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CATASTROPHIC CHANGES IN VEGETATION ca. 8.2 ka & LAKE SETTLEMENTS IN THE VOLGA-OKA REGION (based on the site Zamostje 2)

The most important changes in the economy and material culture in the foraging societies of the Eastern Europe forest zone on the eve of the spread of ceramic production coincided with the 8.2 ka Cold Event and its consequences. We consider these changes in the local example of the site Zamostje 2 located in Volga-Oka region, using the results of many years of multidisciplinary research. The results of our archaeological and paleoecological studies and comparison with published data for the region show a picture of local changes against the background of regional instability of the ecological situation, as well as discontinuity in the development of traditions of material culture in the second half of the 7th – beginning of the 6th mil. cal BC.

Key words: 8.2 ka Cold Event, paleoenvironmental changes, Upper Volga region, Late Mesolithic, last hunter-gatherer societies, lake settlement Zamostje 2

INTRODUCTION

Climatic and ecological changes have always directly or indirectly influenced the economic and social life of prehistoric communities. However, the high-resolution comparison of particular phenomena in human life with specific paleoecological events is restricted by numerous factors. First of all, different speed and sequence of natural changes and human response to them (from quick decisions to gradual adaptation to new conditions), availability and accuracy of absolute dating, and finally, just the variety and quality of the information base.

A climatic event of ca. 8200 BP, known as 8.2 ka Cold Event, is considered as a relatively short-term global cooling of the Middle Holocene in the context of generally increasing annual temperatures and humidity (up to the climatic maximum). Its influence on the historical process is widely evidenced as a prolonged period of drought and cooling in the Eastern Mediterranean, North and East Africa, which was encountered by the early Neolithic cultures (Weninger et al. 2006). In the forest zone of Eastern Europe, this event coincided with the final stage of the Mesolithic – societies of hunter-fishers and gatherers. Around that time, the first pottery began to penetrate the region, which prompted researchers to the idea of migration of the southern Neolithic population to the north along large river routes (for example, Spiridonova, Aleshinskaya 1999; Aleshinskaya et al. 2001; Mazurkevich et al. 2013, p. 99–100, etc.). However, other components of the Neolithic way of life (first of all, agriculture and cattle farming as the basis of the economy) were not adopted by the local population, which kept forager forms of economy for a few millennia more. Inhabitants of the forest zone chose strategically advantageous sites on shores of large lakes and rivers, often with swampy surroundings, which created a relatively stable complex system of aquatic and terrestrial food resources.

Changes in the economy and material culture on the eve of pottery production expansion among forager societies in the forest zone of Eastern Europe and in particular the Upper Volga basin have repeatedly been under detailed consideration (Kostyleva 2003; Lozovski 2001; 2003; Lozovski, Mazurkevich 2014, etc.), although the mechanism and reasons for this epochal phenomenon have not been revealed. We can only state that the preconditions were formed at the end of the 7th – the beginning of the

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6th mil. cal BC, which coincides with the 8.2 ka Cold Event and its implications. Let's consider what this sharp cooling was manifested in at the local level on the basis of specific examples.

8.2 KA COLD EVENT. KEY FACTS

The 8.2 ka cold episode has been thoroughly studied and reconstructed for many regions of Europe based on isotopic data from ice and cave cores, as well as from independent series of paleobiological data. It is believed that the reason for the strong but short-term cooling was the change in the circulation regime of the ocean and atmosphere after the collapse of the last ice sheet. The most dramatic cooling is reconstructed for the North Atlantic, where the decrease in average annual temperatures exceeded 3° C. In Central Europe and Baltic, the cooling was somewhat weaker (1–2° C). Duration of the cold episode in different areas and based on various data is estimated at 150–300 years (Borzenkova et al. 2017). The impact of the 8.2 ka Event on the vegetation cover is reflected in the pollen diagrams. In Western Europe and Baltics, the cooling was expressed in reduction or even complete disappearance of thermophilic wood species (oak, elm, linden, hazel) in the pollen spectrum and a simultaneous increase in the amount birch pollen. Many pollen diagrams of the European territory of Russia also show "late boreal cooling" (Khotinsky et al. 1991), however, it is less pronounced than in Northern Europe, which gives grounds for conclusions about a milder manifestation of the 8.2 ka Event (Borzenkova et al. 2017). Nevertheless, in several pollen diagrams with a high degree of temporal resolution one can see short-term changes in the spectra similar to those described for Northern Europe and the Baltics. For the Moscow region, two relatively well-dated and sufficiently detailed pollen diagrams covering the entire Holocene have been published to date: these are the sediment core sample of Lake Dolgoe ((Kremenetski et al. 2000; Borisova 2018) and the peat bog in the Losiny Ostrov (i. e. Elk Island) National Park (Myagkaya, Ershova 2020) (Fig. 1a). The both columns reflect a regional signal and can act as a basis for reconstructing changes in vegetation and climate in the Volga-Oka interfluve. The 8.2 ka Climatic Event is quite distinctly revealed in both diagrams in the form of a noticeable but short-term reduction in pollen of broad-leaved trees, especially oak, and a peak in birch pollen. In Elk Island, there is also a sharp change in the botanical composition of peat, which indicates a relatively short-term increase of hydration level.

ARCHAEOLOGICAL MATERIALS

Vegetation is most sensitive to climate change. In most cases, at sites of the Stone Age and even later periods, wood and other plant remains have not been preserved. Wetland lake settlements of the Mesolithic – Bronze Age represent a rare type of sites where fragile organic materials are represented in a more or less complete spectrum. This provides for a unique opportunity to compare different data in order to reconstruct a more complete picture of the vegetation change.

Several Late Mesolithic sites with archaeological layers dating back to the end of the 7th mil. cal BC are known in the Volga-Oka region. Site Zamostje 2 is the most informative among them (Fig. 1a).

The site has been investigated since 1989 (V.M. Lozovski, O.V. Lozovskaya), 164 m^2 are excavated up to date (Fig. 1e). Three of the five archaeological layers date from the period of our interest: two date from the Late and Final Mesolithic in the 6300–5750 cal BC interval. A layer with ceramics of the Upper Volga culture directly overlaps them (ca. 5700–5300 cal BC). Numerous artefacts of stone, flint, bone, antler, as well as wood and plant fibers were found in all the three layers. Selective determinations of wood by (the method of) identifying structural features of cells were carried out by Maria I. Kolosova (The State Hermitage Museum, St. Petersburg) in 2009–2013 (Lozovskaya, Kolosova 2011; Ershova, Lozovskaya 2018). The species composition of charcoal (samples from sieving) was determined by Alexandre A. Alexandrovskiy (Institute of Geography RAS, Moscow) in 2015–2017 (Alexandrovskiy 2018). The analysis of macrobotanical residues was carried out by Eleonora A. Krutous (Institute of Geochemistry and Geophysics AS of Belarus, Minsk) in 1991 (seeds) (Krutous 2018), Marian Berihuete-Azorín (Institute of Botany, University of Hohenheim) (seeds) in 2013–2018 (Berihuete, Lozovskaya 2014; Berihuete 2018) and Ludmila I. Abramova (Moscow State University) (peat) in 2011–2013 (Ershova 2013). Palynological analysis and reconstruction of vegetation were carried out by Elena A. Spiridonova (Institute of Archeology RAS) in 1989–1997 (Aleshinskaya et al. 2001) and Ekaterina G. Ershova (Moscow State University) in 2013–2018 (Ershova 2013; Ershova, Lozovskaya 2018). The radiocarbon dates for the period under consideration were obtained in the laboratories of the Geological Institute of RAS, Institute for the History of Material Culture RAS, Russian State Pedagogical University, the Universities of Kiel and Uppsala, and the Centro Nacional de Aceleradores in Sevilla in 1989–2018 (Lozovski et al. 2014; Lozovskaya, Lozovski 2018).

