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RADIOCARBON DATING OF WETLAND MESO-NEOLITHIC ARCHAEOLOGICAL SITES WITHIN THE UPPER VOLGA AND MIDDLE VYCHEGDA

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Abstract: Wetland sites are widespread through the central and northeastern European Russia. We performed a detailed radiocarbon dating on four such sites within the Upper Volga river basin, and one site within the middle Vychegda river basin (Komi Republic). Most of the sites contain cultural layers documenting human occupation in the Mesolithic and Neolithic periods. A variety of sample types were collected: archaeological (bones, bone artefacts, worked and unworked wood, charcoal, carbon residue etc.) and enclosing organic deposits (peat, gyttja, mud). We paid special attention to the stratigraphic relationship of the samples, concerning their archaeological context. Plant macrofossil analysis of organic deposits was performed towards determining their origin and depositional features.
This work resulted in a chronology of full Mesolithic and early Neolithic settling within the Upper Volga area, together with new data on Neolithic settling of the Sub-Ural region.

1. INTRODUCTION

Radiocarbon dating is widely used to estimate ages of archaeological cultures and to specify the stages of their development. Ages of Paleolithic to Mesolithic transition coinciding with the end of glaciation and the beginning of the Holocene; chronology of Mesolithic settling in the so called "forest zone" of Eastern Europe and ages of Mesolithic to Neolithic transition at the transition of the Boreal/Atlantic periods; and chronology of a following Neolithic settling at the same area – these are the points of a great interest for many archaeologists of the Stone Age.

We focused our studies on some aspects of this matter. The best subjects for such investigations are wetland sites. These sites often include a sequence of well-stratified Mesolithic and Neolithic cultural layers and provide a variety of materials for radiocarbon dating.

Wetland sites are widespread in central and northeastern European Russia. We studied key peat-sites enclosing a number of Mesolithic and Neolithic cultural layers, and one oxbow settlement within the Upper Volga and Middle Vychegda areas.

The main goal of our studies was to perform an extensive and detailed radiocarbon dating of cultural layers and thus obtain new chronological data for various stages of the Mesolithic and Neolithic culture development. Resulted dates and some additional plant macrofossil data of the dated samples are discussed in this article.

2. STUDY AREA

Site description

We analysed four multilayered key peat-sites within the Upper Volga river basin (Middle Russian plain), and one oxbow site within the Vychegda river basin (Komi republic, Subural) (**Fig. 1**). The Upper Volga sites are the following: Ivanovskoe-7 (Yaroslavl' region), Stanovoe-4, Sakhtysh-14, and Sakhtysh-2a (Ivanovoe region). The oxbow site Pezmog-4 is located on a right bank of the river Vychegda, 55 km eastward of Syktyvkar (**Fig. 1**).

Ivanovskoe-7 is located 30 km northeastward from Pereslavl'-Zalesskiy. The site occupies a cape at the northern side of a fen (eutrophic) bog in a lake-shaped broadening of Nerl'-Kliazminskaia river valley (Alioshinskaya

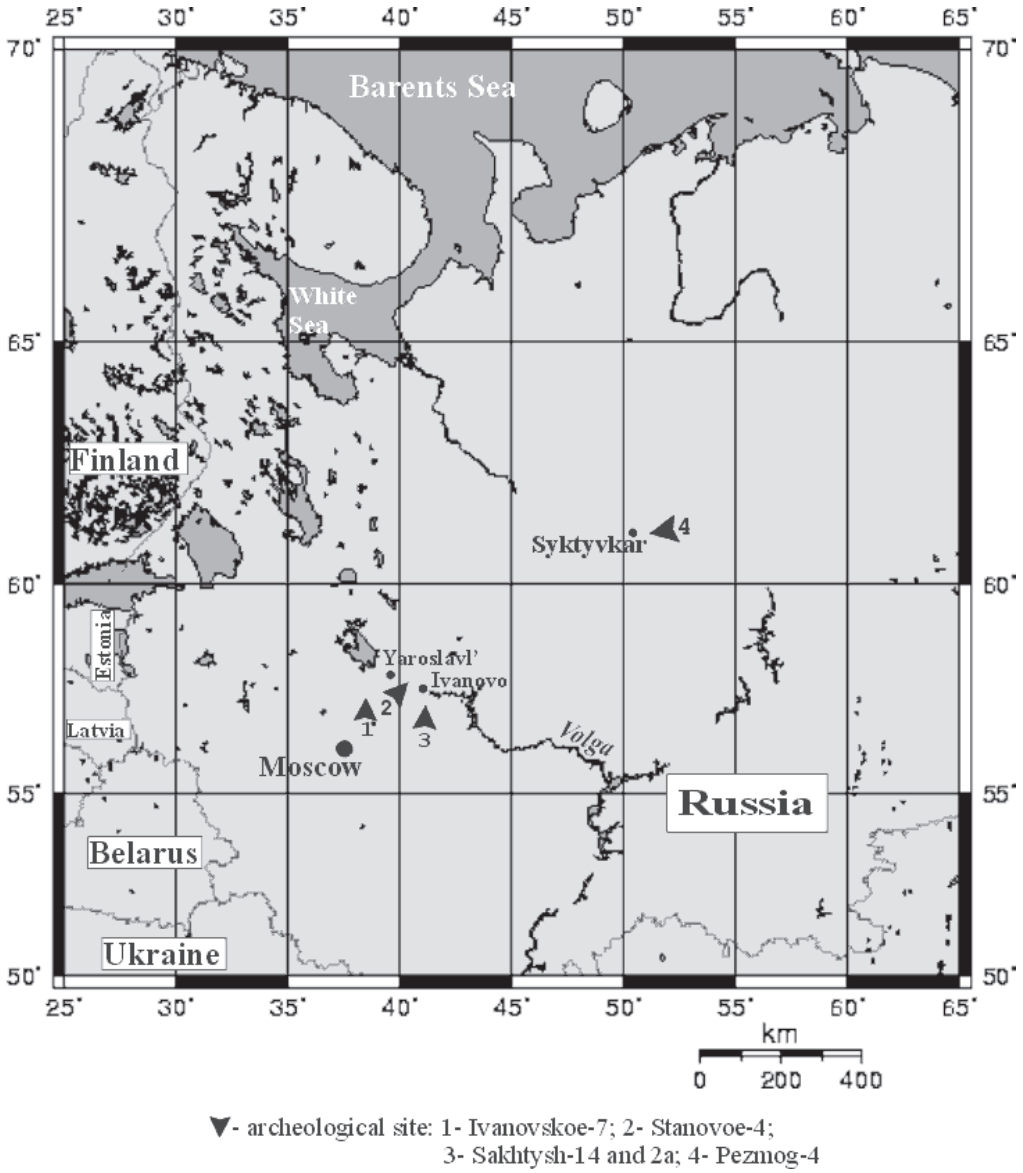

Fig. 1. *Study area: dated wetland sites of the Upper Volga and Middle Vychegda.*

and Spiridonova, 1998). This bog was formed as a result of degradation of periglacial lake; two thick gyttja layers evidence a past existence of two subjacent lakes connected with a channel (Alioshinskaya and Spiridonova, 1998). We analysed three full sections and collected individual samples over the excavation area (**Fig. 2a**).

Stanovoe-4 is located halfway between Yaroslavl' and Ivanovo, at the outlet of the Lakhost' river from Podoserskiy peat bog (Zhilin, 2002b). This peat bog was formed within an extensive glacial bolson with a lake in the central part. The site occupies a cape of an ancient lake terrace and an adjacent part of the peat bog (Zhilin, 2002b). We collected samples from the two full sections and over the excavation pits (Zaretskaya *et al.*, 2002; **Fig. 2b**).

Sakhtysh-14 and Sakhtysh-2a are located within the Sakhtysh peat bog, *ca* 45 km southwestward from Ivanovo, at the right bank of the present Koika river. According to gyttja layers underlying peat deposits, a wide lake occupied this area in the past (Zhilin, 2002a). Most of the samples descended from one full section and a reconnaissance trench at Sakhtysh-14; few samples were collected from the excavation wall of the Sakhtysh-2a site, and ceramic fragments were collected over the excavation pit (**Fig. 2c**).

Pezmog-4 is located far from the other sites, in the centre of Komi Republic, on the right bank of Vychegda river. The site is related to a floodplain, and buried by oxbow lake (and then by oxbow bog) deposits. Now the site is surrounded by a pine forest. The samples were collected from the excavation pit (**Fig. 2d**).

Ivanovskoe-7, Stanovoe-4, and Sakhtysh-14 have been excavated for years by M.G. Zhilin and contain 5, 4, and 5 cultural layers respectively (Zhilin, 1998; 1999; 2002a and 2002b). Sakhtysh-2a has been excavated by E.L. Kostyliova and M.G. Zhilin and contains 3 cultural layers (Kostyliova and Zaretskaya, 2000). Pezmog-4 has been excavated by A.V. Volokitin and V.N. Karmanov (Volokitin *et al.*, 1998) and contains 1 cultural layer. Layer numbers and their archaeological attribution are presented in **Table 1**.

