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Freshwater fishing at Ringkloster, with a supplement of marine fishes

by Inge Bødker Enghoff

INTRODUCTION

During the Atlantic period, the stone age settlement Ringkloster was situated at Lake Skanderborg in Jutland, Denmark. Lake Skanderborg drains towards the west through the river Gudenå and is situated 15-20 km from the nearest seacoast (Kattegat to the east). At the time when the Ringkloster settlement was inhabited Lake Skanderborg was much larger and much more ramified than today.

The Ringkloster settlement was situated at the shore of a prehistoric arm of the lake, just where the arm was connected with the rest of the lake through a narrow passage. Conditions for fishing must have been good here, because fish concentrate at such places when passing from one basin to the other.

Pollen analysis indicates that the area off the settlement has been an alder (*Alnus*) swamp, not reed-swamp which would have been an obstacle for fishing (Rasmussen 1998 - this volume). The bottom of the lake off the settlement falls steeply towards west. In addition to Ringkloster, there were several other stone age settlements at Lake Skanderborg. Ringkloster is, however, so far the only inland settlement from the Ertebølle period in Jutland which has been systematically excavated, and from where bones have been preserved. For this reason, Ringkloster is of particular interest. For an archaeological treatment of the Ringkloster settlement, see Andersen (1975; 1998 - this volume).

MATERIAL AND METHODS

The Ringkloster settlement was excavated during the period 1969-1983 under the supervision of Søren H. Andersen (Institute of Prehistoric Archaeology, University of Aarhus). The site includes a settlement area on land (ca. 200 X 75 m) and a refuse zone in the former lake which is now a swamp. 105 m^2 of the refuse zone have been excavated. The settlement was excavated systematically, but the sediment was not consistently sieved in the field. This has presumably reduced the number of recovered fishbones considerably. However, selected samples were sieved (2½ mm mesh) as a routine in order to control the presence of small objects. These samples gave the impression that there were only few fishbones in the former lake, except near the shore where fishbones were locally numerous. Owing to a highly complicated stratigraphy only few squares were, however, excavated in this zone. In the settlement area conditions for preservation were very bad and almost no organic remnants have been preserved. Thus, the majority of the fishbone material derives from the refuse zone in the near-shore zone of the former lake. The vertebrae in the material are well-preserved, but fish headbones are generally not.

$_{14}$C datings are available from bottom to top of the refuse zone and cover the interval 4110-4460 B.C. The dates are calibrated according to Stuiver & Pearson (1993) by U. Rahbek, The C-14 Dating Laboratory, The National Museum, Copenhagen.

Lab. No.	$_{14}$C-age BP	B.C. cal.	± 1 std. dev.
K-1652	5610 ± 110	4460	4540-4350
K-1765	5500 ± 100	4350	4460-4250
K-1653	5490 ± 100	4340	4450-4240
K-1654	5320 ± 100	4220-4110	4320-3990

As the fishbone material was recovered from the former lake, it cannot be assumed *a priori* to repre-

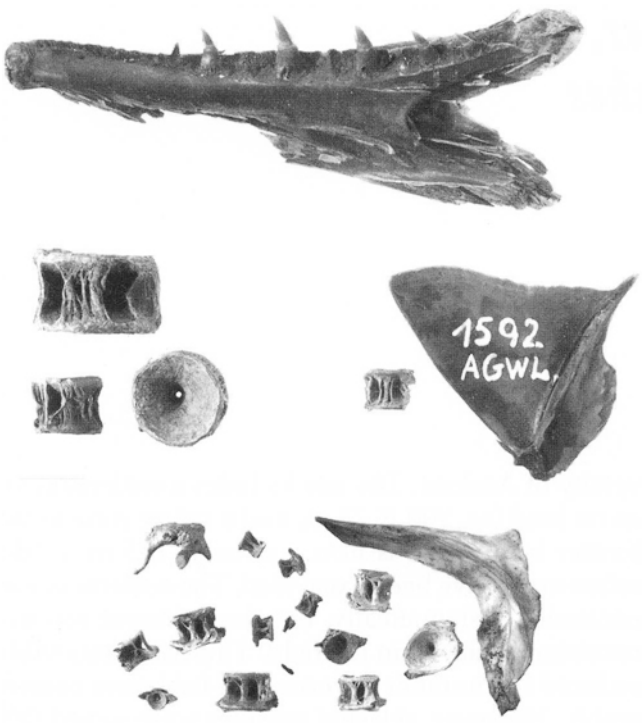

Fig. 1 Fishbones from Ringkloster, representing the most frequent species. Top: Dentale of Pike. Middle left: three vertebrae of Pike. Middle right: One vertebra and one operculum of Perch. Bottom: One pharyngeal bone, 12 vertebrae, and one cleithrum of cyprinids (1:1). G. Brovad photo.

