Pile dwellers in the Sukhona basin? Wooden structures of the 4th and 3rd millennium cal BC at Veksa, Northern Russia

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Veksa — a diachronic reference site of the NE European forest zone

The multi-period site of Veksa is a key location with regard to the cultural development of Northeastern Europe. With its extensive package of archaeological remains up to three meters thick and the good preservation of organic material especially in the lower horizons, the site enables a reference chronology to be developed for prehistoric cultures and the history of environment in north-eastern Europe that covers a time span of more than eight millennia. The unique sequence of cultural layers comprises all periods from the Early Neolithic (Ceramic Mesolithic in European terminology) of the 6th mill. cal BC through to the Medieval Period, including an extensive concentration of wooden piles and structures of the Late Neolithic (Nedomolkina 2000). Such a comprehensive series of archaeological remains encompassing a similarly large portion of the Holocene almost without any gaps is a very rare occurrence in the vast region between the Baltic and the Urals, best comparable, perhaps, to the pivotal stratified site of Rakushchechnyj Yar, southwards in the Lower Don region of southern Russia (Mazurkevich and Dolbunova 2015). Veksa represents a crucial monument in the European forest zone, and new research has now further developed its great potential for the diachronic assessment of human-environment interactions and, connected to this, of economic developments including the introduction of agriculture.

Located in the upper Sukhona basin ca. 20 km east of the provincial capital Vologda and ca. 400 km north of Moscow, Veksa is situated on an important river confluence of the Vologda and Sukhona rivers and at the same time in the vicinity of the European watershed (Figure 1, Figure 2). This favourable location was probably one of the reasons why the place had been a focal point for settlement ever since the Neolithic period. Archaeological remains extend along the left bank of River Vologda on both sides of the small tributary Veksa. The area west of the Veksa mouth is called Veksa 1, while the stretch to the east is named Veksa 3 (Figure 3). The cultural layers lie within floodplain sediments, indicating millennia of seasonal riverside settlement. The Stone Age remains are especially well preserved due to partial water-logging, they include the above-mentioned concentrations of wooden stakes, piles, and fishing baskets of the Late Stone Age directly at the river bank (Figure 4). Today this unique archaeological monument is endangered due to the ongoing erosion of the river bank, and modern investigations aim to document the wealth of culture-historical and environmental information provided by this site.

Archaeological works at Veksa started in 1981. Under the direction of Nadezhda G. Nedomolkina, archaeologist at the Vologda State Museum-Preserve, an increasing understanding of the culture-historical de-

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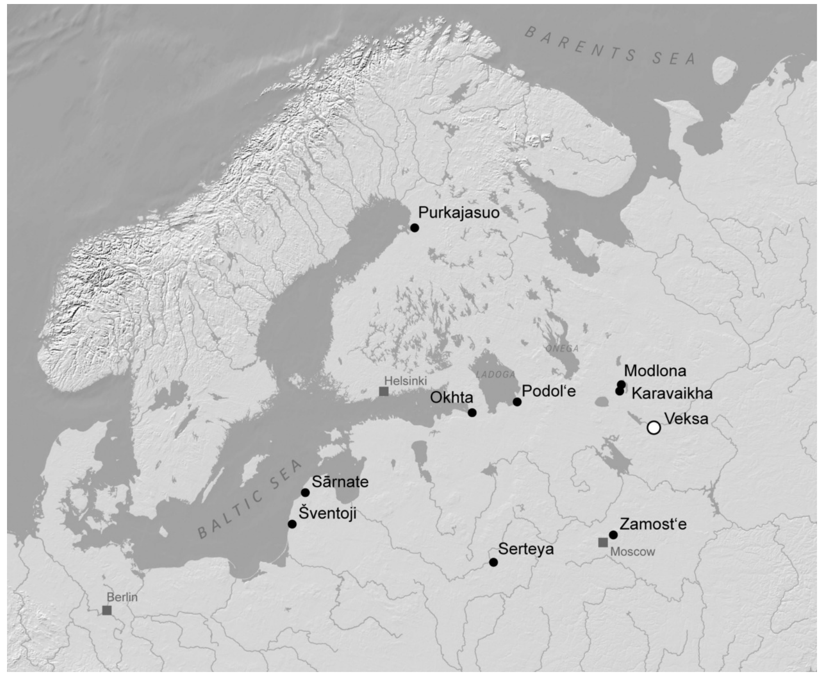


Figure 1: Veksa in NE Europe and other sites mentioned in the text. Illustration Henny Piezonka.

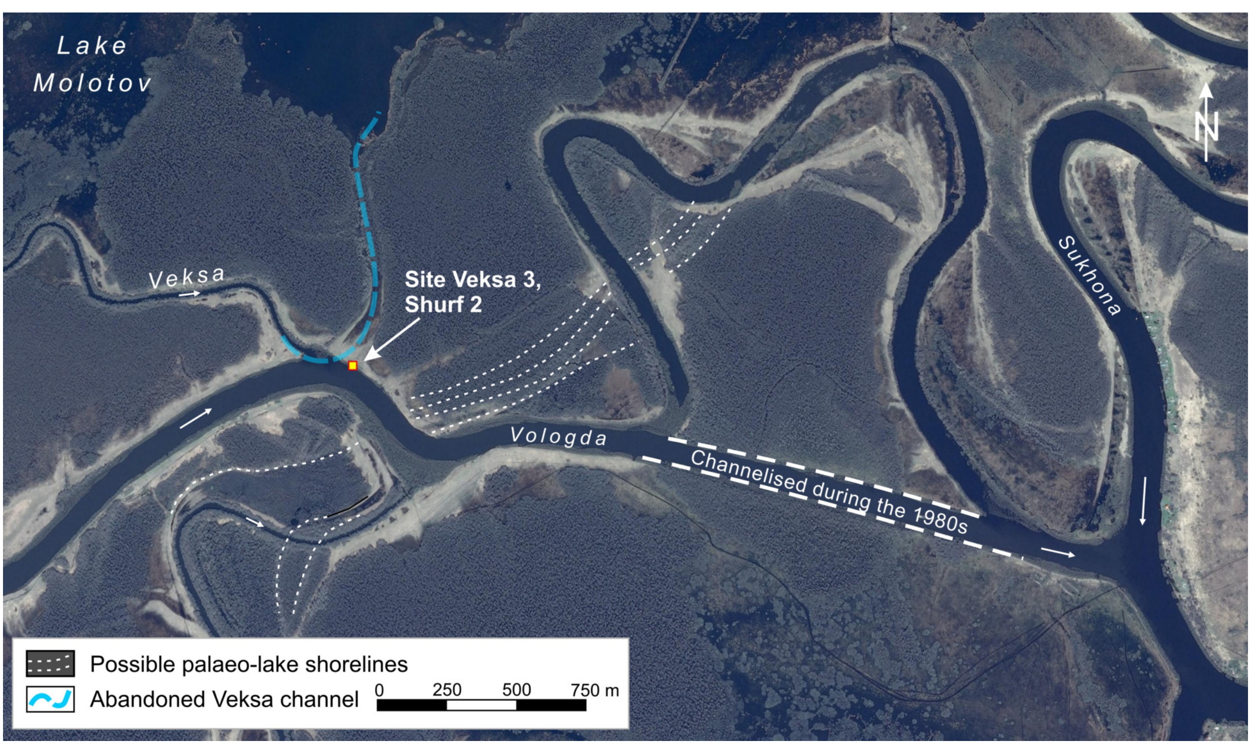


Figure 2: Satellite image of the investigation area with River Vologda and River Sukhona junction, the confluence of the small tributary Veksa as well as the southern fringe of lake Molotov. The image shows the hydrographic situation during high water levels in spring time. Illustration Sebastian Lorenz (based on Google Earth image).

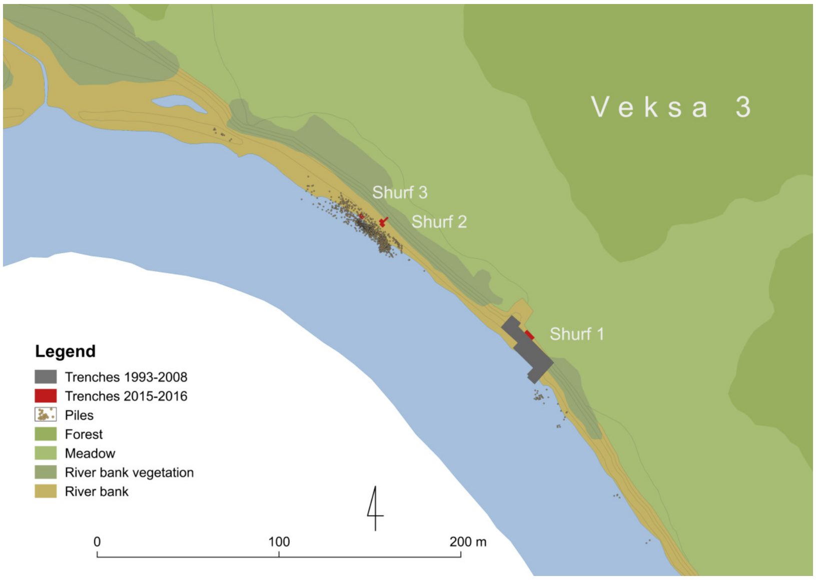


Figure 3: Veksa 3. Pile concentrations at the northern bank of Vologda River and excavation trenches. Illustration Christoph Engel.

Figure 4: Veksa 3. Main pile concentration at low water in September 2011, seen from the southeast. Photo Sebastian Lorenz.

velopments in the region has been worked out (Nedomolkina 2000; Недомолкина 2004). Since 1993, seven areas of various sizes were excavated along the river bank of Veska 1 and one area at Veksa 3, focusing on areas which were especially severely damaged by erosion. These works led to a detailed picture of the variation of the archaeological sequence and the respective cultural complexes preserved in various parts of the river bank. In years with low water levels, a concentration of well-preserved wooden piles was noted in the lower part of the bank of the River Vologda. Stratigraphical evidence as well as a conventional radiocarbon date (Le-5871, see Table 1 and Figure 10) suggested that at least part of these timbers stem from the Neolithic/Eneolithic period (Недомолкина 2004). Starting in 2007, joint Russian-German investigations have concentrated on multi-disciplinary research at the site, including geomorphological sampling, surface surveys, archaeometric analyses, and radiocarbon dating (Lorenz et al. 2012; Piezonka 2008; Недомолкина et al. 2014; Недомолкина and Пиецонка 2010). In 2015 a larger research project was granted by the German Research Foundation (DFG) to the German Archaeological Institute and later transferred to the Institute of Pre- and Protohistory at Kiel University, enabling new test trenching at the site as well as targeted research towards a diachronic assessment of human-environment interactions and palaeo-landscape reconstructions within the frames of Russian-German cooperation. A multidisciplinary approach of archaeological, geoscientific, archaeobiological, and biomolecular investigations is being employed for the first time in this region in order to reconstruct the dynamics of the environment and of land use as well as the development of economy and diet over eight millennia.

Materials and Methods

Recent fieldwork

A first joint Russian-German survey campaign at Veksa in 2011 was devoted to the creation of a digital plan of the pile concentration and to initial geomorphological drillings. Very low water levels had led again the exposure of the wooden remains, enabling the precise recording of their location on a 3D topographical plan, using a Leica TCRP 1201+ total station. In 2013, test trenches followed up the unexpected findings in the drillings of cultural layers further up to one hundred meters away from the bank of River Vologda (Lorenz et al. 2012; Недомолкина et al. 2014, 2015; Недомолкина and Пиецонка 2010). In 2014, dredging works along the River Vologda resulted in a partial disturbance and covering of the pile concentration by extracted sediments, and in 2015, the archaeology team in cooperation with members of the Vologda Diving Club conducted an underwater survey of the area to verify whether the pile settings documented in 2011 were still in place (see Figure 5). In 2015 and 2016, four test trenches (Russian: shurf) have been excavated in different sections of the river bank at Veksa 1 and 3, among which trenches 2 and 3 at Veksa 3 are relevant for the investigation of the wooden pile concentration. The excavations were supplemented by extensive series of drillings to assess the geomorphological situation on and around the site and to gain near-site pollen profiles.

