are four middens along a c. 5 km stretch of the north shore of Norsminde Fjord in eastern Jutland (Fig. 5) and, originally, there may well have been several more.

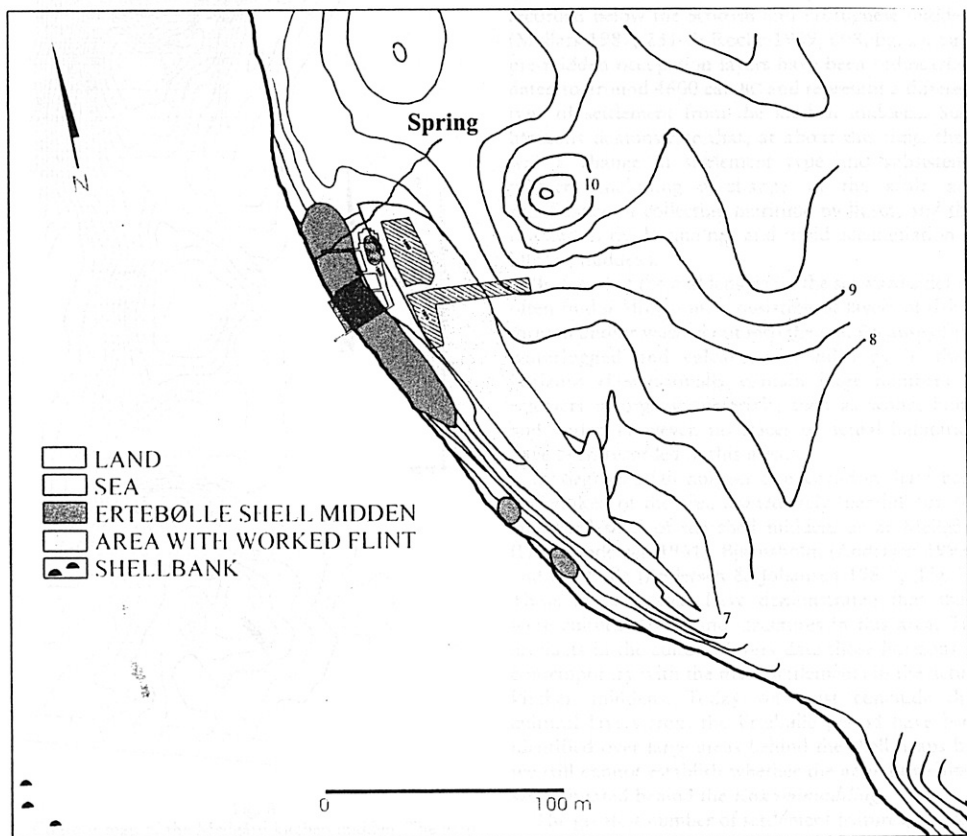


Fig. 4

The Ertebølle *Køkkenmødding* (*Locus classicus*) and the contemporary shell bed in front of it

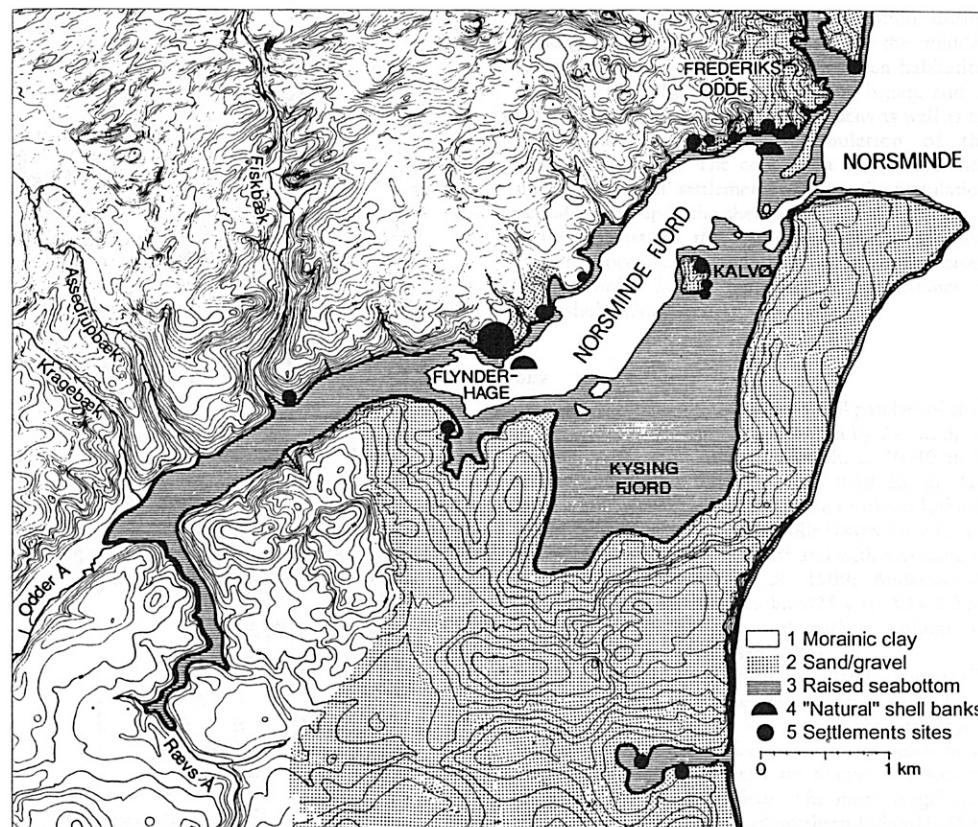


Fig. 5

The Norsminde fjord in eastern Jutland. All Ertebølle shell middens and ordinary coastal settlements are indicated. The largest site, the Flynderhage *Køkkenmødding*, is centrally located in the territory

FORM AND SIZE OF THE DANISH SHELL MIDDENS

Form

The Danish *Køkkenmøddinger* generally have an oblong outline. This is in contrast to the dome-shaped middens of Scotland and Portugal (Mellars 1987, 118, fig. 8.1; 154, fig. 11.1; 170-1, fig. 11.18, 11.19, 194; Roche 1972, 28, fig. 4) or the horseshoe-shaped examples in Japan (Koike 1986, 32, fig. 3). In cases where the surface and contour of the midden is well preserved it can be demonstrated that they consist of

more-or-less clearly delimited, individual 'heaps' - a fact which has also been demonstrated by stratigraphical analysis.

The form of the middens is a product of depositional and post-depositional processes. Horizontal as well as vertical series of radiocarbon dates combined with stratigraphical analysis demonstrate that the shape and size of the middens is a direct function of the duration of occupation at the same location. The dates reflect a gradual, chrono-

logical movement – mainly in a horizontal but also in a vertical manner along the prehistoric coast, thereby creating the characteristic form.

In order to cast new light on the essential question as to where the occupants actually lived during midden accumulation, extensive excavations have been performed in the areas beneath, around, and in the middens. The area beneath the *Køkkenmøddinger* is generally rich in cultural debris and features indicating that, generally, substantial occupation took place before shell accumulation started (pre-midden occupation horizon), but these occupation layers seldom contain shells. Identical patterns have been recorded below the Scottish and Portuguese middens (Mellars 1987, 231–2; Roche 1989, 608, fig. 2). Such pre-midden occupation layers have been radiocarbon dated to around 4600 cal. BC and represent a different type of settlement from the kitchen middens. Such horizons demonstrate that, at about this time, there was a change in settlement type and subsistence pattern, including a change in the scale and significance of collecting maritime molluscs, and this resulted in the beginnings and rapid accumulation of kitchen middens.

'In front' of the middens (ie on the seaward side) we often find a 'drop-zone' consisting of layers of debris thrown and/or washed out into the sea. Because of the waterlogged and calcareous conditions in these horizons they normally contain large numbers of artefacts in organic materials, such as wood, bone, and antler. However, no traces of actual habitation have been recorded in this area.

