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Front cover: Gathering plant foods on the Mesolithic river-dune site at Yangtze Harbour, the Netherlands. Artwork by Martin Valkhoff, Rotterdam.
Back cover: (left) The transverse section through the rhizome of the bracken fern (Pteridium aquilinum) showing parenchyma cells packed with starch granules (polarised light microscope) (photo: Lucy Kubiak-Martens); (right) Sarcocephalus latifolius.(photo: Mathieu Grèye).

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Dedication

Lydia Zapata Peña

(June 1965–January 2015)

We dedicate this book to the memory of Lydia Zapata. Lydia was an archaeobotanist who achieved much in her life. She received her PhD in 1999 on *Plant Resource Exploitation and the Origins of Agriculture in the Basque Country through the Analysis of Plant Macroremains* at the University of the Basque Country which showed the importance of plants amongst prehistoric communities of northern Iberia. Her research on prehistoric plant use through the analysis of both wood charcoal and seeds established the bases for the development of archaeobotany in the Iberian Peninsula and more specifically in the Basque Country. Throughout her career, Lydia explored not only agrarian communities but also Epipaleolithic and Palaeolithic groups. Her interrupted work in her dear Balzola, Basque Country, highlights her capacity for undertaking extraordinary research. She was also very interested in ethnography and her work comprised studies of hulled wheat growers, plant gatherers and producers of wood charcoal.

Lydia had recently been awarded a highly prestigious ERC (European Research Council) grant for her project 'Paleoplant', an investigation into the use of plants by Palaeolithic and Mesolithic populations in Iberia and North Africa. Though Lydia's untimely death prevented completion of this project some of the research she initiated is being realised. We hope that Lydia's vision and her optimism, enthusiasm and extraordinary capacity for engaging people, will serve as an inspiration and will encourage new researchers to follow in Lydia's footsteps and work towards a better understanding of the use of plants by the pre-agrarian people of the past.

Leonor Peña-Chocarro

Vladimir Lozovski (May 1968–July 2015). As the book was going to press, we heard that Vladimir had passed away. His work at the outstanding site of Zamostje is well known and the chapter he has co-authored in this book will form part of the extended bibliography which demonstrates his lifelong dedication to that site.

13. Prehistoric fish traps and fishing structures from Zamostje 2, Russian European Plain: archaeological and ethnographical contexts

Ignacio Clemente Conte, Vladimir M. Lozovski, Ermengol Gassiot Ballbè, Andrey N. Mazurkevich, and Olga V. Lozovskaya

Fish traps and nets documented ethnographically on the Russian European Plain and in Siberia are described and compared with similar archaeological finds from the north and north-west of Russia and the Baltic States of Latvia and Lithuania. We analyse the features they have in common in order to interpret the fishing structures from Zamostje 2. The site has yielded occupation levels covering the transition from the Mesolithic to the Early and Middle Neolithic. A comparative study of the fish remains from Zamostje 2 and modern species in the Volga and Oka river basins suggests that the greatest diversity of species (11) is found in the earliest Mesolithic level, with only six species recorded for the Late Mesolithic and Early Neolithic. The number of individuals caught also varies over time, with a steady increase in the capture of cyprinids, which is particularly striking in the last phases of the occupation. Wooden artefacts connected with fishing demonstrate a high level of technological expertise while the finds of several possible paddle fragments and one whole paddle confirm the use of boats.

Thirteen sites have been identified along a 2 km stretch of the Dubna River. The sites lie on what is today, the banks of the river which runs through a broad alluvial plain of lacustrine origin. The sites are located in the village of Zamostje, 50 km north of the city of Sergiev Posad and 110 km from Moscow (Fig. 13.1). Archaeological excavations at Zamostje 2 (1989–1991; 1995–2000; 2010–2013) extended along a 160 m^2 stretch of the west river bank and 190 m^2 in an area that is today, underwater (Lozovski *et al.* 2013). Altogether the excavations covered an area of 40 × 4–5 m.

The archaeological occupations are located in a sedimentary sequence that is directly associated with the lakeside context and evidence for fluctuations in water levels. The two oldest layers, 'LL' and 'UL', are Late Mesolithic and date to 7900–7600 uncal BP and 7400–7100 uncal BP (7000–6600 cal BC and 6400–6000 cal BC). They are separated by a level of peat that has a significantly lower density of archaeological remains. Above this, two layers, 'EN' (Upper Volga culture = UVC) and 'MN' (Lialovo culture), have been interpreted as Neolithic due to the presence of pottery. The first of these occupation horizons (UVC) coincides with a warm period; it is dated to 6800–6200 uncal BP (5800–5200 cal BC) and is considered to be Early Neolithic. The second occupation horizon dates to approximately 5700 uncal BP (*c.* 4900–4300 cal BC) and took place

Fig. 13.1. Location map of Zamostje 2

during a period of lakeside soil formation amid receding water levels (Lozovskaya *et al.* 2013; Lozovski *et al.* 2014). There are few archaeological remains dating to the Late Neolithic, possibly because they were destroyed by the large transgression which occurred towards the end of the 4th millennium BC, which signaled the final abandonment of the site (Lozovski 1996; 1997).

Following analysis of the fishbone assemblage (Radu, Desse-Berset 2012; 2013; Lozovski *et al.* 2013), a comparative study was conducted between the modern fish species from the Volga and Oka rivers with those exploited during the Mesolithic and Neolithic. The most numerous range of species identified occurred during the Early Mesolithic (11 species); in the Late Mesolithic and Early Neolithic only six species were identified, while seven species were identified towards the end of the site's occupation. The following species were present in all of the excavated layers: *Carassius carassius*

(crucian carp), *Exos lucius* (pike), *Leuciscus idus* (ide), *Perca fluviatalis* (perch), and *Rutilus rutilus (roach)*. The quantity of fish caught also changes to a certain extent over time; most notable is the increasing evidence for cyprinids (carps), in particular towards the end of the occupation. This may be related to an increased use of nets (either with or without boats), which would permit greater numbers of fish to be caught in less time. Analysis of bone size suggests that pike were caught in the year following their birth, and mostly in the spring, which also coincides with the spawning season.