Inhabitants of the site lived off intensive fishing and hunting for elk and beaver, as well as water and wetland birds. The archaeological inventory includes evidence of all activities typical for a base settlement. In the Late Mesolithic layer, some data indicates year-round habitation (Lozovskaya, Lozovski 2018).

METHOD

Pollen analysis. We used the data of spore-pollen analysis of several sections studied at different time during excavations of the site Zamostje 2. Two main stratigraphic sections – sq. A9-A12 (1995–2000) and sq. AA18 (2013) (Fig. 2); the data on sections near the fish-traps (sq. A8' and 2, 2013) were also partially used (Fig. 1e). For more clarity, the analysis results were recalculated again using the same method – the participation of pollen taxa was calculated in % of the total pollen, and the participation of spore ones – in % of the total of pollen and spores. Some taxa were combined into groups: broadleaf forest trees, including *Corylus*, terrestrial grasses, aquatic plants, ferns.

Dating. For section AA18 (2013), based on seven radiocarbon dates in the OxCal program (Reimer et al. 2020), a model of the sediment accumulation rate was constructed (Fig. 3), and using this model, the dates were calculated for all samples, starting from the lower layer of the Late Mesolithic (LM LL). The beginning of peaty deposits accumulation was determined from a series of 14C dates obtained from the underlying sapropel (peaty gyttja) from several sections. Since all dates are close enough to each other, we combined them in the OxCal program. We assume the obtained result to be the lower boundary) of the beginning of archaeological layer accumulation.

Comparison. For comparison, we used the published data of pollen analysis for two objects located closest to the Zamostje 2 site (Fig. 1a): a column of lacustrine sediments from Lake Dolgoe (Kremenetskiy et al. 2000; Borisova 2018) and a peat column from a swamp in the center of the Losiny Ostrov National Park (Myagkaya, Ershova 2020).

RESULTS

The considered period of time, from the viewpoint of impact assessment of the 8200 cal BP cooling on the landscape surrounding the lake settlement at Zamostje 2, is reflected in the sediments of the Late Mesolithic Upper (LM UL) and Final Mesolithic (FM) archaeological layers. In the most complete section A9-A12, layers included two horizons each (Fig. 2).

The lower horizon of the LM Upper layer is a dark gray sapropel (gyttja) with poorly decomposed plant remains; numerous fragments of wood chips were evenly and densely distributed; many branches and other large wood fragments were found; remains of fish bones and broken scales are abundant.

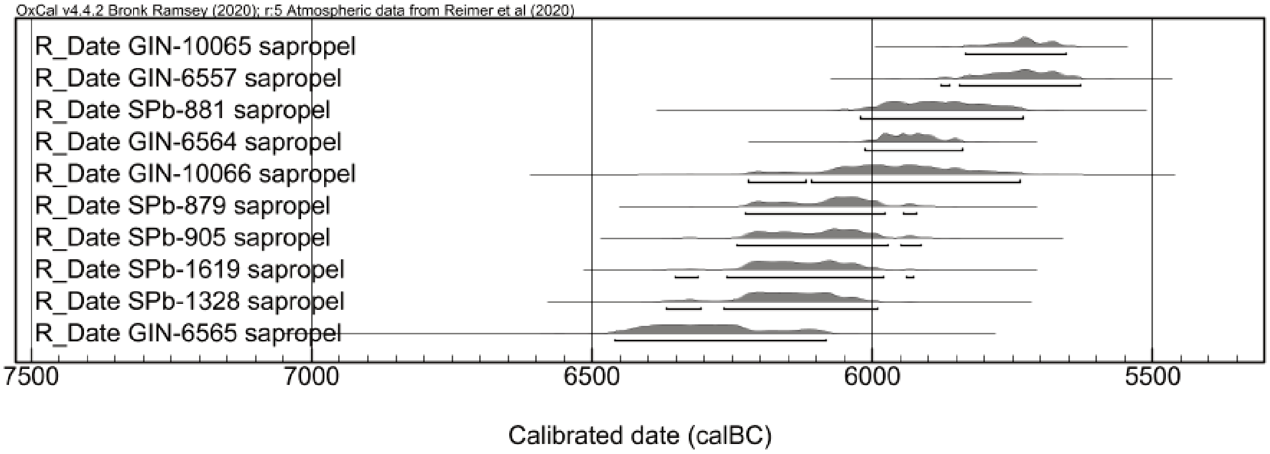
The upper horizon of the LM Upper layer is represented by deposits of dark gray sapropel, sometimes black, sandy, with numerous macroremains as small wood chips and bark, fish scales and bones, as well as small charcoals. The density of finds and saturation with sandy inclusions is especially high in the upper part of the layer. It is difficult to say for sure whether this is related to the residential surface or also to the washing out of sediment as a result of natural water processes. Yu.A. Lavrushin (Aleshinskaya 2001, p. 250) unambiguously indicated the intact state of the layer, estimating the duration of sedimentation at several decades. The upper boundary of the layer is clearly delineated (with the exception of pit AA18).

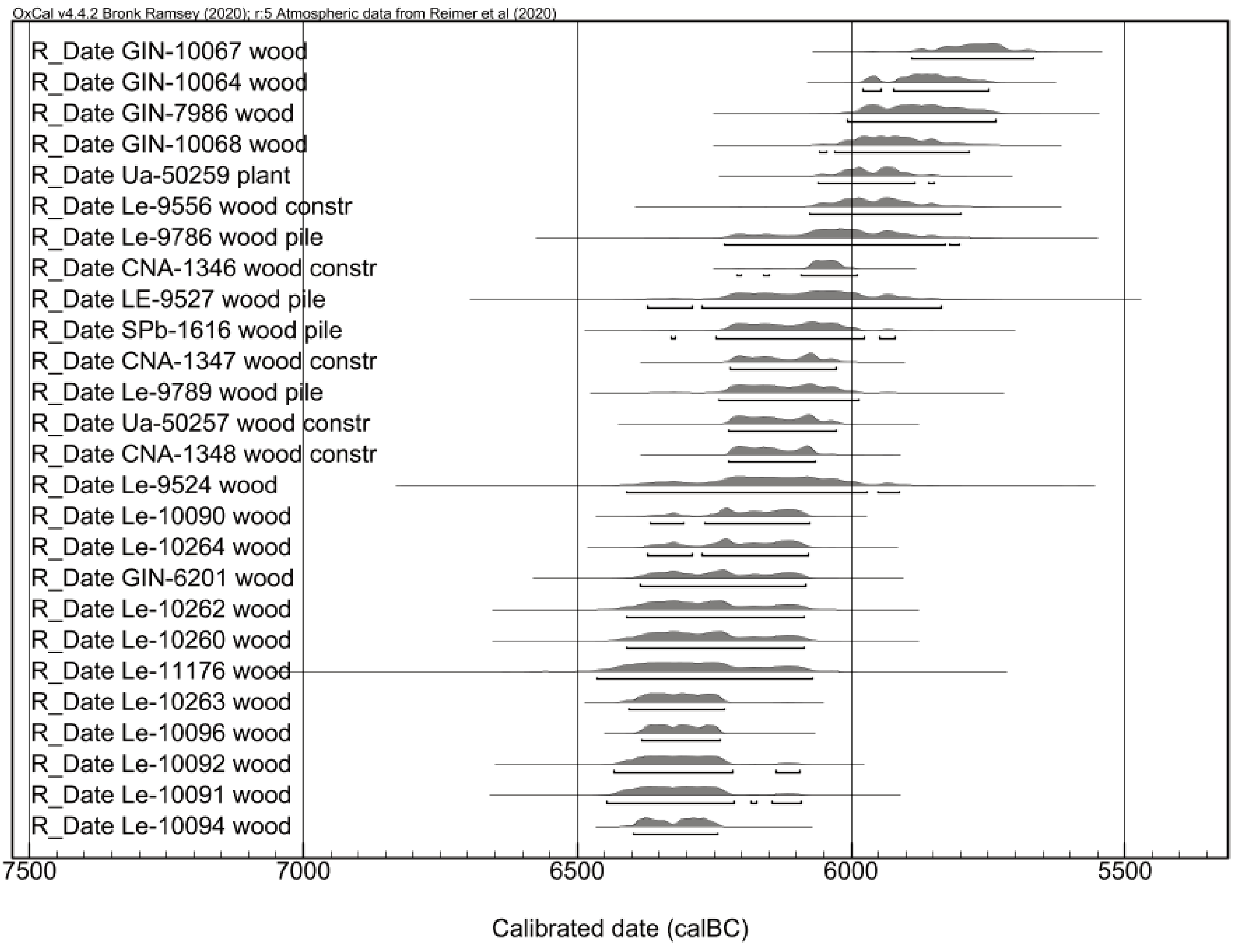
It is overlapped by a 5–10 cm thick horizon of olive sapropel with plant remains (leaves, roots, etc.) and numerous fragments of small branches and bark. The upper horizon of the FM layer is represented by dark gray sandy sapropel, with fine grit, abundant wood chips, big charcoals, plant seeds, and small fish bones. The layer has a limited distribution – so it is absent near the fish-traps, while the surface of the LM UL shows numerous traces of erosion. In pit AA18, which is characterized by a more regular and even accumulation of artefacts, the FM layer is homogeneous: it is a dark gray sapropel with numerous plant and small woody remains as bark and wooden crumbs, as well as many broken fish scales. In section A9-A12, the layer was interpreted as a kind of a mud flow, which had incorporated some archaeological remains (Aleshinskaya et al. 2001, p. 250). It contained pieces of twisted ropes made of willow fibers (identified by M.I. Kolosova) (Lozovskaya, Lozovskiy 2018, Fig. 67).

