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Buried oaks and malacofauna of Holocene oxbow lake sediments in the Valakupiai section, Lithuania

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This paper presents results of investigation of oxbow lake sediments of the Neris River in the Valakupiai section in the vicinity of Vilnius (capital of Lithuania). The grain-size data enabled to define the uniformity, homogeneity and genetic sterility of the floodplain alluvium. Sandy sediments in oxbow lake deposits show 18 flood events of the Neris River during the Subboreal / Subatlantic time. The buried Holocene oaks and malacofauna were studied from the lower part of fluvial sediments. During the Atlantic period (before 5600 BP) thermophilic tree forests were growing. Late in the Atlantic and early in the Subboreal (after 5600 BP), according dendrochronological measurements the climate got cooler. The *Ancylus fluviatilis* dominates in reophile mollusk fauna. Mollusk fauna reveals warmer climatic conditions in the Atlantic period, too. The malacofauna contained an immigrant mollusk *(Theodoxus fluviatilis)* from the Black Sea basin. The Valakupiai section at the Neris River reflects two stages – riverbed and lacustrine – of oxbow lake development.

Key words: malacofauna, Holocene, oxbow lake sediments, radiocarbon, Lithuania

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INTRODUCTION

The greatest changes in our understanding of geological events result from new, rapidly evolving methods of dating from fossils in continental sediment studies and from the stratigraphy revealed by sediments. Data on oxbow lake sediments were used to distinguish climatic and environmental fluctuations during the Holocene in Lithuania. These sediments are horizontally layered or laminated and reflect the cyclic fluctuations of nature. Climate is the main factor of oxbow lake deposit formation in a river valley. Holocene optimum climatic conditions favoured organic matter sedimentation in the oxbow lake of the Neris River. Special attention was paid to organic remnants in the oxbow lake of the Neris River valley meander at the Valakupiai site and to the lake-bog deposits filling it. Buried dark oak trunks and mollusk shells on the bottom of the oxbow lake in the Neris River valley are located on the first terrace above the floodplain in the Valakupiai site in the vicinity of Vilnius (capital of Lithuania) in Eastern Lithuania 98.5 ma.s.l. (Fig. 1) (co-ordinates: 54°43'58"; 25°18'33"). In the Holocene optimum, this oxbow lake was situated on the floodplain. Dark oak wood remains of the Atlantic climatic period are found at the bottom of the floodplain alluvium (Gaigalas, 2004). The dendrogram of oak trunks from the oxbow lake sediments of the Neris River (Vilnius) demonstrated the deterioration of climatic conditions after the Atlantic period in the beginning of the Subboreal. In these oxbow lake sediments, organics such as peat, wood remains, etc. were dated by the radiocarbon method (Gaigalas et al., 2006; Pawlyta, Gaigalas, Michczynski, Pazdur, Sanko, 2006). This paper presents results of investigation of oxbow lake sediments in the Neris River Valakupiai section in Vilnius. Oxbow lake sediments with wood remains and organics have been studied by different methods and dated by the radiocarbon method (Table 1). These deposits provide more specific data for palaeoecological reconstruction and on climatic events.

THE STUDY SITE

In the Valakupiai section, oxbow lake sediments of the Neris River were investigated by different methods and have been recently radiocarbon-dated (Gaigalas et al., 1976; 1987; Gaigalas, 2004; Gaigalas, Pazdur, 2004). In the study section, from bot-

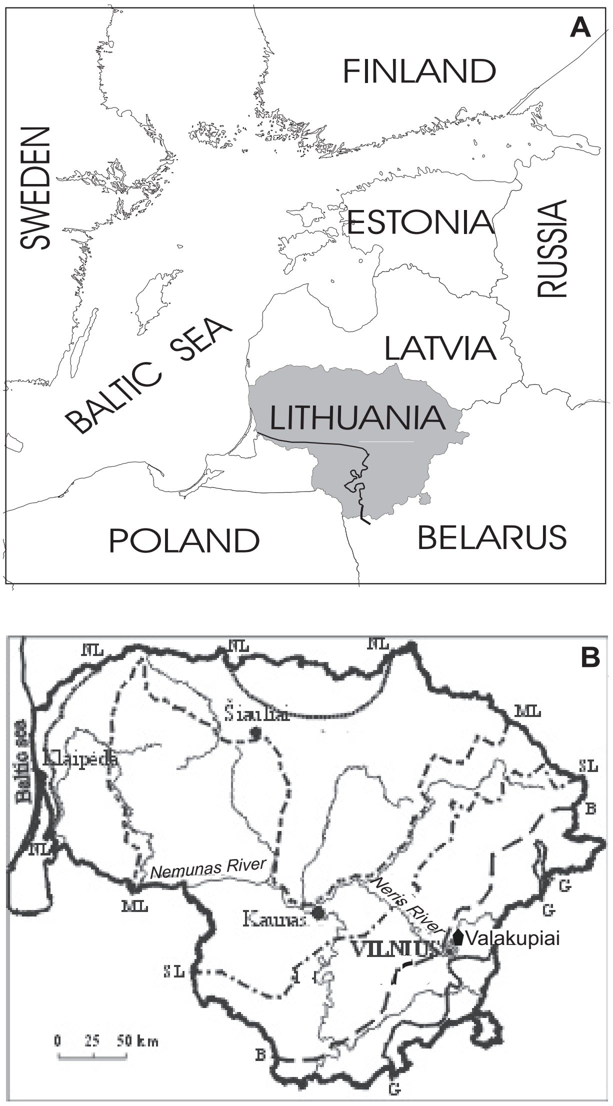


Fig. 1. Location maps: *A*. In Baltic countries, *B*. In local site. Limits of Last (Nemunas) ice cover during: G – Grūda stadial, B – Baltija stadial, SL – South Lithuanian phasial, ML – Middle Lithuanian phasial, NL – North Lithuanian phasial. Valakupiai co-ordinates: 54º43′58″; 25º18′33″

1 pav. Situacijos žemėlapiai: *A* – Lietuvos padėtis Baltijos kraštuose, *B* – Tirtų pjūvių padėtis Lietuvoje. Nemuno apledėjimo stadijų, fazių ribos: G – Grūdos stadijos, B – Baltijos stadijos, SL – Pietų Lietuvos fazės, ML – Vidurio Lietuvos fazės, NL – Šiaurės Lietuvos fazės. ⬟ – tirtų pjūvių vietos

tom to top we found the following complexes of sediments: 1) Pleistocene till in the basement of the first terrace above the floodplain, 2) basal conglomerate (perluvium), 3) buried dark oak timbers and mollusk fossil fauna, 4) white quartz sand with interlayers of organics and wood remains, 5) oxbow lake organogenic sediments with interlayers of flood quartz sand, 6) aeolian sand admixture at the top of oxbow lake sediments, 7) recent soil (Fig. 2).

The basement (socle) of the terrace is formed by brown boulder loam (till). The till loam of the Medininkai Glaciation at the toe of the first above-flood-plain terrace lies above the Neris River waterlevel, but in the river channel it lies about 3.5 m below the water. In the Holocene, the Neris River cut into this till by 3–4 m and an alluvial cover (about 4 m) was formed. The rate of erosion of the river (about 6 cm per 100 years) during formation of the alluvial cover (about 6 cm per 100 years) of the first terrace above the floodplain was in equal balance. This equality shows the neotectonical stability of the study area.

The terrace is formed on the till of Middle Pleistocene glaciation overlain by a basal pebble conglomerate of brown colour. The river channel alluvium (perluvium) boulder–pebble–gravel deposits were cemented by iron hydroxide. Fossil mollusk shells were found on the basal conglomerate at a depth of 3.9–4.0 m. They occur in rare lenses of fine sand filling kettle-form depressions in red-brown till loam. Above the basal horizon, floodplain and oxbow lake sediments rich in organics and plant remains (buried oak trunks) were found, together with sand of channel alluvium and oxbow lake sediments with thin interlayers of humus only and aeolian sand with soil on the top of the terrace (Fig. 2). The oxbow lake deposits were settling unevenly in time. The section shows 18 floods, which were separated by oxbow lake sedimentation (Table 1). Washed away by the river, sand particles during floods were settled together with other fine particles on the flood plain and formed floodplain alluvium interlayers in oxbow lake sediments. Samples were collected from the sediments of the first terrace above the floodplain (Table 1).

MEDININKAI TILL PEBBLE AND COARSE GRAVEL PETROGRAPHY

A 4.24 m thick accumulative alluvium cover occurs on the erosional till toe (substratum) formed of brown till loam, calcareous, hard and monolithic, with pebble and gravel (up to 15%). It resembles a natural optimal mixture composed of various-size particles ranging from pelites to large psephites. The macroscopic view of till clay resembles the Middle Pleistocene Medininkai Glaciation till. To prove this, petrographic analysis of large fragments of the till was carried out, the data being expected to help in identifying the glaciation name in the stratigraphical chart.

Three pebble and gravel samples were taken in the Valakupiai outcrop till loam for petrographic analysis; the sampling sites are shown in Fig. 2. Small pebble (30–10 mm) and coarse gravel (10–7 mm) samples were taken. For each sample, 300 pebbles were collected. The first sample was taken between the 0 and 5 m pickets, the second between 70 and 75 m, and the third between 130 and 135 m.

