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Corresponding Member of the Academy of Sciences of the USSR I. E. Starik and Kh. A. Arslanov

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Abstract

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RADIOCARBON AGES OF SOME QUATERNARY SAMPLES

The present paper gives the results of radiocarbon dating of samples of Quaternary deposits from the European part of the USSR, obtained by means of the scintillation dating method developed by us ([1], [2]). From the carbon of the samples studied, the scintillation solvents ethylbenzene or benzene were synthesized; in these, the radiocarbon activity was determined on a scintillation counter by the coincidence method.

To remove carbonates, the samples were first treated with a solution of hydrochloric acid. All ancient samples, consisting mainly of decomposed wood, were supplied to us in limited quantity and therefore were not treated with an alkali solution for the purpose of removing humic acids, since a specially conducted experiment showed that, when decomposed wood is treated with an alkali solution, a considerable part of the sample is carried away. The absence of such treatment in the case of wood samples apparently could not have introduced a large error. Olson and Broecker' s investigations of sample contamination showed that contamination of wood by humic acids brought in by ground waters is possible, but is not the rule ([3]). Numerous wood samples not treated with alkali showed ages beyond the sensitivity of the method (older than 44 thousand years) ([3], [4]). Humic acids isolated from ancient wood samples in most cases showed the same age limit as the main sample. Similar results were obtained by the same authors in separate dating of different components (lignin, cellulose) of one and the same sample. In the case of peat, humified soil, and various silty substances, contamination by extraneous humic acids occurs to a greater extent than in the case of coal and wood ([5]).

Samples having a young age (Nos. 11–15), as well as ancient samples (Nos. 17, 22), the quantities of which were insufficient for the synthesis of benzene, were dated by ethylbenzene. The ages of the remaining samples were determined by benzene. Data on the absolute ages of the dated samples are given in Table 1.

Samples Nos. 11–13 were dated in order to check and refine the ages of certain horizons of Holocene deposits in the northwest of the European part of the USSR. The relative scale for this region, tied to the absolute chronological scale, was compiled by K. K. Markov ([6]).

On the basis of spore-pollen analysis, the formation of the deposits from which

samples Nos. 12 and 13 were taken belongs to the transition from the Boreal to the Atlantic period, i.e., according to K. K. Markov, to the period 7000–7700 years ago. The radiocarbon ages obtained by us, 7370 ± 210 and 7970 ± 260 years, confirm the correctness of the previously developed scale for this zone.

On the basis of spore-pollen analysis, sample No. 11 should have

age of approximately 4000 years (end of the Atlantic—beginning of the Subboreal period). By radiocarbon, the sample is dated to 3050 ± 180 years.

Sample No. 14, on the basis of spore-pollen analysis, is dated to the Subatlantic period (above the upper elm maximum). Its radiocarbon age agrees well with the data of the spore-pollen analysis.

Sample No. 15, taken from a depth of 3 m on the first terrace above the floodplain of the Kasplya River (terrace height 5.5 m), is also of Holocene age. In the opinion of V. P. Grichuk, the bluish-gray sands at the base of the exposure belong to

Table 1

Sample No.	Description of the sample	Age in years
11	Peat from a depth of 2.6 m below the surface at the 189th km of the Leningrad—Petrozavodsk highway. Thickness of the peat bog 2.65 m. Submitted by L. G. Lisitsina (Institute of Archaeology, Academy of Sciences of the USSR)	3050 ± 180
12	Peat from a depth of 1.8 m from the upper wall of the diatomite quarry near Tyrvala on the right bank of the Neman River. Submitted by G. N. Lisitsina	7370 ± 210

Sample No.	Description of the sample	Age in years
13	Peat from an exposure on the left bank of the Oyat River (Leningrad Province), from a depth of 4.3 m below the edge of the exposure. Submitted by G. N. Lisitsina	7970 ± 260
14	Wood from the floodplain of the Kasplya River near the village of Voloty, Smolensk Province, taken from a peat layer at a depth of 0.85 m from the edge of the floodplain terrace. Submitted by V. P. Grichuk (Institute of Geography, Academy of Sciences of the USSR)	1170 ± 150
15	Wood from a depth of 3 m below the edge of the first terrace above the floodplain of the Kasplya River near the village of Voloty, Smolensk Province. Submitted by V. P. Grichuk	2630 ± 160

Sample No.	Description of the sample	Age in years
17	Wood from a peaty-gyttja horizon at a depth of 4.5 m from the edge of a ravine near the village of Cheremoshnik, near the city of Rostov, Yaroslavl Region. Submitted by K. K. Markov (Moscow State University)	more than 31600
19	Peat from a depth of 4.8–5.1 m from the edge of the Gremyachka ravine near the city of Ples. Submitted by V. P. Grichuk	36600 ± 1500
20	Wood from the same exposure, but from a depth of 5.8–6.6 m. Submitted by V. P. Grichuk	more than 40600

