Anciens peuplements littoraux et relations Homme/Milieu sur les côtes de l'Europe atlantique

Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts

Sous la direction de / Edited by

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BAR International Series 2570
2013

Published by

Archaeopress
Publishers of British Archaeological Reports
Gordon House
276 Banbury Road
Oxford OX2 7ED
England
bar@archaeopress.com
www.archaeopress.com

BAR S2570

Anciens peuplements littoraux et relations Homme/Milieu sur les côtes de l'Europe Atlantique / Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts

ISBN 978 1 4073 1191 3

pour citer ce volume / how to cite:

Daire M.Y., Dupont C., Baudry A., Billard C., Large J.M., Lespez L., Normand E., Scarre C. (dir.), 2013. Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts / Anciens peuplements littoraux et relations Home/Milieu sur les côtes de l'Europe atlantique. Proceedings of the HOMER 2011 Conference, Vannes (France), 28/09-1/10/2011. British Archaeological Reports, International Series 2570, Oxford: Archaeopress.

Printed in England by Information Press, Oxford

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EELERS IN DANISH WATERS - INTERACTION BETWEEN MEN AND THEIR MARINE ENVIRONMENT OVER 8000 YEARS

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Background

Around the world, fish are a much sought-after protein-rich food source. Consequently, far back in time people devised gear to provide them with fish in large quantities (Connaway 2007). One effective way was to construct stationary devices that would catch fish galore without the fisherman needing to be present. The earliest find to date that proves the existence of passive fishery in Northern Europe is a willow-bark net with floats of pine bark from Antrea, Estonia, i.e. *c*. 8600 BC cal. (Hel. Nos. 296, cf. 1303; Matiskainen 1989, 9; pers. com. 1994). Stationary devices for passive fishery require investment of time in their production and installation; subsequently they have to be looked after, emptied and maintained. Active fishing methods, for example hook and line, spear and push-net, require time not only for the production of the gear, but also for the fisherman's participation in the fishing process.

The following types of equipment for passive fishery are known from freshwater and marine habitats:

- nets
- wooden structures
- stone structures
- combinations of stone and wood

In recent years, these constructions have attracted increasing interest (Bannerman & Jones 1999; Bulten *et al*. 2002; Connaway 2007; Dawson 2004; Fischer 1995; Hale 2005; Hirsch *et al.* 2007; Klooss in press; McQuade *et al.* 2007, Mordant *et al.* 1992; Pedersen 1995; Pedersen *et al.* 1997; O'Sullivan 2001). The present article introduces one type of Danish coastal wooden fishing device into a European discussion of human relations with marine and freshwater resources over time. Specifically, it deals with the use of fish weirs to catch silver (i.e. adult) eels in autumn, presumably one of several ways in which these structures were employed in prehistoric Denmark. The subject will be addressed on the basis of two essentially different groups of sources:

- Results from archaeological excavations of fishing structures from the Stone Age
- Descriptions, legal documents, photographs and ethnological interviews from the mid-20th century – just before traditional fishing technologies disappeared from collective memory (Figure 1).

Stationary fishing devices made of for example wood are, however, dependent on the availability of raw materials in sufficient quantities and of the necessary quality. In some cases, there may also be a requirement for ways in which surplus catches can be stored and preserved. Consequently, the article also identifies certain principles, in nature and in organisation, which are sine qua non for fishing with permanent wooden devices in a productive interaction between terrestrial and marine/freshwater resources.

Figure 1. Asnæs Sønderstrand, Kalundborg 1990. Thyge Olsen†, eeler, built a catwalk like those on the old eel weirs - but for water hoses. Together with the free-standing pound net in the background, the boat reflects later eel catching methods (photo A. Fischer 1990).

Fish weirs in Denmark

Written sources, place names, paintings etc. document that fishing with permanent wooden constructions, in the form of fish weirs, was widespread in Denmark in the 13th century AD and up until the end of the 18th century. Throughout these centuries, permanent fishing devices are known from both freshwater and coastal locations with or without a great tidal range (Drechsel 1890; Møller 1953). Variants for tidal conditions appeared in the Wadden Sea, along the south-west coast of Jutland, where the weirs were erected in the water to form so-called 'skuldegårde' ('fish pens' or 'Vees'). As the latter name suggests, these were placed in a V-shape, with the wide opening towards land and the point extended with a 5 m long trap reaching out into deeper water. When the tide went out, the trap would catch shoals of fish or solitary flatfish carried by the water (Møller 1953, 79).

On coasts with low tidal amplitude, fishing was practised using weir structures built of wood or a combination of stones and wood, which extended from the coast to varying depths. In south-eastern Denmark, on Bornholm and off the chalk cliffs of Møn and Stevns – where the hard ground made it impossible to ram in wooden poles – the wattle-and-wood combinations were kept in place with boulders (Møller 1953, 25 & 86).

