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UPPER PLIOCENE AND PLEISTOCENE
OF THE SOUTHERN URALS REGION
AND ITS SIGNIFICANCE FOR CORRELATION
OF THE EASTERN AND WESTERN PARTS OF EUROPE

Excursion Guide

Ufa – 2002

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BASHKIR STATE UNIVERSITY

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Summarised information on the Upper Pliocene – Pleistocene deposits of the Southern Urals with descriptions of the key sections and with the distribution of significant ostracode species, molluscs, large and small mammals and plant remains.

The Late Cenozoic history of the Southern Urals region is characterised by the transgression of the Aktschagylian Sea, which flooded all river valleys of the Southern Fore-Urals during the Pliocene. The Pleistocene deposits in the area are of continental origin. The Pleistocene glaciations did not reach the Southern Urals; however the Quaternary climatic fluctuations affected the history of the fauna, flora and human societies as well as the geomorphological setting of the area.

The Southern Urals region is an important area for the correlation between the European and Siberian/Asiatic stratigraphic schemes. To improve the correlation between the two areas and to expand our understanding of the complexity of the area, future (bio)stratigraphical investigation of the Pliocene–Pleistocene deposits of the Southern Urals region is indispensable.

EDITORS:

Thijs van Kolfschoten
Faculty of Archaeology, Leiden University,
PO Box 9515, 2300 RA Leiden, The Netherlands

Philip Leonard Gibbard
Godwin Institute for Quaternary Research,
Department of Geography, University of Cambridge,
Downing Place, Cambridge CB2 3EN, England

The Excursion Guide is produced with the help of:

Drawings
Nataliya Nechaeva
Anatolyi Yakovlev
Guzel Danukalova

Imposition
Alexander Chernikov

ISBN

Organisers:

Institute of Geology – Ufimian Scientific Centre – Russian Academy of Sciences
INQUA, International Union for Quaternary Research
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Academy of Sciences of the Bashkortostan Republic
State Geological Department of the Bashkortostan Republic
Oil company "Bashneft"
Russian Science Foundation for Basic Research
Bashkir State University

***Scientific Committee*:**

Dr. **Thijs van Kolfschoten**, Leiden University, The Netherlands (Chair).
Dr. **Philip Gibbard**, Cambridge University, United Kingdom.
Prof. **Leczek Marks**, Polish Geological Institute, Poland.
Dr. **Guzel Danukalova**, Institute of Geology USC RAS, Bashkortostan, Russia.

***Organising Committee*:**

Dr. Ph. **Victor Puchkov**, Institute of Geology USC RAS, Corr. Member of RAS, Bashkortostan, Russia (Chair).
Rasikh Khamitov, The Head of the State Geological Department of the Bashkortostan Republic, Bashkortostan, Russia.
Alexander Chernov, the State Geological Department of the Bashkortostan Republic, Bashkortostan, Russia.
Victor Philippov, the Council of Ministers of the Bashkortostan Republic, Bashkortostan, Russia.
Dr. **Emir Gareev**, Ufimian Scientific Centre RAS, Bashkortostan, Russia.
Rauf Nugumanov, Chair of the Administration of Ufa, Bashkortostan, Russia.
Prof. **Mukhamet Kharrasov,** Rector of the Bashkir State University, Bashkortostan, Russia.
Prof. **Rifkat Talipov,** Pro-rector of the Bashkir State University, Bashkortostan, Russia.
Irek Zaripov, Chair of the Administration of the Burzyan region, Bashkortostan, Russia.
Khamza Akhmetov, Chair of the Administration of the Karmaskaly region, Bashkortostan, Russia.
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Ravil' Davletov, Chair of the Administration of the Dyurtyuly region and Dyurtyuly town, Bashkortostan, Russia.
Alexander Kim, Chair of the Administration of the Ilish region, Bashkortostan, Russia.
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Iljaz Abdrachmanov, the director of the Uchaly mountain-concentrating group, Russia.
Mikhail Kosarev, the director of the Narional park "Bashkortostan", Bashkortostan, Russia.
Dr. **Guzel Danukalova**, Institute of Geology USC RAS, Bashkortostan, Russia.
Dr. **Anatoly Yakovlev**, Institute of Geology USC RAS, Bashkortostan, Russia.
Dr. **Larisa Belan**, Bashkir State University, Bashkortostan, Russia.

CONTENTS

INTRODUCTION

The region of the Bashkortostan Republic (Russian Federation) that will be visited during the excursion covers the Fore-Urals border depression area, the east slope of the Southern Urals as well as the Southern Ural mountains (Fig. 1). Since the end of XIX century many famous Russian scientists studied the Cenozoic deposits in the Fore-Urals (V.I. Meller, F.N. Chernyshov, A.V. Nechaev, G.V. Vahrushev, A.V. Myrtova, V.L. Yakchemovich, *et al*.). More detailed descriptions of the upper Cenozoic deposits and the ancient drainage system in the Belaya-river basin were made during the geological survey by the Bashkirian territorial geological department and during thematic investigations by the Institute of Geology of the Scientific Centre of the Ufa Russian Academy of Sciences.

The location of the Pliocene and Pleistocene deposits and the present relief depends mostly on the pre-Paleozoic and Paleozoic bedrock and it's tectonic history. A well-developed drainage system was formed in the territory. The ancient drainage was filled by alluvial and lacustrine sediments of Upper Pontian (?) – Kimmerian (Kinel series; up to 350 m thick), Aktschagyl, Apsheron (Eopleistocene) and Pleistocene age. Numerous boreholes were made in the buried overdeepened, down cutted valleys.

Due to extensive land subsidence in the south (in the region of the Caspian see) brackish water basins were formed during Kimmerian and Aktschagyl time. The deposits in the basins reflect the changes in the sedimentary conditions (limanian[1] freshwater, marine brackish water and terrestrial). Large rivers were almost absent during the Middle and Late Pliocene due to the transgression of the sea; alluvial depostis were only formed in deltas and in shallow valleys located at the edges of the reservoirs. The activity of the ancient river depended, apart from the Caenozoic diastrophic movements, on exogenetic (climatic) factors, which resulted in considerable changes of the Caspian and Pechorian sealevels. The influence of the exogenetic factors refers to processes of surface run-off, denudation and accumulation in all the structural zones of the Southern Urals region.

[1] Liman – the local name of estuary

METHODS

For the investigations of the Pliocene and Pleistocene deposits different biostratigraphical and magnitostratigraphical methods are used.

Biostratigraphical investigations: ostracoda (M.G. Popova-Lvova), mollusks (A.V. Sydnev, A.L. Chepalyga, G.A. Danukalova), large mammals (N.N. Yakchemovich, B.S. Kozhamkulova, P.A. Kosyncev), small mammals (V.P. Suchov, A.G. Yakovlev), pollen and spores (V.K. Nemkova, L.I. Alimbekova), Carpological remains (P.I. Dorofeev) have been studied. The result is that the history of fossil organic forms and plants associations could be traced, characteristic complexes could be recognised and a curve with changes in the vegetation changes could be constructed.

Palaeomagnetical investigations: the summarizing magnitostratigraphic data of the Pliocene and Pleistocene sections in the nonglacial zone of Fore-Urals have been presented by V.L. Yakchemovich and F.I. Suleimanova (1981).

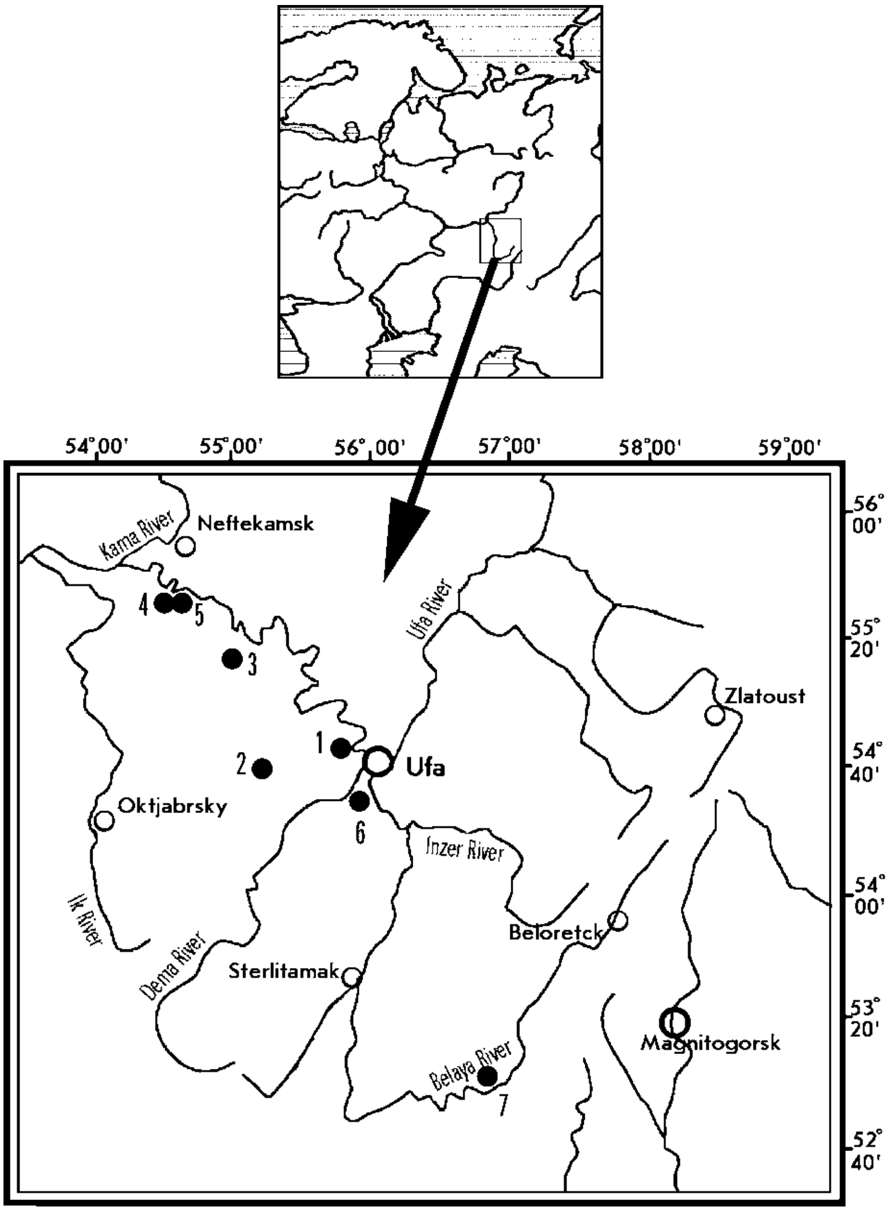

Figure 1. The Geographical Map of area with the excursion points

1 – Bazitamak,
2 – Chui-Atasevo,
3 – Symbugino,
4 – Novo-Sultanbekovo,
5 – Gornova,
6 – Ilenka,
7 – Shulgan-Tash

NATURAL CONDITIONS OF THE REGION

The region is located in the eastern part of the Eastern-European Plain, the Southern Urals and the western part of the Western-Siberian Plain (fig. 1).

The Bashkortostan Republic covers an area of 143.600 square kilometers. The republic has a population of almost 4 million people (39 % of them are Russian, 28,5% – Tatar, 22% – Bashkir and 20,5% – other nationalities: Mari, Chuvash, Ukrainian, Komi and others).

The capital of the Bashkortostan Republic is Ufa, a city with 1,1 million inhabitants. Other large towns are: Sterlitamak, Ishimbai, Salavat, Beloretsk, Neftekamsk and Tuimazy.

Several rivers cross the region; the larger rivers are: Belaya, Ai, Yuryuzan, Sim, Inzer, Nugush, Sakmara and Ural.

Proterozoic and Paleozoic metamorphic, sedimentary and magmatic rocks form the mountaineous part of the region. Karst phenomena exist in the areas where limestone and dolomite occurs; many caves are known from the river valleys in the mountains: exemples are the Shulgan-Tash (Kapova) cave with Paleolithic pictures, the Kutuk-Sumgan caves, the Salavat Yulaev cave, the Muradymovskaya cave and the Askynskaya icy cave.

The territory of the Bashkortostan Republic can be divided into two parts: the eastern slope of the Eastern-European plain and the western slope of the Southern Urals with the two higher massifs Yamantay (1640 m) and Iremel (1584 m).

More than 3 thousands mineral deposits are known in the area of the Bashkortostan Republic: 200 oil and gas-condensate fields, about 10 brown coal deposits, 15 copper pyrite deposits, more than 20 iron deposits, 50 gold deposits and placer deposits. Coal, bauxite, manganese, chromite, fluorite, barite, rock salt, limestone, dolomite, phosphorite, gypsum, magnesite, talc, brick earth, fire-clay, sands, facing and industrial stones, peat, mineral water and others occur in the subsoil.

The territory covers 4 different geographical regions of the temperate zone characterised by the dominance of: mixed forest, broad-leaved forest, forest-steppe and steppe. The forest zone penetrates far to the south into the forest-steppe and steppe zones due to the influence of the Ural mountains.

The broad-leaf forests are dominated by *Quercus, Tilia, Populus tremula, Ulmus*; *Corylus, Sorbus,* and *Euonymus* occur in a lower percentage. Coniferous forests with *Picea, Pinus* and *Abies* occur in the mountainous part of the territory. The forests on the flood plain are characterised by the occurrence of *Populus, Salix* and *Tilia*. Steppe vegetation covers the slopes of the hills in the Trans-Urals region and the Fore-Urals plain. Grassland occurs in the river valleys and covers open patches in the forests. Moors only occur in small areas and tundra vegetation can only be observed on the summits of the Iremel and Yamantay mountains.

The mountains of the Southern Urals also show a zonation in climate, soils and vegetation. The landscape changed from steppe and forest-steppe at the foot of the mountains and lower foothills to a *Picea-Abies* taiga at the height between 600 – 1100 m. The highest summits (more than 1600 m high) are poor in vegetation. The landscape of the Trans-Urals is similar to that of the southern part of Western Siberia and the northern part of Kazakhstan.

The region is also situated in the central part of the Eurasian continent. The aerial mass that formed over the Atlantic Ocean in the west (in a reduced way), the Arctic Ocean in the north and the dry regions of the Kazakhstan and For-Caspian lowland in the south have influence on the continental climatic conditions in the area. The climate is chracterised by warm summers and long cold winters. In winter the cold weather comes from Siberia through the Urals. The mean July temperatures vary from +17 to +19° C; the mean January temperatures between –15 and –17° C. The yearly amount of precipitation on the western slope of Urals is 640–700 mm, on the eastern slope less than 300–500 mm and in the plain 400–500 mm. July is the warmest and sunniest month: the daily temperature normally rise up to +30 °C, the temperatures during the night are about +15 – +17°C. The precipitation in the month July is normally restricted to some heavy showers and storms or sometimes to more continuous rain.

The fauna in the region is very divers; several species represent the different groups: Protozoa (120 species), Annelides (700 species), Nemathelminthes, Plathelminthes, Mollusca (121 species), Arthropoda (5000 species), Osteichthyes (47 species) , Amphibia (10 species), Reptilia (10 species), Aves (296 species), Mammalia (76 species). Many species have a wide geographical range. However, some are restricted to the Ural mountains (*Salmo trutta morpha fario*, *Thymallus thymallus*, *Styzostedion lucioperca*, *S. volgensis*, *Cyprinus carpio*, *Leociscus cephalus*, *Rana temporaria*, *R. lessonae*, *Bombina bombina*, *Triturus cristatus* ets.). *Emys orbicularis* and *Vipera* sp. are rare; they occur only in the southern part of the territory.

The open areas are inhabited by: *Marmota bobac*, *Allactaga jaculus*, *Lepus europaeus*, *Mustela eversmanni*, *Perdix perdix*, *Alauda arvensis*; the forested areas are inhabited by: *Alces alces*, *Capreolus capreolus*, *Sus scrofa*, *Ursus arctos*, *Felis lynx*, Canidae (*Canis lupus*, *Vulpes vulpes*, *Nyctereutes procyonoides*), Mustelidae (*Martes martes*, *Mustela vison*, *M. sibirica*, *M. erminea*, *M. nivalis*, *M. eversmanni*, *Meles meles*), *Eutamias sibiricus*, *Sciurus vulgaris*, Tetraonidae (*Tetrastes bonasia*, *Lyrurus tetrix*, *Tetrao urogallus*); the water reservoirs are inhabited by: *Castor fiber*, *Lutra lutra*, *Ondatra zibethica*, Anceriformes (*Anas crecca*, *A. querquedula*, *A. platyrhynchos* ets.), Lariformis, Podicipediformes, *Emys orbicularis* etc.

NEOTECTONICS OF THE URALS

The time span between the Oligocene and nowadays is commonly accepted as a neotectonic epoch (Trifonov, 1999). As for the Urals, it is usually thought to be a time when the modern Urals mountains were formed (Rozhdestvensky, 1971, 1997; Rozhdestvensky, Zinyakhina, 1997).

The modern Urals is a mountain range with Narodnaya mnt. (1885 m above sea level) of the Cis-Polar Urals as a highest point. The highest mountain in the Southern Urals is Jaman-Tau (1640 m). Compared with the Uralian foldbelt which used to be a huge mountain ridge in the Late Paleozoic, the modern Urals is a more narrow and much less prominent, low-amplitude feature. Paleozoic Urals was formed as a common orogen, at plate boundaries, while the modern Urals is an interplate, intracontinental structure (Puchkov, 1988). It follows faithfully the strike of the most important tectonic zones, faults and massifs of the western zones of the Paleozoic Urals, and only in the Southern Urals most of the Paleosoic structural zones are exposed, while in the North the easternmost zones dive under rather thick cover of the West Siberian basin and therefore experience not neotectonic uplift but oppositely, submersion.

The position of the modern Ural Mountains is at a bisector between two highly active neotectonic lines interpreted by L. Zonnenshain *et al*. (1984) (maybe not quite justly) as moderm plate margins. One line follows Alps-Caucasus-Pamirs mountanous chain, and the other goes along the mountains of Tien-Shan, Altay, and Baikal area. One line is intercontinental, commonplace plate margin but the other – intracontinental (it is not accompanied by any young suture zone). The origin of the second type of mountains must have much more in common with the Urals: they are both the result of intraplate deformation of a continent, though in case of the Urals the process was much less intense.

The Paleozoic Uralian orogen was a result of collisions started in the Late Devonian and completed in Permian time. It was strongly eroded and partially peneplained by the end of the Permian, when a considerable eastern part of the Southern Urals was invaded by the Tethyan transgression. Triassic was time of a strong basaltoid trapp magmatism, and therefore a new phase of mountain building of that epoch was probably connected with a distributed rifting. The altitude of the Early Triassic mountains is thought to be 2–3 km, while Triassic graben-like depressions are filled with coarse-grained sediments and basalts, up to 3,5 km thick. The sediments in the East of the Urals are partially affected by the Early Jurassic Old Cimmerian thrust and fold deformations which probably kept the surface of the area fairly high for some more time later (Arkhangelsky, 1968; Tuzhikova, 1973; Puchkov, 1997, 2000, 2001).

The mountains were eroded again very soon after that last alpine-type deformations. Since the second half of the Middle Jurassic, the sea started to come periodically very close to the Urals from the southwest, though the most of the territory was a place of either a slow erosion and weathering or formation of continental coal-bearing sediments, including mature quartz sandstones. During the peak of the vast Late Cretaceous (Santonian-Maestrichtian) transgression, the sea covered the whole Preuralian foredeep, the southern part of the Uraltau antiform and Zilair synform with Sakmara allochthon, and a major part of the Transuralian zone. It is evident that by that time the Uralian foldbelt was inactive. The surface of its axial part was probably above the sea, though not very high, taking into account the quartz composition of Cretaceous sandstones and presence of weathering crusts and bauxites.

The position of the restored shoreline at the peak of the next (and the last) transgression in the mid-Eocenian time was approximately the same.

Before the Oligocene the sea left the territory of the Urals, and Oligocene and younger sediments are continental and mostly terrigenous. Since then, or later, the modern Urals mountains started to be formed.

This scenario (though in a very general way) is supported by recent fission-track data. These analyses have given an information concerning low temperature history of rocks in the Ural Mountains. It was shown that cooling through the 110 ºC temperature isotherm occurred mostly in the Jurassic (Seward *et al*., 1997, 2002), though some preliminary data show a possibility of Cretaceous normal faulting in the area to the south of Jaman-Tau mountain (Glasmacher *et al*., 1999, 2001). Taken as a whole, the data means that the rocks which are now exposed in the surface were in Jurassic (and locally in Cretaceous) at the depth about 2,5–3 km. It leaves the question when in the later history these 2,5–3 km were eroded, still unanswered. Moreover, if the application of the method does not follow exactly geological restrictions it leads to maistakes. For example, based on the fission-track data (Leech, Stockli, 2000) it was supposed that the Maksyutovo complex came to the surface only at the neotectonic stage, but according to geological data, the complex was exhumed and covered by marine sediments in the Late Cretaceous.

A new method, that of (U–Th) / He chronometry using apatite was recently suggested (Reiners, 2002). The low closure temperature of apatite (U–Th) / He chronometry (~70ºC, as opposed to annealing temperatures of 110ºC for fission tracks in apatite) makes this method more promising for study of the late, neotectonic history of mountains, particularly the Urals. The studies using this method are to be started during this field season with our Spanish colleagues.

The modern altitudes of the Upper Cretaceous and Mid-Eocene marine deposits in the Southern Urals give the lower limit (minimum value) for the amplitude of the neotectonic uplift of the territory. These amplitudes are below 200 m in the Transuralian zone, about 400 m in the Sakmara allochthon, up to 500 m in the southern part of the Uraltau antiform, and again below 200–300 m in the Preuralian foredeep. The pre-neotectonic Cretaceous / Eocene denudation levels of those territories of the Urals where the transgressions did not reach, had still higher altitudes, though it is very difficult to say how higher they were. Anyway, the Eocene-Cretaceous surfaces were considerably deformed during the neotectonic stage, but again it is hard to tell if it was a simple arched uplift or more complex deformation. There is no much evidence for the active high-amplitude faults during the neotectonic stage, though Bachmanov *et al*. (2001) give a series of evidences for the oligocene-quarternary faults with the amplitude up to 100–200 m, supported by a series of references. Paleomagnetic studies of the Late Pleistocene deposits in the Yuruzan-Ai and Magnitogorsk depressions have shown a presence of local young plicative and disjunctive dislocations (Minibaev and Sulutdinov, 2001). Systematic monitoring of tectonic noises have shown their concentration along some old faults in the Southern Urals (Kazantsev *et al*., 1995, 1996). The modern researchers attribute a great importance to strike-slip movements in the Urals (Kopp, 1999; Bachmanov *et al*., 2001; Tevelev, 2002). The data on the modern fault deformations were given by V. P.Trifonov (1976).

The relief of the Southern Urals is a combination of ridges and mountain massifs with relics of rather smooth denudation surfaces (e.g. North Kraka mountains with a denudation level of about 1000 m) and lower plateaus (e.g. Zilair plateau, 500–700 m high). The relief around the highest mountains (Jaman-Tau, Mashak, Ieremel and others) is a combination of narrow ridges with relics of plains at the altitudes up to 1300 m and U-shaped valleys clearly suggesting their glacial origin in Pleistocene (Kolokolov, Lvov, 1945; Astakhov, 1984; Cenozoic, 1970; Levina *et al*., 2001), though good descriptions of moraines in the Southern Urals are still not published.

No marine fauna to date the denudation levels in the higher part of the Urals had been found. According to D. Borisevich (1992), the ranges and massifs dominating over the level of peneplained watersheds of the Urals mountains have a relic nature and originated as a result of erosion of the Middle Triassic peneplain. This point of view has no direct proofs and conflicts with the fission-track data telling that about 3 km-thick mass of rocks was eroded above the samples taken at the altitudes up to 500–700 m since the Jurassic time. In this case, even Jurassic peneplain had no chance to survive. More realistic guess could be Late Mesosoic or even Cenozoic age of it. The existence of Late Cretaceous marine straits connecting the eastern and western seas surrounding the Urals land (Papulov, 1974; Amon, 2001) suggests that the modern Urals as a single continuous mountain chain was formed only in Cenozoic.