By degrees a fair number of excavations have been undertaken of the area immediately 'behind' (on the landward side) of the shell midden, as at Meilgård (H.H. Andersen 1961), Bjørnsholm (Andersen 1993), and Ertebølle (Andersen & Johansen 1987), (Fig. 7). These investigations have demonstrated that there were cultural layers and structures in this area. The artefacts in the cultural layers date those horizons as contemporary with the main settlements in the actual kitchen middens. Today we must conclude that cultural layers from the Ertebølle period have been identified over large areas behind the shell heaps but we still cannot establish whether the actual dwellings were situated behind the *Køkkenmødding*.

The greatest number of settlement features, discrete distribution of cultural debris around the fireplaces, and extensive ash horizons defining old surfaces, come from the midden layers themselves, thereby

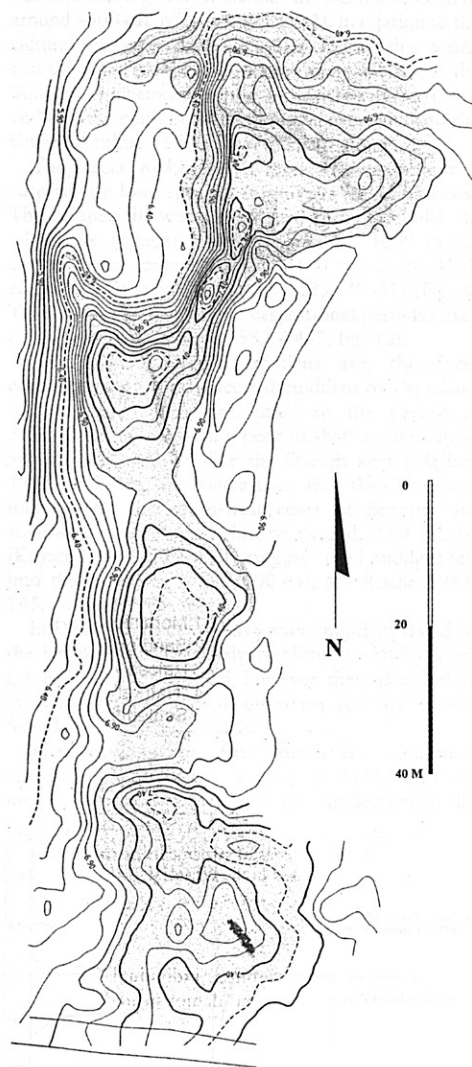


Fig. 6

Contour map of the Meilgård kitchen midden. The map contours demonstrate that the midden constitutes at least four individual, smaller 'heaps'. The grey shading indicates the total extent of the shell midden

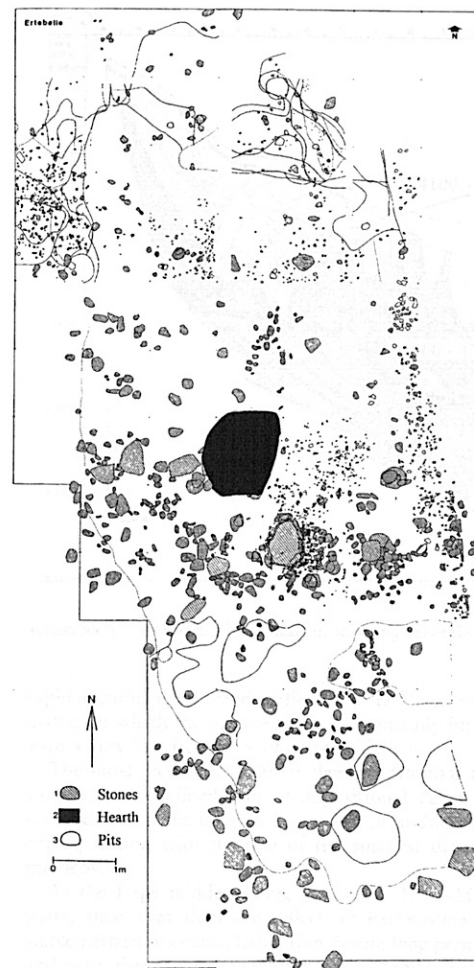


Fig. 7

Plan of the occupation area to the rear of the Ertebølle *Køkkenmødding*. It is contemporary with the main occupational period of the midden and comprises a centrally located hearth and a nearby large stone, which has served as a *locus* for flintknapping; in the periphery is a series of shallow pits

demonstrating that the actual occupation during midden accumulation took place on the midden surface. Taken as a whole there has been habitation below (before) the shell accumulation began, and in the area immediately behind the middens as well as on the midden during the accumulation of the *Køkkenmøddinger*. The conclusion is that the shell middens are 'real' settlements and that the population actually lived upon the shell heaps.

In contrast to the Mesolithic sites, extensive Neolithic occupation horizons have, in several cases, been recorded *behind* the middens, for instance at Bjørnsholm (Andersen 1995, 65–6).

Size

The size of middens varies from small patches of shell debris measuring as little as c. 2–7 m by 2–7 m up to middens of c. 600–700 m in length, c. 30–40 m in width, and with a thickness of c. 0.10–2.0 m. The largest kitchen middens are found in northern Jutland, the finest examples being Ertebølle (140 x 20 x 1.9 m) covering an area of c. 2800 m² and with a volume of c. 2000 m³ (Madsen *et al.* 1990; Andersen & Johansen 1987) and Bjørnsholm (325 x 10–50 x 1.2 m) covering c. 10,000 m² and with a volume of c. 5000–8000 m³ (Andersen 1993).

The shell middens in northern Jutland are generally more extensive with thicker deposits than the middens in eastern Denmark and, at the same time, the layers in the east Danish middens seem to be much more compressed while the shells are thinner and smaller than in the Jutland middens. The mean length and width of the shell middens of northern Jutland is 59 m and 27 m respectively and for the Zealand middens it is 33.2 m (length) and 15.8 m (width).

The Danish middens are substantially thinner than, for instance, the Portuguese ones which are up to c. 2–5 m in thickness but they cover a much larger area than these, which are only c. 1000–8000 m² in extent (Arnaud 1989, 619, table 2).

CHRONOLOGY

The oldest *Køkkenmøddinger* date back to c. 5600–5400 cal. BC. The numbers of shell middens reflect a clear increase towards the later part of the Atlantic Period, and the majority belong to the period c. 4900–3900 cal. BC. The most intense phase of

Køkkenmødding accumulation in Denmark centred around 4500 cal. BC (Andersen 1992). In relation to the cultural sequence of the Danish Mesolithic this means that the oldest Danish *Køkkenmøddinger* belong to the Younger Kongemose culture (c. 6000–5400 cal. BC) and that the main body of middens corresponds to the Ertebølle culture (5400–3900 cal. BC) (Fig. 8).

The larger *Køkkenmøddinger* were used over a surprisingly long span of time, c. 1000–1500 years. This is especially well documented at the Ertebølle site where the occupation extends over c. 1000 radiocarbon years, ranging from c. 5100 cal. BC to 4100 cal. BC (Andersen & Johansen 1987, 49–51) (Fig. 8; Table 1); at Bjørnsholm the depositional periods cover c. 1500 years (Andersen 1993, 74–7, fig. 13).

The Danish kitchen middens are, therefore, contemporary with the Scottish middens on the island of Oronsay, which are dated to the period c. 5100–4000 cal. BC with a peak in shell accumulation around 4500 cal. BC like the Danish sites (Mellars 1987, 139–49). In contrast to this the American middens on the south-west coast of Brittany are somewhat older as they date to around 5600 cal. BC (Kayser 1986) while the Portuguese shell middens fall into the period c. 5400–3500 cal. BC (Roche 1983, 165; Arnaud 1989, 619).

In Denmark there are also many middens dated to the beginning of the Early Neolithic (c. 4000–3700 cal. BC). After this period, however, there is a decline in midden frequency and only very few are known from later Neolithic periods.