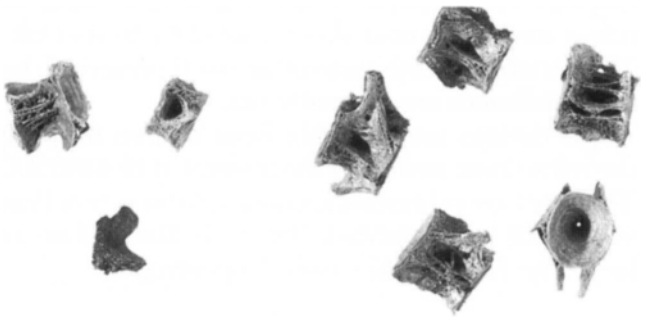

Fig. 2 Bones of marine fishes from Ringkloster. Top left: two vertebrae of Cod. Bottom left: Burnt praemaxillare of Cod. Right: Five vertebrae of Plaice/ Flounder/Dab (2:1) G. Brovad photo.

	No. of bones	% of total
FRESHWATER SPECIES		
Pike, *Esox lucius*	253	26.89
Cyprinids, Cyprinidae, TOTAL	536	56.96
Roach, *Rutilus rutilus*	(19)	(2.02)
Rudd, *Scardinius erythrophthalmus*	(3)	(0.32)
White bream, *Blicca bjoerkna*	(4)	(0.43)
Common bream, *Abramis brama*	(1)	(0.12)
Cyprinidae unspecified	(509)	(54.09)
Perch, *Perca fluviatilis*	114	12.11
Ruffe, *Gymnocephalus cernuus*	2	0.21
MIGRATORY SPECIES		
Trout/Salmon, *Salmo* sp.	2	0.21
Eel, *Anguilla anguilla*	8	0.85
SALTWATER SPECIES		
Gadids, Gadidae, TOTAL	15	1.59
Cod, *Gadus morhua*	(11)	(1.17)
Pollack/Saith, *Pollachius* sp.	(1)	(0.12)
Gadids, unspecified	(3)	(0.32)
Plaice/Flounder/Dab, *Pleuronectes platessa/ Platichthys flesus/ Limanda limanda*	11	1.17
Total	941	

Table 1 Species of fish in the Ringkloster material. Numbers of identified bones of each species, and their frequency in percent of a total of 941 identified fishbones, are given.

sent refuse from human meals. The bones might as well derive from fish dead from natural causes (Noe-Nygaard 1988).

However, the fishbones were found in layers with clear characteristics of a midden, containing flint refuse, mammal and bird bones, sherds, charcoal, wood etc. Datings from this refuse layer form a vertical chronological sequence, and the layer is delimited above and below by sterile layers (Andersen 1975).

All artefacts from the refuse layer are of the Ertebølle type and resemble the artefacts from the settlement area. The majority of the fishbones were found at places with maximum concentration of Ertebølle artefacts.

Some of the fishbones derive from marine fish species (see below) which could not have lived in

	Pike	Cyprinids	Perch	Ruffe	Trout/ Salmon	Eel	Gadids	Plaice/ Flounder/Dab
Head bones								
Parasphenoideum	4	1					1	
Frontale	1							
Basioccipitale	6	2	1					
Praemaxillare							1	
Maxillare	1	1						
Dentale	25	2						
Articulare	1		3					
Quadratum	2							
Palatinum	2							
Ectopterygoideum	1							
Praeoperculare		2	1					
Operculare		6	3					
Hyomandibulare	1							
Keratohyale	4	7	3					
Epihyale	1							
Os pharyngeum inferius		50						
Keratobranchiale	1							
Detached teeth	15	10						
stumps with teeth sockets	11							
Shoulder girdle								
Supracleithrum	2		7					
Cleithrum	7	1	5					
Scapula		3						
Pelvic girdle								
Basipterygium		2						
Vertebrae	168	446	88	2	2	8	13	11
Others								
Os suspensorium		3						
Scales	1	95	2					
unspecified bones			3					
Total	253 + 1 scale	536 +95 scales	114 + 2 scales	2	2	8	15	11

