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GEOLOGY

A New Biostratigraphic Level of Pliocene in West Siberia and the Age of the Lower–Middle Miocene Stratotype of the Beshcheul Horizon

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Stratigraphic substantiation of the age of local and regional units defined in the Oligocene, Lower Miocene, and Middle Miocene continental units of West Siberia, as well as their correlation, are mainly based on palynological and paleocarpological data. In this respect, the Lower–Middle Miocene Beshcheul Horizon is one of the best-substantiated stratigraphic units. At an Interdepartmental Stratigraphic Meeting in 1967, the exposure described by M.G. Gorbunov and V.P. Nikitin in [2] on the right scarp of the Irtysh River near the Isakovka Settlement [1] was proposed as its stratotype. It encloses seed flora of the Isakovka level and Isakovka palynoflora that characterize, in opinion of paleobotanists, the Middle Miocene stage in Neogene flora development [1, 3, 4]. Some researchers [3, 4] suggest that the Neogene section of West Siberia begins with the Beshcheul Horizon containing the Isakovka palynoflora.

The detailed studies of main Neogene sections carried out on the right scarp of the Irtysh River valley 80–240 km downstream of Omsk in the area between the Krutaya Gorka and Kartashevo settlements in 1998–2002 specified the stratigraphic succession of Neogene sediments and revealed remains of small mammals in the stratotype of the Beshcheul Horizon near the Isakovka Settlement. The majority of researchers working on Cenozoic stratigraphy consider these mammals to be the most reliable group for correlation of Miocene continental sediments. These data made it possible to substantially refine the Neogene stratigraphy of West Siberia.

The Neogene section on the right scarp of the Irtysh River valley near the Isakovka Settlement includes the stratotype of the Beshcheul Horizon and almost continuously extends along the river over a distance of 6 km to the south and north of the settlement (Fig. 1). The stratotype of the Beshcheul Horizon is located 3 km north of the Isakovka Settlement, 0.5 km downstream of the Krasnaya River mouth (Isakovka 1). Near the Isakovka Settlement, Quaternary sediments are underlain by five different-age Cenozoic sequences with distinct erosion boundaries, certain positions in the section, and specific lithostratigraphic features.

The Neogene section includes the following units (from bottom to top). The basal sequence exposes the upper part of the sequence (apparent thickness 1.4 m) which corresponds in lithology to the Upper Oligocene Abrosimov Formation. The basal sequence is overlain with a sharp erosion surface by a sequence lithologically similar to the Beshcheul Formation described by V.A. Nikolaev 15 km downstream of the eponymous settlement. The most complete section of the formation (up to 15 m thick) is exposed in outskirts of the Isakovka Settlement 400 m upstream of its southern margin (Isakovka 3). This sequence is composed of horizontally alternating grayish brown clay-rich micaceous silt (up to 0.5 m) and light gray fine-grained silty polymictic micaceous sand (up to 0.4 m). The beds show distinct small-scale ripple marks emphasized in silty layers by sand laminae up to 1 cm thick. The thickness of the second sequence decreases to 2.6 m in downstream of the Isakovka Settlement.

The intensely eroded surface of the Beshcheul Formation 4–12 m above the low water level is overlain by a intricate sandy–silty sequence considered by most researchers to be the Beshcheul Formation [1, 4], which encloses the stratotype of the Beshcheul Horizon in the Neogene section. The third sequence constitutes the largest part of the river bank scarp that extends north and south of the Isakovka Settlement over a distance of 5 km. This sequence characterizes a complete cycle of fluvial sedimentation up to 25 m thick. In terms of lithological features (lesser density, color, and structure), bedding conditions, and paleontological characteristics, the third sequence sharply differs from the Besh-

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cheul Formation exposed along the right scarp of the Irtysh River between the Krutaya Gorka and Kartashevo settlements. Therefore, we define this sequence as the autonomous Isakovka Formation. The section exposed over 5 km near the Isakovka Settlement is accepted as the stratotype of the Isakovka Formation. The northern margin of the exposure area is located 2.9 km north of the Isakovka Settlement and 0.5 km downstream of the Krasnaya River mouth, while the southern margin is located 400 m south of the settlement. The lower unit (alluvial sediments) of the sequence includes a basal horizon (up to 0.2 m thick) of small clayey pebbles and gravel. This horizon is overlain by light gray and brownish gray, polymictic and mainly fine-grained sands with ripple marks, rare interbeds of greenish gray silt (up to 0.3 m), and rare lenses of poorly sorted clayey gravel (up to 0.2 m) with bones of small mammals and fish, as well as plant detritus with seed remains. The thickness of the sandy bed varies from 9 m in the area located 2.8 km north of the settlement to 3.1 m in the Isakovka 2 area located 0.3 km south of the settlement. The upper part of the alluvial sediments accumulated on the near-channel shoal is represented by greenish gray to gray, locally brownish gray, clayey silt (up to 12.6 m thick in the northern area to 18.8 m thick in the southern area) with interbeds of light gray fine-grained sandstone, the quantity and thickness of which increases downward along the sequence. Silty and sandy beds show abundant ripple marks and, less commonly, diagonal lamination. In the northern part of the exposure, the sequence is crowned by floodplain sediments that include greenish gray clayey silt (up to 1.8 m) with iron hydroxide nodules in the lower part and a pedocomplex of two soil layers (0.6 m each) composed of gray montmorillonite clay with vertical prismatic jointing separated by a greenish gray silty layer up to 1 m thick. The pedocomplex encloses abundant burrows of shrews. Upper layers of the sequence are eroded in the southern part of the exposure.