Test trenches 2 and 3 at the river bank of Veksa 3

Test trench 2 was situated at the modern river bank in the area of the main concentration of wooden piles and stakes dating to the Late Neolithic/Early Metal Age transition around and just after 3000 cal BC (Piezonka et al. 2016; Недомолкина et al. 2015). In 2015, an initial area of 6 x 1 m was opened perpendicular to the river bank. Its aim was to investigate whether the pile concentration continued into the riverbank beyond its exposed portion, and if so, to document its position within the archaeological stratigraphy (Figure 5). In 2016 the trench was extended to a total of 12 square meters in order to fully excavate a large fish trap found in its south-western part (Figure 6). During the 2015 and 2016 campaigns numerous wooden remains and structures in excellent condition were found within the sediments of the river bank in trench 2, including

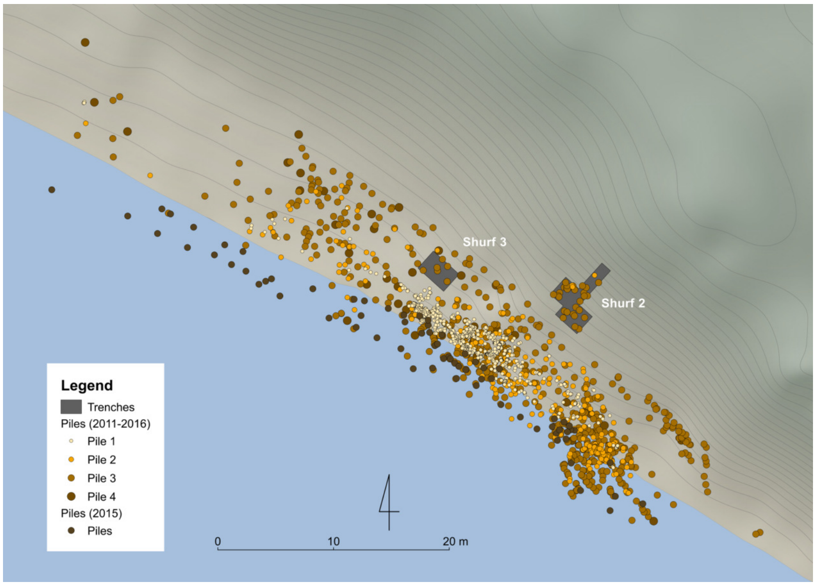


Figure 5: Veksa 3. The main pile concentration, showing four diameter classes for the piles documented in 2011 and in Trench 2, and additional piles documented by divers under water in 2015 without distinction of diameter classes. Diameter classes: 1 — 0–3 cm, 2 — 3–5 cm, 3 — 5–10 cm, 4 — 10–15 cm. Illustration Christoph Engel.

Figure 6: Veksa 3. Excavation trenches 2 and 3 seen from the river, summer 2016. Photo Nadezhda Nedomolkina.

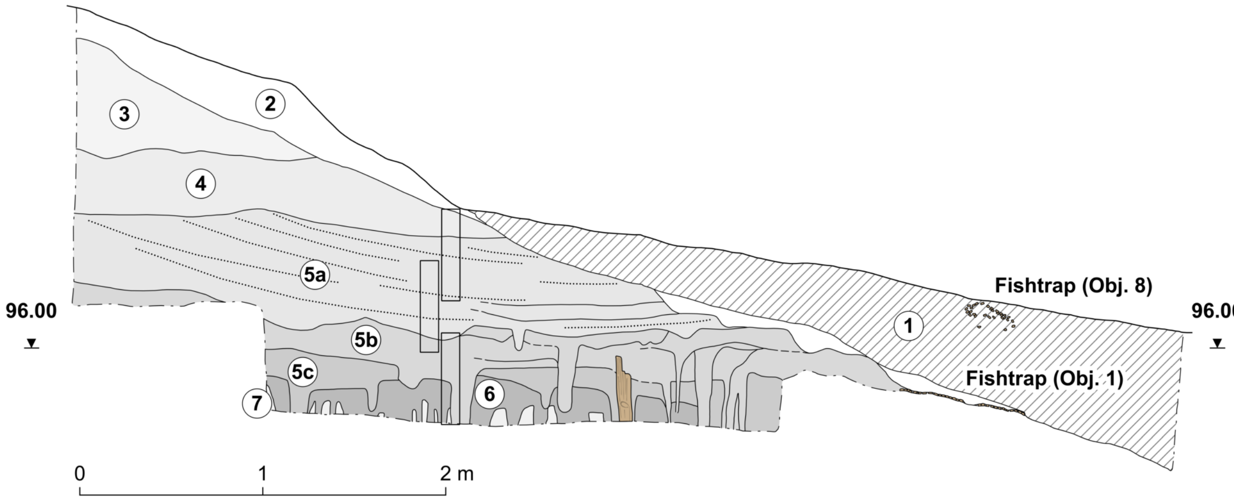


Figure 7: Veksa 3, trench 2. Eastern wall of excavation in 2015. 1 — layer 1, spoil heap of river dredging works in 2014; 2 — layer 2, topsoil before dredging works in 2014; 3 — Bronze Age layer 3 (c. 2nd half of 2nd millennium cal BC); 4 — Bronze Age layer 4 (c. 2nd half of 2nd millennium cal BC); 5a — Early Bronze Age layer 5a (c. 2nd half of 3rd millennium cal BC); 5b, c — Eneolithic layers 5 b, c, later phase of pile settings (c. 1st to 2nd quarter of 3rd millennium cal BC) with wooden post in situ; 6 — Eneolithic layer 6, early phase of pile settings (around 3000 cal BC); 7 — paleolake clay sediments layer 7; boxes: metal box soil samples; heights: relative to internal site system. Illustration Christof Engel, Henny Piezonka.

fragments of five fish traps and remains of post constructions with several upstanding posts. Approximately ten meters to the west of trench 2, another small test trench was opened in 2016 around a concentration of worked wooden battens visible on the surface (test trench 3, see Figure 5, Figure 6).

Geomorphological investigations

The general sedimentary succession for the archaeological complex of Veksa is concluded from 38 drillings reaching a depth of 4–8 m which cover an area of 10 ha from the eastern part of Veksa 1 to the west of the Veksa course to the eastern periphery of Veksa 3. The drillings extended up to 250 m north from the current northern bank of River Vologda. All 38 drillings with stratigraphical and pedological purpose were operated with percussion gaugers (60 mm and 80 mm diameter, 1 m and 2 m length, Stitz Company, Gehrden/Germany) with extension rods, gasoline percussion hammer, ball clamps, and mechanical rod pullers. Immediately after the drilling process the sediment stratigraphies were cleaned, photographed as well as described in the fields. The sedimentological and pedological documentation followed the 'Bodenkundliche Kartieranleitung, KA5' (Ad hoc AG Boden 2005), the national German mapping instructions for soils and sediments. For sedimentological and palynological analyses additional liner cores were taken at three sites in vicinity of Veksa river as well as at three sites within the adjacent Molotov palaeolake. We used a percussion piston corer with polyethylen (PE) liner tubes of 50 mm diameter with 1 m or 2 m length (Stitz Company, Gehrden/Germany). Before splitting and sampling, the cores were logged for magnetic susceptibility using a Bartington MS2C core logger. The splitted cores were photographed and sampled each centimeter. Every second sample was used for sedimentological analyses, every tenth sample for palynological investigations. Sedimentological investigations comprised car-

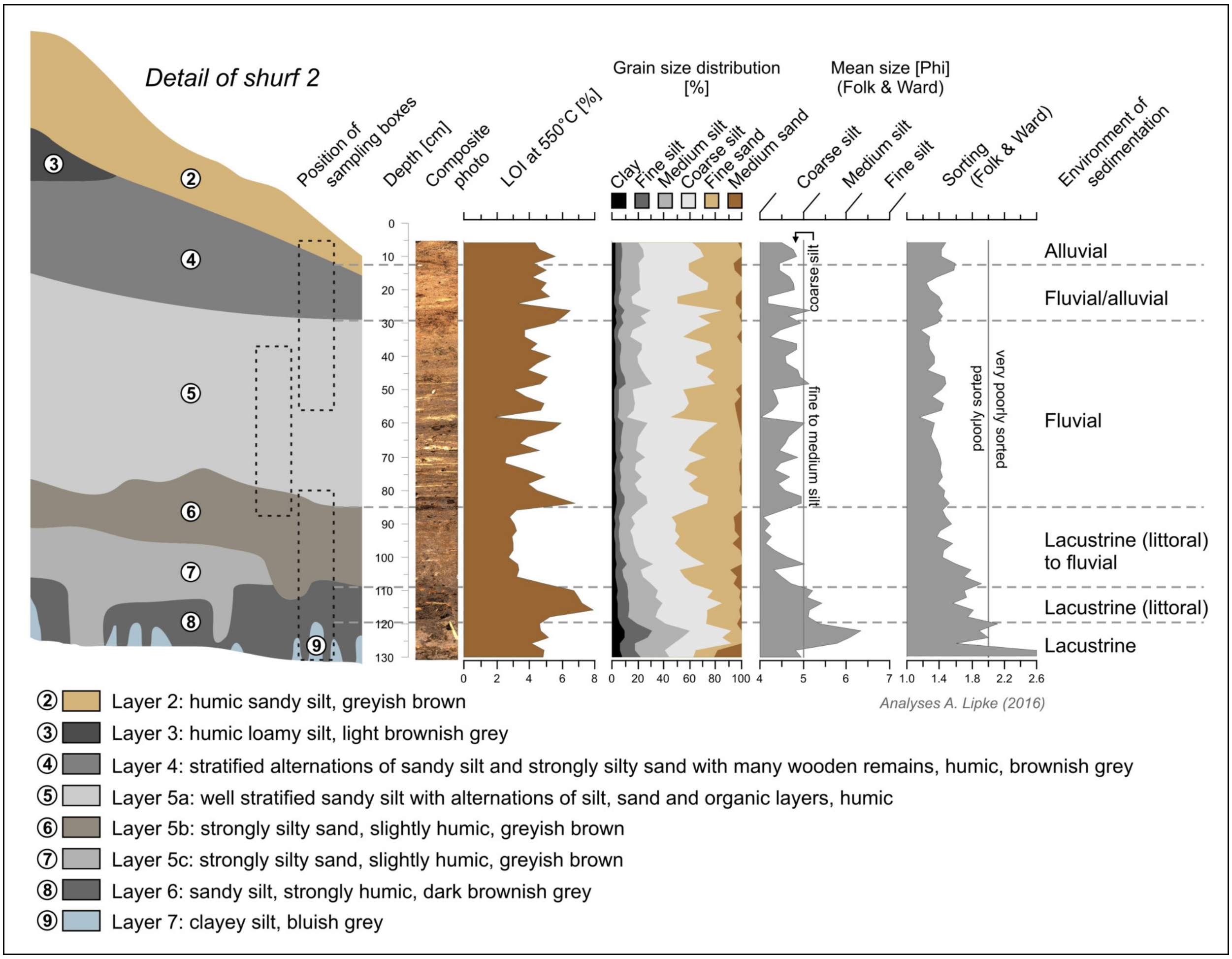
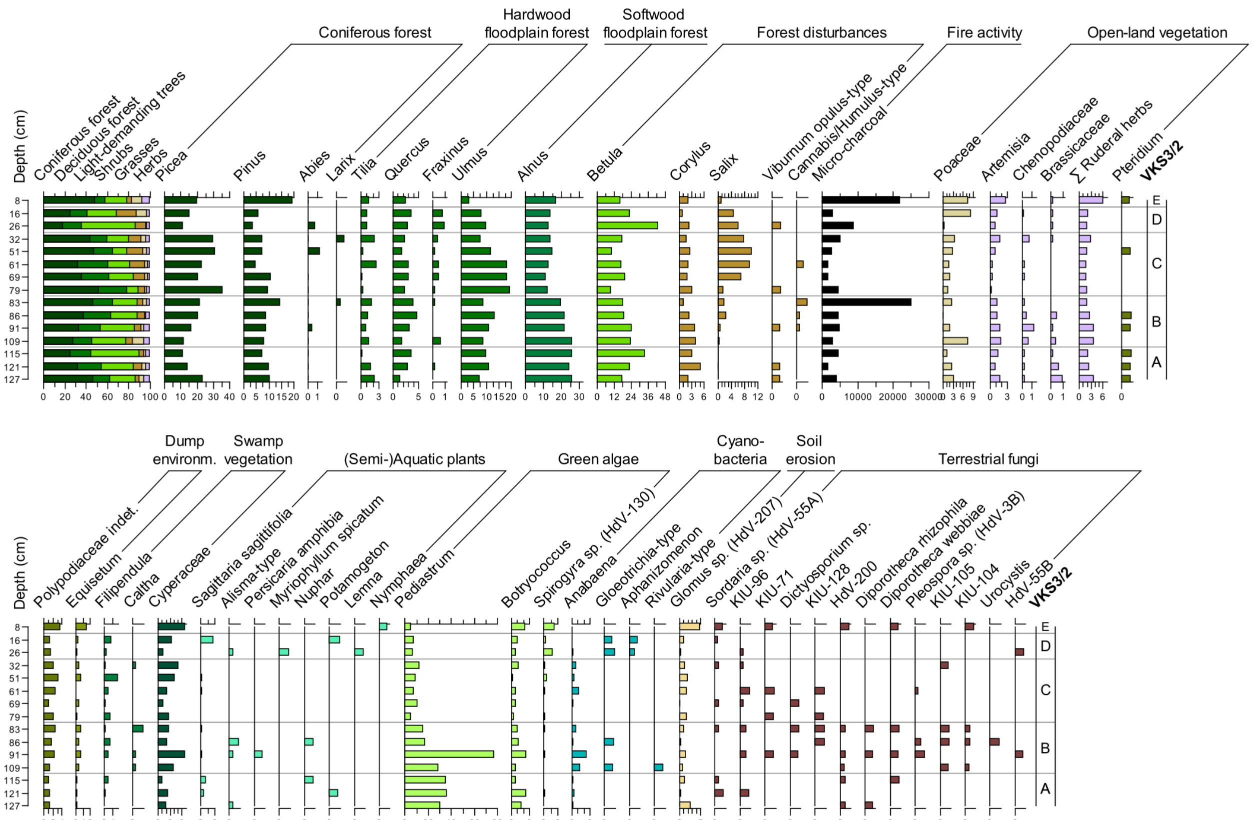