Five groups of pebble and coarse gravel samples were formed according to the petrographic genetic rock features: (1) crystalline rocks brought by glaciers from the Baltic Precambrian crystalline sheet in Fennoscandia; (2) sandstone and siltstone brought by a glacier moving over the Phanerozoic rocks; (3) Devonian dolostones collected by glaciers moving over the Baltic Devonian field; (4) Ordovician and Silurian limestone exarated by glaciers in the northern zone of the bottom in the central part of the Baltic Sea, as well as Estonian land and islands; (5) other limestones scraped by glaciers from Mesozoic beds. No fragments of other rocks were detected in the samples studied by us.

The percentage of each group was determined for each sample and cyclodiagrams were constructed (Fig. 2). Generalisation of the data showed that the major part of the fragments consisted of

Table 1. **Sequence of sediments and collected samples of radiocarbon, palynology and grain-size analysis with radiocarbon dates**
1 lentelė. **Nuosėdų seka ir ėminiai radiokarboninei, granuliometrinei, palinologinei analizėms, radiokarboninės datos**

Layer No.	Laboratory sample index and ^{14}C age, years	Depth, m	Thick-ness, m	Sediments	Samples
1	2	3	4	5	6
1		0.00–0.30	0.3	Soil (pd IV)	
2		0.30–0.53	0.23	Sand, brown, with dispersed organics (a_{sn} IV)	
3	Gd-12734: 1170 ± 40	0.53–0.69	0.16	Peaty soil, sandy, dark brownish grey with greenish spots (b IV)	For palynology analysis No. 30 For radiocarbon dating No. 10
4		0.69–0.85	0.16	Sand, fine-grained, silty, greenish grey with brown spots and limonitization (a_{sn} IV)	For palynology analysis No. 29
5		0.85–1.15	0.3	Sand, fine-grained with rare organics and limonitization spots (a_{sn} IV)	For palynology analysis No. 28
6		1.15–1.36	0.21	Sand, greenish grey with organics, lacustrine origin (l IV)	For palynology analysis No. 27
7		1.36–1.52	0.16	Sand with rare organics and greenish grey (l IV)	For palynology analysis No. 26
8		1.52–1.57	0.05	Sand, yellowish brown with limonitization (a_{sl} IV), **flood 18**	Sample for grain-size analysis No. 23
9	Gd-17343: 990 ± 240	1.57–1.73	0.16	Sand with organic sand charcoal, greenish grey with blue tint (l IV)	For palynology analysis No. 25 For radiocarbon dating No. 9
10		1.73–1.83	0.1	Sand, yellowish brown (a_{sl} IV), **flood 17**	Sample for grain-size analysis No. 22
11	Gd-16338: 1350 ± 100	1.83–1.86	0.03	Sand with organics and greenish grey (l IV)	For palynology analysis No. 24 For radiocarbon dating No. 11
12		1.86–1.88	0.02	Sand yellowish brown, with brown limonitization lenses ($a_{sl+}a_{sv}$ IV), **flood 16**	Sample for grain-size analysis No. 21
13		1.88–1.92	0.04	Sand with organic, grey with brownish tint (a_{sn} IV)	For palynology analysis No. 23
14		1.92–1.94	0.02	Sand, greenish grey, massive structure (l IV)	Sample for grain-size analysis No. 20
15		1.94–2.25	0.31	Sand with organic, dark grey brown blooms (a_{sn} IV)	For palynology analysis No. 21 and No. 22
16	Gd-12770: 3570 ± 95	2.25–2.55	0.3	Sand with organic and wood remnants, greenish grey, in top part the lense of whitish sand (a_{sn} + l IV)	For palynology analysis No. 19 and No. 20; Sample for grain-size analysis No. 19; For radiocarbon dating No. 8
17		2.55–2.63	0.08	Sand, yellowish brown (a_{sl} IV), **flood 15**	Sample for grain-size analysis No. 18
18		2.63–1.71	0.08	Sand with organic, drab colour (a_{sn} IV)	For palynology analysis No. 18
19		2.71–2.73	0.02	Sand, yellowish brown with dark lenses (a_{sl} IV), **flood 14**	Sample for grain-size analysis No. 17
20		2.73–2.82	0.09	Sand with organic, of many colours, yellowish brown with lenses of dark brown colour (pd IV)	For palynology analysis No. 17
21		2.82–2.94	0.12	Sand, fine-grained with organic, grey and lenses of limonitization (pd IV)	Sample for grain-size analysis No. 16 For palynology analysis No. 16
22	Gd-15832: 3220 ± 70 Gd-12732: 4660 ± 70	2.94–3.11	0.17	Sand with organic, ashy grey (pd IV)	Sample for grain-size analysis No. 15 For palynology analysis No. 15 For radiocarbon dating No. 7

Table 1 continued
1 lentelės tęsinys

1	2	3	4	5	6
23	Gd-30093:4780 ± 100	3.11–3.13	0.02	Peaty soil, brownish grey (b IV)	For palynology analysis No. 14 For radiocarbon dating No. 6
24		3.13–3.18	0.05	Sand, lightly yellowish grey (a_{sl} IV), **flood 13**	Sample for grain-size analysis No. 14
25		3.18–3.20	0.02	Peaty soil, brown grey (b IV),	For palynology analysis No. 13
26		3.20–3.23	0.03	Sand yellowish grey (a_{sl} IV), **flood 12**	Sample for grain-size analysis No. 13
27	Gd-15531: 2845 ± 80	3.23–3.25	0.02	Peaty soil, brownish grey (b IV)	For palynology analysis No. 12
28		3.25–3.27	0.02	Sand, yellowish grey (a_{sl} IV), **flood 11**	Sample for grain-size analysis No. 12
29		3.27–3.29	0.02	Peaty soil, brownish grey, muddle up (b IV)	For palynology analysis No. 11
30		3.29–3.31	0.02	Sand, yellowish grey, laminated (a_{sl} IV), **flood 10**	Sample for grain-size analysis No. 11
31	Gd-12736: 4610 ± 55	3.31–3.33	0.02	Peat sandy (b IV)	For palynology analysis No. 10 For radiocarbon dating No. 5
32		3.33–3.38	0.05	Sand fine-grained, yellowish grey (a_{sl} IV), **flood 9**	Sample for grain-size analysis No. 10
33	Gd-15529: 3460 ± 65 Gd-12739: 3840 ± 60	3.38–3.41	0.03	Peat sandy, with wood remnants (a_{sn} IV)	For palynology analysis No. 9 For radiocarbon dating No. 4
34		3.41–3.47	0.06	Sand fine-grained, yellowish grey (a_{sl} IV), **flood 8**	Sample for grain-size analysis No. 9
35	Gd-15835: 3500 ± 90 Gd-15776: 4880 ± 75	3.47–3.48	0.01	Peaty soil, dark with brownish tint, non-carbonate (b IV)	For palynology analysis No. 8 For radiocarbon dating No. 3
36		3.48–3.56	0.08	Sand fine grained, yellowish grey, with lamina of peaty soil (a_{sl} IV), **flood 7**	Sample for grain-size analysis No. 8
37	Gd-12769: 4190 ± 90	3.56–3.58	0.02	Peaty soil, dark with brownish tint, non-carbonate (b IV)	For palynology analysis No. 7 For radiocarbon dating No. 2
38		3.58–3.60	0.02	Sand fine-grained, yellowish grey (a_{sl} IV), **flood 6**	Sample for grain-size analysis No. 7
39	Gd-12773: 3190 ± 60 Gd-15779: 4590 ± 90	3.60–3.62	0.02	Peaty soil, dark with brownish tint, non-carbonate (b IV)	For palynology analysis No. 6 For radiocarbon dating No. 1
40		3.62–3.66	0.04	Sand fine-grained feldspars, quartz, yellowish grey, non-carbonate (a_{sl} IV)	Sample for grain-size analysis No. 6
41	Hv-2663: 4040 ± 30 Lu-5069: 4190 ± 60 Gd-12538: 4040 ± 65 Gd-11720: 4200 ± 4 / 50	3.66–3.67	0.01	Peaty soil, sandy, brownish grey, with remnants of wood, non-carbonate (bIV)	For palynology analysys No. 5
42		3.67–3.71	0.04	Sand fine-grained, feldspars, quartz, brownish grey (a_{sl} IV), **flood 5**	Sample for grain-size analysis No. 5
43		3.71–3.72	0.01	Peaty soil, brownish grey, with wood remnants, non-carbonate (b IV)	For palynology analysis No. 4

Table 1 continued
1 lentelės tęsinys

1	2	3	4	5	6
44		3.72–3.77	0.05	Sand, fine-grained, brownish grey, with organic, in separate lenses non-carbonate (a_{sn+sl} IV), **flood 4**	Sample for grain-size analysis No. 4
45		3.77–3.79	0.02	Peaty soil, sandy, darkly brownish grey, non-carbonate (b IV)	For palynology analysis No. 3
46		3.79–3.85	0.06	Sand, fine-grained, feldspars, quartz, yellowish grey, non-carbonate (a_{sl} IV), **flood 3**	Sample for grain-size analysis No. 3
47		3.85–3.87	0.02	Peaty soil dark colour with brownish tint, non-carbonate (b IV)	For palynology analysis No. 2
48		3.87–3.93	0.06	Sand fine-grained, feldspars, quartz, non-carbonate (a_{sl} IV), **flood 2**	Sample for grain-size analysis No. 2
49		3.93–3.95	0.02	Peaty sand, dark, rich in organics, with wood remnants, non-carbonate (b IV)	For palynology analysis No. 1
50	Vs-163: 4900 ± 130 Vs-164: 5690 ± 160 Vs-162: 5800 ± 1 40	3.95–4.01	0.06	Sand, fine-grained, feldspars, quartz, greyish, non-carbonate, in lower part with tree branches (a_{sl} IV), **flood 1**	Sample for grain-size analysis No. 1
51		4.01–4.24	0.23	Conclomerate of boulders with pebbles and gravel, brown, calcareous, limonitization. The boulders of crystalline rocks, pebble and gravel of crystalline and sedimentary rocks (as_v IV)	
52		4.24–4.88	0.64	Till with gravel and pebble (10%), greenish grey, massive structure (g II žm)	

Devonian dolostone pebble and gravel, while the least part comprised small pebble and the coarse gravel fraction of sandstone and silts. Crystalline rock fragments in the till of all three samples made up 23.4% on average (20.7–25.8%) and sandstone and silts 3% (1.2–6%). Devonian dolostones averaged to 30% (range 29.3–30.3%), while Ordovician and Silurian limestone to 25% (21.7–27.3%). Other limestone types in the till made up 18.6% (16.3–21.3%).