The stratotype of the Isakovka Formation contains abundant remains of small mammals, seeds [1, 2], pollen, and spores [3–5]. Its lower part yields remains of small mammals from two localities, which belong to a single new (Isakovka) mammalian assemblage of West Siberia. In the Isakovka 2A locality 0.3 km upstream of the eponymous settlement and 6.2 m above the river water level, the assemblage includes remains of 12 insectivorous, double-toothed rodents and rodent genera: *Desmana* sp., *Sorex* sp., *Paranourosorex gigas* Rzebik-Kowalska, *Petenyia* sp., *Ochotona* sp., Castoridae gen. indet.; *Lophocricetus (Paralophocricetus)* sp., *Micromys* sp. Cricetinae gen. indet., *Anatolomys* sp., *Promimomys insuliferus* Kowalski, and *Prosiphneus* sp. The overwhelming majority of the remains belong to *P. insuliferus* (over 90 molars). Other forms of small mammals are represented by scarce specimens. The section representing the stratotype of the Beshcheul Horizon and located 3 km downstream of the Isakovka Settlement 6 m and 9 m above the water

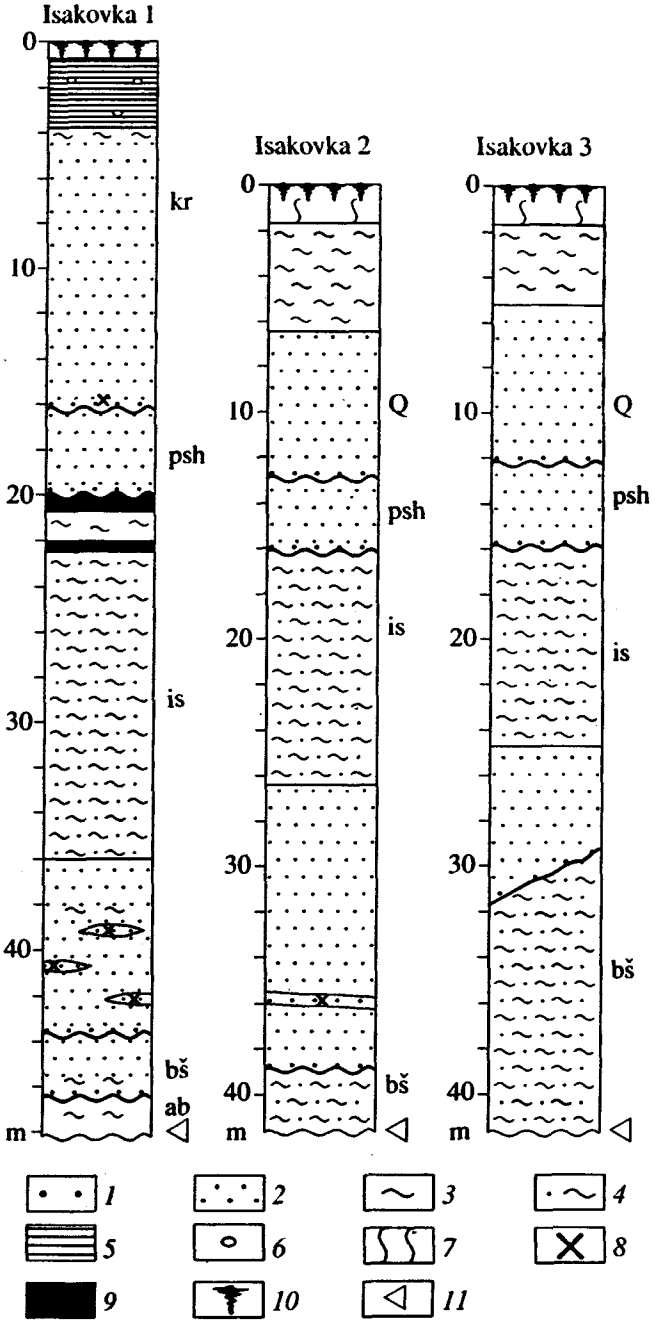

Fig. 1. Neogene sections in the right scarps of the Irtysh River valley near the Isakovka Settlement. (*1*) Gravel and small pebbles; (*2*) sand; (*3*) silt; (*4*) alternating sand and silt; (*5*) clay; (*6*) marly concretions; (*7*) loesslike loam; (*8*) small mammal finds; (*9*) fossil soil; (*10*) present-day soil; (*11*) water level. Formations: (ab) Abrosimovka, (bš) Beshcheul, (is) Isakovka, (psh) Peshnev, (kr) Krutaya Gorka; (Q) Quaternary sediments.

level encloses the remains of eight insectivorous and rodent genera (Isakovka 1A locality): *Desmana* sp., *Sorex* sp., *Paranourosorex gigas* Rzebik-Kowalska, *Blarinini* gen. indet., *Urotrichini* gen indet., *Scalopini* gen. indet., *Microtinae* gen. indet., and *Prosiphneus* sp.

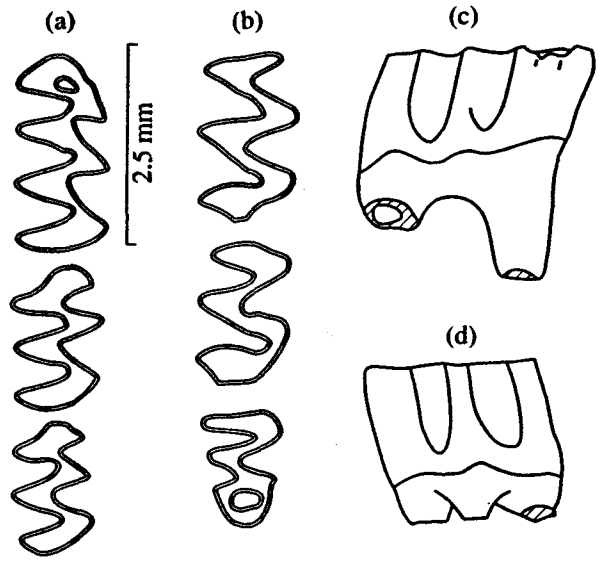

Fig. 2. The structure of molars in *Prominomys insuliferus* Kow. from the Isakovka 2A locality (magn. 20; reprod. 4/5). (a, b) Chewing surface of (a) lower and (b) upper molars; (c) labial side of M_1; (d) lingual side of M^1.

