The Source of the River – Mesolithic settlement and ritual in relation to a changing river landscape in Motala

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Abstract

The large archaeological project in Motala have included paleoenvironmental studies of macrofossil, pollen and diatoms from radiocarbon dated lake and river sediments as well as from excavated sites. These investigations have revealed evidence of the Yoldia Sea regression, the Ancient Lake Vättern transgression, and the following stepwise river formation process, major natural phenomenon and changes that interacted with key stages of Mesolithic settlement, c. 9000–4000 BC.

During the Boreal, the first stage of River Motala Ström was formed, in 7200 BC, and the oldest burial was established at the Mesolithic cemetery at Strandvägen. Around 5800 BC, a second erosional event cut down the river-threshold to modern day level. At this time, the Late Mesolithic settlement in Motala was established, all starting with major ritual events at Kanaljorden and Strandvägen expressed by extensive depositions of artefacts and parts of humans and animals in water.

We argue that ritual depositions, in addition to appeasing the spirit world, also may have acted as boundary markers for hunter-gatherers in the region, and thereby, as with graves, have become agents in territorial struggles. We also suggest the possibility that the people in Motala believed that the water environment of the newborn river was seen as alive, being sentient with a more-than-human personhood, to whom it was essential to have good relations with.

Introduction

The river valleys in the province of Östergötland were roughly shaped during the last glacial period and early Holocene, by retreating ice sheets and was covered by glaciolacustrine and marine clays during the Baltic Ice Lake and Yoldia Sea stages (Johansson 1976). In the case of the Lake Vättern basin the differential isostatic uplift had a direct effect on the drainage, and a new river was formed during the Middle Mesolithic at today's town of Motala. This event probably had a major impact on the Mesolithic groups of hunter-gatherers who lived in the area.

River formation in formerly glaciated areas, where isostatic uplift and shore displacement is a dominating component of the postglacial landscape development, is a relatively poorly researched area (cf. Lindén *et al*. 2006; Saarnisto 2012). Few river valleys in southern Scandinavia have been the stage for such intense Mesolithic activity as in Motala, and Motala has been described as a focal point in Mesolithic society in south-central Sweden (Larsson 2005; Carlsson 2008; Molin *et al*. 2014). Considering this, the landscape and river development need to be understood. In a recent multi-disciplinary paper, Bergman *et al.* (2020), report and discuss the relevant sediment stratigraphy, chronology and river formation processes that took place in Motala. Environmental data from the archaeological sites are discussed and corroborated by data from sediment cores retrieved from Lake Boren, downstream from Motala. The paper pays special attention to the chronology of the River Motala Ström formation process, and the local shoreline displacement in the Vättern basin.

Three partly contemporary Mesolithic sites, dating between c. 9200–4000 BC have been excavated by the source of the river. The excavations were conducted within the

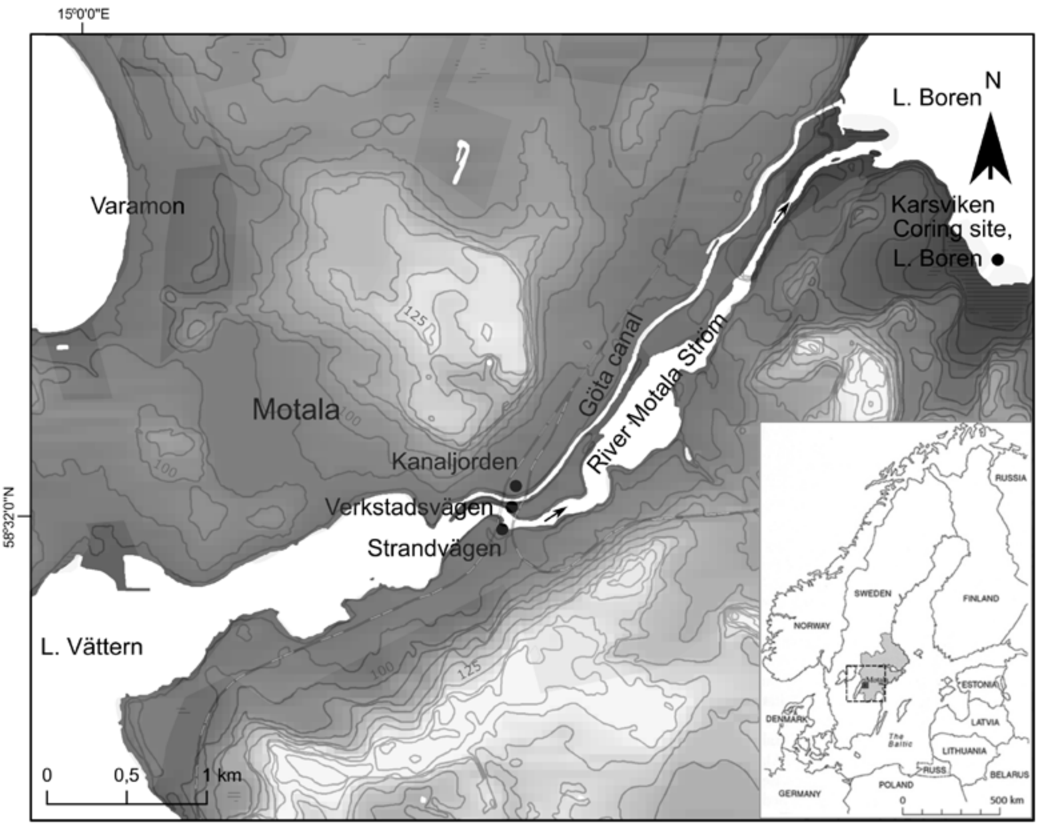


Fig. 1. Elevation map showing Motala and the present-day River Motala Ström. The three Mesolithic sites; Strandvägen, Verkstadsvägen and Kanaljorden are marked by black dots, as well as the coring site in Lake Boren. The encapsulated map shows the location of the town Motala in east-central Sweden and the province of Östergötland highlighted in grey. From Bergman *et al.* 2020.

Swedish contract archaeology system as a consequence of the construction of a new railway bridge in Motala, and carried out with the highest of ambition. Kanaljorden and Verkstadsvägen are situated on the northern side, whereas the site Strandvägen is located on the opposite southern side of the river (fig. 1). Together, they comprise the largest and most complex Mesolithic settlement area known and excavated in this region (Carlsson 2008; Molin *et al.* 2018; Hallgren *et al.* 2021). The areas at Verkstadsvägen and Strandvägen consist of central parts of the settlement, with several documented post-built dwellings, and the first excavated Mesolithic cemetery in central Sweden (Hagberg & Westermark 2015; Gummesson & Molin 2016; Gruber *et al.* 2021). Kanaljorden comprises Early Mesolithic remains, as well as a Late Mesolithic ritual context, with human remains placed onto a stone-packing on the bottom of a shallow wetland (Hallgren & Fornander 2016; Hallgren 2017).

Together, these sites form a large contiguous area at the side of River Motala Ström. Such a site (Motala) can be understood from three spatial characteristics: material, social and symbolic space (Molin *et al.* 2014). The three aspects interact when people create or construct places and evoke the mental symbols and values that people ascribe to it (cf. Lefebvre 1991; O'Meara *et al.* 2020). These are part of the negotiations about the place, that is, the social processes that constantly reinterpret the meaning of places, which ultimately lead to new expressions. The ever-changing landscape and its natural phenomenon most certainly affected the people who created these places. First the melting of the ice sheet and the transformation of Lake Vättern, with the start of a major flooding of land in form of the Ancient Lake Vättern transgression (ALV) and concluding with the decisive steps when the river Motala Ström was formed.

In this paper, we discuss the major events in the formation of the river and reason about the perception the hunter-gatherers present may have had of these natural phenomena, and of the consequences these may have had for the ritual events at the site. In a way, the paper may be seen as a contribution to the evolving field of environmental humanities, challenging us to improve our environmental responsiveness and perhaps even to environmental changes (cf. Fredengren 2018).

The Ancient Lake Vättern transgression

The lowlands east and west of central Lake Vättern were deglaciated about 9800 BC (Björck *et al.* 2001) and as the ice sheet retreated north of Mt. Billingen the Baltic Ice Lake was drained down to sea level, marking the onset of the Yoldia Sea (9600–8750 BC). Shore lines at 120 m a.s.l. mark the maximum level near Motala (Johansson 1976). The shore displacement was rapid, and by 9150 BC, sites down to 105 m a.s.l. south of Motala had been lifted above sea level (Plikk & Risberg 2012). At that time, the Vättern basin formed a bay with a northern connection to the Yoldia Sea (fig. 2) and the first traces of human presence are visible in the Motala area (Hallgren 2018).

As the straits that connected the Yoldia sea with the North Sea were lifted above sea level, the next freshwater stage of the Baltic basin, the Ancylus Lake (8750–7750 BC) was initiated (Björck 2008; Hansson *et al.* 2017). The differential isostatic uplift led to the northern part of the basin rising faster, and this N–S tilting of the Ancylus Lake initiated a transgression of the southern shores of the Baltic basin, which would last approximately 500 years, until c. 8250 BC (Björck 2008; Björck *et al.* 2008; Hansson *et al.* 2017; Hansson *et al.* 2019).