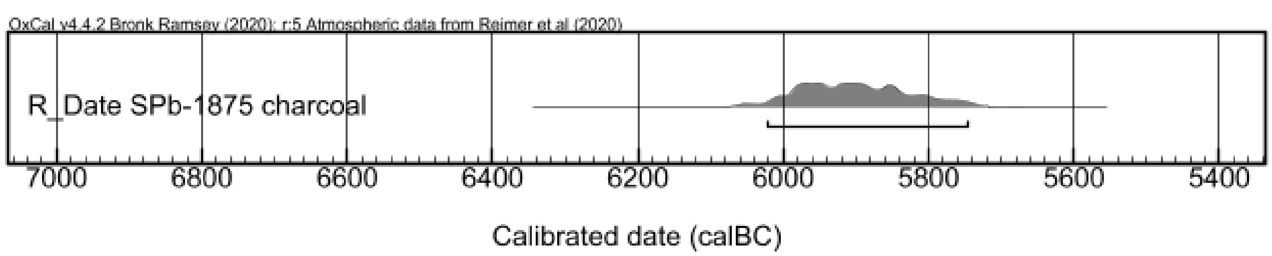
For these two archaeological layers, there are the following 14C dates made on sapropel, wood and charcoal (Tables 1 and 2).

Thus, it is obvious that during the formation of the FM layer, i. e., ca. 5900–5750 cal BC (seven 14C dates), sedimentation proceeded in different ways in various parts of the site; the investigated zone covers 35 m along the modern

Tabl. 1. Zamostje 2. Calibrated 14C dates for Late Mesolithic Upper layer and Final Mesolithic layer for: a – sapropel (peaty gyttja); b – wood (fish constructions, piles from fish-fences, branches and chips from archaeological layers)







Tabl. 1. Zamostje 2. Radiocarbon dates for Late Mesolithic Upper layer and Final Mesolithic layer

Lab. No	BP	cal BC	material	sample context
Final Mesolithic layer				
GIN-10065	6850±40	-5837-5659	sapropel	1996, layer 5, sq. A11
GIN-6557	6850±60	-5873-5635	sapropel	1990, layer 5, sq.2
GIN-10067	6890±50	-5886-5674	wood	1996, layer 5, sq. A11
GIN-10064	6980±40	-5981-5753	wood	1996, layer 6, sq. A10
GIN-7986	7000±70	-6003-5741	wood worked	1991, layer 5, sq. Г15
SPb-881	7010±80	-6021-5733	sapropel	2013, western section, sq. AA18, -380-372, layer 5/6
SPb-1875	7030±70	-6022-5752	charcoal	1996, layer 5, sieving
Late Mesolithic, Upper layer				
GIN-6564	7050±40	-6009-5846	sapropel	1990, layer 6, sq. A5
GIN-10068	7050±60	-6033-5789	wood	1996, layer 7, sq. Б12
Ua-50259	7087±45	-6052-5885	plant fiber	2011, layer 5a, sq. A8´, sieving, net knot 13
Le-9556	7090±70	-6081-5796	wood	2011, SubA, fish-screen №1, pine, sq. К XIII-XVI
KIA-51096	7094±38	-6047-5896	human bone	1996, layer 7, sq. B9
GIN-10066	7100±120	-6217-5743	sapropel	1996, layer 7, sq. Б12
Le-9786	7150±100	-6232-5811	wood	2011, SubA, vert. pile № 117, sq. МН XIV, bird cherry
CNA-1346	7198±30	-6202-6002	wood	2011, SubA, fish-screen №1, pine, sq. К XIII-XVI
Le-9527	7200±120	-6363-5843	wood	2011, SubA, vert. pile № 120/127, sq. Л XV, hornbeam
SPb-879	7200±70	-6226-5927	sapropel	2013, western section, sq. AA18, -390-380, layer 7
GIN-7988	7200±90	-6247-5892	elk bone	1991, layer 6, sq. Г15, Д16
SPb-905	7220±80	-6245-5920	sapropel	2013, western section, sq. A8´, -354-364
SPb-1616	7232±80	-6252-5979	wood	2012, SubA, vert. pile № 134, sq. К VII, alder
CNA-1347	7248±35	-6216-6035	wood	2011, SubA, fish-screen №4, sq. И XVII, pine
Le-9789	7250±70	-6243-5996	wood	2012, SubA, vert. pile № 134, sq. К VII, alder
SPb-1619	7253±80	-6346-5985	sapropel	2013, western section, sq. A8´, -364-374
Ua-50257	7257±45	-6223-6034	wood	2014, SubA, fish-screen № 2, sq. М XVIII
CNA-1348	7267±31	-6217-6064	wood	2011, SubA, fish-screen № 2, sq. КЛ XVII, willow
Le-9524	7270±120	-6406-5916	wood	2011, layer 6a, sq. Б8´-A10´, №155, -399-411
SPb-1328	7280±80	-6356-6005	sapropel	2013, western section, sq. AA18, -400-390, layer 7
Le-10090	7350±45	-6361-6079	wood	2013, layer 8, sq. AA18-19, sieving
Le-10264	7360±50	-6369-6088	wood	2013, layer 6a, sq. Б8'/3, -411-418
GIN-6201	7380±60	-6392-6094	wood	1989, layer 7, sq.
Le-10262	7400+75	-6420-6095	wood	2013, layer 7, sq. 7, № 111/112, -463-476
Le-10260	7400±75	-6420-6095	wood	2013, layer 7, sq. AA18-19
Le-11176	7430±110	-6467-6067	wood	2013, sq. 14, vert. pile № 165/244
Le-10263	7440+40	-6403-6232	wood	2013, layer 8a, sq. A9´Б9´10´, № 214-216, -428-450
Le-10096	7440±20	-6381-6245	wood	2013, layer 8, sq. 4
GIN-6565	7450±100	-6467-6088	sapropel	1990, layer 7, sq. A5
Le-10091	7450±70	-6453-6117	wood	2013, layer 8, sq. AA18-19, sieving
Le-10094	7460±20	-6399-6251	wood	2013, layer 5a, sq. Б9´