The locality upstream of the Isakovka Settlement should be considered a type locality of the assemblage.

The structure and dimensions of molars in *Prominomys insuliferus* representatives (Fig. 2) from this section are similar to those from the Podlesice type locality in Poland and the Antipovka and Chugunovka localities in the Russian Plain ([6] = *Prosomys insuliferus*). The molars are mesodont formations without cement. Enamel along the entire tooth periphery is almost uniformly thick. An anteroconide M_1 is strongly simplified. The entering corners are poorly developed and manifested only in the upper part of the anteroconide. The labial prismatic (*Mimomys*-type) fold is very shallow and rapidly disappears with tooth abrading. The enamel insula on the anteroconide M_1 and posterior prism M^3 are preserved for a very long time. The anterior enamel insula on M^3 appears on the chewing surface at the late stage of tooth abrading. The dentine tracts in the molars are very low (Fig. 2). The length of the molars is as follows (mm, $n = 5$): M_1 2.45 (2.40–2.55), M_2 1.82 (1.75–1.90), M_3 1.55 (1.40–1.65), M^1 2.20 (2.10–2.25), M^2 1.87 (1.75–2.00), M^3 1.62 (1.50–1.70). *P. insuliferus* is a characteristic form in Zone 14 of the European Neogene mammal scale [7], which allows the Isakovka Formation to be dated back to the Early Pliocene. The coexistence of *Prominomys insuliferus* and *Paranourosorex gigas* in the Isakovka 2 locality indicates its synchronism with the Early Pliocene (Early Ruscinian) Podlesice, Antipovka, and Chugunovka localities in Europe.

In the Isakovka 1 locality, the Early Pliocene age of the fauna is evident from the presence of *Paranourosorex gigas* and *Prosiphneus* sp. The development history of the *Paranourosorex* genus in Eurasia implies the belonging of *P. gigas* to Zone 14 of the Neogene mammal scale [8]. The belonging of fossil remains from both localities to a single mammalian assemblage is supported by a similar evolutionary morphological development of the molars in *Paranourosorex gigas* and *Prosiphneus* sp.

