Journal of Danish Archaeology vol. 10. 1991, pp. 105–118.

Mesolithic Eel-Fishing at Bjørnsholm, Denmark, Spiced with Exotic Species

by INGE BØDKER ENGHOFF

INTRODUCTION

The Bjørnsholm settlement is situated at the Limfjord in northern Jutland, Denmark, about 8 km N of the contemporaneous *køkkenmødding* at Ertebølle (S. H. Andersen 1993, this volume, fig. 2). During the Atlantic and early Subboreal period, when the midden was formed, it lay on a c. 7 km long fiord, very close to its mouth into the Limfjord. The salinity of the Limfjord was at that time higher than today (Petersen 1987 and references therein; Petersen 1992). Three or four freshwater streams flowed into the past Bjørnsholm Fjord. However, the find of the mollusc *Bittium* in Atlantic sediments indicate high salinity in the Bjørnsholm Fjord during this period (K. S. Petersen pers. comm.). For further archeological and geological information on the settlement, see S. H. Andersen 1993 (this volume).

MATERIAL AND METHODS

The Bjørnsholm *køkkenmødding* is the largest known shell-mound in Denmark. Its extent has been about 325×10−40×max. 1.2 m. The first excavation of the *køkkenmødding* took place in the 1930'es, where only 11 fish bones (Eel, Rudd and Pike) were found (Rosenlund 1976). During 1985–1991 new excavations were made under the leadership of Søren H. Andersen (Institute of Prehistoric Archaeology, University of Aarhus) and Erik Johansen (Aalborg Historiske Museum). A 28 m long, 1 m broad ditch was excavated in the preserved remnant of the midden, as well as 3 short ditches parallel to the western (2) and eastern (1) ends of the main ditch (fig. 1). Some squares in the main ditch were, however, not or only partly excavated. The shell-mound consists mainly of Mesolithic deposits (up to 70–80 cm thick) but these have been disturbed by a few postholes from the Iron Age in the western end, and in the eastern end Early Neolithic layers (up to 30–40 cm thick) overlay the Mesolithic ones. These circumstances were considered as well during the excavation as during the analysis.

The fishbones analyzed here all derive from the new excavations. The entire material comes from the *køkkenmødding* itself, within which no traces of natural sedimentation have been observed. Part of the top of the Mesolithic layers may have been eroded by a transgression of the sea, but the underlying layers have not been disturbed.

Radiocarbon dates of the Mesolithic layers cover the period 5050±100 → 4050±90 BC. Dates for the Neolithic layers cover the period 3960±95 → 3530±90 BC (all dates calibrated, see K. L. Rasmussen in S. H. Andersen 1993, this volume).

During the excavation all recorded objects were plotted in a 3-dimensional coordinate system, and all sediment was sieved through a 2–3 mm mesh. Both wet and dry sieving were used.

Square K, which was very rich in fish bones, was excavated in 5 cm layers which were sieved in the laboratory, first through the field sieve (2–3 mm) and thereafter through a 0.6 mm mesh. The results from this square were used as a control of the method of excavation employed in the field. At the same time, the stratified sampling in square K provides a column showing the vertical

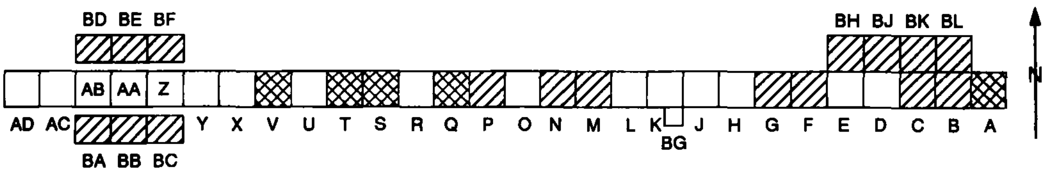

Fig. 1. Plan of the excavation at Bjørnsholm. Cross-hatched = not excavated, hatched = partly excavated squares, white = fully excavated squares.

distribution of fish bones in the midden (table 3). Some special fish bone samples were collected in square K: samples QUO, QUN, and OSU near a fireplace; sample SPT appeared in the northern profile of square K as a layer (c. 50 cm long, 10 cm thick) of fishbones. These special fish bone samples were sieved through a 0.6 mm mesh in the laboratory. See table 4.

Also square U was excavated in 5 cm layers but was only sieved through the field sieve. It does, however, provide further information on the vertical distribution of fish bones.

The fishbones generally appeared to lie in small groups in the field (Andersen 1992, fig. 5). The fishbones are overall very well preserved although neural arches and similar projections are broken. Only very few bones are burnt.

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

NOTES TO IDENTIFICATION

Cyprinids: Cyprinid bones are difficult to identify, but Roach (11 bones) and Rudd (8 bones) could be recognized from the species-specific bones ossa pharyngea inferiora, processus pharyngeus ossis basioccipitalis and basioccipitale. Nine very large and characteristic vertebrae could be identified as belonging to Tench. The many small cyprinid vertebrae presumably derive from Rudd and in particular Roach.

Gadis: Of the gadid bones the following characteristic bones were identified to species: praevomer, parasphenoideum, praemaxillare, maxillare, dentale, and vertebrae 1–4. All of these bones in the material derived from Cod. In addition, otoliths were identified, these belonged to Cod and Saithe. The gadid bones are assumed to derive mainly from Cod – apart from the otoliths there is no indication of other species.

Flatfish: For difficulties in identification of flatfish bones, see Enghoff (1987, 1991). In the present material Flounder and Turbot could be identified by means of dermal denticles, the former in addition by means of 1 urohyale.

SPECIES OF FISH AND THEIR RELATIVE FREQUENCIES IN THE MATERIAL

The subfossil fish bones were identified by means of the comparative fish bone collection at the Zoological Museum, University of Copenhagen. The result is shown in table 1. The material has been divided into a Mesolithic and a Neolithic part. Bones from transition layers between the two periods, bones from mixed layers, and bones which for other reasons could not be stratigraphically placed with certainty, have been excluded.

The species list includes a total of 28 species. In the following text, these will be referred to by their English names. Scientific and Danish names are given in table 1. For each species the number of bones is given, and for the Mesolithic part of the material the relative frequency of each species is given as a percentage value. These percentages were calculated on the basis of 11490 identified bones. The Neolithic part of the material includes too few bones (252) for percentage calculations to be meaningful. The following analysis and discussion almost exclusively concern the Mesolithic phase which includes nearly the entire material.

Eel is the absolutely dominating species on the list, representing 56% of the identified bones. The cyprinids, represented by Roach, Tench, and Rudd, constitute 14%. Next in frequency follow the gadids, represented by Cod and Saithe, with 10%, Three-spined Stickleback with 7%, Greater Weaver with 6%, Mackerel with 2% and the Flatfish, represented by Flounder and Turbot, with 1%. The remaining species constitute a total of 4%.

The migratory species (see table 1) may be caught in both salt and freshwater, and the same is true of Three-spined Stickleback. These species constitute 63% of the fish bones.

The marine species (see table 1) constitute a total of 22% and the freshwater species (see table 1) 15%.

It must be mentioned that the percentual frequencies of bones of different species cannot be directly translated into percentual frequency of the species deposited in the shell-mound: Different species may have different numbers of bones per individual, and bones from different species have unequal chances of preservation (Enghoff 1987 and references therein). See also the chapter "Control of sieving efficiency".