Figure 8: Veksa 3, trench 2. Stratigraphical and sedimentological units based on the analysis of the box samples (indicated by dashed lines on the profile drawing). Ilustration Sebastian Lorenz.

bon content (TOC, TIC) and grain size analyses with a laser particle sizer (FRITSCH Analysette 22 Microtec). Test trenches and archaeological excavations were sampled with self made metal sampling boxes of 15 x 15 x 45 cm size, which were hammered into the profile, afterwards released, sealed carefully and sampled with comparable procedures like done with liner cores. At the site of Veksa close to the dense occurrence of wooden posts along the river bank at area, the cliff section has been investigated by the archaeological test trench 2, and from its eastern profile, a box sample column was taken for sedimentological and archaeobotanical investigations (Figure 8; see also Figure 7). The information from the profile and the box samples was supplemented by three drillings along a transect up to 20 m from the river bank (see Figure 5).

Archaeobotanical investigations

Palynology: In the course of the Russian-German project, near-site and on-site pollen analyses have been conducted at Veksa and its vicinity for the first time. The results of the near-site core of VKS16 (a liner core extracted in the course of the geomorphological drillings) are discussed



Analysis: M. Wieckowska-Lüth (2016)

Figure 9: Veksa 3, trench 2, box samples. Simplified percentage diagram of palynological results, showing selected pollen taxa, spores, and non-pollen palynomorphs. Percentages are based on the sum of terrestrial pollen (AP+NAP) excluding wetland and aquatic pollen types. Microscopic charcoal particles are presented as black bars showing concentration in cm^3 sediment (location of box samples: see Figure 7). Graphics Magdalena Wieckowska-Lüth.

elsewhere (Kirleis et al. accepted). On-site pollen and non-pollen palynomorphs (NPP) analyses at Veksa 3, trench 2, were conducted on sediments from the box sample column cut out from the excavation profile using overlapping sample boxes (see Figure 7). Its sediment consisted of alluvial deposits. For palynological studies, fifteen sediment samples were taken at distinctive stratigraphical transitions in the profile. The samples were prepared for the analysis of pollen and NPP according to the standard techniques outlined by Moore et al. (1991). Nomenclature of pollen types follows Beug (2004) and that of spores Moore et al. (1991). NPP were identified using a reference catalogue at the University of Kiel and available literature (Hawksworth et al. 2016; Van Geel 2001; Van Geel and Aptroot 2006; Van Geel et al. 2003, 1989, 2011; Vánky 2013). Unknown NPP found in the samples are termed as 'KIU-xxx' (KIU = Kiel University). On average, 350 arboreal pollen (AP) grains per sample were counted due to low pollen concentration. The calculation of pollen percentages is based on the total terrestrial pollen sum (trees, shrubs, and dwarf-shrubs + pollen of herbaceous terrestrial plants or non-arboreal pollen [NAP], respectively), excluding wetland and aquatic pollen types. The data from the microscopic charcoal analysis are expressed as concentration per cubic centimetre of sediment. The diagram was produced with the help of the program C2 version 1.7.7 (Juggins 2014) (Figure 9).

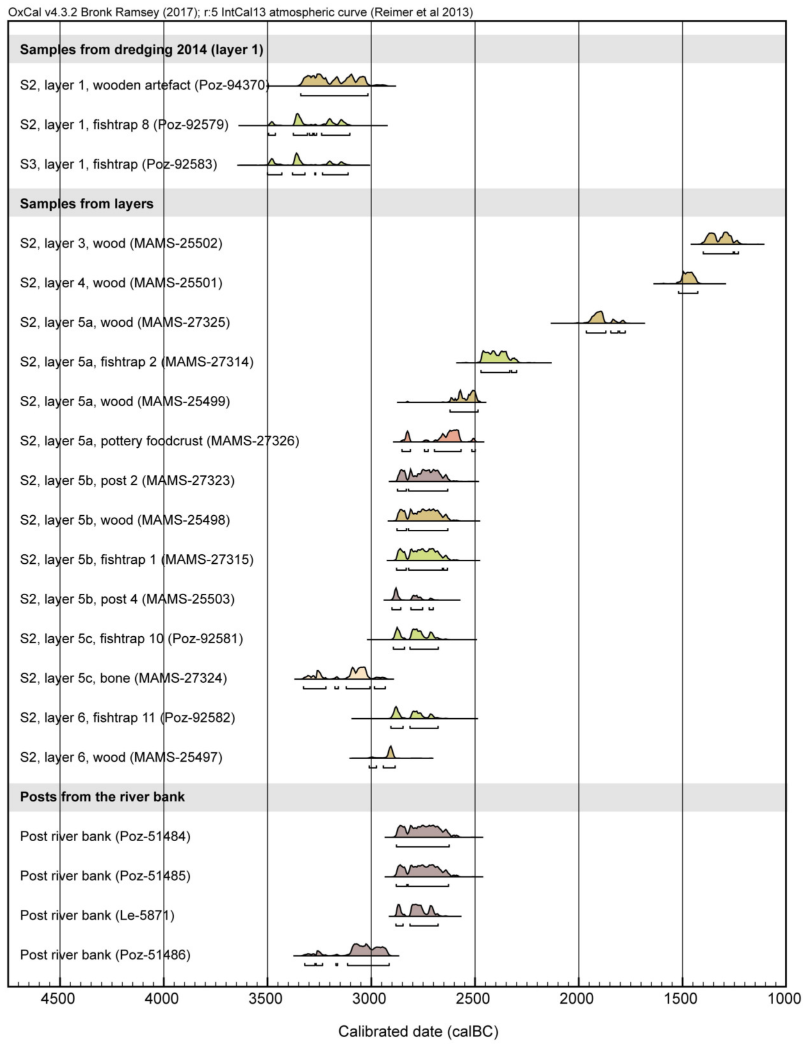


Figure 10: Veksa 3. Radiocarbon dates from the northern of River Vologda including pile concentration, trenches 2 and 3 (see also Table 1). Dark brown — posts, light brown — wood pieces, green — wood from lath screens, yellow — bone, red — foodcrust from pottery. Graphics Henny Piezonka.

Macrobotanical remains: Macrobotanical investigations on material from Veksa 3, trench 2, contribute to the reconstruction of the local environment. Eleven soil samples from the cultural layers 5a–c and 6 were investigated with respect to the content of macrobotanical remains (Table 3, see Figure 7). From the layers 5a and 6 three samples, respectively, were analysed, while four samples stem from layer 5b and one from layer 5c. Samples from layer 5a are located landwards (squares IV–VI). All other samples originate from the squares I–III closer towards the river. For analyses of the 1 mm and 0.3 mm fractions, 0.5 l of sediments were treated with the wash-over method to gain the small-seeded remains (Jacomet 2007). As bigger plant remains tend to be underrepresented in such small samples (Antolín et al. 2017), in addition 2 l of sediment were treated in the same way by use of 2 mm sieves to gain a representative number of seeds and fruits larger than 2 mm. Altogether 14.274 (0.3–1 mm) plus 3.714 (> 2 mm) water-logged plant remains (seeds, fruits, and vegetative remains) were identified. Find concentrations for remains < 1 mm reach in average 1.300 and for remains > 2 mm 34 per 0.5 l.

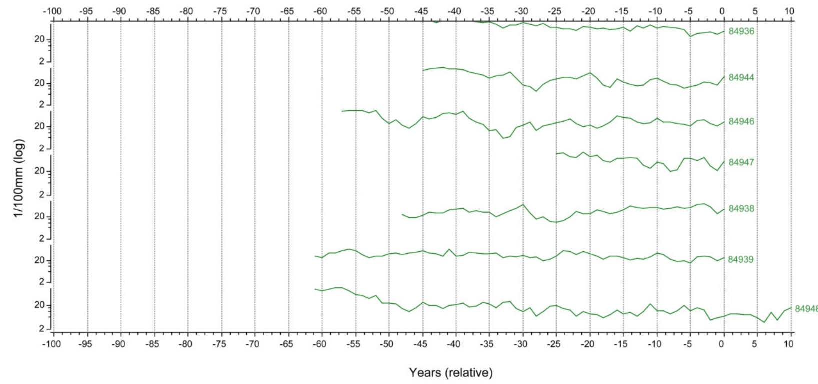


Figure 11: Veksa 3, trench 2 and adjacent riverbank. Tree ring curves of seven sampled posts from Veksa 3, see Table 2. Graphics Karl-Uwe Heußner.

Radiocarbon dating and dendrochronology

One of the main aims of the Russian-German cooperation work at Veksa was the creation of a comprehensive series of radiocarbon dates and other chronological evidence in order to better understand the temporal dimension of the cultural sequence at this site. From the riverbank at Veksa 3, a total of 21 radiocarbon dates exist now (Table 1, Figure 10). Among them are four dates on piles from the pile concentration, three of which stem from upstanding posts sampled in 2012 *in situ*. Fourteen dates come from various archaeological horizons in trench 2, among them two dates of upstanding posts, four dates on fish traps, six dates on unworked fragments of wood, one date of a bone from a large mammal, and one date on a pottery food crust. Three dates were received for samples that were found in the spoil of the dredging of the river bank in 2014 which was called layer 1 in trenches 2 and 3. Among these are two dates on fish traps and one date of a wooden artefact.