Table 1. *Cultural layers of the analysed sites.*

Sites	Ivanovskoe-7 (Zhilin, 1998)	Stanovoe-4 (Zhilin, 2002a)	Sakhtysh-14 (Zhilin, 2002b)	Sakhtysh-2a (Kostyliova and Zaretskaya, 2000)	Pezmog-4 (Volokitin *et al.*, 1998)
Layers and cultures					
I	Lyalovskaia advanced Neolithic		Final Butovo Mesolithic	Upper Volga early Neolithic	Kamskaya early Neolithic
II	Upper Volga early Neolithic	Upper Volga early Neolithic	Late Butovo Mesolithic	Final Butovo Mesolithic	
IIa	Final Butovo Mesolithic			Upper Butovo Mesolithic	
III	Late Butovo Mesolithic	Middle Butovo Mesolithic	Middle Butovo Mesolithic		
IIIa		Ienevo Mesolithic			
IV	Early Butovo Mesolithic	Earliest Butovo Mesolithic	Early Butovo Mesolithic		

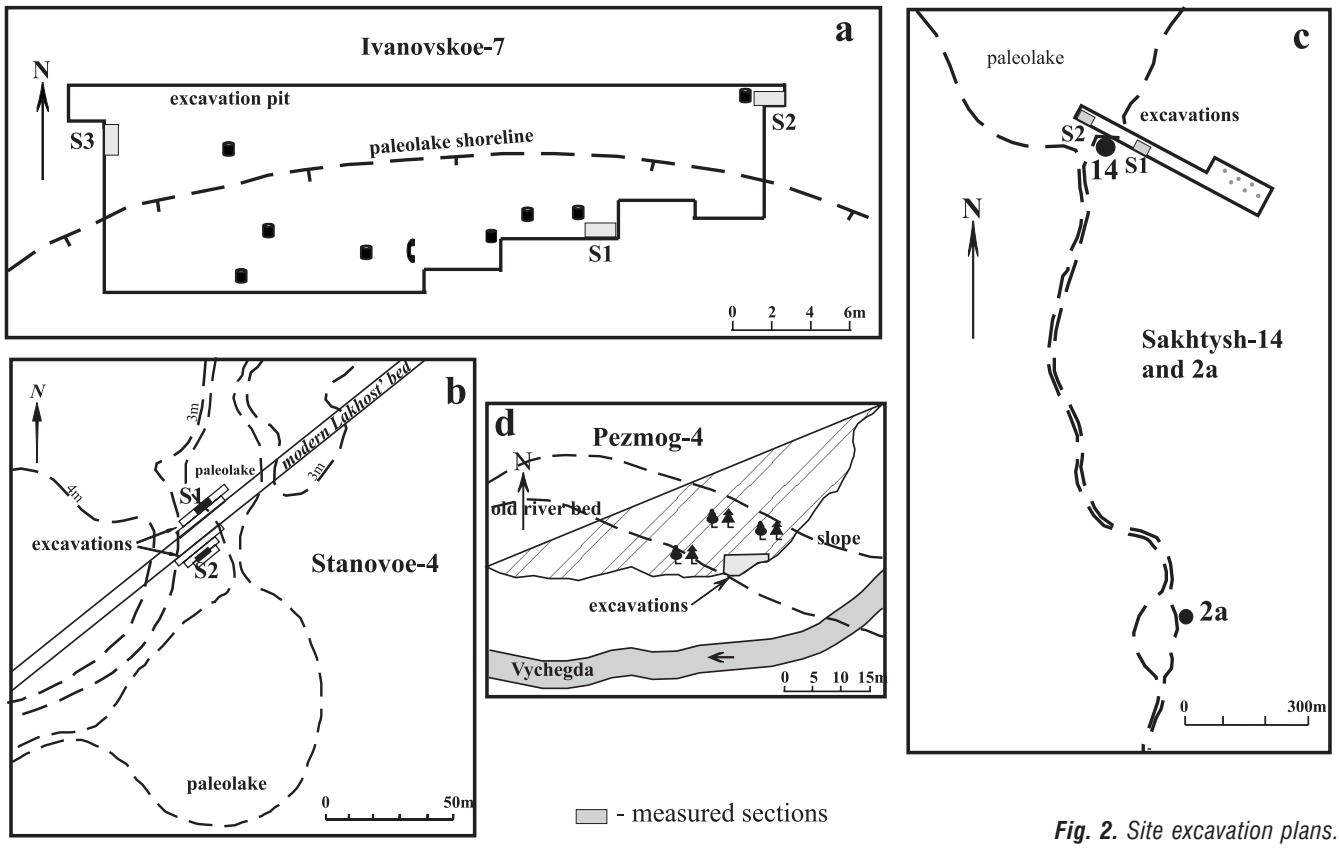

Fig. 2. *Site excavation plans.*

3. METHODS

Radiocarbon dating

Sample selection strategy

We collected all the possible types of radiocarbon samples at the sites during the excavations.

First of all, the whole section (one at Sakhtysh-2a and 14, two at Stanovoe-4, and three at Ivanovskoe-7) was dated; we collected peat, gyttja, and organic silt, taking samples from the boundaries of lithological and cultural layers (**Figs 3-5**). In the case of two- or three-section sampling, all sections were thoroughly correlated *inter se*. From each section, 10-25 samples were collected. At Pezmog-4, mud enclosing cultural remnants was collected for dating (**Fig. 6**). Taking such samples we tried to establish the synchronicity of cultural remains and enclosing deposits, and to study the possibility of dating archaeological layers in the case of absence of artefact dating material. As a result, a sort of "chronological framework" for each site was established.

A part of each sample (except for Ivanovskoe-7 and Sakhtysh-2a) was forwarded for plant macrofossil analysis.