Within the last 20 years, a number of archaeological excavations in Denmark have demonstrated that fishing with permanent wooden devices – fish weirs – has taken place along Danish coasts since the Mesolithic, i.e. for at least 8000 years. Fishing devices of wood, or stone and wood in combination, may well prove to be one of the most widely occurring types of construction surviving from all prehistoric and historical periods in Denmark.
Wooden structures frequently occur in archaeological excavations in wetlands and reclaimed former wetland areas in Denmark. These may be the remains of roads, platforms, dug-out boats and various kinds of debris (e.g. Kunwald 1944; Malmros 1986; Myrhøj & Willemoes 1997; Price & Gebauer 2005; Rønne 1997), but the remains of wooden fishing structures also occur. A c. 4 m long section of wattle found in Søborg Lake, and dated pollen analytically to the Early Atlantic (the early part of the period 7000-4000 BC), has consequently been interpreted as part of a trap in a weir erected in a small Stone Age inlet (Becker 1943). In other Stone Age inlets, the actual traps, the so-called pots, have also turned up. A fragment of one of these, from Villingebæk, dated to c. 6000 BC (Kapel 1969, 94), is so far the oldest of its kind in Denmark. At Svinninge Vejle, both the remains of the wickerwork trap and the poles from a fishing structure from the Late Atlantic (the latter part of the period 7000-4000 BC) were discovered (Becker 1941). The Ventehuse locality has yielded hundreds of vertical hazel rods, 2-5 cm in diameter; most likely the uprights of fish weirs which were erected in the same good fishing spot over a long period (Fischer 2007, 60). These finds date from the Mesolithic, whereas a section of an almost vertical wattle construction found at Ølby Lyng is from the Neolithic, c. 2900-2350 BC (Fischer 2007, 61; Pedersen 1995).

The above examples demonstrate that passive fishing, using stationary wooden constructions, was practised in several places along Danish coasts in both the Mesolithic and the Neolithic. However, documents and other historical sources also refer to this technology being in general use in the country in historical times (Møller 1953; Rasmussen 1988). This is true, in particular, of the so-called eel weirs, the use of which can be established in many places in Denmark from c. AD 1600 to AD 1900 through land registers and cadastral maps (Housted 1980, 9). A distinction is made between two basic forms: freshwater and marine coastal eel weirs. In the present article, which focuses on the relationship over time between humans and the coastal culture landscape, only the latter type is considered.

The coastal eel weirs were constructed for large-scale fishery of silver eels, i.e. the extremely fat and nutritious mature eels which migrate through Danish waters each autumn (Figure 2). These constructions were erected between the shore and water depths of 2-3 m. A distinction is made between stake-built and caisson-like eel weirs (Møller 1953, 10) (Figure 3). Stake-built eel weirs were located in protected inshore waters in Denmark, in inlets and bays, as systems of long wattle panels woven of thin rods and attached to a row of vertical poles, leading towards a trapping device or wing. In certain areas, the poles were also supported at the top by catwalks leading out to the outer end of the trap (Housted 1980; Møller 1953). On these, a fisherman might edge his way out, dry-shod, to empty the pot, which he would then

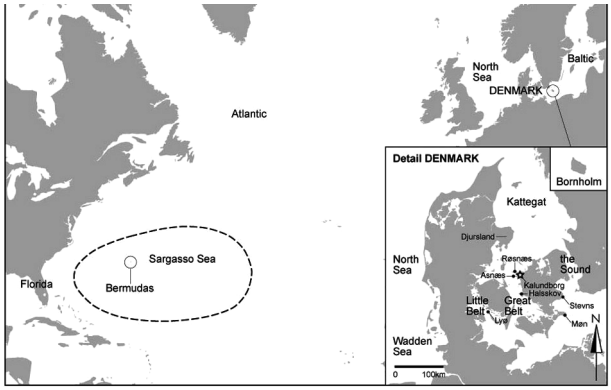

Figure 2. "The watery world" of the European eel (*Anguillla anguilla*) in the Sargasso Sea. The insert shows the Danish waters (Bendt Nielsen's Studio, after sketch by L. Pedersen).

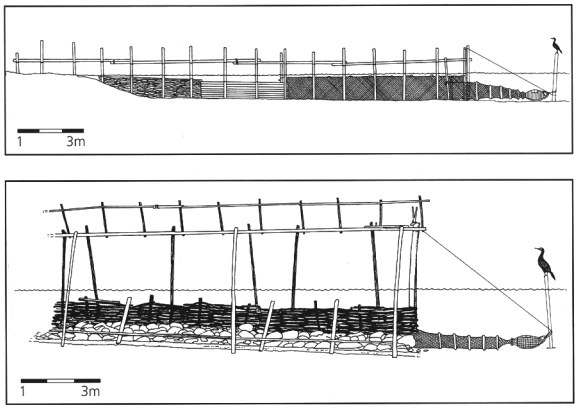

Figure 3. Construction principles of the coastal eel weirs in Denmark. Top: stake-built eel weir with catwalk as used in inner, protected waters in Denmark. The sketch shows materials used for the panels in the course of time. At the outer end of the weir: modern nets; at the middle: planks as used here and there in the 1800s, until nets became really popular. Close to land: the old technique - wickerwork mats and stakes. Bottom: caisson-like eel weirs, used at open exposed coasts. The structure is viewed from the side where vertical mats would lead the eel into the trap (after L. Pedersen 1997a, Kurt Petersen del.).

pull ashore with a pot-hook (Højrup 1955, 42). In parts of the country where catwalks were not used, the catch was brought ashore by boat (Housted 1980, 9).
In contrast, the caisson-like eel weirs were sited on open, exposed coasts. They were robust structures, in which vertical and horizontal panels of woven hazel rods were dovetailed to bottom laths. The structures were made in sections on land and then floated out and weighted down to the seabed by placing heaps of stones on the horizontal mats. The sections were supported by sloping posts, which also carried a gangway. These constructions usually consisted of four or five sections and extended out to water depths of c. 3 m. From the early 1800s, textile nets were used in the traps or wings. The pots were mostly oblong containers, often made of osiers and a few hazel rods (Højrup 1955; Michelsen 1952).