Petrographic peculiarities are used to distinguish tills of different Pleistocene glaciations in Lithuania (Гайгалас, 1979). The till studied was attributed to the Medininkai Glaciation. The till is indexed as gIImd. Its belonging to the Medininkai Glaciation is confirmed by a rather high content of dolostone fragments in the small pebble and coarse gravel fraction (about 25%). The petrographic composition of till shows that the glacier that had formed it was moving from NNW towards SSE via the field where Ordovician and Silurian limestones and Devonian dolostones occurred in the Baltic region, mainly in its central part.

The till loam of the Medininkai Glaciation at the toe of the first above-floodplain terrace lies above the Neris River water level, but in the river channel it lies below the water. In the Holocene, the Neris River cutting into this till, washed away sand particles which during floods were settled together with other fine particles on the floodplain and formed floodplain alluvium interlayers in oxbow lake sediments. Grain-size data of this sand are analysed in the next chapter.

SAND GRAIN SIZE COMPOSITION

For grain-size analysis, 22 samples were taken from various depths in the first section of the first above-floodplain terrace in the Valakupiai outcrop. Floodplain sand brought by the Neris River during floods into the oxbow lake separated from the river channel was sampled for investigations. The sands of interlayers in the oxbow lake alluvium show recurrence of stronger floods during the Subboreal and Subatlantic climatic periods. The sands were divided into 12 fractions. Their grain-size data are given in Table 2. These data enabled to construct polygonal curves. Then the data were analysed according to sand and silt fractions (Table 3), and lithological names were given to the sand of the samples.

The data of grain-size analysis made by us were used for two purposes: (1) to adjust the lithological name of the floodplain sand studied, as mentioned above; and (2) to check the unambiguous attribution of sand to the floodplain alluvium facies and to ascertain that there was no admixture of another matter.

As the generalised grain-size data on the samples (Tables 2 and 3) show, the fine sand interlayers were brought during floods into the oxbow lake situated on the first above-floodplain terrace. The fine sand fraction (0.25–0.1 mm) prevails nearly in all samples. Its content, however, varies with samples. The highest content was found in samples Nos. 7 and 8 in which fine sand fraction made up 91.8% and 91.09%, respectively. The lowest content (63.39%) of this fraction was found in sample No. 17. So, we can see that all samples, even the sample with a minimum content of this fraction, contained more than 50% of fine sand. Such prevalence of fine sand in the oxbow lake alluvium confirms its dependence on river alluvium brought by floods onto the floodplain.

Fine sand interlayers in the oxbow lake alluvium of the first above-floodplain terrace were found at eighteen different vertical levels (Table 3). They prevail in the middle part of the alluvium cover. Other levels were found to contain fine sand with ad-

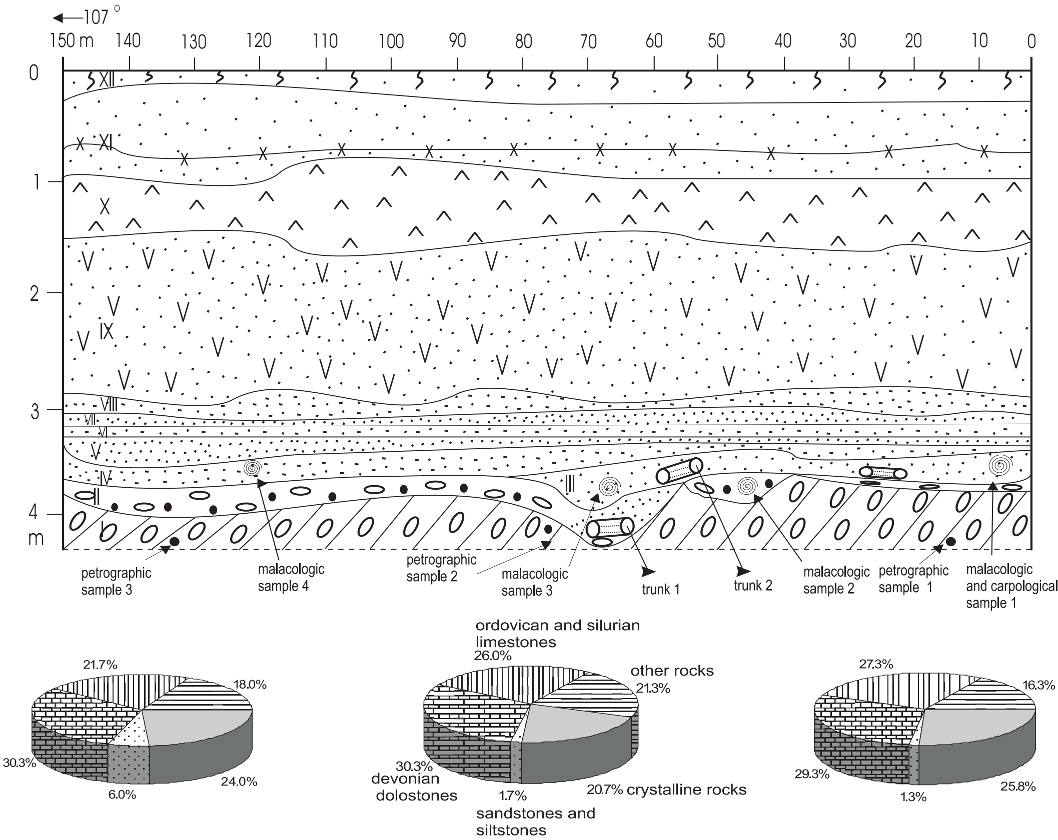


Fig. 2. Valakupiai section of sediments first terrace above flood plain with sites of sampling and petrographic diagrams. Layers: I – till, II – basal horizon ferriferous, III, V, VII – fine grain sand , IV, VI, VIII – peat, IX–fine grain sand with dispersed organic, X – sandy peat dark colour in upper part, XI – fine grain sand with ferriferous bands, XII – soil

2 pav. Pirmos viršsalpinės terasos Valakupių pjūvis su ėminių paėmimo vietomis ir morenos gargždo petrografinėmis ciklogramomis. Sluoksniai: I – moreninis priemolis, II – pamatinis limonitizuotas horizontas, III, V, VII – smulkiagrūdis smėlis, IV, VI, VIII – durpžemis, IX – smulkiagrūdis smėlis su dispersiška organika, X – smėlingas durpžemis, viršuje juodas, XI – smulkiagrūdis smėlis su limonitizuotomis rusvos spalvos juostelėmis, XII – dirvožemis

mixture of medium-grained fraction (Fig. 3, samples Nos. 1, 4, 5, 6, 9, 10, 17 and 22) or coarse silt (samples Nos. 15, 16, 18, 19 and 21). Admixture of medium-grained sand and coarse-grained silt in the floodplain alluvium reflects the evolution stages of the Neris oxbow development. As an admixture, medium-grained sand settled in the oxbow during its first stage of development (Gaigalas, Dvareckas, Banys, 1987; Gaigalas, Dvareckas, 2002), i. e. when it had a connection with the riverbed. The coarse silt fraction in the oxbow lake alluvium shows the second (lacustrine) stage, when it was already separated from the riverbed and reached the lake development state.

The grain-size data enabled us to define the uniformity, homogeneity and genetic sterility of the floodplain alluvium. For this purpose, the grain-size coefficients (Table 3) were calculated and the distribution curves constructed.

The lower part of the section was found to contain an admixture of channel alluvium in the interlayers of floodplain alluvium. This admixture was brought in when there was a connection between the oxbow lake and the river. The upper part of the floodplain alluvium interlayers was found to contain also aeolian sand admixture. In the closed oxbow lake, during spring floods, floodplain alluvium was settling, while during the dryer summer period, wind-driven sand was brought in from the terrace surface, especially from the near-channel part of the terrace and river levees.

We have made such conclusions after assessing the coefficient values and the evenness of the distribution curves. The curves expressing the distribution of floodplain alluvium containing aeolian sand admixture are notable for an uneven distribution and a peak in the zone of finer fractions. Floodplain sand with aeolian admixture is not so well-sorted, asymmetric and differs in other grain-size indices (Table 3). Thus, the grain-size data enabled us to adjust the lithological name of the sand and to reveal the peculiarities of sedimentation conditions.

The Valakupiai section at the Neris River reflects two stages of oxbow lake development: (1) near-channel stage, when it was connected with the river, and (2) lake development stage, when it was separated from the channel, but used to be periodically flooded. The oxbow lake development stages are depicted in a scheme constructed in 2002 (Gaigalas, Dvareckas, 2002).

Sediments formed during the above-mentioned stages and phases are recognised after investigating and analysing their structure and texture. The first stage oxbow lake sediments in the Valakupiai outcrop are sandy. Sand deposits are white, washed and contain wood remains. The sedimentary environment of this stage is reflected in the grain-size composition of sand. Texture features are expressed by horizontal layering. Wood remains were brought into the oxbow facies from the river through the junction canal by river stream swirls.