There is, however, no doubt that as far as the present material is concerned, Eel has been by far the most important species.

Those species which are common in the material are represented by bones from all body regions, se table 2.

Most of the species on the list are common in Danish waters today, Mackerel, Garpike, and Atlantic Horse-

	Species	Mesolithic No. of bones		%		Neolithic No. of bones	
M	Eel (*Anguilla anguilla*), Ål		6460		56.22		154
F	Cyprinids (Cyprinidae), Karpefisk, total		1639		14.26		14
F	including: Roach (*Rutilus rutilus*), Skalle	111		0.97		5	
F	Tench (*Tinca tinca*), Suder	9		0.08			
F	Rudd (*Scardinius erythrophthalmus*), Rudskalle	8		0.07		1	
F	Cyprinids (Cyprinidae), Karpefisk, unspecified	1511		13.15		8	
S	Gadids (Gadidae), Torskefisk, total		1159		10.09		48
S	including: Cod (*Gadus morhua*), Torsk	253		2.20		7	
S	Saithe (*Pollachius virens*), Sej	8		0.07			
S	Gadids (Gadidae), Torskefisk, unspecified	898		7.82		41	
FS	Three-spined Stickleback (*Gasterosteus aculeatus*), Trepigget Hundestejle		754		6.56		
S	Greater Weaver (*Trachinus draco*), Alm. Fjæsing		721		6.28		1
S	Mackerel (*Scomber scombrus*), Makrel		177		1.54		12
S	Flatfish (Heterosomata), Fladfisk, total		169		1.47		9
S	including: Flounder (*Platichthys flesus*), Skrubbe	17		0.15			
S	Plaice/Flounder/Dab (*Pleuronectes platessa/Platichthys flesus/Limanda limanda*), Rødspætte/Skrubbe/Ising	147		1.28		9	
S	Turbot (*Psetta maxima*), Pighvarre	3		0.03			
S	Flatfish (Heterosomata), Fladfisk, unspecified	2		0.02			
S	Black Seabream (*Spondyliosoma cantharus*), Havrude		82 (+21 scales)		0.71		1
S	Clupeids (Clupeidae), Sildefisk, total		52		0.45		
S	including: Herring (*Clupea harengus*), Sild	40		0.35			
S	Clupeids (Clupeidae), Sildefisk, unspecified	12		0.10			
F	Perch (*Perca fluviatilis*), Aborre		51 (+ 5 scales)		0.44		
S	Eelpout (*Zoarces viviparus*), Ålekvabbe		51		0.44		1
S	Garpike (*Belone belone*), Hornfisk		41		0.36		4
S	Gurnard (*Eutrigla/Trigla*), total		26		0.23		1
S	including: Grey Gurnard (*Eutrigla gurnardus*), Grå Knurhane	11		0.10			
S	Gurnard (*E. gurnardus/Trigla lucerna*), unspecified	15		0.13		1	
F	Pike (*Esox lucius*), Gedde		26		0.23		
S	Atlantic Horse-mackerel (*Trachurus trachurus*), Hestemakrel		25		0.22		1
M	Salmonids (Salmonidae), Laksefisk, total		23		0.20		
M	including: Trout (*Salmo trutta*), Ørred	1		0.01			
	Trout/Salmon (*S. trutta/S. salar*), Ørred/Laks	20		0.17			
	Whitefish (*Coregonus* sp.), Helt/Snæbel	2		0.02			
S	European Seabass (*Dicentrarchus labrax*), Bars		11		0.10		
S	Spurdog (*Squalus acanthias*), Pighaj		10		0.09		1
S	Bullhead (*Myoxocephalus scorpius*), Alm. Ulk		8		0.07		2
S	Sand-eel (*Hyperoplus/Ammodytes* sp.), Tobis		2		0.02		
S	Gobiid (Gobiidae), Kutling		2		0.02		
S	Smoothhound (*Mustelus* sp.), Glathaj		1		0.01		2
S	Common Stingray (*Dasyatus pastinaca*), Pilrokke (K. Rosenlund det.)						1
Total			11490		100.01		252

Table 1. The species of fish in the Bjørnsholm material, numbers of bones of each species (or higher category), and for the Mesolithic part percentual occurrences. English, Latin, and Danish names of the species are given. F = freshwater species, S = saltwater species, M = migratory species. 254 fish bones which could not be uequivocally assigned to Mesolithic or Neolithic layers, are not included in the table.

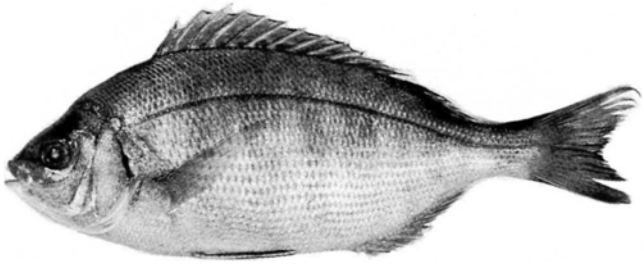

Fig. 2. *Spondyliosoma cantharus* – specimen caught near Skagen, Denmark. The fish has a characteristic deep body and a small head. The colour of back and sides usually varies in greyish blue and greyish brown hues with darker vertical bands and golden longitudinal lines; the belly is silver-grey. 1:2.

Fig. 3. Subfossil bones of *Spondyliosoma cantharus* from Bjørnsholm. Left: vertebra caudalis, top center: right articulare, bottom center: vertebra praecaudalis, right: parasphenoideum. 2:1.

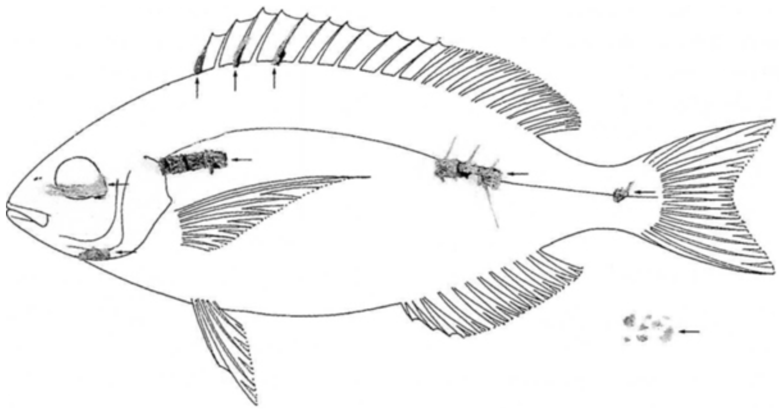

Fig. 4. Subfossil bones of *Spondyliosoma cantharus* from Bjørnsholm arranged in place on an outline drawing of the fish. A group of scales is seen in the lower right corner. The arrows indicate the bones. The bones probably all derive from a single individual.

mackerel only in the warmer half of the year, however. Four of the species, viz., Black Seabream, European Seabass, Smoothhound, and Common Stingray, are common south of England today but are more or less rare in Danish waters. The former three of these are new to the Danish subfossil fauna.

SOUTHERN FISH SPECIES IN THE BJØRNSHOLM MATERIAL

Black Seabream, *Spondyliosoma cantharus*, Da.: Havrude
This species (fig. 2) is represented by no less than 83 bones in the Bjørnsholm material, some of which are shown in fig. 3. In addition several finrays, isolated neural arches, and 21 scales were referred to Black Seabream. Black Seabream belongs to the family Sparidae, a large family with many similar-looking genera and species. The first discovered bones of this species included vertebrae only, and a safe identification was not possibly until a parasphenoideum appeared (fig. 3).

