

# Evidence of fishing in the Satrup bog, Kr. Schleswig-Flensburg, Germany

*Hinweise auf Fischfang im Satrupholmer Moor,  
Kr. Schleswig-Flensburg, Deutschland*

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**ABSTRACT** - The excavation of several late Mesolithic and early Neolithic sites in the Satrup bog, a former silted-up lake, in the northern part of Schleswig-Holstein revealed evidence for fishing. These were carried out by amateur archaeologist in the first half of the 20<sup>th</sup> century which found late Mesolithic and early Neolithic pottery, flint stone tools and faunal remains. Prof. H. Schwabedissen took over between 1947 and 1963 with a series of scheduled excavations, partly employing advanced excavation and analysis techniques. The evidence contained organic equipment indirectly related to fishing like nets, eel leister prongs, watercrafts and wooden net floats – which were initially not recognized as such. Additionally, during recent excavations, remains of fish bones were also found. The data suggest that fishing was probably a mere supplement to hunting and gathering in this region.

**ZUSAMMENFASSUNG** - Das Satrupholmer Moor, ein etwa 25 km südlich von Flensburg in der Landschaft Angeln gelegener verlandeter See, war in der ersten Hälfte des 20. Jahrhunderts Ziel von zahlreichen Amateurarchäologen, die beim Torfstechen Keramik, Steinartefakte und Knochen aus spätmesolithischem und frühneolithischem Kontext entdeckten. Zwischen 1947 bis 1963 führten Archäologen unter der Leitung von H. Schwabedissen die Arbeit fort. Dabei wurden mehrere Feuchtbodenplätze am Rand des Moores, teils unter Anwendung moderner Methoden untersucht. Obgleich zunächst einige geborgene Artefakte und Befunde nicht vollständig einem Fischfangkontext zugeordnet wurden, zeigen sie jedoch die Bedeutung des Fischfangs am ehemaligen Satruper See.

**KEYWORDS** - Mesolithic, Eel leisters, nets, fish bones, wetland archaeology  
Mesolithikum, Aalstecher, Netze, Fischknochen, Feuchtboden Archäologie

## Introduction

The eastern part of Schleswig-Holstein including the Satrup bog area was created by the final glaciations of the Weichsel cold period. The geological events which formed these lakes subsequently silted up thereby creating bogs. One of the former lakes is situated east of the town of Satrup, ca. 25 km south east of Flensburg and ca. 25-30 km from the present day Baltic coast. In the late 1930s the Satrup bog area was subjected to intensive draining in order to aid peat-cutting activities thus creating agricultural land. Shortly after the Second World War wetland research was at the forefront of archaeology as it was recognized that the anaerobic and waterlogged conditions could offer good preservation conditions for organic materials. However, the reduction of the water level in the wetland areas and the use of deep ploughing which would in turn lead to the deterioration

of organic matter was unknown. Following finds made by peat cutting, H. Schwabedissen initiated a series of excavations which ran from 1947 to 1963 yielding many artefacts from numerous sites around the Satrup bog (Feulner 2010; Schwabedissen 1994).

## The sites

The sites are situated around the bog on dry land and the majority have been destroyed by farming and erosion (Fig. 1). Only widely distributed flint scatters have been found, often brought to the top by ploughing. All-important organic finds were discovered, embedded in sediments of the former lakeshore and the shallow-water midden zones. As many finds were made during the peat extraction it is not known how much evidence was destroyed during this process, however, owing to some amateur archaeologists among the field workers and peat-cutters some larger finds and features were recorded (Feulner 2010).

From the late Mesolithic to early Neolithic site of **Rüde LA 2** (excavated 1949, 1951 and 1955), situated

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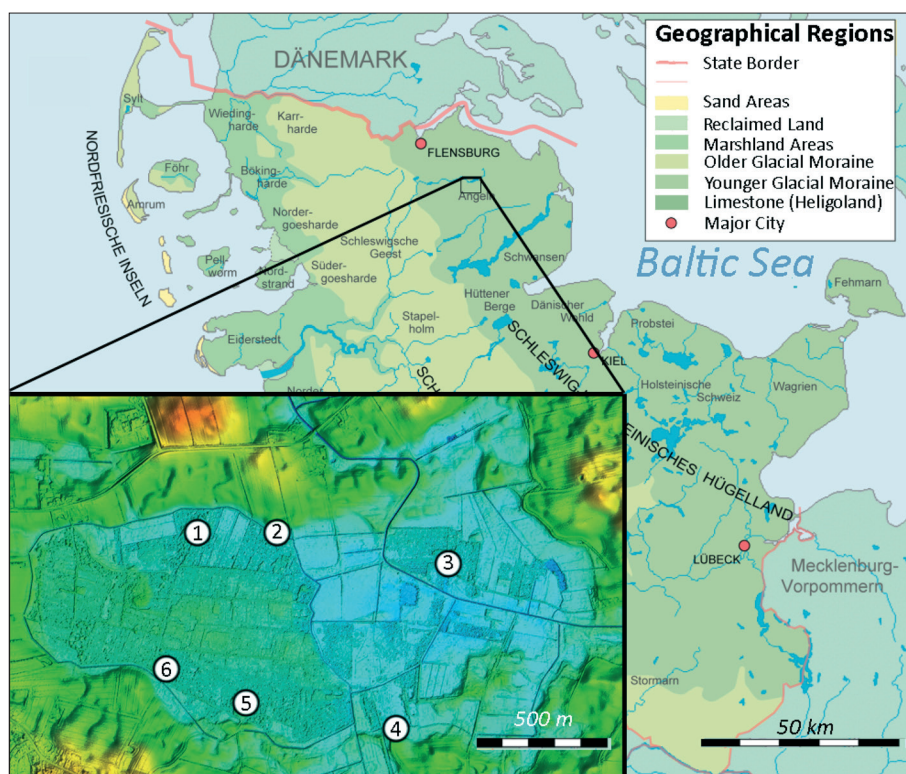