Table 2. **Size-grain composition of sandy flood sediments in Valakupiai section, %**

2 lentelė. **Valakupių pjūvio nuogulų granuliometrinė sudėtis %**

Sample No	Depth, m	Size, mm											
		0.63–0.5	0.5–0.4	0.4–0.315	0.315–0.25	0.25–0.2	0.2–0.16	0.16–0.125	0.125–0.1	0.1–0.08	0.08–0.063	0.063–0.05	<0.05
		1	2	3	4	5	6	7	8	9	10	11	12
1	3.95–4.01	1.56	0.85	2.38	12.93	29.56	29.16	13.54	4.69	3.03	1.43	0.46	0.40
2	3.87–3.93	0.00	0.04	0.42	7.60	24.75	34.07	19.16	6.65	4.16	1.90	0.65	0.61
3	3.79–3.85	0.00	0.06	0.30	6.91	27.90	34.59	17.50	6.06	4.04	1.70	0.55	0.38
4	3.72–3.77	0.02	0.04	0.61	12.12	36.15	33.20	11.78	3.19	1.78	0.75	0.22	0.14
5	3.67–3.71	0.00	0.02	0.93	14.59	32.35	32.19	14.25	3.39	1.56	0.55	0.10	0.08
6	3.62–3.66	0.08	0.10	2.02	20.99	35.79	25.14	10.69	3.05	1.48	0.48	0.12	0.06
7	3.58–3.60	0.00	0.00	0.04	2.99	20.79	42.33	21.50	6.47	3.76	1.52	0.34	0.26
8	3.48–3.56	0.00	0.00	0.06	2.89	20.93	42.82	21.34	6.71	3.56	1.17	0.34	0.18
9	3.41–3.47	0.00	0.06	0.95	19.22	39.75	26.79	8.93	2.36	1.25	0.48	0.14	0.06
10	3.33–3.38	0.00	0.04	1.27	21.34	37.70	26.83	8.47	2.40	1.27	0.51	0.10	0.06
11	3.29–3.31	0.00	0.02	0.53	8.08	24.67	34.90	18.61	6.18	3.70	1.88	0.77	0.67
12	3.25–3.27	0.00	0.04	0.04	2.20	15.92	36.33	26.91	8.57	6.06	2.49	0.81	0.63
13	3.20–3.23	0.00	0.00	0.08	4.16	24.09	38.67	21.07	6.06	3.62	1.52	0.40	0.32
14	3.13–3.18	0.00	0.10	0.71	7.13	22.73	31.22	23.72	7.48	4.67	1.62	0.34	0.28
15	2.94–3.11	0.00	0.04	0.34	2.16	9.21	29.72	27.68	11.56	10.04	5.37	1.84	2.02
16	2.82–2.94	0.00	0.04	0.10	2.16	10.10	30.57	27.28	10.93	10.51	4.83	1.58	1.90
17	2.71–2.73	0.06	0.48	6.28	25.58	29.32	21.46	9.40	3.21	2.26	1.19	0.38	0.36
18	2.55–2.63	0.00	0.00	0.06	1.11	8.08	29.54	33.28	11.28	10.31	3.98	1.31	1.05
19	2.25–2.55	0.14	0.04	0.16	3.15	16.16	34.94	24.93	8.08	7.13	3.19	1.07	0.99
21	1.86–1.88	0.20	0.04	0.33	5.19	17.37	31.01	24.23	8.60	7.12	3.47	1.17	1.26
22	1.73–1.83	0.10	0.08	1.07	10.63	24.11	31.20	18.79	6.47	4.22	1.92	0.69	0.73
23	1.52–1.57	0.04	0.02	0.65	8.51	25.08	32.85	20.51	5.78	4.04	1.60	0.51	0.42

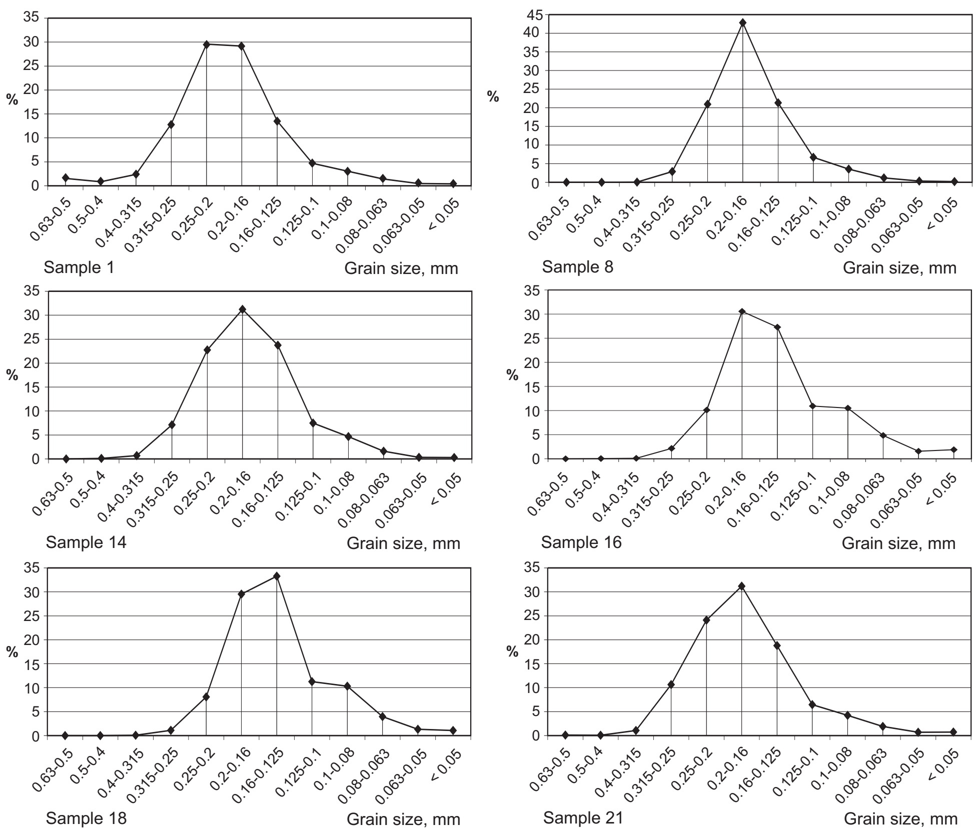


Fig. 3. Grain-size distribution of channel alluvium (samples 1 and 8), flood plain alluvium (sample 14) and aeolian sands (samples 16, 18, 21)

3 pav. Vaginio aliuvinio smėlio (ėminiai Nr. 1 ir 8), salpinio aliuvinio smėlio (ėminys Nr. 14) ir eolinio smėlio (ėminiai Nr. 16, 18, 21) granuliometrinės sudėties pasiskirtymo kreivės

Table 3. **Sand and silt grades of flood sediments in Valakupiai section, %**
3 lentelė. **Smėlio ir aleurito frakcijų kiekis Valakupių pjūvio potvynio nešmenyse %**

Sample No	Depth, m	Grades, mm: Middle-grained sand 0.5–0.25	Fine-grained sand 0.25–0.1	Coarse silt 0.1–0.005	Fine silt 0.05–0.01	Total, %	Coefficients: Md	So	Sediments
1	3.95–4.01	17.72	76.95	4.92	0.4	100	0.196	1.162	Sand, fine-grained with middle-grained admixture
2	3.87–3.93	8.06	84.63	6.71	0.61	100	0.18	1.219	Sand, fine-grained
3	3.79–3.85	7.27	86.05	6.29	0.38	100	0.183	1.208	Sand, fine-grained
4	3.72–3.77	12.79	84.32	2.75	0.14	100	0.199	1.176	Sand, fine-grained with middle-grained admixture
5	3.67–3.71	15.54	82.18	2.21	0.08	100	0.197	1.19	Sand, fine-grained with middle-grained admixture
6	3.62–3.66	23.19	74.67	2.08	0.06	100	0.213	1.191	Sand, fine-grained with middle-grained admixture
7	3.58–3.60	3.03	91.09	5.62	0.26	100	0.175	1.169	Sand, fine-grained
8	3.48–3.56	2.95	91.8	5.07	0.18	100	0.176	1.166	Sand, fine-grained
9	3.41–3.47	20.23	77.83	1.87	0.06	100	0.213	1.172	Sand, fine-grained with middle-grained admixture
10	3.33–3.38	22.65	75.4	1.88	0.06	100	0.214	1.177	Sand, fine-grained with middle-grained admixture
11	3.29–3.31	8.63	84.36	6.35	0.67	100	0.181	1.214	Sand, fine-grained
12	3.25–3.27	2.28	87.73	9.36	0.63	100	0.165	1.201	Sand, fine-grained
13	3.20–3.23	4.24	89.89	5.54	0.32	100	0.178	1.188	Sand, fine-grained
14	3.13–3.18	7.94	85.15	6.63	0.28	100	0.175	1.229	Sand, fine-grained
15	2.94–3.11	2.54	78.17	17.25	2.02	100	0.149	1.273	Sand, fine-grained with coarse silt admixture
16	2.82–2.94	2.3	78.88	16.92	1.9	100	0.151	1.269	Sand, fine-grained with coarse silt admixture
17	2.71–2.73	32.4	63.39	3.83	0.36	100	0.22	1.238	Sand, middle-grained--fine-grained
18	2.55–2.63	1.17	82.18	15.6	1.05	100	0.148	1.228	Sand, fine-grained with coarse silt admixture
19	2.25–2.55	3.49	83.81	11.39	0.99	100	0.165	1.215	Sand, fine-grained with coarse silt admixture
21	1.86–1.88	5.76	81.21	11.76	1.26	100	0.165	1.233	Sand, fine-grained with coarse silt admixture
22	1.73–1.83	11.88	80.57	6.83	0.73	100	0.182	1.238	Sand, fine-grained with middle-grained admixture
23	1.52–1.57	9.22	84.22	6.15	0.42	100	0.181	1.221	Sand, fine-grained

The second (lake) stage of the oxbow lake is reflected in a rhythmic alternation of oxbow lake sediments and floodplain alluvium lamina in the Valakupiai section studied. The oxbow lake alluvium contains humus and is dark in colour. Floodplain alluvium is periodically brought in by floods, and its mineralogical composition is different – it is notable for a grey yellowish colour and contains an admixture of aeolian sand that entered the oxbow lake from the terrace surface due to wind erosion of the floodplain alluvium during summer droughts.