Two chronological extremes in Danish fish weirs

Archaeological excavations have shown that the principles of fishing with weirs comprised of rammed-in stakes,

wattle panels and pots were developed during the Mesolithic (Figure 4). The oldest find so far was recorded on the seabed at a depth of 6-7 m and has been dated to c. 6400 BC (Fischer 2005; 2007).

In Denmark, larger sections of prehistoric wooden fishing devices were first unearthed in 1988. These structures were traced via targeted search strategies employed at Halsskov Overdrev, an area of reclaimed land which, in the Stone Age, was a branched inlet off the Great Belt, one of the most important European migration routes for silver eels (Pedersen *et al*. 1997). At the site of Oleslyst, a Neolithic fishing construction was examined in more detail. Other excavations along the coastline of the former inlet uncovered the remains of Mesolithic constructions as well as the accumulated driftwood debris from similar wooden devices. These have been examined and interpreted on the basis of the Neolithic structures found at Oleslyst (Myrhøj & Willemoes 1997; Pedersen 1997a). This background, and a model of an eel weir from the 1800s in the collections at Kalundborg Museum, in combination with archive materials and oral information from fishermen about traditional eel-weir fishing along the coast, encouraged the interpretation of these prehistoric wooden structures as fish weirs for catching migrating silver eels (cf. Møller

Figure 4. Eeling spots in Denmark. Solid lines show places where eeling was practiced with pound nets in 1978. Question marks indicate areas with incomplete records of eeling with pound nets. Names of provinces and archaeological sites with permanent wooden fishing structures mentioned in the text are marked: Circled names refer to the Neolithic, rectangular ones to the Mesolithic (Bendt Nielsen's Studio, after sketch by L. Pedersen after Vestergaard 1985).

1953; Rasmussen 1988; Pedersen 1992a; 1992b). This interpretation was supported by evidence from ethnological studies carried out in other parts of Denmark during the 1940s. These described the traditional autumn eel fishery using fixed eel weirs, just before this technology became superseded by the fishing methods of the industrial society (Højrup 1955).

Neolithic eel weirs, Oleslyst

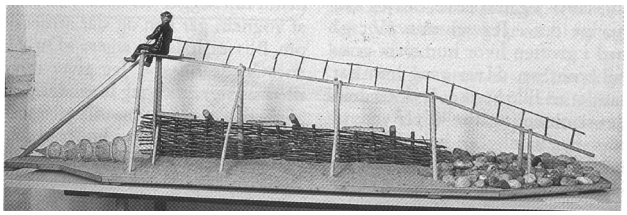

Figure 5. Model of caisson-like eel weir from the Røsnæs Peninsula, north of Kalundborg. Kalundborg inv. No. KAM 6060, received by Kalundborg Museum *c*. 1944, made by 75 year-old Ebbe Larsen† to illustrate eeling with caisson-like eel weirs at Røsnæs at the end of the 1800s. The stones in the foreground mark the edge of the water edge (Photo Per Christensen).

The Neolithic wooden structures encountered at Oleslyst have, to date, provided the frame of reference for interpretations of stationary fishing devices in Denmark and will for that reason, in this context, be addressed first. They consisted of a belt – c. 40 m by c. 2 m – of vertical stakes, rammed into the seabed, and a 5.5 m long wattle panel. The remains were well enough preserved for parts of the structure to be compared with elements of fishing devices from the 19th and 20th centuries (Højrup1955) (Figure 6).

The wattle panel had been woven using at least 23 long straight rods. However, some had been washed away, so the panel had originally been higher than the 1.7 m measured during the excavation. The rods had been woven around 12 uprights spaced at intervals of 40-45 cm. The thick ends of the uprights had been carefully sharpened and showed signs of wear which revealed that they had originally been placed vertically in the seabed. One upright was in two parts – a technical refinement demonstrating that a panel might be joined to other panels on the tongue-and-groove principle to form a tight, continuous fence-like structure (Pedersen 1997a, 130).

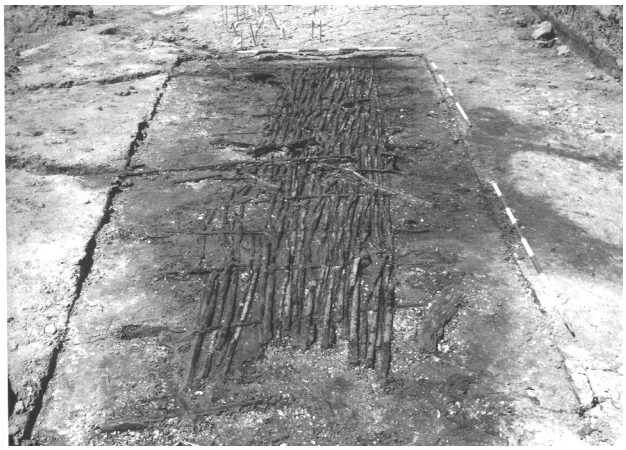

Figure 6. Oleslyst, Halsskov; Neolithic fishing structures viewed from the south. The elements were a *c*. two meters wide belt of vertical stakes, traceable *c.* 40m into the water, and, at the outer end, a 5.5m long swarm of stakes, corresponding to the length of a panel, curve backwards like the barb of a harpoon. A wickerwork panel, 5.5m by 1.75m, of long uniform hazel rods was found among the vertical stakes of the main section (Photo L. Petersen 1988).