Table 2 Specification of 941 identified fishbones from Ringkloster. Numbers of different bones of each kind of fish are given. Detached teeth of Pike derive from oral bones, those of cyprinids from *os pharyngeus inferius*. Of the cyprinid bones, 19 *Os pharyngeum inferius* belonged to Roach; 1 *Os pharyngeum inferius*, 1 detached tooth and 1 *basioccipitale* to Rudd; 4 *Os pharyngeum inferius* to White bream; 1 *cleithrum* to Common bream; the remainder could not be identified to species. Of the gadid bones, 11 vertebrae, 1 *praemaxillare*, and 1 *parasphenoideum* belonged to Cod, 1 vertebra to Pollack/Saith; 3 vertebrae could not be identified to species.

the lake. A few fishbones, including one of the "marine" bones, are burnt, their connection with a settlement being therefore beyond doubt.

Finally, the refuse zone contained many long, straight hazel sticks with one pointed end; they most probably are remains of stationary fish traps (see Discussion). If the Ringkloster people set up fish traps, they certainly caught and ate fish.

On the basis of this evidence I regard at least the majority of the fishbones to be human refuse, i.e. remains from meals, deriving from the Ertebølle settlement on the shore. An insignificant contamina-

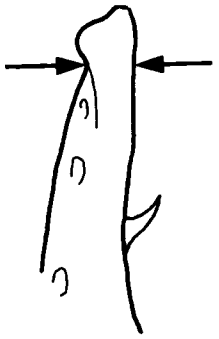

Fig. 3 Dentale of Pike (lateral view), showing the measurement used for estimation of total body length.

tion with bones from fish died from natural causes can of course not be excluded.

Enghoff (1995) gave a brief account of the Ringkloster fishbone material.

SPECIES OF FISH AND THEIR RELATIVE FREQUIENCIES

The fishbones were identified by comparison with recent skeletons from the collection of the Zoological Museum, University of Copenhagen. 28 bones had previouly been identified by U. Møhl as belonging to Pike, Perch and Common bream (in Andersen 1975).

The fishbone material contains the 12 species listed in Table 1 together with the relative frequency of each species. The percentages have been calculated on the basis of 941 identified bones. Detailed specification of the fishbone material is given in Table 2. Fig. 1 shows selected bones of the most frequent species.

The majority of the bones, viz. 57%, derive from the family Cyprinidae which is represented by Roach, White bream, Rudd and Common bream at Ringkloster. The former three species were identified by means of pharyngeal bones (plus basioccipitale for Rudd). Common bream was identified by means of cleithrum. The remaining cyprinid bones are mostly vertebrae, a closer identification of which was not attempted. The vertebrae are, however, assumed to derive from the same four species. The White bream is of particular interest, as it is new for the Danish subfossil fauna. In our days, the White bream is known from all of Denmark (including Lake Skanderborg) but is less frequent than its close relative the Common bream.

The second most frequent species is Pike, 27% of the bones. It is followed by Perch, 12%. Each of the remaining species on the list is only represented by a few bones. It is, however, noticeable that the material includes two bones of Ruffe, a species that is otherwise known as a subfossil in Denmark from the Eem interglacial only.

The relative frequencies of bones of different species cannot be taken as an exact measure of the relative importance of the species, see Enghoff (1987) and references therein. Also the fact that sieving has not been consistently used during the excavation has contributed to an uneven representation of the species. It is worth noticing that 3/4 of the fishbones were recovered from four out of 198 samples. These four samples, which were all taken in the former shore zone and which were all sieved, each contained many species. Apart from these samples, the fishbone material chiefly consists of scattered finds of one or a few bones, in particular from Pike. Out of the 198 samples, no less than 172 contain Pike bones - an indicator of the general availability of this species. 30 samples contain cyprinid bones, and 16 contain Perch bones.

The most interesting aspect of the species list from this inland site undisputedly is the element of marine species. Bones of Cod, Saith/Pollack and Plaice/Flounder/Dab have been found (Fig. 2). All in all, the marine bones constitute no less than 3% of the total number of identified fishbones. 96% of the bones are from freshwater fishes, and 1% from migratory ones. All species are common in Denmark today.

The marine fish in the Ringkloster material

All but one of the 26 bones from the marine fish species, Cod, Saith/Pollack and Plaice/Flounder/Dab, derive from the above mentioned fishbone-rich samples from the shore zone. The marine bones are scattered over a horizontal distance of ca. 35 m, indicating that they may represent several independent fishing episodes.