The shoreline development of Lake Vättern is complex and was subject to

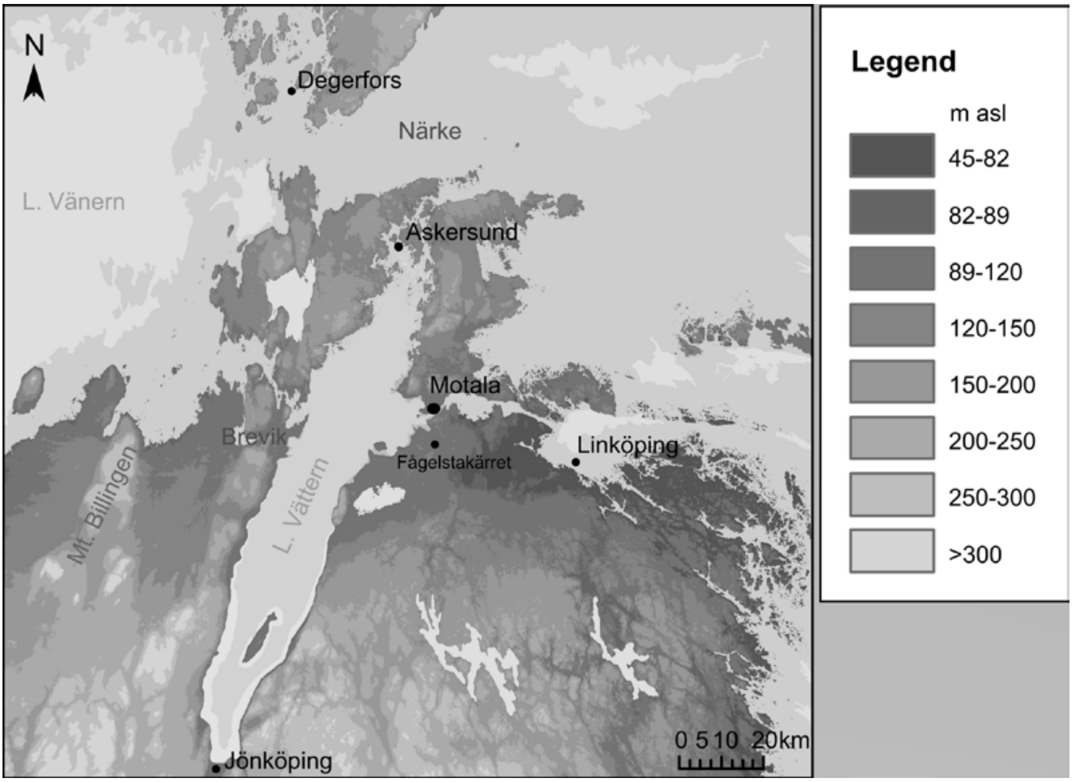


Fig. 2. The extent of the Yoldia Sea at c. 9000 BC. Motala is situated at the eastern shore of Lake Vättern. From Bergman *et al.* 2020.

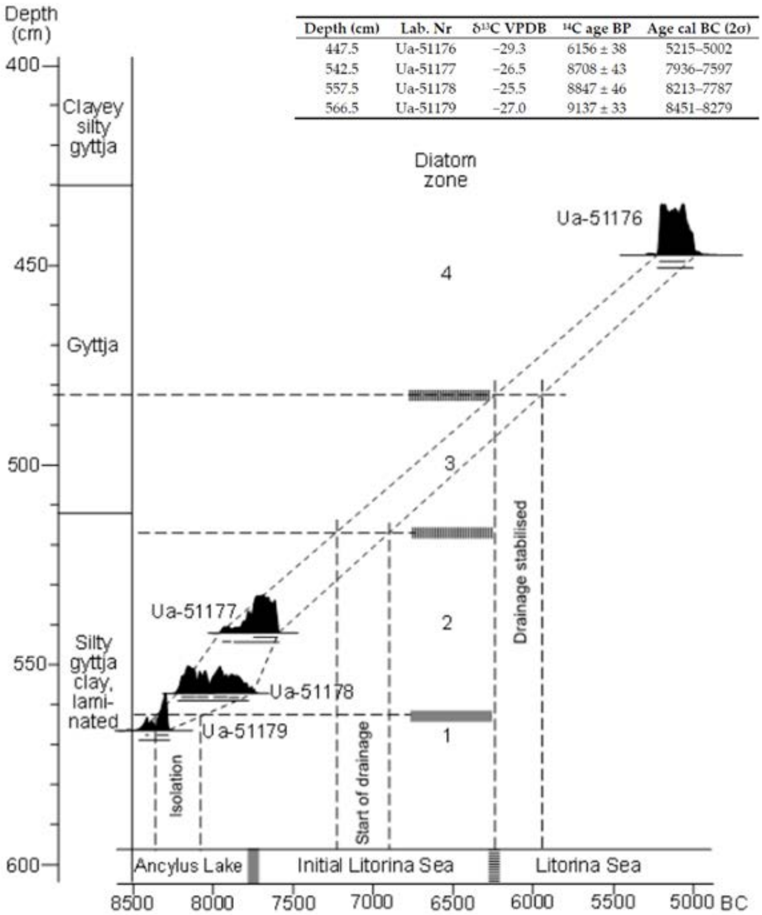
intensive geological studies in the first half of the 20th century (cf. Nilsson 1968). The more pronounced uplift towards the north, in combination with the elongated N–S extent of the lake, has led to a tilting of the lake surface towards the south. The southern shore of the lake is presently being submerged, and records shows that formerly exposed ground (with tree stumps) have been found 11 m below the present lake surface in the vicinity of Jönköping (fig. 2) (Granlund 1933), but the oldest shoreline can be traced down to at least 31 m below the present lake surface, near the southern end (Svantesson 1985). The tilting led to a shift in outlets, from a probable northern outlet located near Askersund (fig. 2), to the present-day outlet at Motala (River Motala Ström). The tilting also caused the lake level to rise in the whole basin, thus starting the Ancient Lake Vättern transgression which continued after the new outlet was formed. These previous studies of the Vättern basin, thus, has shown that: (1) the River Motala Ström did not form immediately after deglaciation, and (2) There is an (ongoing) tilting of the lake, and a transgression in the Vättern basin during the early Holocene, resulting in the formation of the river and a new river valley.

The river formation process and dating of River Motala Ström

The recent investigations (Bergman *et al.* 2020) have revealed sedimentary evidence of the Yoldia Sea regression, the Ancient Lake Vättern transgression, and the following stepwise river formation process. Around 9000 BC, two small kettle hole basins, a backwater at Strandvägen (Lake Strandvägen) and the wetland at Kanaljorden (Lake Kanaljorden), became isolated from the Baltic basin. However, as a result of the Ancient Lake Vättern transgression Strandvägen and Verkstadsvägen become inundated sometime after 8000 BC. The threshold in Motala at 92.5 m a.s.l. was reached by the transgression around 7200 BC, and River Motala Ström was initially formed. Radiocarbon dated diatom records from Lake Boren downstream of Motala, and shoreline deposits in Motala, confirm this event. The water level in Lake Vättern initially fell around 1.5 m, and at c. 5800 BC, a second erosional event cut down the threshold to modern day level (Bergman *et al.* 2020, figures 8 and 9).

Sediment coring in Lake Boren

To date the breakthrough of the river into Lake Boren, a sediment coring was performed at Karsviken, close to the river outlet (fig. 1). A Russian corer was used to retrieve 3.5 m of sediment, from five parallel cores. Sediment was sampled for diatom analysis as well as macrofossils for ^{14}C-dating. Calibrated dates were then combined into an age-depth plot (fig. 3). By combining analysed sediment



Depth (cm)	Lab. Nr	δ^{13}C VPDB	^{14}C age BP	Age cal BC (2σ)
447.5	Ua-51176	–29.3	6156 ± 38	5215–5002
542.5	Ua-51177	–26.5	8708 ± 43	7936–7597
557.5	Ua-51178	–25.5	8847 ± 46	8213–7787
566.5	Ua-51179	–27.0	9137 ± 33	8451–8279

Fig. 3. Chronology (age-depth plot) and stratigraphy of sediment cores from Karsviken in Lake Boren. Modified from Bergman *et al.* 2020, Tab. 1 and Fig. 4.