Due to the excellent state of preservation of most wooden artefacts on and in the river bank at Veksa 3, there is also good potential for dendrochronological studies. As a pilot study, 13 samples collected during the 2015 field campaign were analysed at the dendrochronological laboratory of the German Archaeological Institute in Berlin (Table 2). Ten of the samples (nos. 4–8, 10–13, Ufer 3) stem from posts that had been dislocated by the dredging works at the river bank in 2014 and were found lying on the surface of the excavated soil in the area of the post concentration. It is very likely that these posts had originally been part of the post concentration. Three samples come from the excavated layers in trench 2, two of them also from the spoil of the dredging works (layer 1, see Figure 7) and one from a post in layer 5.

Results

The development of the local environment

Geomorphological results

The archaeological complex of Veksa is situated within the wide-stretched basin of the Late Weichselian proglacial Lake Sukhona. Nowadays this basin comprises the River Sukhona, originating from Lake Kubena, the

River Vologda and beside others, the small River Veksa, which is originating from the shallow Lake Molotov which has been severely hydromeliorated since the 1980s (see Figure 2). Within the proglacial lakes several decameters of glaciolacustrine sediments, mainly clay and silt, were accumulated. A sediment core from the western fringe of Lake Molotov, which was part of Sukhona palaeo-lake, revealed 40 m of lacustrine sedimentation since the Valdaj Late Glacial (site N1: Gey et al. 2001). Due to the final decay of the glaciers, the lake levels of the proglacial lakes dropped, transforming them into several smaller lakes and exposing Late Glacial lake terraces 10–20 m above the recent basin surfaces (120–130 m a.s.l.; Kvasov 1979; Lunkka et al. 2001).

The plain surface of the Sukhona basin and its fine grained sediment inventory strongly influence the recent hydrography with low flow velocities and the suspension of enormous loads in the rivers. The humid boreal climate determines large annual water-level fluctuations of 3–4 m: During summer and autumn the river banks are exposed as 3–4 m high cliffs, while in spring time high water levels lead to extensive floodings and alluvial sedimentation in surrounding areas. The annual fluctuations of water levels as well as the alluvial sedimentation induce strong channel dynamics and have created a dense network of active rivers, backwaters, and shallow lakes (see Figure 2).

There are two fossil geomorphologic features which probably had an impact on the formation of the archaeological structures at the riverbank area of Veksa 3 in the late 4th and the 3rd millennium cal BC. The first are linear structures which probably represent fossilised beach ridges of a larger palaeo-lake phase of Lake Molotov (Figure 2, white dashed lines). In comparison to recent river channels the linear structures show clearly differing radiuses or even missing loops, which makes a lacustrine or littoral origin more probable. Secondly there is an abandoned, fossilised river channel east to River Veksa, which shows a good parabolic congruence to the present River Veksa (Figure 2, blue dashed line). Putting sedimentological and morphological evidence together, Lake Molotov developed during the gradual decay of Lake Sukhona and during the first half of the Holocene was much larger than it is today. Intense fluvial sedimentary influx and the evolving drainage system lead to a gradually diminishing in size of the lake basins, while a more hierarchic network with larger and tributary rivers developed. At some stage River Veksa came into being as an outflow of Lake Molotov, meandering at the bottom of the former Lake Molotov, but close to the larger River Vologda. Meanders of both rivers came closer to one another, until River Vologda tangentially eroded the banks of River Veksa and thus created its current confluence.

The general sedimentary succession for the site of Veksa is concluded from the 38 drillings between 4 and 8 m in depth:

1. The lowermost sediments are light to bluish clays, lacking macroscopically discernible organic remains. Only four drillings reached these sediments in more than 3.5 m depth. The clays are classified as sediments from the deeper (profundal) parts of the Late Glacial Sukhona paleolake. Gey et al. (2001, p. 1351) describe these glaciolacustrine clays with more than 14 m thickness also for the adjacent Lake Molotov.
2. Above the clays, silty silicate gyttjas with varying humic contents and light to dark grey color succeed. They occur in 2–8 m below surface,

show embeddings of sandy layers and they are rich in small wooden remains and partly also molluscs. The coarsening of the sediments is regarded as an indicator for a remarkable decline of the lake level and the diminishing lake area and volume. The organic remains point to a Holocene lacustrine sedimentation, the sandy layers to fluvial influx or lake-level fluctuations.

3. The present surfaces consist of 2–3 m thick alluvial loam, which shows intense reddish colors of hydromorphic influence and gleyic soil formation. Their origin is the annual flooding and the suspended river loads in springtime. The loamy sediments represent a fluvial drainage system at a place of former lakes. The persistent reworking and resedimentation of older (glacio)lacustrine sediments is leading to a strong similarity of younger alluvial and older lacustrine sediments. Due to intense drying during summer, the alluvial loams have a higher bulk density than the lacustrine silts. They are also lacking a discernible stratification because of bioturbation.

Despite their close spatial relation, there are distinct stratigraphical differences between the sediment layers in test trench 2 at Veksa 3 (Figure 8) and the adjacent banks of River Vologda roughly 2 m above the excavation pit. The lowermost sediments in Shurf 2 are bluish grey glaciolacustrine silts (layer 7). Their clay content of 6–9 per cent reaches maximum values for the entire profile. Its very poor sorting supports the genetical classification as a lacustrine sediment accumulated in deep water. Layer 7 is disturbed by the superimposed layers 5b, 5c, and 6, which cut as posthole fillings into the lacustrine sediments. The pronounced differences in organic carbon content (LOI) point to a hiatus between layers 6 and 7. A chronological framework is given by several ^{14}C datings (see Figure 10): layers 5c and 6 were accumulated around 3000–2650 cal BC, the top of layer 5b dates back to 2550 cal BC. Only layers 5b and 6 were covered by sedimentological sampling. Layer 6 is characterised by high (7–8 per cent), layer 5b by low but stable organic carbon contents (LOI). The loss on organic contents is accompanied by coarsening of the mean grain size (fine sand), indicating increasing sedimentation dynamics in shallow waters. The slightly better sorting also points to an increasing influence of currents and wave turbulences. A broad variety of archaeological findings as well as shape and structure of layers 5b to 6 classify these horizons as cultural layers, which formed in littoral sediments. As far as the ^{14}C ages of the (mostly wooden) archaeological finds are taken as sediment ages, a landscape of small and shallow lakes existed until ca. 2500 cal BC in the vicinity of the site of Veksa, while the lake shores were settled. Most probably the lakes were connected by rivers. Layer 5a started to form around the middle of the 3rd millennium cal BC and is characterised by a distinct change of sediments and a concave sloping stratification (see Figure 7). Numerous plant and wooden remains lead to high LOI values (6–7 per cent). Also the comparatively good sorting indicates a fluvial sedimentation environment, while the well preserved lacustrine layers underneath point to a non-erosive, but accumulating sedimentation with little or any hiatus. The mean water level is expected to have fluctuated well above the sediments. The onset of layer 4 is again distinguished by a layer rich in organic content, indicating a calm sedimentary environment of a lake or backwater. In layer 4, dating to the Bronze Age around 1500 cal BC, well stratified sediments continue bearing several larger wooden remains. Together with their horizontal alignment layer 4 is classified as partially fluvial, but mainly of alluvial origin during floodings. The uppermost layers

2 and 3 (not covered by sediment samples) represent poorly sorted allocated or colluvial floodplain sediments of the present river bank.

In summary, the Late Stone Age wooden constructions at the modern river bank at Veksa 3 were erected in slighty streaming or still waters. From a sedimentologic point of view, the post constructions and fish traps were probably placed at the diminishing Lake Molotov as well as across the evolving small River Veksa.

Palynological results

Based on the different sediment layers, five local pollen assemblage zones (VKS3/2 [Veksa 3/Trench 2] A–E) were distinguished in the pollen diagram from the stratigraphical sequence in the box sample column (Figure 9, see also Figure 7, Figure 8). The two oldest zones VKS3/2 A–B, which are encompassing the archaeological layers 6 and partly 7 (zone A) and 5b (zone B), in general display a high amount of arboreal pollen. *Alnus* (alder) is the dominant tree taxon during this time, demonstrating a softwood floodplain forest adjacent to the water body. At the same time, the presence of *Ulmus* (elm) pollen mirrors a hardwood floodplain forest on higher terraces, admixed with other broad-leaved tree taxa, such as *Quercus* (oak), *Fraxinus* (ash), and *Tilia* (lime). Conifers, such as *Picea*, *Pinus*, *Abies*, and *Larix*, are also present within the pollen record. Except for the latter, however, they probably represent the contribution of pollen transported over long-distances. Elevated amounts of *Corylus* (hazel) and *Viburnum opulus*-type (guelder-rose) may indicate small-scale openings in the forest, whereas the relatively high proportions of *Betula* (birch) reflect succession stages within the lowland woodland. In accordance with this, the occurrence of the *Humulus/Cannabis*-type, most probably representing common hop, points to open sites within the floodplain forest.

The stage represented by VKS3/2 A–B is also characterised by slightly elevated amounts of open-land indicators such as ruderal herbs, in particular *Artemisia* (mugwort), Chenopodiaceae (goosefoot family), and Brassicaeae (cabbage family) as well as the fern *Pteridium* (bracken). The values of Poaceae (grass family) fluctuates strongly, whereby the sample in the depth of 109 cm has the highest amount. Micro-charcoal is present in all samples of this section, reaching its highest quantity at 83 cm depth. During this phase, there is also evidence of pollen of littoral and aquatic plants such as *Sagittaria sagittifolia* (arrowhead), *Alisma*-type (water plantain), *Nuphar* (pond lily), *Persicaria amphibia* (water knotweed), and *Potamogeton* (pondweed) in the pollen record. The presence of those taxa indicate standing water or, respectively, low flow conditions of the water body, as high velocity in general prevent the setting up of aquatic plants. At the same time, the high amounts of green algae, in particular, *Pediastrum* and *Botryococcus* may also point to stagnant or slow-moving water, because only those habitats are important for the development of phytoplankton.

In contrast to VKS3/2 A, the following VKS3/2 B contains more evidence of pollen of swamp plants such as *Caltha* (marsh marigold), *Filipendula* (meadowsweet), and Cyperaceae (sedges) suggesting, at least temporarily, somewhat drier conditions than before. At the same time, the slight rise in the proportions of Polypodiaceae indet. (ferns) and *Equisetum* (horsetail) may demonstrate the progressive spread of terrestrial vegetation towards the water body. Contemporaneously, more frequent occurrence of ascospores of terrestrial fungi, among them decomposers (e.g. *Sordaria* sp., HdV-55B, *Dictyosporium* sp., *Pleospora* sp.), plant parasites (e.g. *Diporotheca webbiae*, *Diporotheca rhizophila*, *Urocystis* sp., HdV-200), and others (e.g. KIU-96, KIU-71, KIU-128, KIU-105, KIU-104) probably demonstrates their proliferation on dead and decaying terrestrial plant material in highly productive shallow water biotopes during periodical drying. The simultaneously elevated evidence of Cyanobacteria (*Anabaena*, *Gloeotrichia*-type, *Rivularia*-type) may be indicative of increasing water eutrophication, which could be associated with nutrient enrichment during a lowering of the water table and/or due to human activities.

In VKS3/2 C, which corresponds to archaeological layer 5a, the abundance of light-demanding woody taxa, such as *Betula* and *Corylus* decreases slightly, along with ruderal herbs and *Pteridium*, whereas the values of *Ulmus* increase visibly. This may indicate fewer open areas in the hardwood floodplain forest during this time. The values of microscopic charcoal particles also drop to some extent, pointing to decreased fire activity. Within the softwood floodplain forest, the proportion of *Alnus* diminishes, whereas the amounts of *Salix* (willow) increase significantly. This suggests the existence of frequent pioneer habitats contiguous with the water body. Open areas alongside the watercourse are also demonstrated by the presence of Cyperaceae and *Filipendula*. Such sites commonly occur during periods of high stream velocity. Changes in flow dynamics are also indicated by the disappearance of pollen of most aquatic and amphibian plants in parallel to the marked decrease in green algae and cyanobacteria. In addition, still occurring records of terrestrial fungal spores in the alluvial deposits may be associated with soil erosion processes responsible for their input to the water. In accordance with this, slightly increased finds of chlamydospores of *Glomus* sp. verifies such inputs of erosional material into water.