There is a small amount of evidence for human action on the bones, though little evidence for contact with fire; this occurs on only around 0.5% of all identified bones. Most of the evidence for human activity was found on pike bones, but even here there are no cut marks. There was proportionally less evidence for certain bones, in particular vertebrates of large individuals. It is possible that these were preserved whole for consumption at a later date. Tools for skinning and cleaning fish were identified, which suggest activities related to preservation, either through drying or smoking. They include knives manufactured from elk rib bones; these all have use wear traces that are identical to those on the experimental tools (Clemente *et al.* 2002; Clemente and Gyria 2003; García and Clemente 2011) and which also correspond with ethnographic tools documented across Siberia (Fig. 13.2).

We have also investigated the possibility that specific tool types or activities were linked to fish species and we have begun a series of experiments to determine whether the harpoons and hooks found at Zamostje 2 were in fact used or not (Clemente *et al.* 2013; Gyria *et al.* 2013; Maigrot *et al.* 2014a; 2014b). Other material linked to fishing found at Zamostje 2 include fish-screens, fish-fences, wooden fish traps, and needles, which were used for mending nets, several small fibre knots which may have formed part of a net, and pine bark floats. Several possible fragments of paddle, as well as one whole paddle were also recovered, confirming the use of the river, presumably for transport as well as fishing (Figs 13.2–13.6).

In this chapter, we will describe the artefacts used in construction of the stationary fish traps at Zamostje 2. First, however, we will contextualize these structures by comparing them to other archaeological traps found in the region. We will describe these, and we will also outline the ethnographic record for fish traps in the European part of Russia and Siberia (Lozovski 1997; 1999).

Ethnographic sources for the use of fences and enclosed traps for fishing in the Russian Plain and Siberia

Ethnographically, the use of fish traps, manufactured both in stone and a wide variety of wood, is common in the Russian Plain and Siberia. Zelenin writes that fish traps were

> made from thin twigs or nets. They were constructed of two cones, a smaller one which is inserted into a larger one though there are many variations both on materials used to construct them and on the structures themselves. In some cases they were made from willow slats … In the north of Russia, the fishermen would cover the inside surface with bait … but the most common way was to construct a fence in the river with an 'opening' in the centre where they would place the bait … (Zelenin, 1991, 103)

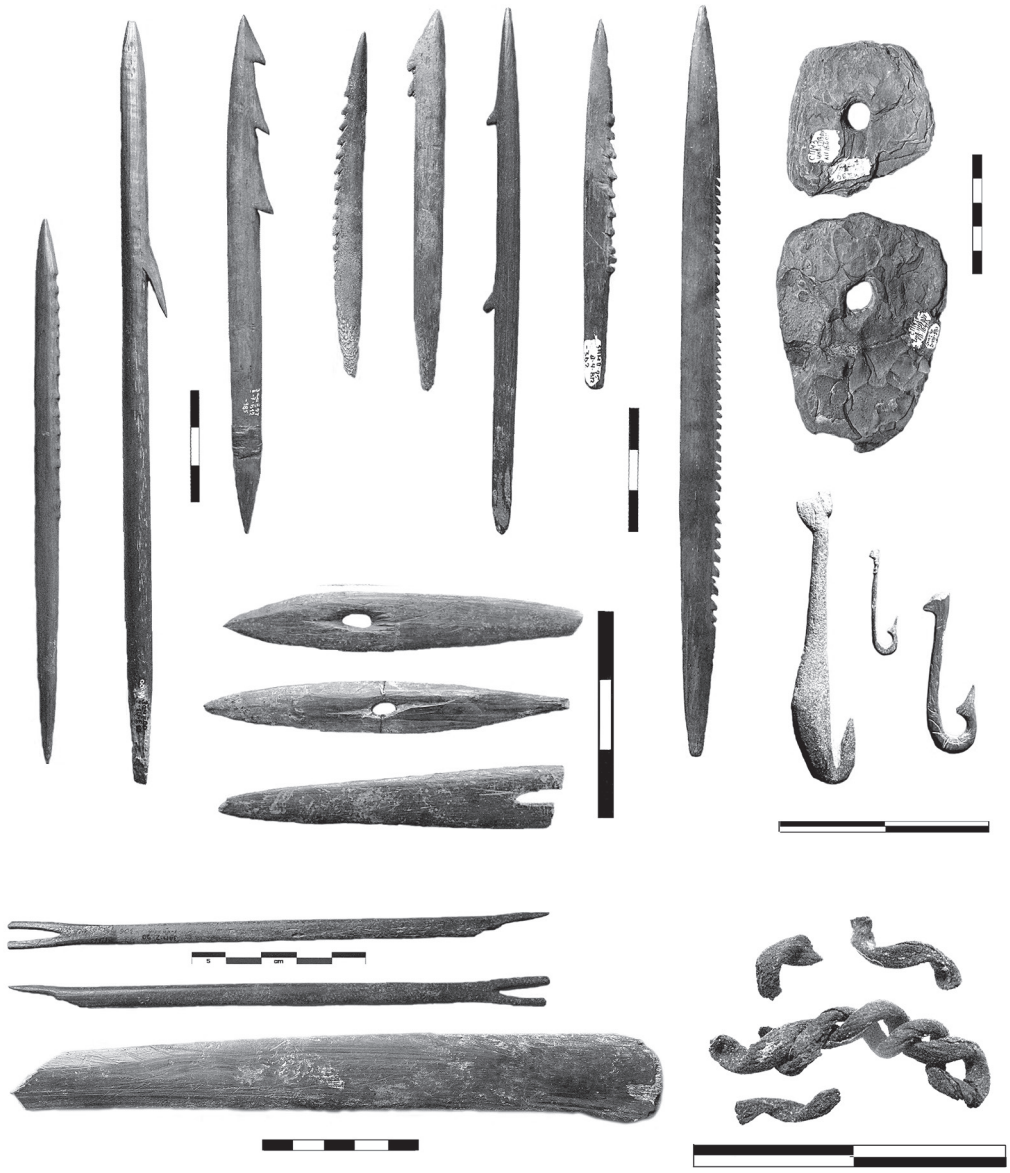

Fig. 13.2. Tools from Zamostje 2 for fishing and processing fish

The exterior opening was either square or oval. Ethnographic accounts suggest that thin branches (willow, elm, etc) were used in their construction. In some cases, slats were used, for example among the Korjaki of Siberia (Tolstov 1956). At the end of the 19th and early 20th centuries, the Comí (a Finno-Ugrian population), used pieces of pine 0.4–0.7 m long (Kondakov 1983) to construct their fish traps. All the ethnographic