The lithology and facies of the sediments of the neotectonic stage bear their own information on the character and development of neotectonic processes (e.g., Astakhov, 1984; Stefanovsky, Shub, 1997; Unific stratigraphic schemes, 1997). Oligocene in the Urals is preserved in the Preuralian, Orsk-Tanalyk and Transuralian zones and is represented by quartz sandstones, siltstones and clays of alluvial and lacustrine nature. The thickness is up to 50 m. Miocene in the Preuralian zone is represented by Preuralian series developed in karst depressions situated above the Kungurian evaporites and constituted of quartz sands, silts, clays, sometimes conglomerates, up to 300–350 m of total thickness, with coal seams (Yakchemovich and Adrianova, 1959). In higher places of the zone Miocene is represented by lacustrine and alluvial terrigenous sediments. In the Late Miocene after the accumulation of the Preuralian series a period of an intense erosion started, though is is hard to explain it by an uplift of the territory. Oppositely, it was due to a messinian-like event of a great depression of the Caspian sea (lake) level. The valleys of Belaya and Ural river were eroded down to 100–200 m below the modern sea level, while the depth of the Caspian sea level was at – 550 m (Milanovsky, 1963; Sidnev, 1985; Rozhdestvensky, Zinyakhina, 1997; Leonov *et al.*, 1998). Meanwhile, due to the uplift of the Urals the upper reaches of these rivers have not so anomalously downcut valleys (Varlamov, 1960). In the central part of the Urals, Miocene is sporadic; in the area of Beloretsk it is also represented by the coal-bearing sediments of the Preuralian series (Kozlov, 1976); in other places, lacustrine and alluvial sediments are predominant. In the Transuralian zone, erosion was predominant, and only locally deluvial and eluvial-proluvial red-coloured sediments were accumulated.

Pliocene in the Preuralian zone was a time of filling up of the downcut river valleys. First it were coarse-grained alluvial-lacustrine sediments; they changed upwards by less coarse silty-clayish Aktschagyl sediments with marine fauna, up to 120 m thick. Due to rise of the Caspian lake above the normal level, the ingression of brackish waters far into the river valleys took place (Sidnev, 1985; Danukalova, 1996). In the Central Urals Pliocene is represented sporadically in erosional depressions by red-coloured alluvial, deluvial-lacustrine sediments (clays, silts, gravel and pebble boulders. For the first time, the sediments are clearly polymictic which witnesses for the acceleration of erosion. In the Transuralian zone Pliocene is represented by thin differently coloured clays, some sands, gravel and pebble.

The Quaternary sediments are characterized by a greater role of coarse-grained, polymictic deposits of alluvial, alluvial-deluvial and fluvioglacial sediments. Most of the river terraces are dated as Quaternary (Stefanovsky, 1997).

That is why the author has a feeling that the tectonic activity was accelerating through the neotectonic stage towards the modern time.

The modern tectonic activity of the Urals is shown in many ways. First of all, the intense movements of the Earth's surface were proved by the repeated topographic levelling. The velocities of the surface uplift are up to 5 mm/year which is by 10 times more than needed to make the Urals mountains since Oligocene (Trifonov, 1976; Kononenko *et al*, 1990).

The Urals is known for its seismicity. Some strong and even destructive earthquakes were recorded during the historical period (Seismicity, 2001). They are concentrated mostly around the protruding salient of the Russian Platform, which is acting as an indenter. The measured maximal stress directions in the Middle Urals are oriented perpendicularly or slightly oblique to the structural grain of the Paleozoic basement. The intraplate stress resurresting some "weak" zones is probably responsible for the modern deformations and uplift of the Urals.

The data on the stress which is experienced now by the Urals was used in the attempt to explain the mechanism of the formation of the modern Ural mountains (Mikhailov *et al*., 2002). The presence of the cold, rigid Magnitogorsk block taken into account, it was shown that under sufficient intraplate stress the territory immediately to the West of this block ought to be deformed with an origin of a fault (destruction zone), deep in the crust under the Central and Western Uralian zones, where maximal deformations and uplift are concentrated.

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THE STRATIGRAPHY OF THE UPPER PLIOCENE AND PLEISTOCENE DEPOSITS OF THE SOUTHERN URALS REGION

In accordance with the "Stratigraphic scheme of Pliocene and Pleistocene deposits of the Volga-Urals area" the following Pliocene units are distinguished in the Southern Fore-Urals:

1) Kinel Series, subdivided into six suites: I–III Tchebenka (Upper Pontian (?) – Kimmerian); Karlaman and Kumurly (Lower Aktschagyl); Zilim-Vasiljevo (the beginning of the Middle Aktschagyl);

2) Akkulaevo (maximum of the middle Aktschagylian transgression/ingression);

3) Voevodskoye (Upper Aktschagyl);

The Eopleistocene (Apsheron) is subdivided into two units (links) (Unific schemes, 1980):

1) Dema, Davlekanovo Horizons (Lower Apsheron);

2) Karmasan Horizon (Upper Apsheron)

In the Southern Fore-Urals The Neopleistocene is subdivided into three units (links) with the horizons:

1) October, Minzityarovo, Chui-Atasevo, Chusovskoye (Lower Neopleistocene);

2) Belaya, Larevka, Gornova, Yelovka (Middle Neopleistocene);

3) Mikulino, Saigatka, Tabulda, Kudashevo (Upper Neopleistocene).

A summarising description of the Upper Pliocene – Pleistocene deposits from the Southern Urals region (the middle and lower course of the river Belaya) is presented below.

Neogene

Pliocene

Aktschagyl stage

Middle substage

The Zilim-Vasiljevo Beds were formed at the beginning of the transgression into the drainage system (before the transgression's maximum).

In the lower part of these beds a layer of black organic clay with gravel and pebbles occurs at the base. This is overlain by Bluish-grey and greenish-grey, brown dense sticky clay with sandy interbeds. The average thicknes of the unit is 18–24 m (the thickness varies from 4 to 41 m).

The flora present during this period was closely similar to that of today: i.e. the Akchagyl flora proper. *Picea-Pinus* forests were predominant in the north, whilst *Picea* forests with *Tsuga* and *Pinus* grew in the south. The beginning of this period is characterised by a climatic amelioration when *Pinus*- and broad-leaf forests with rich herb vegetation appeared.

The Ostracod fauna showed a development from euryhaline to brackish-water conditions whilst the Mollusc fauna was of the freshwater type.

The deposits are correlated with the lower part of the Matuyama paleomagnetic Epoch; i.e. their top often coincides with the base of Réunion Episode.

The Akkulaevo Beds were laid down during the maximum of the Aktschagylian ingression.

The upper part of these beds consists of deltaic sands which include a lens of clay (4–4,5 m thick) and gravel (shingle) containing marine and freshwater (Levantine) molluscs, mammalian remains of the Chaprov complex and wood.

The lower (marine) part of this unit consists of sands and clays upto 20–25 m thick. Erosional features sometimes occur in the middle part of the bed. Brackish water and marine Mollusca and Ostracoda characterise the lower part of the unit (Yakchemovich *et al*., 1992; Danukalova, 1996).

The flora represented in these sediments is of the modern forest type with *Tsuga* and single relic forms; but overall modern species predominate. The vegetation of this time reflected several temperature fluctuations. The final period when the upper deltaic part of this unit was formed was warm and *Betula*-broad-leaved forests and herbage steppe colonised the area.

The Akkulaevo Beds are equated with the Biklyan and Menzelinsk Beds of the Lower Kama and with the Matuyama palaeomagnetic Epoch (Yakchemovich *et al*., 1981).

Upper substage

The Voevodskoje Beds cover the erional surface of the Akkulaevo Beds; they are subdivided into the lower and the upper part.

The lower part of this unit consists of alluvial gravels and sands with a strong secondary iron-staining. The inwash of ferric hydrate took place after after deposition of the upper part of the Voevodskoje Beds. The thickness is about 2,5 m.

The upper part of this unit consists of brackish water, liman sediments. Two different levels can be recognised: a) gravel (Shingle), coquina and marl silt deposits with *Cerastoderma, Aktschagylia* and *Dreissena*, Foraminifera and Ostracoda that represent a transgressive phase (Danukalova, 1996); b) deposits of the drying liman that represent a regressive phase. The thickness is 2,8–10 m.

The flora represented in the sediments is of the modern forest-steppe type that changed into a taiga type of vegetation, with single species that are phylogenetically close to presentday species together with species that have, nowadays, a more southern distribution (*Fraxinus, Elaeagus*). The vegetation changed from a Poaceae-herb steppe and forest-steppe through a *Betula-Pinus* forest to a *Picea* taiga. The deposits are equated with the upper part with the Ilchembet Episode of the Matuyama palaeomagnetic Epoch (Yakchemovich, Suleimanova, 1981).

Quaternary System

Quaternary deposits are widespread in the territory of the Southern Fore-Urals. G.V. Vachrushev, L.A. Yushko, K.V. Nikiforova (1937), V.I. Gromov (1941), N.A. Preobrazhensky, V.L.Yakchemovich *et al.* investigated these sediments (Yakchemovich 1965; Yakchemovich *et al*., 1977, 1980, 1981, 1983, 1987, 1992; Nemkova *et al*., 1972; Cenozoic of the Bashkirian Fore-Urals. Stages of the geological development of the Bashkirian Fore-Urals in Cenozoic, 1970; Stratigraphy of the USSR. Quaternary system, 1984, 1986; Sydnev, 1986).

The Bureau of the ISC postulated the Stratigraphic scheme of Quaternary deposits of the area of Permian, Bashkirian and Orenburgian Fore-Urals as the standard of the area in 1984.

Pleistocene

Eopleistocene –Apsheron

In the Fore-Urals terrestrial lacustrine and alluvial deposits at the lower interfluves and high terrace deposits of nonglacial origin with low thickness and a small quantity of organic remains represent the Eopleistocene. For a long period of time it was regarded as terrestrial deposits of the Upper Aktschagyl (the Domashka Suite). Nowadays it is subdivided into the Dema, Davlekanovo and Karmasan Superhorizons of the Lower, Middle and Upper Subformations.

The deposits are equated with the upper part of the Matuyama palaeomagnetic Epoch.

Lower Eopleistocene

The Dema Superhorizon. The lower part consists of alluvial and lacustrine sediments (2–10 m thick); the upper part of reddish-brown lacustrine loams (1–3 m thick) with marl concretions.

The first part of this period is characterized by a *Pinus-Betula* forests and a herb steppe; isolated pollen of *Pinus* sect. *cembrae, Picea excelsa* Link.and herbs are known from the upper part of the deposits.

The small mammal fauna from the lower part, with *Promimomys moldavicus jachimovichi* Sukhov, *Prolagurus (P.)* cf. *praepannonicus* Topač. and *Allophaiomys* cf. *pliocaenicus* Kormos, corresponds to the Odessa Complex. Characteristic molluscs are *Bogatchevia* ex gr. *sturi* (Horn.), *Corbicula apscheronica* Andrus., *Viviparus* aff. *tiraspolitanus* Pavl., *V. subcrassus* Lung., *Lithoglyphus neumayeri* Brus. and *Bithynia vucatinovici* Brus. The upper part contains *Candona* aff. *candida* (O. Müll.), *Eucypris* ex gr. *horridus* (Sars), *E. famosa* (Schn.) and *Denticulocythere producta* (Task. et Koz.). Subaerial deposits were formed in the interfluves.

The Olduvai palaeomagnetic Event that correlates with the Pliocene–Pleistocene boundary is located in the lower part of this unit.

The Davlekanovo Superhorizon. The lower part (0,6–2 m thick) is represented by alluvial sediments deposited by small rivers; the upper part by lacustrine loams (0,2–3 m thick).

The small mammal fauna of the lower part with *Lagurus (Lagurodon)* cf. *praepannonicus* Topač., *Allophaiomys pliocaenicus* Kormos corresponds to the Odessa Complex. Characteristic molluscs are: *Bogatschovia scutum* Bog., *B. subscutum* Tshep., *Microcondylaea apsheronica* Tshep., *Pseudosturia brusinaiformis* Modell, *Unio chasaricus* Bog., *U. apscheronicus* Alizade.

The landscape during the period of deposition is characterized by the presence of broadleaf forests in the river valleys and open woodlands in the interfluves.

The period is equated with the Jaramillo Event of the Matuyama palaeomagnetic Epoch.

Upper Eopleistocene

The Karmasan Superhorizon. The lower part is represented by alluvial gravels and sands (0,9–1,5 m).

The period of deposition is characterized by the presence of forest-steppe (small forests with *Pinus, Picea,* broad leaf taxa, *Betula, Alnus*) in the northern part of the region and by the presence of steppe with herbs, *Artemisia,* Chenopodiaceae and Poaceae in the south. The climate was warm and dry.

The upper part of the unit is represented by dark-brown, reddish-brown lacustrine loams (1,8–2,1 m thick) with white-pink marlconcretions.

Neopleistocene

Neopleistocene deposits, formed during Brunes paleomagnetic Epoch, are widely distributed in the territory described.

Lower Neopleistocene

The October Horizon. The deposits (6–8 m thick) located in deep river valleys (4–12 m below the modern levels), consist of alluvial, coarse gravels at the base covered by sands with pebble lenses. They lay on top of eroded Perm, Kinel or Aktschagyl deposits.

The climate during deposition was warm. The mammalian fauna with *Archidiskodon trogontherii wüsti* (Pav.), *Elasmotherium sibiricum* Fischer, *Panthera* sp., *Megaloceros* sp. corresponds to faunas from the Tiraspol complex.

The Minzityarovo Horizon. The horizon consists of lacustrine loams (3–4 m thick) with *Archidiskodon trogontherii* (Pohl.). Its upper part is of periglacial origin.

The Chui-Atasevo Superhorizon is subdivided into three parts.

The lower alluvial part is characterized by a fauna with freshwater and terrestrial molluscs and a Tiraspol small mammal fauna with: *Microtus (Pitymys) gregaloides* Hinton, *Microtus* ex gr. *arvalis-agrestis, Mimomys (Microtomys) pusillus* Mehely, *Microtus* ex gr. *oeconomus* Pallas, *Clethrionomys* ex gr. *glareolus* Schreber, *Mimomys (Cromeromys) intermedius* Newton, *Lagurus transiens* Janossy, *Microtus (Stenocranius) gregalis* Pallas, *Microtus* ex gr. *malei-hyperboreus*, *Ochotona* sp., *Myospalax* sp., *Sicista* sp., *Citellus* sp. The thickness of the lower part, deposited under warm climatic conditions, is 4–6 m.

The middle part consists of periglacial lacustrine deposits.

The upper part with sands and gravels contains remains of small mammals: *Microtus (Pitymys) gregaloides* Hinton, *M. (P.) hintoni* Kretzoi, *M.* ex gr. *arvalis-agrestis*. Usual were – *M.* ex gr. *oeconomus* Pallas, *Mimomys (Microtomys) pusillus* Mehely, *Lagurus transiens* Janossy, *M. (Cromeromys) intermedius* Newton, *Microtus (Stenocranius) gregalis* Pallas, *M.* ex gr. *malei-hyperboreus, Clethrionomys* ex gr. *glareolus* Schreber, *Cl. (?)* ex gr. *glareolus* Schreber, *Sorex* sp., *Ochotona* sp., *Allophaiomys pliocaenicus* Kormos, *Prolagurus (Prolagurus)* cf. *posterius* Zazhigin, *Arvicola mosbachensis* Schmidtgen, *Talpa* sp., *Citellus* sp., *Miospalax* sp., *Eolagurus luteus praeluteus* Schevtchenko, *Lemmus* sp., *M. (P.) arvaloides* Hinton, *Cricetus* sp., *Allactaga* sp. and *Lepus* sp.

The «Chui-Atasevo» palaeomagnetic Episode of reverse polarity is correlated to these deposits.

The deposits of this superhorizon are equated to the Belovezhsk, Don and Il’insk horizons of the interregional stratigraphic scale.

The Chusovskoye Horizon. In the extra glacial area the deposits consists of lacustrine and lacustrine-colluvial periglacial sediments (sands and loams) (8 m thick). Chenopodiaceae and herbs dominated the vegetation during the time of deposition.

Middle Neopleistocene

The Belaya Horizon. The deposits, located in deep river valleys, consists of gravels, sands and dark grey lacustrine loams on top of eroded Early Neopleistocene or Permian deposits. The thickness is 3–7 m.

Remains of *Mammuthus chosaricus* Dubrovo, *Coelodonta antiquitatis* Blum. and *Bison* sp. are known from this horizon. Based on carpological remains from the lacustrine deposits it is concluded (by P.I. Dorofeev) that the vegetation is similar to the Syngyl or Hazar floras.

The Larevka Horizon. The horizon consists of glacio-lacustrine deposits with periglacial sands and loams located in the upper part of the IV terrace. The thickness is 6–15 m.

The small mammal fauna from the periglacial gravels of the Krasnyi Yar section corresponds to the Hazar fauna Complex. Represented species are: *Lagurus lagurus* Pallas, *Microtus (Stenocranius) gregalis* Pallas, *Eolagurus luteus* Eversmann, *Microtus (Microtus)* ex gr. *oeconomus* Pallas, *Marmota* aff. *bobac* Müller, *Mustela (Mustela) nivalis* L., *Citellus* sp., *Alactagulus* sp., *Ochotona* sp., *Arvicola* cf. *chosaricus* Alexandrova, *Cricetulus* sp., *Allocricetulus eversmanni* Brandt, *Allactaga* sp.

The Gornova Horizon. The horizon consists of lacustrine blue and dark grey loams, sandy loams and alluvial gravels that form the lower part of III floodplain terrace. There is a gradual transition of the deposits of this horizon to the deposits referred to the Larevka Horizon. The thickness is 1,5–8 m.

Remains of *Mammuthus chosaricus* Dubrovo, *Mammuthus primigenius* Blum., *Coelodonta antiquitatis* Blum., *Bison priscus gigas* Flerov, *B. priscus mediator* Hifzh., *Bos primigenius* Boj., *Alces alces L.*, *Megaloceros giganteus* cf. *giganteus* (Blum.), *Cervus elaphus* L., *Camelus* sp., *Equus* cf. *hemionus* Pall., *Equus cabalus fossilis* are known from this horizon. The fauna corresponds to the Upper Palaeolithic complex with a number of Khazar mammal species. Smaller mammals are represented by *Microtus (Stenocranius) gregalis* Pallas, *Lagurus lagurus* Pallas, *Eolagurus luteus* Pallas, *Microtus (Microtus) oeconomus* Pallas, *Sicista* sp., *Microtus* ex gr. *arvalis-agrestis*, *Ochotona* sp., *Ellobius* sp., *Marmota* sp., *Clethrionomys* cf. *glareolus* Schreber, *Arvicola* sp., *Alactagulus* sp., *Cricetulus* sp. (Sections Klimovka, Gruzdevka).

The Yelovka Horizon. The horizon consists of lacustrine-colluvial loams, which form the upper part of III floodplain terrace. The thickness is 6–14 m.

Mammuthus primigenius Blum., *Coelodonta antiquitatis* Blum., *Bison priscus* Boj. representing the early stages of the Upper Palaeolithic complex of large mammals, are known from these deposits.

Upper Neopleistocene

The Mikulino Horizon. Alluvial deposits, referred to this Horizon, are practically unknown; these deposits might be covered locally by sediments of the Ostashkovo Horizon, due to tectonic uplift of the territory and fluvial erosion. Lacustrine silts (0,2–0,8 m) with intercalated soils and a freshwater mollusc fauna are known in the Bashkirian Fore-Urals (Sultanaevo). The yellowish-brown loess clayey loams (3 m) from the middle part of the III terrace above the floodplain of the river Kama (Krasnyi Bor) (with a small mammal fauna of described by V.P.Sukhov (1972)) is according to Yakovlev of Mikulino age.

The period of deposition is characterized by the presence of a *Pinus-Betula* forests with *Picea*, *Tilia*, *Quercus*, *Ulmus* and *Carpinus*. Open territories were covered by grasslands with herbs and Chenopodiaceae (Nemkova, 1981).

The Saigatka Horizon. The horizon, exposed on the left bank of the river Kama, is subdivided into two units. The lower consists of loess loams with precipitation of carbonate, iron and manganese hydroxides, the upper part of greenish-brownlacustrine silts. The total thickness is 0,35–1 m. In the Bashkirian Fore-Urals the deposits of this horizon consists of greenish-brown clays and yellowish-brown loams intercalated with subaerial sediments and periglacial brown loams of the III terrace.

Small mammals, molluscs and ostracoda are known from these deposits. The vegetation during the cold period of deposition is characterized by a periglacial steppe with a coniferous open forest (Nemkova, 1981).

The Tabulda Horizon. Deposits referred to this horizon are widely distributed in river valleys of the South Fore-Urals, in the lower part of the II terrace. The deposits consist of fluvial and lake sediments (3–7 m thick) and subaerial sediments (the soil is 0,2–0,6 m thick).

Remains of large mammals, molluscs, ostracoda and Upper Palaeolithic flint implements are known. The radiocarbon dates are: 34900±100 y. (LU–1377A) (Tabulda), 22660±125 (BashGI–35) and 28800±124 (BashGI–36) (Gornova).

The vegetation during the time of deposition is characterised by a *Pinus*-forest with some deciduous trees (*Tilia, Quercus, Carpinus* and *Betula*). A *Picea-Pinus* forest with *Abies* dominated the beginning and the end of the interglacial and in the north of the region (Gornova a.o.) (Nemkova, 1981).

The Kudashevo Horizon. The periglacial fluviatile and lacustrine, slope deposits on the II terrace (7–13 m; subaerial 1,25 m) are widely spread. They covered the interfluves and its slopes. Radiocarbon data indicate an age of 18315±300 (BashGI–41) (Old Kudashevo) (Yakchemovich, Nemkova, *et al*., 1981).

A herbage-*Artemisia-Chenopodiaceae* grassland-steppe association characterised the vegetation during the time of deposition. A *Picea*-forest with *Betula* and broad-leaf taxa occurred in the river valleys (Nemkova, 1981).

Table 1 shows the correlation between the subdivision of the Upper Pliocene, Eopleistocene and Neopleistocene in the Southern Fore-Urals and the schemes which are used as standards in other areas: the East European Platform (RISC, 2000) and Europe (W.H. Zagwijn, 1996; Berggren *et al*., 1995).

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Table 1. The stratigraphic subdivision of the Late Pliocene, Eopleistocene, Neopleistocene in the Southern Fore-Urals and correlation to the stratigraphic schemes of The East European Platform, The Netherlands and Southern Europe

Time (MA)	Palaeomagnetic scale: Polarity	Palaeomagnetic scale: Chrons	Palaeomagnetic scale: Subchrons	General Stratigraphic scale (ISC of Russia, 02.02.1995): System	Super subdivision	Subdivision	Link	The East European Platform (RISC, 2000): Horizons / Suite	The Southern Fore-Urals: Suites / Layers (Yakchemovitch *et al.*, 1981, 1987; RISC, 1999)	The Southern Fore-Urals: Type sections	The Netherlands (W.H. Zagwijn, 1996)	Southern Europe (Berggren *et al.*, 1995)
0.01		Brunhes		Quaternary	Holocene							Upper Pleistocene
					Pleistocene	Neopleistocene	Upper	Ostashkovo	Kudashevo	village Kudashevo	Upper Weichselian	
								Leningrad	Tabulda	village Tabulda	Middle Weichselian	Middle Pleistocene
								Kalinin	Saigatka	village Saigatka	Lower Weichselian	
0.12								Mikulino	Mikulino		Eemian	
							Middle	Moscow	Elovka	village Elovka	Saalian	
								Chekalin	Gornova	village Gornova		
								Kaluga	Larevka	bore-hole Larevka 129	Holsteinian	
0.39								Likhvin	Belaya	village Gornova	Elsterian	
							Lower	Oka	Chusovskoye	village Sultanaevo	Cromerian	
								Muchkap	Chui-Atasevo	village Chui-Atasevo		
								Don				
								Iljinsk				
								Pokrovsk	Minzityarovo	village Minzityarovo		
0.8								Petropavlovsk	October	town Oktyabrskyi		
		Matuyama	Jaramillo			Eopleistocene	Upper		Karmasan	village Symbugino	Bavelian	Lower Pleistocene (Calabrian)
1.2							Lower		Davlekanovo	village Akkulaevo village Yulushevo	Menapian	
1.8			Olduvai						Dema	village Akkulaevo	Waalian Eburonian	
				Neogene	Pliocene	Aktschagyl	Upper	Domashka	Voevodskoye	village Voevodskoye	Tiglian	Upper Pliocene (Gelasian)
2.1–2.2			Reunion				Middle	Akkulaevo	Akkulaevo	village Akkulaevo		
2.5–2.6								Chistopol	Zilim-Vasiljevo	Zilim river, village Vasiljevka		
		Gauss					Lower	Sokolsky	Kumurly	village Kumurly	Reuverian	Piacenco
									Karlaman	village Karlaman		

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RADIOCARBON DATA

Material for radiocarbon dating (wood, peat, charcoal, large and small mammal remains) was collected during the investigations in the territory of the Southern Urals region by scientists of the Cenozoic Laboratory of the Institute of Geology Scientific Centre of Ufa RAS. The published and new radiocarbon data are summarised in Table 1. Dates marked by * are obtained in the period 1995–2001.