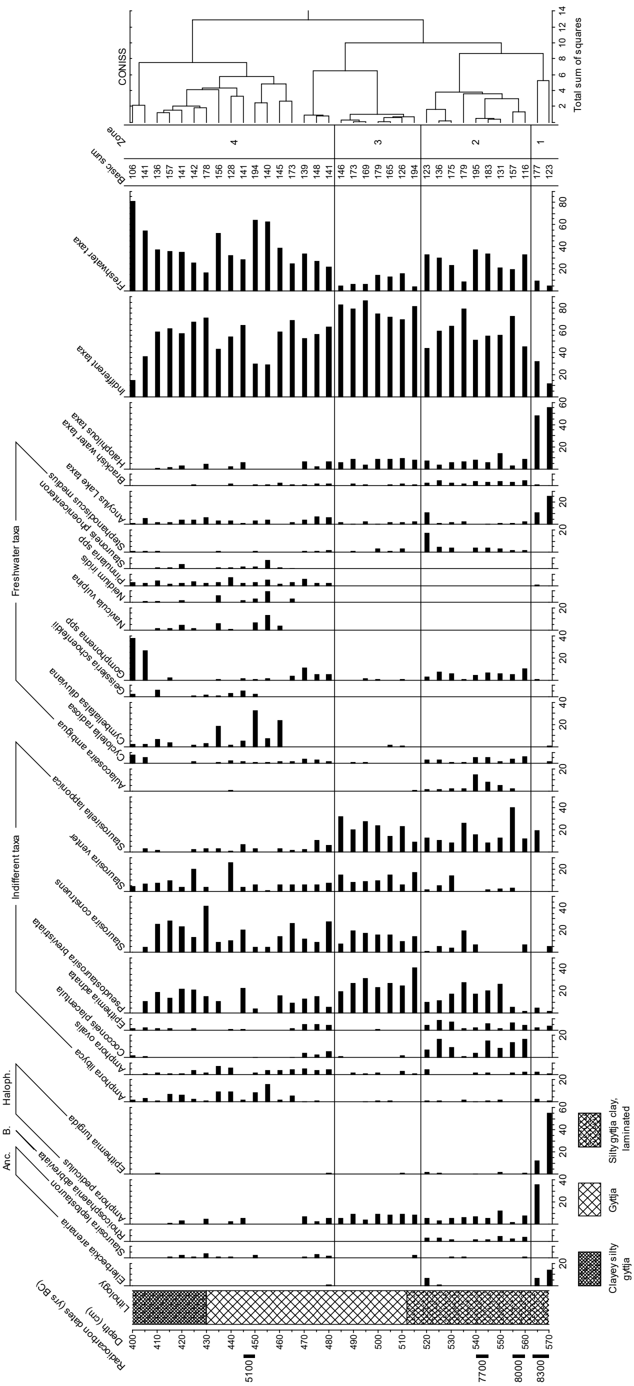


Fig. 4. Diatom data from Lake Boren. The diatom stratigraphy has been divided into four zones and shows the change in diatom taxa from the late Ancylus Lake, via the isolation of Lake Boren to the newly formed river. Zone 3 shows that water from Lake Vättern started to flow into the Lake Boren basin from the west representing the opening of the spillway over the Motala threshold and establishment of River Motala Ström. From Bergman *et al.* 2020.

stratigraphy from Karsviken and Strandvägen evidence from all interpreted geological events have been found.

The diatom stratigraphy of Lake Boren has been divided into four zones (fig. 4). The first zone is dominated by taxa typical of the late Ancylus Lake, whereas in zone 2, indifferent and freshwater taxa increase, interpreted because of the isolation of Lake Boren from the Ancylus Lake (Eronen 1974; Risberg 1991; Hedenström & Risberg 1999; Bona *et al.* 2007). The age-depth plot indicates the isolation event to around 8250 BC (fig. 3). In zone 3, freshwater taxa decrease, and indifferent taxa increases with species flourishing during periods of pronounced changes in the environment, e.g., in water chemistry (King *et al.* 2006; Hargan *et al.* 2015) likely to have occurred when water from Lake Vättern started to flow into the Lake Boren basin. This represented the opening of the spillway over the threshold in Motala, starting around 7200 BC (as interpolated from the age-depth plot in fig. 3.). Zone 4 shows a stabilizing environment with the establishment of new and common freshwater taxa around 6200–5900 BC. The dating of the isolation of Lake Boren thus agrees with earlier studies from the area around Linköping, following the Ancylus transgression at 8250 BC (Fromm 1976; Hansson *et al.* 2017).

Strandvägen sediment records

Macrofossil and pollen samples were analysed from several sections at Strandvägen, from both terrestrial, fluvial, and aquatic sediments. All terrestrial, telmatic and aquatic plants have been identified, as well as lithic, faunal, and other archaeological remains (fig. 5). In the bottom of the aquatic stratigraphy is postglacial clay once deposited in a shallow near-shore environment during the last phase of the Yoldia Sea. This Yoldia clay is roughly of the same age as the earliest Preboreal remains at Kanaljorden (see below) but shows no anthropogenic traces. Above the clay is a calcareous gyttja characterized by shell fragments of molluscs and calcareous sand, representing a shallow freshwater environment, in a small isolated lake basin (ILB) (the kettle hole Lake Strandvägen). The basin isolated from the Yoldia Sea after c. 8800 BC (fig. 5). On dry land, around the small kettle hole lakes in Motala (Strandvägen and Kanaljorden), pine, birch, hazel, and grasses dominated the vegetation, with some elm and ash. A couple of edible weeds occur in the calcareous gyttja, such as shepherds-purse, fat hen, and seeds of rowan berries, possible indicating a human presence like the settlement at Kanaljorden. The uppermost part of this gyttja is dated to 8200–7600 BC.

The next phase is characterized by dark brown gyttja with a higher sand content, indicating higher energy in the water. Plant macrofossils show similar dates as the previous sequence, and it is likely that the material was accumulated in the Ancient Lake Vättern (ALV), after its transgression over Lake Strandvägen, shortly after c. 8000 BC (fig. 5). The occurrence of elderberry and raspberry may reflect a Mesolithic gathering or the local flora, and small amounts of charcoal occurs, possibly deriving from a contemporary occupation at Kanaljorden. At 86.69 m a.s.l., a two cm sandy layer contains the lowermost distinct charcoal horizon, and the charcoal is most likely of anthropogenic origin. This level corresponds to 7500–7000 BC (fig. 5) and reflects the first fall in water level in the Vättern basin, as River Motala Ström is formed, causing a sudden regression. Parts of the organic material, other than charcoal and berries, originates from occupational waste along the shore, in form of fish scales and fruits of floating sweet grass, probably deriving from the Boreal settlement in the immediate area (see below). The last gyttja

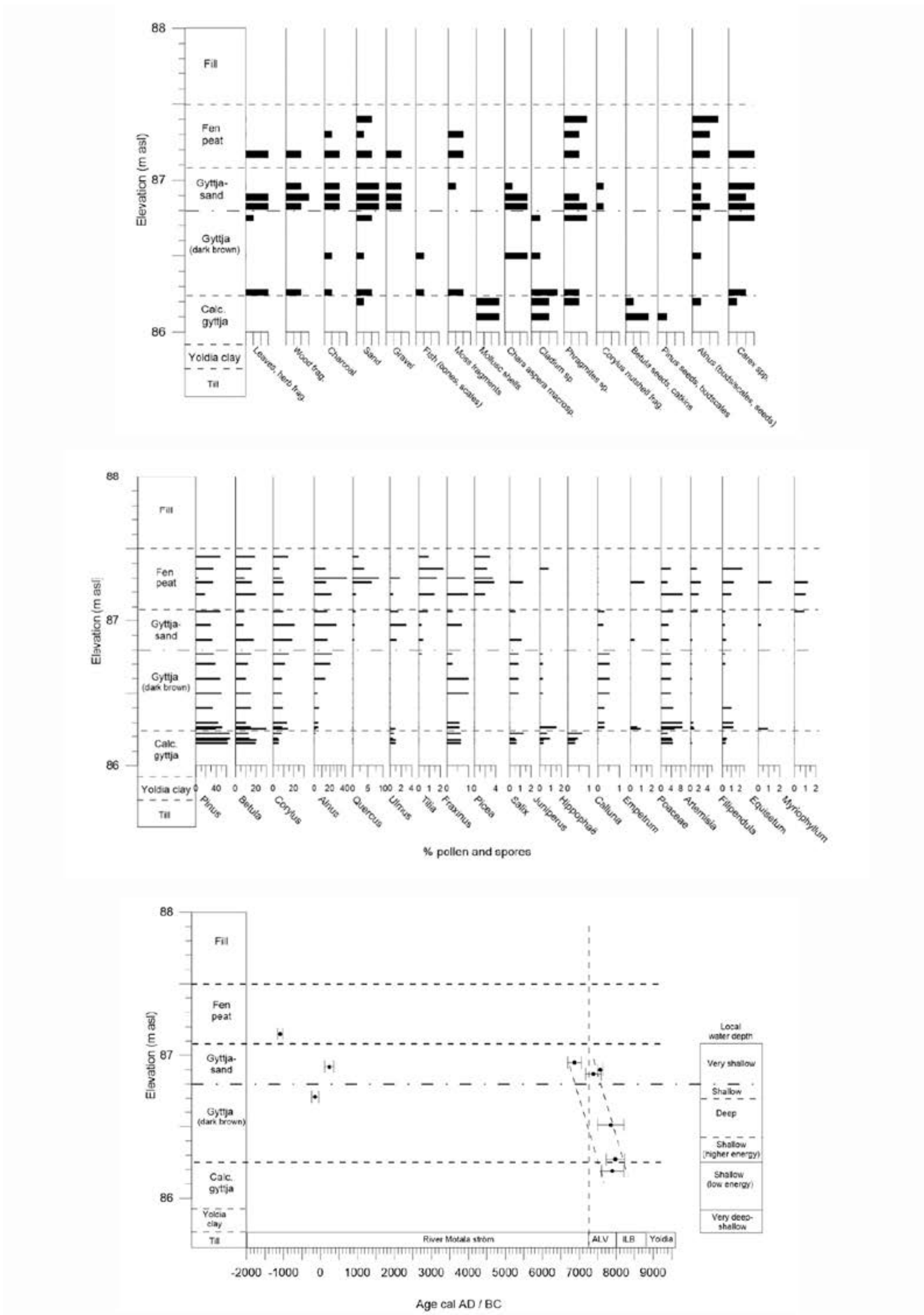


Fig. 5. Macrofossil remains, pollen percentage data as well as stratigraphy and ^{14}C-dates from section C13059 at Strandvägen. Modified from Bergman *et al.* 2020.