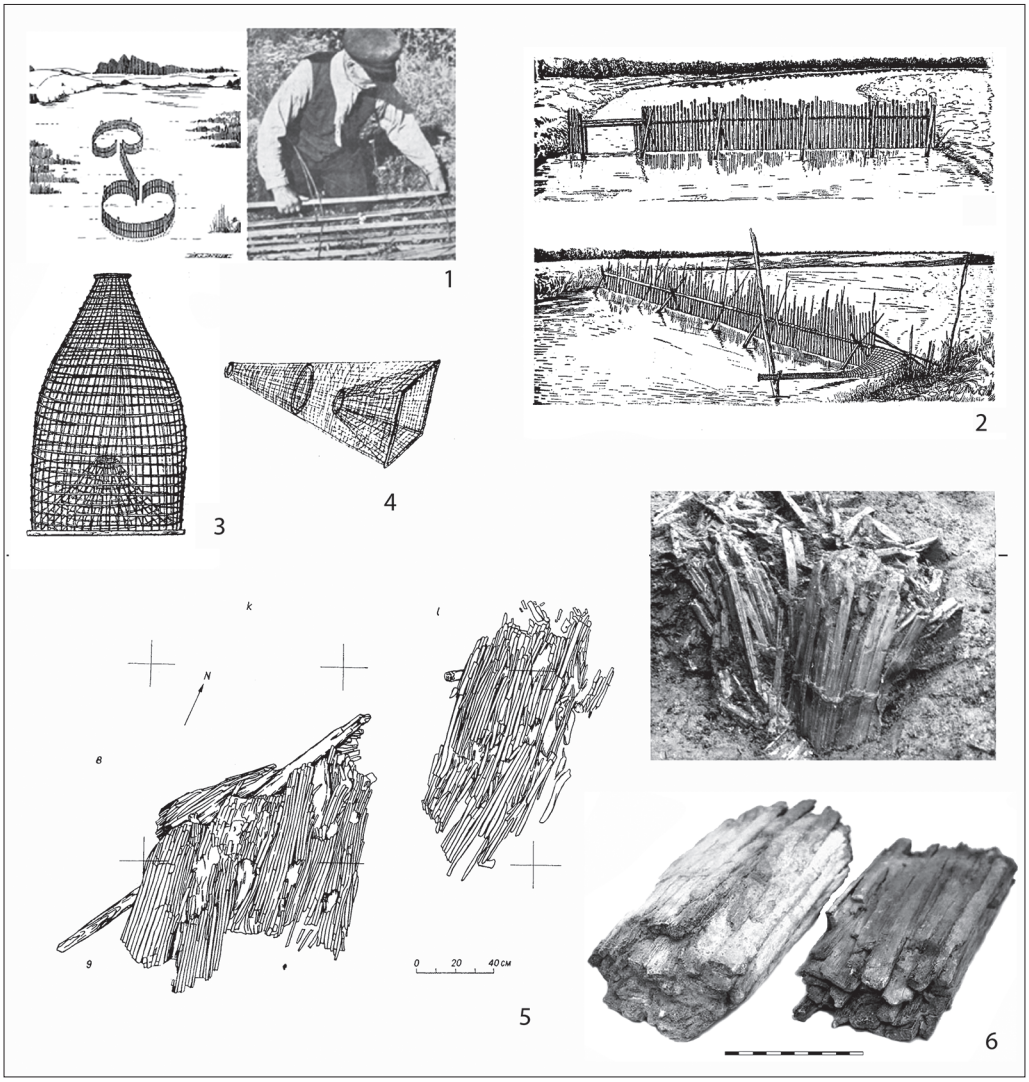

Fig. 13.3. 1) Ethnographic evidence for the use and placement of fences and traps in Latvia (Berzins 2008); 2–3) fish traps from Siberia (Tolstov 1956); 4) fish trap from northern Siberia (Zelenin 1991); 5) remains of fish traps from the Terminal Neolithic at Abora (Loze 1979); 6) archaeological remains related to fishing from the Neolithic site of Sarnate (Berzins 2008)

sources that describe the manufacture and use of fish traps, explain that it is necessary to build a fence, (or dam) using logs, posts and stakes that stretches across the width of the river, or, in the case of lakes, near the shore (Fig. 13.3).

Zelenin (1991) distinguishes two structures that were used across Siberia; 1) light structures made using thin reeds or sticks; 2) larger, stronger structures that were

made using heavy posts. These larger structures could be left in place and were able to survive the spring melts. The Tartars from western Siberia built small fences across rivers using thick branches tied together with string or cords**.** At one edge, near the bank, they would leave a hole into which they inserted the traps (Tolstov 1956). Stakes were hammered into the river bed to hold the fences and traps in place. Fish traps, made from small branches, were inserted into the openings that had been left in the fences for the purpose. These fish traps were used even in winter (Tolstov 1956). Even more common were structures made out of two parallel lines of stakes, hammered into the river bed and filled with sticks and small branches. These were widely used by the Comí, the Uragiri and the Korjaki people (Tolstov 1956) and also in the Ivanovo region, Central Russia (Krajnov 1991).

In some cases, these fences or dams were built using different materials. The Tuva used stones to fill the gaps between the lines of posts (Tolstov 1956). In other cases, different fishing structures were constructed. For example the Ob Ugrians built barriers made solely out of small sticks and twigs; as the fish tried to swim through, they became caught amongst the branches (Vasil'ev 1962). These were exceptions though; most Siberian people, including western Siberian Komes, Shrotses, Selkups, Kets, Evenks, Tartars, Nentser, Ukagirs, Koryals etc., used the more usual method of damming the river and placing fish traps in the openings they had left in the dams. The placing of these fish traps was not always the same; sometimes they were in the middle of the structure (for example among the Russian and Koriak populations) in other cases, they were placed near the shore (Khants, West Siberian Tartars). However, all the traps were secured by stakes hammered into the river beds or were held in place by being weighted down with stones.