The following zones VKS3/2 D–E, corresponding to layers 4 and 2, respectively, are characterised by the renewed occurrence of pollen of littoral and aquatic plants such as *Sagittaria sagittifolia*, *Alisma*-type, *Nymphaea* (water lily), *Myriophyllum spicatum* (Eurasian watermilfoil), *Lemna* (duckweed), and *Potamogeton*, whereas the abundance of *Salix* diminishes gradually, indicating increasingly calm waters during this time. Shallow, stagnant water conditions are also verified by the appearance of the green alga *Spirogyra* sp. At the same time, increased proportions of cyanobacteria (*Aphanizomenon*, *Gleotrichia*-type) may be indicative of elevated levels of nutrients in the water.

Macrobotanical results

The water-logged macrobotanical plant remains from trench 2 at Veksa 3 in general represent the vegetation of the shoreline of a meso- to mainly eutrophic waterbody with its typical zonation (Table 2). Ubiquity values show a regular presence of aquatic and riverine plants as well as tall forbs. The wet grasslands and ruderals are less well represented. The vegetation complexes that connect landwards, the marginal vegetation, the local willow belt and alder carr are indicated by numerous remains. The high representation of coniferous forest shows a regional signal of alluvial allochthonous plant material. According to the macrobotanical analyses, the local vegetation indicated by the material deposited in layers 5a (lower part), 5b, 5c, and 6, can be described as vegetation on the shore of a mainly eutrophic waterbody with either stagnant or slow-flowing water. Ecological indicators show periodical flooding of the riverbank. The ruderal flora hints towards high anthropogenic impact on the vegetation, as it can be expected for a site where fishing and other human activities took place. The stratigraphical differentiation of the deposition of the cultural layer 5a if compared with 5b or 6 is hardly indicated by changes in the macrobotanical assemblage here. This is most possibly an effect that the soil samples originate from the lowermost part of layer 5a, thus representing only the onset of the changes of the waterbody towards an increased flow velocity that is detected by the sedimentological and palynological analyses. The fine layering of the sediments above, that were deposited under the highly dynamic water flow of the proceeding period were not promising to contain any seeds and fruits.

From an archaeobotanical point of view the waterlogged plant remains from this trench allow for reconstruction of the natural environment at the shoreline of the former waterfront. The macrobotanical remains indicate a nutrient rich water body, shallow water-conditions with stagnant to slow-flowing water and periodical flooding of the riverbank. A shift towards increased flow velocity is not observable here, because only the lowermost part of layer 5a was sampled due to the fact that the uppermost fine layers were not suitable for the preservation of macrobotanical remains. There is no macrobotanical indication for any dietary contribution of plants from this trench. However, some taxa identified by pollen analyses owe the potential to be used as dietary supplement, but hard evidence is missing.

Human activities at the river bank in the Late Stone Age

The pile concentration

Archaeological timbers that are upstanding in the sediment at the northern bank of the River Vologda are distributed in several clusters along a 350 m long stretch of the left river bank between the Veksa mouth and the eastern part of the Veksa 3 site (Figure 3). Neither on the water side nor on the land side the edge of the distribution has been reached during the documentation (see Figure 4). In the shallow water, numerous piles were documented, and it is very likely that many more posts and stakes are preserved under water. On the land side, the posts continue into the river bank sediments as can be seen by many examples barely exposed at the foot of the steep slope. During the initial topographical survey in 2011, four different size classes were distinguished. Altogether, a total of 1.802 piles and rods were documented, 786 with diameters between 0–3 cm, 402 with diameters of 3–5 cm, 569 with diameters of 5–10 cm, and 45 with diameters of 10–15 cm (Nedomolkina and Piezonka 2014; Недомолкина et al. 2015). In the course of the survey and excavations in 2015 and 2016, further upright timbers were found in the shallow water of River Vologda and in trench 2 (Figure 5, Figure 12). The larger posts consist of natural tree stems, in some cases with the bark still preserved, with a round cross-section. The lower ends of these posts have been pointed with axe blows

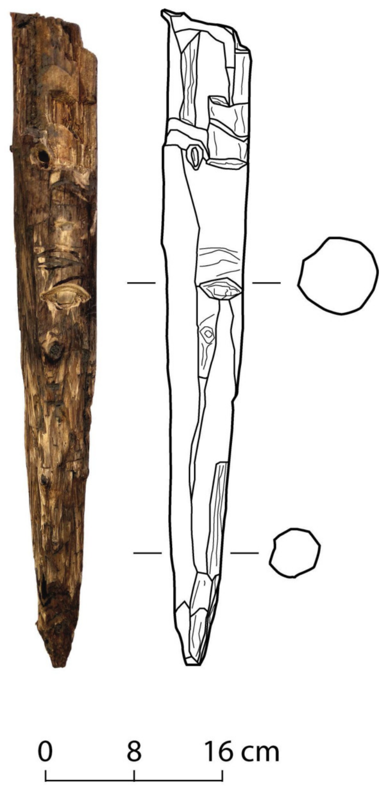


Figure 12: Veksa 3, trench 2. Pile no. 7. Photo and illustration Henny Piezonka.

(Figure 12). Most of the larger posts and stakes stand upright in the sediment, although some of them have already been washed out by the river and were found lying loosely on the ground, and the dredging works in 2014 have further disturbed and dislocated posts.

The largest concentration of piles is located c. 100 m west of the old excavation trench of Veksa 3 and covers an area of c. 65 x 10 m (Figure 5). Here, significant differences in the distribution of the four size classes were noted. The smaller rods (up to 5 cm diameter) form dense localised concentrations and are now, with the excavation results from test trench 2, understood to represent remains of fish traps and fish fences (see below). In contrast, the posts with diameters between 5 and 15 cm are distributed over larger areas and are partly arranged in straight parallel and perpendicular lines. The orientation of these structures does not exactly correspond to the course of the river but is slightly offset, indicating a change of the river course and hydrological regime since the time of building of the pile constructions, a hypothesis which is also supported by the geomorphological and archaeobotanical findings.

Test trench 2 was positioned perpendicular to the river course with the aim to clarify the character and function and the stratigraphical position of the timber structures (Figure 5–Figure 7). During the excavation, 30 further upstanding piles were found *in situ* (27 with diametres between 5–10 cm, and three measuring 3–5 cm) (Figure 5; Figure 13). All of them are associated with layers 5b, 5c or 6 (see Figure 7 for an example of the stratigraphical position of one of the piles). These three layers are also characterised by hundreds of post holes of various sizes that extend into the sediments below. From layer 6 three post holes are cutting into the subsoil (layer 7) that consists of blue clay formed in a periglacial lake during the Pleistocene/Holocene transition (Lorenz et al. 2012). Post holes originating form layers 5b and 5c partly also reach as far down as the palaeolake clay. In the two square meters of excavation squares IV and V alone, 158 post and stake holes were cutting into the clay subsoil of layer 7, alongside with 6 posts still *in situ*. This abundance of post holes in this part of the stratigraphy indicates a very dynamic use of the area by people erecting, dismantling and re-building wooden constructions. As the excel-

Figure 13: Veksa 3, trench 2. Group of upstanding piles in the northwest corner of excavation area 2016. Photo Henny Piezonka.

lent preservation of wood in these layers is proven by the *in situ* posts and other wood and plant remains, it is clear that the post holes must stem from intentionally extracted timbers and not from posts that decayed *in situ*. The results from trench 2 therefore indicate that the ca. 650 upstanding posts of the two largest diameter categories documented at the river bank represent just a very small fraction of all timbers that had been set into the ground in this area during the phase in which layers 6, 5c, and 5b accumulated. The time frame of this phase ranged, according to the radiocarbon dates, from ca. 3000 to 2600 cal BC, the period of transition from the Late Stone Age to the Early Metal Ages (Table 1, Figure 10). It is the phase when this area was characterised by shallow, probably stagnant or only slightly flowing water and by human activity in the vicinity, as indicated by the sedimentological, palynological results and by the plant macroremains. Above this horizon follow layers of river sediments that formed during the Bronze Age (layers 5a, 4, 3) which produced only a small number of archaeological finds (see Figure 7).

A total of six posts from the pile concentration have been radiocarbon dated: four upstanding posts from the riverbank, and two from test trench 2 (Table 1, Figure 10). The two posts from the trench and three of the posts from the river bank produced almost identical dates between ca. 2900 and 2600 cal BC, while one post from the river bank appears several centuries older (Poz-51486, 4410±35 BP). Very interesting results are provided by a dendrochronological pilot study during which thirteen posts from the river bank were assessed (Table 2, Figure 11). All of the samples of this pilot study stem from dislocated posts that were found in the area of the main pile concentration at Veksa 3, most of them had been disturbed by the dredging works in 2014. Their association with the main pile field can be assumed. In general, the timbers are characterised by comparatively narrow rings with small trunk diameters. In most cases the timbers have been felled after the end of the yearly growing period, only sample no. 84938 has been cut during the vegetation period. In six samples, the ring sequences were too short to be assessed. Of the remaining seven samples, six have been felled in the same year while one sample (no. 84948) as been cut ten years after the others. These results indicate that the posts at the Veksa 3 river bank bear substantial potential for dendrochronological investigations and that through a more extensive study it might be possible to identify contemporary structures within the pile field. Due to the good potential indicated by this pilot study, a larger dendrochronological analysis of *in situ* posts from Veksa 3 in association with radiocarbon dating (wiggle matching) is planned.

The lath screens

One of the outstanding results of the archaeological excavations in the trenches 2 and 3 at Veksa 3 is the discovery of the remains of six lath screens, five in trench 2, and one in trench 3 (Figure 14–Figure 23). Like the other wooden remains in this part of the river bank, the organic materials of these features are exceptionally well preserved due to waterlogging. From modern, ethnographical and archaeological comparisons it is clear that these lath screens represent parts stationary fishing equipment such as fish traps and fish fences (e.g. Koivisto and Nurminen 2015; Sirelius 1906; Lozovski et al. 2013b). Common features that all examples at Veksa share are that they consist of pine wood and that the laths have

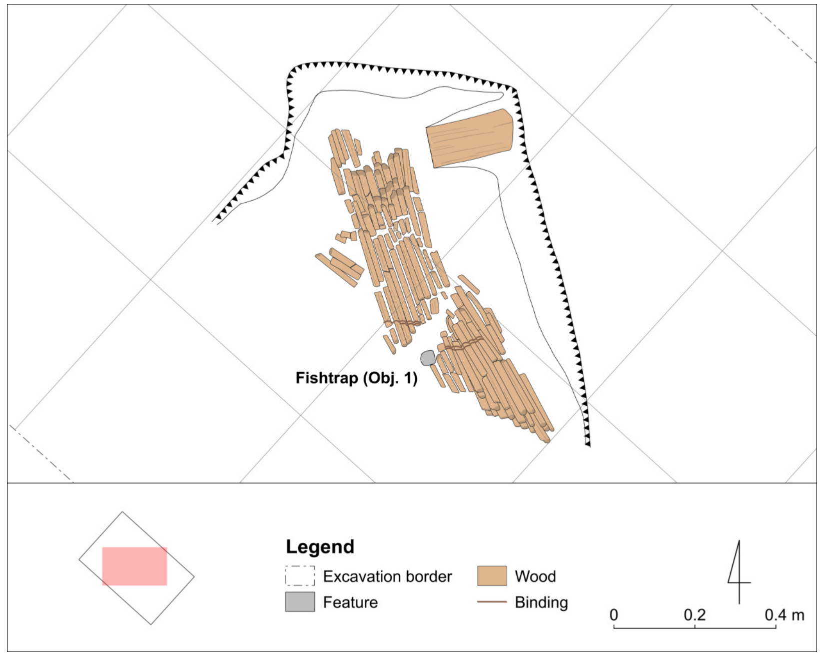


Figure 14: Veksa 3, trench 3. Fishtrap found in sediments re-deposited in 2014 during drainage works. Graphics Christoph Engel.