Dates have been calibrating using O[Cal v 4.2.4 Bronk Ramsay (2009)$ r^5$ IntCal13 atmospheric curve (Reimer et al., 2013)

channel of the Dubna River (Fig. 1e). The data available today for the relief reconstruction of the site indicates existence of a paleo water reservoir on the eastern side (slope and fishing structures in the SE part), a temporary channel at the trench with fish-traps (1989 / 2010–13), a deeply prominent cape in the central part and a small backwater with calm sedimentation from the northern side (Fig. 1b). The age of the stream with fish-traps is estimated as no younger than 6052–5885 cal BC based on the 14C date obtained for the fish net knot (from sieving) 7087±45 BP (Ua-50259) (Table 2).

However, evidence of settlement activities for the LM UL (during more or less long visits, we are not talking about continuous habitation) is recorded for about four centuries 6300–5900 cal BC, and a series of dates falls within ca. 6200–6050 cal BC. Most notably, the wooden fishing structures of the LM UL (fish-screens made of pine splinters at the bottom of the Dubna channel) and several piles of fish-fences (Fig. 1c) are definitely dated to this interval.

In the FM layer, on the contrary, not a single wooden structure or vertical pile has been found yet, taking into account the currently available 58 radiocarbon dates for underwater objects (Lozovski et al. 2013: 74–75; Lozovskaya et al. 2016). It should be noted that the age of all these objects (except for the fish-traps in the Early Neolithic layer in the surface excavation) is determined by direct 14C dating. This phenomenon can be explained, for example, by a temporary movement of the fishing area to some neighboring area.

VEGETATION CHANGES ACCORDING THE DATA OF THE POLLEN ANALYSIS FROM THE SECTIONS OF ZAMOSTIE 2

In the context of a rather slow and progressive development of the forest and vegetation cover, which we observe from the pollen columns of Zamostje 2 for more than a millennium, at least from the middle of the Boreal, even small changes that took place at the end of the 7th mil. cal BC are gaining in importance.

Since the pollen diagrams of the two sections shown in Fig. 4 reflect similar dynamics, development of the vegetation cover in the vicinity of the site can be described by both columns as follows.

Four radiocarbon dates from the clayey sapropel underlying the archaeological layers give us an idea of when the deposits accumulation began; the result of combining dates in OxCal shows the period between 8792±211 and 8581±179 cal BP. Starting with this period and up to 8200 cal BP, i. e. during the accumulation of LM LL and partially LM UL, birch dominates in the pollen spectra (35–55% of the total spectrum), pine makes about 20%, which is a relatively small figure, taking into account its high pollen productivity and volatility, spruce pollen is present, but singularly, perhaps, it was brought from neighboring regions. From the very beginning of the period, broad-leaved forest species (elm, linden, oak, hazel) and black alder (about 5%) are present in significant quantities (about 10% in total). Grass pollen makes a rather large share – about 10% – in the test-pit of 2013 and up to 20% in the trench of 1996. It can be assumed that, although birch forests were most common in the vicinity of Zamostje 2 during the Lower and Upper layers of the Late Mesolithic, there were also areas of elm forests, communities with the participation of oak, linden, and hazel in the undergrowth, as well as open spaces occupied by wet meadows and reed marshes. Similar data were obtained for other sections of the site (sq. A8' and 2).

This data is well harmonized with the regional data: in the diagrams of Lake Dolgoe and Losiny Ostrov (Borisova 2018; Myagkaya, Ershova 2020), the respective period is also characterized by pollen spectra dominated by birch with a small amount of pine and broad-leaved species. At the same time, the beginning of broadleaf forests distribution across the whole region, according to the simulated dates, refers to the period of 9100 (Dolgoe Lake) – 8800 cal BP (Losiny Ostrov). By the time the Mesolithic hunter-fishers had settled in the region, broadleaf forests had already begun to form, although significant areas of birch forests and open treeless grass communities were still in place. Such communities - meadows and marshes – were apparently especially widespread along the banks of water bodies in a vast lake basin near Zamostje 2.

In the period of 8500–8200 cal BP, diagrams of Zamostje 2 show the maximum participation of birch (up to 50% of the total spectrum). It is well synchronized with the regional pollen diagrams. Both in the column from Lake Dolgoe and in Losiny Ostrov during the same period, there is a peak of birch (up to 70% of the total spectrum) and a noticeable reduction in broadleaved species, especially oak. A similar dynamics was described for many pollen columns of Western Europe and the Baltic States (Borzenkova et al. 2017), which is usually interpreted as a response of vegetation to 8.2 ka CE, expressed in the degradation of forests already formed by that time from thermophilic broadleaved species and their replacement with less demanding warm birch forests. In the diagram of AA18 section of 2013 from Zamostje 2 (Fig. 4), at the level of the modeled date 8200 cal BP, one can also see a drop in the curves of broadleaf species and, especially, alder, but it looks weaker and more short-timed than on the regional diagrams. We can cautiously assume that the features of the lowland landscape and the milder microclimate smoothed out the effect of sharp fluctuations in temperature and humidity on local vegetation.

After 8200 cal BP, the pollen spectra of Zamostje 2 abruptly change: the participation of birch decreases, the participation of black alder sharply increases, the participation of oak, elm, linden and hazel is restored, and a hornbeam appears sporadically. In the both trenches, pine growth is also noted (up to 30–50% of the total spectrum). The share of meadow grasses decreases, while the share of spore (mainly forest ferns) increases. A similar trend is observed in both regional charts. Thus, all available pollen data indicate significant transformations of the vegetation cover throughout the region in the short period immediately following the 8200 cal BP event and are apparently associated with both a sharp warming and a change in the water level in reservoirs. The composition of forest communities and their area also changed. In general, in the region, light birch forests were largely replaced by broadleaf forests, meadows in river and lake valleys are overgrown with alder. The latest process – an increase in the area of alder forests due to the reduction of meadow vegetation is especially clearly reflected in the diagrams of Zamostje 2.

The dynamics of pine during this period is of a particular interest. In the regional diagrams, after a minimum, practically, an absence of pine in the period 8500-8000 cal BP, its growth is observed (up to 30% of the total spectrum), after which its participation again drops to a minimum. This extended in time and weakly expressed pine peak dates from 8000–7300 cal BP in the both diagrams. In the sections of the Zamostje 2 site, the same pine peak is much more pronounced (up to 50% of the pollen spectrum), but its dates in the two pits are not the same: in the AA18 section of 2013 it is dated 7900–7300 cal BP, which coincides with the regional data, and in the excavation of 1996, according to the available radiocarbon dates, it corresponds to a shorter period, approximately 8000–7800 cal BP (?).