By comparison with recent specimens, the Cod bones can be seen to derive from individuals of just

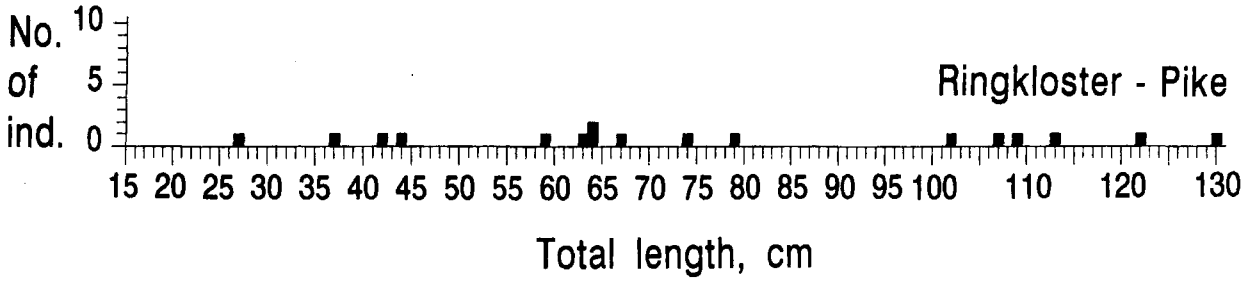

Fig. 4 Size-frequency diagram of Pike from Ringkloster. Length estimated on the basis of measurements of dentale.

below 20 to 35 cm total length. This is exactly the most common size of Cod at coastal Danish Ertebølle settlements (Enghoff 1994). Bones from both head and body are present. If information on size of the Cod and on the distribution of the bones is combined, at least five specimens of Cod are indicated.

A single vertebra represents Saith/Pollack, a specimen of ca. 25 cm total length. Unfortunately the vertebrae cannot be identified to species.

All 11 bones from Plaice/Flounder/Dab are vertebrae and derive from a single square. However, the sizes of the vertebrae indicate that at least two specimens are represented, one of ca. 30 cm total length, one much smaller.

One of the marine fishbones, a praemaxillare from Cod, is black-burnt (Fig. 2) - a clear proof that at least this particular marine bone has definitely formed an integral part of the settlement's activities. Any contention that the marine bones are just regurgitated pellets from gulls coming in from the coast, is hereby falsified.

Size of the pike

Bones of Pike are a characteristic and constant element in the Ringkloster material. Therefore an attempt was made to estimate the size of the subfossil Pikes.

The total length was estimated from subfossil dentale (lower jaw bones) using the equation

$$TL = 119.3059\ D^{0.9048}$$
$$(n = 30,\ r = 0.9947)$$

where TL = total length in mm, D = measurement of dentale in mm (see Fig. 3), n = number of recent individuals on which the formula is based, and r = the coefficient of correlation.

The total lengths of the subfossil Pikes thus estimated were scattered from 27 to 130 cm (17 measurements), see Fig. 4.

Furthermore, the total length of the Pikes was roughly estimated by comparing the subfossil vertebrae with vertebrae from Recent Pikes with a known length. Vertebrae were much more numerous in the material than was dentale but are not suited for accurate size estimation because of difficulties with referring subfossil vertebrae to their exact position in the vertebral column. Two thirds of the vertebrae were found to derive from Pikes of 50-96 cm total length, and one third from larger individuals.

The Ringkloster material thus contains quite a number of bones from very big Pikes, up to 130 cm. The largest Pike ever taken in Denmark was 150 cm long.

DISCUSSION

In the preliminary publication on Ringkloster (Andersen 1975) fishing was considered to have been of minor importance for the economy of the settlement - only 28 fish bones had been found then. This point of view needs revision in the light of the new fishbone material: 941 identified fishbones although sieving was only sporadically done during the excavation.

As mentioned in the introduction, the Ringkloster settlement was well situated for fishing, just like the coastal Ertebølle settlements that in general are concentrated at good fishing sites (Fischer 1986; 1987; 1995; Fischer & Sørensen 1983; Johansson 1964;

1995). The widespread occurrence of straight, pointed hazel sticks in the former lake suggests that stationary fish traps/weirs were used, like those known from several inland and coastal sites (Becker 1943; Kapel 1969; Pedersen 1992; 1995; Fischer pers. comm.). This is a sign of fishing during an extended period at Ringkloster.