The explanation for this very delimited chronological frequency is most probably that the number of shell middens is a direct reflection of the

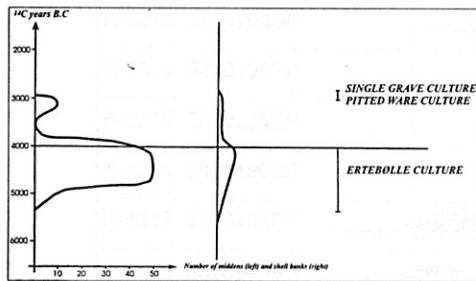


Fig. 8

Graph showing the frequency of shell middens as a function of time (left) and the number of 'natural' shell banks (right)

productivity of the marine biotope and thereby the growth/productivity of the 'natural' shell beds (Fig. 9). The surprisingly long continuity of occupation at the same coastal location – based on resources from the marine biotope – must also have led to distinct social patterns and storing techniques that were different to those of the Earlier Mesolithic (Rowley-Conwy & Zvelebil 1989, 51–6).

COMPOSITION

The shell middens are not homogeneous units but, quite the contrary, display layers containing a mixture of different species of shellfish and a varying intensity of cultural debris (Fig. 10). The range and variation of species is few and comprise oysters (*Ostrea sp.*), cockles (*Cerastoderma edulis*), mussels (*Mytilus edulis*), and periwinkles (*Littorina littorea*).

Stratigraphical observations show that the middens always are compiled of many smaller heaps or layers of shellfish and cultural waste and that the largest middens were never large from the very beginning. Such small heaps measure c. 2–7 x 2–7 m and are not only known from stratigraphical analysis of the large middens but have also been found and excavated during the last decades. No shell midden provides a stratigraphic sequence that can serve as a model for the analysis of every site; rather the individual sites present partial, localised stratigraphies which, to some extent, can be inter-correlated. The excavations reflect that shellfish gathering was a regular, seasonal activity. Most processing, consuming, and disposal of the shell food took place on the midden; each species was processed separately and the refuse was discarded around a fireplace, which explains the small, localised 'heaps' or horizons of single species within the middens (Madsen *et al.* 1900, 22, 28). The location of the areas of the site that were in use shifted through time, as did the refuse heaps surrounding the activity loci.

The mixture of the shell matrix is best interpreted as being the result of cleaning of the occupation surface of rubbish into specific areas of the settlement. Therefore, rubbish from one occupation may easily become mixed with that of the following occupations. By careful excavation and refitting of artefacts it is possible to define and follow old living surfaces within the middens. They are characterised by a slow rate – or no – accumulation and by a high frequency of cultural debris and crushed shells, while periods of

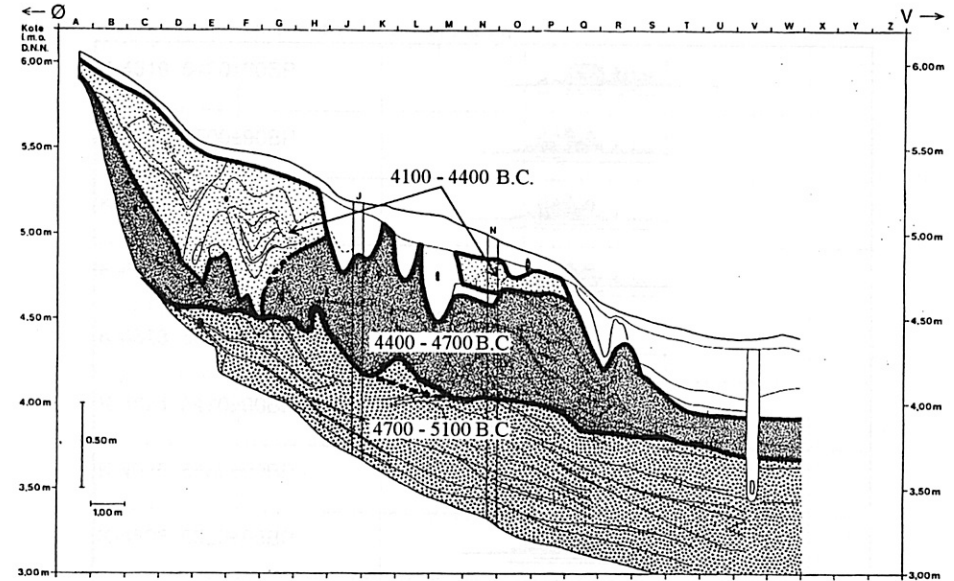


Fig. 9

Cross section of the Ertebølle midden showing generalised accumulation sequence based on radiocarbon dating (Table 1)

rapid accumulation are identified by a very loose shell matrix in which the marine shells are generally intact with a very low frequency of cultural debris.

The most recent excavations demonstrate that the smallest, well-defined unit of depositional debris in the middens seems to be c. 2–7 x 2–7 m in diameter, corresponding with the size of the smallest discrete middens.

As the large middens were used over 1000–1500 years, such sites therefore reflect an extraordinarily stable pattern of coastal habitation during long periods and must, therefore, also reflect resource stability in the coastal/marine biotope. On the Danish Limfjord the intensive fishing of eel (*Anguilla anguilla*) seems to be one of a series of essential elements in the stable subsistence activity throughout the whole occupation period (Andersen & Johansen 1987, 58–9).

The Mesolithic shell middens are dominated by oysters (*Ostrea edulis*: 50–60 %), followed by cockles, mussels, and periwinkles, while the remainder of the residue is composed of sand, pebbles <50 mm in diameter, flint artefacts and debris, bones of mammals,