Figure 15: Veksa 3, trench 3. Fishtrap found in sediments re-deposited in 2014 during drainage works, seen from the east. Photo Marina Tydo.

rectangular cross sections. The lath screens excavated in test trenches 2 and 3 are associated with different layers and time periods (Figure 10, Figure 14, Figure 17).

The two oldest examples stem from the disturbed sediments that had been extracted from the river and were deposited on the riverbank during the dredging works in 2014. According to radiocarbon dates, they both stem from around 3500–3100 cal BC. Object 1 from trench 3 consists of a dense parcel of lath fragments measuring ca. 95 cm in length and ca. 27 cm in width (Figure 14–Figure 16). The laths are approximately 2 cm wide and 0.5–0.6 cm thick. This lath screen is the only one at Veksa so far where fragments of the organic binding (probably bast?) have been preserved (Figure 16). Likewise from the dredging spoil came object 8 in trench 2 (Figure 17, Figure 18, see also Figure 7 for location in the profile).

Figure 16: Veksa 3, trench 3. Detail of fish-trap with remains of organic binding. Photo Marina Tydo.

It also consists of rather substantial laths of ca. 1,5 cm wide and 0.7 cm thick and was preserved at a lengths of ca. 90 cm.

Among the stratified lath screens, the lowermost is object 11, a fragmented fishtrap made of very fine laths of only 0.5 to 0.7 mm width and 0.2 to 0.4 mm thickness (Figure 17, Figure 19). It is associated with layer 6 and has been partially destroyed by a later post hole which again illustrates the dynamics of the use of this formerly lacustrine zone. A radiocarbon date places it within the main activity phase between ca. 2900 and 2700 cal BC. An almost identical date was received for object 10 from layer 5c, another small fish trap made of thin pine laths, in this case between 0.5 and 0.7 cm wide and 0.3 to 0.4 cm thick (Figure 17, Figure 20). Its documented maximal length is ca. 40 cm, but it continues into the southwestern profile of the excavation trench.

Only marginally younger is object 1 of trench 2 which was associated with layer 5b (Figure 17, Figure 21, Figure 22, see also Figure 7 for location in the profile). This lath screen can be traced on a length of more than 3 m, at its well-preserved middle part it measures ca. 50 cm in width. It runs almost north-south and has for its size rather thin laths of about 1.3 to 1.7 cm in width and ca. 0,5 to 0.7 cm thick.

Substantially younger is object number 2, a fish trap found at the base of layer 5a which is associated with the change in the hydrological regime from lacustrine to fluvial (Figure 17, Figure 23). A radiocarbon date places this object in the third quarter of the 3rd millennium cal BC. The dimensions of the laths are similar to those of object 1. Its entire preserved length cannot be judged as the feature runs into the northwestern wall of the trench. Directly on top of it lay a long, band-shape wooden object with a carved pointed end which might have been used for fixing the fish-trap in the intended position.

In summary, the lath screens documented at the river bank at Veksa 3 belong to different types, the larger ones probably representing lath screens of fish weirs (object 1 of trench 3, objects 8 and possibly also 1 and 2 of trench 2) and the two smaller ones (objects 10 and 11 of trench 2) are probably the remains of small fish basket-like traps that might have been used in connection with fish weirs. Chronologically, the documented laths

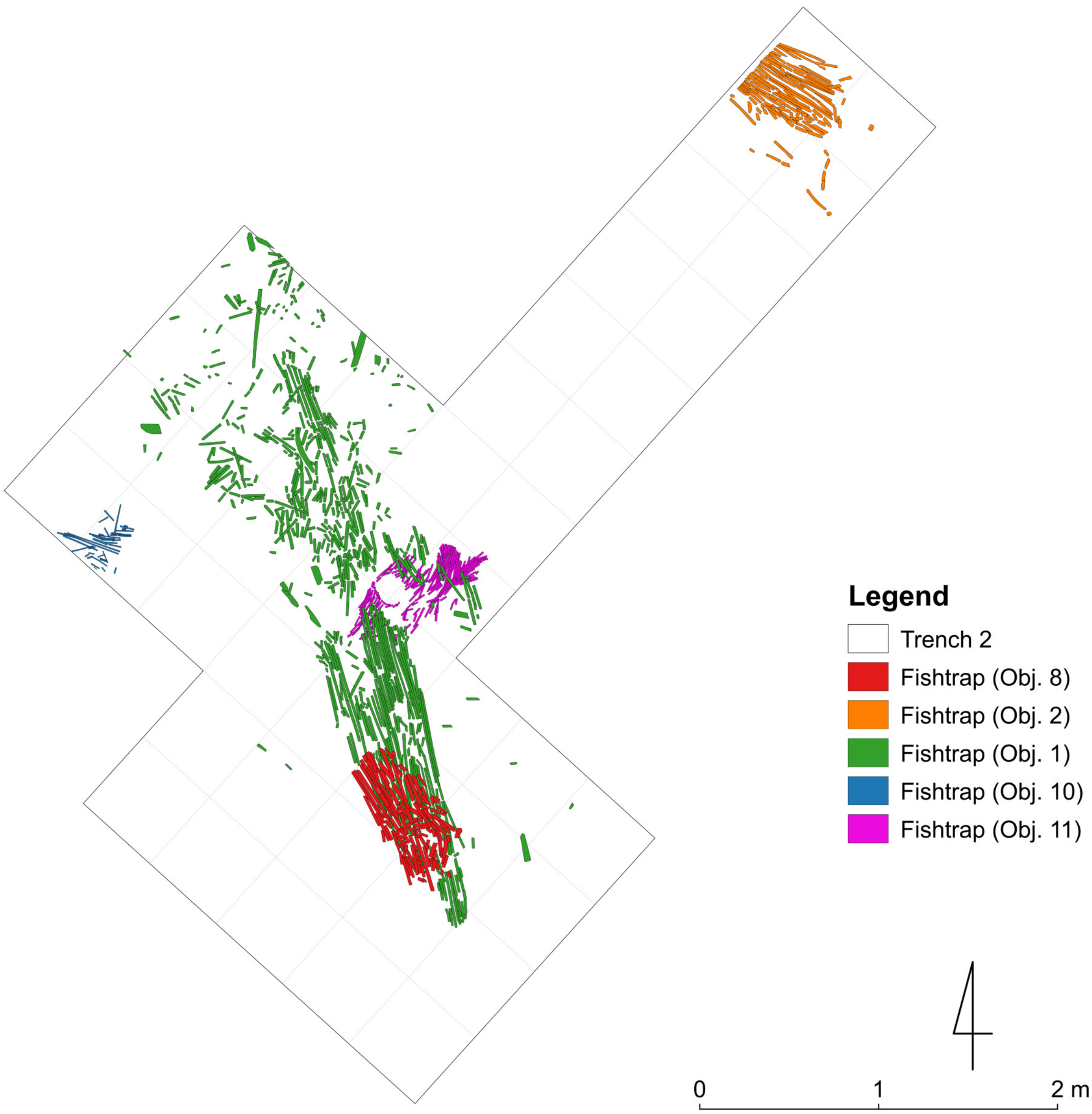


Figure 17: Veksa 3, trench 2. Overview of lath screen remains interpreted as fish traps/fish fences. Graphics Christoph Engel.

Figure 18: Veksa 3, trench 2. Fishtrap (object no. 8). Photo Marina Tydo.

Figure 19: Veksa 3, trench 2. Fishtrap (object no. 11). Photo Marina Tydo.

screens cover a period of more than thousand years, from the middle of the 4rth to the second half of the third millennium cal BC (see Figure 10).

Other finds

The find material from trench 2 is, in comparison with other excavation areas at Veksa 1 and 3, not particularily abundant, which is due to the fact that the sediments preserved here probably do not represent dwellings remains and associated cultural horizons but lacustrine and fluvial accumulations which contain artefacts deposited here mainly through the action of water. A particularity, however, is the good preservation of organic materials (bone, wood) under the prevailing waterlogged conditions. Finds from layers 6, 5c, and 5b, the horizon associated with the

Figure 20: Veksa 3, trench 2. Fishtrap (object no. 10). Photo Marina Tydo.

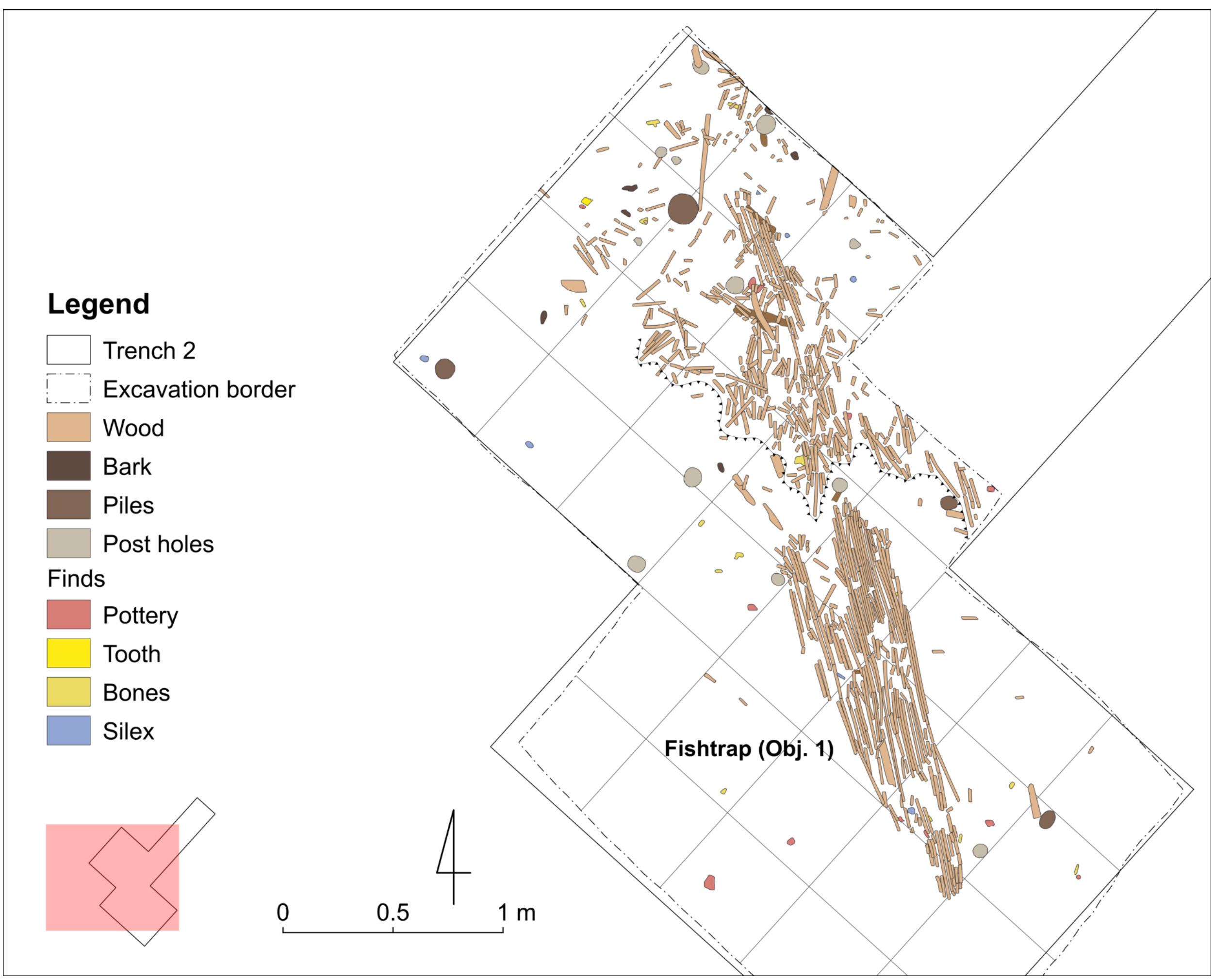


Figure 21: Veksa 3, trench 2. Fishtrap (object no. 1). Graphics Christoph Engel.