We can only speculate on the underlying reason for a rather long – up to several hundred years – increase in the share of pine in the region. This may be a long-term delayed response to the 8.2 ka CE event (restoration through pine in place of previously degraded broadleaf forests). Perhaps this is not related to 8.2 ka CE but to an independent climatic event or several events associated with fires in the period of 8000–7300 cal BP. There is evidence of large fires in the Moscow region dated to this period (Alexandrovskiy et al. 2018). This is partly confirmed in Zamostje 2, given the highest saturation of the Final Mesolithic layer with charcoal (for which there is a date of 7030±70 BP). Sharp and short-term pine peaks belonging to the same period can be observed in other local diagrams in the Moskva River valley (Ershova et al. 2013). Based on the currently available data, we can state that the increase in the share of pine in several areas of the Moscow region during that period was more likely associated with local events (fires) than with general regional trends.

After 7400 cal BP in the 2013 section and after 7800 cal BP in the 1996 section, there is a decrease in the proportion of pine, a sharp increase in alder, and a moderate increase in broad-leaved species. The share of grasses increases again, mainly due to grass, and the total number of meadow taxa also increases. The spectra reflect general dynamics of the region – the maximum distribution of deciduous forests in conditions of climatic optimum. However, the spectra of Zamostje 2 also have noticeable differences from the regional spectra of the same period: they contain less birch and broad-leaved trees, more alder, pine, and meadow grasses. We can assume that this is a reflection of the formation of a specific complex of plant communities in a vast ancient lake basin, consisting of swampy black alder forests, flooded meadows, and lowland marshes in combination with areas of deciduous forests and pine forests at higher levels.

An important general characteristic of changes in this period is related to a pronounced lowering of groundwater, which is confirmed, on the one hand, by the behavior of archaeological layers and their filling, and on the other hand, by an increase in the number of terrestrial taxa in the spore-pollen spectra.

ANTHRACOLOGICAL ANALYSIS AND ANALYSIS OF WOODEN INVENTORY REMAINS

An additional source of changes in forests around the site can be provided by data on the species composition of charcoal (Aleksandrovsky 2018). However, it should be noted that the results have some limitations due to the irregularity of sampling (sieving from random squares), the lack of a reliable connection with the hearth structures and deliberate choice when it comes to the anthropogenic origin of charcoal in the layer. One sample from the FM layer gave a 14C age of 7030±70 BP (SPb-1875) / 6022–5752 cal BC. As for the quantity, the sample is quite representative: 683 charcoals were analyzed for two horizons of the LM UL (separately) and one horizon of the FM layer.

An almost complete absence of pine turned out to be a sensation: together with undifferentiated conifers, its number was 2 (LM UL, low horizon), 9 (LM UL, upper horizon) and 11 (FM) specimens (1.8, 2.8, and 4.2%, respectively). Elm and birch were the most numerous, with the proportion of elm growing from 15-18% in the FM layer to 30%, and the highest percentage of birch was noted, on the contrary, in the lower horizon of the LM UL – 24% plus 33% of diffuse-porous undivided; in the FM layer, these index are 12 and 23%, respectively. Maple, linden and – in the two upper layers – alder are also represented.

The presented regularities can hardly be explained only by problems with availability of various types of raw materials, since local population actively used pine at all stages of the site's existence. Its share in the inventory of the LM UL is especially noticeable (almost 50%, see Ershova, Lozovskaya 2018: p. 37, Table 1) (Fig. 5b): splitted pine and branches were used for various household items, small pickets, as well as long splinters for fishing structures (Fig. 1c) – characteristics of pine wood were best suited for this. At the same time, other tree species were used for stakes (fish-fences), in particular, alder and bird cherry – trees of a inner circle. Bird cherry berries are found in abundance in the layers of the Late Mesolithic (Berihuete, Lozovskaya 2014). Birch, willow, elm, ash, oak and spruce also served as raw materials for other products. Compared with the underlying LM LL, where pine occupied only one fifth (22%) of the species composition of worked wood (Fig.5a), almost on par with birch, elm (19% each) and willow (18%) (bird cherry, ash, alder, maple, spruce, viburnum are also represented – from 6 to 1% in descending order).

The wood inventory of the FM layer is not numerous; there are no structures and vertical piles in the water yet. There are few species determinations (only 8), but pine, willow, birch and elm are represented; without explicit priorities. Analysis of macroremains in pit AA18 (Berihuete 2018) indicates presence of many berries of bird cherry, raspberry, viburnum, and numerous seeds of goosefoot species. Unfortunately, the data for the Late Mesolithic layers is given in an accumulated form, so a detailed comparison is impossible. But it seems that their number increased remarkably further to the Neolithic.

So, analysis of the wood inventory indicates a possible increase in the role of pine wood in the Late Mesolithic Upper layer compared to the earlier layer. However, their optimal characteristics for splitting into splinters retained its relevance later (Early Neolithic fish-traps, for example).

Finally, according to Ludmila I. Abramova, in the sample of peat from the LM UL 20 (25) % remains of coniferous wood were determined, no deciduous ones. In the sample from FM layer, on the contrary, 25 (30) % are represented by remains of deciduous, no conifers.

CHANGES IN MATERIAL CULTURE

According to various remains of material culture in the both layers, even taking into account a "small number" of finds in the FM layer and their possibly displaced nature ("mud flows in humid conditions"), the population did not leave these places during the period of 8.2 Cold Event and its consequences.

At the same time, we are observing a number of cultural, typological and technological changes that can be associated with both internal development, including a response to climate / landscape change, and external impulses.

The Late Mesolithic complex of Zamostje 2 as a whole has many common features with the synchronous sites of the Volga-Oka interfluve, but its cultural interpretation remains open (for a discussion on this topic, see Lozovski 2014; Lozovski et al. 2009). And only with the appearance of the Upper Volga pottery in the Early Neolithic, a more or less unified cultural community was established on this territory. Based on materials from the site, the first ceramics and the beginning of the Neolithic are dated to ca. 5700 cal BC (Meadows et al. 2015).

The most notable changes took place in the way to fishing. Locking fishing techniques appeared here in the last quarter of the 7th mil. cal BC. Dates for the three constructions from pine splinters found at the bottom of the modern riverbed fit into the interval 6223–6002 cal BC. The same range overlaps also two of dated fish-fence piles (№120 / 127 and 134) (Fig. 1c; Tables 1b and 2) (Lozovski et al. 2013).

In the Final Mesolithic, there is no data on fishing structures. In the Early Neolithic, a different type of equipment appears – fish-traps surrounded by barrage structures made of piles, sticks, branches, and possibly nets (Fig. 1d). But their age is estimated ca. 5615–5383 cal BC (Lozovski et al. 2013).

The typology of fishhooks is quite indicative as well: thin miniature hooks with an even shaft and a rounded lower edge and a short appressed curved tooth are distinguished in the LM UL (Fig. 6: 26–30). In the FM layers, for a short period, there appear items with a thickened shaft and a short sharp point separated by a slit (Fig. 6: 14–16). The third technical-typological solution is noted in the Early Neolithic, where the production of the identical fishhooks – with the help of double-sided grooves and a hole drilled at the intersection (Fig. 6: 1–6) – can be considered as a culture-defining feature (*fossile directeur*) for the Upper Volga culture.

Finally, a peculiar type of flat willow-leaved fishing gear with a hole for tying a line turned out to be common for the both Mesolithic layers (LM UL and FM) (Fig. 6: 12–13, 22–24). Considering that the catch composition, from the middle of the 7th mil. cal BC, remained practically unchanged (Radu, Berset 2013), noticeable changes in the fishing gear and fishing structures could hardly have been a result of gradual adaptation, but rather external cultural implications.

The situation with hunting weapons is equally ambiguous. While the LM UL is characterized by the largest typological variety of arrowheads and barbed points, including slotted arrowheads with sharp barbs, for example, or short needle-shaped points (Lozovskaya, Lozovski 2019), which are more characteristic of the upper horizon of the layer (i. e., synchronous with cooling). In the context of general continuity, all the three layers possess their distinctive types, e. g., in the Early Neolithic with a series of figured arrowheads with three thickenings and uni-lateral small-barbed points (Fig. 6: 7–9, 11).