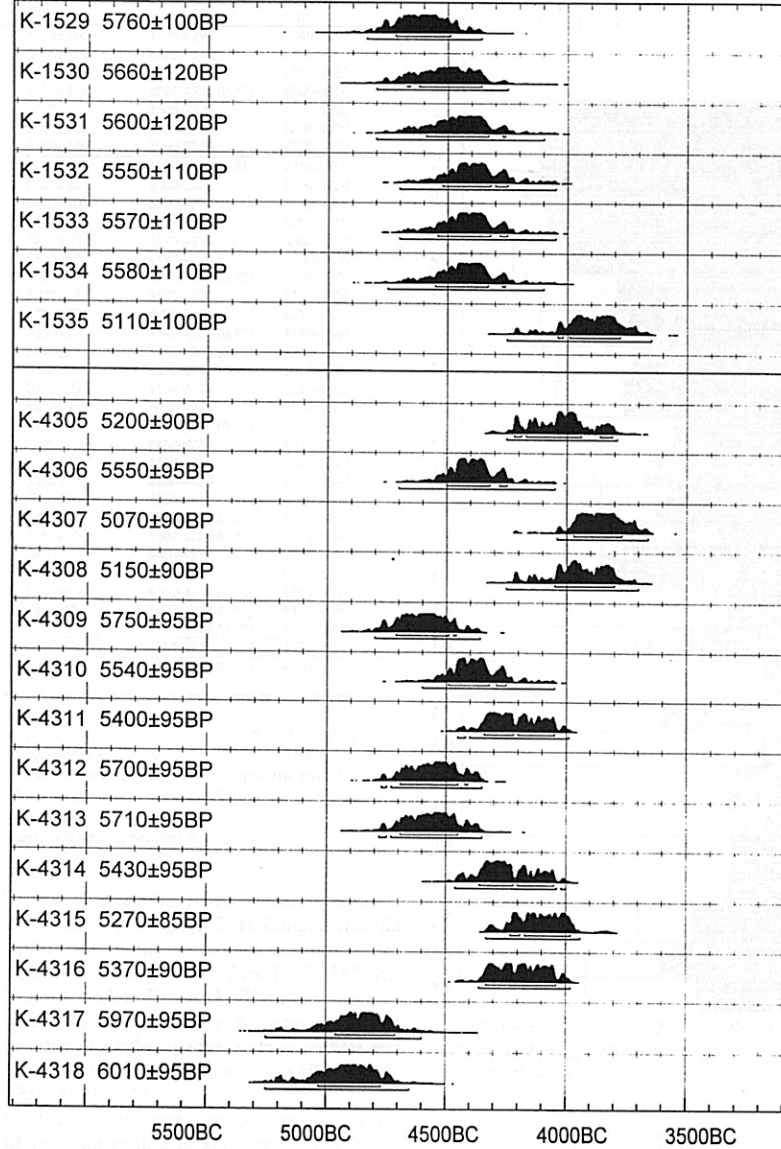


Fig. 10

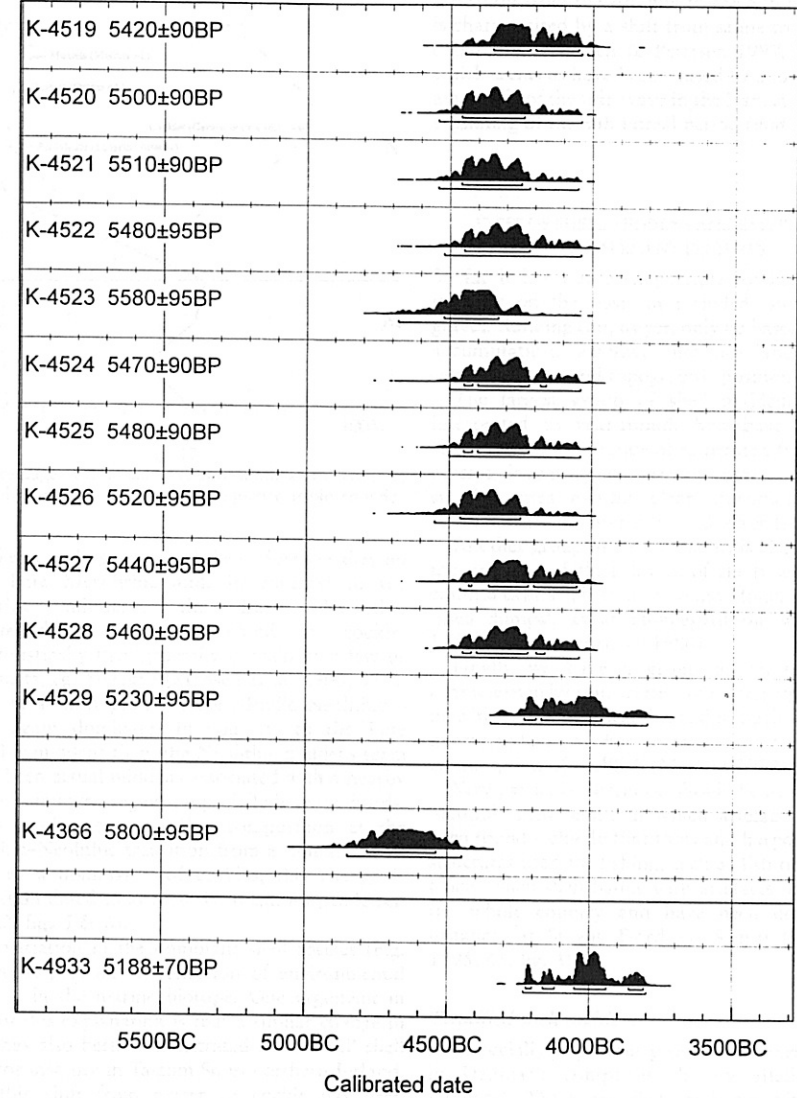
Section through the Ertebølle kitchen midden

TABLE 1: RADIOCARBON DATES FOR THE ERTEBØLLE SHELL MIDDEN

Atmospheric data from Stuiver et al. (1998); OxCal v2.18 cub r.4 sd:12 prob[chron]



Atmospheric data from Stuiver et al. (1998); OxCal v2.18 cub r.4 sd:12 prob[chron]



Lab. Ref.	Determination BP	Date cal. BC (1σ)	Date cal. BC (2σ)
K-1529	5760±100	4720-4490	4840-4360
K-1530	5660±120	4620-4360	4800-4250
K-1531	5600±120	4590-4330	4800-4100
K-1532	5550±110	4520-4320 (0.87)	4700-4050
K-1533	5570±110	4540-4320	4700-4050
K-1534	5580±110	4550-4330	4750-4100
K-1535	5110±100	3990-3780	4250-3650
K-4305	5200±90	4170-3940 (0.81)	4250-3790
K-4306	5550±95	4500-4320	4700-4050
K-4307	5070±90	3970-3770	4040-3660
K-4308	5150±90	4050-3800	4250-3700
K-4309	5750±95	4710-4490	4800-4360
K-4310	5540±95	4490-4320 (0.87)	4290-4250
K-4311	5400±95	4340-4220 (0.60)	4600-4050
K-4312	5700±95	4690-4450	4730-4350
K-4313	5710±95	4690-4450	4730-4350
K-4314	5430±95	4360-4220 (0.72)	4460-4040
K-4315	5270±85	4170-3980 (0.84)	4330-3940
K-4316	5370±90	4330-4040	4360-3980
K-4317	5970±95	4960-4710	5250-4600
K-4318	6010±95	5030-4770	5250-4650
K-4519	5420±90	4350-4220 (0.71)	4450-4040
K-4520	5500±90	4460-4240	4540-4040
K-4521	5510±90	4460-4250	4540-4220
K-4522	5480±95	4450-4220	4520-4040
K-4523	5580±95	4520-4330	4680-4220
K-4524	5470±90	4400-4220 (0.85)	4500-4040
K-4525	5480±90	4400-4220 (0.87)	4500-4040
K-4525	5480±90	4400-4220	4500-4040
K-4526	5520±95	4460-4250	4550-4050
K-4527	5440±95	4360-4220 (0.74)	4460-4040
K-4528	5460±95	4400-4220 (0.82)	4490-4040
K-4529	5230±95	4170-3960 (0.87)	4350-3800
K-4366	5800±95	4780-4540	4850-4450
K-4933	5188±70	4050-3940 (0.75)	4230-3800

The dates K-1519–K-1535, K-4305–K-4318, K-4519–K-4529 are based on oyster shells (*Ostrea edulis*). K-4366 is on charcoal from the pre-midden layer below the midden. K4933 is based on human bone (cf. Fig. 17)

Atmospheric data from Stuiver *et al.* (1998)

fish, and birds, ceramics, ash, charcoal, and firecracked stones (Petersen 1987, 82–3, figs 3–4). Limpets (*Patella sp.*), which are the dominant species in other north-west European shell middens (Mellars 1987, 162, fig. 11, 9) are not found in Denmark. The dominance of oysters in the Danish middens is a characteristic aspect of the region because other species, such as cockles and mussels, seem to dominate in other areas (Pequart & Pequart 1954, 14; Fig. 11).

The Neolithic shell middens contain a greater content of soil, charcoal, ash, and firecracked stones than the Mesolithic ones. Quantitatively the shells do

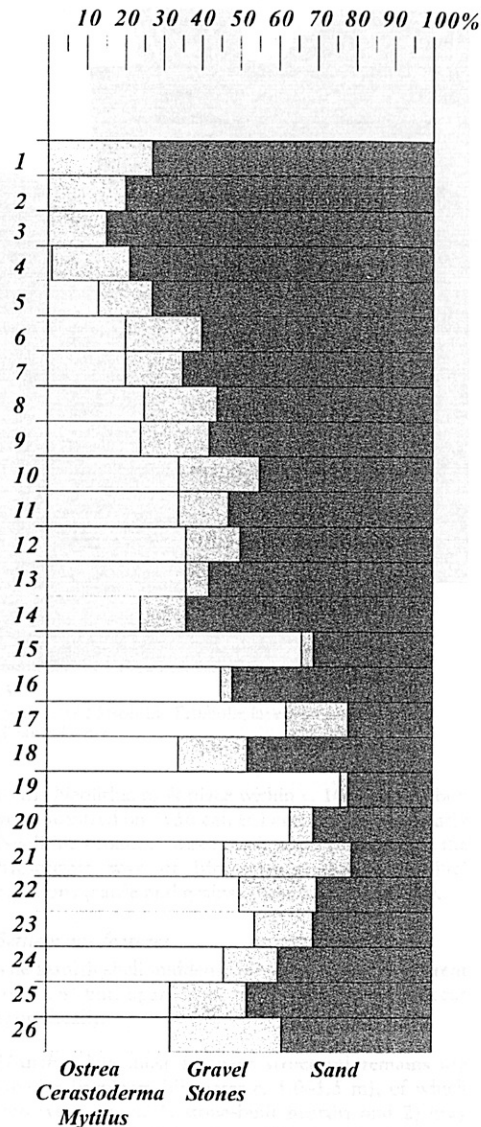


Fig. 11 Graph of the relative frequency of shells, stones, and sand in column sample J through the Ertebølle midden (partially after K.S. Petersen 1987)