At Oleslyst, a total of 259 poles/stakes were recorded, each penetrating 25-42 cm into the marine deposits. A few fist-sized stones had been used to support some of the vertical posts. Apart from these, stones were not used in the construction. It was impossible to establish how the structure continued in towards the former coastline. However, the possibility cannot be ruled out that it could have been connected to the shore and was, accordingly, a couple of hundred metres in length. On the other hand, the short swath of uprights at the northern end of the structure, curving back towards the inner parts of the inlet, probably constituted the arm, or wing, leading the catch towards the trap (Pedersen 1997a) (Figure 7).

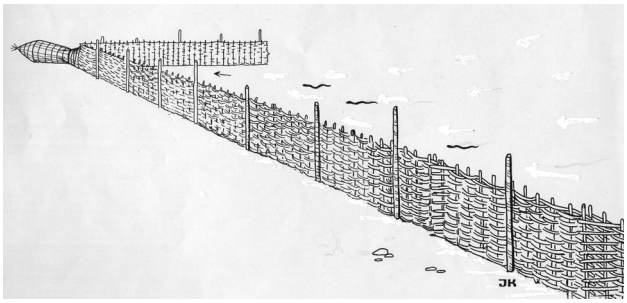

Figure 7. Reconstruction of the Oleslyst structures (J. Kragelund, after Pedersen 1992a).

The Oleslyst structures were subjected to radiocarbon dating: Ten samples of elm, hazel and lime wood were selected from panels and poles in various parts of the structure. The dates were evenly distributed with respect to materials and position, and they fall within two distinct periods in the Neolithic: 3500-3100 BC, when people built dolmens, passage graves and large causewayed camps in Denmark (Andersen 1997), and 2920-2600 BC, when hunting and fishing activities blossomed along many Danish coasts (Nielsen 1993; Rasmussen 1993). Consequently, we are dealing with at least two constructions, located on the same spot, with an interval of 400-600 years.

The Oleslyst panel shares many features with a piece of wattle excavated at Ølby Lyng. This was radiocarbon dated to 2900-2350 BC (Fischer 2007, 61) and therefore corresponds to the later group of Oleslyst dates. However, the Oleslyst wattle panel belongs in the earlier part of the 'forest of poles'. This elementary construction – wattle panels attached to a row of rammed-in stakes – has subsequently become the basis for interpreting similar prehistoric wooden constructions found in marine deposits as fishing devices of the eel-weir type (Fischer 2007; Prangsgaard 2008; Price & Gebauer 2005).

Through dendrochronological analysis of a series of samples from Oleslyst, wood anatomist Kjeld Christensen has shown that the wattle had been woven of long, straight hazel rods, typically containing eight to ten annual rings; these rods had been harvested in very early spring and thereby represented an optimal combination of length, flexibility and durability. The vertical stakes, however,

varied in wood type, quality and age, the dominant species being lime, hazel, ash, common maple, European aspen and guelder rose. Most had been felled in winter and were five to 13 years of age. Kjeld Christensen (1997) has expressed the view that the wattle makers obtained the materials for their constructions from large coppices, mainly of lime and hazel. In late winter and early spring, fishermen would fell whole stands in these open coppices and sort the material by size and quality, as appropriate, for the various parts of the structure.

Mesolithic structures. The Halsskov sites

On the banks of a former small inshore island in the now reclaimed Halsskov fjord, excavations uncovered systems of long woven structures of hazel rods, basically corresponding to the Neolithic examples from Oleslyst, albeit of lighter construction. They had originally lain off-shore from the small island, which had traces of several flint-working sites and other human activity during the period 5060-5470 BC, i.e. the Early Ertebølle culture. The oldest wooden structures were dated to c. 5400 BC. Later ones, dated to c. 4800 BC, were excavated in the former coastal zone and extended outwards to depths of 2-2.6 m below present sea level where, for practical causes, they could not be traced further (Fischer *et al*. 1997, 371; Johansen 1997; Pedersen 1997a). The wooden structures are therefore not unequivocally coeval with the settlement traces on the small island, but also represent fishing activities in the fjord at other times during the Mesolithic.

All the wood samples, bar one, were of hazel. They represented 3-21 years of growth, with the 6-8 year span clearly in the majority. On the basis of the age distribution of these samples, Kjeld Christensen (1997) argued that the wood was felled in hazel coppices that had been allowed to grow for eight years before the rods were harvested. He also concluded that Mesolithic fishermen had practised some kind of forest management in order to produce long, straight hazel rods in sufficient quantities for their fishing structures.