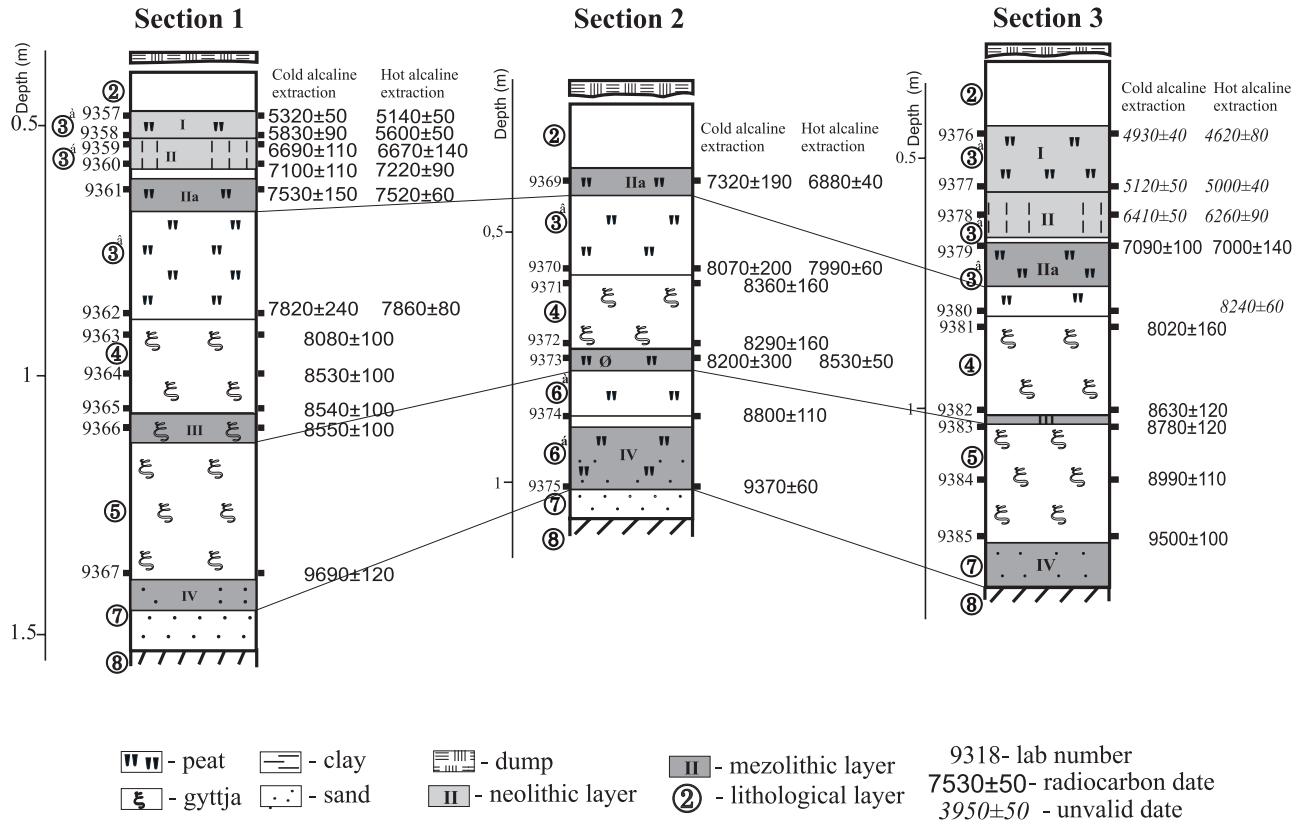

Fig. 3. *Dated sections of Ivanovskoe-7.*

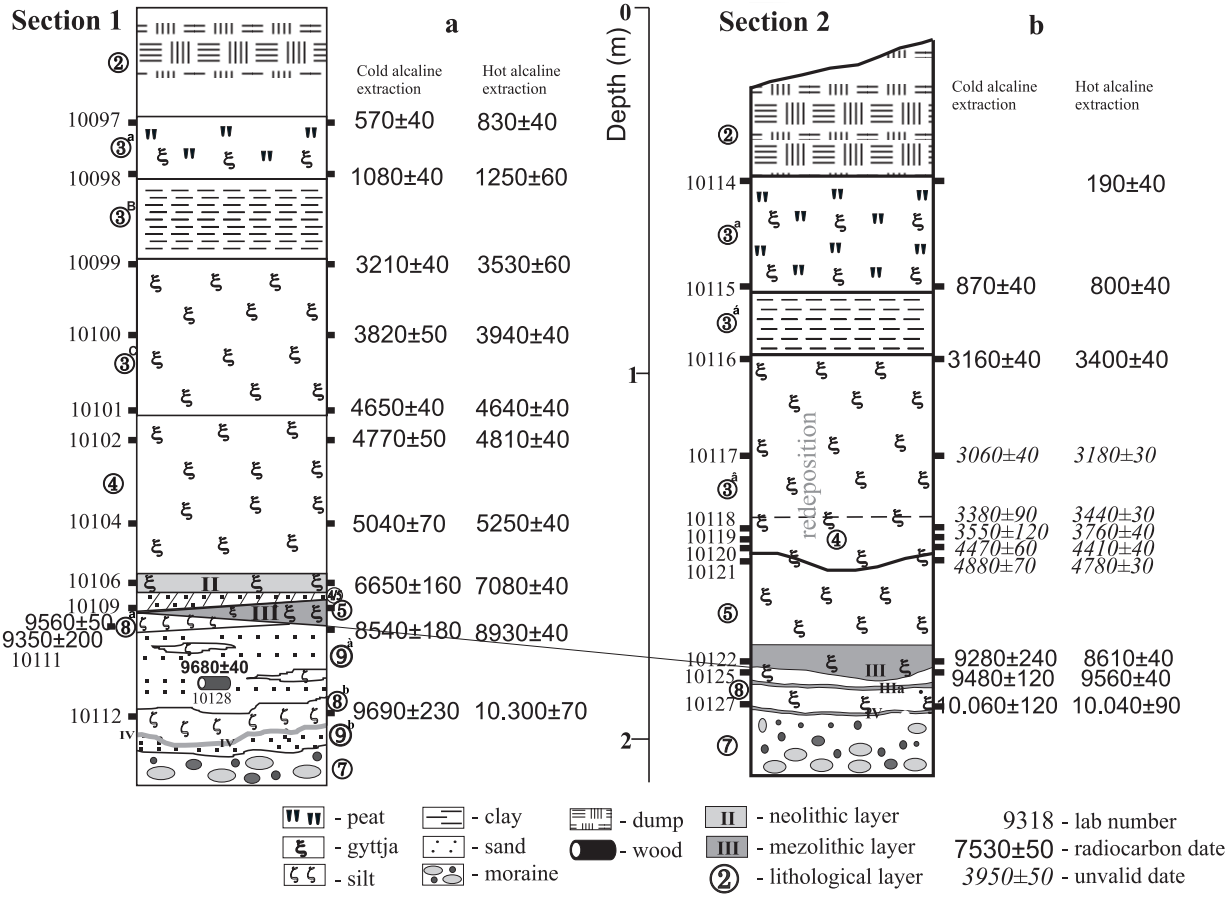

Fig. 4. *Dated sections of Stanovoe-4.*

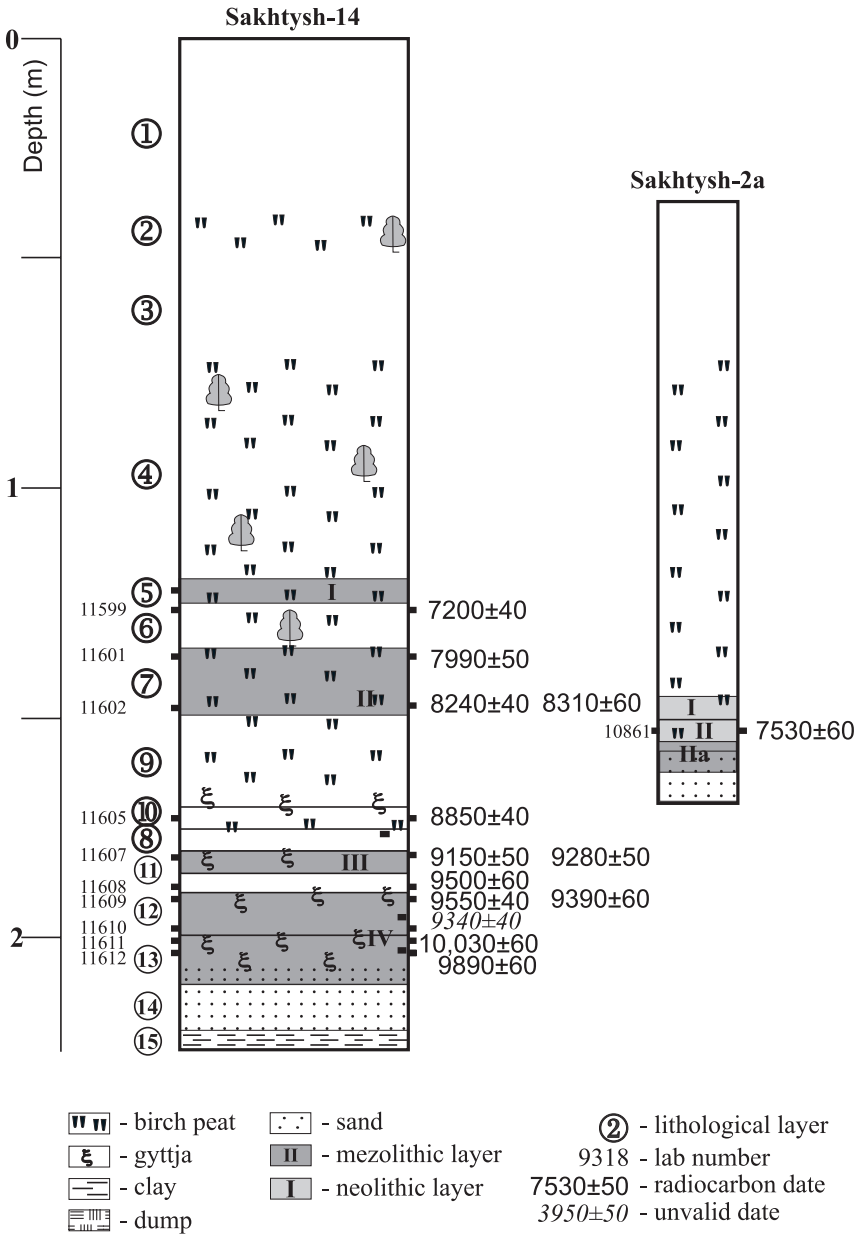

Fig. 5. *Dated sections of Sakhtysh-14 and Sakhtysh-2a.*

Pieces of wood (reworked and non-reworked) were very common all over the surveyed sites. They were collected from the sections and through the excavation areas, from various stratigraphic and archaeological horizons. Non-reworked wood included branches and small logs. Reworked wood was collected from the cultural layers and included sticks (the majority of such samples), charred wood pieces, fire hooks, basket traps, cut wood, and small planks. There were no charcoals at the peat sites; one charcoal sample was obtained from Pezmog-4.

Samples of charred food residues at the ceramic vessels' walls were found only at Sakhtysh-2a and Pezmog-4. The Sakhtysh-2a sample was scraped down from a plenty of ceramic fragments collected at the same archaeological layer. The Pezmog-4 sample was obtained from one well-preserved ceramic vessel.

Bone artefacts (mostly from eaten elks) were collected within the Mesolithic layers of the peat sites.

Laboratory work

Radiocarbon dating of all samples was performed in the Radiocarbon division of the Laboratory for Isotope Geochemistry and Geochronology, Geological Institute of Ras (GIN- index). Pre-treatment A-B-A or A-B_I-B_{II}-A procedures for peat, gyttja, organic silt, charcoal, and wood samples are thoroughly described in the articles of Zaretskaya *et al.* (2001a; 2001b; 2002). Bone pre-treatment is recited by Dr Sulerzhitsky (Sulerzhitsky, 1997; Sulerzhitsky and Romanenko, 1999). In the case of dating peat, gyttja, or silt, we used the two-alkaline extraction process for Ivanovskoe-7 and Stanovoe-4 samples, and one hot alkaline extraction for Sakhtysh sites and Pezmog-4.

Charred food residue samples passed a standard A-B-A pre-treatment: we used low-concentrated cold solutions of HCl and NaOH to wash ceramic fragments with residue (Sakhtysh case) or residue powder (Pezmog case).

Further stages are the same as for other samples (Zaretskaya *et al.*, 2001a; 2001b; 2002).

Resulted data and date selecting strategy

We obtained very large radiocarbon data sets for each archaeological site. In the case of applying two-alkaline-extractions procedure, we obtained two dates for each sample. In other cases, we obtained one date. The total number of dates obtained for each site is given in **Table 2**.

To establish time boundaries of the Mesolithic and Neolithic stages for each site and then to compare "synchronous" ages of settling, we selected valid dates from resulted sets. We propose the following criteria of date validity:

1. Consistency of dates with the stratigraphic order of samples in the profile;
2. Plant composition of sample (pure (*in situ* formed) peat, gyttja, or silt; no dates obtained on redeposited detritus were used);
3. Date synchronicity for the same lithological/cultural layer obtained from various sections within the excavation pit;
4. Consistency of dates of artefacts and deposits from the same archaeological layer;

To calibrate ages, we used the OxCal Program v. 3.9 (Bronk Ramsey, 1995, 2001 and 2003). To avoid "information noise", we haven't calibrated each individual date, but used the operation "sum probability distribution" (Bronk Ramsey, 2003) to estimate the chronological distribution of the dates (ages) within each cultural stage.