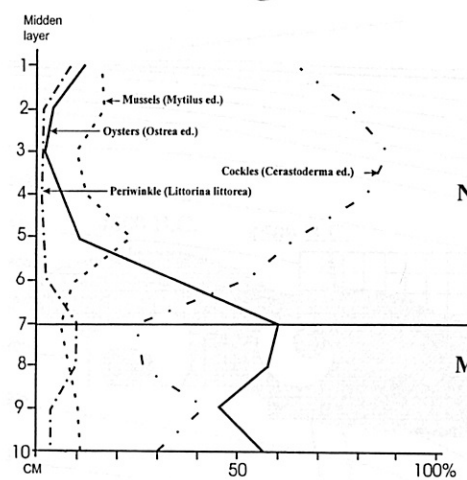


Fig. 12 The percentage of different species of molluscs through the Mesolithic and Neolithic midden sequence at Norsminde

not make up as large a part of the middens as they do in the Late Mesolithic and, in contrast to the Mesolithic middens, the Early Neolithic *Køkkenmøddinger* are dominated by cockle. Characteristically they generally contain very few or no artefacts, eg. Vejlekro (Madsen *et al.* 1900, 117). Later – in a short phase of the Middle Neolithic – oysters again dominate. In contrast to the Late Mesolithic middens then, the Neolithic middens seem to have been actual middens associated with a nearby settlement. In many regions, especially in many fiords, there is a change in midden composition at the Mesolithic–Neolithic transition from a dominance of oysters to a dominance of cockles; this change is radiocarbon dated to around 3950 cal. BC (Andersen 1991, 22, figs 5 & 6).

This variation in the dominant shell species (Fig. 12) is most probably a reflection of environmental change(s) in the marine biotope. One argument in favour of this explanation is that a similar change in species has also been demonstrated in 'natural' shell banks, for instance in Tastum Sø in northern Jutland, where this shift from oyster to cockle has been radiocarbon dated to 4240–4010 cal. BC (Rasmussen & Petersen 1980, 52–3). Another indication of environmental change at this time are the

observations at Korup Sø on Djursland, where the transition from the Atlantic to the Sub-boreal period is characterised by a shift from saline to brackish sea conditions (Pedersen & Petersen 1997, 81) – a fact which seems to have been caused by a lowering of the amplitude of the tide-wave in the Danish waters at the beginning of the Sub-boreal period (*ibid.*, 82).

TYPES OF SHELL MIDDENS AND EVIDENCE FOR SETTLEMENT FEATURES

So far it has not been possible to 'rank' the shell middens on the basis of included 'structures' and graves. Ranking can, as yet, only be based on types of accumulation, artefact intensity and inventory, settlement size, and topographic position.

The largest group of shell middens have been interpreted as year-round, homebase occupations characterised by a range of settlement features and a diverse inventory of artefact types, while other, smaller, sites exhibit clear seasonality, a more restricted artefact inventory and fewer features.

Another group of shell middens is characterised by the presence of thick layers of shells without much cultural debris. These seem to have functioned as pure 'shell dumps', as at Holmegård on Mols, eastern Jutland (Andersen *et al.* 1986).

Finally we have a group of coastal locations characterised by thin scatters of Oyster shells without, or with very few, cultural remains. Such sites are best interpreted as *ad hoc* locations on the beach for consumption of shellfish (Meehan 1982).

Very particular attention should be accorded to the 'natural' shell banks in which artefacts have often been found – chiefly flint tools and harpoons but also structures used for fishing, such as fish traps and fish fences. Such shell banks with artefacts occur around the whole country and have been described, for instance, at Stavns Fiord on Samsø (Troels-Smith 1995, 63, fig. 4).

'Stratified shell middens'

An especially important group of *Køkkenmøddinger* in Denmark comprises the so-called 'stratified middens'. These are shell middens with stratified horizons covering both the Late Mesolithic Ertebølle and Early Neolithic Funnel Beaker culture, ie, the transition from a hunting-gathering economy to a

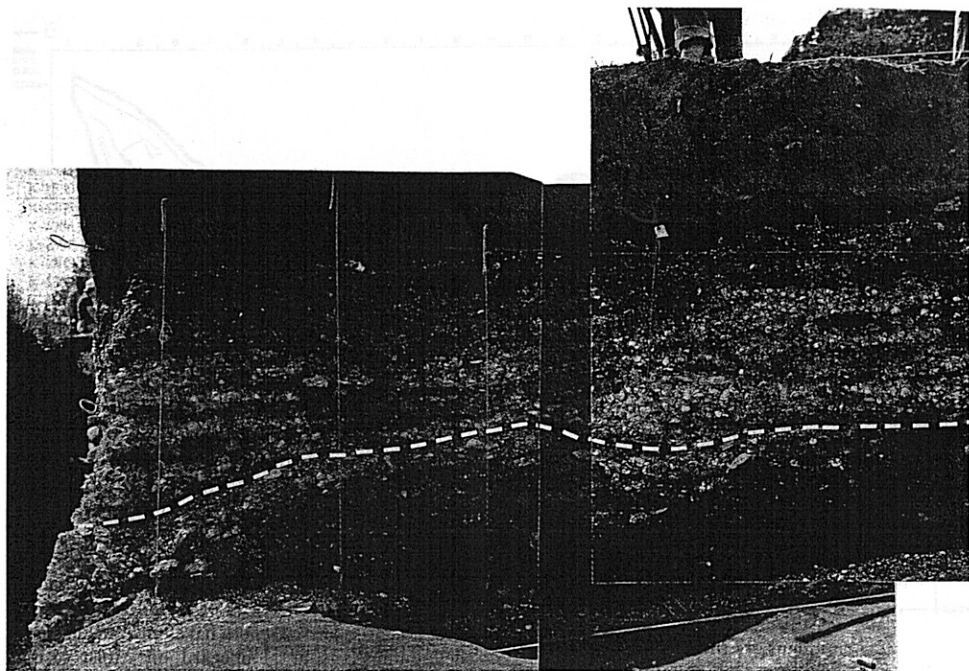


Fig. 13

Section through the stratified Norsminde *Køkkenmødding* with Late Mesolithic Ertebølle layers covered by Early Neolithic Funnel Beaker layers

farming economy in southern Scandinavian *c.* 4000 cal. BC. These middens are our most numerous and important source of information on this essential and still very debated issue in north European prehistory.

Contrary to general opinion, the 'stratified middens' are not the exception, but rather the rule, among the Danish *Køkkenmøddinger*, where 60–80 % (or more) belong to this type. The many 'stratified middens' demonstrate that there was strong settlement stability and also resource stability during the transitional phase (Fig. 13). The evidence from Bjørnsholm tells that the Late Mesolithic fishing (especially of eel) also continued to be an essential part of the diet in the Early Neolithic (Andersen 1993, 90–1; Enghoff 1993, 107, table 1).

Analysis of such sites has provided a wealth of new information on this key issue and demonstrates that the transition in *material culture* from the Mesolithic

to the Neolithic took place within *c.* 100 radiocarbon years (centred on 3950 cal. BC) and also that the Early Neolithic economy was mainly a continuation of the Mesolithic way of life, with a few 'Neolithic' additions (cattle and grains) (Bratlund 1993, 104).

Settlements features

The Danish shell middens contain a series of different 'features' but, apart from fireplaces, they only occur sporadically.