One of the finds (in square AD) probably represents a single individual, since 1 parasphenoideum, 1 keratohyale, 8 vertebrae including both the first and the last vertebra, and 8 scales were found together. This selection of bones represents the whole skeleton (fig. 4).

The 83 bones represent at least three individuals, since there are three first vertebrae and three left palatina. The first vertebrae were found 4–9 m from the palatina so the minimum number of individuals may be six rather than three. The Black Seabream bones are distributed over 20 m of the excavated ditch (squares AD to J). About half of the bones are concentrated in the western end (AD–Z); the radiocarbon dates in this area (4350±95 BC, K-4688, K-4689) are identical. It is not possible to see whether the three individuals represented by the three first vertebrae were caught at one occasion, or whether repeated catches of Black Seabream have been made.

About half of the Black Seabream bones including the three left palatina were found in square U (which was treated as a column sample during excavation). In this column, Black Seabream bones occur from top to bottom (c. 50 cm vertical extent). Radiocarbon dates in the almost neighbouring square R range from 4770–4730 BC (K-5071) to 4220–4050 BC (K-5068). Since the layers in this region of the ditch are horizontal, the same ages may be ascribed to square U (S. H. Andersen, pers. comm.).

One of the Black Seabream vertebrae derives from a Neolithic sample (in square J, where a Neolithic pit is present). Mesolithic contamination can, however, not be excluded.

All in all the horizontal and vertical distributions of bones suggest repeated catches of Black Seabream.

The subfossil Black Seabream were 30–40 long. The maximal length of the species is 60 cm. Black Seabream lives in inshore waters and its present distribution includes Atlantic coastal waters from Scandinavia to Angola, and the Mediterranean (Bauchot & Hureau 1986). It is, however, uncommon in the North Sea (Muus & Dahlstrøm 1964), although some are caught every year in Norway and almost every year in Sweden (Curry-Lindahl 1985).

European Seabass, *Dicentrarchus labrax*, Da.: Bars

The Bjørnsholm material includes 11 bones of this species (fig. 5) Most of the bones derive from fish of 30–40 cm length, a few vertebrae however from a somewhat larger specimen; thus at least two individuals are represented.

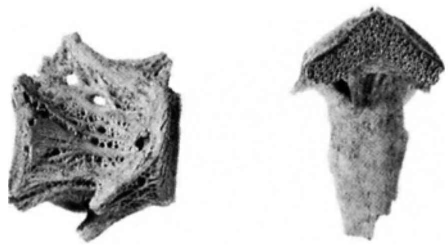

Fig. 5. Subfossil bones of *Dicentrarchus labrax* from Bjørnsholm. Left: vertebra caudalis, right: praevomer. 2:1.

Fig. 6. Subfossil vertebra of *Mustelus* sp. Notice the characteristic ridge in the bottom of the groove. 2:1.

The bones were found in squares AD to Z (3 bones) and square U (8 bones). I the U "column" European Seabass bones occur in the three lowermost samples and also somewhat higher up, all in all a vertical extent of 31 cm. As in the case of Black Seabream this indicates repeated catches.

European Seabass may reach a length of 1 m (Tortonese 1986), but individuals caught in Danish waters are normally 20–45 cm long (Muus 1970). European Seabass lives, often in schools, near the coast. During spring and summer it comes closer to the beach and may migrate into estuaries and bights (Curry-Lindahl 1985). The present distribution of European Seabass includes the North Atlantic from Norway south to Morocco and the Canary Islands, also the Mediterranean (Tortonese 1986). The species is an irregular but not particularly rare visitor in our waters where it probably occurs every year (Curry-Lindahl 1985).

Smoothhound, *Mustelus* sp., Da.: Glathaj

Three vertebrae of Smoothhound were found in the Bjørnsholm material. They are of a characteristic appearance (fig. 6) and give the impression of being more robust,

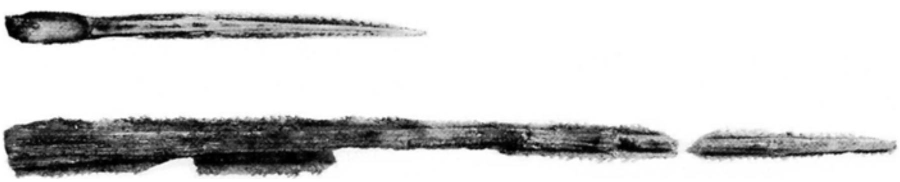

Fig. 7. Tail spine of Stingray. Bottom: subfossil spine from Bjørnsholm. Top: recent spine for comparison. 1:1.

	Eel	cyprinids	gadids	Three-spined Stickleback	Greater Weawer	Mackerel	pleuronectids	Turbot	flatish indet.	Black Seabream	Perch	Herring/clupeids	Eelpout	Garpike	Gurnard	Pike	Atlantic Horse-mackerel	salmonids	European Seabass	Bullhead	Spurdog	Smoothhound	Sand-eel	Stingray	Gobiid
Head bones																									
Parasphenoideum	48		40		4	2	1			2			1		4										
Praevomer	98		91		2		1						1						1						
Frontale	49	1		15	4		1								1										
Parietale	1																								
Supraoccipitale				7																					
Exoccipitale					2																				
Basioccipitale	33	1	19	6	2		1																		
Prooticum	15				1																				
Sphenoticum			1																						
Circumorbitalia		1			2																				
Otolithi			18									1													
Neurocranium unspecified					7		1					1			4										
Praemaxillare		2	26	4	3									6											
Maxillare	119	9	15		3		1																		
Dentale	255	12	8	4	8						2			5		4									
Articulare	98	19	12	2	2					2				1	1										
Quadratum	68	5	8	4	3		1			1							1								
Palatinum			3		7					4								1							
Ectopterygoideum																1									
Pterygoidea			6		2		5																		
Praeoperculare	1	1	1	5			3				2									1					
Interoperculare	14	1																							
Operculare	59	16	2	7	15										1										
Suboperculare	19																								
Symplecticum			3																						
Hyomandibulare	88	1	7	11	21		2									1									
Basihyale	6		2																						
Hypohyale		3			2																				
Keratohyale	214	11	3		3					2			1												
Epihyale	126	7			4																				
Urohyale	26	5	1		2		3			1															
Os pharyngeum inferius		186																							
Processus pharyngeus ossis basioccipitalis		11																							
Branchialia	32		11		2		2																		
Detached teeth[1)]		161														9									
Shoulder girdle																									
Posttemporale			19	6	22		3			1	1				2										
Supracleithrale		6	17		23		3		1																
Cleithrum	461		3	5	1		3								2										
Scapula		15								1															
Pelvic girdle																									
Basipterygium		22		46	1		1			1															
Vertebrae	4931	1137	1044	160	571	146	121		1	66	47	49	50	33	6	8	22	22	10	9	7	3	2		2