Figure 22: Veksa 3, trench 2. Fishtrap (object no. 1) seen from NNW. Photo Marina Tydo.

Figure 23: Veksa 3, trench 2. Fishtrap (object no. 2). Photo Henny Piezonka.

post and lath screen structures, include pottery (mainly organically tempered pourous ware that is typical for the Eneolitic period in the Sukhona region; Figure 24, 1–2), some bone artefacts and numerous remains of animal bone, a few worked wooden remains, and lithic artefacts. Layer 5a produced still less finds, although here, too, a worked wooden tool an some pottery have been found. Of interest is a large sherd of a ceramic vessel that is typologically linked to the Final Neolithic Fatyanovo culture pottery (Figure 24, 3). Foodcrust from the interior surface of the vessel yielded a radiocarbon date in the second quarter of the 3rd millennium cal BC (see Table 2 and Figure 10), which is in accordance with the chronological framework of the Fatyanovo culture but seems a few centuries too old according to stratigraphy. The reason for this could be a freshwater reservoir effect. From the spoil of the 2014 river dredging (layer 1), for worked wooden artefacts with oblique points have been found. All of them are broken, but on one of them it visible that the other end also had been shaped into an oblique point. Their function is unclear at the

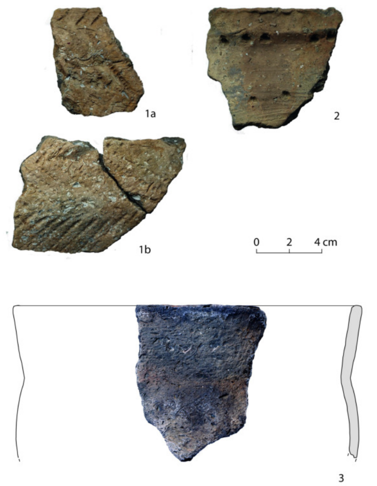


Figure 24: Veksa 3, trench 2. Pottery fragments of the Eneolithic "porous ware" from layer 5b (1–2) and of Fatyanovo type ware from layer 5a (3). Photos and illustration Henny Piezonka and Marina Tydo.

Figure 25: Veksa 3, trench 2. Four wooden artefacts found in sediments re-deposited in 2014 during drainage works. Second left: dating sample Poz-94370 (4460±35 BP). Photo Marina Tydo.

moment. A sample from one of the artefacts yielded a date in the late 4th millennium cal BC (see Table 2 and Figure 10).

Discussion

Landscape development and human impact

Central results of the palaeoenvironmental investigations at the river bank of Veksa 3 encompass the development of the landscape in the course of the Holocene and the character and intensity of human-environment interactions. A general observation concerns the substantial annual fluctuations of the water table which have affected this area over much of the Holocene period and thus have restricted the possibility of human settlement to the higher areas of the banks and terraces. Based on geomorphological assessment of the land surface in the upper Sukhona basin and the sedimentological results of drillings, we suggest here that east of the modern River Veksa, an abandoned, fossilised river channel bears witness of a former meander of the Veksa that at some stage merged with the course of River Vologda, leading to the establishment of the current Veksa mouth (see Figure 2, blue dashed line). This previous situation has probably provided the environmental background for the construction of post structures and fish traps in an area of stagnant or slowly-flowing water, which is very different from today's dynamic fluvial regime at this location.

In test trench 2, the stratigraphical sequence also shows evidence for a substantial change in the hydrological regime during the period of human use in the Late Neolithic and Early Metal Ages. The stratigraphy includes the following main phases:

1. Lacustrine sediments consisting of bluish clayey silt that represent the Late Glacial Sukhona palaeolake.
2. Littoral lacustrine sediments consisting of strongly humic silty sands that have accumulated in an area of stagnant or slowly flowing water. This phase is dated to the mid-4th to mid-3rd millennium cal BC and thus covers the Late Neolithic and Early Metal Ages. This is the period when the area was intensely used by people who erected, dismantled and rebuilt post constructions and fish traps in this shallow water area. The presence of a mainly eutrophic waterbody with either stagnant or slow-flowing shallow water as well as substantial anthropogenic influence in the vicinity are clearly indicated in the palynological record and the botanical macroremains from this horizon.
3. Fluvial and alluvial sediments consisting of stratified sandy to loamy silts which accumulated in a river bank area of a flowing water body. These sediments started to accumulate in the mid-3rd millennium cal BC and thus indicate a substantial change in the hydrological regime at this site from stagmant/slow-flowing waters to a river. This change which is also well documented in the palynological record runs concurrently with the end of the intensive human use of this place, and archaeological remains are now restricted to a few stray artefacts. In the investigated profile at trench 2, this phase is documented well into the Bronze Age up until the second half of the 2nd millennium cal BC.

Chronology

From an archaeological point of view, the thousands of man-made timbers and wooden artefacts preserved in the river bank area at Veksa 3 represent an exceptional and extremely valuable archive for the understanding of landscape use, settlement history and economy in this part of the Northeast European forest zone and beyond. These findings include hundreds of wooden posts with pointed ends that are set vertically into the sediments, and the remains of numerous lath screens interpreted as remains of fish traps and fish fences, of which six have been documented during the recent excavations.

The radiocarbon dates in connection with stratigraphical observations appear to indicate three phases of the activities connected to these structures (see Tab. 1, Fig. 10). Five dates (two lath screens, one post, one wooden artefact, and one animal bone) stem from the second half of the 4th and the very beginning of the 3rd millennium cal BC. Three of the sample have been found in the spoil of the river dredging in 2014 and it is therefore possible that sediments of this older phase have been preserved mainly further down the river bank in the modern river bed of the Vologda from where they have been extracted during the river dredging works. In the undisturbed archaeological sediments documented in trench 2, this phase is apparently not represented, as almost all dates from layers 6, 5c, and 5b belong to the first half of the 3rd millennium. The only exception is the mentioned animal bone fragment (MAMS-27324, 4436±25 BP) which falls into the early phase. As the bone belongs to a large ungulate (bovid or cervid, pers. comm. N. Benecke, German Archaeological Institute, Berlin), it is not very likely that a freshwater reservoir effect is responsible for the comparatively ancient dating result. This could only be a possibility if the bone stems from an elk, as elks can consume aquatic plants in amounts that can affect their radioccarbon age (Philippsen 2019). As the majority of the other dates from layers 6–5b stem from stationary *in situ* structures and are therefore reliably associated with this stratigraphic unit, it seems possible that the dated bone fragment could have been relocated in antiquity and might stem from the older activity phase. Chronological phase 2 encompasses the already mentioned series of dates from the layers 6, 5c, and 5b (samples from three lath screens, two posts, two unworked wood fragments), and three dates of *in situ* posts from the unexcavated parts of the pile concentration. This phase covers the period from ca. 3000 cal BC until ca. 2600 cal BC. A possible third phase of human activities in this area is indicated by the single lath screen from layer 5a which was found at the very base of this stratigraphical unit and produced a date in the third quarter of the 3rd millennium cal BC. Interestingly, this lath screen is also the one furthest up the river bank in this area, thus representing another indication of a possible horizontal stratigraphy, in which the oldest structures are located down the bank in the current river bed towards the south, and the later structures further up the bank, more towards the north. The other two dates from layer 5a stem from samples further up in the stratigraphy. While the wood sample points to a Bronze Age date for the accumulation of layer 5a, the food crust date that stems from a Fatyanovo-type pottery vessel (Fig. 24) appears older. This might be due to a freshwater reservoir effect, a problem that has been repeatedly described for the Veksa materials and other North Russian sites both in Stone Age and in modern contexts (Piezonka et al. 2016, 2017). The two dates from layers 4 and

3, respectively, are in accordance with the stratigraphical sequence and point to an accumulation of these layers in the developed Bronze Age.

The pile and lath screen structures — remains of stationary fishing gear

Apart from the determination of the chronological association and time depth of the wooden structures observed at Veksa 3, one of the main aims of the current project was the better understanding of their character and function. Both the surface survey and the test trench excavations have succeeded in creating a comprehensive picture of the structures, their spatial distribution and constructive properties.

The lath screens, of which six examples have been partially or entirely excavated, can be interpreted as remains of small fish traps (objects 10 and 11 from trench 2) and larger screens probably stemming from fish fences (objects 1 and probably 2 from trench 2, object 1 from trench 3). All six documented lath screens are made of pine wood and consist of laths with rectangular cross sections. Based on this characteristic, they belong typologically to a northeastern European tradition of prehistoric fishing constructions, while further west in the western Baltic and southern Scandinavian regions, Stone Age fish traps tend to be made from either unworked twigs or from split timbers of that have been worked to an oval or rounded cross section. The main species used in this region are hazel, viburnum, and willow (Klooß 2015a, pp. 14–22).

Lath screens of various sizes similar to those excavated in Veksa that are made from coniferous laths with rectangular cross sections are widely known from Stone Age contexts in the Eastern Baltic, Finland, and the adjacient regions of the Russian forest zone. Among the oldest and most impressive examples are the well preserved Late Mesolithic and Early Neolithic lath screens of the late 7th and 6th millennia cal BC documented during underwater excavations in the Dubna bed at Zamostje 2 in Central Russia (Lozovski et al. 2013a). Examples from the 6th millennium cal BC have also been recorded at Karavaikha in Lake Vozhe basin in northern Russia (Kosorukova et al. 2016), younger evidence of post settings and lath screens interpreted as Late Neolithic and/or Eneolithic fishing structures has been found, for example, at Okhta 1 in Saint Petersburg (Gusentsova and Sorokin 2011) and Podol'e 1 on the southern shore of Lake Ladoga (Гусенцова and Кулькова 2016). In Finland, dated examples of prehistoric lath screens from fishing devices stem from the 4th and 3rd millennia cal BC and thus from the same period as the Veksa finds; among the most important sites is Purkajasuo near the northern end of the Gulf of Bothnia (Koivisto and Nurminen, 2015). Close typological parallels of the larger lath screens found at Veksa 3 are known from the Eastern Baltic region where similar structures, even with bast binding remains (such as the ones documented at object 1 from trench 3 at Veksa 3) have been recorded in various Stone and Early Metal Age contexts at sites such as Sarnate (Latvia) and Sventoje (Lithuania) (e.g. Rimantienė 2005, pp. 71–76; Bērziņš 2008, pp. 241–250). Based on ethnographical comparisons from Latvia and Western Siberia, Valdys Bērziņš (2008, p. 246) argues that lath screens preserved as bigger packages of several layers are the remains of rolled-up screens for fish fences, and not of actual fish traps, as had

Figure 26: Tanche-Mache, Taz region, Western Siberia, Russia. Wooden posts prepared by Selkup hunter-fishers in 2001 in advance for future use in the construction of fish weirs for winter fishing. Scale: one meter between left end of thin brown pine rod in the foreground and white mark at which the north arrow points. Photo Henny Piezonka.

Figure 27: Tanche-Mache, Taz region, Western Siberia, Russia. Remains lath screen of fish fence made by Selkup hunter-fishers in 2001 for winter fishing. Photo Henny Piezonka.

sometimes been suggested earlier. This is also in accordance with our interpretation of the larger examples from Veska (see above).