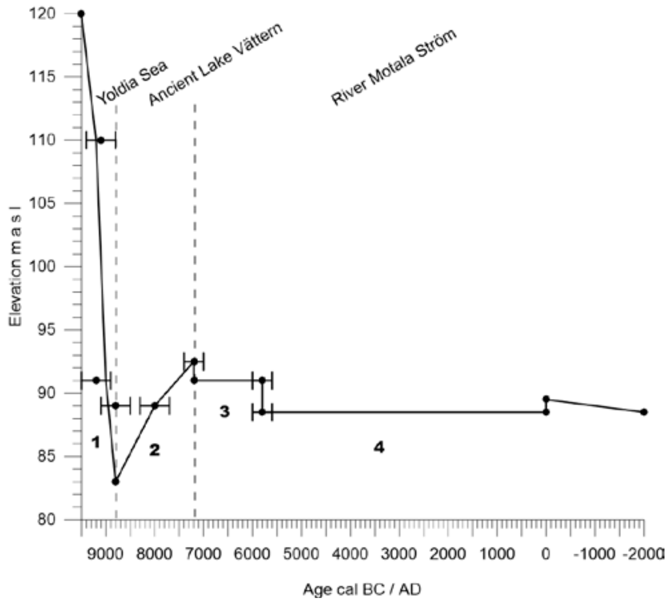


Fig 6. Summary of the shore displacement history in Motala. (1) The Yoldia Sea shoreline fall from c. 120 m a.s.l., and Lake Kanaljorden (91 m a.s.l.), and Lake Strandvägen (89 m a.s.l.) become isolated around 8800 BC. Ancient Lake Vättern (ALV) is isolated from the sea and drops to c. 83 m a.s.l. (2) The ALV transgression starts. The Strandvägen and Kanaljorden basins become inundated shortly after 8000 BC. (3) River Motala Ström is first formed between 7500–6900 BC, and this first channel head (at the first rapid) was located east of Strandvägen. As it quickly erodes through glaciofluvial deposits, the Lake Vättern water level drops to c. 91 m a.s.l. The Strandvägen site becomes an island, with early Boreal settlement remains, and the Kanaljorden basin becomes part of the Lake Vättern beach zone during the Lake Vättern stillstand. (4) At 5800 BC, the headward erosion has moved the channel head west to Strandvägen, and the Lake Vättern shoreline falls to c. 88.5 m a.s.l., or slightly higher. The Late Mesolithic settlement are founded at the first rapids. Later, during the Early Iron Age (c. 200 BC–100 AD), the mean water level rises slightly again. Events are based on one or several ^{14}C-dated (2σ error) units or records. From Bergman *et al.* 2020.

sand, rich in e.g., gravel, charcoal, fragments of wood, hazel nutshells, is interpreted as the near-shore river sediment, deposited in the backwater adjacent to the Late Mesolithic settlement (fig. 5). This layer is the most well-dated of all at Strandvägen, with numerous dates of charred (and uncharred) hazelnuts, telmatic macrofossils and numerous finds of bone and antler. The age is mainly 6000–5000 BC (e.g. Carlsson 2008; Molin *et al.* 2018; Gummesson & Molin 2019).

Consequently, the small kettle hole basins, Lake Strandvägen and Lake Kanaljorden, emerged from the Yoldia Sea around 9000–8800 BC, and in the two small, isolated lake basins (ILB), the accumulation of calcareous gyttja started. The ILB stage ended sometime after 8000 BC (probably 8000–7600 BC), as the calcareous gyttja was eroded by the transgression (fig. 5 and 6).

It is possible that the rising shoreline in Motala caused massive groundwater infiltration into the glaciofluvial deposits, effectively slowing the transgression as it reached above c. 90 m a.s.l. The groundwater aquifer in the sand and gravel material would then have been drained by springs on the eastern slope of the esker. These would, in turn, have created a small stream which drained into the Lake Boren basin. The rising ground water table would also have affected the water level of the two small, isolated lake basins, making it rise as the Ancient Lake Vättern transgression progressed. During this first phase of the river (fig. 6), the channel head (the first rapids) would have been located further east, gradually eroding the glaciofluvial deposits. Through headward erosion, the channel head then migrated upstream to the west. It is uncertain, however, if the threshold erosion and channel cut-down process was slow or sudden.

Preboreal remains at the shore of the Yoldia Sea

The earliest human remains in Motala were found at Kanaljorden, in form of a small lithic assemblage sealed by layers of the subsequent lake transgression covering parts of the site (Hallgren 2018). The lithics was accompanied by a few features resembling small post-holes. It turned out that transgression sand covered older organic soils with evidence of the first human occupation in Motala, c. 9000 BC. The lowermost calcareous gyttja at Kanaljorden is ^{14}C-dated on terrestrial macrofossils to an age around 9200–8800 cal BC (Ua-41614,

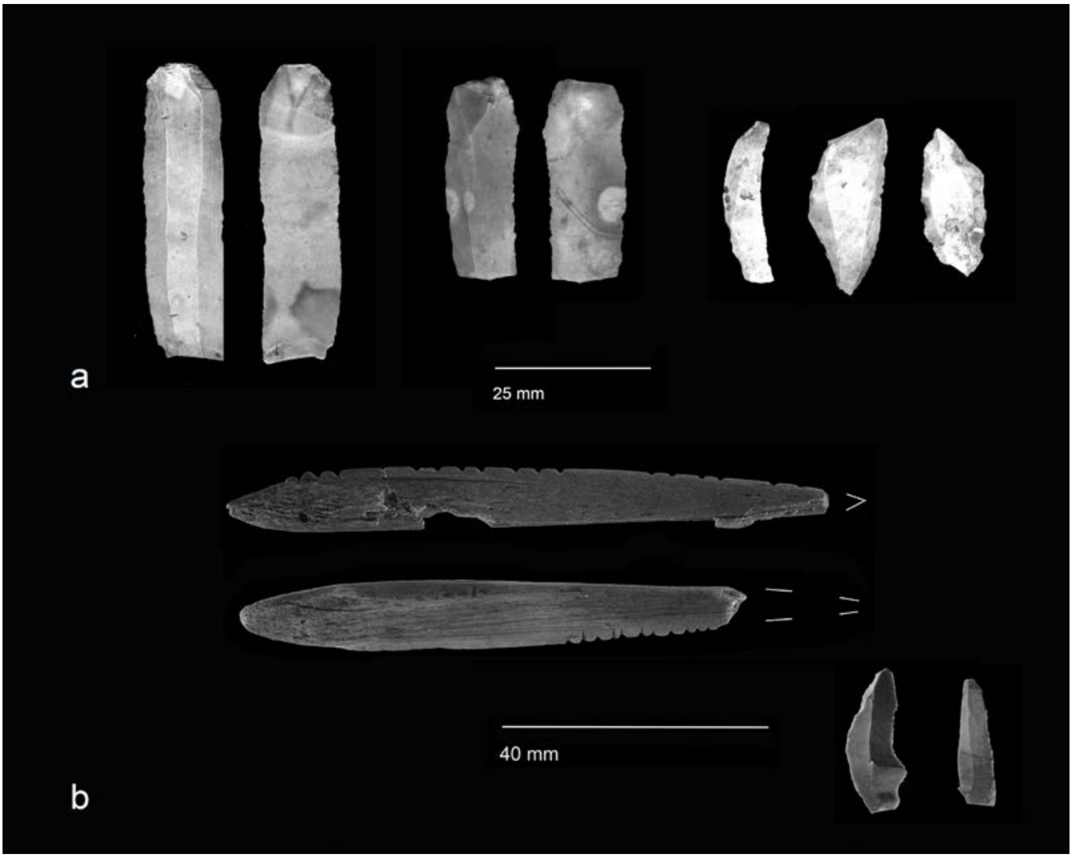


Fig. 7. a) Examples of flint blades and three lanceolate microliths from the Preboreal/early Boreal settlement at Kanaljorden. From Hallgren *et al.* 2021. b) Two bone point arrowheads with notches and short tapered bases, and two lanceolate microliths, from the Boreal settlement at Strandvägen. Photo: Peter Zetterlund, National Historical Museums.

9699±62 BP and Ua-41615, 9876±186 BP), and the uppermost interpreted age of the gyttja is c. 8400–7900 cal BC, based on a dated sample of birch seeds and catkin scales (Ua-41616, 9016±95 BP) (Hallgren 2018; Bergman *et al.* 2020).