Plant macrofossil analysis

Detailed radiocarbon dating went along with plant macrofossil analysis of peat, gyttja, silt, and oxbow lake sediments (mud). Determination of plant macrofossils was performed by O.N. Uspenskaya for the sections of Stanovoe-4 (**Figs 7-8**) and Sakhtysh-14 (**Fig. 9**). As a result, we obtained lists of plant and algae species composing these samples.

Plant composition of peat and the plant-algae/mineral ratio of gyttja are the main characteristics indicating their origin and depositional features. A proportion of palustrine, palustrine-aquatic, and aquatic plant species can reflect the mire, littoral or lacustrine environment at the studied site. Species composition of gyttja deposits usually shows sedimentary depth and environment.

Also, plant macrofossil data reflect local environmental conditions that followed accumulation of archeologically mute strata alternating with layers containing cultural remains. Unlike the spore-pollen data showing regional climatic changes during the Holocene, plant macrofossil data allows to receive evidence of local environmental influence on site development through Mesolithic and Neolithic periods.

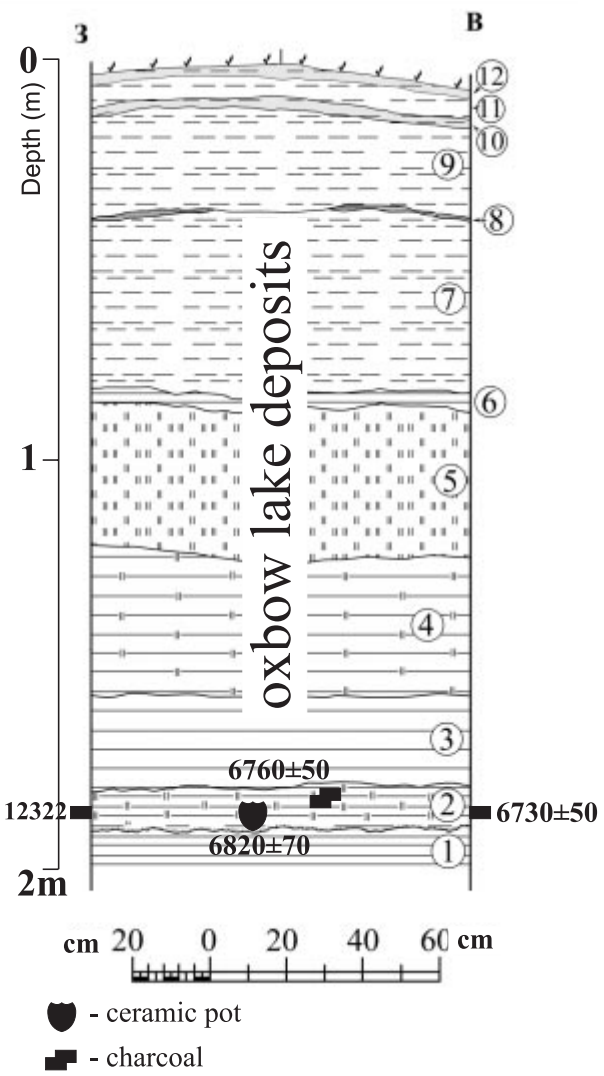

Fig. 6. *Dated section of Pezmog-4.*

Table 2. *Number of radiocarbon dates obtained for wetland sites.*

Archeological site	Total number of samples/dates	Peat, gyttja, silt and mud dates	Wood dates (non-reworked, reworked, charcoal)	Bone dates	Charred food residue dates
Ivanovskoe-7	40/54	41	9	1	
Stanovoe-4	34/55	42	11	1	
Sakhtysh-14	28	18	7	3	
Sakhtysh-2a	5	1	2	1	1
Pezmog-4	3	1	1		1