Hearths: The most frequent structural remains are circular fireplaces (diameter *c.* 1.0–1.5 m), of which two types occur: 1) stone-built hearths and 2) gray lenses of burned shell matrix. The stone built hearths are always few and are generally found at the bottom of (below) the shell layers, while the other type is numerous and occurs in the shell horizons. The

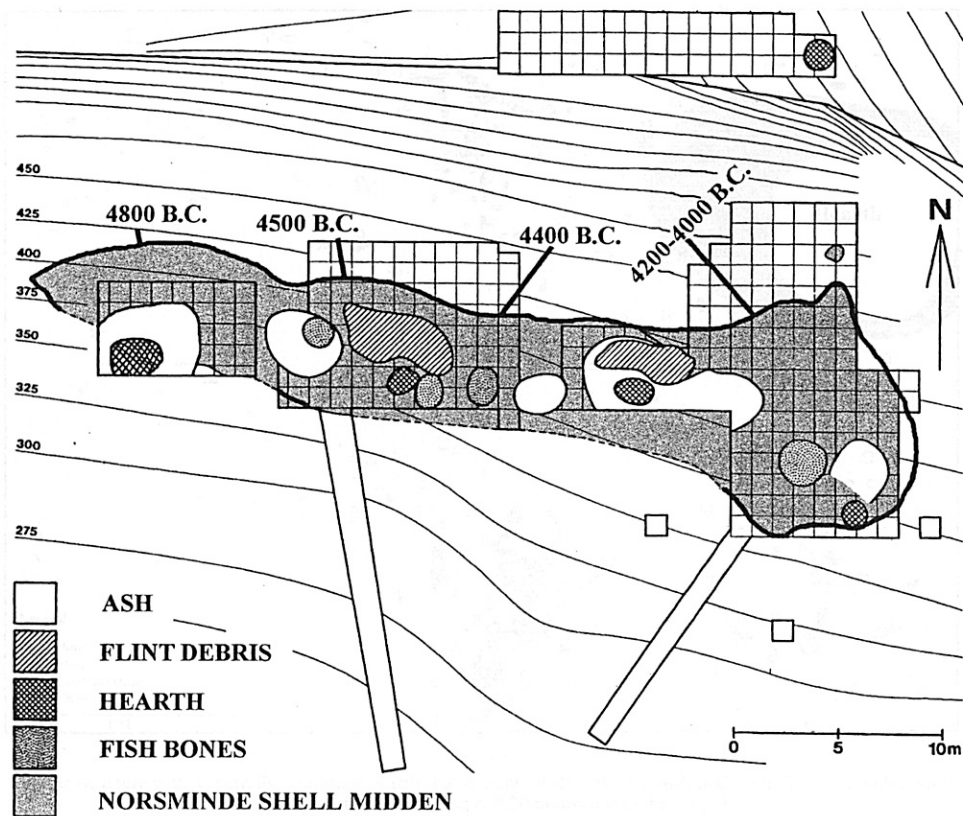


Fig. 14

The horizontal distribution of fireplaces in the Norsminde shell midden

hearths are, in some cases, found evenly spaced along the prehistoric coastline or in stratigraphic series within very narrow sections of the middens (Figs 14 & 15). This most probably reflects strong internal structuring of the middens over long time periods and provides an indication that the shell middens were 'organised' and that this structure was constant/maintained throughout occupation of the site, eg, Ertebølle (Andersen & Johansen 1987, 46–8, fig. 15).

The evidence seems to suggest that multiple hearths were in use at any one time. The presence of hearths in the cultural layers beneath the middens strongly

suggests habitation and that dwellings were located there in the initial stages of accumulation. A similar pattern of stratigraphical series of superimposed hearths has also been recorded at the Oronsay middens (Mellars 1987, 185, fig. 12.3, 186, fig. 12.4).

The fireplaces were of great importance as focal points on the shell midden sites and analysis of the spatial distribution of shells, artefacts, and debris around them demonstrates a clear concentration of cultural waste in these areas. Flint 'splinters' and small bone fragments are found close to the hearths ('drop zone') while larger pieces are more frequent further away ('toss zone'), exactly as described by Binford

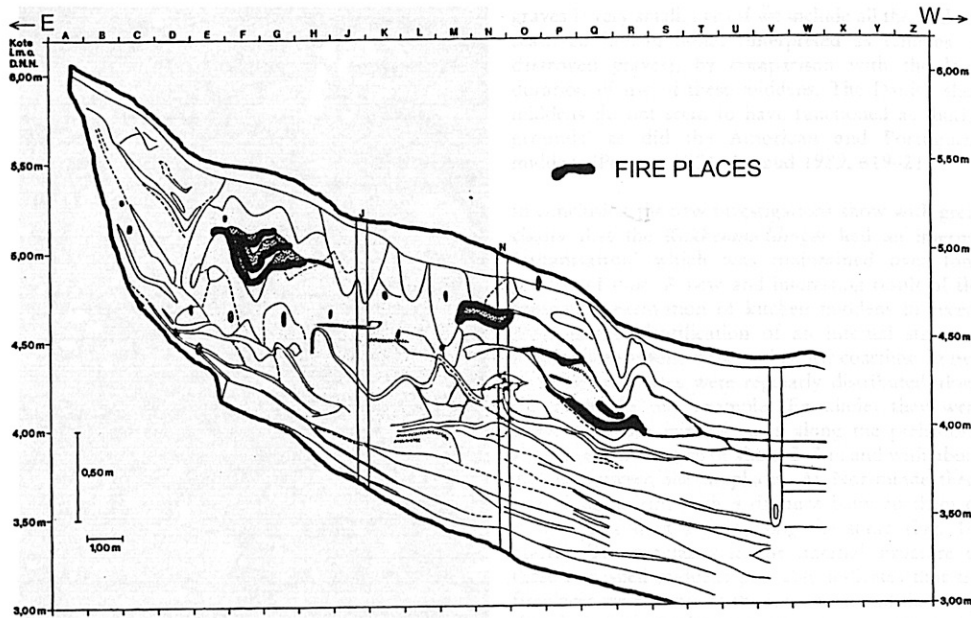


Fig. 15
The vertical position of fireplaces in the Ertebølle midden

(1983, 151-3) and a distribution that is typical for outdoor activity areas. The large quantities of flint debitage and bone splinters around the hearths, in contrast to other sections of the middens, clearly imply that flint knapping and food processing took place around the fireplaces on the surface of the shell dumps.

Ash layers: These occur around the fireplaces and show that they were burning under the open sky and not within huts; at Ertebølle it has been possible to follow such horizons up to 5-8 m from the hearths (Andersen & Johansen 1987, 44).

Fish bone layers: In many middens 10-150 mm thick horizons of fish bones have been documented, especially in the proximity of fireplaces. At Ertebølle such horizons have been found in three positions where they seem to be connected with nearby fireplaces (*ibid.*, 47, fig. 12). Such concentrations may reflect periods of intense fishing or a systematic use of specific areas of the midden for fish processing.

Pits: Steep-sided pits filled with successive layers of charcoal, burned shell, and clay have been recorded from some shell middens, such as Ertebølle (*ibid.* 47, fig. 13, right). Although they may be interpreted as fireplaces, the form and content are so different from the other hearths, that other interpretations may be suggested, such as cooking pits or firepits, as described by Klinge (1931; Meehan 1982, 112-18).

Stake-holes: No definite stake built structures have been identified though stake-holes have been recorded in several middens.

Activity areas: As a result of the rapid accumulation rate in the shell middens, the debris often covers or seals old surfaces. The concentrations of flint debitage, bone, and pottery that are frequently encountered around the hearths are clear indications that these areas were focal points for a wide range of activities such as the production and consumption of food and production of flint- and bone/antler artefacts, etc.