Archaeological fish traps from Russia and the Baltic regions

Latvia

Zvidze is a Neolithic site on the edge of Lake Lubans, in east Latvia. This site is located on the edge of a rolling plain that gradually drops down to the lowlands on the western side of the ancient Lake Lubans. The site is dated to between 7565–7170 cal BP (5876–4810 cal BC) which corresponds with the Early Neolithic. The remains of the fish fences were found at a depth of 1.2 m in a stratum of decomposing organic sediment; these had been dug into an Earlier Neolithic layer (post-hole with charcoal) to 60 cm depth. The fish fence was 6 m from the ancient edge of the marshy Lake Zvidze. Loze (1986) describes the remains of the fish traps and fence found here and suggests that the structure stretched along tens of metres following the shoreline of the lake; he suggests it was used in spring during the pike spawning season. The fence was constructed using vertical and horizontal posts. Fish traps, made from pine and willow, were attached to both sides of the fence. The frame of the fence comprised three rows of posts vertically hammered into the lake bed. The diameter of the posts was 5–8 cm.

Loze believes that the two lines of posts were the walls of the fence and that the third line supported the completed construction. Between the lines of posts, four layers of large posts, made from elm and willow were inserted and slats and bundles of twigs were placed at a slight angle. The remains of nets and hooks were also found in amongst the posts. The preservation of the fish traps was uneven and appeared in the archaeological deposits as concentrations of wooden slats. Four traps were identified though only one was in good condition. This fish trap was in two pieces, possibly representing the area around the wide opening of the trap. The large fragment consisted of a main body, made of slats with an inner funnel made of small branches, 1–2 cm in diameter.

The fish trap was formed with ten rows of slats and an inner row constructed of sticks. The outer layer of slats overlay the perpendicular line of sticks. The sticks were 1–2 cm in diameter, and with a rectangular or square cross-section. A large number of pike vertebrae and mandibles were found between the rows of sticks. In one trap, the bones of up to 16 pike were recorded (Loze 1986).

Another site is Sarnate, which is situated in western Latvia, around 2.5 km from the Baltic Sea. This site was first excavated between 1938 and 1940 by E. Shturms. After a temporary interruption during WWII, the History Museum of Lithuania and the Institute of History of the Lithuanian Academy of Sciences, took over the investigations which were directed by L. V. Vankina in 1949 and between 1953–1959. Forty dwellings were identified, 25 of these classified as *sarnatski*' type and dated to the 3rd millennium BC. A large number of well-crafted wooden items were recovered including construction materials and six fish traps. The traps were made of slats 1–2 cm wide and 0.5 cm deep. Only two fish traps were well preserved. One of these, with 2.5 m long slats, was located near one of the houses. The slats were attached together with fibres in three different places. The fish traps were conical; the narrow end containing straps while the opening was located at the wider end. The second trap, which was found beside the first one, was broken in two. On the larger fragment, a thin band of fibres joined the slats together in two places. The trap appears to have had two walls – an outer wall with larger slats and an inner layer made out of thinner sticks – these walls were bound together with cords (Vankina 1970).

Fish traps have also been found in Abora, a site in Eastern Latvia which was excavated by Loze between 1964–1971. This site was located in the right bank of the Abora River in the lowlands of Lubans. Radiocarbon dates place the site in the Late Neolithic (4510–4010 cal BP and 4530–3980 cal BP)[2] (3870±70 BP, LE-671; 3860±100 BP, LE-749) (2561–2141 cal BC; 2581–2017 cal BC) (Loze 1979). The remains of three fish traps were found in peaty, decaying, organic deposits at a depth of 1 m. Three bundles of sticks were tied together. The first measured 0.80–1.15 m. long, and consisted of three layers of slats and a post, 1.88 m long, which was attached. This trap was found beside fragments of other traps. Each trap was held together by cords which were between 13–18 cm apart. The remains of the other two traps were found to the east of the first trap and measured 1.5 × 0.75 m and 0.6 × 0.5 m respectively. The traps also had various attached slats and pieces of wood. It has been suggested that these three traps formed part of a large structure and that, at some point after abandonment of the site they fell off (Loze 1979).

Lithuania

The fishing-related finds from Šventoji (Shvjantoji) were mainly found in sites excavated by R. K. Rimantene near Shvjantoji in the Baltic coast where Neolithic and Early Bronze Age sites were located on the shores of a lake or sea lagoon (Rimantene 1979; 1992). The remains of the fish traps were divided into two groups: 1) Fish traps made of 2–3 cm pine slats tied with cord. These objects were made with a narrow end which closed with a lid; 2) fish traps made from nets attached to a wooden frame. The first type is found in the Early Neolithic of Shvjantoji 2^{b}, in this case the narrow end of the trap had a lid that was 10 cm in diameter. In Shvjantoji 1^{a} (Late Neolithic–Early Bronze Age) a fence had been constructed within the site and the remains of three fish traps were found near this. One trap measured 80 cm long and 20 cm wide; it was built in two layers within which were flat pebbles, 5cm in diameter that may have acted as a means for closing the ends of the basket. The other two objects were not well preserved but appeared similar to this (Rimantene 1991). A further fishing fence was identified in a stream that connected the lake to the sea at Shvjantoji 9 (Late Neolithic–Early Bronze Age). This fence measured about 40 m, and was constructed in the form of an arc. It began on the north shore of the old channel and stretched into the centre of the stream. Several holes were located in the centre of the fence, which is where the baskets would have been placed. The fence was constructed out of two rows of stakes driven into the stream bed. The stakes were near each other and were more abundant in the middle than at the edge of the structure. The area between the rows of stakes was filled with large pieces of bark. The stakes, which were 8–10 cm in diameter, measured 1.20–1.47 m in length; however, the tops of the stakes were all at exactly the same level. To improve the secure fixing of the stakes, these were attached with cross-pieces held in place by planks which measured 2.60 m. Near the central openings of the system, several bundles of sticks were found with some transverse small branches attached, which may also have been part of the fish traps. Two examples of a second type of trap were recovered from the site of Shvjantoji 2B. The frames that held the mouth of the traps were constructed using small branches that were 1.5 cm thick. The net was made of fibres tied with a 'fisherman's knot' to the wooden frame (Rimantene 1980).