	Eel	cyprinids	gadids	Three-spined Stickleback	Greater Weawer	Mackerel	pleuronectids	Turbot	flatish indet.	Black Seabream	Perch	Herring/clupeids	Eelpout	Garpike	Gurnard	Pike	Atlantic Horse-mackerel	salmonids	European Seabass	Bullhead	Spurdog	Smoothhound	Sand-eel	Stingray	Gobiid
Others																									
Tripus		16																							
Os suspensorium		10																							
Os anale							10																		
dorsal spines				39																	1				
pelvic spines				62																					
tail spine																								1	
dorsal scutes				37																					
lateral scutes				133																					
scales etc.[2]		+					16	3		(21)	(5)						4								
unspecified bones	2		3	216	4	41				2				2	6	5									
Total	6763	1659	1280	770	723	189	179	3	2	83	52	51	53	47	27	28	27	23	11	10	8	3	2	1	2
										+	+														
										21	5														
										scales	scales														

Table 2. Specification of 11996 identified fish bones from Bjørnsholm. Numbers of different bones of each kind of fish are given. Regarding cyprinids, gadids, and pleuronectids, see text, page 106.
Notes: [1] Detached teeth of cyprinids derive from os pharyngeus inferius, those of Pike from oral bones. [2]+ means that scales were found but not counted (impossible). Scales of Black Seabream and Perch are not included in the total. The entry under pleuronectids refers to dermal denticles of Flounder, under Turbot also to dermal denticles, under Atlantic Horse-mackerel to the large, keeled scales of the lateral line.

i.e., more calcified, and with stouter ridges, than vertebrae from most other Danish cartilaginous fishes.

Two closely related species of *Mustelus* occur today in European waters: *M. asterias* and *M. mustelus* (Muus & Dahlstrøm 1964). Study of Recent comparative material showed no difference between vertebrae of these species which in general are very similar to each other.

The Smoothhound vertebrae were found in squares AB, J, and H and seem to derive from at least two individuals since two of the vertebrae are from sharks of about 80 cm length and one is from a somewhat larger specimen. Smoothhound may reach a length of 2 m (Curry-Lindahl 1985).

Two of the vertebrae were found in Neolithic samples (squares J and H), one of them together with a Black Seabream vertebra, see above. Again, Mesolithic contamination cannot be excluded. The horizontal distribution suggest at least two catches of Smoothhound.

Both species of Smoothhound are coastal species. Their present distribution includes the Atlantic from Morocco and Madeira northward to the British Isles, *M. asterias* even to the Shetlands, the North Sea and the Mediterranean (Branstetter 1984). They are irregular visitors in Danish, Norwegian, and Swedish waters (Curry-Lindahl 1985; J. Nielsen pers. comm.). *M. asterias* has been caught in set nets close to the Danish coast (Otterstrøm 1917).

Stingray, *Dasyatis pastinacea*, Da.: Pilrokke

Already during the beginning of the new excavations at Bjørnsholm a well-preserved tailspine of Stingray was found in the Early Neolithic layers in square G (Rosenlund 1985, 1986a). Almost the entire spine has been preserved, only the base and the very tip are missing; the break at the basis is ancient. The preserved fragment measures about 15 cm (fig. 7). All in all four subfossil finds of Stingray from Denmark are now known (Rosenlund 1985, 1986a, 1986b). On a living Stingray the spine is situated on the long, slender tail and is connected with poison glands. The spine of recent specimens may be as long as 35 cm; the fish is normally 50 cm to 1 m long, maximal length more than 2 m (Muus & Dahlstrøm 1985).

Stingray lives in from shallow to about 200 m deep water. Its recent distribution includes Atlantic coastal waters from South Africa northward to the British Isles, southern Norway, and (rarely) the western part of the Baltic, also the Mediterranean (McEachran & Capapé 1984). It is a casual visitor to Danish waters (at least 26 finds) (Curry-Lindahl 1985).

See also Enghoff (in press) concerning the southern species from Bjørnsholm.

CONTROL OF SIEVING EFFICIENCY

The column from square K which was sieved through the field sieve as well as a finer mesh in the laboratory invites some comments on the field excavation technique. Fine-sieving of all soil in the field is a practical impossibility. This does not necessarily matter as far as one realizes what is lost by the coarse mesh in the field sieve!

For each 5 cm layer which was sieved through the field sieve (2–3 mm) the material passing through the mesh was collected. One bag (c. 2 kg) of this material from each 5 cm layer was then fine-sieved (0.6 mm mesh) in order to control which bones pass through the coarse mesh. Material passing through the 0.6 mm mesh was examined but contained nothing of interest. In table 3 the bones recovered by the two sieves are shown, ordered in a sequence from top to bottom (unfortunately 2 samples are missing). The soil of each 5 cm layer was not weighed before the sieving. Therefore the columns G and F cannot be directly compared. But it remains a fact that all bones found on the fine mesh have passed through the coarse mesh – actually many more bones than shown in the table have passed through since only part of the material from each 5 cm layer was fine-sieved.

Table 3 shows which kinds of bones that are lost by the field sieve. Only some of the most frequent species are tabulated but the tendency is obvious: Some Eel bones are lost but many are also retained by the field sieve. The situation is worse regarding the small bones of cyprinids, and of the tiny Three-spined Stickleback the majority of bones are lost, if not almost all. The generally bigger gadid bones, on the contrary, are largely retained by the field sieve, to the extent that they have been preserved in the soil at all.

In summary, this shows that many small bones have been lost during field sieving on this settlement. For a general discussion of sieving efficiency, see Payne (1972).

Sample	Numbers of bones				Three-spined			
	Eel		Cyprinids		Stickleback		Gadids	
	G	F/2 kg	G	F/2 kg	G	F/2 kg	G	F/2 kg
RAX	8						1	
ORL	1	40	1	112				
ORO	5	24		4				
ORR	sample lost							
ORU	sample lost							
ORX	44	20	1			28		
OSA	8	50		6		78		
OSF	90	120	14	32	3	50		
OSP	17	24	1		1	6	2	
OSQ	250	54	71	26	2	22	2	
OSW	242	324	47	216	1	40	16	6

Table 3. The column in square K. The samples are arranged in accordance with their vertical position in the column. Samples RAX, ORL, and ORO are of mixed Mesolithic/Neolithic origin. Samples ORR and ORU have been lost. The remaining samples are purely Mesolithic. For the sake of clearness only the commonest species are tabulated. The special fish samples (QUN, QUO and OSU, see table 4) belong to levels OSQ and OSW. Each sample was sieved through a 2.5 mm mesh. About 2 kg of the material passing through the 2.5 mm mesh was sieved through a 0.6 mm mesh.
G = coarse mesh (2–3 mm).
F = fine mesh (0.6 mm). The bone numbers have been adjusted to correspond to exactly 2000 g of sediment.

Sample	Weight of sample (kg)	Numbers of bones:				
		Eel	Cyprinids	Three-spined Stickleback	Gadids	Other species
SPT	1.90	363	352	15	11	34
QUN	1.08	157	239 +numerous scales	43	2	24
QUO	0.26	13	62 +numerous scales	35		2
OSU	0.17	425	13 +2 scales			

Table 4. Special fish samples excavated from square K. These samples were sieved through a 0.6 mm mesh, which seems sufficient for retainment of all bones of any significance.

These circumstances must be taken into account in connection with estimations of the importance of individual fish species in the material.