Eel weirs in recent times

The prehistoric structures seen at Halsskov and Oleslyst consisted basically of wattle panels attached to a line of poles. In prehistory, wattle was used for many purposes, e.g. wattle-and-daub walls in houses and the construction of wooden roads and track ways (Coles & Orme 1977; Malmros 1986). However, the Oleslyst wattle differed from the structure of ancient wooden roads in the regularity of its weaving technique and the uniformity of the material selected. Furthermore, it was found in marine deposits, which argues against a use in buildings. On the other hand, its location in deposits on the seabed and the many similarities to eel weirs from historical and recent times seem to indicate that we are dealing with stationary fishing devices. The principles of these fence-like structures have been described in ethnological studies of fixed eel weirs in Danish waters (Højrup 1955; Møller 1953).

Based on the knowhow of generations, the structures were sited off the coast, facing a break (or channel) in a sandbank, so that the water forced behind the sandbank by an on-shore wind would stream out through the gap, flushing eels and small fish close to and along the wattle weir into the trap or pot. Preparations for these constructions started some time in advance, on a winter's day, with wood being cut in the local coppice. The poles were then sharpened, giving the points smooth, even faces, but not made so thin that they would break when hammered in. Wattle panels and traps were made and repaired and specialist craftsmen produced a number of wicker pots. However, actual construction work did not begin until late summer, when the poles which were to keep the wattle panels in place, and support the catwalks, were rammed down in a long row, extending from the shore out towards the gap in the sandbank. The wattle panels, c. 5.8 m in length, were attached to the poles by means of withy rings, which also supported the catwalk planks – if there were any. The height of the individual panels varied according to the depth of the water.

The wattle mats would last several years if removed from the water before winter set in. They were woven with the base (i.e. root ends) of the rods pointing towards the end of the panel and protruding just enough to give a snug fit that would prevent an eel from slipping through. Moreover, the weave had to be even so the weir would not catch seaweed that might clog access to the pot at the outer end and also increase the risk of the structure capsizing due to pressure from waves and the current. A single structure consisted of three to four wattle panels. However, these were replaced by knotted netting towards the end of the 1800s.

Until the beginning of the 1900s, the pot itself was often woven of osiers and hazel branches according to principles familiar from many Stone Age finds (Myrhøj 1997). Early in the 1800s, however, wickerwork traps, as known from several archaeological finds and historical sources, were replaced by net funnels; the latter were easier to pull ashore along the row of poles. The coastal structure could be extended further out from the shore by employing similar structures, located close enough to one another that the fisher was able stride from one to the next. Consequently, a structure could consist of at least three trapping devices and have a total length of 70 m (Højrup 1955, 40).

Neither the heaps of stones nor the bottom laths seen in the more robust caisson-like weirs were encountered in the prehistoric structures at Oleslyst. Nevertheless, the latter have so many aspects of their basic structure, dimensions, wickerwork/wattle techniques, preparation of poles etc. in common with the fixed devices which were erected in Danish inshore waters each autumn for centuries in order to catch migrating silver eels, that the Halsskov finds and the Oleslyst structures have been interpreted as coastal fence-like structures (i.e. fish weirs), dating respectively from the Mesolithic and the Neolithic, for trapping eels.

Material requirements

Several ethnological studies describe how eel fishers were dependent on access to woodland resources in order to obtain materials, in the necessary quantities and of the right qualities, for constructing their fishing structures. The caisson-like eel weirs were particularly resource demanding (Højrup 1955; Rasmussen 1988). In these, sections might be up to 8 m long and require as many poles and hazel rods, and as much wattle, as a half-timbered cottage.

We know that the farmers in some areas needed one to two cartloads of beech or alder poles for uprights and a corresponding quantity of hazel rods for wattle panels for their eel weirs (Hejgaard 1954). They therefore took care to save parts that could be reused at the end of the fishing season, before winter storms and ice drift really set in. This interdependency between terrestrial and marine resources can also be exemplified by the parcelling-out, in 1796, of small patches of forest where the hazel and ash understory was to be kept as coppice in order to ensure that eel-weir fishers on the Røsnæs Peninsula near Kalundborg had access to the right materials for their fishing structures (Pedersen 1992b; Petersen 1988, 21). Other fishermen in the area had, on the other hand, to buy their materials in woods more than 20 km away from their fishing places. Scant remnants of these coppice woods still survive in the area, representing a living cultural heritage (Figure 8). They reflect the same kind of coppice management that dendrochronological analysis of wood from prehistoric fishing structures has shown was practised by Stone Age fishermen in order to build their fishing structures in the sea (Bartholin 1996). In this respect, it is no surprise that Neolithic 'fisher-farmers' could produce materials and build fish weirs in the sea at a time when they were also able to construct complicated fortifications and dolmens and passage graves. However, analyses of materials from Mesolithic constructions have shown that the hunters and fishers of this period also manipulated natural resources and give more than a hint that forest management is a far older occupation than farming in Denmark (Christensen 1997; Pedersen 1997a, 143). Similarly, the case has been argued for early woodland management in relation to Mesolithic and Neolithic wooden constructions in the Southwest Baltic (Klooss in press). Coastal fishery with stationary wooden structures was therefore made possible far back in prehistory by conjoint utilization of obtainment of desired provisions.