Fig. 1. Map of Schleswig-Holstein (source wikimedia commons) and LIDAR-generated map showing the excavations. 1: Satrup LA 60 „Fasaneninsel“, 2: Satrup LA 2 „Bondebrück“, 3: Südensee LA 1a „Südensee-Damm“, 4: Rüde LA 2, 5: Satrup LA 60 „Pöttmoor“, 6: Satrup LA 71 „Förstermoor“.

Abb. 1. Karte von Schleswig-Holstein (Quelle wikimedia commons) und laserscan-basierende Höhenkarte des Untersuchungsgebietes mit den Ausgrabungsstätten: 1: Satrup LA 60 „Fasaneninsel“, 2: Satrup LA 2 „Bondebrück“, 3: Südensee LA 1a „Südensee-Damm“, 4: Rüde LA 2, 5: Satrup LA 60 „Pöttmoor“, 6: Satrup LA 71 „Förstermoor“.

in the south-eastern part of the bog there is evidence for fishing where paddles, eel-leister prongs and perforated wooden disks have been found. In this locale the midden zone was boggy and therefore a platform made of multiple layers of tree bark and branches was constructed. This platform has been interpreted as a living area since a fireplace, faunal remains, shards of pottery and flint debris were found nearby (Feulner 2010; Feulner accepted). In the eastern part the bark and branch layers were positioned into the former lake. Upon excavation several wooden artefacts were found. Several paddles of different shapes and leister-prongs were recovered. Interestingly these artefacts were only recognized recently as they had previously been interpreted as objects for agricultural purposes (Feulner 2011).

The culturally affiliated Ertebølle sites of **Satrup LA 71 "Förstermoor"** and **Rehberg LA 1 "Bregentwedt"** are situated on the south-western corner of the bog. In this area the silting-up process started rapidly and progressed towards the east (Feulner 2010; Kolumbe & Beyle 1941). Multiple layers of peat have developed here which has embedded multiple archaeological layers; the majority containing finds which have been dated to the terminal Mesolithic. From the excavations (carried out 1953, 1959, and

1960) at this site further evidence for the use of lake-borne equipment is known. At least three paddle fragments were recovered from the midden zone as well as parts of net and wooden sticks (Schwabedissen 1957/58).

In the north-eastern part of the bog lies the site of **Südensee LA 1**, which was actually discovered and destroyed during peat extraction after the First World War. Different layers of peat, as well as well-stratified finds and features were recognised by the peat-cutters (Loewe 1998: 596). Among these were pointed poles of different diameters, sticking into the clay bottom of the lake (Röschmann 1941: 166). In 1955/56 and 1963 efforts were made to find features preserved beneath a modern causeway through the bog. This site, **Südensee LA 1b "Südensee-Damm"**, yielded another paddle, net floats and other rounded wooden poles (Schwabedissen 1957/58; 1958: 38; 1994: 366).

Situated on the northern shore of the former Satrup lake, the late Mesolithic/Ertebølle site of **Satrup LA 2 "Bondebrück"** yielded evidence for large game hunting and a flint workshop specialised in the productions of burins. New excavations carried out between 2009 and 2011 revealed a number of fish bones.



Fig. 2. Heart-shaped paddle from Rüste LA 2 (photo: Archäologisches Landesmuseum Schloß Gottorf).

Abb. 2. Herzförmiges Paddel aus Rüste LA 2 (Foto: Archäologisches Landesmuseum Schloß Gottorf).