The radiocarbon data are from the Institute of Geology Scientific Centre of Ufa RAS, Geological Institute RAS (Moscow) and the Institute of Geography of the St. Petersburg State University (St.Petersburg).

Table 2. Radiocarbon data of material collected at localities in the Southern Urals region (Data collected by the Institute of Geology Scientific Centre of Ufa Russian Academy of Sciences)

№	Stratigraphic scale		Climatic-Chronological units	Age	Reg. Nr. of the data	Locality	Dated Material
1	2	3	4	5	6	7	8
1.	HOLOCENE	Modern horizon	Subatlantic	210±40*	GIN – 10857a	v. Uteimullino, Kuz-Elga river, I floodplane terrace	Wood
2.				250±40*	GIN – 10858	v. Upper Lemeza, Lemeza river, I floodplane terrace, layer 6	Wood
3.				380±70*	LU – 4152	v. Arkaulovo, Yuryuzan river, I floodplane terrace, layer 5, 1,0 m depth	*Equus* sp., lower mandible
4.				900±90	BashGI – 81	v. Karjyatmas, peat bog, 0,7–0,8 m depth	Peat
5.				1389±80	BashGI – 80	v. Karjyatmas, peat bog, 0,25–0,5 m depth	Peat
6.				1460±80	BashGI – 86	Yukalykul I, peat bog, 0,6–0,7 m depth	Wood
7.				1600±50*	GIN – 10852	Bajslan-Tash cave, layer 2	Wood coal
8.				1770±50*	GIN – 10857б	v. Zorenka, Lemeza river, I floodplane terrace	Wood
9.				1920±170	BashGI – 71	v. Ishkarovo, Saryjaz river, peat bog, 1,1 m depth	Peat
10.			Subboreal	2630±110	BashGI – 102	v. Ishkarovo, Saryjaz river, peat bog, 1,3–1,4 m depth	Peat
11.				2650±70	BashGI – 82	v. Karjyatmas, peat bog, 1,4–1,6 m depth	*Pinus* sp., wood
12.				2720±130	BashGI – 84	v. Tally-Kulevo, peat bog, 0,5–0,6 m depth	Peat
13.				2760±60	BashGI – 103	v. Ishkarovo, Saryjaz river, peat bog, 1,5–1,6 m depth	Peat
14.				2830±110*	LU – 3713	v. Khvorostyanskoye, Tanalyk river, Tanalyk II, 0,3–0,4 m depth	*Equus* sp., bones & teeth
15.				3110±90	BashGI – 104	v. Ishkarovo, Saryjaz river, peat bog, 1,6–1,7 m depth	Wood
16.				3130±150	BashGI – 70	v. Ishkarovo, Saryjaz river, peat bog, 2,75 m depth	Peat

1	2	3	4	5	6	7	8
17.	HOLOCENE	Modern horizon	Subboreal	3160±160	BashGI – 88	Yukalykul II, peat bog, 1,2–1,3 m depth	Peat
18.				3210±150	BashGI – 57	v. Zuevy Klyuchi, Kama river	Wood coal
19.				3410±50	BashGI – 89	Yukalykul II, peat bog, 1,3–1,5 m depth	Mud with peat
20.				3470±90	BashGI – LU–729	v. Karjyatmas, peat bog, 2,0–2,2 mm depth	Peat with wood
21.				3720±100	BashGI – 87	Yukalykul II, peat bog, 2,2–2,35 m depth	Peat with wood
22.				3890±100	BashGI – 28	v. Utyagan, Azyak river	
23.				3980±180	BashGI – 69	v. Kileevo – v.Old Ilikovo, Syun river	
24.				4620±40*	GIN – 10859	v. Kalinovka, Lemeza river, I floodplane terrace, layer 7, 3,9 m depth	Wood
25.				4650±150	BashGI – 85	v. Burnak, 0,65 m depth	Peat
26.			Atlantic	5050±60	BashGI – 29	v. Utyagan, Azyak river	
27.				6300±200	BashGI – 72	v. Koyanovo, Mulyanka brook, peat bog, 1,5–1,6 m depth	Peat
28.				6450±150	BashGI – 75	v. Kushnarenkovo, peat bog, 0,7–0,9 m depth	Peat
29.				6850±150	BashGI – 74	v. Bogatyrevo	Wood
30.				7050±100	BashGI – 54	v. Sharkan, Kama river, peat bog, 0,8 m depth	Peat
31.				7100±150	BashGI – 68	v. Kileevo – v. Old Ilikovo, Syun river	
32.				7110±220	BashGI – 90	Yukalykul II, peat bog, 1,5–1,8 m depth	Soil
33.				7140±170*	GIN – 10854	Bajslan-Tash cave, layer 3	Large mammal's bone
34.				7620±90	BashGI – 105	v. Ishkarovo, Saryjaz river, peat bog, 2,6 m depth	Peat with wood
35.			Boreal	8320±110	BashGI – 58	Oktyabrskyi town, Ik river, Mullino II	Wood coal
36.				8460±130	BashGI – 87	Oktyabrskyi town, Ik river, Mullino II, layer of lacustrine clay	Wood
37.				8500±180	BashGI – 59	Oktyabrskyi town, Ik river, Mullino II	Wood coal
38.				8510±150	BashGI – 55	v. Sharkan, Kama river, peat bog, 1,9 m depth	Peat
39.				8570±40	BashGI – 31	v.Ishbulatovo, Belaya river	
40.				8730±150	BashGI – 13	v.Dutovo, Pechora river, 1,7–2,1 m depth	Peat
41.				8820±250	BashGI – 56	v. Sharkan, Kama river, peat bog, 2 m depth	Peat
42.				8880±60	BashGI – 32	v. Ishbulatovo, Belaya river	
43.				9260±210	BashGI – 83	v. Abdullino, 1,6–1,7 m depth	Peat
44.			Preboreal	9620±50	BashGI – 76	v. Kholodny Klyuch, Syun I, 1,2–1,6 mm depth	Sand with wood coal
45.				9650±50	BashGI – 77	v. Kholodny Klyuch, Syun I, 1,2–1,6 m depth	Wood coal

1	2	3	4	5	6	7	8
46.	UPPER NEOPLEISTOCENE	Ostashkovo horizon	Dryas III	10700±220	BashGI – 22	Nyzva river, peat bog, 3,3 m d.	Peat
47.			Alleröd	11270±55	BashGI – 42	v. Old Kudashevo, Orjya river	Wood
48.				11680±90	BashGI – 43	v. Old Kudashevo, Orjya river	Wood
49.			Dryas II	12330±120	LU – 1668	v. Zlatoustovka, Ashkadar river, floodplane terrace	*Coelodonta antiquitatis* Blum., teeth
50.				12380±150*	LU – 3861	Zapovednaja cave, floor	Wood coal
51.			Dryas I	13560±250*	GIN – 108533	Bajslan-Tash cave, layer 4	Small mammals bones
52.			Arctic	17000±100	BashGI – 78	v. Kholodny Klyuch, Syun I, 4,3–4,6 m depth	Wood
53.				17200±170	BashGI – 79	v. Kholodny Klyuch, Syun I, 4,3–4,6 m depth	Wood
54.				18310±300	BashGI – 41	v. Old Kudashevo, Orjya river	
55.				21280±550	LE – 145	v. Gornova, Belaya river, II floodplane terrace, section II, layer 2	Wood
56.				22660±125	BashGI – 35	v. Gornova, Belaya river, II floodplane terrace, section II, layer 2	Wood
57.				22750±1210*	LU – 3714	Verkhnyja cave, floor	*Spelaearctos spelaeus* (Rosen. et Heinroth), bone
58.				25798±100	BashGI – 34	v. Aknanyshbash	Wood
59.		Leningrad horizon		26950±560*	LU – 3711	v. Gornova, Belaya river, II floodplane terrace, section II, layer 2	Wood
60.				26990±150*	LU – 3712	v. Gornova, Belaya river, II floodplane terrace, section II, layer 2	Wood
61.				27570±480	BashGI – 33	v.Aknanyshbash	Wood
62.				28800±125	BashGI – 36	v. Gornova, Belaya river, II floodplane terrace, section II, layer 2	Wood
63.				28700±1050*	LU – 3715	Zapovednaja cave, layer 3; 0,75 m depth	*Spelaearctos spelaeus* (Rosen. et Heinroth), bone
64.				29700±1250	H–1856/1287	v. Gornova, Belaya river, II floodplane terrace, stripping 2, layer 2	Wood
65.				30700+800*	GIN – 10856	v. Lower Bikkuzino, Belaya river, II floodplane terrace	*Equus latipes*, cannon bone
66.				31360±250	LE – 2153	v. Tabulda, Sukhoi Kundryak river	*Mammuthus primigenius*, bones
67.				≥ 33670*	LU – 3712	v. Gornova, Belaya river, II over flood plane terrace, section II, layer 3	*Bison sp.*, teeth
68.				34910±300	LE – 2154	v. Tabulda, Sukhoi Kundryak river	*Mammuthus primigenius*, bones
69.				34900	LU – 1377A	v. Tabulda, Sukhoi Kundryak river	*Mammuthus primigenius*, bones
70.				35650±170	BashGI – 73	v. Krasnyi Bor, lacustrine loams, lower part	Wood
71.				360000	LU – 1380A	v. Buribai, quarry	*Mammuthus primigenius*, tusk
72.				37250*	LU – 3876	Zapovednaja cave, floor	*Spelaearctos spelaeus* (Rosen. et Heinroth), bone
73.				> 38100*	GIN – 10855	Bajslan-Tash cave, layer 4	*Equus* sp., bone

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THE LATE PLEISTOCENE PALAEOENVIRONMENT IN THE SOUTHERN (BASHKIRIAN) FORE-URALS

The Late Pleistocene can be divided into two warm and two cold phases (Nemkova, 1992). The first phase dated to the beginning of the Late Pleistocene is correlated to the Late Khazarian transgression. All the older terraces, in particular in the area near the Urals, have been eroded intensively during the Mikulino phase (Yakchemovich *et al*., 1987). Broad-leaf Birch-Pine forest covered large areas to the north of Ufa and herbaceous steppe dominated in more open regions (Yakchemovich *et al*., 1983). The percentage of broad-leaf species in the forest was lower than in the central part of the Russian Plain (Nemkova, 1992). The climate resembled the modern one; it was only slightly warmer.

Periglacial brown loams which are forming the upper part of the III floodplain terrace, refer to the second phase, the period of the Late Khazarian regression that coincides with the Early Valdai Glaciation (Yakchemovich *et al*., 1987). Birch-coniferous forest occurred in the area north of Ufa during the first half of the Podporozhie phase. *Ephedra* appeared in open areas and the percentage of Chenopodiaceae increased (Yakchemovich *et al*., 1983). An assemblage with the dominance of pine and without deciduous tree is known from the region to the south of Ufa (Nemkova, Alimbekova, 1985). Periglacial, tundra plant-associations occurred on the Russian Plain at that time (Stratigraphy.., 1984).

The Early Khvalynian transgression (Leningrad Interstadial) marks the second erosional phase when the lower part of II river plain terraces were formed (Yakchemovich *et al*., 1987). Pine dominated forest with a low percentage of *Betula* and broad-leaf trees occurred in the area to the northwest of Ufa; open areas were covered by a herbaceous steppe vegetation (Yakchemovich *et al*., 1983). The composition of the flora at that time was almost indistinguishable modern one; however, the climate was more humid (Kolesnikova, 1957). At the end of the interstadial the forest vegetation was replaced by a cold, periglacial steppe vegetation. In the Russian Plain plant associations changed from a birch forest to a periglacial tundra at that time (Stratigraphy.., 1984).

The Late Valdai (Ostashkovo) Glaciation marks a considerable increase of periglacial conditions. Alluvial and lacustrine brown loams and clays covered the slopes of the interfluves and formed the upper part of the II terraces (Yakchemovich *et al*., 1987). The vegetative cover at the same latitude as Ufa consisted of grassland-steppe associations with herbage, *Artemisia* and *Chenopodiaceae* which covered most of the territory and fir-birch forest with a low percentage of deciduous trees occurred in the valleys. The climate became colder and more humid during the second half of that time: broad-leaf trees disappeared and the percentage of *Betula* decreased (Yakchemovich *et al*., 1983, 1987). Periglacial forest-tundra conditions and arctic deserts occurred, at that time in the central part of the Russian Plain (Stratigraphy.., 1984).

During the Late Pleistocene the climate of the territory of the South Fore-Ural differed from that of the Russian Plain because of the greater distance to the inland ice-sheets and its altitudinal higher position. The climate in the South Fore-Urals was colder and dryer during the interglacials and colder and more humid the glacial phases. Only the Leningrad Interstadial optimum is know in the South Fore-Ural; the data are, therefore insufficient to make a reliable comparison to the palaeoclimatic conditions at Russian Plain during the Leningrad Interstadial.

THE GORNOVA SECTIONS

Location

The Palaeolithic site is located on the left bank of the river Belaya near the village Gornova (Ufimian region, Bashkortostan Republic) (Fig. 1). The top of the terrace is approximately at 94,3 m above sea level and its base is at +78,9 m. The thickness of terrace deposits is 15,4 m (Yakchemovich *et al.*, 1987).

History

A.P. Shokurov carried out archaeological investigations in the valley of the Belaya river in 1959 and discovered a Palaeolithic site near the small village Gornova. He found below 13 metres of "reddish" loams a horizon of bluish-grey loams with remains of large mammals. The bone layer was exposed along the river over a length of about 100 m. The layer is 1–1,4 m thick. A.P. Shokurov also found two stone implements.

In 1959 the locality was investigated by O.N. Bader and V.L. Yakchemovich (Shokurov, Bader, I960). V.L. Yakchemovich described the section for the first time.

In 1983 the Leningrad Branch of the Institute of Archaeology together with the Bashkirian Branch of the Academy of Sciences of the USSR re-started the investigations of the Gornova sections; T.I. Sherbakova was the Leader of the team of archaeologists.

In 1983–1985 V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev described in detail the deposits of the II terrace and collected samples.

The large mammal remains have been identified by B.S. Kozhamkulova (Alma-Ata), E.A. Vangengeim (Moscow); the small mammals by A.G. Yakovlev (Ufa), the molluscs by G.A. Danukalova (Ufa); the insects by E.V. Zinovjev (Ekaterinburg); the ostracods by M.G. Popova-Lvova (Ufa), pollen and spores by V.K. Nemkova, L.I. Alimbekova (Ufa) and carpological remains – by P.I. Dorofeev (St. Petersburg). Radiocarbon dates were obtained by the Institute of Geology (Ufa) and the Institute of Geochronology of St. Petersburg University. Palaeomagnetical investigations were carries out by F.I. Suleimanova (Ufa).

Description of the sections

Section I

The upper part of the terrace consists of brown loams and sandy loams of periglacial origin (Fig. 2 a, b, c). The following layers occur starting from the edge of the terrace.

Quaternary

Holocene – Q_4

(subaerial deposits – *pd)*

Thickness, m

1. Soil (chernozem) fine blocky, perforated by plant roots and burrows (diameter is 5–6 cm) filled by brown loam……………………………………………………………………………………….0,8

Pleistocene

Upper Neopleistocene – Q_3

Ostashkovo Horizon – Q_3^4 *os*

(periglacial deposits – *l, ld(pgl))*

l, ld(pgl) 2. Light brown dense loam with humus in the upper part, with burrows (diameter is 4–5 cm), which are filled with loam and humic deposits. Approximately 0,5 m from the top of the layer a loess horizon with lime nodules (diameter is 1–2 cm and an irregular form) occur. *Succinea oblonga* Drap. (4), *Vallonia* sp. (2), *Zenobiella rubiginosa* A. Schm. (1), *Clessiniola julaevi* G.Ppv. (7) *Dreissena polymorpha* (Pall.) (10) have been collected from the gravel lens……………………………………………….0,6

ld(pgl) 3. Brown loess-like unconsolidated loam with columnar jointing, with iron-staining and little precipitation of manganese, with interbeds of bluish-grey clay (thickness 0,2–0,4 cm)……………...3,4

ld (pgl) 4. Light brown massive loam with numerous interbeds of bluish-grey clay (thickness 0,3–0,4 cm). The loam becomes denser and damper in the lower part of the layer…………………………………...8

ld (pgl) 5. Brown dense loam with interbeds of bluish-grey clay (thickness 0,3–0,5 cm). The number and thickness of these interbeds increase in the lower part of the layer. Pebbles and yellow sandy interbeds are also present in the lower part of the layer. Shells of *Succinea oblonga* Drap. (83), *Pupilla muscorum* L. (7), *Vallonia costata* Müll. (30), *Dreissena polymorpha* (Pall.) (12), *Paraspira spirorbis* L. (1) and *Clessiniola julaevi* G. Ppv. (6) have been collected from the lower part of the layer…………………3,1

l (pgl) 6. Bluish-brown clay with iron-staining. The lower boundary of the layer is erosional. Shells of *Succinea oblonga* Drap. (9), *Vallonia costata* Müll. (1), *Dreissena polymorpha* (Pall.) (1) are rare; they come from the lower part of the layer…………………………………………………………………0,3

Erosional base / Sedimentary break.

Leningrad Horizon – Q_3^3

(alluvial deposits, floodplain facies – *a (pr))*

7. Dark grey clay with organic remains and numerous mollusc shells: *Succinea oblonga* Drap. (>100), *S. pfeifferi* Rossm. (>100), *Vallonia costata* Müll. (>100), *Pupilla muscorum* L. (>50), *Zenobiella rubiginosa* A. Schm. (2), *Stagnicola palustris* Müll. (5), *Limnaea* sp. (1), *Planorbis planorbis* L. (2), *Paraspira spirorbis* L. (>50), *Gyraulus laevis* Alder (>50), *Bathyomphalus contortus* L. (1) and *Pisidium amnicum* Müll. (1)……………………………………………………………………………………..0,6

Section II

The lower part of the periglacial strata discovered 20 m downstream of the river Belaya during the archaeological excavation. The following layers are covered by brown loams in the lower part of the terrace sequence. (Fig. 3 a, b, c; 4 a, b).

Pleistocene

Upper Neopleistocene – Q_3

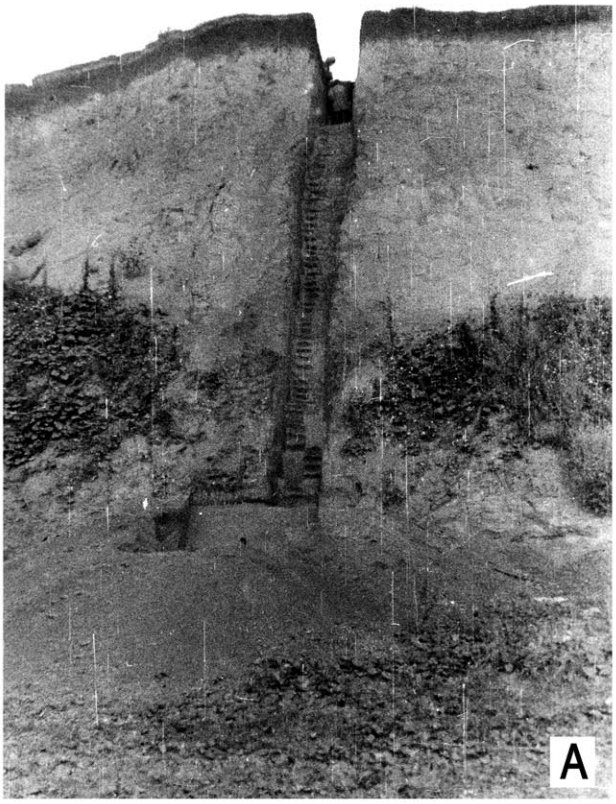
Ostashkovo Horizon – Q_3^4 *os*

(lacustrine, alluvial periglacial deposits – *l, al (pgl))*

Thickness, m

l, al (pgl) 1. Brown dense loam with a lens of gravels and sand and with interbeds of bluish-grey clay. Shells of *Succinea oblonga* Drap. (4), *Vallonia* sp. (2), *Zenobiella rubiginosa* A. Schm. (1), *Clessiniola julaevi* G. Ppv. (7), *Dreissena polymorpha* (Pall.) (10) have been collected from the gravel lens. The observed thickness is…………………………………………………………………………………...0,85

Erosional base/Sedimentary break.



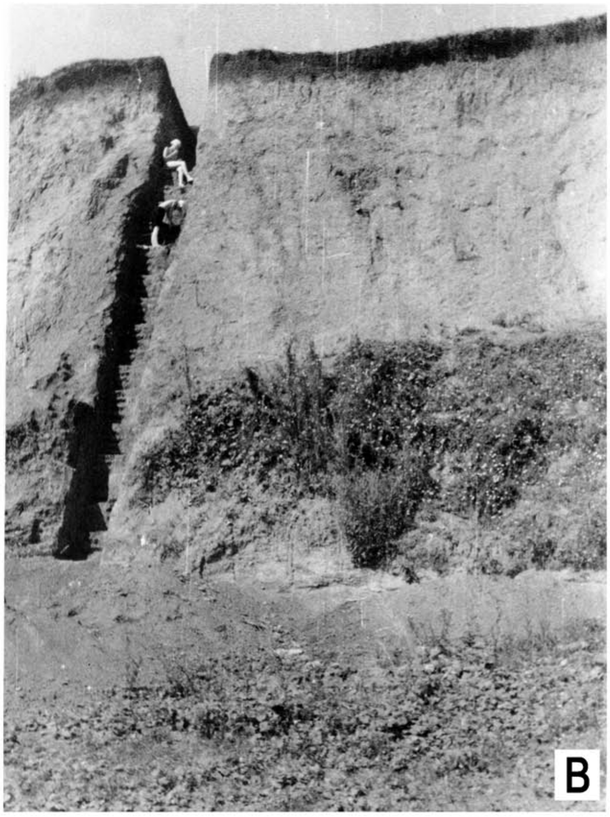


Fig. 2. Gornova, section I
(A, B, C - fragments of the section).

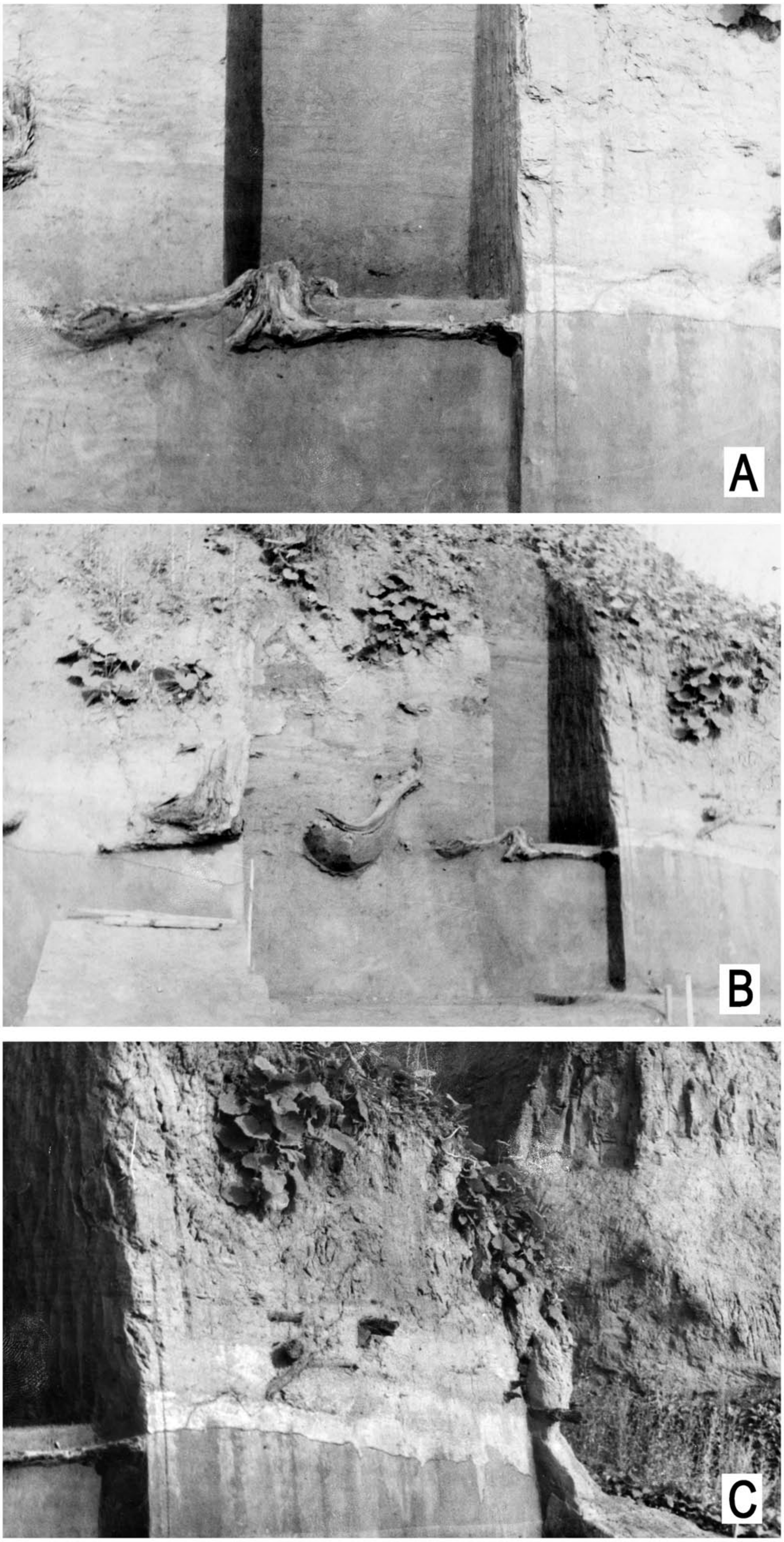


Fig. 3. Gornova, section II, the layer 2 with stumps and roots of Picea sp.