The north part of European Russia

Vis 2 is situated in the Vichegda river basin in a peat bog in the lowlands surrounding Lake Sindor. The remains of a fishing fence constructed in an ancient lake was found here (Burov 1968). The fence consisted of posts hammered vertically into the lake bed and supported by transverse planks which were fixed between the upright large posts. The materials from the excavation site suggest the site is Early Iron Age and dates to the 2nd milennium BC (Burov 1969).

Marmugino is located on the Ug River near the city of Veliky Ust'ug. Here, Burov excavated sites in two peat bogs where the remains of fish traps were located in deposits of clay and decomposed organic matter, at a depth of 2.8–3.5 m beneath the surface. Both constructions were made with slats measuring 2.20 m long, arranged in three rows,

and joined together (Burov 1969). The radiocarbon dates for this site are 4510±50 uncal BP(Le-703), 4700±60 uncal BP(Le-711) (Sementsov *et al.* 1969; Burov, 1988).

Fixed fishing structures have also been recorded in the north-west part of the Russian Plain. Serteya I was discovered by A. M. Miklyaev on the banks of the Serteika river near Smolensk in the Velizh region. Since 2010, underwater archaeological excavations, led by A. Mazurkevich and E. Dolbunova, have investigated 50 m of the river bed and three accumulations of materials have been identified, one of which was *in situ*. One fishing structure has been dated to the Middle Neolithic through its association with pottery types, and by radiocarbon dating of some of the wooden stakes. Several wooden slats with a rectangular cross section, had been hammered vertically into the river bed and were attached together by fibre cords to create a fence. One end of the slats was pointed while the other ends had been broken and around 70 cm of the length had survived. The fence crossed a stream that, at the time, joined two lakes. Near the western end of the fence, ten net-sinkers and two large stones (*c.* 20 cm wide) were piled together; string and cord fragments were found amongst them. The net-sinkers consisted of pebbles, *c.* 7 × 3 cm in size, wrapped in birch bark. A fragment of fibre net is preserved on one of these pebbles. One metre downstream from here is the remains of another structure, though it is less well preserved. Weights and slat fragments were located in other places along the river, and are thought to have originally been part of the fishing structures.

Other similar Early Neolithic structures have been located nearby, at Rudnya Serteïskaya and Seteya X and XIV, though none was well preserved (Dolukhanov *et al.* 1989; Mazurkevich and Miklyaev 1998). The most striking find comes from Rudnya Serteïskaya where two rows of stakes hammered into the river bed held a concentration of hazel branches and pine sticks that were arranged in two levels forming a 90 ° angle. No lithic or ceramic finds were found here.

Central Russia

Lugovskoje is a site located in a peat bog in the upper region of the Svijaga River, near the city of Uljanovsk. Here, a line of posts aligned in a north-west to south-east direction and made from elm and alder were found in a peaty sediment at a depth of 2.45–2.50 m. Most posts were in a horizontal position, though one post leaned slightly (Burov 1972).

Sakhtysh is located in the Upper Volga region, near Lake Sakhtish and has been in excavation for many years by D. A. Krajnov. A large dwelling, dating to between the Middle and Late Neolithic was found with the entrance facing the river. Fish traps with a Late Neolithic date were located both near and and inside the house. One fish trap was found just inside the entrance to the house, at a depth of 1.30–1.40 m. The trap was rectangular and constructed out of wooden slats. It measured 1.50 m long, with a 0.50 m opening and it narrowed to 0.20 m at its thin end. The second trap, which was partially destroyed, was found in the north-west corner of the house, also near the entrance. The surviving fragments measured 0.70 m long and 0.4 m wide. The trap was constructed out of rectangular wooden slats that were still attached together. The

third object, which was 2 m long, was recovered in the south-west corner of the house; this may have been a trap, though the excavator thought it could also have been a mat (Krajnov 1991).

Podzorovo is a Late Neolithic site, situated in the upper stretches of the Voronezh River and was excavated by V. O. Levenok. A bundle of pine slats were found, 2.2 m below the surface. The slats measured 2.50 × 3.00 m long, 1 cm wide and 0.5 cm deep and were separated from each other by 0.5–1 cm. Levenkov (1969) suggested that this construction was very similar to modern fish traps.

Finally, wicker (*Salix* sp.) fish traps dated to *c*. 9620 BP (uncal) (9230–8810 cal BC; 9224–8824 cal BC) were also found at Stanovoje 4 and Sakhtysh 2a; these traps are similar to those found at Zamostje 2 (Zhilin 2004: figs 27 and 28).

General features

All of the prehistoric fish traps described, have some common features. First, all the traps were made with wooden slats from coniferous trees (mainly pine). Though at times the traps recovered had disintegrated, it was possible in certain cases to distinguish a conical shape and at Zvidze, Šventoji and Sakhtysh the slats were attached either by ropes and/or crossed posts. Only the three objects recovered from Šventoji had lids attached to the trap openings. One remarkable find was at Abora where a series of additional stakes were found driven in to the ground beneath the actual structure. These can only be explained as having served to attach the trap to the fence. The location of the traps, which is always connected to lake or river sediments and the presence of large numbers of fish remains inside some of the traps, such as occured at Zvidze, provides direct evidence for their use in fishing. This is particulary clear in the cases of Zvidze and Šventoji 9 where the structure consisted of fences with interrelated traps. In each case, the gap between 2–3 rows of vertical posts had been filled with horizontal tree trunks, branches and bark. It is very likely that the structures from Vis 1 and Marmugino were the same. The fish traps inside and near the houses at Sarnate and Sakhtysh 1 may have been incomplete and /or in a state of repair.

The fish traps from Zamostje 2

Two traps were recovered during the 1989 excavation season (Lozovski 1996; 1997). Of these, only one was in a good state of preservation. It was almost intact and was only missing the narrow end of the cone. Only parts of the frame and some wooden posts were recovered from the second trap. However, a large fragment of bast fibre was recovered on one part of the frame; this measured 2–2.5 cm in diameter and 1 m long, The bast fibre tethering was 2 mm thick × 3 cm wide and *c.* 12 cm long (Figs 13.4, 13.6 and 13.7).