Ethnographic evidence represents a valuable source for the better understanding of prehistoric fishing methods and the associated structures, and it has been repeatedly consulted for finds from northern and northeastern Europe (e.g. Bērziņš 2008; Klooß 2015a,b; Koivisto and Nurminen 2015). A very important source is the comprehensive account of weir fishing of Finno-Ugrian peoples by the Finnish scholar Uuno T. Sirelius (Sirelius 1906). For our study, the numerous examples of fish fences in Sirelius‘ work that have been constructed from rows of upright posts, lath screens fixed to the posts, and removable fish traps attached to open passages in the screens are of special interest, as such constructions could account for the archaeological evidence recorded at the river bank of Veksa 3 (e.g. Sirelius 1906, 47, Fig. 84, 67, Fig. 132a, 73, Fig. 139b).

Up until today, comparable stationary fishing constructions are being used in parts of the Western Siberian taiga. In 2016 and 2017, a winter fish fence made by the local Northern Selkup that was last used in 2001 has been recorded at the River Pokal’ky, a tributary of the River Taz in the northern taiga zone (Figure 26, Figure 27). Two factors are especially interesting in connection with the evidence from Veksa: (1) A pile of prepared pine posts that were intended for later use in the re-erection of this fish fence consists of posts almost identical to the posts recorded at Veksa, including shape and dimensions, and also the bark left in place. Timber used in Selkup dwellings, in contrast, generally have the bark stripped off. (2) Valeri Irikov, a Selkup hunter-fisher that had been involved in the building of the fence, described the construction which consisted of the above-mentioned combination of stationary post rows, lath screen fixed to them, and removable fish traps attached to the passages left open in the fence. Irikov explained that the posts were driven into the river bed at distances of two man's feet from one another in a straight line across the river — a stucture that closely resembles the rows of posts at the river bank at Veksa.

Altogether, it is likely that the majority of wooden constructions recorded at Veksa 3 represent the remains of stationary fishing constructions and not of pile dwellings or other settlement structures. Sites that are interpreted as pile dwellings, for example Modlona or Serteya II in northern and western Russia, have certain other characteristics that are not present at Veksa, such as clear ground plans of (rectangular) buildings, and the presence of floor remains, cultural layers, and waste accumulations (Mazurkevich et al. 2010; Ошибкина 1978). Also, the immense dynamic of construction and dismantling of structures that is indicated by the presumably thousands of empty post holes from which the post had been drawn out, is better explained by stationary fishing constructions that have to be repaired and renewed virtually every year, rather than by dwellings and living platforms that would be long-lived. This said, it is nonetheless possible that some of the post structures at Veksa might have served as substructions of wooden footbridges or platforms on the dynamically used shallow water area at what is now the northern bank of River Vologda.

Conclusions

Recent archaeological investigations at the northern bank of River Vologda in the area of the site Veksa 3 east of the Veksa mouth have substantially furthered our understanding of the chronology, character and functions of the wooden constructions preserved in this area and of the human-environment interactions taking place during the Late Neolithic and following periods. A multidisciplinary approach within the frames of a Russian-German research project has been successfully applied to shed more light on this key site of the northeast European forest zone.

Geomorphological and sedimentological studies have been able to reconstruct three main phases of sedimentation that are represented in the riverbank sediments, including lacustrine sediments of the Late Glacial Sukhona paleolake, followed after a hiatus by lacustrine sediments of a stagnant or slow-flowing shallow water zone in the late 4th and early 3rd millennium cal BC, which are in turn covered by fluvial sediments indicating a substantial change of the local hydrological regime towards a dynamic riverbank around the middle of the 3rd millennium cal BC. It was also shown that the current mouth of the River Veksa is probably the result of a former meander of this small river merging with the larger River Vologda.

The wooden constructions at the river bank have been investigated by surface survey and by small test trenches in several field campaigns since 2011. They encompass thousands of archaeological timbers, many of them upstanding posts with pointed ends, and several lath screens, six of which have been excavated. Radiocarbon datings place the constructions within a time frame between the second half of the 4th and the first half of the 3rd millennium cal BC. They are associated with the lacustrine, shallow water phase identified in the palaeoenvironmental studies. Based on archaeological comparisons and on ethnographic information, it is likely that these wooden structures represent the remains of stationary fishing constructions that encompass rows of piles, lath screens, and fish traps.

Future work at this exceptional archaeological assemblage will include further systematic dendrochronological investigations as well as the assessment of the faunal remains. Excavations of larger areas within and around the main pile concentration have good potential to gain further insights especially into the organic parts of the material culture of the hunter-gatherer-fisher groups of the forest zone in the Late Stone and Early Metal Ages.

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Table 1: Radiocarbon dates from Veksa 3, river bank and trenches 2 and 3.

Lab. Code	Context	Material	Age ^{14}C	Err.
Poz-51486	River bank	Wood	4410	35
Le-5871	River bank	Wood	4180	20
Poz-51485	River bank	Wood	4160	35
Poz-51484	River bank	Wood	4155	35
MAMS-25497	Qu. V, Layer 6, E profile	Wood	4308	24
Poz-92581	Qu. BII-III, Layer 6, fishtrap 11	Wood (pine)	4220	35
MAMS-27324	Qu. V, Layer 5c, bone	Bone	4436	25
Poz-92581	Qu. Z'-AII, layer 5c, wood	Wood (pine)	4200	30
MAMS-25503	Qu. IV, Layer 5b, E profile, post 4	Wood	4221	24
MAMS-27315	Qu. II, Layer 5b, fishtrap 1	Wood (pine)	4160	28
MAMS-25498	Qu. III, Layer 5b, E profile	Wood	4153	27
MAMS-27323	Qu. II, layer 5b, post 2	Wood	4149	23
MAMS-27326	Qu. VI, Layer 5a, pottery	Foodcrust	4084	24
MAMS-25499	Qu. V, Layer 5a, E profile	Wood	4039	22
MAMS-27314	Qu. VI, Layer 5a, fishtrap 2	Wood (pine)	3910	28
MAMS-27325	Qu. 5, Layer 5a, wood	Wood	3553	23
MAMS-25501	Qu. VI, Layer 4, E profile	Wood	3207	24
MAMS-25502	Qu. VI, Layer 3, E profile	Wood	3052	23
Poz-92583	Shurf 3, Layer 1, fishtrap	Wood (pine)	4585	35
Poz-92579	Qu. CI-II, Layer 1, fishtrap 8	Wood (pine)	4570	35
Poz-94370	Qu. DII, Layer 1, wooden artefact	Wood	4460	35

Table 2: Results of dendrochronological pilot study of posts from Veksa 3.

Lab. No.	Wood species	Internal sample no.	Start	End	Felling	Notes
C			Relative date			
84936	Coniferous wood	1 (Bagger 3)	-45	0	0	Dull edge
84937	Coniferous wood	2	?	-	-	No date
84938	Coniferous wood	3 (2 I)	-48	0	1	Summer dull edge
84939	Coniferous wood	4	61	0	0	Dull edge
84940	Coniferous wood	5	?	-	-	Too short (13 rings)
84941	Coniferous wood	6	?	-	-	Too short (30 rings)
84942	Coniferous wood	7	?	-	-	Irregular
84943	Coniferous wood	8	?	-	-	Too short (31 rings)
84944	Coniferous wood	10	-45	0	0	Dull edge
84945	Alder	11	?	-	-	Too short
84946	Coniferous wood	12	-57	0	0	Dull edge
84947	Coniferous wood	13	-24	0	0	Dull edge
84948	Coniferous wood	Ufer 3	-61	10	10	Dull edge

Table 3: Absolute numbers of waterlogged plant remains (0.3-1 mm fraction) from Veksa 3, trench 2. x = present in the fraction 2 mm.

Sample numbers	**8, 11, 16**	**17, 162, 165-167**	**169-171**
Square	**VI**	**IV, Z III, B I-II, A III**	**B III, A II-III**
Cultural layer	**5a**	**5b,c**	**6**
Volume (Litres)	**0.5**	**0.5**	**0.5**
Aquatic plants			
Nuphar lutea	x	x	-
Potamogeton cf. *gramineus*	1	-	-
Potamogeton lucens	2	5	3
Potamogeton cf. *natans*	2	5	3
Potamogeton pectinatus	-	6	2
Potamogeton cf. *perfoliatus*	10	9	3
Potamogeton praelongus	-	1	1
Potamogeton spec.	9	8	4
(Herbal) Riverine vegetation			
Alisma spec.	173	39	26
Bidens tripartia	11	3	1
Butomus umbellatus	-	3	1
cf. *Carduus crispus*	2	-	-
Chenopodium album	66	28	37
Chenopodium glaucum/rubrum	22	144	172
Chenopodium spec.	x	-	6
Eleocharis palustris	26	13	21
Lycopus europeaus	2	-	-
Mentha aquatica	79	113	40
Oenanthe aquatica	219	189	58
Persicaria maculosa	18	15	9
Persicaria lapathifolium	28	50	18
Ranunculus sceleratus	2	-	-
Rumex maritimus	9	55	33
Sagittaria sagittifolia	68	130	159
Schoenoplectus lacustris	-	-	1
Schoenoplectus spec.	x	-	-
Solanum dulcamara	10	2	-
Tall forbs and marginal vegetation			
Filipendula ulmaria	141	104	15
Galeopsis spec.	2	-	1
Galium spec.	2	1	-
Stachys spec.	16	4	4
Thalictrum flavum	109	37	9
Urtica diocia	15	42	21
Wet grassland vegetation			
Carex (2) spec.	690	454	155
Carex (3) spec.	4	-	3
cf. *Cirsium palustre*	-	1	1
Cirsium spec.	-	3	-
Potentilla palustris	16	-	-
Potentilla spec.	2	-	2
Ranunculus acris	2	x	-
Ranunculus repens	2	-	-
Ranunculus spec.	82	9	1
Rumex crispus	-	5	3
Scirpus sylvaticus	5	-	-
cf. *Scirpus*	-	x	-
Silene flos-cuculi	5	-	3
Ruderal vegetation			
Fallopia convolvulus	2	-	-
Galium spurium	8	-	-
Plantago major	2	26	6
Polygonum aviculare	2	-	-
Solanum nigrum	-	3	1
Sonchus arvensis	-	-	1
Urtica urens	-	7	-

Sample numbers	8, 11, 16	17, 162, 165-167	169-171
Square	**VI**	**IV, Z III, B I-II, A III**	**B III, A II-III**
Cultural layer	**5a**	**5b,c**	**6**
Volume (Litres)	**0.5**	**0.5**	**0.5**
Deciduous forest (incl. shrubs and herbs)			
Alnus glutinosa	263	250	17
Alnus incana	282	545	27
Fragaria vesca	-	3	-
cf. *Fragaria*	6	-	-
Prunus padus	x	x	x
Rhamnus frangula (modern?)	x	-	-
Rosa spec.	-	1	1
Rubus fruticosus agg.	-	2	1
Rubus ideaus	x	3	-
Rubus spec.	2	-	-
Salix spec. (fruit capsule+A22)	16	922	293
Tilia cordata	3	-	-
Viburnum opulus	2	-	-
Coniferous forest (incl. shrubs)			
Betula spec.	52	97	79
Picea abies	9	32	18
Vaccinum myrtillus	5	-	3
Indeterminable			
Apiaceae	-	-	2
Asteraceae	-	4	2
Caryophyllaceae	2	-	-
Cyperaceae	8	4	5
Lamiaceae	2	2	2
Poaceae (small-grained)	-	8	-
Polygonaceae	-	-	3
Vegetative remains			
Alnus spec. (fruit scale)	x	3	1
Betula pendula (fruit scale)	4	3	2
Betula spec. (male inflorescence)	-	x	-
Picea abies (needle fragment)	2726	2493	110
Picea abies (fruit scale)	2	-	-
Picea abies (seed wing)+A74	4	4	2
cf. *Picea abies* (cone)	x	-	-
cf. *Picea abies* (cone scale)	x	x	-
Vegetative remains	10	21	4
Bud	151	38	14
Bud scale	1161	51	33
Leaf /bud	64	107	13
Miscellaneous			
Varia	2	x	-
Indet.	14	38	17
Sum	**6656**	**6145**	**1473**

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