Sample No.	Description of the sample	Age in years
21	Wood from ancient alluvial sands (with shells of mollusks *Dreissena polymorpha* and others), occurring in the upper part of the first terrace above the floodplain of the Volga River near the village of Cheremnino, not far from the city of Rybinsk. The sample was taken from a depth of 2 m below the edge of the terrace. Submitted by K. K. Markov	25900 ± 900
22	Wood from the same horizon, but at a greater depth (about 2.5 m) below the edge of the terrace. Submitted by K. K. Markov	28800 ± 2000
23	Wood from the same exposure, taken from the upper layers of the gyttja bed. Submitted by K. K. Markov	31900 ± 880

Sample No.	Description of the sample	Age in years
24	Wood from the same horizon, taken from the base of the gyttja bed at a height of about 1 m above the waterline of the Volga River. Submitted by K. K. Markov	39400 ± 2000

Sample No.	Description of the sample	Age in years
25	Wood from an exposure by the Cheremukha River on the southern outskirts of the city of Rybinsk. According to its stratigraphic position, it corresponds to gyttjas occurring at the base of the first terrace above the floodplain of the Volga River near the village of Cheremnino. The sample was taken from a layer of gyttja at a height of 1.5 m above the waterline of the Cheremukha River. On the basis of spore-pollen analysis, V. P. Grichuk assigns the formation of this gyttja layer to the climatic optimum of the Mikulino interglacial epoch. Submitted by N. S. Chebotareva (Institute of Geography, Academy of Sciences of the USSR)	39600 ± 2000

Sample No.	Description of the sample	Age in years
26	Wood from the same horizon, but at a lower height (about 1.2 m) above the waterline of the Cheremukha River. The layer from which the sample was taken, according to V. P. Grichuk, belongs to the first half of the climatic optimum phase of the Mikulino interglacial. Submitted by N. S. Chebotareva	42700 ± 2000

to the young Upper Pleistocene interglacial, while the overlying gray sands, 4.1 m thick, belong to the Holocene, represented by the Atlantic, Subboreal, and Subatlantic phases.

It does not seem possible to judge the age of the ancient-lake deposits near the village of Cheremoshnik (sample No. 17) from a single determination made on a small amount of material. For this, additional, more systematic determinations are necessary.

The age of sample No. 19, established from peat, should be regarded as a minimum, since peat, as noted above, can easily be contaminated by extraneous humic acids. Therefore, the age of samples Nos. 19, 20 (more than 40,600 years for the beginning of the Mikulino interglacial epoch and more than 36,600 years for its end) does not contradict the assignment of these deposits to the Mikulino interglacial epoch ([7]).

The most interesting results were obtained for interglacial deposits near the city of Rybinsk (samples Nos. 21-26). Samples Nos. 21-24 represent a series of four consecutive samples from deposits of the first terrace above the floodplain of the Volga River near the village of Chermenino. The deposits of this terrace are represented by a 12-meter layer of gyttja underlain by a layer of sand 2.5 m thick (Fig. 1). According to A. I. Moskvitin, these gyttjas in the vicinity of Rybinsk accumulated in the Mologa-Sheksna lake, which existed during the young interglacial of the same name ([8]). Two successive samples (Nos. 25-26) from an exposure near the Cheremukha River have an age similar to that

of sample No. 24 from the base of the first terrace above the floodplain of the Volga River, which confirms the synchrony of formation of the gyttja sequence at both points. Thus, judging from the obtained age values, formation of the gyttja sequence in the area studied took place approximately 42,000–30,000 years ago.

Fig. 1. Section of the first terrace above the floodplain of the Volga River near the village of Chermenino, with the emergence of gyttja of the Mologo-Sheksna interglacial according to A. I. Moskvitin. **1** —Holocene peat, **2** —fine-grained sand with shells at the base, **3** —clayey gyttja with shells at the base.

The Mikulino interglacial is usually correlated with the Eemian interglacial in Western Europe. Radiocarbon dating of samples belonging to the end of the Eemian interglacial or to one of the early interstadials showed an age of 64,000 years ([9]). Similar age values (about 70,000 years) for the beginning of the last glacial epoch have been obtained from paleotemperature analyses of ocean cores ([10]). Therefore, the period from 42,000 to 30,000 years ago, during which the gyttja sequence accumulated, apparently belongs to an interglacial period younger than the Mikulino. This period, judging from the obtained age values, may be correlated with the Göttweig interstadial in Western Europe (lasting 44,000–29,000 years), which divides the last glacial epoch into the early Würm and main Würm stages, or with the interstadial that divides the Wisconsin glaciation in North America into the early Wisconsin and main Wisconsin stages ([11], [12]).

The data obtained are insufficient for final confirmation of the presence in the Rybinsk area of interglacial deposits younger than the Mikulino. The additional investigations necessary in this direction will be carried out in the near future.

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Note: Figure translations are in progress. See original paper for figures.