Figure 8. Remains of a coppice wood at Røsnæs near Kalundborg. Interview with Villy Larsen, retired fisherman, about how regular coppicing of ash, hazel, elm, and lime in these woods provided the fishermen with the right materials for eel weirs in modern times. Villy Larsen, now departed, was the son of Ebbe Larsen, model builder and fisher (Photo A. Fischer 1988).

Right of access to resources

In historical times, eel weirs were constructed specifically for trapping silver eels during the dark nights around the new moon in the autumn months from August to November. It is especially during these dark periods that large shoals of silver eels migrate through Danish straights and belts. These then become narrows and barriers when eels in their thousands – mature and fat – leave the places where they have grown up around the Baltic Sea and make for the Sargasso Sea, east of Florida (cf. Figure 2).
Anguilla anguilla is the European eel, with a distribution extending from the White Sea in the north, along European coasts, including Ireland and the British Isles, to the Mediterranean and the Black Sea and as far as Western Africa in the south. Its lifecycle was always something of a mystery, and it remained so until the early 1900s, when a Danish biologist, Johannes Schmidt, traced the tiny eel larvae to the Sargasso Sea and mapped their migration with the Gulf Stream to Europe and North Africa (Petersen 1904, 14). Here, the larvae change into elvers and disperse to inhabit both fresh and coastal waters during their growing (juvenile) period. Throughout the summer, when the growing yellow eels – 'golden eels' in Danish – are actively foraging, they are much sought-after for the table. They can be caught in watercourses and bogs as well as in shallow coastal waters, using passive methods with baited hooks and lines and improvised 'tubular traps' made from items such as drain pipes and old car tyres, or, along the coasts, with small eel pots. When the eels reach maturity, at six to ten years of age (the males earlier than the females, who are, on the other hand, larger and fatter), they stop eating and their gut degenerates. Their eyes become larger and, especially at night, the eels begin to return in great shoals to the Sargasso Sea, more than 7000 km away from the Baltic and Denmark, in order to spawn, after which they die. At the beginning of their long trek, the eels have large fat deposits and this fat adds to the comparative nutritional value of the live silver eel, by enabling it to live in captivity for a long time without food. On top of that, eels are eminently suited to preservation by smoking. Consequently, when in season, the silver eel is a reliable and nourishing food resource which, with the right technology, can not only be caught in great numbers, but also keeps well and is suitable for preservation and transportation.

Until the early 1900s, the life cycle of the eel was unknown to fishermen: They positioned their gear in keeping with knowhow and experience of coastal weir fishing acquired over thousands of years, as the only known practical method for catching silver eels (Vestergaard 1985, 7). Eel fishing in for example west-facing Kalundborg Fjord was especially rewarding with a westerly or south-westerly wind, and it peaked when the current ran in the same direction. Large numbers of eels would then be whirled into the turbid waters of the fjord and stopped by the eel weirs, where the wattle fences and traps would lead them into

the pot when they tried to return to their migration route. Along the best stretches, the eel weirs could be spaced only a few metres apart. As the eels consistently moved in one direction, the structures needed to have one or more wings on one side only, corresponding to that seen on the Neolithic structure at Oleslyst (Hildebrandt 1894; Housted 1980; Rasmussen 1988).

Eel-weir fishing stopped in late November when eel migration declined, the water became too cold for the fishermen and stormy weather caused too much damage to the gear (Højrup 1955). If the weather became too severe during the actual eel season, the fishermen had to salvage their panels and weirs. The wattle panel found amid the poles in the prehistoric structure at Oleslyst shows that Stone Age fishermen also had the occasional stroke of bad luck and lost their equipment.

Historical and ethnological sources list silver eels as the main catch, but many young cod and 'golden eels' were also caught in the traps during the autumn fishing. The cod and the young eels became part of the daily diet, whereas the fat silver eels were salted or smoked for later use locally or in neighbouring areas – a welcome change in the peasant fare. For centuries, weir fishing for silver eels in the autumn provided a cherished supplement to the menu during frugal winter months in Denmark. This was probably also the case in prehistoric times. None of the general Danish fish stock of historical and prehistoric times (Enghoff 2011) can match the eel with regard to fat, protein and vitamins A, B1, B2 and D (Suhr 1972, 493). As a food source, silver eels also had several advantages over other fish in preindustrial times: They could be caught in great numbers by passive fishing at a time of year when weather conditions made active fishing from small boats increasingly problematic, they could stay alive in water without food for long periods (up to several months), and their preservation was simple, by smoke-curing, at times in prehistory when salt was not available in the required quantities and of the necessary quality. On the other hand, fishing with fish weirs presupposed both a confirmed right to the appropriate marine resources and an investment in woodland management on land in order to procure the required materials. Stationary fishing devices necessitated an exclusive right to the fishing place and to the catch resulting from the fishing device. Numerous documents indicate that this kind of fishing gave rise to conflicts with respect to ownership and right of use as far back as court records from Denmark extend.

Until the agricultural reforms of the late 1700s, the right to practise coastal fishing with eel weirs in Denmark belonged to the owners of the shore, principally the Crown. Following these reforms, the right to have eel weirs at the coast followed the ownership of farmland and was often sold to farmers who then either began to set up eel weirs themselves or rented out the rights to the lucrative eel fishery.