The upper part of the best preserved trap had a series of planks and branches which presumably were originally part of a fence that had been linked to the trap. The trap was constructed out of pine slats with a rectangular cross section and measured 1 × 0.5 cm

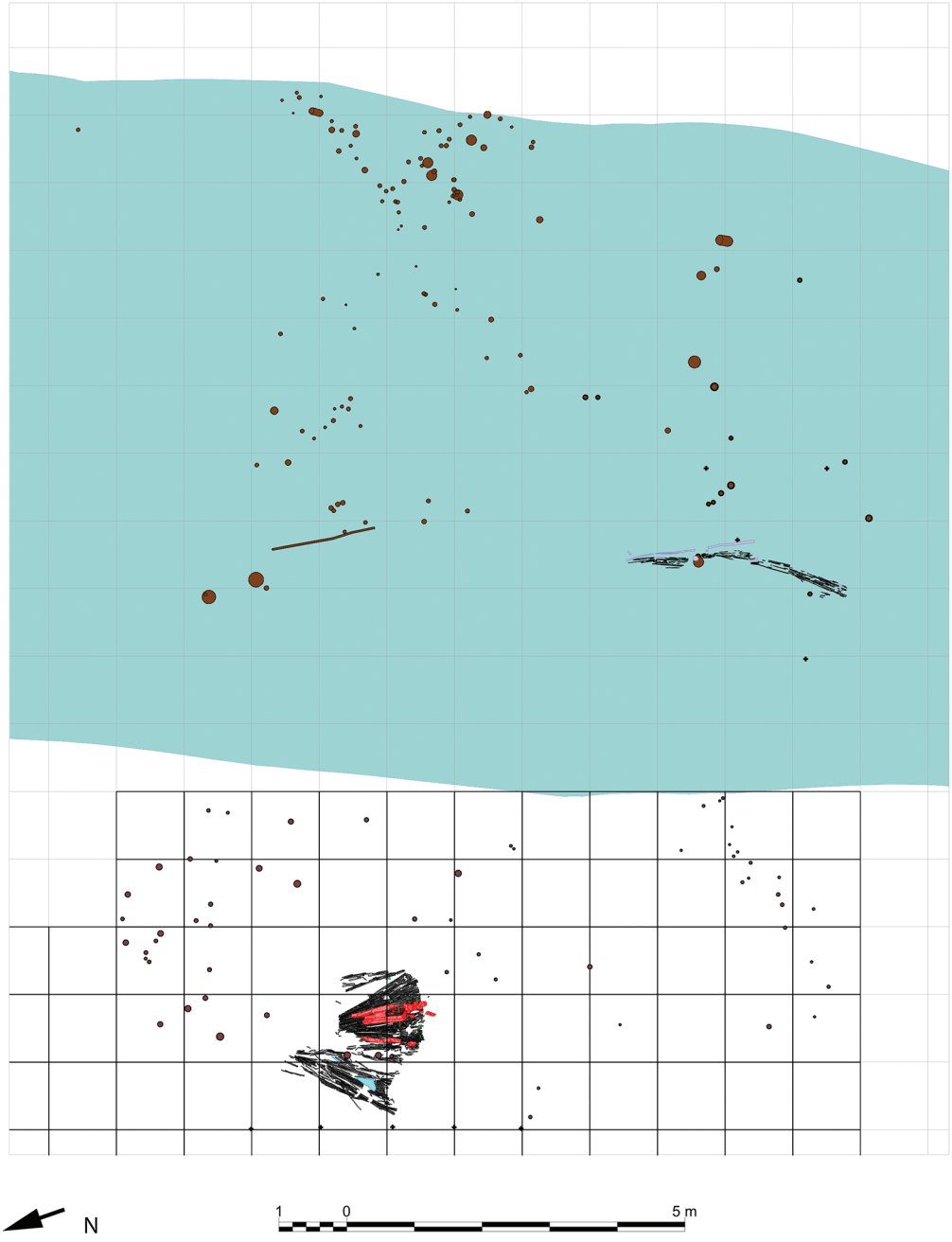

Fig. 13.4. Southern part of the survey and excavation area at Zamostje 2: location of hammered in stakes, and fish trap

around 1.5–2 m long. The slats were linked together every 28–30 cm by a fine fibre cord made of common reed (*Phragmites australis*; Lozovskaya *et al.* 2012; Lozovski *et al.* 2013). Three rows of this cord were found preserved beneath the planks and branches. A slat fragment, with a piece of cord attached was recovered in 2010 and has been radiocarbon dated to 6450±45 BP, 5482–5337 cal BC (CNA 1081). This places it in the Early Neolithic in the region of the Russian Plain.

Usually, the slats lie on south facing slope, with an angle of 25°–30°. The distance between the uppermost part of the slats and the lowest part of the ground surface is 40 cm; this suggests they were lying on the ancient river bank which inclined upwards towards the shore. The best preserved trap was excavated in a block in 2011 and was taken to the Hermitage laboratories for study and conservation, this is still in process. During the excavation of summer 2011, another conical shaped object was found to the west of the other traps. This object was *c.* 2 m long. The orientation of this structure is consistent with the others suggesting that they most likely came from the same fishing complex; however, this trap is thinner and had no surviving fibre attachments. It is located at a higher level, most likely again reflecting the river bank which appears to drop around 10–15cm to 50 cm in the southernmost part, which is similar to the previous examples. An almost complete paddle with an asymmetric blade was found the upper part of this structure. (Figs 13.4, 13.6 and 13.7). The radiocarbon dates for this trap are similar to the previous example, 6539±43 BP, 5613–5588 cal BC (CNA1341) and the paddle, which was found inside the trap was dated to 6676±47 BP, 5636–5602 cal BC (CNA1342). All three traps were found in the same sedimentary layer. This layer comprises a yellowish clayey sediment within a grey–brown sapropel (putrefied mud), with some patches containing small branches, aquatic snail shells and small fish skeletons all in anatomical position (Lozovski *et al.* 2013).