Appearance at the very end of the Mesolithic of a very specific type of sickle-shaped slotted tool with an original ornamentation as a relief zigzag in a deepened groove - neither the ornament nor the type of tool had any close items either before or after (Lozovskaya 2020) – seems to indicate the emergence of some new groups.

CONCLUSIONS

Analysis of archaeological and paleobotanical data associated with changes in vegetation cover and the response to them of human collectives during the second half of the 7th – early 6th mil. cal BC as a whole quite convincingly showed the general picture of an unstable ecological situation and discontinuity in development of material culture traditions.

While general tendencies of changes in the forests composition and the ratio of vegetation species in the vicinity of Zamostje 2 are similar to the regional trends traced in the diagrams of Lake Dolgoe and Losiny Ostrov, in many cases we can observe smoother fluctuations in temperature and humidity for local vegetation under conditions of a milder microclimate of lowland landscapes. In addition, we cannot ignore that the behavior of forest communities could have been influenced not only by global climatic events, such as the 8.2 ka Cold Event, but also by more local independent phenomena such as forest fires.

The data of spore-pollen analysis is in concordance with the analysis of charcoals: both methods show dominance of birch and a wide distribution of broad-leaved species in the Late Mesolithic layers, i. e., in the period up to 8.2 ka CE. According to the data of anthracological analysis, the participation of oak, linden, and, especially, elm in the pollen spectra of the Upper Mesolithic layer is significantly underestimated in comparison with their real representation in the vegetation cover. Charcoal analysis also shows a low proportion of pine and its gradual growth from the Upper Mesolithic to the Final Mesolithic. Appearance of alder charcoals in the FM layer coincides with a sharp increase in the alder pollen curve in the same layer.

Analysis of the wooden artefacts reveals a slightly different picture. Obviously, the choice of wood species was determined not only by availability of the material, but also by its specific properties. First of all, we are talking about large-scale use of pine for splitting into splinters and production of fishing structures (fish-traps, fish-screens). At the same time, the general dynamics of wood use, as well as the data of carpology, generally confirm the conclusions of palynology and anthracology.

Finally, with the undoubted general continuity of the economic strategies and most of the bone and flint implements, the period under consideration is characterized by at least three cultural influences, which are most clearly visible in the partial change of hunting and fishing equipment. At the same time, the earliest appearance of ceramics at the site ca. 5700 cal BC is synchronized, according to some data, with the peak of pine, which possibly occurred after large fires at the beginning of the 6th mil. cal BC. However, this version needs to be additionally studied. Moreover, in the context of obtained data, our interest has been drawn to earlier archaeological horizons and the question if the population of the site during 8.2 ka Cold Event was local in this area.

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КАТАСТРОФІЧНІ ЗМІНИ РОСЛИННОСТІ БЛИЗЬКО 8200 р.т. і ОЗЕРНІ СТОЯНКИ У МЕЖИРІЧЧІ ВОЛГИ ТА ОКИ (на прикладі стоянки Замостьє 2)

Найбільш значні зміни в господарстві і матеріальній культурі суспільств мисливців-збирачів лісової зони Східної Європи напередодні поширення керамічного виробництва збіглися з похолоданням 8200 cal BP та його наслідками. Ми розглядаємо ці зміни на конкретному прикладі стоянки Замостьє 2, розташованої у межиріччі Волги та Оки, використовуючи результати багатолітніх міждисциплінарних досліджень. Результати наших археологічних та палеоекологічних досліджень і порівняння з опублікованими даними по даному регіону показали картину локальних змін на тлі регіональної нестабільності екологічної ситуації, а також стрибкоподібного розвитку традицій матеріальної культури в другій половині 7 – початку 6 тис. cal BC.

Ключові слова: Похолодання 8200 cal BP, палеоекологічні зміни, Верхня Волга, пізній мезоліт, останні мисливці-збирачі, озерне поселення Замостьє 2

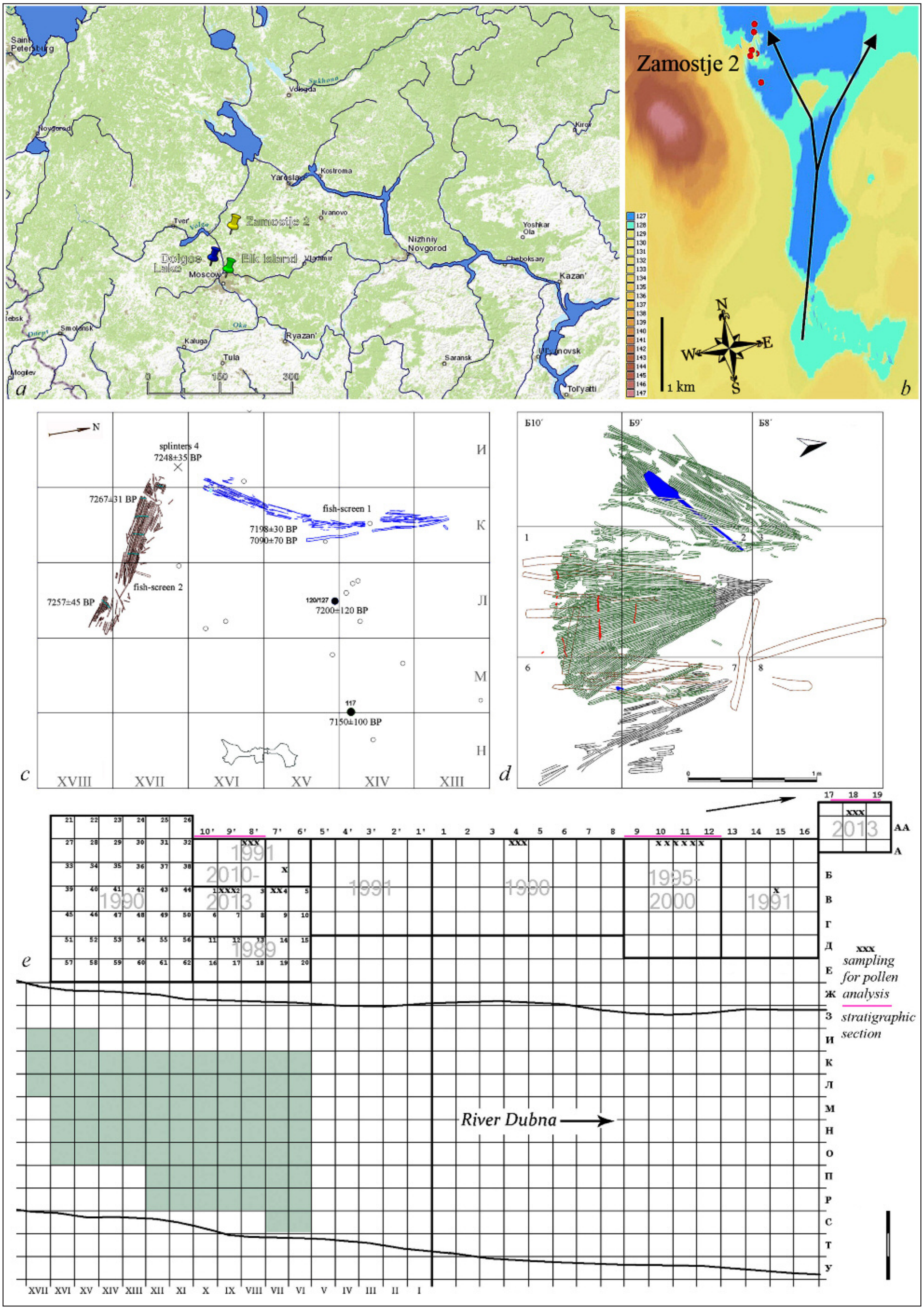

Fig. 1. Zamostje 2. Location of the site Zamostje 2, the Losiny Ostrov National Park and Lake Dolgoe; b – paleolandscape reconstruction in area of the site Zamostje 2; c –Late Mesolithic wooden fishing constructions and vertical piles in the underwater part of the site; d – Early Neolithic fish-traps complex; f – excavation scheme of Zamostje 2 (1989–1991, 1995–2000, 2010–2013) with pollen sampling places