In the middle of the 1800s, however, fishermen began experimenting with freestanding vertical nets and eel bucks and slowly these out-competed stationary eel weirs along the coasts (Hildebrandt 1894). When the Fisheries Act of 1888 legalised fishing within Danish territorial waters for all Danish citizens, coastal eel weirs became serious obstacles to other fishing activities and to marine traffic. The right to build coastal eel weirs was not repealed until 1956, when the Danish State expropriated the rights of ownership against payment of compensation. This represented the definitive termination of a more than 8000 year old fishing technology.

Research-related perspectives

Archaeological research during the last 25 years has shown that stationary fishing devices were sited on many Danish coasts in prehistoric times. Virtually every year since the Halsskov investigations of 1988, Kalundborg Museum has for example uncovered archaeological remains of fixed fishing structures along Danish coasts (Figure 9). Museums with the antiquarian responsibility for areas along the Jutland fjords have had similar experiences: A collapsed wattle panel and a swarm of stakes dated to the period 2100-1850 BC, i.e. the end of the Neolithic period in Denmark, were investigated at Slivsø, in a small fjord off the Little Belt (Prangsgaard 2008). And at Kirial Bro, in a reclaimed inlet on Djursland, an accumulation of wattle panels was dated to c. 3200 BC, i.e. coeval with the oldest structures at Oleslyst.

Figure 9. Stakes from the inner fjord, Kalundborg. Frail leftovers from the construction of wooden fishing structures are not very conspicuous in archaeologists' probing ditches. The stakes were registered at Kærby Stream, south, and dated to *c.* 3600 BC (Photo Niels Hartmann, Kalundborg Museum).

Marine archaeologists have made similar finds on the seabed, for example a structure at Nekselø, dated to *c.* 3550-2950 BC. This had an estimated length of at least 250 m and is so far the longest prehistoric fishing structure recorded in Danish waters (Fischer 2005). In Kalø Vig, south of Djursland, divers have found stakes from the country's oldest known fishing structure, dated to c. 6400 BC (Fischer 2005, 2007). On the basis of the Halsskov research, the wattle panels and many of the accumulations of stakes located during archaeological research in marine layers, above and below present sea level, have been interpreted as fish weirs related to silver eel fishing. These structures have been dated either to the Mesolithic or Neolithic (cf. Figure 4).

Fish bones have been encountered at many prehistoric settlements in Denmark, in particular those from the

Stone Age (Enghoff 1995, 1999, 2011; cf. Ritchie 2010). However, the available data are very heterogeneous as a consequence both of the excavation methods employed and preservation conditions at the sites (Ritchie 2010). However, eel bones occur in varying quantities at many Mesolithic and Neolithic settlements in Denmark and, together with species like the greater weaver, eels appear to have been caught at night (Enghoff 1995). Furthermore, several Mesolithic settlements contain large quantities of yellow eel bones (Ritchie 2010). These fish can be caught by active fishing methods such as hook and line and flare fishing and passively using bait on equipment such as hook and line and small wickerwork eel pots made of woven osiers. Analyses of fish bones recovered from Iron Age settlements – i.e. 500 BC to AD 1100 in Denmark – show that passive fishing with stationary constructions or nets may also have been practised throughout this long period of time (Enghoff 1999, 80). It is therefore remarkable that remains of such structures have not yet been recorded from periods other than the Stone Age, especially as written sources prove that wooden and wood-and-stone structures for eel fishing were in general use along Danish coasts in historical times (Møller 1953; Rasmussen 1988). The obvious conclusion must be that the present lack of finds of this type is due to inadequate archaeological research activity. The Halsskov excavations demonstrated that it is possible to trace even delicate wooden structures in wetlands using mechanical excavators (Pedersen 1997c; Pedersen 2001). Similarly, marine archaeological surveys of the seabed have shown that insubstantial and less conspicuous parts of stationary wooden fishing structures can be located below present sea level using models for the placing of contemporary settlements in the terrain (Fischer 1997; 2007). The obvious approach, therefore, is to look for eel trapping devices, from both prehistoric and historical times, beneath the accumulations of stones left by caisson-like weirs from modern times in shallow waters at many locations along Danish coasts. Fishing structures from the Bronze Age, Iron Age, Viking Age and Middle Ages occur in wetland areas at the many coastal settlements and trading centres located on inlets and coves and by river mouths. Other types of fishing structures and fish weirs, such as the herring pens we know from Northern Germany (Mehl & Tillmann 1999) will probably also turn up sooner or later in these kinds of environment.

Conclusion

Wooden fish weirs were a widespread phenomenon along Danish coasts in recent historical times and in the Stone Age and eels were an important source of fat and protein during these periods. The remarkable absence of finds from the intervening millennia is very probably due to a lack of archaeological attention. A combination of archaeological, ethnological and dendrochronological studies of existing finds and data show that stationary fishing devices contain substantial information on human conjoint exploitation of marine and woodland resources.

It is not surprising that Neolithic people were able to manipulate woodland by large-scale coppice management in order to procure the required materials and that they possessed the organisational capacity to establish large fishing structures at a time when they also constructed complicated fortifications, dolmens and passage graves. The Mesolithic fish weirs also bear witness to relatively complex circumstances relating to the procurement of raw materials, technology and organisation.

In recent historical times, fat, nutritious autumn eels were perceived as food for special occasions. In prehistoric times, the consumption of untold numbers of silver eels, fresh or cured, could just as well have constituted an important ingredient in ceremonial events and confirming communal agreements.