Table 4. **Radiocarbon dates of the samples**
4 lentelė. **Tirtų ėminių radiokarboninės datos**

No.	Sample	Depth, m	Materials	Lab. No.	Age ^{14}C (BP)	Calibrated age range 68% Cal BC/AD		Calibrated age range 95% Cal BC/AD	
1	2	3	4	5	6	7	8	9	10
1	Valakupiai - 10 / 2003 / NaOH- sol	0.65–0.60	Humus	Gd-12734	1170 ± 40	770 AD – 900 AD 920 AD – 940 AD	62.6% 5.6%	720 AD – 740 AD 770 AD – 980 AD	1.4% 94.0%
2	Valakupiai- 9 / 2003	1.60–1.65	Organics with charcoal	Gd-17343	990 ± 240	810 AD – 1260 AD	68.2%	600 AD – 1450 AD	95.4%
3	Valakupiai - 11 / res	1.83–1.86	Humus	Gd-16338	1350 ± 100	580 AD – 780 AD	68.2%	430 AD – 490 AD 530 AD – 900 AD	2.1% 93.3%
4	Valakupiai - 8 / 2003	2.50–2.55	Organics with wood	Gd-12770	3570 ± 95	2040 BC – 1770 BC	68.2%	2200 BC – 1650 BC	95.4%
5	Valakupiai - 7 / 2003/II	2.97–3.00	Organics and humus	Gd-15832	3220 ± 90	1610 BC – 1410 BC	68.2%	1740 BC – 1710 BC 1700 BC – 1290 BC	1.2% 94.2%
6	Valakupiai - 7 / 2003 / NaOH- sol	2.97–3.00	Organics and humus	Gd-12732	4660 ± 70	3620 BC – 3600 BC 3520 BC – 3360 BC	2.8% 65.4%	3650 BC – 3300 BC 3250 BC – 3100 BC	91.4% 4.0%
7	Valakupiai - 6 / 2003	3.11–3.13	Organics and humus	Gd-30093	4780 ± 100	3660 BC – 3490 BC 3440 BC – 3370 BC	53.4% 14.8%	3780 BC – 3350 BC	95.4%
8	Valakupiai / 2003	3.24–3.26	Wood remains	Gd-15531	2845 ± 80	1130 BC– 900 BC	68,2%	1270 BC – 820 BC	95.4%
9	Valakupiai - 5 / 2003 / res	3.31–3.33	Organics and humus	Gd-12736	4610 ± 55	3520 BC – 3420 BC 3390 BC – 3330 BC 3210 BC – 3190 BC 3150 BC – 3140 BC	40.8% 22.2% 3.4% 1.8%	3650 BC – 3600 BC 3550 BC – 3100 BC	1.7% 93.7%
10	Valakupiai / 2003	3.38–3.41	Wood remains	Gd-15529	3460 ± 65	1880 BC – 1730 BC 1720 BC – 1690 BC	58.7% 9.5%	1950BC – 1610 BC	95.4%
11	Valakupiai - 4 / 2003	3.38–3.41	Organics with wood	Gd-12739	3840 ± 60	2460 BC – 2370 BC 2350 BC – 2200 BC	15.7% 52.5%	2470 BC – 2130 BC	95.4%
12	Valakupiai - 3 / 2003 / res	3.47–3.48	Organics and humus	Gd-15835	3500 ± 90	1950 BC – 1730 BC 1720 BC – 1690 BC	63.1% 5.1%	2150 BC – 1550 BC	95.4%
13	Valakupiai - 3 / 2003 / NaOH-sol	3.47–3.48	Organics and humus	Gd-15776	4880 ± 75	3770 BC – 3630 BC 3560 BC – 3530 BC	61.3% 6.9%	3950 BC – 3500 BC 3450 BC – 3350 BC	94.3% 1.1%
14	Valakupiai - 2 / 2003	3.56–3.58	Clay with organics and humus	Gd-12769	4190 ± 60	2890 BC – 2830 BC 2820 BC – 2670 BC	17.1% 51.1%	2910 BC – 2580 BC	95.4%
15	Valakupiai - 1 / 2003 /res	3.60–3.62	Organics and humus	Gd-12773	3190 ± 60	1520 BC – 1400 BC	68.2%	1620 BC – 1370 BC 1350 BC – 1310 BC	92.2% 3.2%
16	Valakupiai – 1 / 2003 / NaOH-sol	3.60–3.62	Organics and humus	Gd-15779	4590 ± 90	3520 BC – 3420 BC 3390 BC – 3310 BC 3300 BC – 3260 BC 3240 BC – 3100 BC	20.1% 17.4% 2.9% 27.9%	3650 BC – 30 00 BC	95.4%
17	Valakupiai / 2003	3.63–3.68	Oak timber	Hv-2663	4040 ± 40	2620 BC – 2480 BC	68.2%	2840 BC – 2810 BC 2680 BC – 2460 BC	5.1% 90.3%
18	Valakupiai / 2003	3.63–3.68	Oak timber	Gd-12538	4040 ± 65	2840 BC – 2810 BC 2670 BC – 2470 BC	4.4% 63.8%	2900 BC – 2350 BC	95.4%
19	Valakupiai / 2003	3.63–3.68	Oak timber	Lu-5069	4190 ± 60	2890 BC – 2830 BC 2820 BC – 2670 BC	17.1% 51.1%	2910 BC – 2580 BC	95.4%
20	Valakupiai / 2003	3.63–3.68	Oak timber	Gd-11720	4210 ± 50	2900 BC – 2850 BC 2820 BC – 2740 BC 2730 BC – 2690 BC	21.8% 34.4% 12.0%	2910 BC – 2830 BC 2820 BC – 2630 BC	29.9% 65.5%
21	Valakupiai / 1976	3.95–4.01	Oak timber	Vs-164	5690 ± 160	4710 BC – 4360 BC 3930 BC – 3870 BC	68.2% 8.5%	4950 BC – 4150 BC	95.4%
22	Valakupiai / 1976	3.95–4.01	Oak timber	Vs-163	4900 ± 130	3810 BC – 3620 BC 3600 BC – 3520 BC	46.3% 13.4%	4000 BC – 3350 BC	95.4%
23	Valakupiai / 1976	3.95–4.01	Oak timber	Vs-162	5800 ± 140	4830 BC – 4810 BC 4800 BC – 4480 BC 5610 BC – 5590 BC	1.6% 66.6% 0.8%	5000 BC – 4350 BC	95.4%
24	Valakupiai / 2006	3.95–4.01	Mollusk (*Unio*)	Gd-12818	6540 ± 55 6850 ± 55	5560 BC – 5470 BC 7740 – 7610	67.4% 68.2%	7800–7580	95.4%

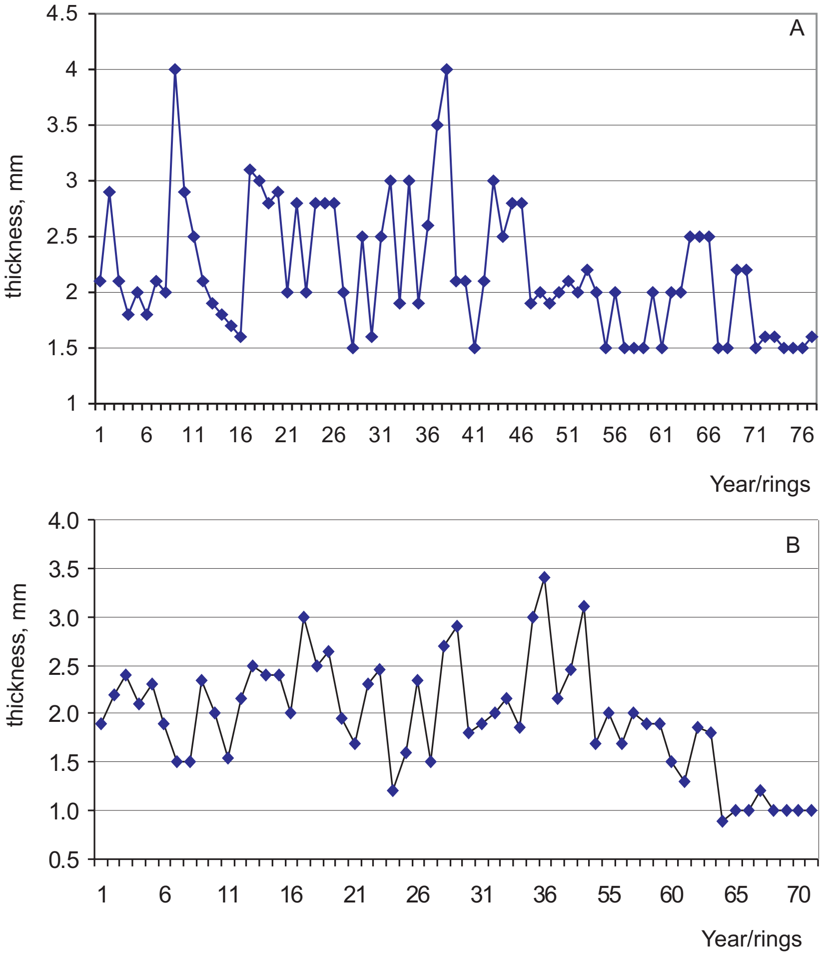


Fig. 4. Dendrochronograms of oak trunks from oxbow lake sediments: *A* – measuring of S. Budėnaitė, *B* – measuring of M. Martinkėnas