P. insuliferus is widespread in Lower Pliocene sections of Eurasia. Its remains are known from France, Greece, Poland, Ukraine, the Russian Plain, and Olkhon Island in eastern Siberia [9]. Finding this species in the West Siberian Plain indicates the existence of its continuous domain in middle latitudes of Eurasia extending from France to Lake Baikal. The generic composition of the Isakovka small mammal fauna is typical of the terminal Miocene–Early Pliocene in southern West Siberia. Based on the morphology of its tooth system, *P. insuliferus* can be placed between the Cherlak representative of *Prominomys* and *P. antiquus* Zazh. from the Peshnev faunal assemblage. The Isa-kovka mammal assemblage with the guide form *P. insuliferus* fills the existing gap in the development history of Early Pliocene small mammals in West Siberia.

The spores–pollen complex from the stratotype of the Isakovka Formation [3–5] slightly differs from that in the stratotype of the Beshcheul Formation [10] in the lower proportion of broad-leaved arboreal plants and Taxodiacea representatives. The carpological complex from the Isakovka Formation stratotype represents a type flora for the floral assemblage of the Isakovka level or Middle Miocene Isakovka flora [1], although Nikitin [2], who described this flora, placed it in the Lower Pliocene.

The Isakovka Formation in its stratotype is overlain by a dark gray silty member (3.4 m thick) with interbeds and lenses of fine-grained sand characterized by ripple marks. These sediments accumulated on near-channel shoals and are referred to the Peshnev Formation. In the northern part of the exposure, the section is crowned by the Krutaya Gorka Formation. Its basal layer yields remains of small mammals of the synonymous assemblage (Isakovka 1C locality) with the guide species *Prominomys* cf. *davakosi* Weerd. In the southern part of the exposure, the section is overlain by Quaternary sediments. As in its stratotype [11], the Krutaya Gorka Formation in this section characterizes the complete cycle of fluvial sedimentation. Its lower part is composed of alluvial light gray fine-grained polymictic sands with ripple marks, while the upper part consists of floodplain silts and dark gray montmorillonite clays.

Thus, the thorough study of main Neogene sections in scarps of the Irtysh River valley north of Omsk allows substantial corrections in stratigraphy of the West Siberian Plain. We have established the Isakovka assemblage, marking a new stage in the development of small mammals in southern West Siberia. This assemblage fills the gap in faunal evolution between the Cherlak and Peshnev assemblages. Based on the strati-

graphic position of the Isakovka assemblage, the stratotype of the Beshcheul Horizon, previously referred to the Middle Miocene, is placed into the Lower Pliocene. The Isakovka Formation is defined as a new stratigraphic unit in the Pliocene succession. The type flora of the Middle Miocene Isakovka floral assemblage should be referred to the Lower Pliocene.

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REFERENCES

1. V. A. Martynov, Z. N. Gnibidenko, and V. P. Nikitin, Stratigr. Geol. Korrelaytsiya **8** (2), 78 (2000) [Stratigr. Geol. Correlation **8**, 177 (2000)].
2. P. A. Nikitin, in *Materials on Stratigraphy of the West Siberian Plain* (Tomsk Univ., Tomsk, 1978), pp. 23–75 [in Russian].
3. V. S. Volkova and I. A. Kul'kova, Stratigr. Geol. Korrelaytsiya **4** (5), 83 (1996) [Stratigr. Geol. Correlation **4**, 496 (1996)].
4. K. A. Merkulova, in *Materials on Stratigraphy and Paleontology of Siberia* (SNIIGGIMS, Novosibirsk, 1969), pp. 51–60 [in Russian].
5. L. V. Aleksandrova, in *Materials on the Stratigraphy and Paleontology of Siberia* (SNIIGGIMS, Novosibirsk, 1969), pp. 151–157 [in Russian].
6. A. K. Agadjanian and K. Kowalski, Acta Zool. Crak. **23** (3), 29 (1978).
7. P. Mein, in *European Neogene Mammal Chronology* (New York, 1990), pp. 73–90.
8. G. Storch and V. S. Zazhigin, Paläontol. Z. **70**, 265 (1996).
9. A. G. Pokatilov, Izv. Akad. Nauk SSSR, Ser. Geol., No. 9, 52 (1985).
10. V. S. Volkova and L. A. Panova, in *Cenozoic Palynology in Siberia* (Nauka, Novosibirsk, 1975), pp. 34–54 [in Russian].
11. V. S. Zazhigin and V. S. Zykin, Geol. Geofiz., No. 3, 42 (1983).