## Evidence for water-craft

Vessels like dug-out canoes could have been used to gain access to a variety of resources on the lake, either fishing or collecting seeds and water chest nuts. Although no evidence of Stone-Age dug-out canoes were found during the excavations, a number of paddles in various stages of preservation were discovered on some of the sites. In sum seven spade- and heart-shaped paddles were found at Rüste LA 2 (Fig. 2). Remarkably several of these implements were complete and measured up to ca. 2 m. One of the heart-shaped paddles had a carved-out knee and showed a rhombic decoration on the blade and two perforations, one of these a knothole. Whether the other was drilled as symmetrical decoration or with a special intent remains unclear. The majority (at least six out of eleven) of the paddles were made from ash wood (*Fraxinus spec.*), a water-resistant hard wood, while at least one paddle was made out of soft wood, probably lime (*Tilia spec.*). Lime wood was also often used as construction material in the south-western Baltic region. Other paddles were found in fragments on other sites of the Satrup bog showing the importance of water craft (Fig. 3). At first, the excavators focus on evidence of early Neolithic farming cultures misled him to put the paddles as "spades" into a early agricultural contest (Feulner 2011). After an analysis Hartz & Lübke (2000: 382) confirmed an interpretation as paddles. Archaeological and ethnological comparison points to specialised uses of different paddle shapes (Burov 1996: 9). Heart-shaped, broader paddles are more difficult to control and tend to break out with higher boat speeds. As they draw air while paddling they produce more noise. On the contrary, they move more water and allow propelling a canoe for a longer stretch with a couple of powerful strokes. The narrow paddles could have been used either as high-speed paddles for faster but weaker strokes or in areas densely overgrown by aquatic plants.

Site	Wood	Condition	Blade			Shaft		Period
			mm			mm		
			Length	Width	Dia	Length	Dm	
Rüste LA2	Ash	Fragment	160	150	14	85	19x18	LM
Rüste LA2	Ash	Fragment	210	160	12	80	18x15	LM
Rüste LA2	Ash	Complete	160	180	15	300	24x22	TM
Rüste LA2	Ash	Complete	200	210	12	1630	32x28	TM
Rüste LA2	Ash	Complete	210	220	15	1120	28x24	TM
Rüste LA2	Ash	Complete	250	150	16	10	35x17	TM
Rüste LA2	Soft	Fragment	410	60	15	90	19x17	TM
Förstermoor LA 71	?	Fragment	160	160	10	130	20x15	TM
Förstermoor LA 71	?	Fragment	160	160	10	20	28x13	TM
Rehberg LA 1	?	Fragment	80	110	9	10	22x10	LM
Südensee LA 1b	?	Fragment	420	80	22	40	30x26	EN

Fig. 3. Paddles found in the Satrup bog (after Schwabedissen 1958, 1994). LM = Late Mesolithic, TM = Terminal Mesolithic, EN = Early Neolithic.

Abb. 3. Paddel aus dem Satrupholmer Moor (nach Schwabedissen 1958, 1994). LM = spätmesolithisch, TM = endmesolithisch, EN = frühneolithisch.

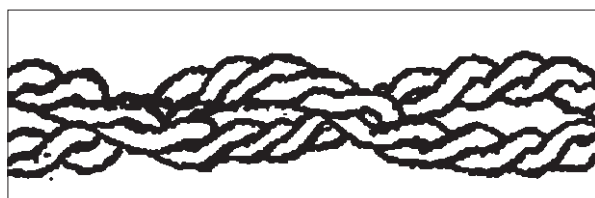


Fig. 4. Details of thread of Förstermoor net.

Abb. 4. Detailabbildung eines Fadens des Netzes aus Förstermoor.

### Fishing nets

Parts of a textile net were found during the 1956 excavation at Satrup LA 71 Förstermoor, as well as some according net floats (Feulner 2010, footnote 56). The net was examined by members of the Bundesforschungsanstalt für Fischerei (federal research authority for fishery) in 1962. The production of nets is part of the primary textile technique which has been documented from around the world for different purposes (Ikle 1935). Although nets have been used for the transportation of goods they have also been used for hunting and fishing purposes. However, it is questionable whether this fragmentary piece of net can be reliably attributed to the Ertebölle culture (Hartz & Kraus 2009: 218). Since the textile techniques do not differ in terms of their desired use it is impossible to state with certainty the purpose for which it was made. However the net recovered from Satrup LA 71 Förstermoor was probably used as a fishing implement, either as a throwing net or a gillnet. Since numerous wooden sticks and poles were found in association the net may well have served as a fish trap, leading the prey into a chamber of the actual catching net. As no net floats were found in the original context, the use as gill net, where fish became entangled in, is unlikely (Von Brandt, written note 1962). However, the absence of evidence is not necessarily evidence of absence.

The meshing was made of S-twisted threads (Fig. 4). In order to avoid curling of the threads, they were twisted in the opposite direction similar to the Z-technique. The meshes themselves were made via

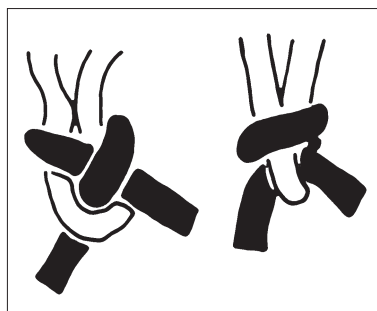


Fig. 5. Details (front and rear view) of a knot from Satrup LA 71 Förstermoor net.