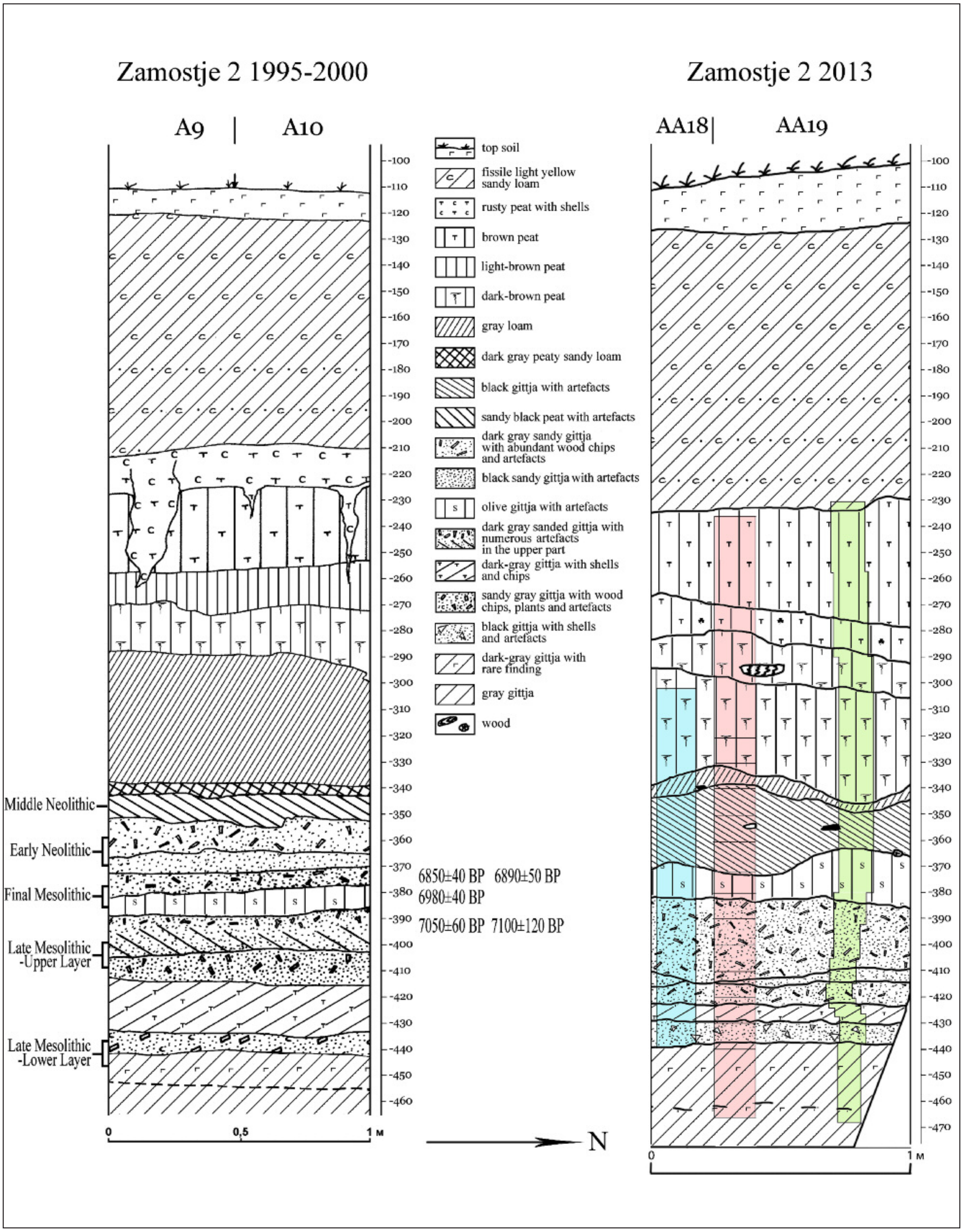

Fig. 2. Zamostje 2. Stratigraphic sections 1995–2000 (A9/A10) and 2013 (AA18), with marked sampling sites (blue column of macrobotany, pink column – 14C, green – pollen)

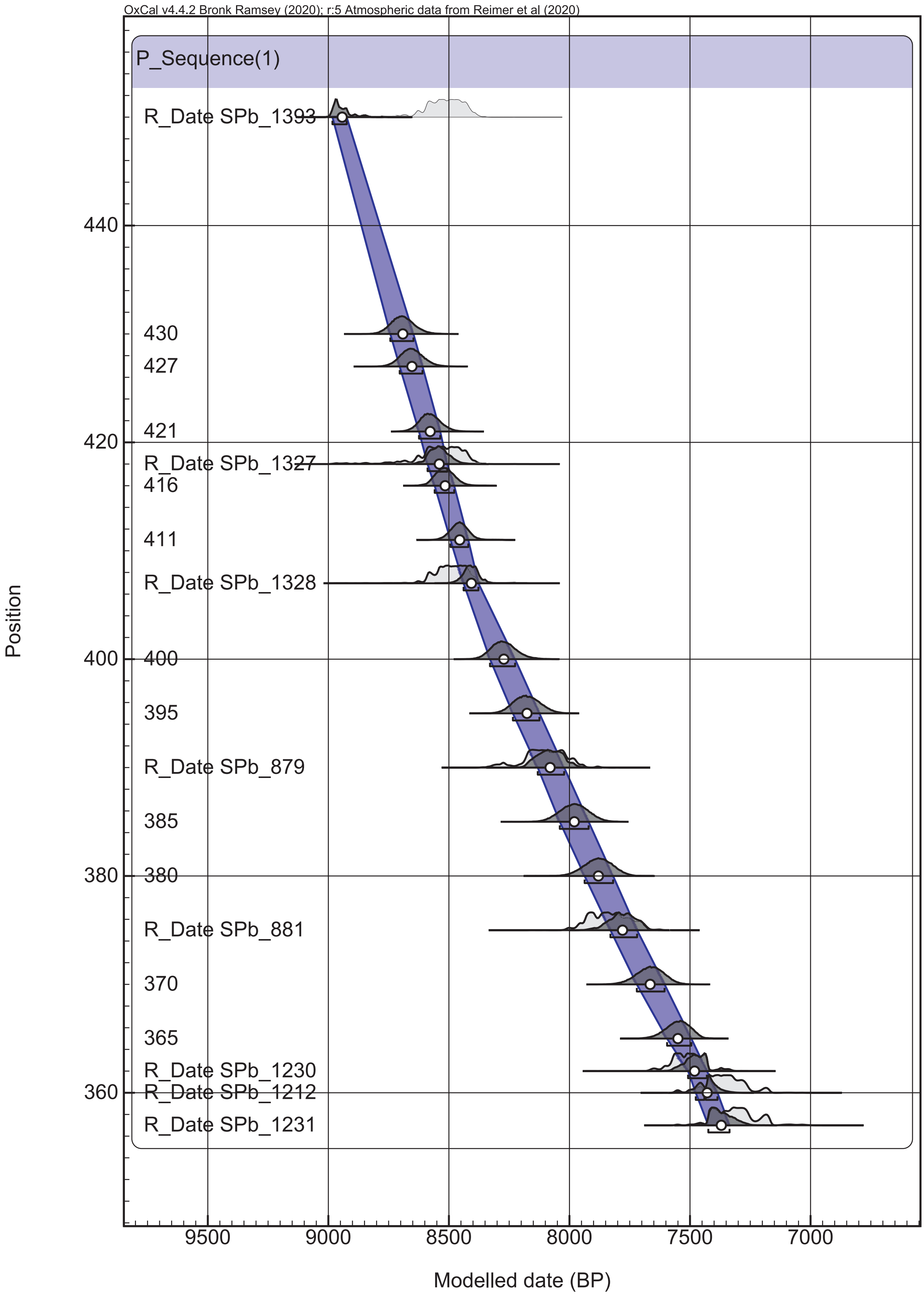

Fig. 3. Zamostje 2. Model of the rate of sediment growth in the section AA18 (2013), built from seven radiocarbon dates in the OxCal program