Several structures, also made with pine slats with associated shells and posts, were located 7–8 m further south-south-east, beyond the artificial dam constructed to carry out the excavation and below the current Dubna River bed sediments. One of these structures measures *c.* 4 m and is made from several layers of semi-parallel slats and one long straight slat positioned in a north–south direction. The slats are thin and narrow and some are slightly twisted. Most have rectangular cross sections though some are square or trapezoidal. A second object was also located underwater though somewhat deeper. So far it has not been fully excavated though over 2 m that has been exposed, here, six lines of stitching, 25 cm apart, using bulrush (*Scirpus lacustris*) fibres has been identified (Lozovskaya *et al.* 2012; Lozovski *et al.* 2013). The slats are laid flat and in a parallel line. To the north, the slats are bent and enter the sediment almost vertically, suggesting a relatively large structure with a width of 40 cm. One of these traps has been radiocarbon dated to 6216–6047 cal BC (7248±35 BP; Lozovski *et al.* 2013, 74–5). The remainder of the underwater objects that have been recorded lie north-west to south-east, which is almost perpendicular to the current flow of the river. Although there is no doubt that they are manufactured, it is unclear whether they are traps or something else, possibly mats, or parts of a fence. However they are all manufactured from long wooden slats of 2–4 m in length.

Stakes

Analysis of the stakes that are hammered in along the full 154 m^2 length of the excavated area on the left bank of the current (artificial) course of the Dubna river, shows that the vast majority of these were located in the southern part of the site, in the same area as the fish traps. Two main groups of stakes have been identified; one, comprising 29 stakes, was found to the north of the traps; this forms a structure facing north-west to south-east. The second group, which is linked to an area of large branches and long trunks, consists of 18–20 stakes. This group, which was found in 1990, lay 4–5 m south of the fish traps and also lay in a north-west to south-east facing direction. Other than these, only 22 individual posts with no apparent link between them, have been recorded altogether on this site.

Additional stakes have been found hammered into the river bed. Approximately 70 m^2 east of the traps, 116 stakes have been recorded, each with a diameter of 4–10 cm, though only 12 are over 8 cm. Half of these artefacts have removal scars linked to the point at the distal end, while there are three pieces that comprise only distal pointed fragments; 12 of the stakes retain their bark. The lack of evidence for removal scars in the rest of the stakes, may be because they were dug in deeper than the level studied. As the river was opened into a canal in the 1980s, some stakes were destroyed together with archaeological levels, and their correct archaeological context cannot be reconstructed. However, the trees used to make the stakes has been identified; these comprise: alder (*Alnus* sp.), European bird cherry (*Padus racemosa* Gilib), elm (*Ulmus* sp.), poplar (*Populus* sp.), hornbeam (*Carpinus betulus* L.), maple (*Acer* sp.), pine (*Pinus sylvestris* L.), birch (*Betula*), ash (*Fraxinus* sp.) and willow (*Salix*) (Lozovski *et al.* 2013).

The stakes can be divided into three groups. The southernmost group, which consists of 21 posts, stretches for 7 m and crosses the whole river. It is possible that it is connected to the line of stakes that was discovered in 1990. A structure made of long wooden posts was also found, lying at right angles to this group. Three stakes were found lying next to the posts, and one actually crosses this line of stakes transversally.

The second group is around 4–5 m further north, and apart from two stakes that were found close to the dam that was constructed for the excavation of 2010–11, the remainder are found in an area measuring 4 × 4 m. Seven stakes were found in the north part of this area, and aligned in a straight line. The stakes were all of a similar diameter and were made of wood from the same trees.

Finally, the third group was located on the east bank of the river. This comprises a dense cluster of stakes, forming a right angle. This large structure was discovered below the ground on the right bank of the river and was not fully excavated, therefore a full analysis will need to wait for future excavations. Most stakes are small (5–6 cm in diameter) though three are 10 cm in diameter and four are 8–8.5 cm. One of the stakes (no. 34) was radiocarbon dated to 5580±40 uncal BP (Beta-283034), 4490–4340 cal BC, which places the structure in the Middle Neolithic period.

Interpretation and discussion

The recent excavations at Zamostje 2 have permitted the confirmation and verification of the structures as moveable fish traps in association with other structures including

static fish traps first identified by V. M. Lozovski in the 1989 excavation. The construction of this fishing equipment suggests a deep technological understanding of wood and woodworking. The people of Zamostje 2 had an elaborate array of tools including axes, adzes, wedges, gouges, and chisels made on flint and other rocks, but mainly on raw materials from animals (Clemente *et al.* 2002; Clemente and Lozovskaya 2011). The use of fish traps represents a breakthrough in fishing technology, since the fish are captured effortlessly while the population can engage in other productive or leisure activities (Morales 2010). Fifteen radiocarbon dates were obtained from materials excavated in 2010 and 2011. These include both fish traps, and mats made from pine, recovered both on land and in the current Dubna river, as well as stakes and the oar found in one of the fish traps (Figs 13.6 and 13.7).

The dates cover a wide period between 6327–6320 cal BC and 4447–4418 cal BC but they fall into three groups. The oldest dates for these structures (6327–6023 cal BC), is linked to a stake near the fish trap that contains the oar, and the traps and other underwater structures manufactured using pine posts, all found in the southern part