The lithics consisted of flint, quartz, mylonitic quartz and sedimentary rock. The flint is of three origins, Senonian-, Danien- and Cambrian flint, showing that raw material was accessible both from south Scandinavia, and/or the Swedish west coast, as well as from nearby Mt. Kinnekulle in Västergötland at this early stage. Flint blades from the site are straight and prismatically executed, probably from conical core-types (fig. 7a). Blade platforms are flat with trimmed edges, the blades thus resulting from a controlled production from well-prepared cores by soft hammer or antler punches. A small unifacial, bipolar blade core of quartz is also among the findings. The latter resembles unifacial blade cores of the Hensbacka culture (c. 9000–7700 BC). The assemblage also included a grinding stone of sandstone and a few notched pebble netsinkers (Hallgren 2018, 228 ff.). Also, from unstratified parts of the settlement area, have similar regular flint blades been collected as well as a few finds of lanceolate microliths, made in microburin technique. However, several irregular cruder blades in patinated flint were also collected, produced by direct hard technique.

The dating of the blades based on morphological traits is problematic in relation to the dated stratigraphy. The latter blades resemble blades from south Scandinavian technology group 1 or 2 from early Maglemose culture, while the prismatic executed blades from the dated stratigraphy resembles later group 2 or 3 from the late Boreal/early Atlantic period (Fischer 1996; Sørensen 2006). This indicates that lithics from c. 9000–7000 BC may have been mixed in the lower stratigraphy as a result of the subsequent lake transgression. It is obvious that various techniques in producing blades are represented in the early assemblage at Kanaljorden, with both soft and hard technology based on cores assumed to have been conical or semi-conical in appearance.

These earliest dates and findings have been interpreted as remains from a small mobile group of people temporarily settling in the area (Hallgren 2018). No remains indicate any lasting or ritual activities as is seen during later periods. A plausible interpretation is that the first settlers were hunters that followed large herbivores northwards during the early Preboreal, like reindeer, European bison, and aurochs, and that this first settlement was situated at the shore of the Yoldia Sea. It cannot, however, be ruled out that these first humans travelled to the region using boats moving along the coast and the ice margin. Later finds shows that the site was still visited after the isolation of the Kanaljorden basin and the subsequent transgression (Hallgren 2018).

Boreal settlement at the source of the river

The first erosional event, and the following lowering of the lake, c. 7200 BC, turned the site Strandvägen into an island, located at the starting point of the new-born river. Also, the sites Verkstadsvägen and Kanaljorden were from now on situated near the rivershore. All three sites display finds from the Boreal, Middle Mesolithic c. 7500–6000 BC, mostly in the form of lithics such as flint blades or various lanceolate points. Radiocarbon dated features are, however, present at both Kanaljorden and Strandvägen, such as cooking pits, as well as dated macrofossil from features and stratigraphy.

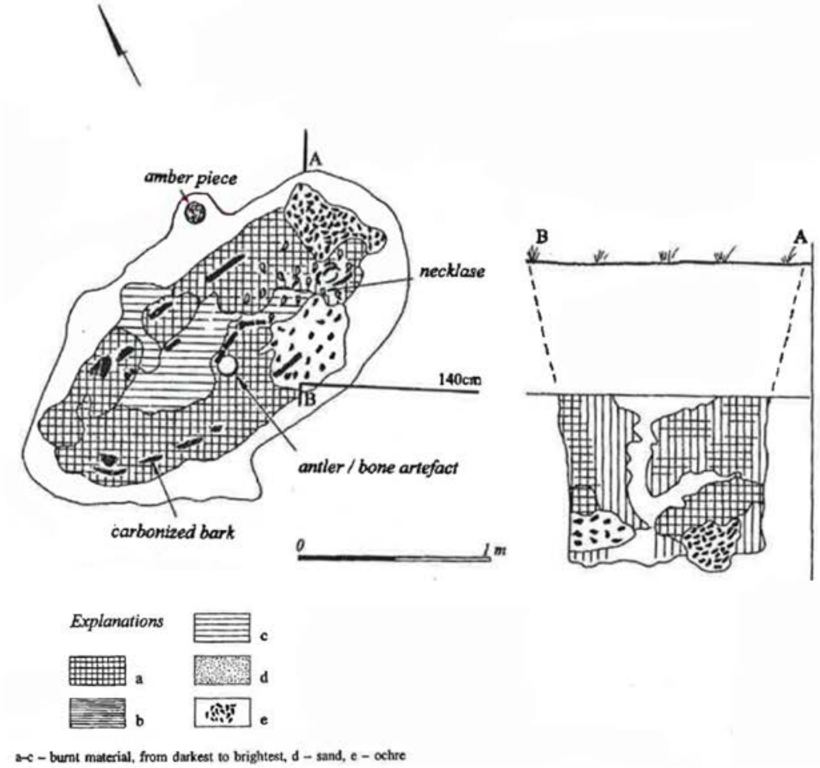
In the gyttja of the river at Strandvägen was found the oldest dated bone point from the settlement, in form of a small unilaterally slotted arrowhead, with the other side showing small perpendicular notches, spaced in groups (Gummesson & Molin 2019) (fig. 7b). The slotted point has a short, tapered base and shows small, incised grooves along the notched edge. It measures approximately 92 mm in length with a slightly damaged tip. Resin from the groove has been dated (2σ error) to 8106±46 BP, 7310–6840 cal BC (Ua-30871). This is the only slotted point from Motala with notches and belongs to the earliest phase of the Strandvägen settlement. This bone point closely resembles finds from the Baltic, for example from Kunda-Lammasmägi in Estonia and from Lake Lubāna in Latvia (Gummesson & Molin 2019, 277). The notched attribute can also be seen on a narrow bi-laterally slotted point from Bussjö mosse in Scania, with fine oblique notches on one side (Clark 1936, plate V.6).

The slotted point is equalled by another find of a notched bone arrowhead from Strandvägen (fig. 7b). It measures c. 76.5 mm in length, with a broken tip and has a triangular and flattened cross-section and likewise a short, tapered base. This bone point shows small, irregular, closely spaced perpendicular notches on the distal half (towards the tip) of one longitudinal side. The circumstances and conditions of the finds in the gyttja, may indicate that the points have been used for fishing in the backwater of the river (cf. Rimkus 2016).

The burned chamber of Burial 09

At Strandvägen a small well-dated part at the highest area of the settlement, 7200–6800 cal BC, c. 91 m a.s.l., revealed several pits and a scatter of lithics. This part coincides with several Mesolithic burials, and among them the oldest excavated grave at the site, Burial 09 (Gummesson & Molin 2016). This burial feature was complex and represents one of the earliest pieces of evidence for human presence at Strandvägen. The conditions of preservation of skeletal parts were very poor in the sandy soil, however, at the very bottom of the burial pit a fragment of an unburned human (adult) tooth was found. Higher up in the burial pit, covered by a small stone-packing, a flint scraper and flakes of quartz were laid close together. The stones covered a distinct filling of soot and charcoal, in which parts of charred poles of pine were visible, arranged in the same direction (fig. 8b). The burial pit measured 1.65 x 0.95 m and was 0.6 m deep, exceeding the layer of soot and charcoal and was dug in pure sand. Further down in the burial pit, was a visible burned construction, c. 1.50 x 0.6 m, with a distinct rounded rectangular form. Denser patches of soot and charcoal as well as remains of burned wood (pine) bear witness to several constructional elements.

The composition of the feature thus indicates the burning of some sort of construction, or container, during the process of the burial. Two charcoal samples showed radiocarbon values (2σ error) of 8310–7960 (9008±59 BP, Ua-31396) and 7140–6750 cal BC (8099±53 BP, Ua-31398), the latter being the reliable of the two. This burial is unparalleled in Motala but shows close resemblances to graves at the Mszano 14 cemetery (near Brodnica) in Poland, where several burned grave chambers with constructions have been documented (Marciniak 1993). One of the best-preserved burials (Tomb 1) showed a burned rectangular burial pit, 2.0 x 0.9 m, and 1.2 m deep, with a vertical shaft (fig. 8a). The walls of the shaft were lined with vertical beams of pine, 15–25 cm in diameter. At the bottom of the chamber were laid an adult woman and a child, wholly covered in bark from a (unidentified) deciduous tree. During the ritual, the shaft and bodies were burned and then covered by sand and ochre, combining cremation and a