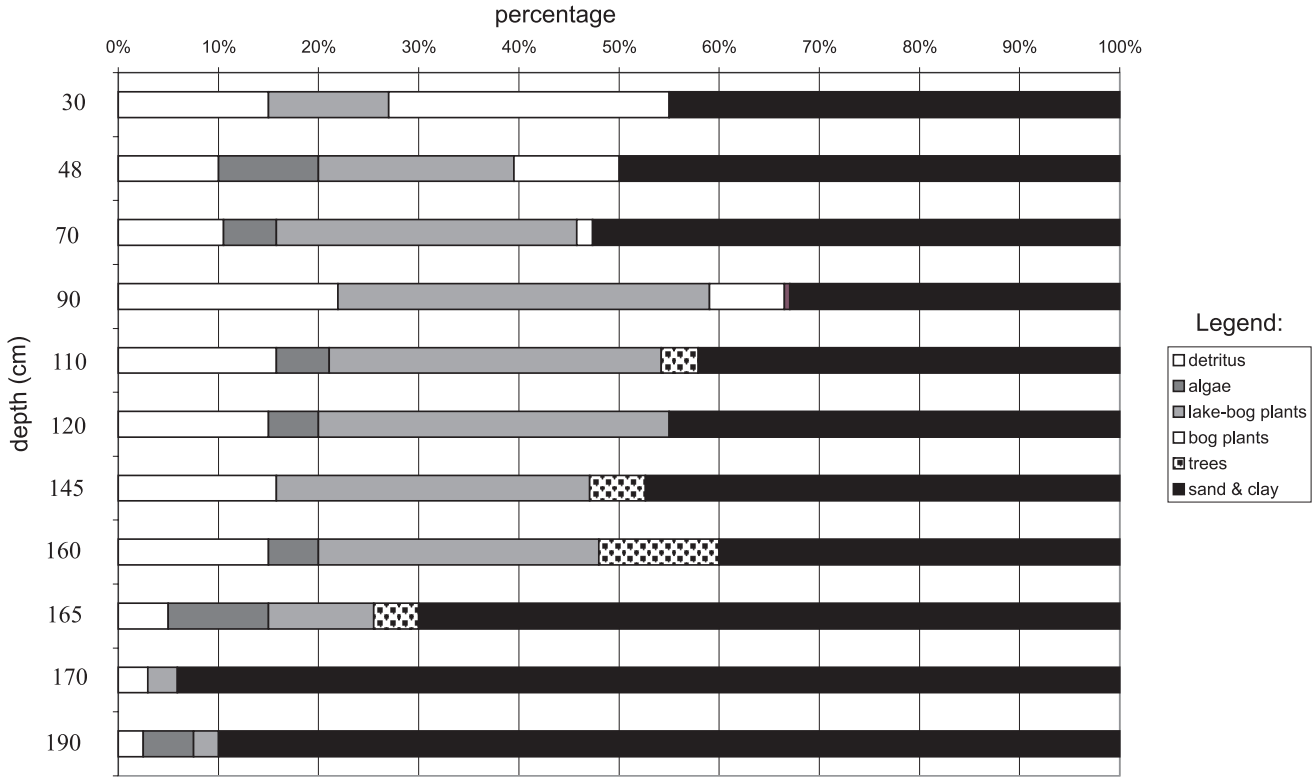

Fig. 7. *Plant macrofossil composition of Stanovoe-4 section 1.*

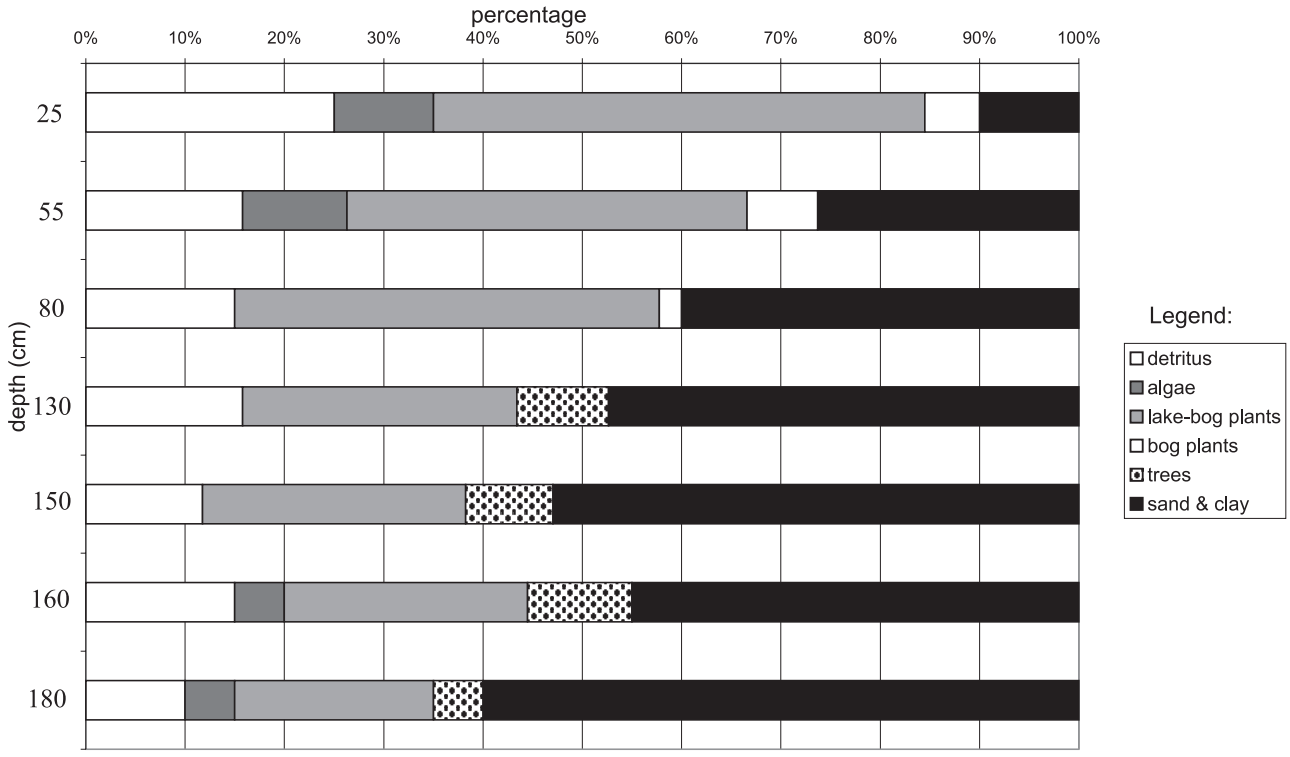

Fig. 8. *Plant macrofossil composition of Stanovoe-4 section 2.*

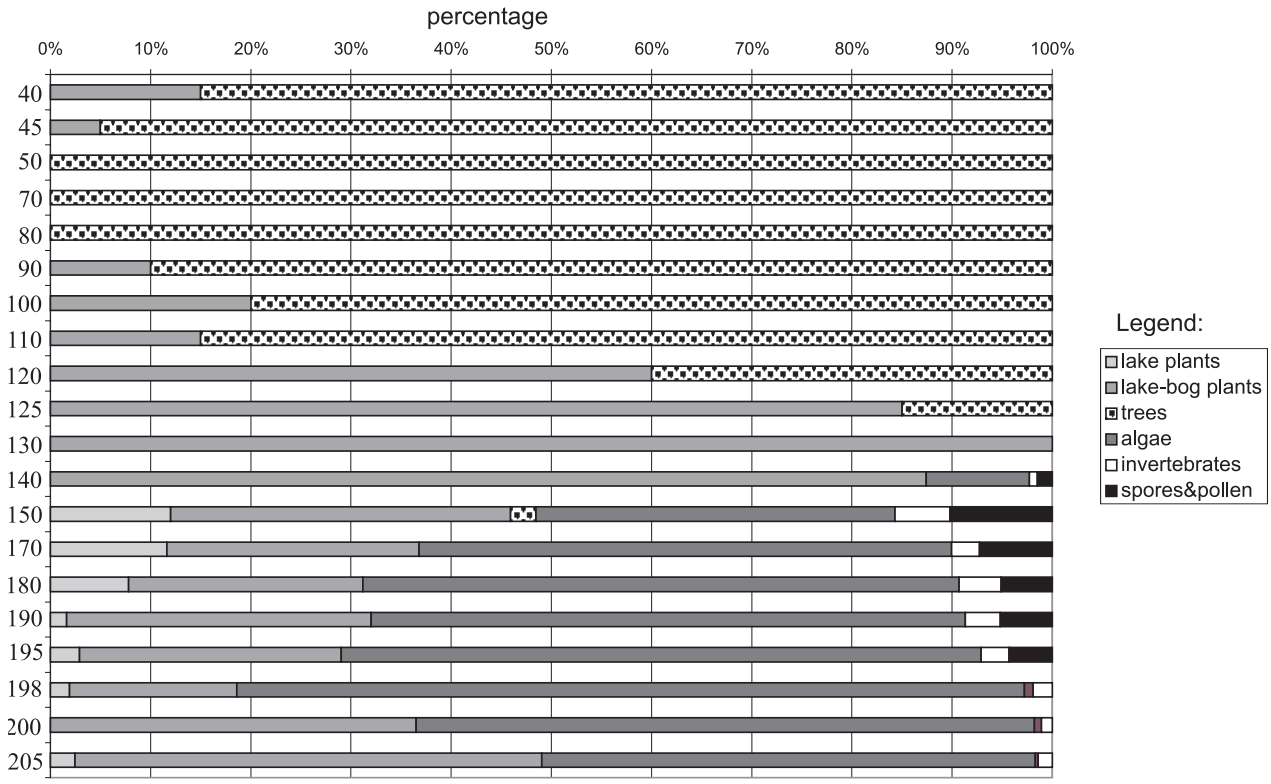

Fig. 9. *Plant macrofossil composition of Sakhtysh-14 section.*

4. RESULTS AND DISCUSSION

Mesolithic

Early Mesolithic

Early Mesolithic layers are found at Stanovoe-4, Ivanovskoe-7, and Sakhtysh-14 sites, and represent Ienevo and the early stage of Butovo cultures (**Fig. 10**). The dates are presented in **Table 3**.

Stanovoe-4 is the earliest dated Mesolithic settlement on the Russian plain. Dates of the lowest cultural layer are obtained on organomineral silt and gyttja overlying the cultural layer IV in section 1 and enclosing it in section 2 (**Fig. 4**). The dated wood (9680±40) was found in the sandy layer overlying the silty layer overlying cultural remains, and it marks the upper time boundary for the earliest Mesolithic settling here. The plant composition of samples overlying/enclosing cultural layer shows a "slowly cooling water" (silt) (**Fig. 4a**) and "shallow littoral" (gyttja) (**Fig. 4b**) environment of sedimentation. Thus we can suppose two ways of layer accumulation (the situation is complicated by the absence of samples from archaeological context): as an apron, then the age of the settling here is *ca* 10,300 - 10,060 BP; the second way is an overlying of cultural remains by transgressing lake sediments, and then the age of early Mesolithic settling here would be older than 10,300 BP. In any case, these are the earliest dates for Russian Plain Mesolithic, marking the end of final Palaeolithic – early Mesolithic transition stage.

Another early Mesolithic layer IIIa at Stanovoe-4 pertains to Ienevo culture. It lies above the Earliest Butovo layer and is separated from it by "mute" sandy and gyttja horizons. The oldest date for this layer, obtained for a stick, is 9620±60 BP. Other dated sticks are 9590±40 and 9620±60 BP old, and the dates for the overlying gyttja are 9560±40 and 9560±50 BP. Thus, that was a very short period of settling that became possible due to short-lasting regression of the nearby lake.

Synchronously to the Ienevo settling at Stanovoe-4, the early Butovo people inhabited Ivanovskoe-7; the dates of cultural remains ranged here from 9650±110 to 9500±110 BP. The gyttja overlying the cultural layer IV has the same span of ages. Thus we can suppose (according to excavation plan) the age of settling to be *ca* 9690-9500 BP, and maybe older; then the settlement moved northwards due to the lake transgression. This natural event caused abandonment of this place and cut off the Ivanovskoe-7 Mesolithic settling for hundreds of years.

Early Mesolithic layer (IV) at Sakhtysh-14 are the youngest among the dated sites. The gyttja enclosing cultural layers is dated from 10,030±60 to 9390±60 BP, though the ages of cultural remains range from 9550±60 to 9350±40 BP. Thus we can suppose that this layer deposited as an apron in the lake littoral zone during the period *ca* 9550-9350 BP, and some of the dated samples sank down the loose gyttja after being thrown out, that caused the lack of coincidence of the gyttja and archaeological dates. Probably, the dates 9250±210 and 9200±90 BP are also related to this layer, marking a transition stage from early to middle Butovo culture, but this statement requires more dating.

Results of calibration of ^{14}C dates are presented in the **Fig. 11**. At Stanovoe-4, the most active earliest Mesolithic habitation period falls within 9600-9250 calBC; Early

Butovo settling of Ivanovskoe-7 went along with Ienevo peopling of Stanovoe-4; the Sakhtysh-14 settling falls into two stages.

Middle Mesolithic

Middle Mesolithic layers are found at Stanovoe-4 and Sakhtysh-14 and represent the middle stage of Butovo culture (**Fig. 10**). All the dates are presented in the **Table 4**.

According to these dates, middle Mesolithic settling at Stanovoe-4 occurred for larger time than at Sakhtysh-14, probably, due to better local environmental conditions.

At Stanovoe-4, the largest phase of settling is represented by layer III. The oldest date for this layer (9280±240 BP) is obtained on the gyttja enclosing cultural remains in the section 2; the synchronous date for a stick was obtained earlier and it is 9220±60 BP. Also the bone was derived from this section (8850±90 BP), and the youngest gyttja here is dated to 8610±40 BP. Gyttja dates from the section 1 are 8930±40 and 8500±150 BP (the oldest and the youngest respectively), thus we can suppose the settlement widening and latter migration northwards within this period of time. Other dates obtained on archaeological samples (sticks) are 8700±70, 8670±50, and 8540±60 BP, and the youngest dates for sticks and gyttja coincide. Therefore, here the cultural layer was accumulating synchronously with enclosing gyttja as an apron, and the settling duration in the middle Mesolithic is estimated to *ca* 800 radiocarbon years.