Abb. 5. Details (Vorder- und Rückenansicht) eines Förstermoor-Netzknotens.

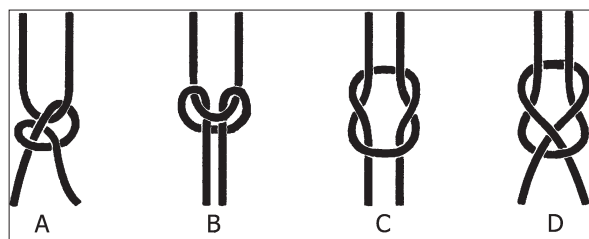


Fig. 6. Major types of fish-net knots. (a: Pfahlbau-type, b, c: reef knot types, d: crown knot type) after Von Brandt 1962.

Abb. 6. Wichtige Netzknoten (a: Pfahlbautyp, b: verschobener Kreuzknoten, c: Kreuzknoten, d: Weberknoten) nach Von Brandt 1962.

reef knots or sheet bend knots.

Usually a few basic knot types are used for making nets, although sometimes nets were produced without knots (von Brandt 1957; Gabriel et al. 2005). The "Pfahlbauknoten", reef knot, crown knot and cow hitch are the most common, although there are many variations and duplications. Figure 5 shows the basic type from the front and rear.

The Pfahlbauknoten type (Fig. 6, a) was first discovered at Alpine lake dwellings (Vogt 1937), but is also known from old lime-fibre nets found in Scandinavia and non-European sites. The reef knot (b, c) is common on ethnological finds from all around the world, while the crown knot (d) is mainly known from prehistoric sites in north-western Europe and North America. For example, this type of knot was also discovered at a Preboreal/Boreal fishing net at the Finnish bog site of Antrea (Sirelius 1934; Jussila & Matiskainen 2003, 607). This emphasizes the use of these knots for fishing nets throughout the north European region since the Stone Age. It is very likely that the crown knot was also used during the production of this net. After preservation works in the museum the mesh size of the Satrup net appeared reasonably large. The length between two knots measures about 6 to 9 cm (Fig. 7). This suggests a use for fishing larger fish like pike, perch, pike-perch, bream, but probably also salmon or sturgeon. Also the fishnet from Antrea showed wider meshes and was likely to be used as gill net (Sauramo 1951).

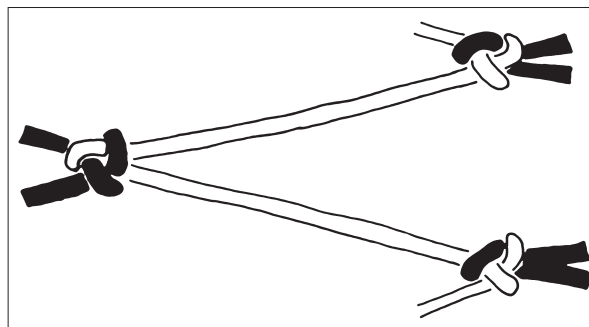
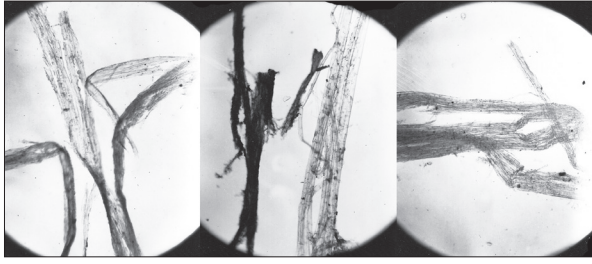


Fig. 7. Satrup net, three knots with preserved mesh (length ~7 cm).

Fig. 7. Satruper Netz, drei Knoten mit unzerstörten Maschenschenkeln (Länge ~7 cm).

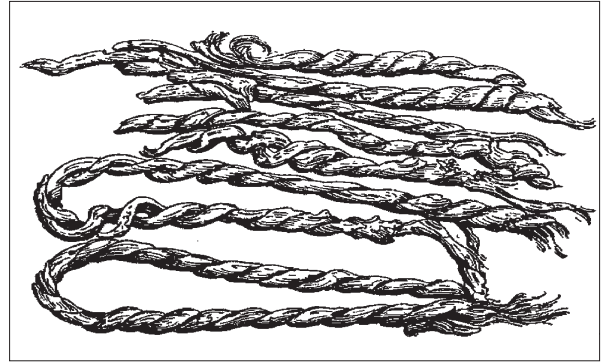


**Fig. 8.** Microscopic view of decaying nettle raw material from Satrup LA 71 Förstermoor.

**Abb. 8.** Mikrofotoaufnahmen des sich zersetzenden Nesselmateri als aus Satrup LA 71 Förstermoor.

The material of choice of nets like the one from Satrup was vegetable fibre (nettle, Fig. 8), similar to the preserved rope rest from the early Neolithic site of Kongstedt (Schwabedissen 1949: 72; Mathiassen 1942). From the Danish bog site of Christiansholm Mose a net made of lime bast is known, but unlike the Satrup net – which was fabricated by lasting knots – the Danish specimen was made of loops (Nielsen 1981: 55).