4 pav. Senvaginėse nuogulose gulėjusių ąžuolo rąstų dendrochronogramos (S. Budėnaitės (*A*) ir M. Martinkėno (*B*) matavimai)

DENDROCHRONOLOGY AND GEOCHRONOLOGY

Buried oaks and Holocene malacofauna are found in the lower part of sediments in the Valakupiai section. Dark oak-wood trunks of the Atlantic climatic period are found at the bottom of the alluvial sequence. As follows from radiocarbon dates, the oaks belong to the late Atlantic and early Subboreal periods (Table 4). The flood and oxbow lake deposits which covered the buried oaks were formed in the Subboreal and Subatlantic periods. For this wood remains nine radiocarbon dates have been received earlier, which ranged from 5800 ± 140 to 4040 ± 68 BP (Gaigalas, 2004; Gaigalas, Pazdur, 2004). The time scale will support investigations of climatic events took place in the Subboreal / Subantlantic transition and were archived in the Neris River oxbow lake sediments. Dispersion of radiocarbon data in the vertical section of the Valakupiai first above-floodplain terrace reflects specific features in the development of the oxbow lake. The older age of the upper samples, if compared to that of the lower-occurring deposit samples, is related to resettlement of the older organic matter and later transport to the oxbow lake. This was caused by the surface washout process and entrance of decaying older wooden matter. We will present our attempt to build a time scale for some climatic events recorded in oxbow lake sediments. Radiocarbon dates were made on organic material collected in a section of the flood plain terrace and oxbow lake sediments. There were eleven samples of oak remains dated (Table 4). For soil samples, different fractions were dated separately.

For dendrological investigations, cross-sections of two oak tree trunks were made (Fig. 4 A, the 1st oak; Fig. 4, B, the 2nd oak). The thickness of the first and the second oaks was 33.6 and 23 cm, respectively.

The annual growth rings were measured and calculated; based on the data obtained, the dendrochronograms were compiled (Fig. 4). The section of the first oak trunk contained 77 annual while that of the second one 74 rings. The rings differed in thickness depending on climatic conditions. During the most favourable climate years, optimal temperature, enough moisture and sun, the rings grew wider, while unfavourable conditions caused narrower rings. Studies of the sections of the both oaks, going from the centre to the periphery of the section, manifested a tendency towards narrower rings. This confirms a conclusion that at the end of the warm Atlantic period and passing to the Subboreal, the climate was getting cooler and unfavourable for broad-leaved trees, including oaks, which grew in the environs of Valakupiai. The thermophilic forests degraded, and the fallen trunks were covered by the alluvium of the above-floodplain terrace and the oxbow lake sediments of the Neris River. As the oak trunks brought in probably by stream whirls were trapped in the oxbow lake, the latter had a temporary connection with the river's main channel. Trunks of decayed oaks were trapped in the oxbow lake (5300–4590 BP) which had a connection with the Neris River

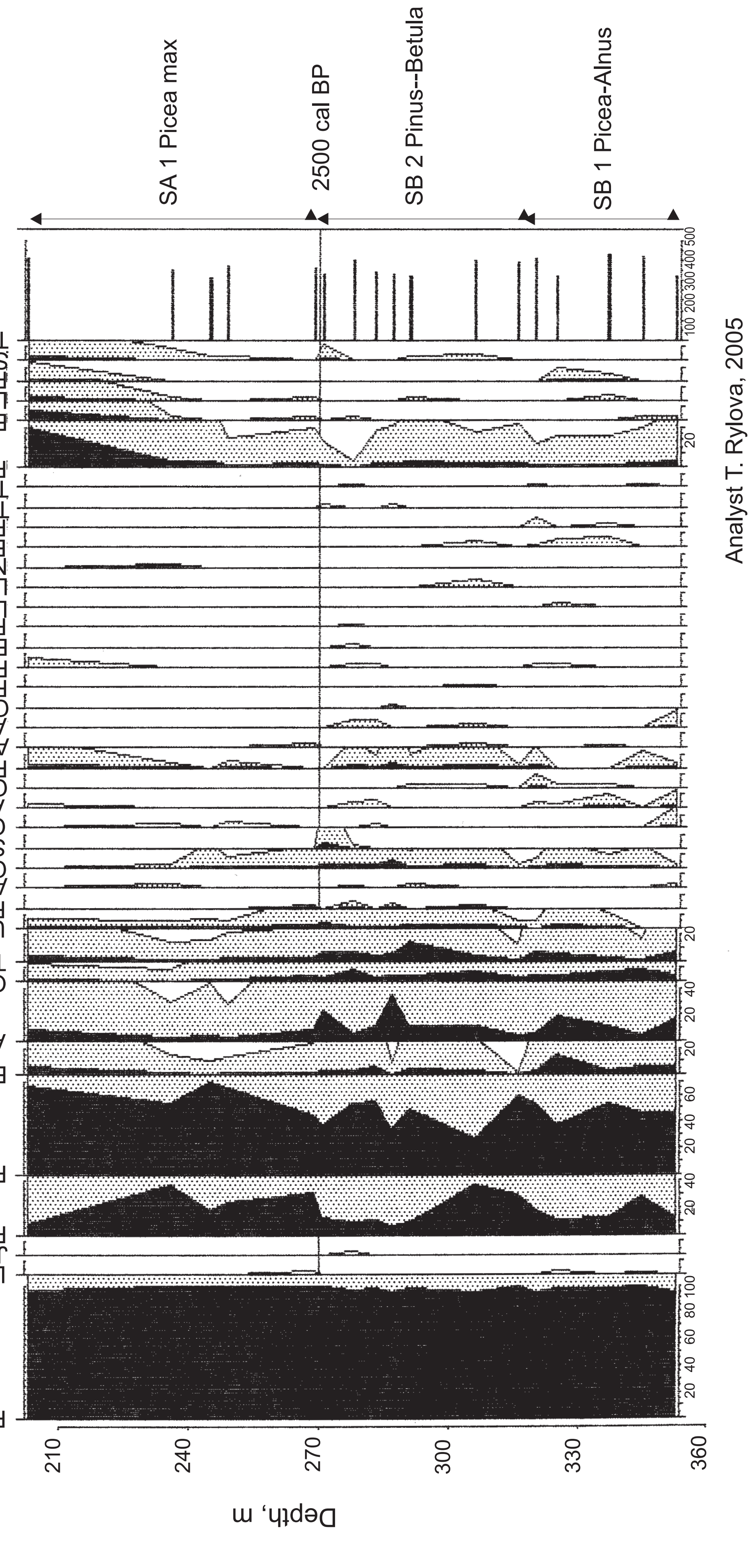


Fig. 5. Palynologic diagram
5 pav. Palinologinė diagrama

Table 5. **Macrofossils of the Holocene plant remains from Valakupiai section (according to G. I. Litviniuk)**
5 lentelė. **Holoceno augalų makrofosilinės liekanos Valakupių pjūvyje (pagal G. I. Litviniuką)**

Taxon	Type of remains	Number of species
Alnus cf. *glutinosa* (L.) Gaertn.	f	>100
Picea excelsa Gaertn.	s	5
Pinus cf. *sylvestris* L.	s	1
Acer sp.	f	4
Scirpus lacustris L.	f	20
Potamogeton pectinatus L.	e	2
P. praelongus Wulf.	e	1
P. natans L.	e	2
P. alpinus Balbis	e	1
Urtica dioica L.	f	1
Carex sp.	f	1
Lamiaceae gen.	f	1
Swida sanquinea (L.) Opiz	f	1
Alisma plantago-aquatica L.	t	1
Nuphar sp.	s	1
Rumex maritimus L.	f	1

Abbreviations. f – fruit, s – seed, e – endocarp, t – tegmen.
Santrumpos. f – vaisiai, s – sėklos, e – endokarpai, t – tegmenai.

channel (4590–3840 BP). The oxbow lake separated from the river at the end of the drier Subboreal (after 3840 BP). Traces of human life were found in the Neris River first above-floodplain terrace deposits formed in the period between 810AD and 1260AD.

PALYNOLOGY AND PALAEOCARPOLOGY

The Atlantic period was the warmest and most humid post-glacial climatic period, so broad-leaved forests flourished (Kabailienė, 1998). The amounts of broad-leaved trees and some spruce decrease during the Subboreal, but pine and birch spread, suggesting a moderately warm dry climate. The Subatlantic period is marked by spreading spruce forests, implying a greater humidity.