The layer IIIa at Sakhtysh-14 is of the same stage of Butovo Mesolithic culture. We obtained only 4 dates for this layer; gyttja enclosing cultural remains showed an accumulation period from 9280±50 until 9150±50, although the archaeological dates are younger: 9010±60 (stick) and 8800±100 (elk bone). Therefore, we guess that 1) people inhabited this place after the lake regression, and were tramping out their garbage into earlier deposited sediments; 2) people settled the near-shore area and were throwing out their garbage into the lake (littoral zone). Anyway, accumulations of lithological and cultural layers are non-synchronous in this case.

Both layers at Stanovoe-4 and Sakhtysh-14 show the synchronous settling, although Sakhtysh-14 was being

Table 3. *Early Mesolithic dates of the Upper Volga wetland sites.*

Site	Culture	Sample No.	Material	^{14}C Age (yr BP)
Stanovoe-4	Earliest Butovo	10112	Silt	9690±230; 10.300±70
		10126	Gyttja	9970±50; 9940±500
		10127	Gyttja	10,060±120; 10,040±90
		10128	Wood	9680±40
Stanovoe-4	Ienevo	8374	Stick	9620±50
		8376	Stick	9590±40
		8377	Stick	9620±60
		10125	Gyttja	9480±120; 9560±40
		10111	Silt	9350±200; 9560±50
Ivanovskoe-7	Early Butovo	9516	Wood	9640±60
		9520	Bone	9650±110
		9385	Gyttja	9500±100
		9517	Wood	9500±110
		9367	Gyttja	9690±120
Sakhtysh-14	Early Butovo	11177	Gyttja	9250±210; 9390±60
		11179	Bone	9350±40
		11612	Gyttja	9890±60
		11611	Gyttja	10,030±60
		11609	Gyttja	9550±40
		11608	Gyttja	9500±60
		11615	Wood	9450±60
		11616	Reworked wood	9550±60
		11621	Reworked wood	9420±40
		11624	Reworked wood	9450±60
		11054	Stick	9400±60

Table 4. *Middle Mesolithic dates of the Upper Volga wetland sites.*

Site	Culture	Sample No.	Material	^{14}C Age (yr BP)
Stanovoe-4	Middle Butovo	10109	Gyttja	8540±180; 8930±40
		10110	Gyttja	8500±150; 8640±60
		10122	Gyttja	9280±240; 8610±40
		8375	Stick	9220±60
		10093a	Bone	8850±90
		8854	Stick	8700±70
		8856	Stick	8670±50
		8853	Stick	8540±60
Sakhtysh-14	Middle Butovo	11180	Elk scull	8800±100
		11607	Gyttja	9150±50; 9280±50
		11053	Stick	9010±60

inhabited for shorter time (ca 200 ^{14}C years) due to lake transgression that terminated the settling at ca 8800 BP (according to a gyttja date of the overlying lithological layer).

Calibration shows (**Fig. 11**) a peak of middle Butovo settling at Stanovoe-4 *ca* 7500 calBC, that reflects the settlement widening; at Sakhtysh-14, on the contrary, the peak occurs at the beginning of the middle Mesolithic peopling, and then the settlement came to naught.

Late Mesolithic

Late Mesolithic layers are found at Ivanovskoe-7, Sakhtysh-14, and Sakhtysh-2a (**Fig. 10**) and represent a transitional stage from the middle to late Butovo culture (at Ivanovskoe-7) and a late stage of Butovo culture (at Sakhtysh-14 and Sakhtysh-2a) respectively. All the dates are presented in **Table 5**. Ages were obtained on deposits enclosing cultural layers; no archaeological dates were determined for these stages.

Layer III at Ivanovskoe-7 was found in all dated sections. The date obtained for the gyttja sample from the "deepest" section 1 (**Fig. 2a**) is 8550±100 BP, and the date of gyttja overlying the cultural layer is 8540±100 BP, thus here we dated an upper stage of the layer accumulation. Dates from section 2 (upwards from the lake, hypsometrically highest of the site) show the time span from 8530±50 BP until 8200±300 BP. Gyttja overlying the cultural layer in this section showed the age 8290±160 BP; little reversal lies within the standard deviation interval. Dates from section 3 (which is hypsometrically between 1 and 2) are older: 8780±120 BP for the layer and 8630±120 BP for the overlying gyttja. Eventually, these dates could relate to the archaeological context, but it is most likely that the cultural remains here were being tramped into older sediments between two transgressive periods of the lake. Thus, people inhabited this site from *ca* 8550 till 8200 BP (**Fig. 10**).

Layer II at Sakhtysh-14 representing the late period of Butovo culture is dated in the section and (one sample) in the reconnaissance trench. The oldest date is 8310±60 BP, and the dates at the section are 8240±40 and 7990±50 BP (the bottom and the top of archaeological/lithological layer), marking the upper limit of late Mesolithic settling of the site. Thus, we suppose that the inhabitation took *ca* 300 ^{14}C years, in a birch forest on a swampy surface near palaeolake.

At Sakhtysh-2a, we have the only date for the late Butovo stage, which falls within the Sakhtysh-14 late Butovo settling time.

The calibration of ^{14}C dates confirm completely the observations set before (**Fig. 11**); a very short transitional settling of Ivanovskoe-7 and quite a long-lasting habitation of Sakhtysh system.

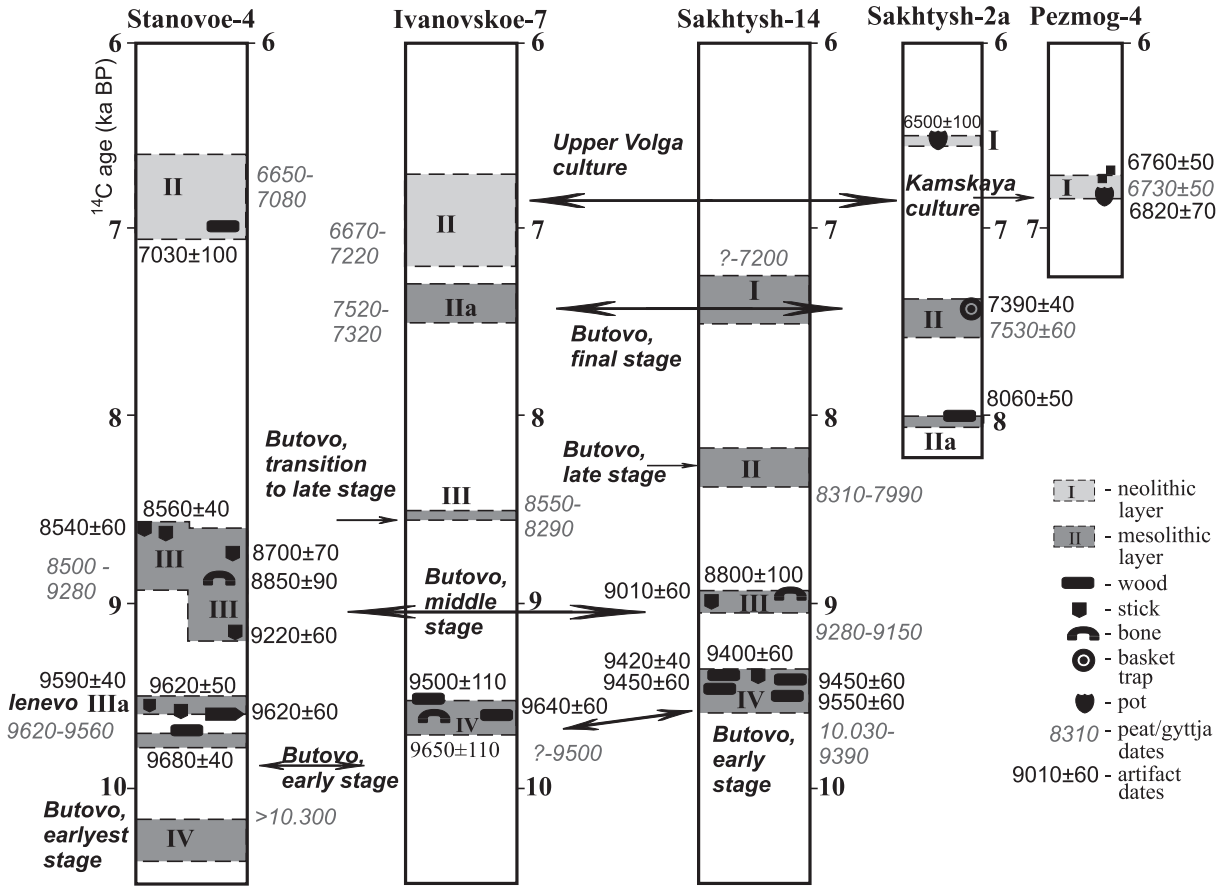

Fig. 10. *Ages of Mesolithic and Neolithic settling within the Upper Volga and Middle Vychegda.*

Final Mesolithic

Final Mesolithic layers were found at Ivanovskoe-7, Sakhtysh-14, and Sakhtysh-2a sites (**Fig. 10**). All the dates are presented in **Table 6**.

At Sakhtysh-2a, samples came from the bottom of the peat overlying the sand. The date of a fish basket trap has a good concordance with that of enclosing peat. The settlement started on a sandy surface near the small lake (Zhilin, 2002a) and then migrated upwards, although people came back to the lake shore and were setting up fishing traps there.