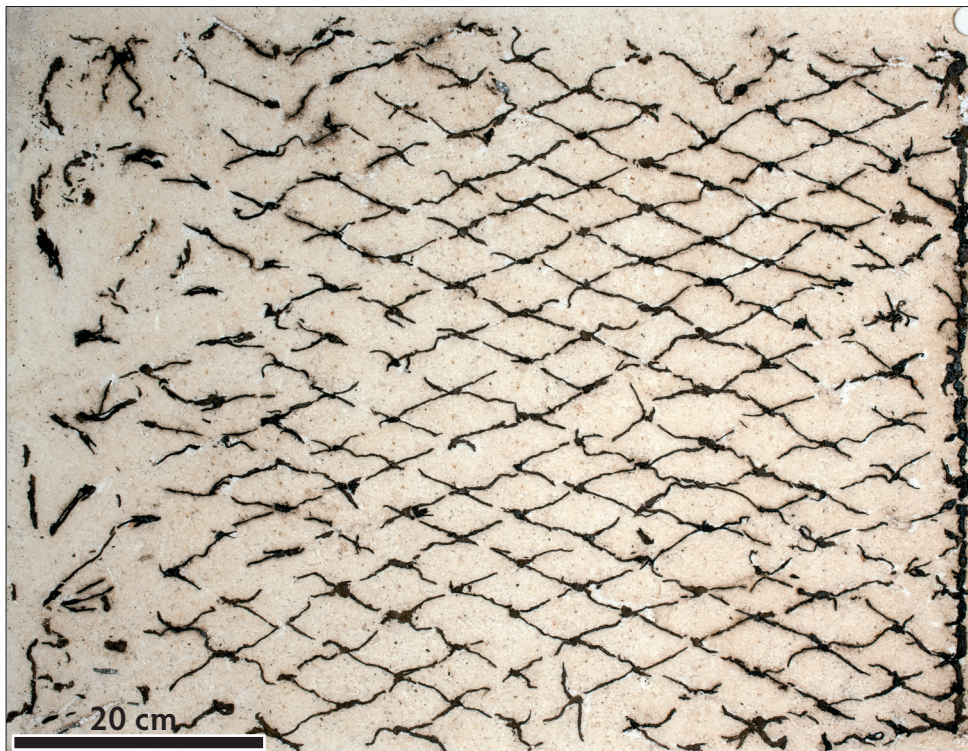
Although net finds from this period are rare, it needs skills to discover, recover and preserve them for future research (Figs. 9 & 19). The anaerobic conditions in the bog helped to preserve the vegetable fibres. Schwabedissen (1957/58: 7) mentions another find from Råde LA 2 but no further evidence on this was found. However, fishing nets from inland sites like Satrup are still very rare, which makes the Satrup net



**Fig. 10.** Illustration of nettle fibre braid of Satrup LA 71 Förstermoor (Schwabedissen 1994: 389).

**Abb. 10.** Abbildung von Pflanzenfaserschnüren aus Satrup LA 71 Förstermoor (Schwabedissen 1994: 389).

important. From the Maglemosian site of Friesack 4 (Brandenburg, Germany) remains of knotted and knotless nets were recovered (Gramsch 2000: 76, 92; Gramsch & Kloss 1990: 323; Probst 1991, Degn Johansson 2000: 111), also from the Boreal site of Antrea (Clark 1948: 56; 1975: 233; Äyräpää 1950: 7; Oshibkina 1983: 124), from the (early) Neolithic sites of Nebbe Mösse (Sweden, Stjernquist et al. 1953: 127-137) and Vlaardingen (Netherlands; Van Iterson Scholten 1977: 138). A small-meshed Boreal-period net with mesh-sizes of about 4,5 cm is also known from the Russian site of Vis I (Burov 1998: 60, Fig. 2-5). Similar finds are known from the more numerous



**Fig. 9.** Photo of spread-out Satrup net. Photo: Archäologisches Landesmuseum Schloß Gottorf.

**Abb. 9.** Foto des ausgebreiteten Netzes aus Satrup. Foto: Archäologisches Landesmuseum Schloß Gottorf.

submerged Ertebølle sites in the Baltic (Andersen 2000a: 117 f; Andersen 2000b: 9; Andersen 2002: 5; Crumlin-Pedersen 2003: 26 f). The late Ertebølle (4300-4000 cal BC) site of Tybrind Vig on Fyn island yielded textile fragments made of lime and willow bast (Jensen 2001: 233) whilst nets made of vegetable fibres have been found from the submerged site of Møllegabet on Aerø island (Andersen 2003: 143, Fig. 8).

### Net floats and sinkers

Further evidence for fishing subsistence in the Satrup bog is indicated by the presence of perforated wooden disks, which are likely to be linked to net fishing. These objects, made of thin wood or bark, were used to keep gill nets afloat. From Satrup LA 71 Förstermoor and Råde LA 2 several of these net floats were recovered. They have a double-conical perforation in the centre of the disk (Schwabedissen 1994: 367; Feulner 2010: 213).