These three lines of evidence: a larger fishbone material, position of the settlement at a good fishing site, and the occurrence of pointed hazelwood stakes, all indicate that the inhabitants at Ringkloster considered fishing as a significant contribution to their economy.

Cyprinids, Pike, and Perch - the commonest fishes in fresh water in Denmark, not surprisingly, dominate the fishbone material. The species in question are not very particular about the type of lake they live in and thus give no hints about Lake Skanderborg during the Ertebølle period. A guess is that the lake has been soft-bottomed and has had a rich underwater vegetation, since this is the type of lake preferred by the fishes. Some of the Pikes have been gigantic (up to 130 cm long). The bottom of the lake off the settlement slopes steeply down to depths where the large Pikes could have lived. Unfortunately the species of fish provide no direct information on possible seasonality of the fishing. However, knowledge of the habits of the fishes (see Otterstrøm 1912; 1914; Muus & Dahlstrøm 1967) may provide an indication of the most probable season of catch.

The Pike occurs in the vegetation zone during the summer but stays on deeper water in winter. Pike is most easily caught during the spawning season from March to May where they swim into very shallow water (to 20 cm). Noe-Nygaard (1988) showed that Pike fishing at the Danish Mesolithic site Præstelyngen was most intense during exactly these months.

Cyprinids spawn during spring (April-June) on shallow water and in general occur in the vegetation zone during summer (as far as Bream is concerned, this is true only for individuals in their first two years). During winter the cyprinids stay on deeper water. Several cyprinid species are inactive during winter.

Perch occur in schools, either in the vegetation zone or on deeper water. During spawning, Perch are easily caught in fish traps.

Rowley-Conwy (1998 - this volume) argued that the evidence from mammal and bird bones from Ringkloster indicates a winter/spring occupation from about November to about May. As is evident from the discussion above, the fishing might well fit into this picture. The fish have been especially easily caught in the spring months.

One of the most interesting aspects of the Ringkloster fishbone material is the element of marine fishes: Cod, Saith/Pollack, and Plaice/Flounder/Dab, which constitute 3% of the identified fishbones. The fishbones are not the only marine indicators from Ringkloster but are accompanied by about five shells of oyster (*Ostrea edulis*) and a rib and two vertebrae of Bottle-nosed Dolphin (*Tursiops truncatus*) (Rowley-Conwy 1998 - this volume). Today, the Bottle-nosed Dolphin has a southern distribution: although it reaches as far as Scotland, it is rare north of the English Channel (Evans 1991). Its occurrence in the Ringkloster material therefore indicates a warmer climate during the Atlantic period, like for instance the southern fish species from Bjørnsholm (Enghoff 1993).

The above-mentioned marine indicators are a proof for a contact to the seacoast. The Ringkloster settlement is situated equally far away from the contemporaneously coastal settlements at Brabrand, Norsminde and Horsens Fjord on the East Coast of Jutland. Enghoff (1991) analysed the fishbone material from Norsminde and the most frequent fishes were Flounder and gadids, exactly the ones which are represented at Ringkloster. However, these are very common fishes which have probably also been caught at Brabrand and Horsens Fjord. It is, however, noteworthy that the Norsminde material is totally devoid of bones from freshwater fishes. Whatever the nature of the contact between inland and coast has been, there is no evidence for transport of freshwater fish from the inland to Norsminde. The small whale, Bottle-nosed Dolphin, is also represented on the contemporaneous settlements from Flynderhage (Norsminde Fjord) and Brabrand (C. Kinze, pers. comm.).

A parallel to the marine fish element in the Ringkloster material is the occurrence of spines of the shark species Spurdog (*Squalus acanthias*) on inland settlements in Åmosen, Zealand (Noe-Nygaard 1971; P. Vang Petersen, pers. comm.).

The marine fishbones from Ringkloster do not throw full light over the contact between coast and inland, but the marine fishes seem to have arrived at Ringkloster at several occasions. This is in agreement with Rowley-Conwy's (1998 - this volume) idea that Ringkloster was a seasonal hunting camp visited repeatedly by the inhabitants from one or several basecamp(s) situated by the seacoast.

CONCLUSION

The fishing at Ringkloster seems to have been more important than previously assumed. Cyprinids, Pike and Perch, possibly taken in fish traps during spring, dominated the catch.

A significant element of marine fishes in the bone material substantiated the indication of a contact to the coast.

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