(A, B, C – fragments of the section)

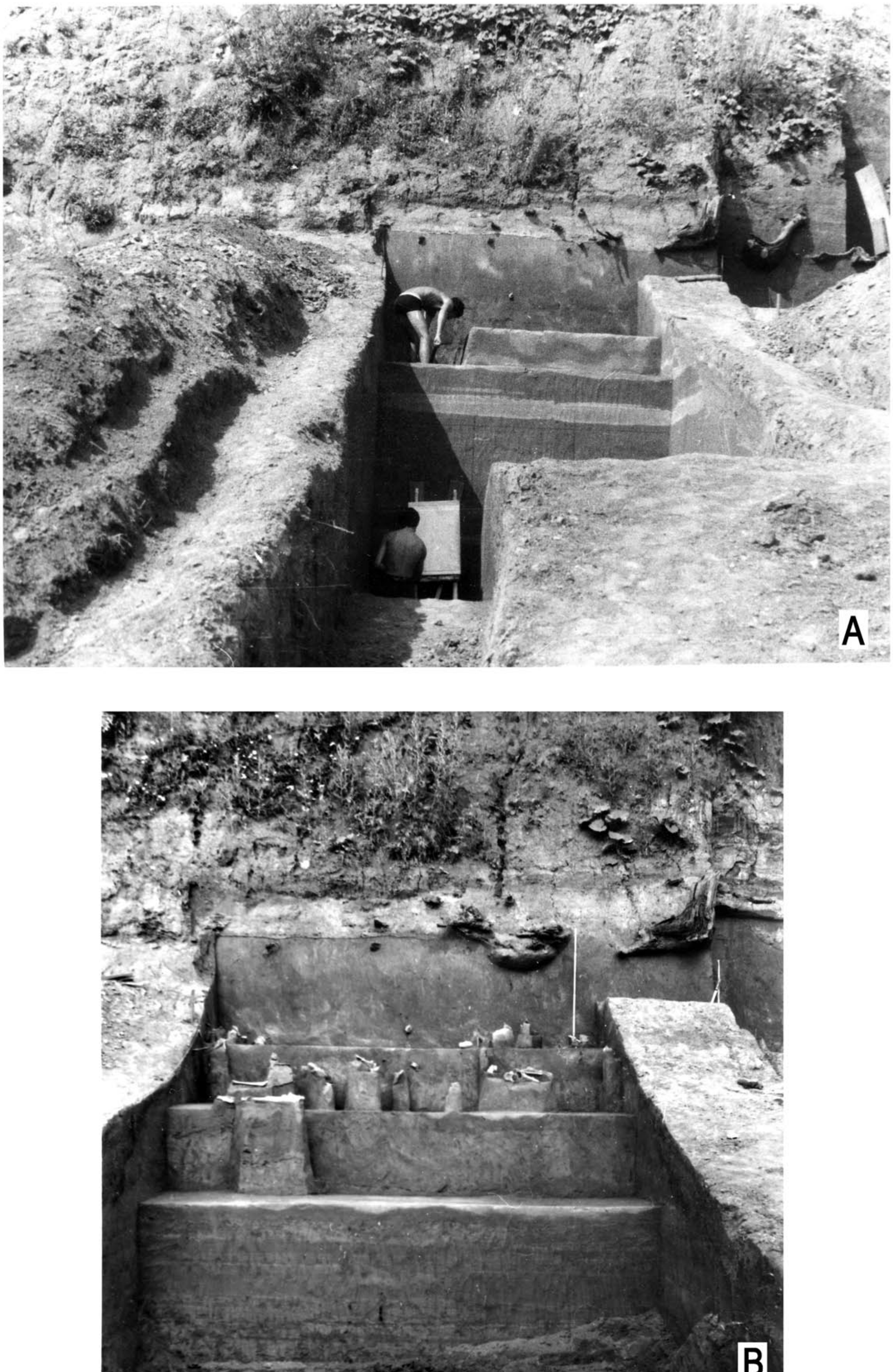


Fig. 4. Gornova, section II (A, B – fragments of the lower part of the section)

Leningrad Horizon – Q_3^3

(lacustrine deposits – *l)*

2. Bluish-grey thin-bedded silty loam with stumps and roots of *Picea* sp. The lower boundary of the layer is erosive. The wood is 21280±550 (LE–145), 22660±125 (BashGI–35), 28800±124 (BashGI–36), 29700±1250 (H 1856/1287), 26950±560 (LU–3711), 26990±150 (LU–3712) years old……………0,65

Greyish-brown clayey silt occur in erosional pockets between layers 2 and 3 (Section II a). Eight stone Upper Palaeolithic implements and bone remains of large and the small mammals: *Ochotona* sp. (4*)*, *Spermophilus* sp. (1), *Clethrionomys rufocanus* Sundervall (1), *Clethrionomys* sp. (4), *Lagurus lagurus* Pall. (5), *Lagurus* sp. (25), *Microtus (Stenocranius) gregalis* Pall. (3), *Microtus (Microtus) oeconomus* Pall. (4), *Microtus* sp. (22) were collected from these sediments.

3. Dark bluish-grey lacustrine silty loam with molluscs shells, mammals remains and rare small indications of the precipitation of iron and with vivianite grains (diameter 1–3 mm). A bone of *Bison* sp. is ≥ 33670 years old (LU – 3712)……………………………………………………………………………2,0

The small mammal assemblage (from the upper part of the loam) is composed of: *Sorex* sp. (4), *Spermophilus* sp. (2), *Allocricetulus eversmanni* Brandt (2), *Clethrionomys rufocanus* Sundervall (1), *Lagurus lagurus* Pall. (3), *Lagurus sp.* (11), *Eolagurus luteus* Eversmann (1), *Microtus (Stenocranius) gregalis* Pall. (4), *Microtus (Microtus) oeconomus* Pall. (13) and *Microtus sp.* (63).

Large mammals: *Bison priscus gigas* (V. Grom.) Florov, *B. priscus* Boj., *Bison* sp., *Alces* cf. *alces* L. and *E. caballus fossilis* (identified by B.S.Kozhamkulova).

Molluscs: *Succinea pfeifferi* Rossm. (>150), *S. oblonga* Drap. (>150), *Vallonia costata* Müll. (>70), *Vallonia pulchella* Müll. (10), *Pupilla muscorum* L. (36), *Euomphalia strigella* Drap. (1), *Zenobiella rubiginosa* A. Schm. (3), *Limnaea* sp. (1), *Stagnicola palustris* Müll. (>128), *Paraspira spirorbis* L. (183), *Planorbis planorbis* L. (4), *Gyraulus laevis* Alder (>200), *Bathyomphalus contortus* Linné (1), *Valvata piscinalis antiqua* Sow. (2), *Sphaerium rivicola* Lam. (1), *Pisidium amnicum* Müll. (1) and *Dreissena polymorpha* (Pall.) (1).

Middle Neopleistocene – Q_2

Kaluga Horizon – Q_2^2

(alluvial, lacustrine periglacial deposits – *a*, *l gl)*

a gl 4. Alternation of light brown loams with thin interbeds (thickness is 1–3 cm) of reddish-brown and bluish-brown clays and light greyish-brown fine grained thin, cross and horizontally bedded sands. The thickness of the interbeds from the top to the base of the layer is: sand (15–20 cm), loam (30–40 cm), sand (20–25 cm), loam (20–25 cm). The upper boundary of the sandy interbeds is undulated………1,0

l gl 5. Brown dark grey silty clay with pebbles and sandy interbeds and traces of frost penetration….2,2

Likhvin Horizon – Q_2^1

(alluvial deposits – *a)*

6. Brownish-grey fine sand with pebbles, plant remains and rare molluscs. Two interbeds of bluish-grey clay (thickness is 2–4 and 5 cm) are located in the upper and the middle parts of the layer………….2,5

Botanical remains: Picea sp., Eleocharis palustris (L.) R. Br. (2), Carex sp. (1), Rorippa sp. (2), Potentilla ex gr. nivea L. (4).

Molluscs: Succinea oblonga Drap. (1), Gyraulus laevis Alder (1), Pisidium amnicum Müll. (2), Dreissena polymorpha (Pall.) (1).

E.A. Vangengeim (1959) described a molar Mammuthus chosaricus Dub. collected from the Middle Neopleistocene deposits at the base of the terrace.

B.S. Kozhamkulova described bones from the beach of the river and reffered these bones to: Bison priscus Boj., Bison sp., Bos primigenius Boj., Bos taurus L., Ovis cf. ammon L., Alces cf. alces L., Megaloceras giganteus (Blum.), Cervus elephus L., Equus cf. hemionus Pall., E. caballus fossilis, Equus sp., Camelus sp., Mammuthus sp. and Coelodonta antiquitatis Blum.

Section III

Section 3 is located upstream of the river Belaya 700 m from the section I. The following layers are covered by brown loams in the upper part of the terrace sequence.

Upper Neopleistocene – Q_3

Ostashkovo Horizon – Q_3^4 *os*

(lacustrine, slope periglacial deposits – *ld (pgl))*

Thickness, m

1. Greyish-brown dense loam with traces of manganization and frost penetration. Observed thickness is 0,8

2. Brown loam with interbeds of fine sand (thickness is 2–5 cm) and iron-staining at the lower part of the layer. The thickness of the iron-staining crust is 2 cm. The lower boundary is undulated………..0,8

Erosional base/Sedimentary break.

Middle Neoleistocene – Q_2

Kaluga Horizon – Q_2^2

(lacustrine periglacial deposits – *l gl)*

3. Alternation of brownish-grey clays and grey fine sands with pebbles and molluscs. The thickness of sandy interbeds is 3–7 cm. The lower boundary is with iron-staining……………………………….....1,4

Likhvin Horizon – Q_2^1

(lacustrine, alluvial deposits – *l, a)*

4. Alternation of greyish-blue clays and fine grey sands with pebbles and mollusc detritus. The thickness of the interbeds is: clay (15 cm), iron-stained sands (25 cm), clay (15 cm), iron-stained, sands (25 cm), dense clay with botanical remains (90 cm)……………………………………………………………1,5

Molluscs: *Succinea oblonga* Drap. (11), *Vallonia costata* Müll. (2), *Pupilla muscorum* L. (1), *Stagnicola palustris* Müll. (3), *Paraspira spirorbis* L. (8), *Planorbis planorbis* L. (4), *Gyraulus laevis* Alder (8), *Valvata pulchella* Müll. (4), *Viviparus* sp. (9), *Lithoglyphus* sp. (3), *Sphaerium rivicola* Lam. (16), *S. corneum* L. (1), *Pisidium amnicum* Müll. (9), *P. supinum* A. Schm. (9) and *Dreissena polymorpha* (Pall.) (1).

5. Series of cross-bedded sands and gravels (fluvial facies) with iron-staining. Exposed thickness is…..1,65 Molluscs: *Succinea oblonga* Drap. (2), *Vallonia costata* Müll. (1), *Zenobiella rubiginisa* A. Schm. (1), *Stagnicola* sp. (1), *Bithynia* sp. (1), *Paraspira spirorbis* L. (6), *Planorbis planorbis* L. (3), *Gyraulus laevis* Alder (7), *Sphaerium rivicola* Lam. (2) and *S. corneum* L. (1).

Base of the section.

Vegetation

Palynological studies indicate that a divers herbaceous steppe vegetation dominate during the Likhvin Inetrgalcial. Coniferous-broad-leaf forests are rare; the occurred in moist areas. The amount of forest increased towards the end of the Likhvin Interglacial.

The upper part of the Likhvin deposits (near the contact with the Kaluga lacustrine-glacial deposits) yielded carpological remains (Tabl. 3). The flora is similar to the Eastern European glacial floras; a small quantity of glacial forms existed. The flora from the Gornova sections is of pre-Saalian, Syngil or Khazar age.

The cold steppes associations from the beginning of the Kaluga time span changed gradually to associations with an increased role of the *Picea* taiga forest. The Taiga forests biocoenosis predominated during the Leningrad Interstadial.

In the Ostashkovo time a herbage-*Artemisia*-Chenopodiaceae grassland-steppe association covered most part of the territory during the Ostashkovo period. A *Picea* forest with *Betula* and a small quantity of broad-leaved trees grew in moist depressions. The climate at the end of the the period became colder and hence, the broad-leaved forms disappeared and the percentage of *Betula* decreased (Fig. 5–8).

Molluscs

The alluvial deposits of sections 2 and 3 yielded the warm interglacial Likhvin mollusc complex (116 shells which belong to 17 species of 15 genera) with: *Succinea oblonga* Drap. (14), *Vallonia costata* Müll. (3), *Pupilla muscorum* L. (1), *Zenobiella rubiginosa* A. Schm. (1), *Stagnicola palustris* Müll. (3), *Stagnicola* sp. (1), *Planorbis planorbis* L. (7), *Paraspira spirorbis* L. (11), *Gyraulus laevis* Alder (16), *Viviparus sp.* (9), *Valvata pulchella* Müll. (4), *Bithynia* sp. (1), *Lithoglyphus* sp. (3), *Sphaerium rivicola* Lam. (18), *S. corneus* L. (2), *Pisidium amnicum* Müll. (11), *P. supinum* A. Schm. (9) and *Dreissena polymorpha* Pall.) (2).

The molluscs of this complex are fluvial, lacustrine or terrestrial; they have a wide stratigraphical range.

The Leningrad mollusc complex is composed of lacustrine and terrestrial species (more than 1405 shells that belong to 17 species of 15 genera): *Succinea oblonga* Drap. (>250), *S. pfeifferi* Rossm. (>250), *Vallonia costata* Müll. (>169), *V. pulchella* Müll. (10), *Pupilla muscorum* L. (>86),), *Zenobiella rubiginosa* A. Schm. (5), *Euomphalia strigella* Drap. (1), *Limnaea* sp. (2), *Stagnicola palustris* Müll. (>128), *Planorbis planorbis* L. (6), *Paraspira spirorbis* L. (>233), *Gyraulus laevis* Alder (>250), *Bathyomphalus contortus* L. (2), *Valvata piscinalis* (Müll.) *antiqua* Sow. (2), *Sphaerium rivicola* Lam. (1), *Pisidium amnicum* Müll. (2) and *Dreissena polymorpha* Pall.) (1).

The Ostashkovo mollusc complex (178 shells belong to 7 species of 7 genera): *Succinea oblonga* Drap. (96), *Vallonia costata* Müll. (35), *Vallonia* sp. (2), *Pupilla muscorum* L. (7), *Zenobiella rubiginosa* A.Schm. (1), *Paraspira spirorbis* L. (1), *Clessiniola julaevi* G. Ppv. (13), *Dreissena polymorpha* Pall.) (23). Shells of *Clessiniola julaevi* G. Ppv. are re-deposited from Pliocene sediments (Tabl. 4).

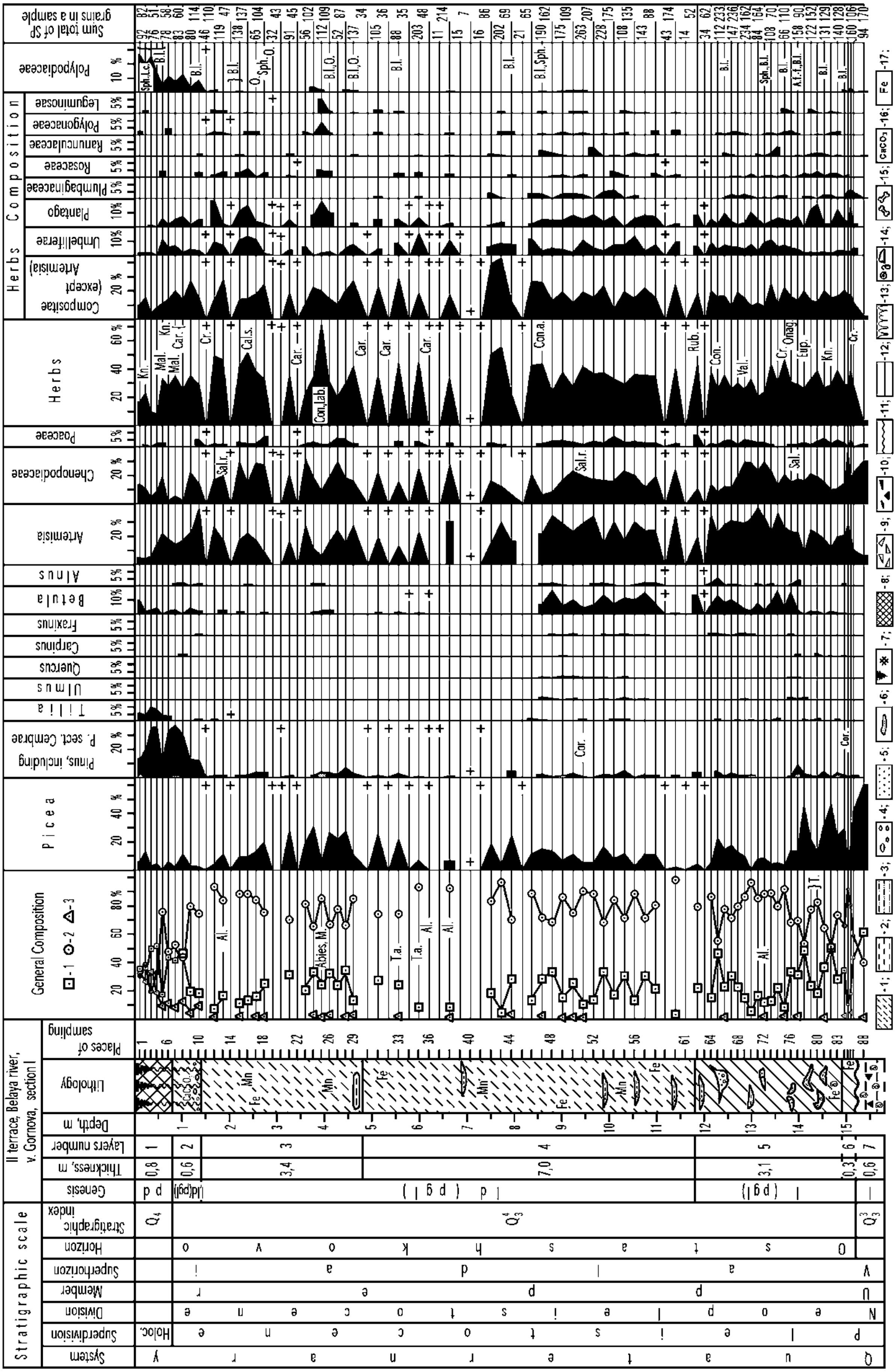


Fig. 5. The Gornova section I and the pollen diagram (by G.A. Danukalova, A.G. Yakovlev, V.K. Nemkova and L.I. Alimbekova)

To Fig. 5. Legend: 1 – Trees and shrubs; 2 – Herbs; 3 – Sporophytes; Acer – *Acer* sp.; A.f.-f. – *Athyrium filix-femina* (L.) Roth.; Al. – *Alisma* sp.; Alnus – *Alnus* sp.; Abies – *Abies* sp.; B.l. – *Botrychium lunaria* (L.) Sw.; Bet.v. – *Betula verrucosa* Ehrh.*;* Car. – Caryophyllaceae; Carp. – *Carpinus* sp.; Ch.al. – *Chenopodium album* L.; Ch.r. – *Chenopodium rubrum;* Cr. – Cruciferae; Con. – *Convolvulus* sp.; Cor. – *Corylus* L.; Cal.sep. – *Calestegia sepium* R. Br.; C.c. – *Centaurea cyanus* L.; C.r. – *Centaurea ruciferae*, Dipsac., Dip. – Dipsacaceae; Dryop. – *Dryopteris filix-mas* (L.) Schott.; E.c. – *Eurotia ceratoides* (L.) C.A.M.; Ech.r. – *Echinops ritro* L.; Eph. – *Ephedra* sp.; Eph. dist., Eph.d. – *Ephedra distachya* L.; Eq. – *Equisetum* sp.; Eup. – Euphorbiaceae; Fraxinus, Frax. – *Fraxinus* sp.; H. – Hydrochoris; K.l. – *Kochia laniflora* Gmel. Borb.*;* K.s. – *Kochia scoparia* (L.) Schrad.; Kn. – *Knautia* sp.; Lab. – Labiatae; Larix – *Larix* sp.; L. – *Lycopodium* sp.; L.an. – *Lycopodium annotinum* L.; L.c. – *Lycopodium clavatum* L.; L.ap. – *Lycopodium appressum;* L.p. – *Lycopodium pungens* La Pyl.; Leg. Legum. – Leguminosae; Lon. – *Lonicera* L.; Lon. t. – *Lonicera tatarica* L.; Myrioph., M. – *Myriophyllum* sp.; N. – *Nuphar* sp.; N.p. – *Nuphar pumila* (Timm) DC.; Nymph. – Nymphaea; Onag. – Onagraceae; Oph., O. – Ophioglossaceae; Osmunda, Os. – *Osmunda* sp.; Os.c. – *Osmunda cinnamomea* L.; O.v. – *Ophioglossum vulgatum* L.; Pot. – *Potamogeton* sp.; Picea – *Picea* sp.; Picea ex. – *Picea excelsa* Link.*;* Picea ob. – *Picea obovata* Ldb.; P.s.O., P.sect Omorica – *Picea* sect. *Omorica;* Pl. – Plumbaginaceae; P. virg. – *Polypodium virginianum* L.; P.v. – *Polypodium vulgar* L.; Pol.bis. – *Polygonum bistorta* L.; Pol.am. – *Polygonum amphybium* L.; Q., Quercus – *Quercus* sp.; Q.robur, Q. r. – *Quercus robur* L.; R.sc. – *Ranunculus scelaratoides* L.*;* Ros. – Rosaceae; Rub. – Rubiaceae; Sal. R. – *Salsola ruthenica* Iljin; Sal. l. – *Salsola lanata;* Salic h. – *Salicornia herbaceae;* Salix – *Salix* sp.; Sph. – *Sphagnum* sp.; S. – *Selaginella* sp.*;* S.s. – *Selaginella selaginoides* (L.)*;* S.sib. – *Selaginella sibirica* (Millde) Heiron; Sp. – *Sparganium* sp.; St. – *Stratiotes* sp.; Tilia – *Tilia* sp.; Tsuga – *Tsuga* sp.; Tsuga div. – *Tsuga diversifolia* (Max.) Mast.; Typha , T. – *Typha* sp.; T.l. – *Typha latifolia* L.; Ulmus – *Ulmus* sp.; Val. – *Valeriana* sp.; Vibur. – *Viburnum* sp.; Weigela – *Weigela* sp.; W. – *Woodsia* sp.; W.fr. – *Woodsia fragilis* (Trev.) Moore.

Lithology: 1 – loam; 2 – clay; 3 – sandy loam; 4 – gravel; 5 – sand; 6 – sandlens; 7 – soil; 8 – ancient soil; 9 – fragments of limestone; 10 – plant remains; 11 – Erosional base/Sedimentary break; 12 – beds boundaries; 13 – erosion; 14 – molluscs; 15 – mammals remains; 16 – calcification; 17 – iron-staining.

Ostracods

The following Pleistocene ostracod-complexes from the Gornova sections have been investigated (Tabl. 5):

The Likhvin complex (Sections II, III); numerous is: *Ilyocypris;* rare are: *Cyclocypris, Cypria, Candona neglecta* Sars *C. rawsoni* Tres., *C. rostrata* Br. et Norm., *C. candida* (O. Müll.), *C. weltneri* Hartw., *Eucypris horridus* Sars, *Sclerocypris (?) clauata* (Baird), *Cytherissa lacustris* Sars, *Denticulocythere dorsotuberculata* (Neg.), *D. caspiensis* (Neg.), *Limnocythere postconcava* Neg, *L. manjtschensis* (Neg.) ets.