DISTRIBUTION OF FISH BONES THROUGH THE EXCAVATION

Fish bones have been found in all excavated squares and they are frequent all over. The western part of the midden (squares Z–AC) is especially rich in fish bones. The largest numbers were, however, found in square K in connection with a fireplace, and in the neighbouring squares J and H, which also contained a fireplace. The samples QUO and QUN from the margin of this fireplace in square K appeared in the field like compact patches of scales. In addition to the numerous cyprinid scales which were compressed into "cakes", these samples also contained many fish bones, especially from Eel, cyprinids, and Three-spined Stickleback, see table 4. Samples QUO and QUN further contained small fragments of mammal bones as well as shells of marine bivalves and a blade scraper with convex end retouch. The "fish layer" (SPT) from the northern wall of square K contained numerous fish bones (mostly from Eel and cyprinids) but also fragmented mammal bones as well as bivalve shells. Sample OSU was also described as a "fish layer", its content is of the same character as that of the above-mentioned samples. Although all these bones were found close to fireplaces none of them were burnt.

In squares A to L inclusive Early Neolithic layers overlie the Mesolithic layers. The rather few Neolithic bones derive from these fields.

Table 3 gives an impression of the vertical distribution of fish bones in square K. This square covers a small part of a Neolithic pit; therefore the three uppermost samples are of mixed origin, whereas the lower samples are purely Mesolithic. It is obvious that the Mesolithic layers, in particular the lowermost ones, are richer in fish bones. The special samples QUN, QUO, and OSU (table 4) belong to the lowermost levels and amplify this tendency. In the other "column sample", square U, the vertical distribution of bones is more uniform (or rather randomly variable).

The individual species of fish are homogeneously distributed through the excavation. The most frequent species, Eel, is found everywhere, actually in almost every sample of fish bones. Also the other frequent species are generally distributed; this is true of cyprinids, gadids, Three-spined Stickleback, Greater Weaver, and Flatfish, as well as of the summer-indicator Mackerel. The remaining species, which are represented by fewer bones, do by necessity not occcur in every square but even they seem to be randomly distributed over the entire excavated area. The distribution of the exotic, southern species in the excavation has been discussed in a special chapter – their bones are also quite dispersed.

The "columns" K and U show a uniform vertical distribution of fish *species* through the various layers.

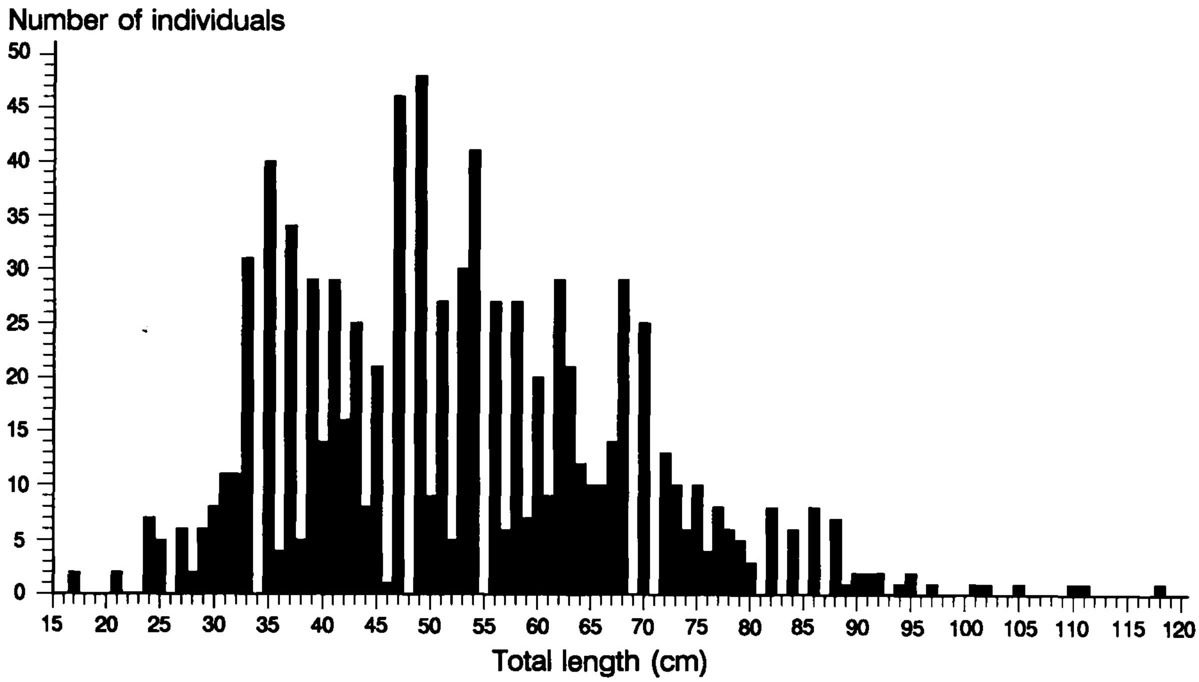

Fig. 8. Size-frequency diagram of eel (*Anguilla anguilla*) from Bjørnsholm. Total length estimated on the basis of measurements of cleithrum, keratohyale, dentale and 1. vertebra. Based on the Mesolithic part of the material only. N = 880.

Finally, it is worth noticing that freshwater species, saltwater species, and migratory species occur together in the same samples throughout the material.

SIZE OF FISH

Eel. The Bjørnsholm material includes very many Eel bones; therefore a size-frequency diagram was made. As in the analysis of the material from Ertebølle four subfossil bones were measured: cleithrum, keratohyale, dentale and 1st vertebra. The total length of the fish was estimated by means of regression equations expressing the relation between the bone measurement and the total length. See Enghoff (1987) for equations and definitions of bone measurements.

The very well-founded size-frequency diagram, which is based on Mesolithic bones exclusively, is shown in fig. 8. It appears that the Eel varied from 17 to 118 cm in total length, most specimens having measured 30–75 cm. An 118 cm Eel has been an impressive one, the present-day maximum length being recorded as 1 m (Muus & Dahlstrøm 1967).

Today all Eel longer than 50 cm are females (Muus & Dahlstrøm 1967) and this probably also applies to the Bjørnsholm material. These larger females probably included both yellow eel and silver eel. Eel shorter than 50 cm may be both males and females; such smaller females are yellow eel whereas males may have been both yellow and silver. The minimum length of male silver eel as known today is 29 cm (Petersen 1896).

Roach. The size-frequency diagram for Roach from the neighbouring settlement at Ertebølle was found to be highly interesting since a grouping of the specimens into sizeclasses was evident (Enghoff 1987). Therefore a size-frequency diagram was made for Roach from Bjørnsholm as well, although the number of Roach bones is modest.

Total length of Roach was estimated by means of regression equations expressing total length as a function of the width of 1. and 2. vertebrae. See Enghoff (1987) for equations and definitions of measurements.