Similar specimens were recovered from the Ertebølle sites of Tybrind Vig and Møllegabet I (Skaarup 1983: 146 f.); perforated net floats made of wood and bark were found at the Russian Boreal site of Veretye I, but also net weights, made of braided marsh plants (Oshibkina 1983: 125). Excavations at Hohen Viecheln (Mecklenburg-Western Pomerania, Germany) yielded 26 centrally pierced pieces of pine bark of ~8 cm diameter and of mainly roundish but also oval, rectangular or irregular shape, which perforations measured about 1-2 cm (Schuldt 1961). However, no direct similarities are evident with the Mesolithic net floats from Antrea (Pälsi 1920; Sauramo 1951; Clark 1975: 223 f.; Burov 1998: 58, fig. 6.5, 1) and Siivertsi (Estland; Indreko 1948: 325 ff.), which are made of thick pine bark, have an elongated form and a smaller perforation at one of its ends. This could be also a local variation, although Wundsch (1961: 74) remarks, that a larger number of net floats should reflect a larger importance of fishery which again should be visible in a larger number of fish bones. Therefore, he concludes that the bark floats could also be regarded as evidence for fishing rods, although no hooks have been found so far. However, the absence of fish bones can be explained by numerous factors like different grades of preservation, the diminutive size and deficient excavation techniques used at that time. Recently, new excavations at the site of Satrup LA 2 Bondebrück proved the existence of fish bones in the Satrup bog.

Although numerous stones and rocks – clearly brought there by man – were discovered in the gyttja layers of the Satrup bog, only very few were actually collected during the excavation. These could have been used as counterparts to the nets, keeping the lower ends of a net on the sea bottom. Hammerstrand Dehman & Sjöström (2009: 20 f) discovered flint slabs and rocks at Rönneholm Mosse (Sweden). From other Ertebølle stations like Vaenesø,

Kolind I and Tagerup perforated net sinker stones were found (Mathiassen 1948), and from many inland sites numerous stones were discovered which could be regarded as net weights, attached to the nets by strings.

### Wooden poles and stakes

Worked wooden poles and stakes of different length and diameter have been recovered from all sites with wooden preservation. Many of the thinner ones were identified as spears. Larger and vertically uprising poles could have been parts of constructions near or in the water like dwellings (Röschmann 1941: 166 f.) or sacrificial platforms (Koch 1998). Possible features existed at Satrup LA 71 Förstermoor and at LA 70-Pöttmoor. At Südensee LA 1 and Südensee LA 1b Südensee-Damm a collection of wooden stakes and poles were recovered from the sediments, closely lined up in a pattern (Reuter-Meßollen 1994: Fig. 41; Loewe 1998: 596 f); Råde LA 2 and Satrup LA 71 Förstermoor showed loosely strewn sticks and thinner poles often more or less parallel to the shore within the activity zone. Due to good three-dimensional feature documentation at Satrup LA 71 Förstermoor it becomes evident that many of these poles were lying in a flat angle, which could have been part of a shallow water fish trap or fishing net installation using net floats to keep it vertically raised, supported by poles to put tension on the net, which were probably destroyed and scattered by the elements.

Fish traps and fish weirs are known throughout the whole of the early Kongemose to the late Ertebølle culture and onwards from settlements sites but also from the actual catching areas (Becker & Troel-Smith 1941; Becker 1943; Bogucki 2004). Fishing could have been carried out directly by nets or fishing rods but stationary, passive-fishing weirs are known from numerous coastal and inland sites (Enghoff 1994; 2011). Parts of a lake, ocean, river or beck could have been fenced off by wattle walls or nets, which guided fish into a trap at the end – an effective fish catching method (Schilling 1997: 95). Although no evidence for fish weirs or baskets made of wickerwork are known from Satrup so far, they have been documented from other Mesolithic sites, for example Kayhunde LA 8 (Clausen 2008: 16), and Priestermoor near Duvensee (both Schleswig-Holstein; Schwabedissen 1949: 72, Fig. 2.2), but also from Ertebølle-sites like the Schlüsbeker Moor south of Kiel (Schleswig-Holstein; Sprockhoff 1953; Hoika 2001: 11) or Neolithic sites like the Danish Oleslyst (Pedersen 1997a; 1997b). The amount of material needed for larger fishing weirs implies a kind of woodland management in order to harvest enough hazel rods – a fact proven on many Danish sites (e.g. Midgley 2005: 17; Bridge 2004: 52; Troels-Smith 1959). Calculations on the amount of rods and stakes necessary to produce such a stationary trap were made by Pedersen (1995: 83). The absence