Limnocythere postconcava, L. manjtschensis, Denticulocythere dorsotuberculata, D. caspiensis are characteristic for Middle Pleistocene deposits in the Eastern Europe and Western Siberia (Negadaev-Nikonov, 1974). Numerous cold-resisting *Candona candida, C. neglecta, C. rawsoni, Eucypris horridus* and *Ilyocypris bradyi* occurred during the end of Likhvin Interglacial.

The Kaluga complex is characterized by cold-resisting ostracods (Sections II, III): *Ilyocypris, Cyclocypris, Cypria, Ilyocypris inermis* Kauf., *Cyclocypris serena* (Kosh), *C. triangula* Neg., *Candona fabaeformis* (Fisch), *Eucypris pigra* (Fisch.), *Limnocythere falcata* Dieb. *Candona candida* (O. Müll.), *C. neglecta* Sars and *C. rawsoni* Tres. are numerous. *Denticulocythere dorsotuberculata* (Neg.), *D. caspiensis* (Neg.), *Limnocythere postconcava* (Neg.), *L. manjtschensis* Neg. and others make the transition forms from the Likhvin Interglacial.

The Ostashkovo complex (Sections I, II, III) consists of numerous species: *Ilyocypris bella* Scharap., *I. inermis* Kauf., *Candona neglecta* Sars, *C. rawsoni* Tres., *C. rectangulata* Alm, *Candona* juv., *Eucypris dulcifons* Dieb. et Pietr., *Denticulocythere dorsotuberculata* (Neg.), *Limnocythere postconcava* Neg., *L. manjtschensis* Neg., *L. falcata* Dieb. and others.

Limnocythere and *Denticulocythere* are relatively small due to the cold climatic conditions. *Candona neglecta, C. rawsoni, C. rectangulata, Eucypris dulcifons, Ilyocypris inermis* are cold-resisting ostracods.

Table 3. The results of the carpological study of the remains from the Gornova sections

Species	Leningrad Horizon, Section II, layer 2	Likhvin Horizon Section III, layer 4
Chara sp.	–	numerous
Larix sp.	–	numerous
Picea sp.	numerous	numerous
Sparganium simplex Huds.	–	numerous
Potamogeton pectinatus L.	–	numerous
P. filiformis Pers.	–	numerous
P. perfoliatus L.	–	numerous
P. vaginatus Turcz.	–	numerous
P. luceus L.	–	numerous
P. friesii Rupr.	–	numerous
Stratiotis aloides L.	–	numerous
Butomus umbellatus L.	–	numerous
Eleocharis palustris (L.) R. Br.	2 nuts	1 nut
Carex sp.	1 nut	numerous
Salix sp.	–	numerous
Scirpus lacustris L.	–	numerous
Chenopodium album L.	–	numerous
C. rubrum L.	–	numerous
C. hybridum L.	–	numerous
Atriplex sp.	–	numerous
A. hastata L.	–	numerous
Corispermum sp.	–	numerous
C. intermedium Schwug.	–	numerous
Stellaria sp.	–	numerous
Cerastium sp.	–	numerous
Silene sp.	–	numerous
Polygonum ex gr. *aviculare* L.	–	numerous
P. ex sect. *aviculare*	–	numerous
Rumex hydrolapathum L.	–	numerous
R. acetojella L.	–	numerous
Rorippa sp.	2 seeds	numerous
Urtica dioica L.	–	numerous
Bunias cochlearioides Murr.	–	numerous
Cruciferae gen.	–	numerous
Crambe tatarica L.	–	numerous
Ranunculus sceleratus L.	–	numerous
R. cf. *flammula* L.	–	numerous
R. ex gr. *nemorosus* Dl.	–	numerous
Botrychium sp.	–	numerous
Thalictrum minus L.	–	numerous
Potentilla anserina L.	–	numerous
Potentilla ex gr. *nivea* L.	4 fruits	numerous
P. supina L.	–	numerous
Myriophyllum spicatum L.	–	numerous
M. verticillatum L.	–	numerous
Hippuris vulgaris L.	–	numerous
Stachys cf. *recta* L.	–	numerous
Linaria vulgaris L.	–	numerous
Valeriana officinalis L.	–	numerous
Viburnum opulus L.	–	numerous

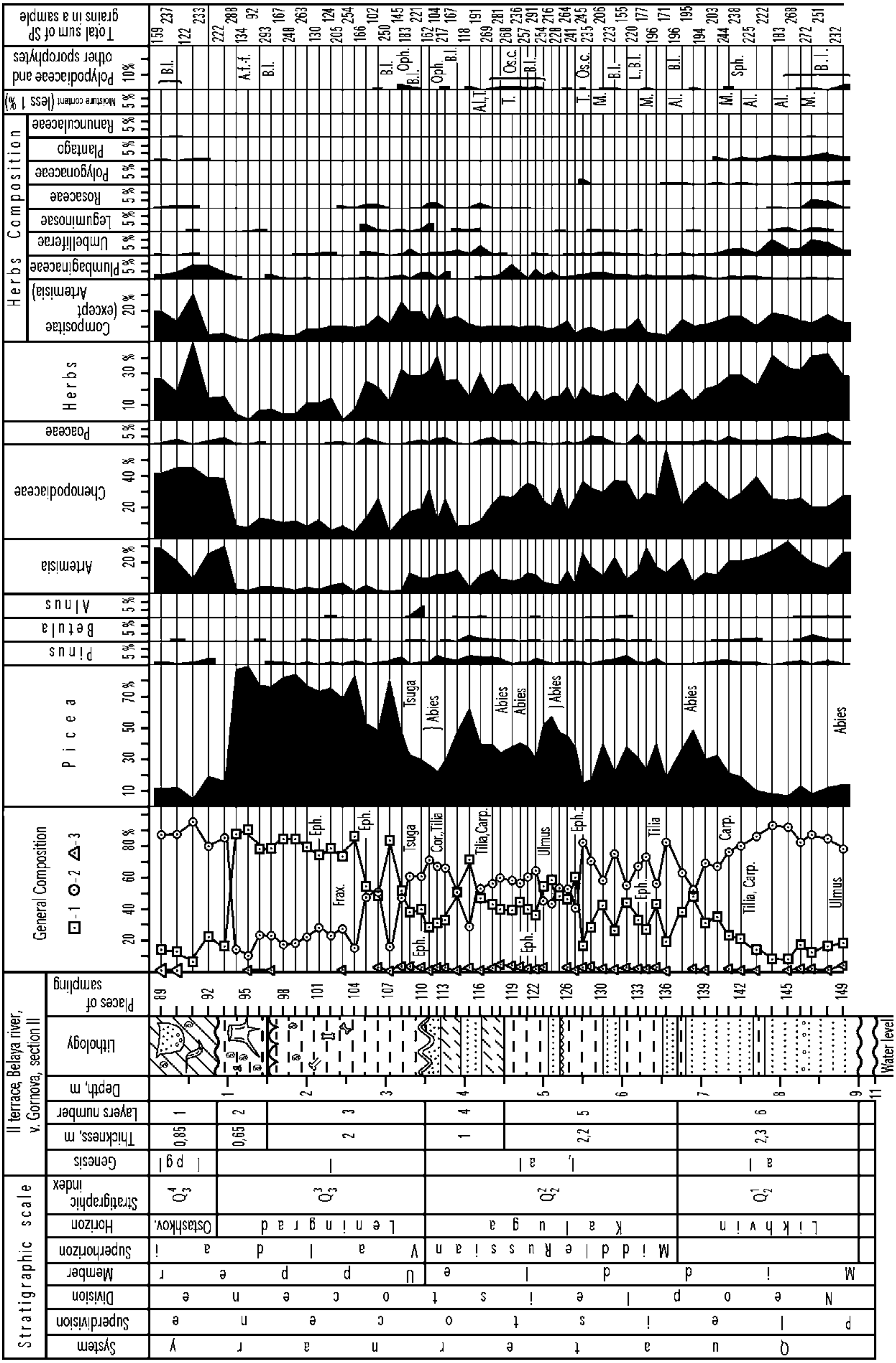


Fig. 6. The section Gornova II and the pollen diagram (by V.L. Yakchemovich, G.A. Danukalova, A.G. Yakovlev, V.K. Nemkova and L.I. Alimbekova).

Legend see Fig. 5

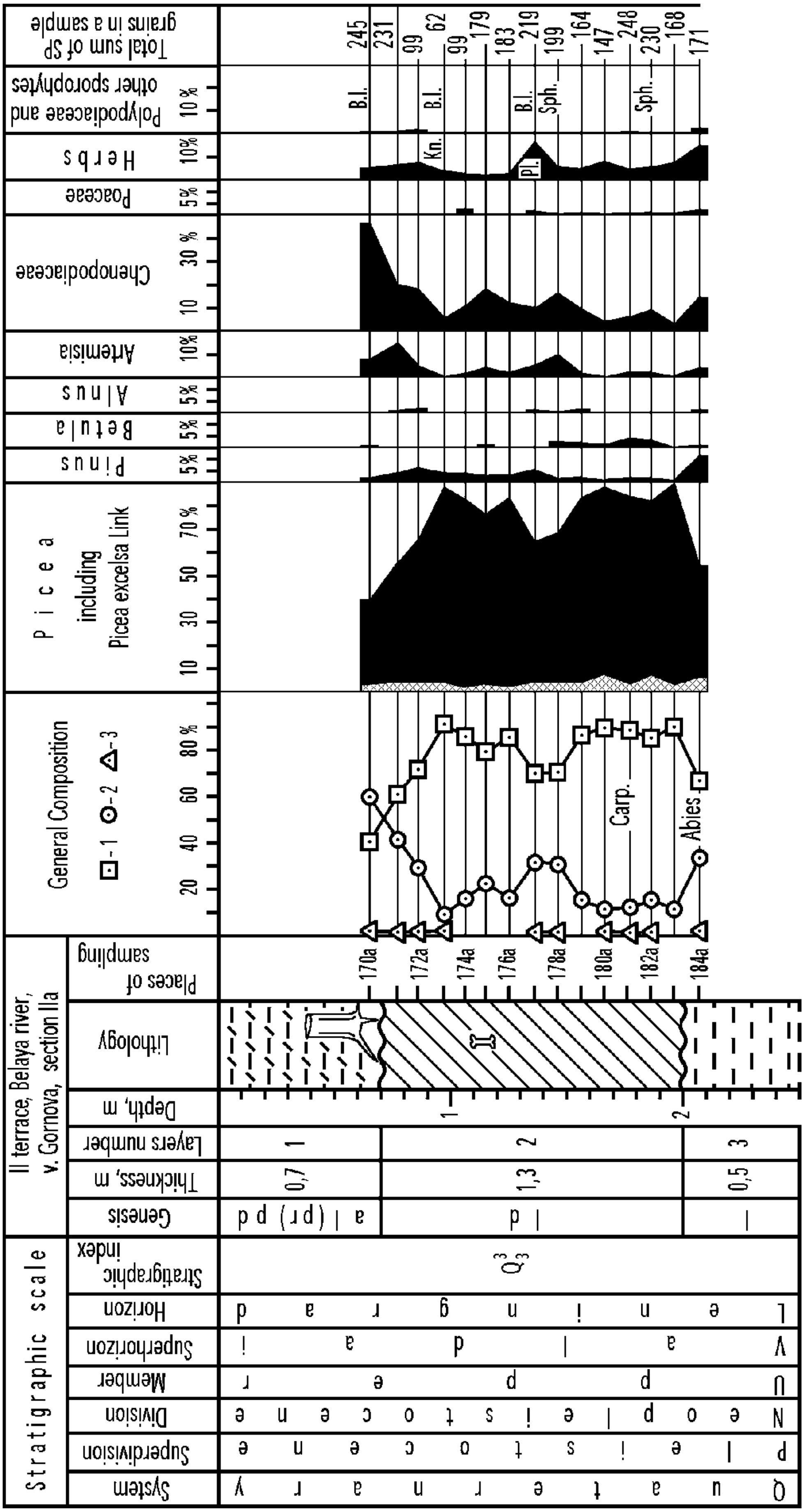


Fig. 7. The section Gornova IIa and the pollen diagram (by A.G. Yakovlev, V.K. Nemkova and L.I. Alimbekova). Legend see Fig. 5

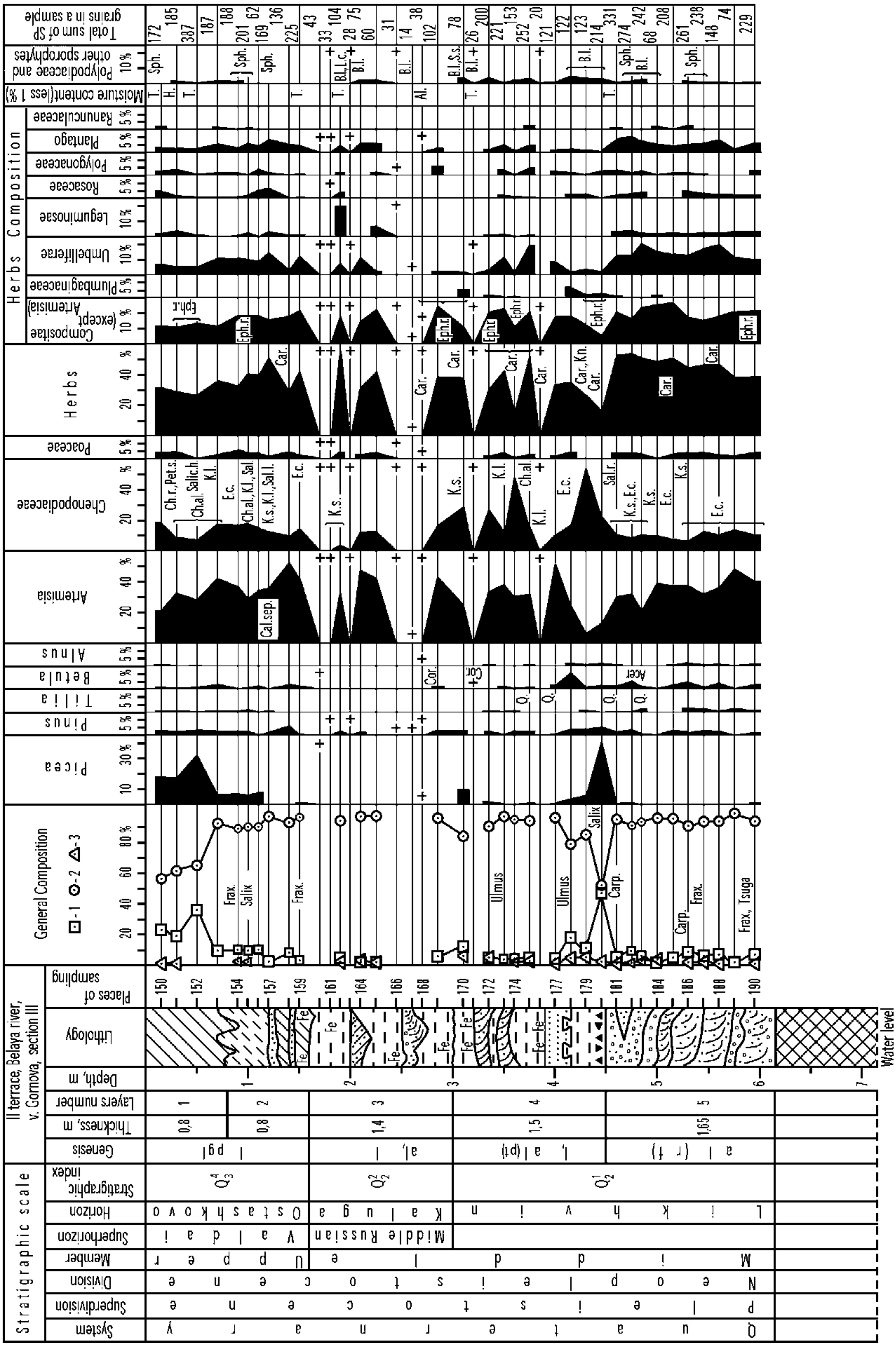


Fig. 8. The section Gornova III and the pollen diagram (by G.A. Danukalova, A.G. Yakovlev, V.K. Nemkova and L.I. Alimbekova). Legend see Fig. 5

Table 4. The stratigraphical distribution of molluscs in the Gornova sections

Species	Quaternary							
	Pleistocene							
	Neopleistocene							
	Middle link			Upper link				
	Likhvin Horizon			Leningrad Horizon		Ostashkovo Horizon		
Sections	III		II	I	II	I		II
Layers	4	5	6	7	3	5	6	1
Succinea oblonga Drap.	11	2	1	>200	>50	83	9	4
S. pfeifferi Rossm.				>200	>50			
Vallonia costata Müll.	2	1		>150	19	30	5	
V. pulchella Müll.				10				
Vallonia sp.								2
Pupilla muscorum L.	1			>80	6	7		
Zenobiella rubiginosa A.Schm.		1		5				1
Euomphalia strigella Drap.				1				
Limnaea sp.				2				
Stagnicola palustris Müll.	3			>100	28			
Stagnicola sp.		1						
Planorbis planorbis L.	4	3		2	4			
Paraspira spirorbis L.	5	6		>50	>183	1		
Gyraulus laevis Alder.	8	7	1	>50	>200			
Bathyomphalus contortus L.				2				
Viviparus sp.	9							
Valvata pulchella Müll.	4							
V. piscinalis (Müll.) *antiqua* Sow.				2				
Bithynia sp.		1						
Lithoglyphus sp.	3							
Clessiniola julaevi G. Ppv.						6		7
Sphaerium rivicola L.	16	2		1				
S. corneum L.	1	1						
Pisidium amnicum Müll.	9		2	1	1			
P. supinum A.Sch.	9							
Dreissena polymorpha (Pall.)	1		1	1		12	1	10

Legend:

1–10 specimens; 11–20 specimens; 21–30 specimens; 31–50 specimens; > 50 specimens

The species composition of the Ostashkovo and Kaluga complexes is similar. The only differ in the abundance of certain species (Yakchemovich *et al*., 1987).

Insects

Remains of the genus *Agonum* have been collected from the bedded grey loams (section 2a, layer 2). Representatives of this genus (*Agonum moestum*) live near water reservoirs and characteristic for the forest-steppe and the forest zones. Single meso-xerophile species are : *Agonum gracilipes* Pz., *A*. sp. cf. *viricupreum* Gz.. The palaeo-environment during time of deposition resembles open biotopes similar to the modern steppes with herbaceous vegetation in areas near open water.

Species of the genera *Agonum, Patrobus* and *Bembidion* have been collected from the bluish- grey clays (section 2, layer 3): *Agonum ? livens, A. moestum, Agonum* sp. (cf. *versutum*), *Platynus mannerheimi, Patrobus septentrionis, P. assimilis, Bembidion (Ocydromys)* sp. cf. *lunatum, Notaris bimaculatus*. All these species lived near water reservoirs. Forest dwellers are also present in these deposits: *Hylobius sp.* (lives in coniferous forests) and *Pterostichus uralensis* (lives in the southern parts of the forest zone). The palaeoenvironment was similar to the modern conditions in the area.

Table 5. The stratigraphical distribution of the ostracods in Gornova sections

Species	Quaternary								
	Pleistocene								
	Neopleistocene								
	Middle link				Upper link				
Horizons	Likhvin		Kaluga		Leningrad		Ostashkovo		
Sections	II	III	II	III	II a	II	I	II	III
Caspiocypris sp.									1
Ilyocypris bradyi Sars	55	91	117	8	1	3	13		12
I. gibba (Ramd.)						1			
I. decipiens Masi	2	3							
I. cf. *decipiens* Masi		3	1	2					2
I. bella Scharap.									107
I. biplicata (Koch)	1	3	1			10			
I. inerris Kauf.			8	11					4
I. aff. *getica* Kauf.		2	2			2	1		1
I. lichvinensis M. Popova	2	10	2						
Cyclocypris laevis (O. Müll.)	7	7	13						1
C. ovum (Jurine)	1	1	3	1					
C. serena (Koch)			6		4				
C. triangula Neg.			2						
Cypria curvifurcata Klie	1	10	4	1	1		23		6
C. tambovensis Mandel.	1	2	1	1	1	1	1		1
C. longa Neg.	1								
C. aff. *ophtalmica* (Jurine)	2								
Candona candina (O. Müll.)	1	1	12						
C. rawsoni Tres.	1	5		2					
C. neglecta Sars	8	12	7	3	22				11
C. rostrata Br. et Norm.	1	3			2				
C. hartwigi G. Müll.									2
C. rectangulata Alm.									6
C. weltneri Hartw.		1							
C. fabaeformis (Fisch.)									
C. balatonica Daday	2								
Candona juv.	61	276	146	15	16	112	4		204
Eucypris dulcifons Dieb. et Pietr.									3
E. horridus Sars		1							
E. pigra (Fisch.)			21						
Sclerocypris ? clavata (Baird)		2							
Cyprinotus? sp.			1						
Potamocypris sp.	2	7	13	2		1			2
Denticulocythere dorsotuberculata (Neg.)	20	25	12	2		3			14
D. caspiensis (Neg.)	3	3	3						
Limnocythere postconcava (Neg.)	13	12	23						2
L. manjtschensis Neg.		3	2						1
L. falcata Dieb.			1						2
L. sanctipatricii Br. et Rob.		1	5						
L. aff. *habarovensis* M. Popova		2							
Limnocythere sp.									5
Cytherissa lacustris Sars		1	7	1	1	2	12	1	
Cyprideis torosa (Jones)	19	11	5	4	1	1	4		2
Paracyprideis naphtatscholana (Liv.)	2	1				24	109	15	

Legend:

1–5 specimens; 6–15 specimens; 16–30 specimens; > 30 specimens

Large mammals

The *Mammuthus chosaricus* molar indicated the age of the lower bone bed. Bones were found on the surface of the Likhvin alluvium. The fauna from the upper bone bed, collected in 1975, dates to the early stage of the Late Palaeolithic complex. It contained ancient elements: numerous remains of *Bison priscus gigas* and *Camelus* sp. The large mammal fauna collected during archaeological excavations in 1983 was poor; only 2 species, dating to the Late Palaeolithic complex, could be identified (Tabl. 6).

Table 6. The stratigraphical distribution of the large mammals and large mammal remains in the Gornova sections

Species	Quaternary		
	Pleistocene		
	Neopleistocene		
	Middle link	Upper link	
Horizons	Likhvin	Leningrad	
Section	II (beach)	II, II a (1975)	II, II a (1983)
Mammuthus chosaricus Dubrovo	+		
Camelus sp.		1	
Megaloceras giganteus cf. *giganteus* (Blum.).		2	
Alces alces L.		1	
Bos primigenius Boj.		21	
Bison priscus gigas Flor.	+	40	
Bison priscus Boj.			2
Bison priscus mediator Hilzheimer		31	
Bison sp.	+	75	15
Ovis cf. *ammon* L.		1	
Equus cf. *hemionus* Pall.		1	
Equus caballus fossilis	+	11	5
Indeterminable fragments			77
Vertebra			1
Cranium fragments			3
Ulna fragment			1
Extremity fragments			22
Jaw fragment			1
Rib fragments			4
Scapula fragments			2

Small mammals

During the Late Pleistocene glacial phases predominantly “lemming” and “mixed” small mammal faunas occurred in the area of the Eastern European Plain. The Gornova fauna is a specific Southern Fore-Urals forest-steppe fauna that indicates cold climatic conditions; the species composition of the fauna is unique without a modern equivalent. The Late Pleistocene steppe faunas of the Trans-Urals and Western Siberia closely resemble the Gornova fauna (Zazhigin, 1980; Maleeva, 1982) (Tabl. 7).

Table 7. The stratigraphical distribution of the small mammals in the Gornova sections

Species	Quaternary			
	Pleistocene			
	Neopleistocene			
	Middle link	Upper link		
Horizons	Likhvin	Leningrad		
Sections	III	II, II a	II	II a
Sorex sp.			4	
Ochotona sp.		13		4
Spermophilus sp.		1	2	1
Ellobius sp.		2		
Allocricetulus eversmanni		1	2	
Clethrionomys rufocanus		2	1	1
Clethrionomys sp.	1	16		4
Lagurus lagurus		54	3	5
Lagurus sp.	1	100	11	25
Eolagurus luteus		1	1	
Eolagurus sp.	1	1		
Arvicola terrestris		7		
Microtus gregalis		28	4	3
M. oeconomus	1	47	13	4
Microtus sp.	4	141	63	22

Archaeological investigations

Archaeological artefacts came from bluish-grey loams (section II, layer 3) and bedded clayey silts (section II a, layer 2) (Fig. 9). Flint cores and flakes were found in sediments between these layers. Two stone artefacts (a flint flake and a fragment of jasper) are from the bedded clayey silt; bone with marks were found in the upper part of the bluish- grey loams. Most of the bones are cracked badly preserved. The thickness of the bed with the bones is nearly 1 m (section 2, layer 3).