The size-frequency diagram, which is based on Mesolithic bones only, is shown in fig. 9. Total length of Roach from Bjørnsholm varied from 5 to 24 cm. A diagram based on so few bones is little revealing in itself, but by comparison with the corresponding diagram from the Ertebølle settlement (Enghoff 1987, fig. 6) size-classes of about 5–6 cm, 10 cm, and 13–14 cm can be recognized on

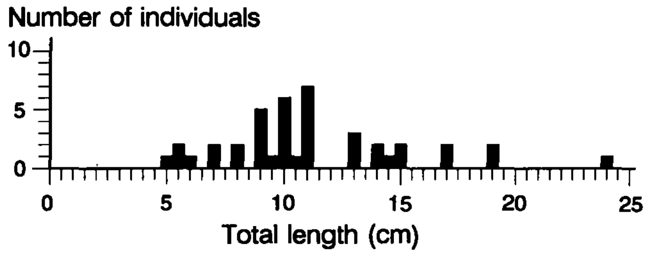

Fig. 9. Size-frequency diagram of roach (*Rutilus rutilus*) from Bjørnsholm. Total length estimated on the basis of measurements of 1. and 2. vertebrae. Based on the Mesolithic part of the material only. N = 42. Compare with the corresponding diagram for the Ertebølle-material (Enghoff 1987, fig. 6).

fig. 9, just as at Ertebølle – an indication that the same conclusions may be drawn (see also p. 116).

Other species. The gadids have been 20–50 cm long (lengths estimated from diameters of subfossil 1st – 4th vertebrae). Seven of the Tench bones derive from a very large specimen (estimated total length 60 cm); today Tench rarely exceeds 50 cm in Denmark but may reach 70 cm in eastern Europe (Muus & Dahlstrøm 1967). The *Salmo* bones on the contrary mostly derive from small specimens (just below 50 cm).

ANALYSIS OF GROWTH-RINGS IN OTOLITHS

Eleven otoliths from Cod (3) and Saithe (8) were particularly well preserved, even the surface appeared convincingly intact. A growth-ring analysis of these otoliths was made by E. Steffensen (The Danish Institute for Fisheries and Marine Research), who has years of experience with analysis of Cod otoliths. A growth-ring analysis may indicate the season at which the fish has died, as well as its age in years (Wheeler & Jones 1989).

Each analyzed otolith was snapped across its width through the nucleus, and the broken surface was ground on a wet grinding machine. The growth-rings on the plane surface could then be clearly seen through a microscope if the broken otolith was immersed in water. The growth-rings were even more conspicuous on the subfossil otoliths than on recent ones due to staining of the rings during the stay in the shell-midden.

All 11 analyzed otoliths turned out to derive from fish caught during late summer/autumn: the outermost growth zone was very broad and showed rapid growth characteristic of summer – however in nine out of 11 otoliths a faint hyaline outer edge indicates the onset of the slow wintergrowth. If the otoliths had been taken from recent fish, their death would have been assigned to the month of September. The otoliths derive from squares AC, AA, Z, P, and BC and thus represent several separate finds with some horizontal dispersion. Even though the number of analyzed otoliths is modest, this dispersion, in connection with the uniformity of the season indicated, suggests an emphasis on fishing in late summer/autumn.

The growth-ring analysis in addition showed that all the Saithes were one year old at death. Of the Cods, one had reached an age of two years, and two an age of three years.

DISCUSSION

The geographic position of the Bjørnsholm settlement (see introduction) was optimal for fishing. The species list accordingly reflects a most varied selection of species from salt as well as fresh water. The majority of bones (56%) derive from Eel. Second, third and fourth in frequency are cyprinids, gadids, and the tiny Three-spined Stickleback (table 1). The control of sieving efficiency clearly shows that many small bones have been lost during excavation, thus cyprinids and Three-spined Stickleback have been much more abundant than the sheer numbers of recovered bones suggest.

Apparently few bones of gadids have been lost during excavation. Also in terms of bone preservation the gadids are favoured, as their bones are poor in fats.

In this respect, the very fatty bones of Eel are less likely to have been preserved. Therefore the absolute dominance of Eel bones can only mean that the fishing at Bjørnsholm was no less than an Eel adventure! This conclusion is supported by the general occurrence of Eel bones in almost all fish bone samples.

Significance of Three-spined Stickleback. At first glance the importance of Three-spined Stickleback may appear strange, this species being usually not regarded as suitable for human consumption today. Its importance at Bjørnsholm is accentuated by its general distribution in the material, horizontally as well as vertically. Numerous bones of Three-spined Stickleback were also found at Ertebølle where their occurrence was, however, more local (Enghoff 1987). At Skateholm, Scania, Sweden, numerous Three-spined Stickleback bones were found, partly in graves, where their occurrence was interpreted as stomach content and food offerings (Jonsson 1986). Three-spined Stickleback may also have played an important role for the Mesolithic people at the Limfjord. The species has a high content of train oil and in historic times it has been exploited for oil extraction and as fish meal (Muus & Dahlstrøm 1967).

Exotic species. The material includes an interesting element of exotic, southern species: Black Seabream, European Seabass, Smoothhound, and Stingray. The vertical and horizontal distribution of the exotic species in the midden, in combination with the radiocarbon dates and the stratigraphical analysis, suggests repeated catches. The fact that their bones are at all represented in the material (in case of Black Seabream even rather richly represented) indicates that these species were much more common in Danish waters than they are today.

The presence of the southern species suggests a warmer climate in Denmark during the period in question than today. The presence of no less than four different species reinforces this interpretation. The higher salinity of the Limfjord has made it possible for them to reach Bjørnsholm, and as they all tend to approach the coast they have been liable to be caught in the traps of the Bjørnsholm people.

The warmer period in Denmark seems to have been quite prolonged – several of the exotic fish (Stingray, Smoothhound) possibly also a single Black Seabream) derive from Neolithic layers. This agrees with the well-known indicator of warmth, the European Pond Tortoise (*Emys orbicularis*), which is known from numerous Danish finds from both the Atlantic and the Subboreal period (Degerbøl & Krogh 1951). The European Pond Tortoise does not belong to the present Danish fauna but lives in southern and eastern Europe, its distribution being limited by summer temperature.

A further indication of a warmer climate may be the very large specimen of Tench from Bjørnsholm.

Even the most important species at Bjørnsholm, Eel, is a warmth-demanding species; today its growth in Danish waters is slow. Several specimens in the Bjørnsholm material have exceeded the maximum length for Danish Eel today (100 cm), perhaps a further indication of a warmer climate.

Characteristics of the fishing for Eel and other species. The situation of the Bjørnsholm settlement leaves no doubt that the most efficient way of fishing for Eel would have been trapping at the mouth of the freshwater streams into the Bjørnsholm Fjord. At such places, Eel tend to concentrate during their migration into the sea. If this has really been the strategy of the Bjørnsholm people, the Eel caught must have come from freshwater. The size-frequency diagram for Eel agrees with this hypothesis: Eel populations growing up in fresh water always contain a majority (80–95%) of females, and the diagram shows the presence of very many females (since all specimens >50 cm are females).

The activity of Eel is cyclic and is coupled to lunar phases (Boëtius 1967), particularly many Eel migrate during autumn interlunar periods. At these periods, silver eel leave the waters in which they have grown up, to start their spawning migration. Two independent lines of evidence suggest that the fishing at Bjørnsholm was primarily directed at this migration of Eel:

1. In the material from Ertebølle the Roach size-frequency diagram was taken as evidence for a strictly seasonal fishing directed at Eel, possibly at the late summer/autumnal migrations (Enghoff 1987). The Roach size-frequency diagram from Bjørnsholm reminds of that from Ertebølle and may be interpreted as an indication that also the Bjørnsholm people have exploited the silver eel migrations. (The Roach bones in question were found in close association with Eel bones at both settlements.)
2. All 11 analyzed otoliths (found somewhat dispersed) derive from late summer/autumn fish. The analyzed otoliths are of Cod and Saithe, but they were lying in small groups of bones together with Eel bones and must be supposed to have derived from the same meals as the Eel.