As already mentioned above, eel-weir rights in Denmark were repealed in 1956, being perceived as antiquated and hidebound. By then, social developments had almost obliterated knowhow acquired through millennia from the collective memory and reduced fishing technology to a part of the cultural heritage and a collection of relics from the past. It put paid irrevocably to coastal fishing technology thousands of years old and its interaction with woodland management on land. Eel fishing is still practised in the Danish waters today, but solely with free-standing pound nets (Vestergaard 1985). The pleasure of eating fat, smoked silver eels in the dark winter months and during Christmas festivities may, however, be short-lived. Since the 1970s, catches have been diminishing due, among other things, to a considerable reduction in the fry, the tiny elver. In addition, there has been the reduction and pollution of their habitats in bogs, lakes, wet meadows and coastal waters, combined with the overfishing of migrating silver eels before they breed. The coastal landscape has been left with a fund of relics that can help us understand how human beings once lived in close symbiosis with marine and terrestrial resources.

Acknowledgements

My warmest thanks go to the organisers of the HOMER 2011 congress for creating such a favourable framework for the submission of contributions and their subsequent publication. My thanks also go to the Danish Agency for Culture, under the Danish Ministry of Culture, for financial support, which made it possible for me to participate and to communicate the results of Danish research to an inspiring congress forum. Anders Fischer Ph.D., the Danish Agency for Culture, is thanked for a multitude of conversations about weir fishing in Danish waters and for his comments on an earlier version of this article. My thanks are also due to Freddy Volmer Hansen (cand. mag.) for his painstaking translation and to David Earle Robinson (Ph.D.) and Anne Bloch (cand. mag.) for subsequent linguistic revision of the manuscript. The late David Liversage, museum curator at the National Museum of Denmark, is thanked for his permission to reproduce the results of the Ølby Lyng excavation. Local historian, the late Kirsten Dandarnell (cand. jur.), is thanked for leaving me her transcripts of court documents relating to eel fishing in the Ars district, near Kalundborg. Furthermore, Thyge Olsen, eel fisher at Asnæs Sønderstrand, is thanked for his inspiring account, given in September 1990, of the principles of traditional eel trapping. Finally, my thanks go to museum curator Trine Fristed Jensen and senior curator Niels Axel Boas, Museum Østjylland, for permission to mention their, as yet unpublished, site at Kirial Bro.

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EELERS IN DANISH WATERS - INTERACTION BETWEEN MEN AND THEIR MARINE ENVIRONMENT OVER 8000 YEARS

Lisbeth PEDERSEN

Key words:
Passive fishing, fishweir, eel, coppice wood, right of property, Mesolithic, Neolithic, historic times, Denmark.

Abstract:
For eight millennia, coastal fishing structures made of wood seem to have provided a very significant part of the diet for the inhabitants of the territory now called Denmark. This communication presents an overview of this type of installation for the time interval between c. 1900 AD to 6400 BC. The study is based on a combination of archaeological, historical and ethnological records, which lead us to conclude that wooden fish weirs were erected especially in the autumn for the purpose of catching mature eel on their way through the narrow Danish straits on their way to spawning grounds in the Atlantic Ocean. Eel is a particularly attractive catch: it is rich in fat, can be harvested in large quantities, and can be easily stored, preserved and transported. The use of stationary fish weirs in historical times was dependent on the existence of exclusive rights to erect and make use of the fishing installations. In addition, their construction depended on a stable supply of huge quantities of wood produced in coppiced forests. It is suggested that similar conditions prevailed in prehistoric times as far back as the Mesolithic.

PÊCHE À L'ANGUILLE DANS LES EAUX DANOISES - INTERACTION ENTRE DES HUMAINS ET LEUR ENVIRONNEMENT MARIN SUR UNE PÉRIODE DE 8 000 ANS

Lisbeth PEDERSEN

Mots clés :
Pêcherie passive, barrage à poisson, anguille, forêt de taillis, droits de propriété, Mésolithique, périodes néolithiques et historiques, Danemark.

Résumé :
Pendant huit mille ans, les barrages à poissons (pêcherie passive) côtiers construits en bois semblent avoir fourni une très grande partie du régime alimentaire des habitants du territoire appelé aujourd'hui Danemark. Cet article présente une vue d'ensemble de ce type d'installations pour la période de temps entre c. 1900 AD à 6400 BC. L'étude se base sur une combinaison de données archéologiques, historiques et ethnologiques, qui nous conduisent à déduire que des barrages en bois étaient construits surtout en automne afin de capturer l'anguille adulte lors de son parcours par les détroits [à l'entrée de la Baltique] en route vers les lieux de frai dans l'Océan Atlantique. L'anguille représente une capture particulièrement attrayante : elle est riche en lipides, elle peut être récoltée en grande quantité, et peut être facilement stockée, préservée et transportée. L'utilisation des barrages à poissons fixes au cours des périodes historiques dépendait de l'existence des droits exclusifs de mise en place et d'exploitation des pêcheries. De plus, leur construction dépendait d'un approvisionnement régulier en bois, dans des quantités importantes, produits dans les forêts de taillis. On suppose que des conditions similaires prévalaient dans des périodes préhistoriques remontant jusqu'au Mésolithique.