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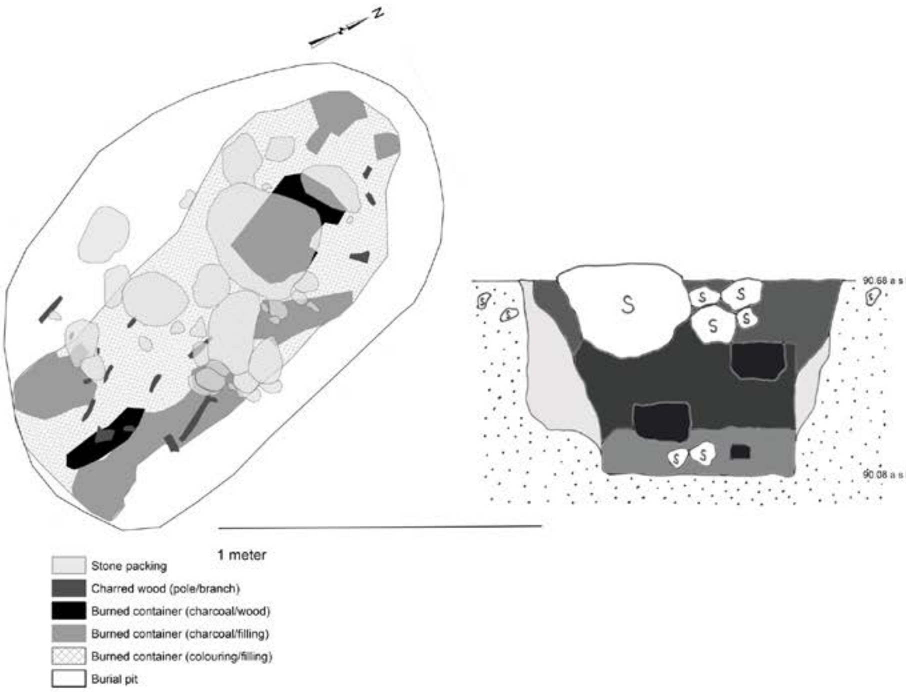

Fig. 8. Burned chamber-graves, c. 7000 cal BC, from a) Mszano, Tomb 1, and b) Strandvägen, Burial 09.

inhumation as a burial rite. Two radiocarbon dates place the burial between 7350–6450 cal BC (8890±180 BP, Gd-6432; 8680±130 BP, Gd-6436), contemporary to Burial 09 at Strandvägen.

The term *biritual* have been applied for the custom use of fire in grave pits of primary inhumation burials (Zulgostowska 2016). In the grave-chambers of Mszano both unburned and cremated bones were found, and the fillings of graves were composed of large amounts of charcoal from burned chambers and bark coffins. At Strandvägen, three Mesolithic burials contained burned bones in conjunction with primary skeletal graves, and the youngest dated burial (Burial 17) at the cemetery (c. 4000 BC) was a fully completed cremation. Additionally, charred human cranial parts was found deposited at three different locations at the water's edge of the river (Molin *et al.* 2021). Apart from Burial 09, accordingly, several facts testify to the continual (bi)ritual use of fire and burned human bones in the mortuary practices during the Late Mesolithic at Strandvägen.

Mesolithic graves as territorial markers

By studying Mesolithic burials in Poland, Zofia Sulgostowska (2016) concludes that complex grave constructions, such as the burned wooden chambers at Mszano (and Strandvägen), and multi-episodic mortuary rituals, are very rare and only appears at cemeteries important (central) for the clan territory of hunter-gatherers. Burials at such central places show traces of ceremonies rarely seen among singular Mesolithic graves outside, or on the outskirts, of lasting territories.

Based on ethnoarchaeological data, Ole Grøn (2015) are of the opinion that Mesolithic graves were made visible in the landscape and acted as territorial markers. He stresses that hunter-gatherer territoriality involved social systems that allowed groups (clans) to have control of a reasonable resource basis. It included a complex system of hard and soft boundaries relative to the right to utilise different types of resources, zones and places with rights shared with other groups, as well as negotiated exceptions from the more general rules (Grøn 2015, 236 f.). Except for graves, such territorial markers are often features, such as hearths, old tent structures, various platforms, markings in trees, and so on, with functions or meanings other than just as "markers" and serve as an indication that a group, within its territory, has been successful in negotiating its rights to utilise an area and place with the local spirits through ritual.

An important type of marker are graves of deceased clan members located at central travel corridors and/or the strategically most important places such as central settlements, or settlement zones, which would have been in use for longer periods and by larger groups (Grøn & Kuznetsov 2004; Grøn *et al.* 2008). To such places the body, or parts of a body, of a deceased after its first disposal could be transported for longer periods to reach the strategic position intended for its secondary and final disposal (Grøn 2015, 241 f.). Based on a study of Late Mesolithic burials from Denmark, Grøn argues that known graves are related either to inlets/fjords, as in important travelling routes, or located in display positions. He emphasizes that people were not always buried exactly where they lived, but rather where their graves gave meaning (as markers) within their group's territory (Grøn 2015, 243 f.).

Considering Sulgostowska and Grøns reasoning, Motala has been interpreted as a central place and focal point in Mesolithic society of eastern central Sweden (Carlsson 2008; Molin *et al.* 2014). From the geographical location, as well as the archaeological record, one could easily depict this area where Lake Vättern flows into River Motala Ström as a central assembly place.

Communications along the waterways were excellent and the local environment may be described as a meeting of several ecological niches. The first burials at Strandvägen, c. 7000 BC, could very well be perceived as territorial markers (among others), for the group of people (a clan) using the area at the new-born source of the river. The continuing tradition with depositions of human and animal remains in connection with water, strengthens that reasoning.

This also enables the argument that the region of Motala and River Motala Ström could have provided a base for a greater population density than other parts of eastern Sweden and would have meant a concentration of settlers and settlements in the area. Lars Larsson (2003, 2005) has discussed how more complex social units require clearer rules for the participants' interactions, which can be reflected in expressions of a symbolic nature, for example, in the form of decorated objects, ritual deposits, and burials (Molin *et al.* 2014; Larsson & Molin 2017; Molin *et al.* 2021). The term central place may, in this respect, be used for places where social constellations, structures, and other activities are both complex and stand out in a larger region.

Late Mesolithic settlements and ritual depositions

At 5800 BC, archaeological material accumulates *en masse* around both Kanaljorden and Strandvägen, as the water level of Lake Vättern dramatically fell, completely isolating the Kanaljorden basin. The Strandvägen basin, instead, was integrated with the river, and since then constitutes the first calm water after the first rapids of the river. This event, the second fall of Lake Vättern and the final forming of the river, c. 5800 BC, was the starting point for the large Late Mesolithic settlement in Motala, as seen at all three excavated sites. Judging by the archaeological record this settlement was initiated by intricate ritual events, both at Kanaljorden and Strandvägen.

The final lowering of Lake Vättern and the stabilizing of the river created excellent conditions for large-scale settlements. Fishing was of outmost importance as seen in comparison to many other Mesolithic inland sites (cf. Carlsson 2008, 177 f.; David *et al.* 2015; Boethius *et al.* 2017). Stable isotope analysis on human remains from Motala show a protein intake dominated by aquatic resources, probably consisting of both freshwater and marine fish in varied proportions (Eriksson *et al.* 2018). Recovered fish bones, as well as numerous finds of fishing implements, like fish-traps, show the targeted species, and the strategies chosen for catching the fish. Perch and pike dominates and in addition have bones of cyprinids, eel, smaller Salmonids, pike-perch, roach, European whitefish and burbot been identified. The identified species shows that fishing took place near the settlement, in the shallow lake at Kanaljorden, in River Motala Ström and Lake Vättern (Molin *et al.* 2018; Gummesson *et al.* 2019). Findings of more than 450 fragments of barbed points have been identified from the Motala sites, interpreted as leister points for fish-spears or harpoon heads (Gummesson & Molin 2019). Perch and cyprinids were most likely caught by net and fish traps, whereas pike and eel seem to have been the main target of the leister fishing.

Some ten post-built dwellings have been excavated at Strandvägen and Verkstadsvägen. The majority have been dated between 5600–5000 BC, and several units interpreted as contemporary to each other. All were situated along the shore of the river and in their proximity activity areas and workspaces, as well as coeval ritual remains and burials (fig. 9). Nearby the dwellings areas for cooking and storage, with outdoor hearths and cooking pits were excavated. Several adjacent areas also show identifiable knapping floors for lithics and bone craft. Knapped flint and mylonitic quartz demonstrate a devotion to a standardized production of microblades and narrow blades, which were used as insets for slotted bone points and daggers (Molin & Gummesson 2021). Several of the dwellings at Strandvägen, and possibly Verkstadsvägen, suggest a linear pattern of contemporary households along the shore of the river.

Depositions of human calvaria

This expansive phase of the Motala settlement, was initiated by large-scale ritual and ceremonial depositions in the shallow, shrinking lake at Kanaljorden and along the rivershore at Strandvägen. In the water were constructed stone-packings (fig. 10), the most monumental at Kanaljorden, measuring c. 12 x 14 m (Hallgren & Fornander 2016; Hallgren 2017; Hallgren *et al.* 2021). These stone-packings, or platforms, were used for ritual depositions, not least by human remains but also complete or decorated artefacts of bone and antler. The ritual deposits at Kanaljorden date to c. 5900–5600 BC. Human skulls were placed on top of the stone-packing, mostly in form of the calvaria. Two of the calvaria were mounted on wooden stakes when found, but others also show damage in the region of *foramen magnum*, suggesting that more skulls were originally mounted. The skulls had, in all respects, been put on display in connection with the depositions. The almost complete lack of sharp force trauma suggests that lower jaws were not forcibly removed but were already disarticulated before deposition. This could have been achieved by previous earth-burials before the final placement at the stone-packing.