The general occurrence of seasonal fish, especially the most frequent of them, Mackerel, shows that fishing has consequently been conducted during the summer half of the year. Many other species would also have been most easy to catch during this season, *e.g.* Greater Weaver which during summer lives close to the coast but stays in deeper waters autumn and winter (Muus & Dahlstrøm 1964). The same is true of small gadids (Cod and Saithe), for which the growth-ring analysis in addition gives a more precise information on the season of capture (late summer). Even Spurdog roams in shallow water during summer (Otterstrøm 1917).

The most frequent of the summer species, Mackerel, occurs very regularly throughout the material, an indication that fishing was *not* conducted during wintertime. On the other hand, there are several winter indicators among the bird and mammal species found in the bone material, for instance the presence of bones of the Whooper Swan (*Cygnus cygnus*) (Bratlund 1993, this volume) shows that the settlement was inhabited during winter. It would thus seem that the people using the settlement during winter did not go fishing.

The fishing at Bjørnsholm shows no temporal variation, and freshwater and saltwater species have been exploited simultaneously. Many fish bones were found around fireplaces, but none were burnt. The bones presumably represent remnants from meals. There is no indication that the fish have been cut up: Both head and body bones are present, and no bones show traces of cutting. A possible interpretation would be that the bones and scales have simply been skimmed off potfuls of fish soup.

Fishing technique. As in the case of previously analyzed Mesolithic fish bone materials (Enghoff 1983, 1987, 1991), the main fishing technique at Bjørnsholm is interpreted as having consisted of stationary fish traps, possibly with leaders made of wattles, placed in shallow water. The list of species is varied and looks like a more or less uncritical sample of the species which would have been present in the local waters. Eel dominates the material, and although it may be caught on hooks or with fish spears, an Eel fishing of this order of size rather indicates trap-fishing. That the fishing, as far as the marine species is concerned, has taken place in shallow water is shown by the presence of species which spend all their life in the *Zostera* belt in shallow water, e.g., Eelpout, a species which occurs sparsely but generally distributed in the material, and Bullhead. The other species on the list spend at least part of their life in shallow water. Greater Weaver, a frequent and constant species in the samples, buries in the sand in shallow water during daytime and swims about during night (Muus & Dahlstrøm 1964) – this species clearly indicates stationary traps being set for at least one night over. Even Eel is a nocturnal species. It is true that about seven fish-hooks (2.5–3 cm long) have been found in the Mesolithic layers at Bjørnsholm (S. H. Andersen 1993, this volume), prooving that hook fishing has been conducted. Among the species on the list, it is probably first and foremost the small gadids, Eelpout and Bullhead which have been caught on hooks. Hook fishing is, however, regarded as having been a mere supplement to the main fishing by traps.

The Neolithic layers. The Bjørnsholm kitchenmidden is chiefly a Mesolithic midden but part of it is overlaid by Early Neolithic layers. The fish bone material also is mainly Mesolithic, and the above discussion refers to the

Mesolithic part exclusively. Some fish bones (albeit only about 250) have, however, been found in Neolithic layers. The low number of Neolithic fish bones does not allow calculations and elaborate speculations but does at least show that fishing appears to have continued to a certain extent into the Neolithic phase. The Neolithic fish species are largely the same as the Mesolithic ones, with some absences which may be due to the low number of bones.

In the Norsminde kitchenmidden (Andersen 1991) the contrast between Neolithic and Mesolithic layers was even more striking than at Bjørnsholm: one single fish bone was found in the former, against about 9000 fish bones in the latter (Enghoff 1991).

Comparison with the Ertebølle køkkenmødding. The settlements at Bjørnsholm and Ertebølle were contemporaneous and were separated by a mere 8 km distance. A comparison between the two is therefore self-inviting. One conspicuous difference concerns the relative proportion of freshwater and saltwater fishes: At Ertebølle 71% of the bones represented freshwater species, 12% marine species, and 17% migratory species (Enghoff 1987). The corresponding figures for Bjørnsholm are: freshwater 15%, marine 22%, migratory 63%. Both settlements agree in the dominance of Eel and cyprinids (esp. Roach). But whereas the cyprinids are number one at Ertebølle (cyprinids 67%, Eel 17%), the roles are reversed at Bjørnsholm (Eel 56%, cyprinids 14%).

There is no doubt that Eel fishing has been a major feature of life both at Ertebølle and at Bjørnsholm. But there has been one significant difference between Eel fishing at the two places. At Ertebølle, the material indicates dominance of freshwater fishing (probably conducted in nearby lakes). Cyprinids are a very characteristic secondary catch during Eel fishing in lakes. Furthermore, quite a number of Perch were caught at Ertebølle, whereas the marine catch was less significant. If the Bjørnsholm people placed their fish traps near the mouths of freshwater streams into the Bjørnsholm fiord, as suggested above, the secondary catch of cyprinids will have been much smaller, whereas the marine element will have been much more important, as is actually the case. In short, the difference between Ertebølle and Bjørnsholm may simply be due to different location of the essential Eel fishing.

Part of the difference is, however, probably due to the excavation technique. As shown by the efficiency control, many cyprinid bones may have been lost during excavation at Bjørnsholm. At Ertebølle, the technique was different and probably resulted in fewer losses of small bones. However, methodological considerations alone are probably not sufficient for explaining the profound difference.

The total lack of exotic species from Ertebølle is puzzling, regarding the importance of these species at nearby, contemporaneous Bjørnsholm. Also the lack of Mackerel at Ertebølle is difficult to explain, as this species is frequent in the Bjørnsholm material. The lack of these species may be due to the lesser importance of marine fishing at Ertebølle. The Ertebølle people have, however, caught quite a few Garpike, a marine species which is rare in the Bjørnsholm material. A further striking detail concerns the gadids: At Ertebølle, most gadids were Saithe, but at Bjørnsholm Cod clearly dominates.

CONCLUSION

The Limfjord has been renowned for its Eel fishing through historic times. A record of Eel-trap stands in Denmark about 1900 (Petersen 1901) shows that the number of traps in the Limfjord (2600) was several times higher than at any other place along the east coast of Jutland. The analysis of the fish bone materials from Bjørnsholm and Ertebølle has shown that also during the Ertebølle period in Denmark, a massive Eel fishing took place in the Limfjord, apparently mainly in late summer/autumn. Let there be no doubt that the fishing from Bjørnsholm was first and foremost directed at Eel, just as at Ertebølle. By this trait these two Limfjord settlements stand out against the other contemporaneous settlements analyzed so far; Vedbæk (Enghoff 1983, unpublished), Norsminde (Enghoff 1991), and Tybrind Vig (Trolle-Lassen 1984). Whereas the growth-ring analysis of gadid otoliths positively indicates late summer/autumn fishing, the Bjørnsholm people apparently did not go fishing in the winter, in spite of the fact that the settlement was inhabited during wintertime. A special detail of the Bjørnsholm material is constituted by the element of exotic, southern species, indicating that the fishing took place in a climate warmer than the present.

Inge Bødker Enghoff, The Zoological Museum, University of Copenhagen, Universitetsparken 15, DK-2100 København Ø.