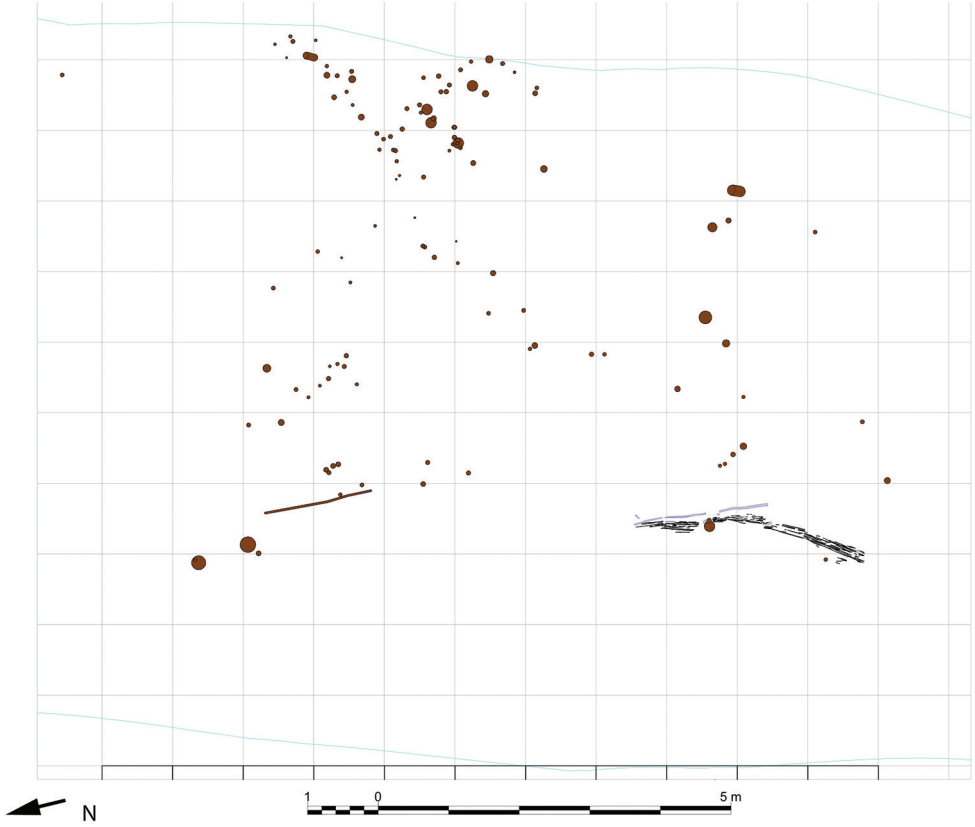

Fig. 13.5. Detail of posts and fishing structures located in the modern Dubna River

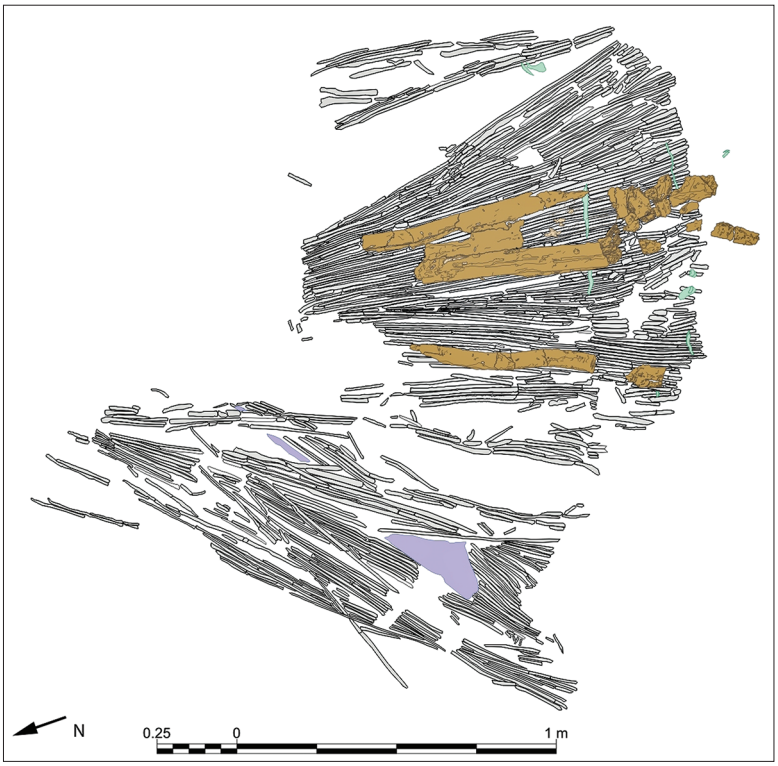

Fig. 13.6. Detail of the fish traps recovered on land in the most recent excavation season. The fish trap at the most easterly point was identified by V. M. Lozovski in 1989

Fig. 13.7. Photograph of the two fish traps recovered on the terrestrial excavations at Zamostje 2. Image taken from the south profile. A paddle is preserved inside the easternmost trap

of the excavation (Figs 13.4 and 13.5). On the other hand, the time period 5636–5462 cal BC contains the oar, the two traps excavated in 1989/2010 and 2011 and two stakes that were near the last trap (Figs 13.4 and 13.6). Finally, stakes nos 12, 35, 38, 88, 101, and 115, all date to between 4992 and 4418 cal BC. This final group was located in the central and northernmost part of the area excavated underwater. It remains to be determined whether all the stakes and posts recovered, are in fact related to fish traps structures.

Even so, we suggest that the fishing structures are likely to have required modifications and replacements over the course of 2000 years. Fluctuations in water level may have meant that the static fish structures had to be moved. An example of this is found in one of the oldest traps (N114), dated to 6070–6023 cal BC, which is crossed by a stake (no. 115), that has a date of 4992–4898 cal BC. It is clear that part of the site could correspond to the lakeshore where a complex structured composed of walls made of branches, planks and bark, and at least three traps, made from thin, long pine slats. Future work further south of the excavated area, in the actual area of the river could provide new records of these traps and perhaps older chronologies.

The work undertaken so far at Zamostje 2 has enabled us to obtain sufficient data to suggest the site was home to a stable population. There is evidence for hunting of animals, especially moose and beavers in summer and winter, migratory birds normally present here only in autumn, as well as evidence for wild fruits present in late summer and autumn. The evidence for fishing suggests it was carried out in spring-summer (Chaix 2003; Radu and Desse-Berset 2012; 2013). Fishing is likely to have had an important role in these societies from the end of the Mesolithic and through the Neolithic in Russian European Plain. Fish are a predictable resource, and with the technological expertise that was evidently available, fish could be captured in large quantities to be stored and consumed later though this requires methods for drying or smoking the fish for storage. Zamostje 2 should be considered as a site that still has great potential for the study of fishing practices in past societies. The potential comprises not only the presence and excellent preservation of fish traps and timber structures related to the capture of fish, but also for the study of other wooden artefacts and the outstanding bone tool collection, which provides insights into the technological capabilities of working with hard materials. Together, the assemblage comprises a wide array of items in bone, teeth and antler of animals all of which are related to woodworking. Taken together this site offers a perspective of impressive expertise in woodworking, and in particular in the use of pine, in the manufacture of all these fishing structures (Lozovskaya 2011a).

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Notes

1 TA-862: 6.535±60 BP y TA-1746; 6350±60 BP. Radiocarbon ages were calibrated using the curve INTCAL13 (Reimer *et al.* 2013).
2 LE-671: 3870±70 BP and LE-749: 3860±100 BP

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