Layer IIa at Ivanovskoe-7 is dated in all the three sections, and shows younger dates of the final Mesolithic settling. The oldest dates come from section 1 (hypsometrically deepest) - 7530±150 BP and 7520±60 BP. Most of other dates lie in the interval between 7320±190 and 6880±40 BP. These dates should be considered as outliers due to sample contamination from a dump directly overlying the cultural layer (section 2) or due to young matter spilling through shrinkage cracks (section 3). Thus, final Mesolithic people inhabited Ivanovskoe-7 at *ca* 7500-7320 BP.

A final Mesolithic date obtained from the peat enclosing layer 1 at Sakhtysh-14 falls in the same time interval, but we cannot estimate the duration of the final Mesolithic settling at this site.

Calibration of ^{14}C dates shows (**Fig. 11**) the consistency of final Butovo settling at Ivanovskoe-7 and Sakhtysh-2a; a latter habitation peak at Sakhtysh-14 shows, most likely, the youngest limit of the final Mesolithic settling at this site.

Early Neolithic

Early Neolithic layers were found at Stanovoe-4, Ivanovskoe-7, Sakhtysh-2a, and Pezmog-4 (**Fig. 10**). All the dates are presented in **Table 7**.

Dates from Ivanovskoe-7 show the longest time span of early Neolithic accumulation. The oldest date is 7220±90 that concides with the upper limit of the Mesolithic settling at the Russian plain. Probably there was no gap between final Mesolithic and early Neolithic there, but the period around 7200 BP was considered as extremely arid over this area (Alioshinskaya, 2001), and any settling was hardly possible then. So we can suppose that this date points only a start of soil accumulation at Ivanovskoe-7, and consider the dates 7030±100 (small plank at Stanovoe-4) and 7080±40 BP (enclosing gyttja) as the most liable of the lower boundary of Neolithic settling in the Upper Volga area.

Other dates from all the dated sites fall in the interval 7030-6500 BP; the date 6500±100 is probably not the youngest one for the Upper-Volga culture, because it is

Table 5. *Late Mesolithic dates of the Upper Volga wetland sites.*

Site	Culture	Sample No.	Material	^{14}C Age (BP)
Ivanovskoe-7	Middle-to-late Butovo	9366	Gyttja	8550±100
		9365	Gyttja	8540±100
		9373	Peat	8200±300; 8530±50
		9372	Gyttja	8290±160
		9383	Gyttja	8780±120
		9382	Gyttja	8630±120
Sakhtysh-14	Late Butovo	11050	Peat	8310±60
		11602	Peat	8240±40
		11601	Peat	7990±50
Sakhtysh-2a	Late Butovo	10862	Small plank	8060±50

Table 6. *Final Mesolithic dates of the Upper Volga wetland sites.*

Site	Culture	Sample No.	Material	^{14}C Age (BP)
Ivanovskoe-7	Final Butovo	9361	Peat	7530±150; 7520±60
		9369	Peat	7320±190; 6880±40
		9379	Peat	7090±100; 7000±140
Sakhtysh-14	Final Butovo	11599	Peat	7200±40
Sakhtysh-2a	Final Butovo	10861	Peat	7530±60
		10860	Basket trap	7390±40

Table 7. *Early Neolithic dates of the Upper Volga and Middle Vychegda wetland sites.*

Site	Culture	Sample No.	Material	^{14}C Age (BP)
Stanovoe-4	Upper-Volga	10106	Gyttja	6650±160; 7080±40
		8378	Small plank	7030±100
Ivanovskoe-7	Upper-Volga	9360	Buried soil	7100±110; 7220±90
		9359	Buried soil	6690±110; 6670±140
Sakhtysh-2a	Upper-Volga	10924	Charred food residue	6500±100
Pezmog-4	Kamskaya	11915	Charred food residue	6820±70
		12325	Charcoal	6760±50
		12322	Mud	6730±50

obtained on the ornament-free ceramic fragments, which belong to the earliest pottery over the Russian plain (Kostyliova, 1994). Although, this date is individual for the Upper-Volga pottery, so we should keep this matter in abeyance, and consider the early Neolithic settling as 7030-6500 BP.

An entirely new data was obtained for the Kamskaya culture of Subural region, earlier considered as synchronous with the middle Neolithic Lyalovskaya culture (6000-5000 BP; Engovatova, 1998). Nevertheless, dates on carbon residue from inside the pot, charcoals and mud enclosing the cultural layer resulted synchronous and showed the very short time span from 6820±70 to 6730±50 BP. This age allows us to consider the Kamskaya culture as the early Neolithic and synchronize it with the Upper-Volga culture of the central Russia. Thus we can suppose an autonomous centre of neolithisation within the Subural zone of Russia, not inherited from the southwestern Upper Volga area.

The calibration of ^{14}C dates (Bronk and Ramsey, 2003; Steiner *et al.* 1998, **Fig. 11**) confirms the observations set before. A "kick-back" of Sakhtysh-2a data could mark the upper boundary of Upper-Volga settling; nevertheless, we couldn't make final conclusions from only one date for this site.

Human occupation and the Holocene environmental events within the studied area.

Paleobotanic data, together with radiocarbon dating and following comparison with palinological record (Alioshinskaya and Spiridonova, 1998; Alioshinskaya, 2001), allowed for the reconstruction of the history of site human occupation within the Upper Volga and Middle Vychegda superimposed on the Holocene local and regional (derived from spore-pollen data by Alioshinskaya and Spiridonova, 1998; Alioshinskaya, 2001) environmental changes (**Fig. 12**).

The presence of organomineral silts and gyttja at the lower parts of the dated sections at Stanovoe-4 indicates the existence of a small channel between two lakes (silts) or a lake (gyttja) (**Fig. 2b**). All the settlements started and then developed near the lake shores or small river banks, and this explains their multi-layered sedimentary records that reflect relatively frequent and discrete episodes of occupation by ancient hunters and fishermen.

The oldest Mesolithic (earliest Butovo) settlement Stanovoe-4 started above 10,300 BP at the periglacial lake shore, during the Younger Dryas (Alioshinskaya, 2001) warming and humidification period; a following lake transgression (gyttja and silt deposition) caused people

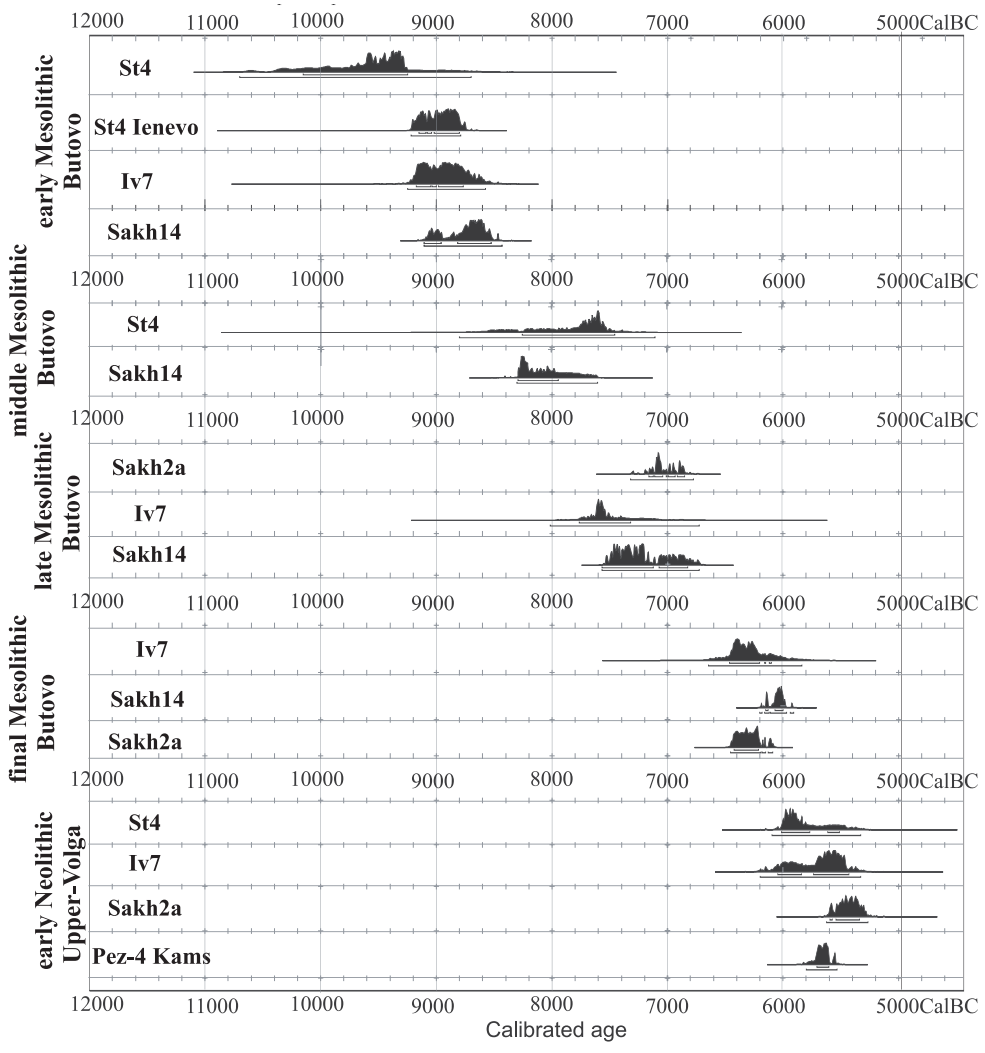

Fig. 11. *Calibration results for all Mesolithic and Early Neolithic dates of the Upper Volga and Middle Vychegda wetland sites.*

migration from the settling area upslope or complete abandonment of this place.