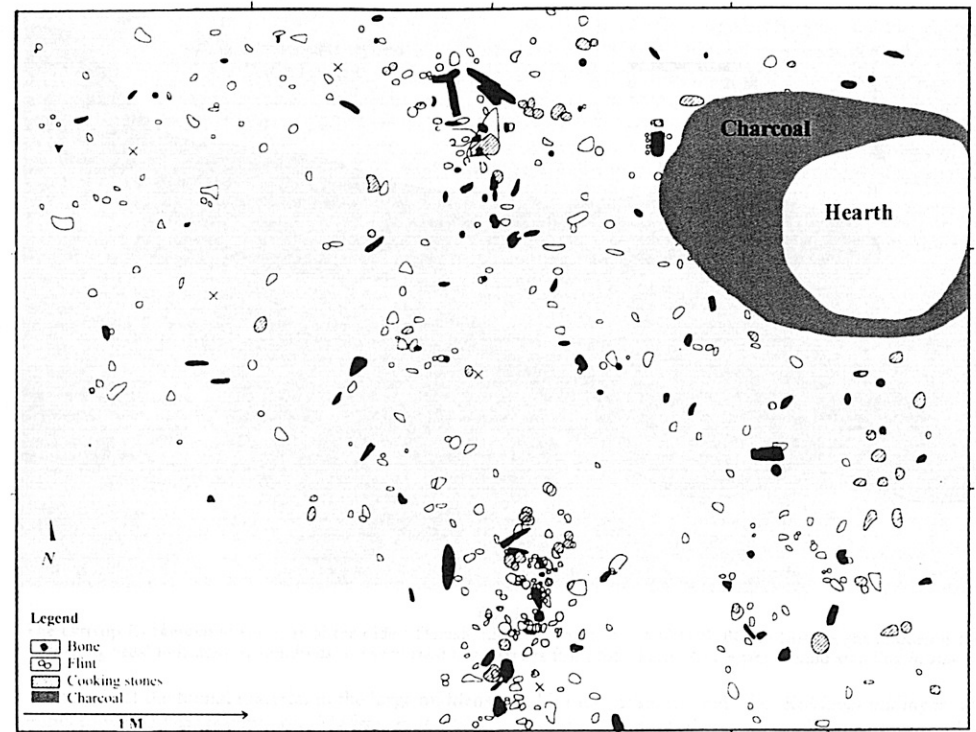


Fig. 16
Circular structure with a centrally positioned hearth (house floor?) below the Åle shell midden in the Bjørnsholm fiord, cf. Fig. 3. The feature was dug c. 0.20 m down into the subsoil.

analysis has shown that it is possible to divide the Ertebølle midden into one area mainly characterised by the deposition of shells ('dumps') and another with different domestic activities such as those listed above (Andersen & Johansen 1987, 44-5).

All such observations show that the surface of the *Køkkenmøddinger* in Denmark - contrary to general opinion - were divided into different activity areas (flintknapping, cooking, production of tools, and disposal of shellfish) and that the fireplaces in particular were essential as locations for activities that continued over very long periods of time.

Dwellings: In general we have not yet been able to define and describe house structures or house plans in

the Danish shell middens. One of the reasons for this could be that substantial houses were never built upon the shell accumulations. Other possibilities are that such huts have been covered and/or destroyed by younger shell accumulations or that they are too difficult to observe during excavation. If we take the evidence for gradual movement along the coastline and the traces of substantial pre-midden occupation into consideration, there is all the reason to suppose that occupation took place beside or between the shell accumulations and that the vestiges of these habitations were gradually covered by later depositions. These areas have only been subject to investigations in recent years.

At some shell middens artificial, round depressions dug into the subsoil with a centrally located fireplace



Fig. 17

Inhumation grave in the Ertebølle midden. The grave has been dated to 4050–3940 cal. BC (K-4933; see Table 1), $\delta^{13}\text{C} = -16.5\%$ PDB. Photo: National Museum of Denmark

have been encountered below the midden layers. This was the case at Åle, where a c. 6 m wide and c. 0.35–0.40 m deep, flat-bottomed depression in the subsoil was documented (Fig. 16). Similar features have been recorded at a few other *Køkkenmøddinger* and they are most reasonably interpreted as house foundations (Sørensen 1995, 20–2). In this respect the Danish results accord with excavations at Oronsay, where house foundations, post-holes, and hearths were recorded below the shell layers (Mellars 1987, 213–40).

Graves: Both inhumation (Fig. 17) and cremation graves are sporadically found in the middens. For the most part these graves are clearly secondary, but a few have been radiocarbon dated as being contemporary with the midden occupation, for instance at Ertebølle, where an inhumation burial has been dated to 4050–3940 cal. BC (K-4933). However, the number of

graves is very small, even if we include all the finds of scattered human bones (interpreted as remains of destroyed graves), by comparison with the long duration of use of these middens. The Danish shell middens do not seem to have functioned as 'burial grounds' as did the American and Portuguese middens (Pequart 1954; Arnaud 1989, 619–21).

In conclusion the new investigations show with great clarity that the *Køkkenmøddinger* had an internal 'organisation' which was maintained over long periods of time. A new and interesting result of the horizontal excavation of kitchen middens in recent years is the identification of an internal structure which seems to follow the prehistoric coastline. In two cases the fireplaces were regularly distributed along the shore. In one example (Egsmind) they were situated in two parallel rows along the prehistoric shoreline at a distance of about 2–3 m and with about 5–6 m between the fireplaces. At Norsminde there were four hearths with a distance between them of c. 8 m placed in a row along the shore (Fig. 14, above). The regularity in the internal structure of these two shell middens probably indicates that the fireplaces were in use at the same time and that they, therefore, most probably represent one camp rather than a series of camps along the shore throughout a certain period. In that case there must have been several fireplaces in use at the same time and we can suggest that, at these two sites, there is some evidence for social units consisting of about 4–5 'households'.

SEASONALITY

The collection of marine molluscs was a highly seasonal activity, mainly taking place in the spring and summer (March–July), and has been documented by several analyses of Danish middens. While oysters were predominantly collected in March–April, cockles seem to have been collected in the summer months, May–July (Jensen 1982; Brock & Bourget 1991). The middens were used repeatedly from year to year and the molluscs, in spite of archaeological appearances to the contrary, were of scarcely no more than incidental importance with regards to caloric value. On the other hand, it is still an open question as to how essential this resource was as a daily supply of minerals such as zinc, iodine, and salts, rather than just food value (Møhl 1979, 74). Another use for the shellfish could have been as fish bait.

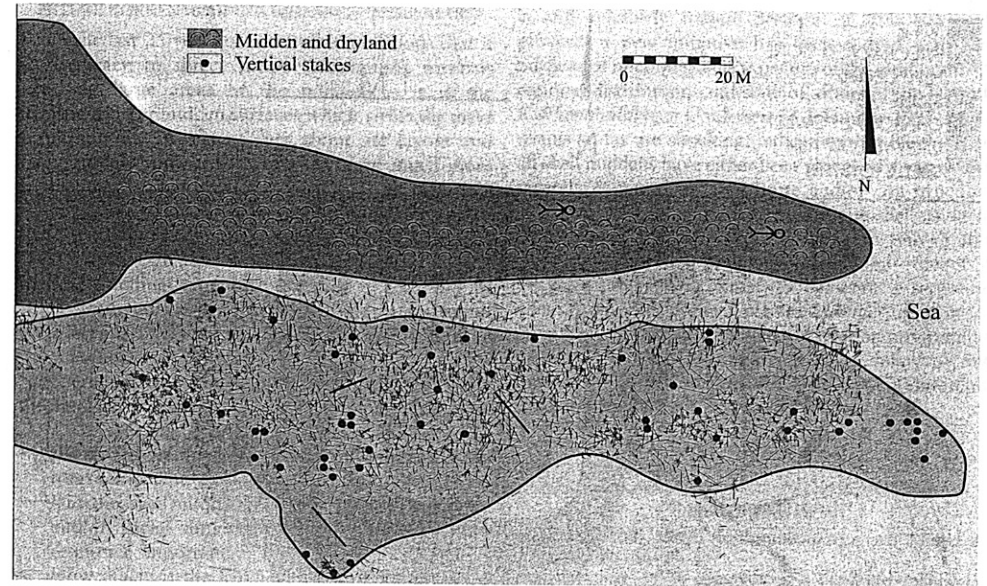


Fig. 18

The Lystrup *Køkkenmødding*—one of the oldest Danish middens, dated to c. 5300 cal. BC. In front of the midden is the 'fishing area' indicated by hundreds of overturned hazel stakes from fish fences. A few were found standing *in situ*

Analysis of the faunal material in the large middens points to whole-year occupation (Madsen *et al.* 1900, 175) while several of the smaller middens demonstrate a marked seasonality. Aggersund, for instance, was a winter occupation site (November–January) with an economy concentrated on the hunting of Whooper swans (*Cygnus cygnus* (L.)) (Andersen 1979; Møhl 1979, 74). This raises some questions about the homogeneity of the large sites – are they really year-round settlements or do they only appear so because all the zoological material from the 'older' excavations has become mixed and treated as one unit? It is an essential task for the future to resolve this question.