Eight artefacts are known from the locality: three were discovered on the surface of the terrace slope, 5 were found in the deposits of the bone bed. The artefacts are well preserved and are not rounded. They are made of the light-grey flint with brown disseminations, dark-grey flint or dark greyish-green jasper. Bones and artefacts are from the same complex.

The artefacts are characteristic for localities that date to the beginning of the Late Palaeolithic, a period that correlates to the last optimum of the Middle Valdai (32–24 Ma) (Velichko, Ivanova, 1969; Rogachev, Anikovich, 1984).

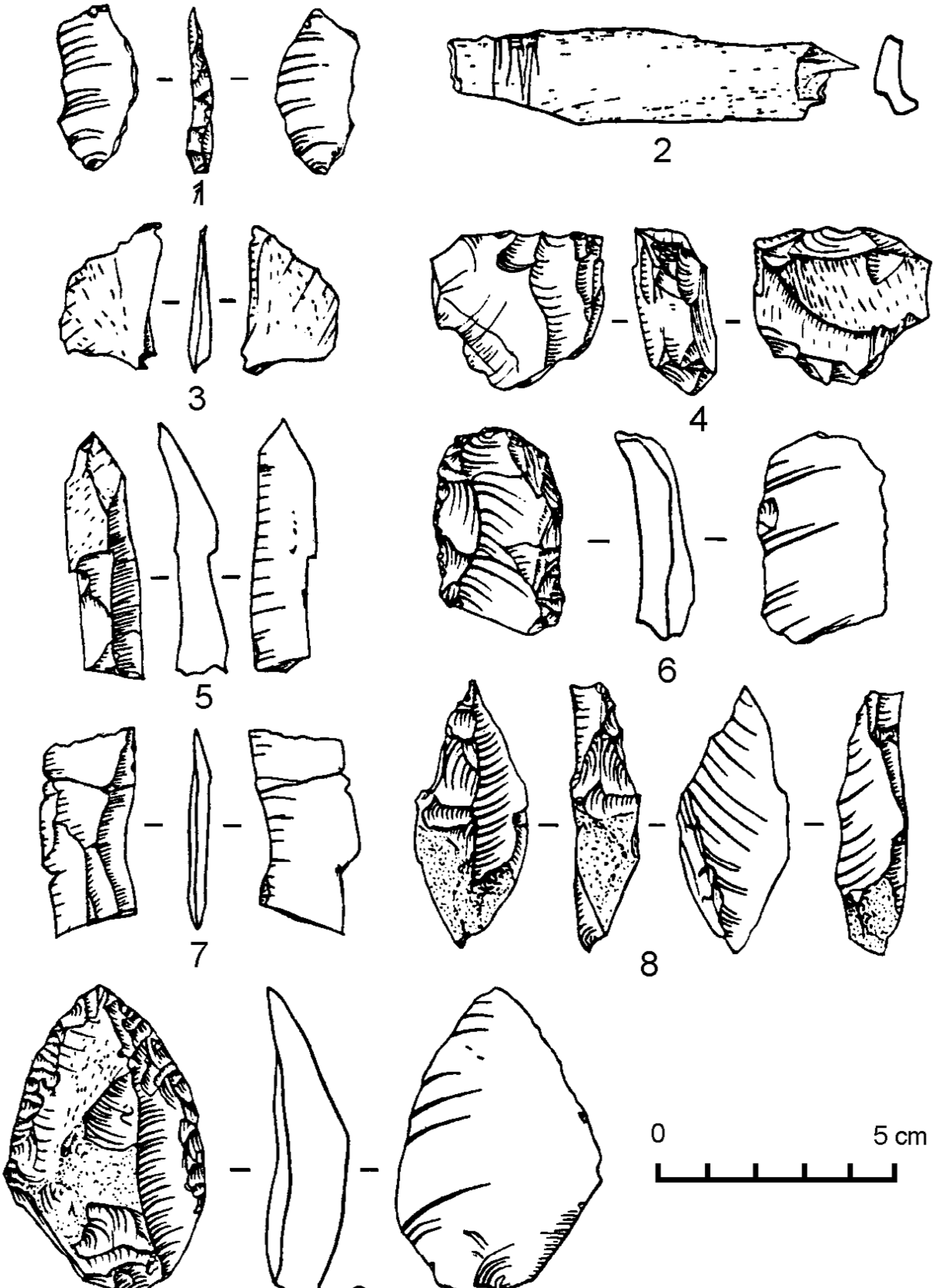


Fig. 9. Flint artefacts from the Gornova sections

1 – dark-grey flint core; 2 – fragment of bone with marks; 3 – jasper fragment; 4 – secondary light-grey flint core; 5 – fragment of the light-grey flint; 6 – scraper on the distal end of the large light-grey flint flake; 7 – fragment of dark-grey flint flake: 8 – middle light-grey flint knife; 9 – spine on the jasper flake.

Palaeomagnetic investigations

Section I (Suleimanova, 1987, 1992; Gleizer, 1983) (Fig. 10).

The Palaeomagnetic samples were taken from the Holocene soil and the Ostashkovo (Kudashevo) loams. The thickness of studied deposits was 16 m. The distance between the samples was 15–20 cm. The quantity of the investigated stratigraphical levels was 63 (F.I.Suleimanova) and 51 (I.V.Gleizer). The Normal remnant magnetization In in the section changed in the interval (5–40)$\cdot 10^{-6}$ Gs; in the soil it was higher than in the Ostashkovo deposits. The sediments were sufficient susceptible.The susceptablility component in the soil formed up to 80% In, in the Ostashkovo deposits – up to 50% In. The samples were examined temporally (F.I.Suleimanova) or temporally and by heating up to 200°C (I.V.Gleizer).

The entire section show a normal polarity and is correlted to the Brunhes Epoch. I. V. Gleizer marked an interval (8 stratigraphical levels) of reverse polarity in the periglacial deposits of the terrace; the interval might be the Geteborg Event of the Brunhes Epoch.

Section II (Suleimanova, 1987, 1992) (Fig. 11).

Pleistocene deposits from Likhvin to Ostashkovo Horizon present in the section. The total thickness of the studied deposits is 10 m. Sampling was detailed, the distance between the samples 15–20 cm. 60 stratigraphical levels were investigated. Value of In changed in the wide interval (2–40)$\cdot 10^{-6}$ Gs, because of changes in the lithological composition in the sequence.

The sections show a normal polarity and is correlated with the Brunhes Epoch.

Section III. Information from F. I. Suleimanova (Yakchemovich *et al*., 1987; Suleimanova, 1992) (Fig. 12).

The total thickness of deposits was nearly 5,5 m. Likhvin, Kaluga and Ostashkovo deposits were investigated. The sampling was detailed; 33 stratigraphical levels were investigated. The Normal remnant magnetization In in the section was uniform and changed in the interval (3–10)$\cdot 10^{-6}$ Gs.

The palaeomagnetic section is correlated to the Brunhes Epoch. F.I.Suleimanova gave part of the palaeomagnetic section with the magnetic anomalies of declination (D°) and inclination (I°) the name “Tukach”. The age of Likhvin deposits is 0,3–0,4 Ma and the “Tukach” magnetic anomaly might be the equivalent of the Biva III Event.

Problems

In the eighties it was assumed that the lacustrine deposits (section II, layer 3) with the bones and the archaeological finds are Middle Neopleistocene in age. This assumption was based on the conclusions drawn by B.S.Kozhamkulova (Yakchemovich *et al*., 1987). She thought that the large mammal fauna of the bone bed (section II, layer 3) belong to the early stage of the Late Palaeolithic complex with Khazar elements: *Bison priscus gigas* and *Camelus* sp.

O.N.Bader assumed that archaeological level dates to the early stage of the Late Palaeolithic (Aurignacian) (Shokurov, Bader, 1960). T.I. Sherbakova assumed a late Mousterian age for the finds locality (32–24 Ka) (Sherbakova, 1984; 1987; Velichko, Ivanova, 1969; Rogachev, Anikovich, 1984). T.T. Sherbakova (1984; 1986) discussed the discrepancy between geological and archaeological data of the bone bed. Archaeological artefacts and bone bed are from the same complex; a complex that is situated under the soil horizon with dates from 21 to 29 Ka.

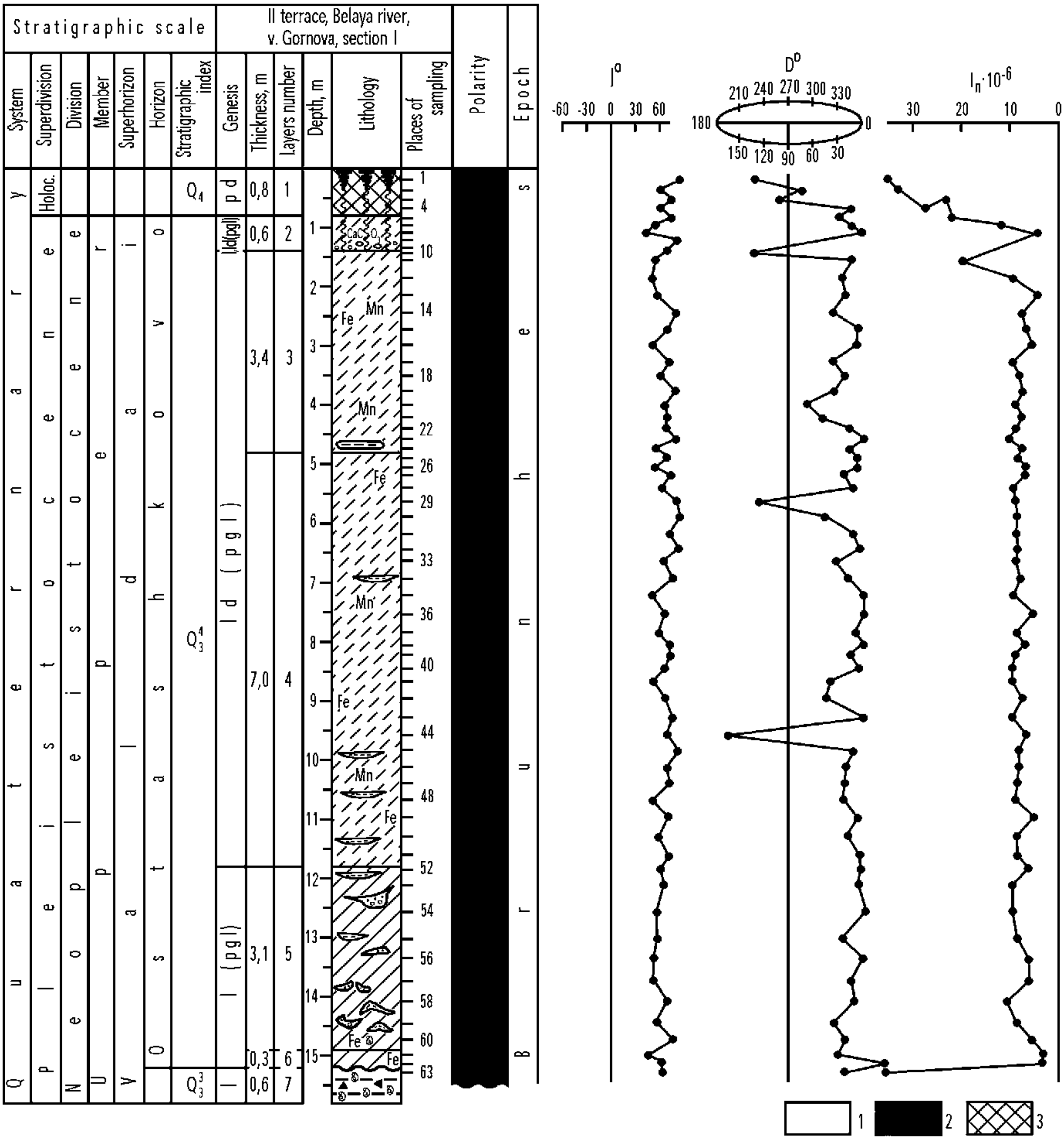


Fig. 10. Gornova, section I. Palaeomagnetic data (by F.I. Suleimanova, V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev, 1987). 1 – reverse palaeomagnetic polarity; 2 – normal palaeomagnetic polarity; 3 – anomaly palaeomagnetic polarity.

In 1996 radiocarbon data were obtained from the layer with the strumbs (section II, layer 2). The age of the upper part of the layer is 26950±560 y. (LU–3711), of the lower part 26990±150 y. (LU–3712) of the teeth of *Bison sp.* have a radiocarbon date of ≥ 33670 (LU–4153, 1998). Thus, the layer with archaeological finds and bones dates to the middle part of the Leningrad period (Late Neopleistocene).

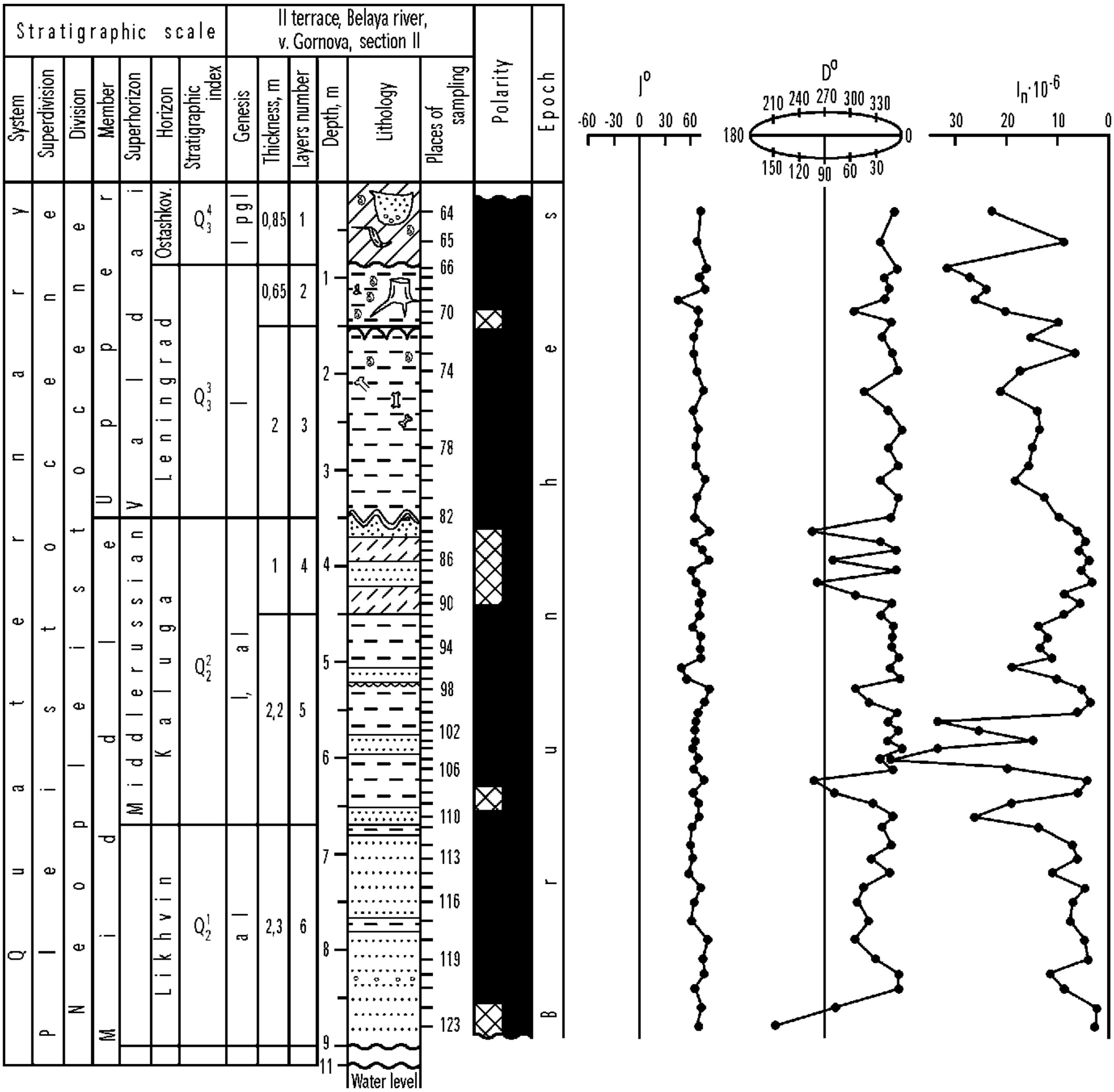


Fig. 11. Gornova, section II. Palaeomagnetic data (by F.I. Suleimanova, V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev, 1987). Legend see Fig. 10.

The greyish-brown bedded clayey silt (section II a, layer 2) was previously dated to the Kalinin stage (Yakchemovich *et al*., 1987). However, now it is clear that layers above (section II, layer 2) and below (section II, layer 3) are of Leningrad age. Thus the time of the deposition of the silt level is the same.

The correlation between the Gornova sections I–III is shown on the Figure 13.

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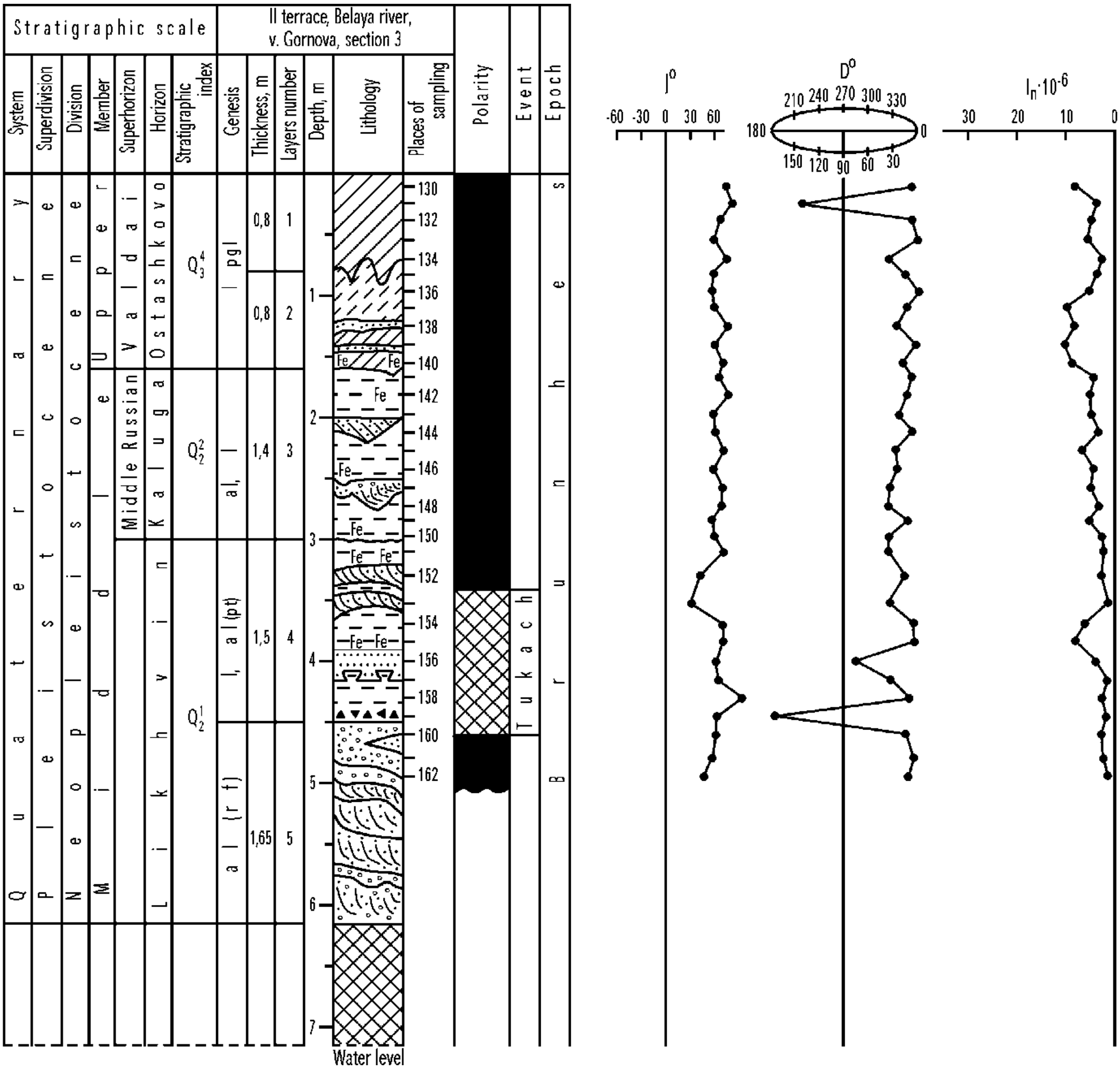

Fig. 12. Gornova, section III. Palaeomagnetic data (by F.I. Suleimanova, V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev, 1987). Legend see Fig. 10.

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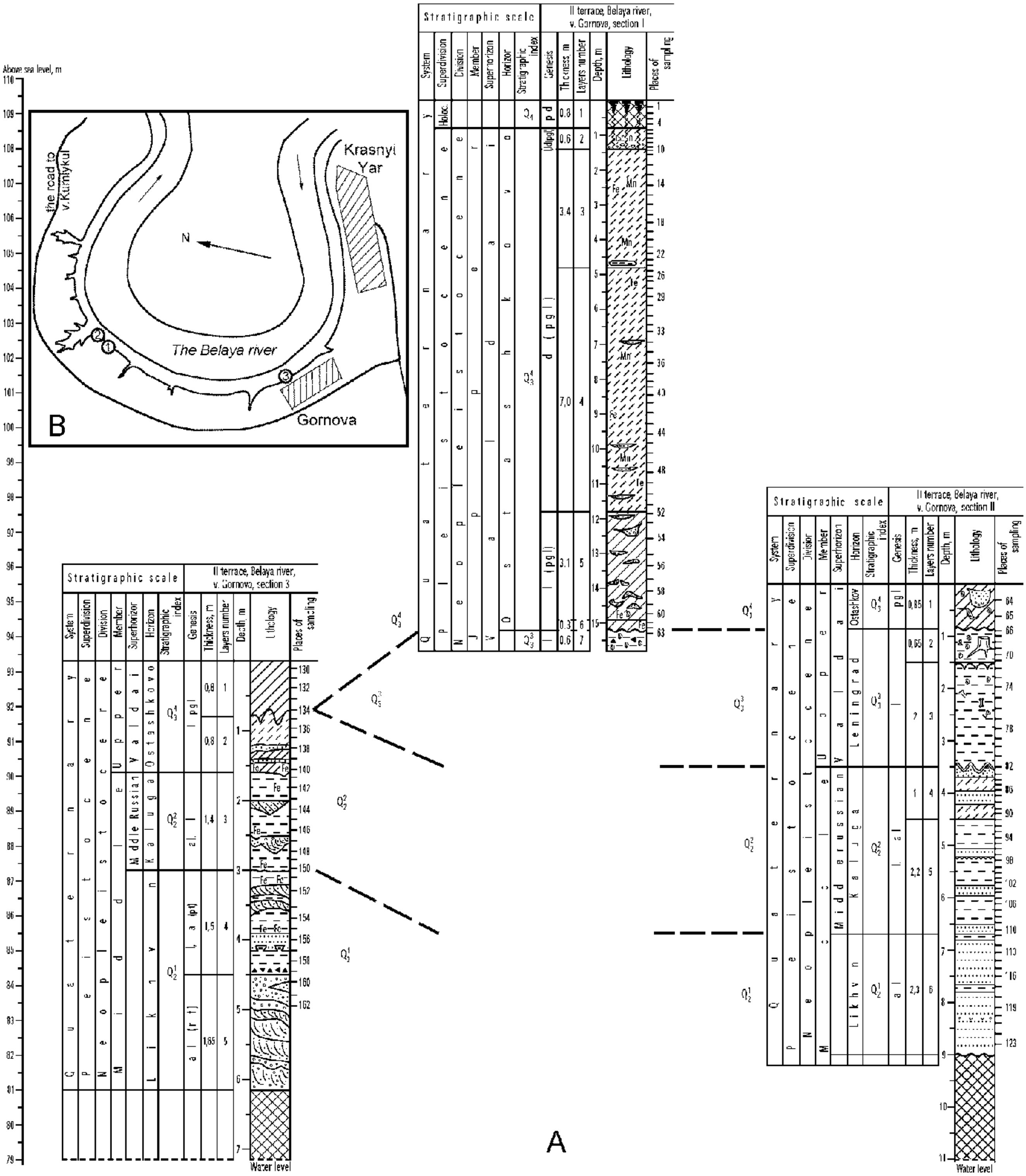

Fig. 13. The correlation between the Gornova sections I–III and a plan with the location of the sections

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THE SYMBUGINO SECTIONS

Location

The sections are located in the galley formed by the creek Batkan (a tributary of the river Karmasan, in the river Belaya Bassin) near the village Symbugino (Blagovar Region; Bashkortostan Republic) (Fig. 1).