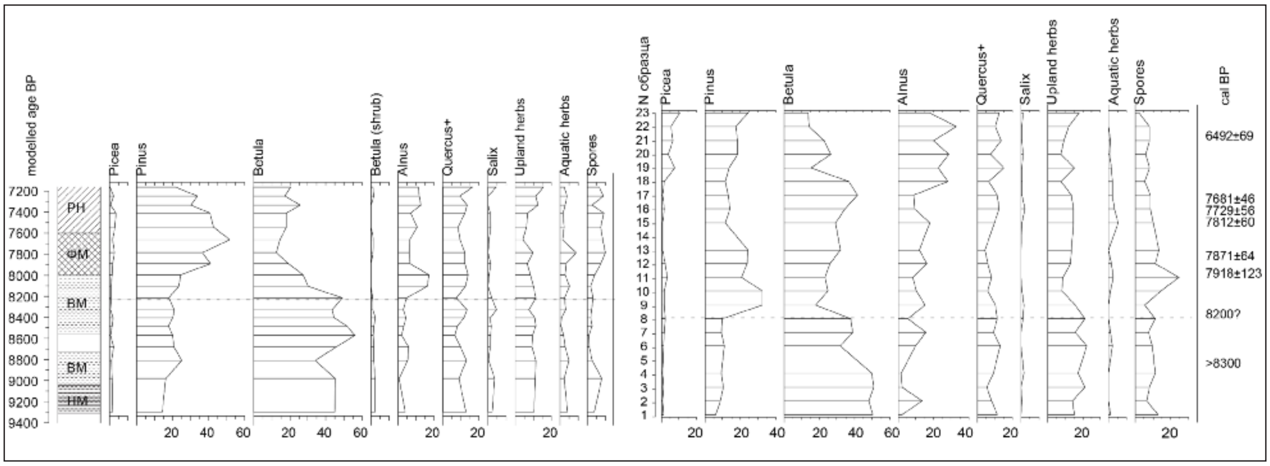

Fig. 4. Zamostje 2. Reduced spore-pollen diagrams for two stratigraphic sections: on the left, section AA18 (2013), with dates modeled in OxCal based on seven radiocarbon dates; on the right, section A9-A10 (1996), new diagram calculated on the data of E.A. Spiridonova (Spiridonova, 1996)

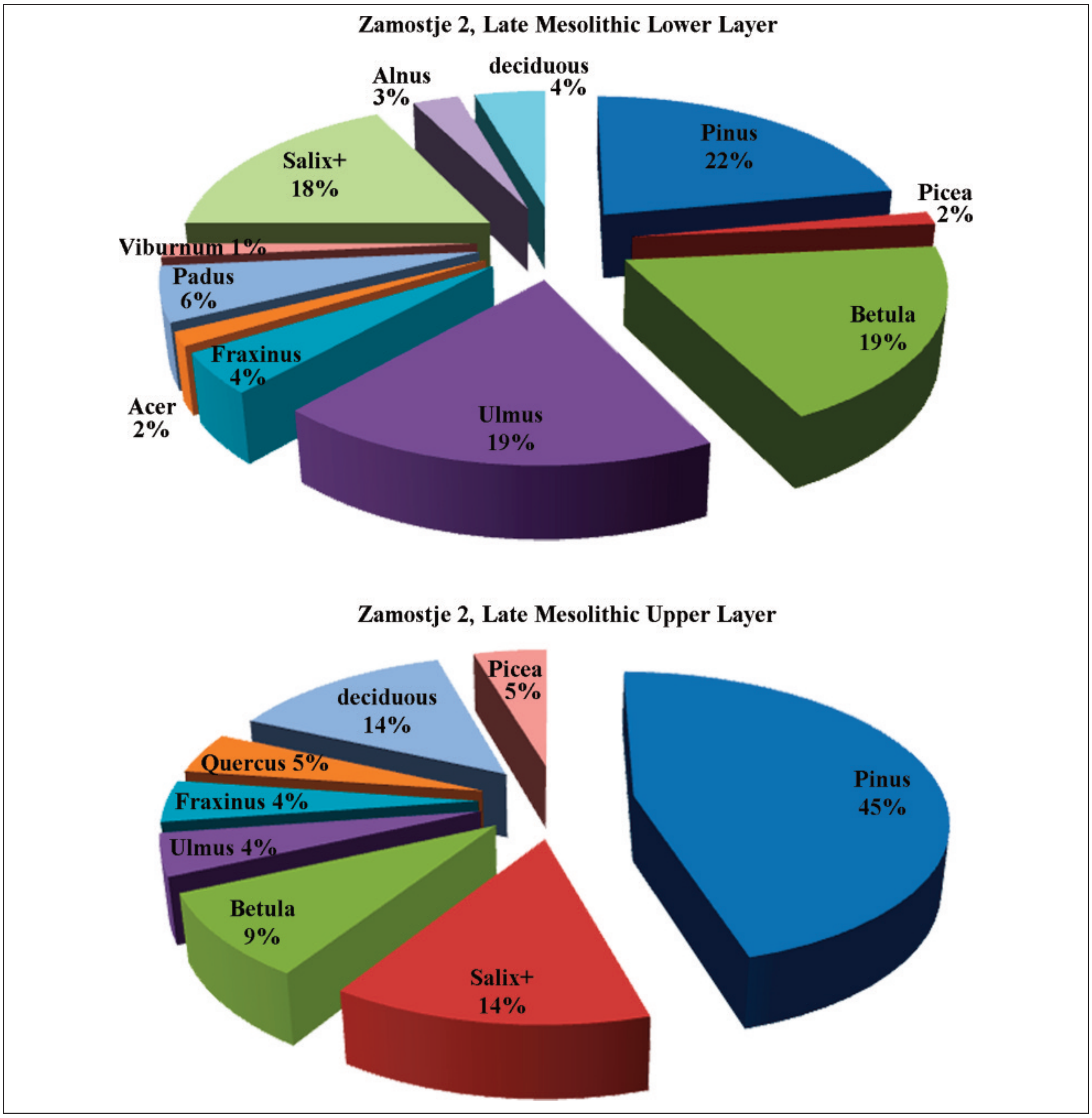

Fig. 5. Zamostje 2. Species of woods used for artefacts of Late Mesolithic layers: a – low layer (LM LL); b – upper layer (LM UL)

Fig. 6. Zamostje 2. Artefacts from bone and elk antler: EN layer – 1–11; FM layer – 12–21; LM upper layer – 22–38. Fish-hooks – 1–4, 6, 14–16, 26–30; willow willow-leaved fishing – 12–13, 22–25, arrowheads – 7–10, 20–21, 25, 33–38; barbed points – 11, 17–19, 31–32