The remains of at least ten individuals, nine adults and one infant, were identified at Kanaljorden (Gummesson *et al.* 2018; Hallgren *et al.* 2021). Adults have been determined through aDNA and osteological analysis and have been determined to six men and three females, aging between late teenage to c. 50 years old. Interestingly, most of the crania exhibited healed blunt force trauma, differentiated between the sexes and it has been suggested that the traumas probably were the result of interpersonal violence (Gummesson *et al.* 2018). Also, scattered bones of at least 14 animals of seven different species were recovered from the stone construction at Kanaljorden (fig. 10a). Wild boar and brown bear are the most common species, and mandibles and post-cranial bones dominate the assemblage. Only one intact cranium, a badger skull with articulated mandibles, was recovered. The element representation and observable cut marks and fresh fractures suggest manipulation and diverse handling of the animal bodies (Gummesson *et al.* 2018, 81).

The findings at the stone-packing at Kanaljorden indicate that the deposits were structured and consciously arranged. The events do not appear to be random, but rather a series of conscious choices. Human calvaria and manipulated animal bones were arranged at the platform, as well as c. 30 objects of bone and antler, among them an ornamented shaft-hole pick axe, barbed bone points and slotted points (Hallgren 2017; Hallgren *et al.* 2021).

The Mesolithic cemetery at Strandvägen consisted mostly of inhumation graves as well as deposits of disarticulated human bones of varying character (Gummesson & Molin 2016; Molin *et al.* 2021). Altogether 19 Mesolithic burials have been documented, which were located at the crest of the low hill and on the northern slope, down towards the river (fig. 9). Primary burials displayed common body positions: supine, seated, and crouched. Secondary burials were represented by pits with single disarticulated or cremated bones. Except in two cases (burials 09 and

Fig. 9. Site plan of the Late Mesolithic settlement at Strandvägen with the location of the Mesolithic cemetery and documented dwellings marked along the shore of River Motala Ström. Grey dots = ornamented leister points. White dots = ornamented bone and antler artefacts. Black dots = deposited human bones. The skulls marks deliberate deposits of human calvaria. Modified from Larsson & Molin 2017 and Molin *et al*. 2021.

17), are the burials dated to the Middle or Late Mesolithic, c. 5900–4800 BC, and are thus contemporaneous with the occupation at Strandvägen and partly with the deposits at Kanaljorden.

In the water, along the riverbed, was a stone-packing, like that of Kanaljorden, constructed (figs. 9 and 10b). Denser parts of the stone-packing show ritual deposits of complete or decorated bone and antler artefacts (Molin *et al.* 2014; Larsson & Molin 2017) and numerous finds of isolated human bones (Gummesson & Molin 2016). Most of the radiocarbon dated isolated bones correspond with the dating of the burials. A part of a tibia, however, is dated to 6090–5870 cal BC, corresponding with the deposits at Kanaljorden. Most of the loose human bones are cranial fragments and preferably from the calvaria and represents an intentional handling of disarticulated skulls for deposition or burial, just like at Kanaljorden. At Strandvägen, five such deposits have been recognized (fig. 9), containing major, though fragmented, parts of human calvaria that belonged to separate individuals (Molin *et al.* 2021). Skull deposits are present among the burials, but mostly by the water. The shoreline of the river was apparently of utmost ritual importance with skulls immersed in the water and deposited along the riverbed. However, whether the handling of the calvaria at Strandvägen included aspects of display cannot be known and no wooden stakes were found in connection to the skull fragments.

Secondary burials in water

The spatial distribution indicates that specific areas of the riverside were chosen deliberately for these depositions, and interestingly with a spatial separation of human cranial and postcranial bone elements. It has been suggested that areas with repeated depositions of disarticulated parts of several individuals might have represented places where bodies became parts of a collective context (Molin et al. 2021). The southernmost of these depositions within the excavated area consisted of seven individual human bones found in relation to two rectangular platforms (stone-packings), c. 10 x 8 m, and 7 x 5.5 m respectively (fig. 10b). Bone elements represent three parts of femur, fragments of a tibia, a part of a mandible, a cranial fragment, and a tooth, belonging to an adult individual (25-45 years of age) (Gummesson & Molin ms). Two cloven parts of the right femur was found standing vertically in the stone-packing. The handling of the bones is most striking. All long-bones, i.e. femurs and tibia, exhibits fresh fractures and are either cloven, with visible points of impact and negative flake scars, and/or with epiphyses removed. The tibia also shows deliberate cut marks. Three of the bones have been radiocarbon dated; 6799±92 BP (Ua-31390), 6565±61 BP (Ua-31391 and 6200±36 BP (Ua-57690) probably placing the deposition between 5800–5400 cal BC (2σ error).

The deposited skeletal parts speak of a deliberate dismemberment of the body and of an advanced handling of bones post-mortem. The question of (ritual) cannibalism is possible, although somewhat theoretical, and modifications of human remains are more often interpreted as defleshing or cleaning of partially skeletonized bodies, rather than cannibalistic practices. However, the frequency of cut marks is usually low, and traces of percussion damage are very rare, on human remains from secondary burial contexts (Bello *et al.* 2016, 739). The circumstance of the finds indicates that these disarticulated bones indeed are part of a secondary burial, in the form of a ritual deposition also consisting of selected animal bones and several artefacts of bone and antler.

Like at Kanaljorden human remains were deposited together with animal bones at the stone-packings (fig. 10b). By using represented species, and the depositional spatial distribution

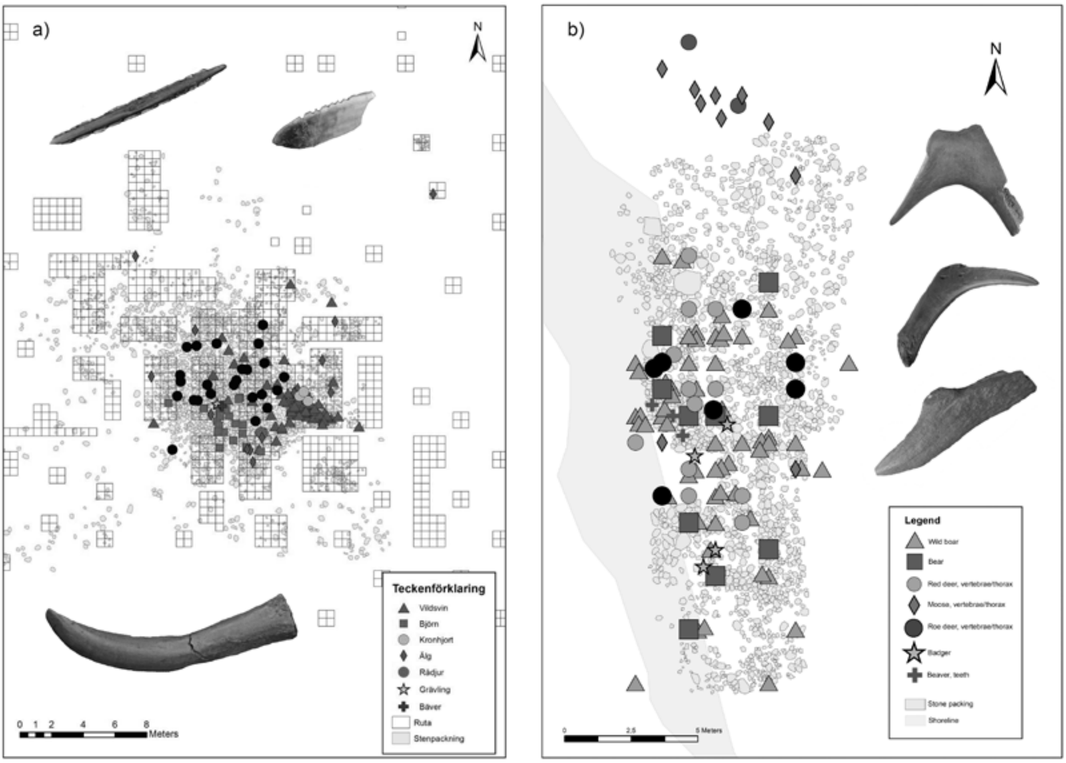

Fig. 10. Stone-packings (platforms) with ritual depositions of human and animal remains at a) Kanaljorden (modified from Hallgren *et al.* 2021), and b) Strandvägen. Black dots = human bones. Encapsulated are examples of bone and antler artefacts; a) Slotted bone point, tool made of a wild boar tusk and a pick axe with shaft-hole, b) Two picks (pick axes) from antler of red deer and an antler-adze from moose. Photo: Fredrik Hallgren, The Cultural Heritage Foundation and Peter Zetterlund, National Historical Museums.

at Kanaljorden as a key, some interesting patterns appear. Like at Kanaljorden, bones of wild boar are most numerous, and form together with human remains a 6.5 x 6 m large concentration in the southern part of the larger platform. Bone elements mainly consist of teeth and cranial parts, as well as from lower extremities, and represent waste from butchering. Interestingly, bones of wild boar mix with meat-rich parts of red deer, such as bones from vertebrae and the thoracic region, probably representing food offerings. Corresponding meat-rich parts of moose and roe deer were instead placed just north of the larger platform, indicating a spatially separate deposition. The platforms also contain all bones of badger from the excavation, in form of fragmented mandibles and long-bones, as well as several bones of brown bear. Among the latter were no less than five canine teeth. Centrally placed in the concentration were also found a few teeth of beaver.