History

In 1945 M.S. Fairuzov discovered the exposure of “post-Pliocene” brown loams and brownish-grey sands with gravel and pebbles. The thickness of the observed deposits was 5 m.

In 1968–1969, during the geological mapping A.V. Sydnev described a section with Aktschagylian and Apsheronian deposits. He collected molluscs and identified two new species *Crassiana praecrassoides* and *Potomida baschkirica* (Sydnev, 1975). A.V. Sydnev also discovered alluvial deposits that are rich in organic remains.

In 1970–75 A.V. Sydnev, V.L. Yakchemovich, I.N. Semenov, P.I. Dorofeev, V.P. Sukhov, A.L. Chepalyga investigated this section and described deposits in detail. Samples for carpological, palynological, microfaunistical, petrographical-mineralogical, palaeomagnetological and engineer-geological investigations were collected (Fig. 14).

In 1974 participants of the Field Symposium, organized by the Volga-Urals Quaternary Comission visited the section.

In 1977 the monograph «Fauna and Flora of Symbugino» (1977) was published.

In 1981 participants of the All-Russian Quaternary Conference visited the section.

In 1981–1983 palaeomagnetologists of the Kazan State University studied deposits of this section (I.V. Gleizer, 1983).

Small mammals have been identified by V.P. Sukhov (Ufa) and A.K. Agadjanjan (Moscow); molluscs by A.V. Sydnev (Ufa), A.L.Chepalyga (Moscow); ostracods by M.G. Popova-Lvova (Ufa), pollens and spores by V.K. Nemkova and L.I. Alimbekova (Ufa), carpological remains by P.I. Dorofeev (St. Petersburg). Palaeomagnetical investigations were done by F.I. Suleimanova (Ufa), I.V. Gleizer (Kazan), petrographical-mineralogical investigations were carried out by E.I. Bezzubova (Ufa), engineer-geological studies by I.B. Rogoza (Ufa).

Description of the sections

The surface of the gully is at 195 m above sea level, the bottom 164 m above sea level. The deposits are described from the top to the base (Fig. 15).

Section I

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

1. Sandy humous soil with a blocky structure and rare limestone rock debris………………………..0,4

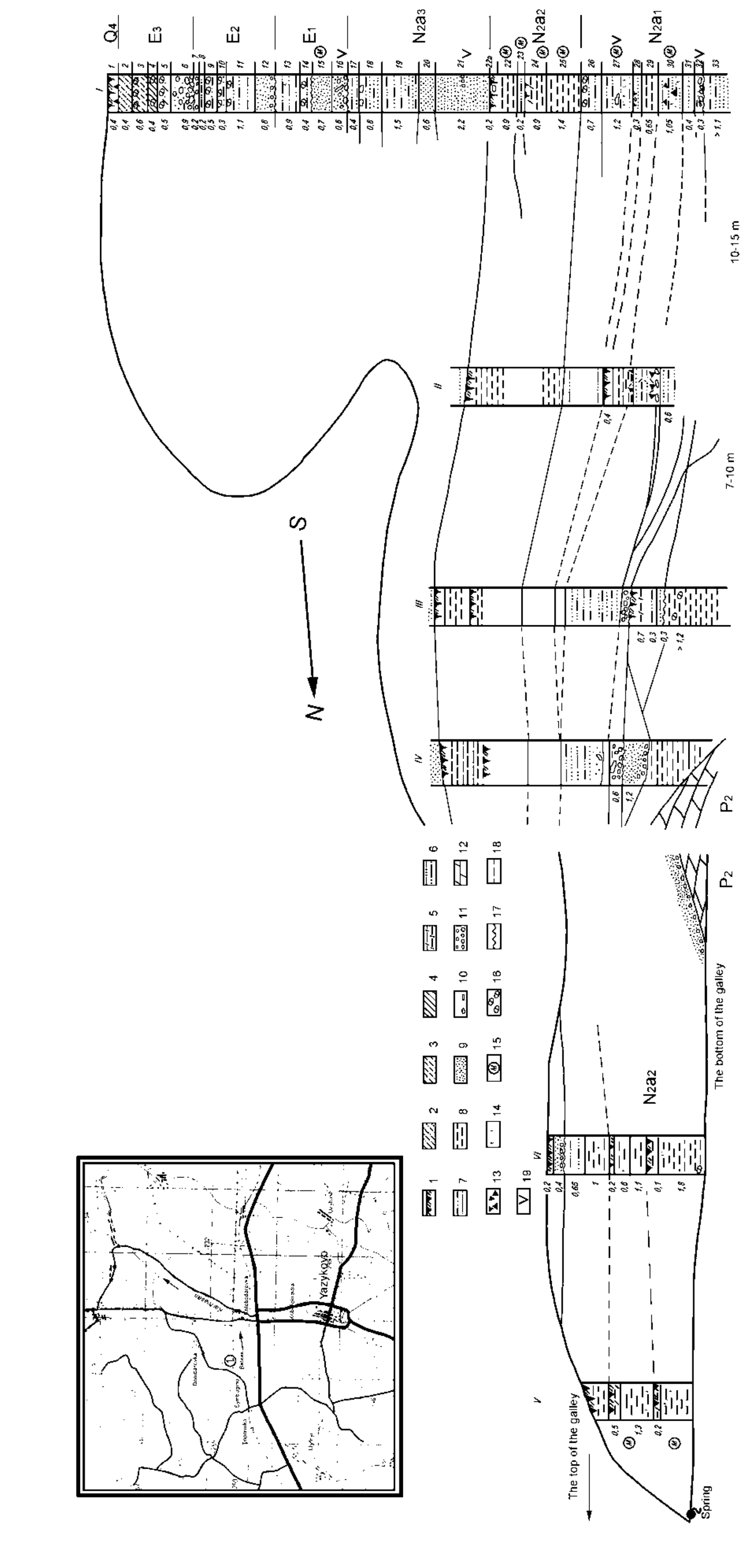


Fig. 14. The map of the territory and the Pliocene and Eopleistocene sections at Symbugino

Legend: 1 – soil; 2–5 – loam; 6 – silt; 7–8 – clay; 9–10 – sands; 11– shingle with sand; 12 – marl; 13 – botanical remains, 14 – molluscs shells; 15 – samples of molluscs shells; 16 – marlaceous concretions; 17 – erosional base/ sedimentary break; 18 – boundary of the layer; 19 – samples of small mammal remains.

Fig. 15. The Pliocene and Eopleistocene deposits at the section Symbugino

Upper Eopleistocene

(lacustrine, alluvial deposits – *l, a*)

l (pgl) 2. Brown loam with a blocky structure and small white carbonate precipitation……………...0,6

l 3. Dark brown loam with white carbonate precipitation. The horizon with unconsolidated carbonate concretions (thickness is 1,5–2 cm, length is 3–10 cm) is located in the upper part of the layer……..0,6

l 4. Dark brown loam with large dense carbonate concretions (thickness is 5 cm, length is 20 cm)….0,4

l 5. Yellowish-brown loam with large carbonate concretions in the upper part of the layer (thickness 10–20 cm, length 18–40 cm)……………………………………………………………………..0,5

a 6. Indistinct laminated gravels of small subangular pebbles and pieces of Permian limestone, sandston and flints and with a matrix of yellowish-brown fine sand……………………………………………0,9

Erosional base/Sedimentary break

Middle Eopleistocene

(lacustrine, alluvial deposits – *l, a*)

l (pgl) 7. Gravel with small subangular pieces of light marl (diameter is nearly 3–4 mm) and with yellowish-brown clayey sand…………………………………………………………………….0,2

l 8. Yellowish-brown silty clay……………………………………………………………………..0,2

l 9. Yellowish-brown clayey silt with thin (thickness is 1–2 cm) interlayers of reddish-brown clay. The horizon of dense marlaceous concretions (thickness is 5–10 cm, length is 7–20 cm) is located in the upper part of the layer……………………………………………………………………………..0,5

l 10. Silt similar to the silt of the layer 9……………………………………………………………0,3

l 11. Pinkish-brown silt with a horizon of dense marl concretions (thickness is 5 cm, length is 12 cm) located in the upper part of the layer……………………………………………………………..1,1

a (pt, rf) 12. Greyish-brown fine sand with green tint and with thin (thickness is 1–2 cm) horizontally bedded interbeds of pink brown clayey silt. Thin interbeds (thickness is 2–3 cm) of small gravels with a Permian origin are located in the lower part of the layer……………………………………………0,8

Erosional base/Sedimentary break.

Lower Eopleistocene

(lacustrine, alluvial deposits – *l, a*)

l 13. Pink brown siltic clay with iron-staining and sandy interbeds in its upper part…………………0,9

Molluscs: *Radix pereger elongata* Clessin.

Ostracods: *Eucypris famosa* Schneid. (149), *E. horridus* Sars (1173), *Eucypris* sp. (1), *Lymnocythere producta* Jasskevich et Kazmina (315).

Radiolaria: *Cenosphaera* (?) sp.

l 14. Pinkish-brown silt with pockets of greenish-yellow sand. Horizon of marlaceous concretions located in the upper part of the layer, rare pebbles occur in the lower part. The lower boundary is undulated….0,3–0,4

Traces of erosion.

a (pt) 15. Brownish-grey fine thin bedded sands with thin interbeds (thickness is 2–3 mm) of brown silt and coarse sand with small pebbles……………………………………………………………………0,7

a (rf) 16. Gravels with small rounded pebbles of Permian origin and with greyish-brown fine sand. Small mammal remains were found in this layer…………………………………………………...0,6

Neogene

Upper Aktschagyl

(lacustrine, alluvial deposits – *l*, *a*)

l 17. Yellowish-brown horizontally bedded silt with thin (thickness is 1 cm) interbeds of pinkish-brown clay and green silt………………………………………………………………………………0,3–0,4

l 18. Alternation of cross bedded fine sand (thickness is 20–40 cm) and reddish-brown silty clay (thickness is 10–12 cm). A horizon of pink marlaceous concretions occurs in the upper part of the layer (thickness is 3–4 cm)……………………………………………………………………………..0,8

l 19. Pink brown clayey silt with interbeds of greyish-brown fine sand. The thickness of the sandy interbeds is in the upper part of the strata 20 cm, in the lower part 2–5 cm……………………………………..1,5

a (pt) 20. Greyish-brown fine horizontally bedded sands with interbeds of greenish-grey coarse sand in the upper part of the layer and with brown silt (the thickness is 2 mm – 1 cm)……………………0,6

a (pt) 21. Greenish-grey fine iron-stained cross-bedded sands with interbeds of greenish-grey sands in middle part and gravel lenses in the lower part of the layer (the thickness is 30 cm). Small mammal remains were found in this layer…………………………………………………………………2,2

Molluscs: *Pisidium amnicum* Müll. (3), *Helicella* sp, (2), ? *Iphigena* sp. (34), *Stagnicola palustris* Müll. (4), *Planorbis planorbis* L. (1), *Gyraulus laevis* Alder (4), ? *Strobilops costata* Cless. (1), *Bithynia tentaculata* L. (5), *Lithoglyphus acutus* G. Ppv. (2), *Caspia turrita* G. Ppv. (6), *Cerastodema* sp.

Erosional base/Sedimentary break.

Middle Aktschagyl – N_2a_2

(limanian deposits – *lm*)

pd 22a. Traces of the soil formation………………………………………………………………...0,2

lm 22. Dark brown clay with iron-staining and manganese precipitation……………………………..0,9

Ostracods: *Aglaiocypris* aff. *chutcievae* Suzin (4), *Liventalina gracilis* (Liv.) (19), *Ilyocypris bradyi* Sars (1307), *I. gibba* (Ramd.) (5), *Cyclocypris laevis* (O. Müll.) (180), *Cypria candonaeformis* (Schw.) (3), *Candona rostrata* Brady et Norm. (2, 700 larvae), *C. neglecta* Sars (130, 600 larvae), *C. angulata* G. Müll. (4, 16 larvae), *C. convexa* Liv. (4), *C. balatonica* Daday (1), *Eucypris famosa* Schneid. (19), *E. puriformis* Mandel. (6), *E.* aff. *crassa* (O. Müll.) (33), *E. magistrala* Schneid. (37), *Pseudostenocypria asiatica* Schneid (47), *Cypridopsis* aff. *formosa* Schneid. (3), *Zonocypris membranae* Liv. (1), *Leptocythere gubkini* Liv. (4), *Limnocythere tenuireticulata* Suz. (215), *L. scharapovae* Schw. (192), *L. chabarovensis* M. Popova (79), *L. flexa* Neg. (54), *Cyprideis torosa* (Jones) (3042).

lm 23. Yellowish-brown clayey, thin-bedded silt layer with iron-staining and with precipitation of manganese in its lower part…………………………………………………………………………0,2

Ostracods: *Ilyocypris bradyi* Sars (30), *Cyclocypris laevis* (O. Müll.) (2), *Pseudostenocypria asiatica* Schneid. (2), *Limnocythere tenuireticulata* Suz. (4).

Traces of the soil formation.

lm 24. Dark grey clay with a little iron-staining……………………………………………………0,9

lm 25. Brown clay with molluscs *Pisidium amnicum* Müll., *P. personatum* Malm. (1) and *Shaerium* sp. Small carbonate concretions and carbonate precipitation occur near the lower boundary……………1,4

Lower Aktschagyl – N_2a_1

Kumurly Suite

(limanian, lacustrine, alluvial deposits – *lm, l, a*)

lm 26. Light brown iron-stained clayey silt………………………………………………………0,7

Ostracods: *Ilyocypris bradyi* Sars (163), *I. gibba* (Ramd.) (68), *Cypria candonaeformis* (Schw.) (2201), *C. pseudoarma* M. Popova (4), *Eucypris famosa* Schneid. (10), *Caspiocypris* sp. (1), *Dolerocypris* sp. (l), *Limnocythere tenuireticulata* Suz. (21) and *Cyprideis torosa* (Jones) (918).

lm 27. Brown silty clay with thin interbeds (thickness is 3–7 mm) of light yellow silt with molluscs and rare small mammals…………………………………………………………………………...1,2

Molluscs: *Sphaerium rivicola* L., *Pisidium amnicum* (Müll.) (42), ? *Iphigena* sp. (1), *Caspia turrita* G. Ppv. (40) and *Clessiniola julaevi* G. Ppv. (2).

Ostracods: *Ilyocypris bradyi* Sars (95), *I. gibba* (Ramd.) (61), *Cypria candonaeformis* (Schw.) (986), *Cytherissa lacustriformis* M. Popova (47) and *Cyprideis torosa* (Jones) (401).

Traces of the soil formation.

l, a 28. Brown fine iron-stained clayey sands with wood and molluscs……………………………0,3

Molluscs: *Potomida ufensis* Tschepalyga (5), *Unio* sp. (1), *Stagnicola palustris* Müll. (1) and *Clessiniolla julaevi* G. Ppv. (1).

l 29. Greyish-brown clay with molluscs *Pisidium amnicum* Müll. (28), *P. personatum* Malm. (1), *Valvata naticina* Menke (2)…………………………………………………………………………...0,65

a (pt) 30. Greyish-brown clayey silt with lenses of dark grey silt and yellow fine sand. Fragments of wood, mammal bones and molluscs were found…………………………………………………….0,95–1,0

Molluscs: *Ebersininaia neustruevi* (Andrus.) (1), *Potomida baschkirica* Sidnev (16), *P. samarica* (Andr.) (6), *P. ufensis* Tschepalyga (25), *Potomida* sp. (2), *Crassiana praecrassoides* Sidnev (8), *Sphaerium solidum* Norm, (15), *Sph. rivicola* L. (4), *Pisidium annicum* Müll. (5), P. *personatum* Malm. (5), *Pisidium* sp. (1), *Dreissena polymorpha* Pall. var *angustiformis* Koles. (1), *Limnaea stagnalis* L. (18), *Coretus corneus* L. (2), *Planorbis planorbis* L. (2), *P. corneus* L. (5), *Gyraulus laevis* Alder (4), *Bathyomphalus contortus* L. (1), *Valvata piscinalis* Müll. (2), *V. naticina* Menke (1), *Bithynia tentaculata* L. (2), *Clessiniola julaevi concinna* G. Ppv. (15), *Caspia* sp. (1) and *Aktschagylia subcaspia* (Andrus.) (2).

Ostracods: *Cypria candonaeformis* (Schw.) (526) and *Cyprideis torosa* (Jones) (349).

a (pt) 31. Grey fine sand with lenses of gravel and mollusks……………………………………....0,4

Molluscs: *Pisidium amnicum* Müll. (32), *Valvata pulchella* Müll. (1) and *Clessiniola julaevi* G. Ppv. (2).

Ostracods: *Cypria candonaeformis* (Schw.) (20) and *Cyprideis torosa* (Jones) (8).

a (rf) 32. Gravels with small pebbles of Permian origin and with clayey sand and iron-staining. Fragments of wood, bones and shells occurred…………………………………………………………………...0,3

Molluscs: *Potomida ufensis* Tschepalyga (25), *P. baschkirica* Sidnev. (1), *P. andrussovi* G. Ppv. (5), *Crassiana praecrassoides* Sidnev (5), *Unio* aff. *hybrida* V. Bog. (3), *U.* cf. *kujalnicensis* Mand. (1), *Sphaerium capillaceum* Lindh. (3), *Pisidium amnicum* Müll. (82), *P. personatum* Malm. (8l), *Pisidium* sp. (1), *Dreissena polymorpha* Pall. var. *angustiformis* Koles. (4), ? *Jphigena* sp. (8), *Succinea oblonga* Drap. (1), *Vallonia pulchella* Müll. (50), *Vertigo* sp. (20), *Carichium* sp. (11), *Coretus corneus* L. (2), *Planorbis planorbis* L. (1), *Paraspira spirorbus* L. (8), *Gyraulus laevis* Alder (25), *Valvata cristata* Müll. (8), *V. piscinalis* Müll. (8), *Bithynia tentaculata* L. (18). *Lithoglyphus acutus* G. Ppv. (2), *Caspia turrita* G. Ppv. (29), *Glessiniola julaevi* G. Ppv. (18).

Ostracods: *Cypria candonaeformis* (Schw.) (446), *Cyprideis torosa* (Jones) (76).

Erosional base/Sedimentary break.

Karlaman Suite

(limanian deposits – *lm*)

lm 33. Dark grey dense clayey silt with (0,3 m) brown interbeds of yellowish-brown fine sand in its upper part. The observed thickness is…………………………………………………………………1,1

Ostracods: *Ilyocypris bradyi* Sars (144), *I. gibba* (Ramd.) (26), *Cypria canonaeformis* (Schw.) (408), *C. pseudoarma* M. Popova (26), *Cyclocypris laevis* (G. Müll.) (9), *Candona angulata* G. Müll. (3), *C. visenda* Schneid. (1), *C. convexa* Liv. (3), *Eucypris famosa* Schneid. (2), *E.* aff. *crassa* (O. Müll.) (2), *Cyprinotus* sp. (2), *Pseudosienocypria asiatica* Schneid. (4), *P. jachimovitschi* M. Popova (8), *Potamocypris* sp. (2), *Zonocypris membranae* Liv. (6), *Limnocythere tenuireticulata* Suz. (10), *L. chabarovensis* M. Popova (2), *L. scharapovae* Schw. (2), *Cyprideis torosa* (Jones) (1804).

Radiolaria: *Cenosphaera* sp. (2).

Numerous small mammal remaines were found in layers 31–33.

The base of the section.

Section V

Middle Aktschagylian deposits (equal to layers 22–25 of section I) were have been observed in section V, upstream of the section I.

Thickness, m

pd (lm) 22a. Dark grey loam (soil)…………………………………………………………………….0,5

m (lm) 22–23. Greyish-brown bedded loam with iron-staining……………………………………….1,3

Molluscs: *Cerastoderma pseudoedule* (Andrus.) (24), *Clessiniola julaevi* G. Ppv. (11), *Pisidium amnicum* Müll. (4).

pd (lm), m 24. Black clay with brackishwater and freshwater mollusks………………………….0,2–0,3

m 25. Dark brown clay with brackishwater and freshwater molluscs. Observed thickness is………...1,2

In layers 24 and 25 molluscs occurred: *Cerastoderma pseudoedule* (Andrus.) (4), *Micromelania* sp. (5), *Clessiniola julaevi* G. Ppv. (5), *Limnaea stagnalis* L. (5), *Succinea* sp., *Helicella* sp. (2). In 1974 Z. N. Fedkovich determined *Cerastoderma pseudoedule* (Andrus.), *C. vogdti* (Andrus.), *Aktschagylia ossoskovi* Andrus., *Pisidium* sp., *Succinea pfeifferi* Rossm. and *Bathyomphalus contortus* L.

Ostracods: *Ilyocypris bradyi* Sars (10), *Cypria candonaeformis* (Schw.) (1) and *Candona angulata* G. Müll. (1, 16 larvae).

Vegetation

Forest-steppe vegetation dominated during Kimmerian time; herbaceous pollen (in particular pollen of Dipsacaceae) are numerous. The climate was dry and warm.

During Karlaman time coniferous *Pinus-Picea* forests with a diversity of trees species grew in surroundings of Symbugino and in others regions of the Southern Fore-Urals. The forests were composed of Far-Eastern-Asian and Western European species (see the carpological data, Tabl. 8).

The pollen complex of the Kumurly deposits was similar to the Karlaman one; tree pollen dominated. The percentage of taiga species (*Picea, Abies* and *Tsuga*) increased during the first part of the Kumurly period.

The Karlaman and Kumurly vegetation was of the characteristic Late Kinel type of vegetation with Pre-Pliocene relics, Far-Eastern-Asian and Western European species and modern species.

In the Akkulaevo period (Middle Aktschagyl) several vegetation complexes occurred.

During the transition from Zilim-Vasyljevo to Akkulaevo the taiga forest was replaced by steppes. It was time of the onset of the maximal transgression. During the second half of this period (the maximum of the Aktschagylian transgression) when the climate became colder, a *Picea* (*P. excelsa* Link., *P. obovata* Ldb.) forrest dominated; *Pinus* sect. *Eupitys and Abies* sp. were rare, *Tsuga* dissapeared almost. Pollen of *Betula* and *Alnus* are present, single pollen of *Tilia* and *Quercus* were also found.

During Late Aktschagyl time after the retreat of Aktschagylian transgression, steppe vegetation dominated on dry and salinated soils. Coniferous forest grew on the interstream areas and small patches of deciduous forests occurred in the river valleys. The climate was cold.

During the Lower Eopleistocene (Dema and Davlekanovo time) the climate was dry and warm, probably warmer than the modern climate. At the end of this period it became colder. The quantity of trees and grass pollen was about equal. Trees: *Betula, Alnus, Quercus* (*Q. robus* L., *Quercus* sp. indet.), *Ulmus (U. foliacea* Gilib., *U. laevis* Pall.), *Carpinus betulus* L., *Tilia cordata* Mill., *Fraxinus* sp., *Acer* sp. and *Corylus* sp. Grasses: *Artemisia*, herbaceous, Chenopodiaceae, Poaceae.

During the Upper Eopleistocene the climate was dry and became colder at the end. The pollen composition of this time was similar to that of the Lower Eopleistocene (Fig. 16).

Ostracods

The Karlaman ostracod complex consists of widely distributed Pliocene fresh-water species *Cypria candonaeformis, C. pseudoarma, Candona visenda, Zonocypris membranae* ets., and typical Aktschagylian brackish-water species *Limnocythere tenuireticulata* Suz., *L. scharapovae* Schw., *L. chabarovensis* M. Popova, *Eucypris* aff. *crassa* (O. Müller), *Pseudostenocypria asiatica* Schneid., *P. jachimovitschti* M. Popova, *Potamocypris* sp., *Candona angulata* G. Müller, *Eucypris famosa* Schneid., *Candona visenda* Schneid. (Tabl. 9).

The Kumurly ostracod complex is characterised by the presence of *Darvinula stevensoni* (Brady et Roberts.), *Eucypris* aff. *crassa* (O. Müller), numerous *Cypria, Cyprideis, Cytherissa lacustriformis* M. Popova and *Limnocythere tenuireticulata* Suz.