During the Atlantic period (before 5000 BP) when the climate was more humid, large amounts of iron were leached from the soils and cemented as iron hydroxide in the basal conglomerate in the lower part of fluvial sediments. Palynological analyses of fluvial organic sediment samples from the Valakupiai outcrop were carried out by T. Rylova and resulted in a diagram, 2005 (Fig. 5). The transition from the Subboreal to the Subatlantic climatic period is expressed by spruce decline (Late Subboreal) and re-advance (Early Subatlantic time). According to recent radiocarbon dates, this transition was observed in the Valakupiai section studied about 2500 years ago. The Late Subboreal pollen spectra representing the Late *Betula–Pinus* 2PAZ are characterised by greatly reduced quantities of *Picea* about 4000–3300 years BP. The first peak of the Subboreal in *Picea* pollen is dated to 4610–4000 BP, and the second peak of the Subatlantic in *Picea* pollen is dated to about 3000–1200 BP.

Palaeocarpological analysis of the sediments at the basal part of alluvium of the first above-floodplain terrace in the Valakupiai section revealed 16 taxa (Table 5). The organic remains contain fruits, seeds, endocarps and tegmens. Wood remains are composed by alder, spruce, pine and maple. According to the association of palaeocarpologic remains, mixed spruce and broad-leaved forests were mainly covering the area at this time. During the Atlantic period (5600 BP), thermophilic tree forests, including oaks, were growing. At the end of the Atlantic and beginning of the Subboreal period (after 5600 BP), the climate got cooler. Dryer climate conditions are reflected by a reduction of spruce (4000–3000 BP). An increase in humidity is related to expansion of spruce (4610–4000 BP and 3000–1260 BP). The boundary between the Subboreal and the Subatlantic is dated to 2500 BP.

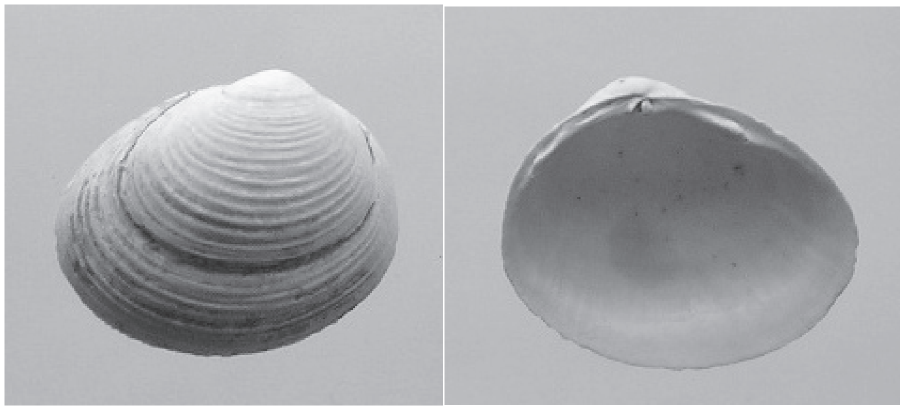
Table 6. **Mollusk fauna of Valakupiai section (2004, specimens, analyst A. Sanko)**
6 lentelė. **Valakupių pjūvio malakofauna (2004, ėminiai, analizavo A. Sanko)**

E	Species	1	2	3	4
1	*Acicula polita* (Hartmann)		1		
2	*Arianta arbustorum* (Linnaeus)		1		
5	*Vallonia costata* (Müller)	1			
5	*V. pulchella* (Müller)	1	1	1	
9	*Vertigo antivertigo* (Draparnaud)		1		
9	*Succinea putris* Linnaeus	1			
10	*Valvata cristata* (Müller)	8	4	1	
10	*Bithynia leachi* (Sheppard) – shells	45	29	8	
10	*Lymnaea* e gr. *palustris* (Müller)	1	1		
10	*L.* e gr. *peregra* (Müller)	5	5	1	
10	*Planorbis planorbis* (Linnaeus)	2			
10	*Segmentina nitida* (Müller)	1			
11	*Valvata piscinalis* (Müller)	91	68	1	1
11	*Bithynia tentaculata* (Linnaeus) – shells	37	134	13	1
11	*B. tentaculata* (Linnaeus) – opercula	53	21	12	
11	*Lymnaea auricularia* (Linnaeus)		1	2	
11	*Gyraulus albus* (Müller)	8	2		
11	*G. laevis* (Alder)		4		
11	*Armiger crista* (Linnaeus)	1	1		
11	*Sphaerium corneum* (Linnaeus)	35	7	31	
11	*Pisidium henslowanum* (Sheppard)	84	20	9	
11	*P. subtruncatum* Malm	2	3		
11	*P. casertanum* (Poli)	35	16	11	
11	*P. casertanum ponderosa* Stelfox	10	13	2	
11	*P. milium* Held	1			
11	*P. moitessierianum* Paladilhe	3			
12	*Theodoxus fluviatilis* (Linnaeus)		2		1
12	*Ancylus fluviatilis* Müller	201	127	28	
12	*Unio* sp. (fragments)	33	100	80	50
12	*Sphaerium rivicola* Lamarck	15	19		
12	*Pisidium amnicum* (Müller)	38	65	11	2
	Total	**712**	**646**	**211**	**55**

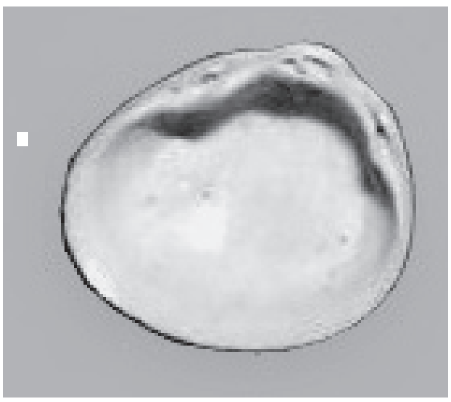
HOLOCENE MOLLUSK FAUNA

Mollusk shells were found in Holocene beds 5 m thick on the Neris River terrace at a depth of 3.9–4.1 m. They occurred in rare lenses of fine sand filling kettle-shaped depressions in red-brown till loam. Fauna-bearing deposits lie in the basal horizon of the Neris River alluvium 0.2–0.4 m thick and are represented by various-grained sand and gravel, as well as cobble and small

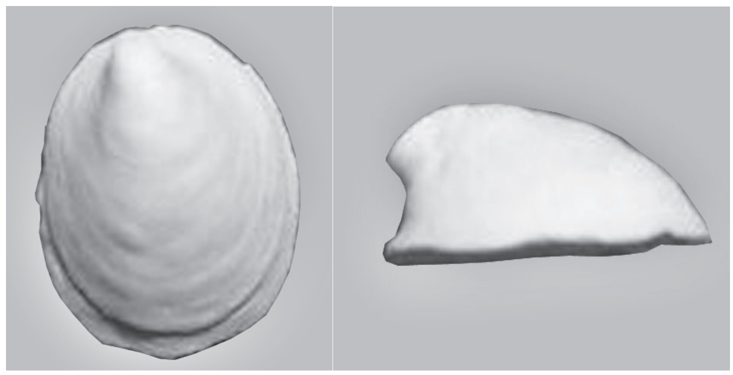
Shells of *Bithynia leachi* (Sheppard) (5–7 × 4–4.5 mm)



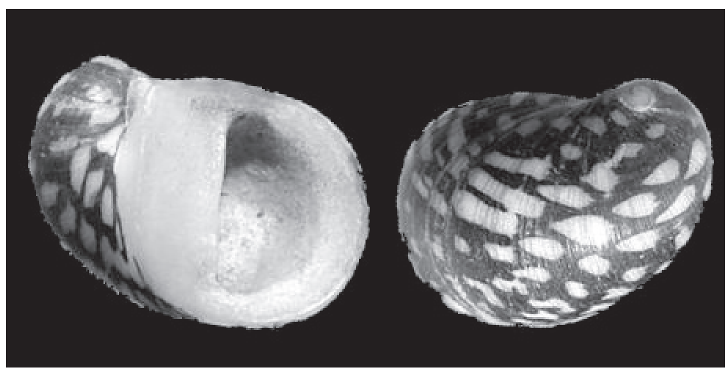
Shells of *Pisidium amnicum* (Müller) (7.0–11.0 × 5.0–9.5 mm)



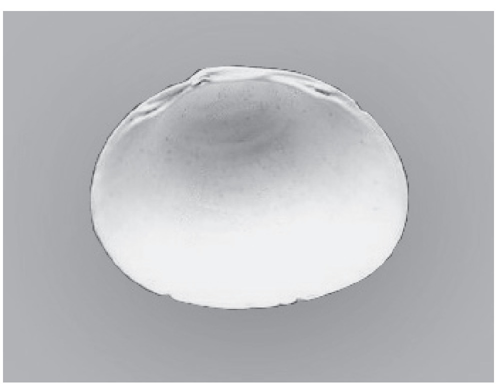
Shell of *Pisidium casertanum ponderosa* Stelfox from (3,5–6,5 × 3,0–5,5 mm)



Shells of *Ancylus fluviatilis* Müller from (2.5-5x4.5-10.6 mm)



Theodoxus fluviatilis (Linnaeus) (6–14 × 4–8 × 3–6 mm)



Shell of *Sphaerium corneum* (Linnaeus) (8,0–16,0 × 7,0 –11,5 mm)

Fig. 6. Shells of mollusks from Valakupiai site
6 pav. Valakupių pjūvio moliuskų geldelės ir sraigės

boulders. The channel deposits are overlain by sand belonging to oxbow lake and floodplain (with a series of buried organics inter layers) alluvium of the Neris River.