Then a short-lasting lake regression allowed the Ienevo people to occupy this place for some 100 years, and a following transgression and the "inter-lake" channel activating (gyttja and sand deposition) pushed them away due to inundation of the settlement area. At the same time, settling of Ivanovskoe-7 by early Butovo people started at the lake shore, and it ceased due to lake transgression at *ca* 9500 BP (gyttja deposits).

The settling of Sakhtysh-14 started together with (and maybe due to) the middle preboreal warming, and it ceased after the lake transgression ("deep-water" gyttja deposition) synchronously with the start of late preboreal cooling period.

The end of the late preboreal cooling went out with the middle Mesolithic settling at Stanovoe-4. *Ca* 8900-9000 BP the widening of the middle Butovo settlement occurred at Stanovoe-4, synchronously with the middle Butovo settling at Sakhtysh-14. Probably, this stage went along with Boreal warming (8600-8300 BP according to Alioshinskaya, 2001), which could become apparent later on due to rigidity of shift of pollen spectra against local vegetation structure. *Ca* 8850 BP the lake started to overgrow at Sakhtysh-14, and since then peat accumulated at the site area.

A short-lasting regression of Ivanovskoe lake enabled the mid-to-late Butovo people to occupy the site area in the period of 8550-8200 BP, i.e. during the maximum of Boreal warming. The end of this period was caused by the lake transgression, and so people abandoned the area.

During the late Butovo stage, people inhabited the Sakhtysh-14 bog and a shore of lake-shaped spreadout at Sakhtysh-2a; the end of this stage (*ca* 8000 - 7990 BP) coincided with a cooling at the Boreal-Atlantic transition.

During the early Atlantic period (ca 7500 BP), final Butovo settling at Ivanovskoe bog and Sakhtysh system took place. The maximum of aridity at *ca* 7200 BP marked the end of Mesolithic of the Upper Volga area, and a time gap between Mesolithic and Neolithic settling periods.

The neolithization of the Upper Volga area and the synchronous Neolithic settling of northeastern Subural region could mark a decrease of aridity and general upturn of environmental conditions.Thus the Upper-Volga settlement developed at Ivanovskoe-7 on the soil instead of peat; at Sakhtysh-2a on a peat bog dry surface; at Stanovoe-4 at the lake shore; and at Pezmog-4 at the shores of an oxbow lake.

The environmental history of these wetland sites is summarized in **Table 8**.

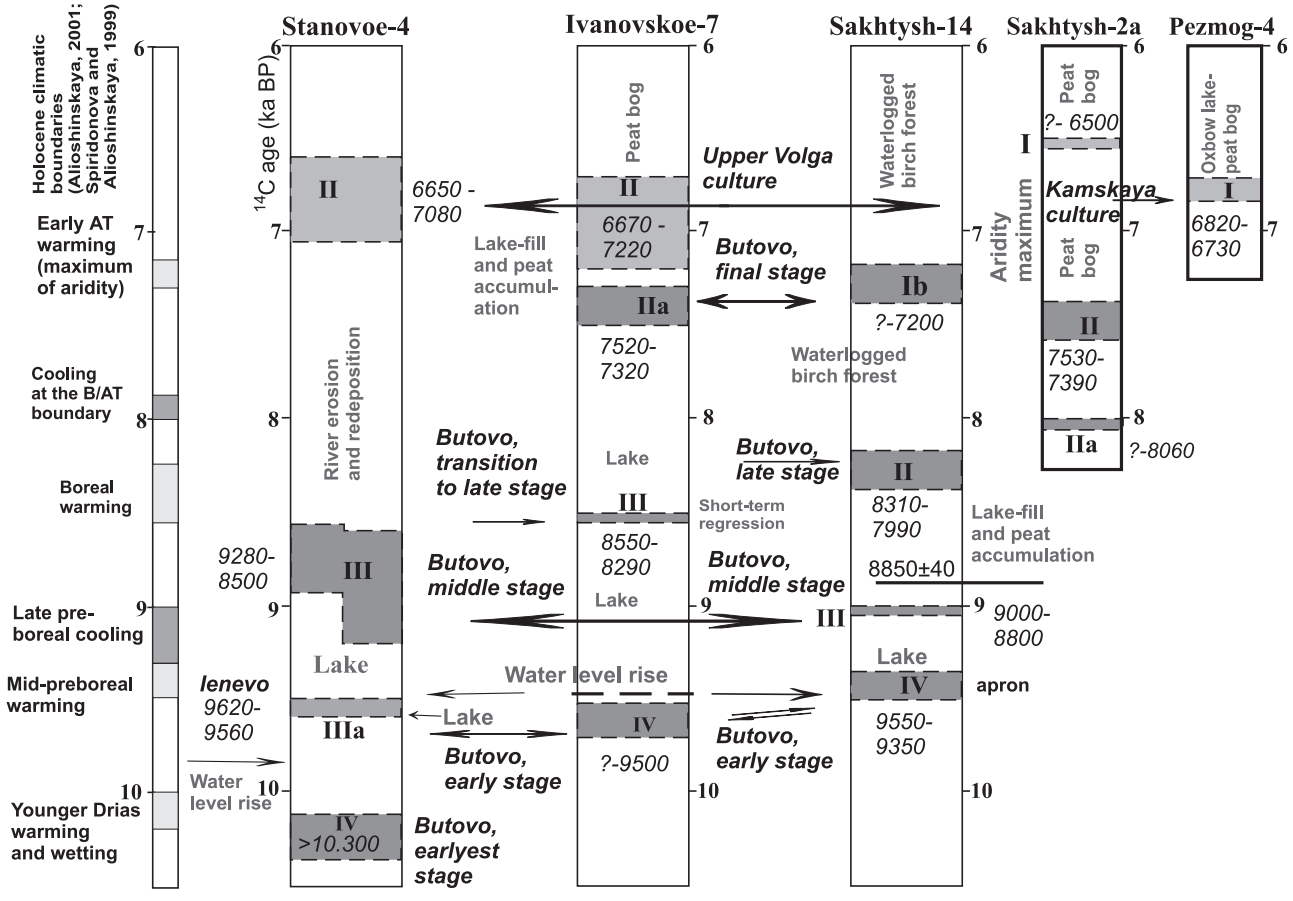

Fig. 12. *Human occupation and the Holocene climatic events within the Upper Volga and Middle Vychegda (see legend on* ***Fig. 10****).*

Table 8. *Environmental chronology of wetland sites within the Upper Volga and Middle Vychegda.*

Ages of the Holocene climatic boundaries (Alioshinskaya, 2001; Spiridonova, Alioshinskaya,1999)	**Stanovoe-4**	**Ivanovskoe-7**	**Sakhtysh-14**	**Sakhtysh-2a**	**Pezmog-4**
6000 BP, mid-atlantic cooling	Peat bog, no settling	6650 BP, lake transgression, no settling	Birch forest	Peat bog, no settling	Oxbow lake
Early Atlantic warming	7080 – 6650 BP; Upper-Volga settling; regression	7100-6670 BP; Upper-Volga settling; soil formation	Birch forest	6500±100 BP; Upper-Volga settling on a peat bog	6820 - 6730 BP; Kamskaya settling
7200 BP Maximum of aridity	River bed; no settling	Peat bog	Birch forest	Peat bog	River bed
		7500 - 7320 BP; final Butovo; peat bog	7200 BP; final Butovo; birch forest	7530 - 7390 BP; final Butovo; peat bog	
8000 - 7900 BP Boreal/Atlantic cooling	River bed; no settling	Lake transgression; no settling	8310 - 7990 BP; late Butovo; peat bog	8050±50 BP; late Butovo; sandy lake-shore	
8600 - 8300 BP; Boreal warming	9280 - 8500 BP; middle Butovo; lake shore	8550 - 8200 BP; mid-to-late Butovo; regression	9010 - 8800 BP; middle Butovo; lake shore		
9300 – 9000 BP Late preboreal cooling					
9500 – 9300 BP Mid-preboreal warming	River bed; no settling 9620-9560, Ienevo; lake shore	Lake transgression; no settling 9690-9500, early Butovo; lake shore	9550 - 9350, early Butovo; lake shore		
10,200 – 10,000 BP Warming and wetting at the end of the Younger Dryas	Above 10,300 BP; earliest Butovo; lake shore	Periglacial lake			

5. CONCLUSIONS

We have obtained a continuous chronology of all the stages of Mesolithic settling within the Upper Volga basin; the earliest Mesolithic settling started above 10,300 BP (>12,000 cal BP), and the final stage ended *ca* 7200 BP (8000 cal BP).

The start of Neolithisation (Upper-Volga culture) is ambiguous: while the most of dates (enclosing peat and gyttja) show the age *ca*. 7200 - 7100 BP (8000-9000 cal BP), worked wood, elk bones and other finds (carbon residue on ceramic fragments) show the interval 6800 - 6500 BP (*ca*. 7600 - 7400 cal BP);

An autonomous centre of neolithisation within the Subural zone (6800 - 6700 BP; *ca*. 7600 - 7550 cal BP) has been identified, synchronous, but not inherited to the Upper-Volga culture.

By multisampling, we were able to cross-conform radiocarbon dates and determine the time relationship between the deposition of archaeological layers and the enclosing ones;

Plant macrofossil data allowed us to determine the origin and local environmental conditions following the accumulation of layers containing cultural remains.

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