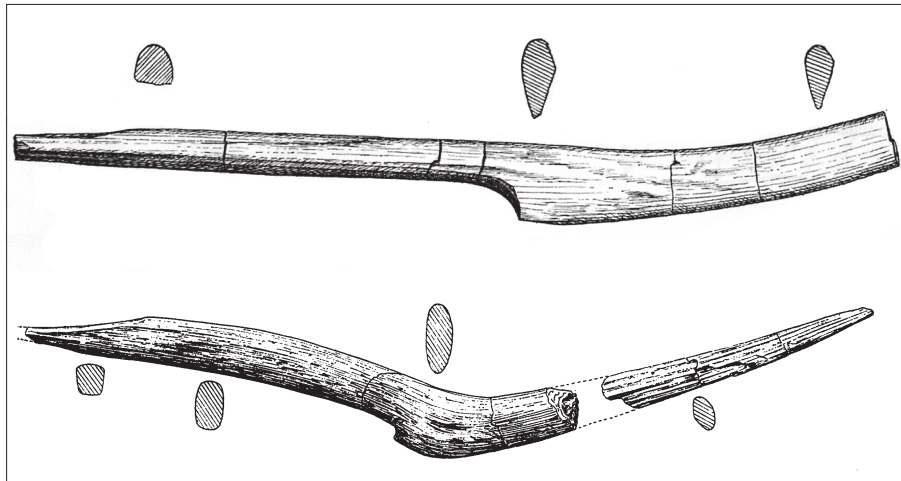


Fig. 11. Eel leister prong from Satrup bog (above: Råde LA 2; below Satrup LA 71 Förstermoor).

Abb. 11. Aalstecherschalmen aus dem Satruper Moor (oben: Råde LA 2; unten Satrup LA 71 Förstermoor).

of these traps in the Satrup bog can be explained by the suboptimal location compared to a river mouth, sheltered seaway or area with current as known from coastal sites (Myrholm & Willems 1997: 163; Andersen 1995: 55) as well as the general classification of the Satrup sites. Most of them tend to be small scale temporary hunting camps which did not need mass-catching capabilities. According to Gramsch (1973: 71), the use of gill nets and fish traps for mass catching was dominant in the late Mesolithic, while during the Preboreal fish spears and fishing hooks were commonly used.

A further interpretation for the straight wooden poles in the shore zone is the use as rack or frame for smoking or drying fish or fish nets, though this theory could not be proven by archaeological means so far. Thicker poles or wooden platforms near the water might implicate jetties for boats or a similar construction to overcome the reed zone, as assumed for Tybrind Vig and Vedbaek Boldbanner (Andersen 1985: 55 f; Tauber 1987: 233; Vang Petersen 1979: 60) or Satrup LA 71 Förstermoor and for the bark platform at Råde LA 2 (Feulner accepted; Fig. 10).

### Eel Leisters

Basically, two methods of fishing are known; "passive", where fish are caught by stationary traps and "active", where they are caught by fishing rods, spears, and alike. Besides stationary fishing methods, the excavations at Satrup LA 71 Förstermoor and Råde LA 2 revealed important evidence for fishing using fish spears also known as eel leisters. Usually, these leisters consist of a long wooden shaft with two wooden symmetrical shaped leister prongs attached to it, and a centred, sharpened spike, which could be made of antler or bone (Mertens 1988: 44). This spike was fixed by and adhesive in a cavity cut into the shaft;

strings attached the leister prongs. In the early 1950's Schwabedissen (1952; 1957/58; 1994; Fig. 10) presented several leister prongs, at first not knowing what they were intended for. In the search for evidence from early Neolithic farming he deemed these for look-a-like butter knives for many years (Feulner 2011). Due to the excavation techniques and local circumstances only the characteristic leister prongs were discovered, while smaller items like the spikes, organic strings or even the accompanying wooden shafts could have been overlooked. The recovered specimens may also represent discarded unfinished preparatory work. Due to missing documentation, the exact locations of these finds are not known; therefore they could have been produced elsewhere and washed up at Råde LA 2 and Satrup LA 71 Förstermoor. Although Thomsen (1906) indicated a relationship between the single components and their use, further evidence or complete specimens were discovered in the Baltic region decade's later (Meurers-Balke 1981; Skaarup 1983; Rimantienė 1995). An intact leister head from the Danish site of Næbbet (Ærø) seems to have no central spike, just relying on pressure of the barbs (Skaarup & Grøn 2004: 88; Pickard & Bonsall 2007: 178). Many of these leister prongs were discovered on now submarine coastal Ertebølle sites like Timmendorf (Mecklenburg-Vorpommern) and Neustadt/Holstein (Schleswig-Holstein), most of them were made of commonly available hazel wood (*Corylus avellana*) but also from different hard woods (Kloß et al. 2009; Hartz & Kraus 2003/2004).