Samples for malacofauna investigations were taken from four different lenses situated at about 50 m from each other. The mollusks were studied by A. Sanko who used his own experience (Sanko, 1999). Under warm climatic conditions the mollusk fauna prospered (5600 BP). The results of mollusk species identification are shown in Table 6. The reconstructed mollusk fauna embraces species corresponding to different types of environmental conditions. The land fauna is represented by six taxa in four ecological groups. The freshwater fauna includes 24 taxa of three ecological groups.

The forest species are represented by two taxa: *Acicula polita* and *Arianta arbustorum*. *Acicula polita* is a typical forest mollusk species. Now it inhabits moderately wet areas in deciduous forests or moss–lichen biotopes on sand–gravel outcrops of the underlying rocks. This species is mainly Central European, with its northern boundary reaching South Sweden and Saint Petersburg, whereas its southern boundary reaches the Mediterranean Sea. The other species, *Arianta arbustorum*, which is mainly West European, belongs to the group of mollusks found in shadowed or partly shadowed sites – lighter forests and bush-overgrown areas. The height of the contemporary shells reaches 28 mm.

Species of open sites – *Vallonia costata* and *V. pulchella* – are widely distributed meadow mollusks often met in river floodplain communities. The hydrophilic mollusks *Vertigo antivertigo* and *Succinea putris* inhabit wet media such as flooding meadows, meadow floodplains with bushes as well as bogged banks of rivers or lakesides.

Among the six taxa belonging to the group of ephemeral water bodies, the most abundant is *Bithynia leachi*. This widely distributed species, as a rule in high quantities, is found in water bodies situated in river floodplains. It inhabits also small rivers with low currents, near-bank zones of large rivers where they live at a depth 0.5 to 2 m. *B. leachi* can survive during a long dryout of a water body (Fig. 6).

Species of stable water bodies in the Valakupiai fauna form two ecological subgroups: lacustrine and so-called euryecological. Lacustrine mollusks are rare in the fauna studied. The fauna in stable water bodies consists mainly of euryecological mollusks, which can inhabit both lakes and rivers. Quantitatively, the complex of such mollusks as *Bithynia tentaculata, Valvata piscinalis, Pisidium henslowanum* and *Sphaerium corneum* is most distinguished.

River species do not vary much in their taxonomic composition, but they prevail by the quantity of specimens in the association. The main role is played by the representatives of the genus *Unio* and European mollusks *Ancylus fluviatilis* together with *Pisidium amnicum* and partly with *P. casertanum ponderosa, Sphaerium corneum* (Fig. 6). The latter species is leading by the quantity of specimens not only in their ecological group, but also in all fauna; it is a typical representative of rheophiles. *A. fluviatilis* inhabits rivers and brooks, as well as sometimes is seen in a surf zone of lakes and seas. They found optimal conditions in running water on a deep stony bottom where they stick to stones or plants. Abundance of their shells is a marker of clean water. Under long-term pollution of water the colonies of this mollusk decrease significantly. Their contemporary shells are 1.5–5 mm in height and 4.5–10.6 mm in diameter (Fig. 6).

In general, the mollusk fauna is characteristic of the Baltic drainage area. There is also a species external for river fauna – *Theodoxus fluviatilis* – which is sparse in the Valakupiai fauna in which only three specimens have been found. It belongs to a fauna typical of the Black Sea (Ponto-Caspian) drainage basin, but now this species is widely spread in all Europe. The size of its shells ranges within 6–14 mm in length, 4–8 mm in width and 3–6 mm in height (Fig. 6).

At the beginning of the Holocene and during the Muravian Interglacial, *Th. fluviatilis* had not crossed the divide between the Black and the Baltic seas (Санько, 1999). Hence, in the Holocene this species was brought to the Lithuania's area as well as to other European countries by man. There was already a relation among people inhabiting the Black Sea basin. Most probably this happened due to migration of humans along the rivers of South Europe to the northern regions. It cannot be excluded that the appearance of the species in the Baltic drainage area was related to the development of trade and discovery of river ways "from Varangians to Greeks". In any case, in this regard, the first appearance of *Th. fluviatilis* in the Baltic drainage area, including Lithuania, can bear a particular geochronological significance.

CONCLUSIONS

The lower part of fluvial sediments is rich in dark oak wood remains. For this wood remains, radiocarbon dates range from 5800 ± 140 to 4040 ± 68 BP. Calibrated dates of oxbow lake sediments cover the time period from 3770 BC to 1260 AD. It means that the accumulated terrace was formed in 5000 years. The sedimentary environment of oxbow lake evolution is reflected in the grain-size composition of sand. Sandy sediments in oxbow lake peaty deposits of the section show 18 flood events of the Neris River during the Subboreal / Subatlantic time.

Wood remains of the sediments in the basal part of alluvium of the first terrace above floodplain in the Valakupiai section are composed by alder, spruce, pine and maple. During the Atlantic period (5600 BP), thermophilic tree forests, including oaks, were growing. At the end of the Atlantic and beginning of the Subboreal period (after 5600 BP) the climate got cooler. The transition from the Subboreal to the Subatlantic climatic period (about 2500 BP) is expressed by spruce decline (Late Subboreal) and re-advance (Early Subatlantic time).

Ancylus fluviatilis dominates in reophil mollusk fauna. The most abundant mollusks *Unio* found in Valakupiai site sediments live in stream water. These molluscs, together with the forest species *Acicula polita, Arianta arbustorum*, are indicative of warmer climatic conditions in the Atlantic period.

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NERIES UPĖS SENVAGĖS NUOGULOSE PALAIDOTI ĄŽUOLAI IR MALAKOFAUNA VALAKUPIŲ PJŪVYJE (LIETUVA)

Santrauka

Neries upės Valakupių meandroje holoceno senvaginių nuogulų pjūvio pagrinde surasti palaidoti ąžuolų kamienai, kurių radiokarboninės datos patvirtino priklausymą atlančio klimato periodui (prieš 5000 metų). Ąžuolų kamienai slūgso virš pamatinio gargždo konglomerato, sucementuoto geležies oksidais ir hidrooksidais, nusėdusiais šilto, drėgno klimato sąlygomis, palaidoti po vaginio, senvaginio ir salpinio aliuvio nuogulų danga. Kamienai įstrigo senvagėje, kai ši turėjo ryšį su upės vaga. Dendrochronologiniai tyrimai patvirtina, kad pereinant iš atlančio į subborealį klimatas atvėso. Senvaginio aliuvio organogenine medžiaga praturtinti tamsesni sluoksneliai kaitaliojasi su potvynių metu suklotais šviesesniais salpinio aliuvio smulkiagrūdžio smėlio tarpsluoksniais. Salpinio aliuvio granuliometrinė sudėtis ir vidutingrūdžio smėlio bei aleurito frakcijų priemaiša atspindi Neries upės senvagės raidos stadijas: prievaginę (daugiau smėlio) ir ežerinę (daugiau aleurito). Pagal salpinio aliuvio tarpsluoksnių skaičių senvaginio aliuvio nuogulose nustatyta 18-a ryškių potvynių per beveik 3730 metų senvagės raidą. Granuliometriniais duomenimis, apatinėje senvagės dalyje surasti vaginio aliuvio tarpsluoksniai rodo buvus senvagės ryšį su pagrindine upės vaga. Viršutinės dalies salpiniame aliuvyje išryškėjo eolinio smėlio priemaiša. Pamatinio konglomerato pažemėjimuose surinkti moliuskų kiauteliai. Gėlavandenių moliuskų faunai atstovauja 24 trijų ekologinių grupių taksonai. Sausumos moliuskai priklauso keturių ekologinių grupių 6 taksonams, tarp jų yra miško rūšis *Acicula polita*. Gėlavandenis moliuskas *Theodoxus fluviatilis*, imigrantas iš Juodosios jūros baseino, į Neries vandenis pateko žmonėms migruojant ankstyvajame neolite.

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ПОГРЕБЕННЫЕ ДУБЫ И МАЛАКОФАУНА В ГОЛОЦЕНОВОЙ СТАРИЦЕ В РАЗРЕЗЕ ВАЛАКУПЯЙ, (ЛИТВА)

Резюме

Погребенные стволы дубов найдены в разрезе старичных отложений в Валакупском меандре р. Нярис. Радиоуглеродные даты подтверждают их принадлежность к атлантическому климатическому периоду возрастом до 5000 лет. Стволы дубов залегают в верхней части базального галечного конгломерата, сцементированного гидроокислами и окислами железа, накопившегося в условиях теплого и влажного климата. Они перекрыты отложениями руслового, старичного и пойменного аллювия. Дендрохронологические исследования показали, что климат стал прохладнее при переходе от атлантического климатического периода к суббореальному. Отложения старичного аллювия, обогащенные органикой, переслаиваются со светлоокрашенными прослоями мелкозернистого песка, сформированными во время паводков. Гранулометрический состав пойменного аллювия с примесью среднезернистого песка и алеврита соответствует различным стадиям развития старицы р. Нярис: прирусловой (с преобладанием песка) и озерной (с примесью алеврита). По числу прослоев пойменного аллювия в старичных отложениях установлено 18 заметных наводнений в течение 3730 лет развития старицы. Прослои руслового аллювия в нижней части разреза свидетельствуют о связи старицы с руслом реки. В верхней части разреза выявлена примесь эолового песка. В понижениях базального конгломерата собраны раковины пресноводных моллюсков, представленные 24 таксонами из трех экологических групп. Наземные моллюски относятся к 6 таксонам из четырех экологических групп. Среди них присутствует лесной вид *Acicula polita*. В составе пресноводной фауны выявлен *Theodoxus fluviatilis,* который, по всей вероятности, попал в воды р. Нярис из черноморского бассейна благодаря миграции человека в раннем неолите.