Acknowledgements

The material was put at my disposal by S. H. Andersen (Institute of Prehistoric Archaeology, University of Aarhus), who also provided radiocarbon dates and other necessary information and advice throughout the analysis. Photographs were prepared by G. Brovad (Zoological Museum, University of Copenhagen), and diagrams by K. Rosenlund (Zool. Mus.), who also provided stimulating discussions. E. Steffensen (The Danish Institute for Fisheries and Marine Research) analyzed otoliths, and I. Boëtius (same institute) helped with interpretation of the Eel size-frequency diagram. J. Nielsen (Zool. Mus.) and Nanna Noe-Nygaard (Institute of Historical Geology and Palaeontology, University of Copenhagen) read the manuscript and provided many useful suggestions. I extend my sincere thanks to these persons. The analysis was made possible by grants from Århus Universites Forskningsfond, the Carlsberg Foundation, the Danish Natural Science Research Council.

REFERENCES

ANDERSEN, S. H.: 1991: Norsminde. A "køkkenmødding" with Late Mesolithic and Early Neolithic Occupation. *Journal of Danish Archaeology* vol. 8, 1989: 13–40.

– 1992: Marin udnyttelse af Limfjorden i stenalderen. In *Limfjordsprojektet. Rapport nr. 4: Limfjordsfiskeri i fortid og nutid*: 65–96.

– 1993: Bjørnsholm. A Stratified "køkkenmødding" at the Central Limfjord, North Jutland. *Journ. Da. Arch.* vol. 10, 1991: 59–93.

ANDERSEN, S. H. & JOHANSEN, E. 1987: Ertebølle Revisited. *Journal of Danish Archaeology* vol. 5, 1986: 31–61.

BAUCHOT, M.-L. & HUREAU, J.-C. 1986: Sparidae. In P. J. P. WHITEHEAD, M.-L. BAUCHOT, J.-C. HUREAU, J. NIELSEN & E. TORTONESE (eds.): *Fishes of the North-eastern Atlantic and the Mediterranean*, II: 883–907.

BOËTIUS, J. 1967: Experimental indication of lunar activity in European silver eels, *Anquilla anquilla* (L.). *Meddelelser fra Danmarks Fiskeri- og Havundersøgelser, N. S., 6*, 1: 1–6.

BRANSTETTER, S. 1984: Triakidae. In P. J. P. WHITEHEAD, M.-L. BAUCHOT, J.-C. HUREAU, J. NIELSEN & E. TORTONESE (eds.): *Fishes of the North-eastern Atlantic and the Mediterranean*, II.

BRATLUND, B. 1993: The Bone Remains of Mammals and Birds from the Bjørnsholm Shellmidden. A Preliminary Report. *Journal of Danish Archaeology* vol. 10, 1991: 97–104.

CURRY-LINDAHL, K. 1985: *Våra fiskar. Havs- och sötvattensfiskar i Norden och övriga Europa*. Stockholm.

DEGERBØL, M., & KROGH, H. 1951: Den europæiske Sumpskildpadde (*Emys orbicularis* L.) i Danmark. *Danmarks Geologiske Undersøgelse. II. Række, 78:* 1–129, 3 pl.

ENGHOFF, I. B. 1983: Size distribution of cod (*Gadus morhua* L.) and whiting (*Merlangius merlangus* (L.)) (Pisces, Gadidae) from a Mesolithic settlement at Vedbæk, North Zealand, Denmark. *Vidsk. Medd. da. naturhist. Foren.*, 144: 83–97.

– 1987: Freshwater Fishing from a Sea-Coast Settlement – the Ertebølle *locus classicus* Revisited. *Journal of Danish Archaeology* vol. 5, 1986: 62–76.

– 1991: Fishing from the Stone Age Settlement Norsminde. *Journal of Danish Archaeology* vol. 8, 1989: 41–50.

– in press: Rare species of fish in the Bjørnsholm shell-midden, Denmark – Indicators of a warmer climate. *B.A.R. International Series*.

JONSSON, L. 1986: Fish bones in late Mesolithic human graves at Skateholm, Scania, South Sweden. *B.A.R. International Series*, 294: 62–79.

MCEACHRAN, J. D. & CAPAPÉ, C. 1984: Dasyatidae. In P. J. P. WHITEHEAD, M.-L. BAUCHOT, J.-C. HUREAU, J. NIELSEN & E. TORTONESE (eds.): *Fishes of the North-eastern Atlantic and the Mediterranean*, I: 197–202.

MUUS, B. J. 1970: *Fisk I. Danmarks Dyreverden 4*. Odense.

MUUS, B. J. & DAHLSTRØM, P. 1964: *Havfiskeri og fiskeri i Nordvesteuropa*. G.E.C. Gad, København.

– & – 1967: *Europas ferskvandsfisk*. G.E.C. Gad, København.

OTTERSTRØM, C. V. 1917: *Danmarks Fauna. Fisk III., Tværmunde m.m.* G.E.C. Gad, København.

PAYNE, S. 1972: Partial recovery and samples bias: the results of some sieving experiments. In E. S. HIGGS (ed.): *Papers in economic prehistory:* 49–64. Cambridge University press.

PETERSEN, C. G. J. 1896: Den almindelige Aal (*Anguilla vulgaris, Turton*) anlægger før sin Vandring til Havet en særlig Forplantningsdragt. – Om denne Sags Betydning for Systematiken og Aalefiskeriernes praktiske Drift. *Fra den danske biologiske Station*, V (1984): 4–35, 2 pl.

– 1901: Fortegnelse over Aalerusestader i Danmark optaget i Aarene 1899 og 1900. Med Bemærkninger om Ruseaalens Vandringer etc. *Fra den danske biologiske Station*, X (1899 and 1900): 3–28, 1 pl.

PETERSEN, K. S. 1987: The Ertebølle 'køkkenmødding' and the Marine Development of the Limfjord, with Particular Reference to the Molluscan Fauna. *Journal of Danish Archaeology* vol. 5, 1986: 77–84.

– 1992: Om større geologiske/miljøhistoriske ændringer i Limfjorden i Holocæn. In *Limfjordsprojektet. Rapport nr. 4: Limfjordsfiskeri i fortid og nutid:* 17–28.

ROSENLUND, K. 1976: *Catalogue of subfossil Danish vertebrates. Fishes*. Zoological Museum, University of Copenhagen.

– 1985: Pilrokken i Danmark i fortid og nutid. *Dyr i Natur og Museum*, 1985, 2: 20–24.

– 1986a: The strategy, *Dasyatis pastinaca* (L.) in Denmark. *B. A. R. International Series*, 294: 123–128.

– 1986b: Hvad en kommodeskuffe kan indeholde. *Dyr i Natur og Museum*, 1986, 2: 30–31.

TORTONESE, E. 1986: Moronidae. In P. J. P. WHITEHEAD, M.-L. BAUCHOT, J.-C. HUREAU, J. NIELSEN & E. TORTONESE (eds.): *Fishes of the North-eastern Atlantic and the Mediterranean*, II.

TROLLE-LASSEN, T. 1984: A preliminary report on the archaeological and zoological evidence of fish exploitation from a submerged site in Mesolithic Denmark. *C.N.R.S. Centre de Recherches Archaéologiques. Notes et Monographies techniques* 16.

WHEELER, A. & JONES, A. K. G. 1989: *Fishes*. Cambridge Manuals in Archaeology, Cambridge University Press.