### Fish Bones

Despite the many artefacts associated with fishing in the Satrup Bog the actual number of fish bones is small (Fig. 12). Remains of fish were found at Råde LA 2,

Satrup LA 71 Förstermoor and Satrup LA 2 Bondebrück. In all cases, pike (*Esox lucius*) bones were recovered. However this does not necessarily imply that only pike was selectively caught. This species has comparatively large bones especially when one considers the composition of the vertebrae and therefore improved chances of preservation and detection in the sediments. The small number is probably due to the recovery methods used, where neither dry nor wet sieving has taken place. Therefore the number of discovered bone is probably limited (Heinrich 1989) but also as fish bones are more easily destroyed or dispersed by waves. Otoliths, gill branches, spines and similar elements were not discovered at all. However, during new excavations in 2010 further bones were discovered at the site of Satrup LA 2 Bondebrück, where three bones from pike were found during dry sieving.

A reason for the exclusivity of subfossil pike bone is rooted in the fact that these fish are were the largest among the species living in the former Mesolithic lake, yielding large and more compact bones. Therefore, mainly remains of larger specimen were discovered; bones of only two medium sized individuals of about 50 cm length were proven, the remaining are from animals of at least 70 cm, in three cases they had a length of more than 100 cm. The verifiable total span of length ranges from 48 to 108 cm with a mean value of 83 cm (Fig. 13). However, this should not act as argument for a selective hunt for large individuals but is more likely rooted in taphonomic processes (data and personal communication U. Schmolcke, Schleswig Sept. 2011). Another reason might be the presence of dogs at least on the site of Satrup LA 2 Bondebrück.

Site	Skeletal element	Number
Rüde LA 2	Dentale	1
	Cleithrum	1
Satrup LA 71	Palatinum	1
	Articulare	1
	Operculare	1
	Vertebra praecaudalis	1
	Vertebra caudalis	1
Satrup LA 2 (Old site)	Vertebra praecaudalis	1
Satrup LA 2 (2010)	Vertebrae	4
	Indefinable element	2
Satrup LA 2 (2011)	Vertebra praecaudalis	3
	Vertebra caudalis	2
	Vertebra indet.	4
<b>Satrup bog overall</b>	<b>Total:</b>	<b>23</b>

Fig. 12. Fish bones from archaeological excavations at Satrupholmer Bog. All finds are bones from pike (*Esox lucius*).

Abb. 12. Fischknochen aus archäologischen Ausgrabungen im Satrupholmer Moor. Alle Knochen sind vom Hecht (*Esox lucius*).

These companions of man might have consumed the parts of fish they could get their paws on – likely leftovers or similar which were then digested.

At the current time we have no further evidence for other species caught in the former Satrup lake. From other settlements a wider range of fish is known, which – apart from pike – includes species including bass (Percidae), carp, tench, rudd and bream (Cyprinidae). They likely existed in the former lake, although migratory fish species can largely be ruled out. The occurrence of eel (*Anguilla anguilla*), salmon and trout (Salmonidae) in small quantities could have been possible on sites connected more closely to the sea. Although the former Satrup lake was very close to the Baltic, it was connected by a long river system to the North Sea in a distant west. Nevertheless, on some inland sites like Ringkloster (Jutland, Denmark) marine species like flatfish, pollack (*Pollachius pollachius*) and cod (Gadidae) are known (Enghoff 1994: 85).

### Conclusions

The recent excavations that took place in the Satrup bog, especially at the site of Satrup LA 2 Bondebrück finally brushed aside any doubts of the absence of fishing at the late Mesolithic and early Neolithic sites along the former lake shore. The former excavator’s desideratum of early agricultural influence visible in many prehistoric finds can now unfailingly be waved aside. Many of the finds from the 1947 to 1963 excavation campaigns are no longer in doubt and are addressed correctly as fishing-related equipment by more recent research. The initial absence of fish bones in the faunal remains of the old excavation can be attributed to an inadequate excavation technique. The use of wet sieving and careful monitoring during the recent excavations revealed evidence of fish bones. Taphonomic processes added to the relative underrepresentation of fish. To conclude, we can

Site	Skeletal element	Vertebra size [mm]	Overall length
			[cm]
Rüde LA 2	Dentale	-	80
Satrup LA 71	Vertebra caudalis	5,2	48
Satrup LA 2 (2011)	Vertebra praecaudalis	10,9	102
Satrup LA 2 (2011)	Vertebra praecaudalis	7,9	74
Satrup LA 2 (2011)	Vertebra praecaudalis	5,6	52
Satrup LA 2 (2011)	Vertebra caudalis	11,6	108
Satrup LA 2 (2011)	Vertebra caudalis	11,3	105
Satrup LA 2 (Old site)	Vertebra praecaudalis	10,4	97

Fig. 13. Summary of faunal remains offering chances for reconstruction of total length. Calculated after Lepiksaar & Heinrich 1977.

Abb. 13. Zusammenfassung der Fischknochen bei denen Längenaussagen getroffen werden können. Berechnet nach Lepiksaar & Heinrich 1977.



assume that fishing took place and played a role in the diet of the late Mesolithic and early Neolithic population visiting the former Satrup lake. However, the full-range of fish catching equipment (weirs and hooks) known from synchronous coastal sites in Scandinavia is missing.

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