Many artefacts of bone and antler were found in the refuse-layer around the bone deposition. Most of them were broken and discarded after usage. However, 15 artefacts in astonishing condition were found in connection with the platforms and may be interpreted as part of the ritual deposition. The artefacts consist of leister points, plain bone points, pressure flakers, burins from wild boar tusks, as well as an awl and several objects of antler. Perhaps, in terms of a secondary burial, they may constitute grave goods, although it is more likely that they have been deposited at the stone-packings over a longer period. Most striking is several objects made of antler, not least two picks (pick axes) from antler of red deer and an adze from moose (fig. 10b).

The Late Mesolithic settlement in Motala thus included a ceremonial setting where people practised advanced rituals incorporating remains from both human and parts of selected animals and artefacts. Proper burials on the other hand seem to have been placed on the south side of the river, within the Strandvägen site. Skull depositions and other disarticulated parts of bodies may be viewed as relics of deceased relatives and handled in a secondary burial ritual or be seen as trophies of defeated enemies put on display, and finally been submerged in the water (Hallgren 2017, 143; Molin *et al.* 2021).

Several radiocarbon dates show that the rituals with human and animal remains, as well as proper primary and secondary burials, both at Kanaljorden and Strandvägen, start 5900–5800 cal BC, at the very beginning of the Late Mesolithic settlement. The ritual events thus coincide with the final formation of the river and the lowering of Lake Vättern. A natural phenomenon of that scale must have had a great impact on the Mesolithic population in Motala. Also, Christina Fredengren (2015) has argued that rivers, wetlands, and lakes exhibiting important depositions may have acted as boundary makers (and markers), and thereby (as graves) have become agents in territorial struggles. Depositions at places of centrality, as in Motala, could be understood as both marking out a water boundary, and working in conjunction with that specific water landscape as a meeting place and connector between areas and communities. Intricate depositions could then operate to draw attention to these places and may have become important in negotiations of these boundaries.

Landscape change and social responsibility

Anthropological sciences have long been interested in how hunter-gatherers perceive and interact with their spatial environment (see O'Meara *et al.* 2020 for a recent overview). A somewhat underexplored aspect is how spatial phenomena are employed in reference to supernatural entities and environments. In a world populated by continually encountered spirits and deities, spatial reference and notions of place and motion have a constant supernatural dimension.

The philosopher Thomas Heyd (2008, 2018) has addressed human engagement with nature in times of rapid landscape change. He explores the relation between vulnerability to rapid change, on the one hand, and conceptions of land and responsibility for landscape, on the other. Heyd discusses the notion of vulnerability to natural phenomena, and possible ways of addressing these, and of the ways in which natural phenomena and processes have been perceived. He also takes note of the sense of responsibility toward landscape, and how this can be expressed among peoples who are deeply rooted in the land.

With support of the anthropologist Julie Cruikshank (2001, 2002), Heyd has studied cultural responses to environmental changes and phenomena. Grander elements of land, such as glaciers, lakes or rivers may be seen as entities that pay attention and respond to human behaviours, e.g. such as speaking carelessly, spilling blood, making noise etc. in their vicinity. The way of people's conceiving of all spatial characteristics ('the whole ensemble') of a certain area, made up of human and non-human beings, including grander elements, is described by the term "sentient landscapes." The notion is that the land is not just inert matter but alive, and capable of something akin to perception and action. To conceive of a stretch of land as a sentient landscape means that its diverse animate and inanimate components are not treated as mere resources (or mere obstacles, as the case may be) but, in some way, as counterparts to human beings (Heyd, 2008, 99 (also cf. Ingold 2002)).

Social responsibility arises from the social nature of all relations between humans and nonhumans, that is, animals and landscape features. This approach to landscape, of course, is common to many peoples who have deep roots in their lands, for example Alaska Tlingit, Indigenous people of the Russian North or the Inuit (Cruikshank 2001). Cruikshank (2001, 391) stresses that this local knowledge embedded in oral traditions displays commitment to an active, thoroughly positioned human subject whose behaviour is understood to have consequences. The relationship displayed in these approaches to landscape underscores the social content of the world and the importance of taking personal and collective responsibility for changes in that world. One may speak of responsibility to natural entities themselves, on the supposition that those entities may have a good of their own.

Heyd proposes (2018) that the crucial feature of the approach to landscape and the non-human beings that populate it, as exemplified by Cruikshank, consists in its characteristic conceptualization of natural entities as active and responsive. Entities may as such be potentially dangerous. Social responsibility for changes in the landscape, as described by Cruikshank, seems to arise from a combination of respects. Insofar as natural phenomena can cause us trouble, we may want to take precautionary steps, and, insofar as the natural environment is seen as constituted by entities, which are self-organized enough to resemble us in relevant ways, we may want to establish something akin to social relations with them.

Sometimes the respect generated by the recognition of the autonomy of natural phenomena may lead to more indirectly adaptive behaviours, such as the creation of myths and the establishment of taboos about occupying certain areas of the land (cf. Lowe *et al.* 2002). In those cases, the direct cultural memory of the astounding or catastrophic event may become lost but not before leading to an adaptation that exhibits respect for the natural phenomena at issue through habitual, ritual, or mythical means (Heyd 2018).

Motala Ström as a living agent

Tom Carlsson (2008) argues that water was a crucial cosmological component in the ritual manifestations by River Motala Ström. He believes that the location of the site beside a large body of water and a flowing current was doubtlessly of great significance for the choice of a place of assembly. Although the establishment of the place can be explained in terms of communication and resources, great cosmological significance ought to be ascribed to the water, in form of beliefs and actions shared by a group of people, through which the world becomes comprehensible, and which explains its creation (and phenomenon) and maintains the social order. Carlsson states that cosmological ideas cannot be regarded as merely intellectual expressions but are also closely linked to material culture. They had actual practical consequences for the people who lived their lives in a place. The cosmology made reality comprehensible, and the ritual ceremonies and depositions, dictated how people should act and accept changes in their everyday circumstances.

Water is often explained as life-giving and as an activating element and can be seen as a material agent in several various ways. It may seem important to understand the multiple sensory appeal of water and cross-cultural understandings of different waters (e.g. Strang 2008). Fredengren (2011) believes that there is a need to clarify how various waters may have provided different depositional practices, and how the different forms of water could have been used as an ally in the depositional situation. A deposition could be placed in various textures of water, e.g., still lakes or flowing waters of rivers. The distinct quality of the water would have added to the character of the deposition.

Depositions of artefacts and human or animal remains in wet contexts are often understood as sacrifices made to spirits or divine beings located in the otherworld. However, there is much to suggest that waters were observed as being alive, as immanent beings (entities), as more-than-human persons who could have received these depositions as gifts. The practice of depositing may perhaps be taken as proof that these watery environments were alive with different personhoods, and that deposited artefacts contributed to the renewal and extension of such personhood, and actually were intended for that personhood, then other humans or spirits. Such an interpretation shifts focus from mainly dealing with the deposition of the artefacts themselves or the landscape (territory) and places, towards an examination of how the water itself was understood and recognized (Fredengren 2018).

River Motala Ström may very well have been recognised by hunter-gatherers in Motala as a living presence in the water landscape, that may be captured as if the new-born river had a personality. These insights are important for shaping an 'ecological sensitivity' that can be brought to the fore by not drawing too sharp a line between living and non-living things (cf. Bennett 2010). It follows that archaeological material, like the aquatic environment, may need to be recognized as having the ability to act and be active in the formation of transversal alliances; at the same time, it was also accepted as a living entity. The personhood of the river was enhanced by the ritual deposition, through the meeting with human and animal body parts, and of meaningful objects such as bone and antler artefacts.

Therefore, a possible interpretation is that the things deposited in the river were not only intended as territorial markers or for spirits in the otherworld, but for the more-than-human person in the river itself, who also interacted in the world of the living. The deposit of human remains, and artefacts may have contributed to making the river more human, bringing the entity alive. The 'thinking through the environment' of hunter-gatherers could have perceived the living water as an agency, affecting people's thoughts and accessing, intervened, and expanding human minds, suggesting a comprehensive ontology of how relationships between humans-animals and nature were interconnected across generations of several species (cf. Fredengren 2018).

The effect of the constant movements of Lake Vättern, and the formation of the river with the possibilities that it brought, are important components in the conception of the Motala site. The long site continuity, moreover, reflects both significant long-distance contacts and the establishment of distinct local traditions. In this place, rational everyday actions were interwoven with equally rational ritual acts, and through myths, burials, and depositions (ritual props) these reflected the conceptual world of the inhabitants.

The people's cultural memory, and the mythological representation of the origin of the river, dictated the conditions for rituals necessary in negotiating and asserting the right to this place. The constancy to always relate to, was the River Motala Ström, in form of an active and present entity.

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