CONCLUSIONS

The Danish *Køkkenmøddinger* are not a unique type of coastal settlement but represent coastal, homebase settlements characterised by a dominance of shellfish in the cultural deposits. This is the only aspect by which they differ from the rest of the coastal

habitation system, and the *Køkkenmøddinger* are always a part of the total settlement system. The kitchen middens are a special variant of the Ertebølle culture's coastal settlements.

The content and new investigations of the Danish shell middens testify that they were settlements integrating a diversity of terrestrial as well as marine resources over a considerable part of the year and were repeatedly used from year to year. The long duration of use at such sites (up to c. 1000–1500 years) clearly demonstrates settlement stability over long periods and, thereby, long-term resource stability in the marine biotope. In many locations this place-continuity extends into the Early Neolithic.

The shell middens are not only 'shell dumps', but localities on whose surfaces every-day activities took place. This is proved by the mixture of food waste and activity areas, 'structural' remains, artefacts, and their distribution in the middens (Fig. 19). If we add to this observations of the structuring of the fireplaces and shell dumps over long periods of time, and the presence of some graves, we have all the ingredients

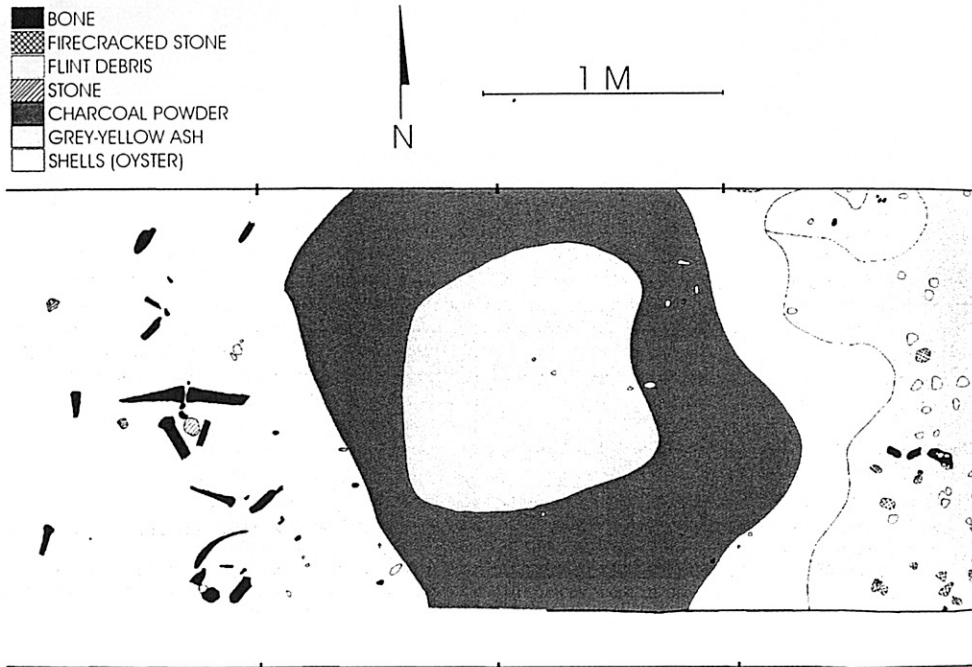


Fig. 19

Area around a hearth in the Early Neolithic Visborg shell midden in north-eastern Jutland (cf. Fig. 1). To the left of the fireplace is a concentration ('dump') of large bones of red deer (*Cervus elaphus*) (black) and to the right 'cooking Stones' (cross hatched)

which archaeologists normally use to define settlement sites in a Mesolithic sense; the only features which are still lacking are well defined dwellings. The essential question: 'are the middens settlements proper', must therefore be answered by a 'yes' – they have all the constituent elements defining a settlement.

The content may vary from the Mesolithic middens dominated by oyster and a wide range of tool types and cultural debris to the Early Neolithic middens characterised by cockles, ash, and firecracked stones while the content of cultural material mainly consists of pottery. The organisation of the settlements was linear and followed the prehistoric coastlines.

The smallest depositional unit is c. 2–7 x 2–7 m. The shell middens are not *ad hoc* accumulations, quite the contrary, they seem to have been 'organised in their layout; in particular the hearths are

normally found in the same areas throughout the period of occupation, while other areas were used for workshop activities and deposition of food-waste. Fireplaces are placed with regular intervals between them, which is an indication that several fireplaces were used at the same time and that the social unit included several households (Fig. 14).

In the Late Mesolithic the *Køkkenmøddinger* seem to be 'living floors' – a mixture of waste deposits and places for production and consumption while, in the Neolithic, they rather seem to be waste disposal areas associated with nearby settlement.

Danish Stone Age shell middens seem to flourish in periods characterised by a rich marine biotope – therefore I see coastal habitation as a direct reflection of the variations/changes in the marine biotope.

FUTURE KØKKENMØDDING RESEARCH IN DENMARK

From the last 25 years of research it is obvious that it is necessary to direct future excavations towards exposing large areas of the middens – it is the investigation of midden surfaces which yields the most promising and important data about site layout and ethnographic comparisons must be used much more frequently than has previously been the case to supply a wide range of possibilities for the interpretation of such living floors.

It is also essential to pursue the quest for well defined dwelling structures – here it is necessary to concentrate on the fireplaces and the area around these because, very often, these are likely to indicate the presence of dwellings.

A series of questions has to be investigated in the future. These include:

- What was the function of the shell middens in the total settlement pattern?
- Did the shell middens have a 'special' economic and/or social importance, and what was their economic importance?
- How much of the *Køkkenmødding* was in use at the same time?
- How and how often did people change living-places on the shell heap?

In which ways have the shell middens been of importance for Danish Mesolithic research?

First, and foremost, essentially, the investigations of the shell middens from the very start established the beginning of a multi-disciplinary research tradition which has had, and still has, an enormous importance for Danish Mesolithic research throughout the last 150 years. Secondly, the shell middens have provided the best European basis for detailed analysis and descriptions of the transition from the Mesolithic to the Neolithic.

What is the future for Danish Køkkenmødding research?

It has become increasingly evident from the excavations of Danish shell middens undertaken in the last 10–15 years that nearly all the middens are heavily threatened by modern agriculture. Comparisons between sections drawn during excavations conducted in the 1890s and during recent investigations demonstrate that only about one-tenth of the original number of shell middens

is still relatively intact! Because of this alarming prospect a new initiative has been started with the purpose of obtaining a clear picture of the total number, regional distribution, and state of affairs of the Danish *Køkkenmøddinger* (Andersen & Johansen 1997). The results so far are shocking, indicating that 80–90% of all shell middens have either been ploughed away or are severely damaged by agriculture and/or construction works. If we are still going to continue shell midden research in Denmark in the future – in one of the 'classical' areas for this type of archaeology – then it is of prime importance either to conserve a series of scientifically important *Køkkenmøddinger* as soon as possible or to initiate a full scale excavation programme to save the basal information from as many of the threatened middens as possible. That is one of our main tasks for the future!

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