Table. 8. Carpological remains from the Kumurly deposits (Symbugino sections)

Species	Kumurly Suite
1	2
	Layer 30
Salvinia tuberculata Nikit.	2 megaspores
Pinus ex sect. *Strobus* Spach	4 seeds
Pinus sp.	16 seeds
Picea sp.	numerous
Abies sp	numerous
Taxus cf. *baccata* L.	2 seeds
Sparganium minutum Dorof.	16 endocarps
S. cf. *simplex* Huds.	12 endocarps
Sparganium sp. 1	8 endocarps
Sparganium sp. 2	1 endocarp
Potamogeton vaginatus Turcz	1 endocarp
P. pectinatus L.	4 endocarps
P. cf. *acutifolius* Link.	1 endocarp
P. cf. *coloratus* Vahl	2 endocarps
P. cf. *heterophyllus* Schreb	4 endocarps
P. cf. *natans* L.	5 endocarps
Potamogeton sp. 1	2 endocarps
Potamogeton sp.2	1 endocarp
Potamogeton sp. 3	10 endocarps
Potamogeton sp.	18 endocarps
Alisma plantago-aquatica L.	4 fruits, 30 tegmens
Sagittaria sagittifolia L.	14 tegmens
Scirpus cf. *triqueter* L.	many nuts
Scirpus sp.	7 nuts
Cyperus sp.	1 nut
Carex rostrata-pliocenica Nikit.	many nuts
C. flagellata C. et E. M. Reid	2 nuts
C. szaferi Dorof.	16 nuts
Carex sp. 1	2 nuts
Carex sp. 2	1 nut
Carex sp. 3	2 nuts
Carex sp. 4	1 nut
Carex sp. 5	1 nut
Carex sp. 6	1 nut
Carex subgen. *Vignea* (Beauv.) Kirschl.	10 nuts
Lemna sp.	1 seed
Alnus sp.	6 nuts
Corylus sp.	fragment of the nut
Quercus sp.	2 fragments of cupule
Chenopodium hybridum L.	5 seeds
Chenopodium sp.	2 seeds
Morus cf. *alba* L.	2 endocarps
Humulus rotundatus Dorof.	5 endocarps
Urtica sp. 1	4 fruits
Urtica sp. 2	3 fruits
Pilea sp.	1 fruit
Polygonum cf. *persicaria* L.	8 fruits
Hamamelidaceae gen.	1 capsule
Nuphar cf. *tanaitica* Dorof.	2 seeds
Ceratophyllum cf. demersum L	1 fruit

Species	Kumurly Suite
1	2
	Layer 30
Rubus pseudooccidentalis Dorof.	numerous
Potentilla sp. 1	8 fruits
Potentilla sp. 2	4 fruits
Potentilla sp. 3	2 fruits
Potentilla sp. 4	1 fruit
Potentilla sp. 5	17 fruits
Fragaria viridis Duch.	7 fruits
Filipendula cf. *ulmaria* (L.) Maxim.	4 fruits
Euphorbia cf. *palustris* L.	16 seeds
E. cf. *esula* L.	13 seeds
Acer campestrianum Dorof.	7 endocarps
A. bashkiricum Dorof.	8 endocarps
Paliurus cf. *spina-christi* Mill.	1 endocarp
Frangula sp.	1 endocarp
Tilia tomentosella Dorof.	9 fruits
T. uralensis Dorof.	6 fruits
Viola sp. 1	12 seeds
Viola sp. 2	13 seeds
Viola sp. 3	15 seeds
Viola sp. 4	11 seeds
Viola spp.	numerous
Decodon ex gr. *globosus* (E.M.Reid) Nikit.	1 seed
Hippuris sp.	5 fruits
Aralia bashkirica Dorof.	9 endocarps
Eleutherococcus uralensis Dorof.	4 endocarps
Araliaceae gen.	1 endocarp
Sium cf. *latifolium* L.	2 half-fruits
Oenanthe sp.	1 half-fruit
Umbelliferae gen. 1	1 half-fruit
Umbelliferae gen. 2	fragment of fruits
Swida sanguineaeformis Dorof.	Numerous
Swida kineliana (Dorof.) Dorof.	numerous
Naumburgia subthyrsiflora Nikit.	1 seed
Lysimachia sp.	1 seed
Stachys palustris L.	17 fruits
Siderites sp.	7 fruits
Mentha arvensis L.	33 fruits
Origanum sp.	2 fruits
Thymus sp.	1 fruit
Lycopus sp.	7 fruits
Labiatae gen. 1	2 fruits
Labiatae gen. 2	1 fruit
Solanum dulcamara L.	2 seeds
Physalis alkekengi L.	5 seeds
Viburnum lantanoides Dorof.	8 endocarps
Viburnum cf. *opulus* L.	1/5 endocarps
Sambucus pusilla Dorof.	many seeds
S. bashkirica Dorof.	many seeds
S. cf. *nigra* L.	12 seeds
Sambucus cf. *racemose* L.	8 seeds

1	2
Ranunculus trachycarpoides Dorof.	many fruits
R. cf. *pseudobulbosus* Schur	1 fruit
R. cf. *acer L.*	7 fruits
R. cf. *repens* L.	8 fruits
R. ex gr. *sceleratoides* Nikit.	56 fruits
Ranunculus sp. l	3 fruits
Ranunculus sp. 2	1 fruit
Thalictrum cf. *flavum* L.	1 fruit
Th. cf. *foetidum* L.	2 fruits
Thalictrum sp.	2 fruits
Cerasus cf. *avium* (L.) Moench	1 endocarp
Prunus cf. *fruticosa* Pall.	1 endocarp
Padus uralensis Dorof. sp. nov.	15 endocarps

1	2
Weigela bashkirica Dorof.	many seeds
Valeriana cf. *pliocenica* Dorof.	1 fruit
Carduus sp. 1	7 fruits
Carduus sp. 2	8 fruits
Carduus sp. 3	8 fruits
Cirsium sp. 1	5 fruits
Cirsium sp. 2	1 fruit
Cirsium sp. 3	5 fruits
Cirsium sp. 4	1 fruit
Cirsium sp. 5	2 fruits
Senecio sp.	3 fruits
Arctium sp.	2 fruits
Carpolithus rosenkjaeri Hartr	3 fruits

The Middle Aktschagylian complex consists of brackish-water, fresh-water and marine species: *Limnocythere gubkini* Liv., *Cyprideis littoralis* (Brady), *Candona neglecta* Sars, *Limnocythere flexa* Neg., *L. scharapovae* Suz., *L. tenuireticulata* Suz., *L. chabarovensis* M. Popova, *Candona convexa* Liv., *Aglaiocypris* aff. *chutcievae* Suz., *Eucypris puriformis* Mandelst., *E. magistrata* Schneid., *Cypridopsis* aff. *formosa* Schneid.

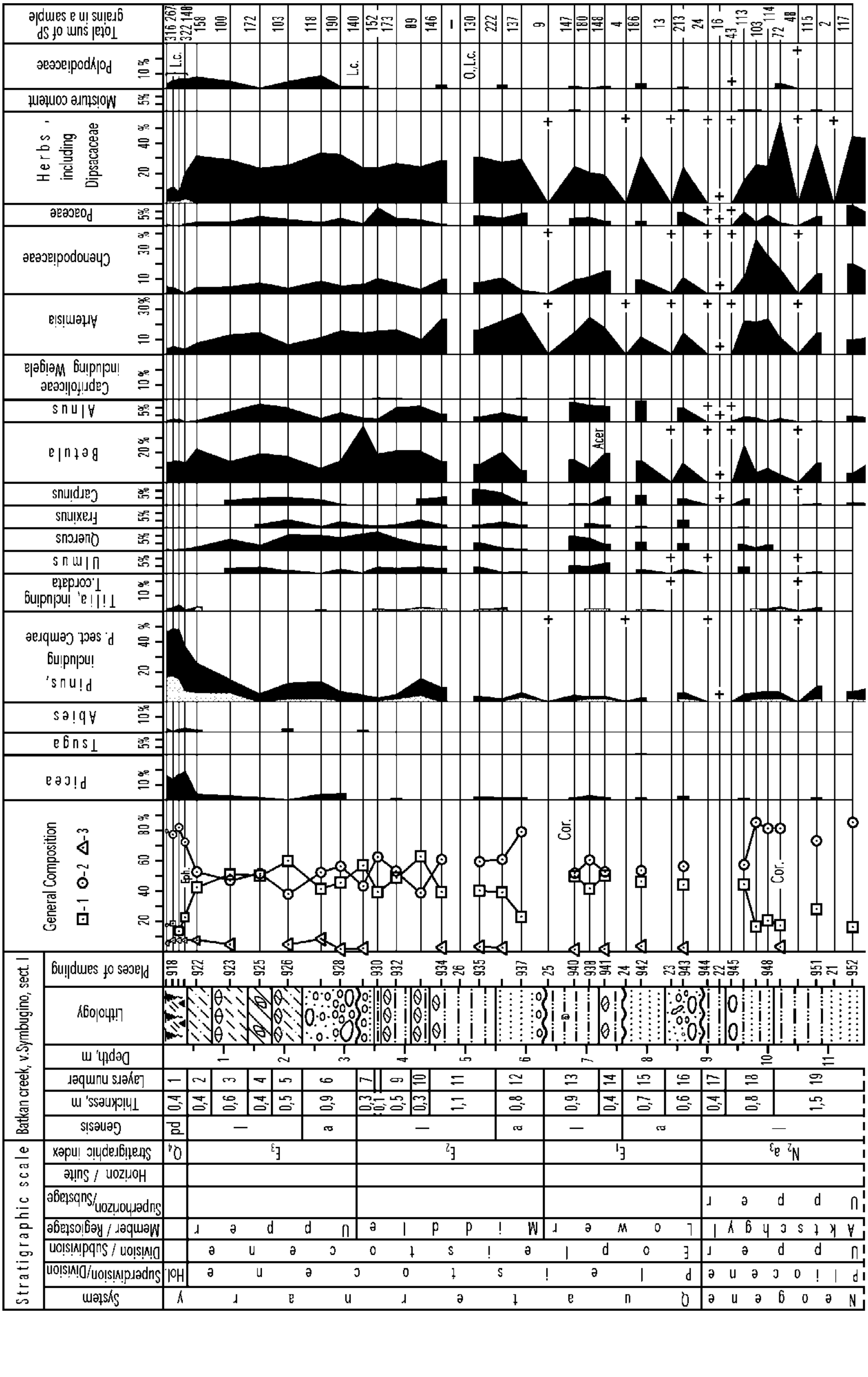
The Lower Eopleistocene complex contains numerous specimens of *Eucypris famosa* Schneid., *E. horridus* Sars and *Limnocythere producta* Jaskevich et Kazmina.

Molluscs

The Lower Aktschagylian mollusc complex (layers 26–33): *Microcondylaea uralica* Tshepalyga (2), *Ebersininaia neustruevi* (Andrus.) (31), *E. sculpta* Tshepalyga (2), *Potamida baschkirica* Sidnev (26), *P. ufensis* Tshepalyga (56), *P. samarica* (Andrus.) (6), *Potomida* sp. (35), *P. andrussovi* G. Ppv. (8), *P. inflata* Tshepalyga (3), *P. karmasanica* Tshepalyga (5), *P. circula* Tshepalyga (16), *P. triangulata* Tshepalyga (15), *P. tumidiformis* Lindh. (2), *Crassiana praecrassoides* Sidnev (9), *Unio* aff. *hybrida* V. Bog. (7), *Unio* cf. *kujalnicensis* Mand. (1), *Anodonta* sp. (1), *Sphaerium rivicola* L. (8), *Sph. solidum* Norm. (15), *Sph. capillaceum* Lindh. (4), *Pisidium amnicum* Müll. (178), *P. personatum* Malm. (96), *Dreissena polymorpha* (Pall.) var. *angustiformis* Koles. (6), *Euconulus fulvus* Müll. (1), *Iphigena* sp. (9), *Succinea putris* L. (14), *S. ob-longa* Drap. (10), *Vallonia costata* Müll. (13), *V. pulchella* Müll. (57), *Vallonia* sp. (16), *Vertigo substriata* Jeff. (14), *Vertigo* sp. (20), *Cochlicopa* sp. (2), *Albinula* sp. (6), *Carychium minimum* Müll. (5), *Carychium* sp. (11), *Limnaea stagnalis* L. (29), *Limnaea* sp. (4), *Stagnicola palustris* Müll. (1), *Planorbarius corneus* L. (20), *Planorbis planorbis* L. (12), *Paraspira spirorbis* L. (8), *Gyraulus laevis* Alder (50), *G. albus* Müll. (42), *Bathyomphalus contortus* L. (1), *Valvata cristata* Müll. (8), *V. naticina* Menke (3), *V. piscinalis* Müll. (10), *Valvata pulchella* Stud. (1), *Strobilops costata* Cless. (1), *Bithynia tentaculata* L. (56), *Lithoglyphus acutus* G. Ppv. (4), *Caspia turrita* G. Ppv. (94) and *Clessiniola julaevi* G. Ppv. (40).

The Middle Aktschagylian complex: *Cerastoderma pseudoedule* (Andrus.) (34), C. *dombra* (Andrus.) (2), *Avimactra subcaspia* (Andrus.) (2), *Micromelania* sp. (10), *Caspia* G. Ppv. (4), *Clessiniola julaevi* G. Ppv. (12), *Pisidium personatum* Malm.(l), *Helicella* sp. (2), *Iphigena* sp. (1), *Limnaea stagnalis* L. (6), *Radix ovata* Drap. (1) and *Valvata piscinalis* Müll. (5). Z. N. Fedkovich (Saratov, 1973) defined next species: *Cerastoderma vogdti* (Andrus.), *Cerastoderma (Replidacna)* sp., *Aktschagylia ossoskovi* Andrus, *Pisidium* sp., *Succinea pfeifferi* Rossm., *Bathyomphalus contortus* L.

The Upper Aktschagylian complex: *Pisidium amnicum* Müll. (3), *Stagnicola palustris* Müll.(4), *Helicella* sp. (2), *Iphigena* sp. (34), *Planorbis planorbis* L. (l), *Gyraulus laevis* Alder (4), *Strobilops costata* Cless. (1), *Bithynia tentaculata* L. (5) and *Lithoglyphus acutus* G. Ppv. (2) (Tabl. 10).


Total sum of SP grains in a sample
Polypodiaceae
Moisture content
Herbs, including Dipsacaceae
Poaceae
Chenopodiaceae
Artemisia
Caprifoliceae including Weigela
Alnus
Betula
Carpinus
Fraxinus
Quercus
Ulmus
Tilia, including T.cordata
Pinus, including P. sect. Cembrae
Abies
Tsuga
Picea
General Composition
Places of sampling
Lithology
Depth, m
Layers number
Thickness, m
Genesis
Batkan creek, v.Symbugino, sect. I
Stratigraphic index
Horizon / Suite
Superhorizon/Substage
Member / Regiostage
Division / Subdivision
Superdivision/Division
System
Stratigraphic scale

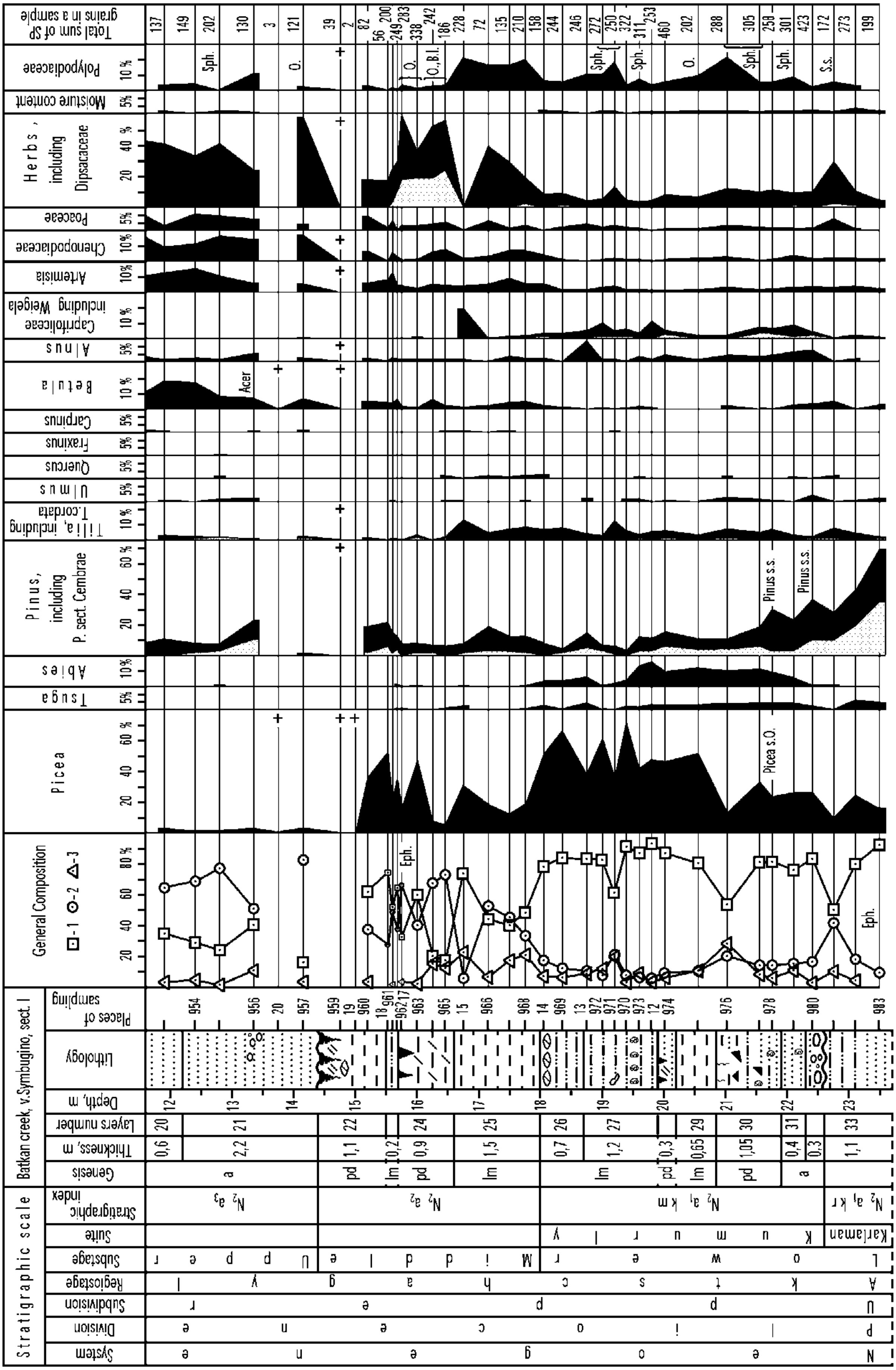


Fig. 16. The section Symbugino and a pollen diagram (by A.V. Sydnev, V.L. Yakchemovich, I.N. Semenov, V.K. Nemkova and L.I. Alimbekova). Legend see Fig. 5.

Table 9. The stratigraphical distribution of the ostracods in the Symbugino sections

Species	Neogene			Quaternary
	Pliocene			Pleistocene
	Aktschagyl			Eopleistocene
	Lower Aktschagyl		Middle Aktschagyl	Lower link
	Karlaman Suite	Kumurly Suite		
Darwinula stevensoni (Br. et Rob.)		1		
Aglaicypris aff. *chutcievae* Suz.			1	21
Liventalina gracilis (Liv.)			1	
Ilyocypris bradyi Sars	439	253	1337	
I. gibba (Ramd.)	26	133	5	
Cyclocypris laevis (O. Müll.)	9		182	
Cypria candonaeformis (Schw.)	592	3177	1005	
C. pseudoarma M. Popova	24	9		
Candona neglecta Sars			1430	
C. neglecta juv.				
C. angulata G. Müll.	3		20	
C. convexa Liv.			4	
C. rostrata Brady et Norm.			2	
C. balatonica Daday			**1**	
C. visenda (Schn.)	1			
Eucypris famosa Schn.	2	12	19	149
E. pusiformis Mandelst.			6	
E. aff. crassa (O. Müll.)	2	1	33	
E. magistrata Schneid.			37	
E. horridus (Sars)				1073
Dolerocypris sp.		1		
Pseudostenocypria asiatica Schneid.	4		49	
P. jachimovitschi M. Popova	8			
Cyprinotus sp.	2			
Cypridopsis aff. *formosa* Schneid.			3	
Potamocypris sp.	2			
Zonocypris membranae Liv.	6		1	
Cytherissa lacustriformis M. Popova		47		
Leptocythere gubkini Liv.			4	
Limnocythere tenuireticulata Suz.	9	23	219	
L. scharapovae Schw.	2		192	
L. flexa Neg.			54	
L. chabarovensis M. Popova	2		79	
L. producta Jaskevich et Kazmina				315
Cyprideis torosa (Jones)	1822	1780	3050	

Legend:

light grey	1–5 specimens
medium grey	6–15 specimens
dark grey	16–30 specimens
black	> 30 specimens

Table 10. The stratigraphical distribution of molluscs in the Symbugino sections

Species	Neogene			
	Pliocene			
	Aktschagyl			
	Lower Aktschagyl		Middle Aktschagyl	Upper Aktschagyl
	Karlaman Suite	Kumurly Suite		
1	2	3	4	5
Succinea oblonga Drap.	9	1		
S. pfeifferi Rossm.			**	
S. putris L.		14		
Vallonia costata Müll.	13			
V. pulchella Müll.		57		
Vallonia sp.	16			
Vertigo substriata Jeff.	14			
Vertigo sp.		20		
Cochlicopa sp.		2		
Albinula sp.	6			
Carychium minimum Müll.	5			
Carychium sp.		11		
Euconulus fulvus Müll.		1		
Helicella sp.			2*	2
?? Iphigena sp.		1		34
??Strobilops costata Cless.				
Limnaea stagnalis L.	11	18	6*	
Limnaea sp.	4			
Radix ovata Drap.			1	
R. pereger Müll.				
Stagnicola palustris Müll.			1	4
Planorbis planorbis L.	10	3		1
Paraspira spirorbis L.		8		
Coretus corneus L.	12	4		
Gyraulus laevis Alder.	21	29		4
G. albus Müll.	42			
Bathyomphalus contortus L.		1	**	
Valvata pulchella Müll.		1		
V. cristata Müll.		8		
V. naticina Menke		3		
V. piscinalis Müll.		10	5*	
Bithynia tentaculata L.	38	20		5
Lithoglyphus acutus G. Ppv.	2	2		2
Caspia turrita G. Ppv.		94	4	6
Clessiniola julaevi G. Ppv.		40	22	
Micromeiania sp.			10	
Cerastoderma pseudoedule (Andrus.)			34	
C. vogdti (Andrus.)			**	
C. dombra (Andrus.)			2*	
Aktschagylia subcaspia (Andrus.)			2*	
A. ossoskovi (Andrus.)			**, *	

1	2	3	4	5
Micricondylaea uralica Tshepalyga		2*		
Ebersininaia neustruevi (Andrus.)	6*	25		
E. sculpta Tshepalyga	2*			
Potomida baschkirica Sidnev		26, *		
P. inflata Tshepalyga	3*			
P. agydelica Tshepalyga	15*	8		
P. karmasanica Tshepalyga	5*			
P. circula Tshepalyga	16*			
P. ufensis Tshepalyga	15*	39		
P. samarica (Andrus.)		6*		
Potomida sp.	1	34		
Unio praecrassoides Sidnev		9, *		
U. aff. *hybrida* V. Bog.	4	3		
U. cf. *kujalnicensis* Mand.		1		
Anodonta sp.	1			
Sphaerium rivicola L.		8*		
S. solidum Norm.		15		
S. capillaceum Lindh.	1	3		
Pisidium amnicum Müll.	16	162	4	3
P. personatum Malm.	11	85	1	
Dreissena polymorpha (Pall.) var. *angustiformis* Kolesn.	1	5		

*Species, identified by A. L. Chepalyga (Moscow, 1972).

** Species, identified by Z. N. Fedkovich (Saratov, 1973).

Legend:

[light grey]	1–10 specimens	[grey]	11–20 specimens	[dark grey]	21–30 specimens	[very dark grey]	31–50 specimens	[black]	> 50 specimens

Mammals

The bone-bearing layer is composed of sands and shingles of the Kumurly suite. The revised faunal list of small mammals includes Insectivora: *Sorex* cf. *runtonensis, Sorex* cf. *minutus, Petenyia* sp., *Beremendia* sp., *Blarinoides mariae, Allosorex* sp., *Talpa* sp., *Desmana* sp., and *Erinaceus* sp., Lagomorpha: *Ochotona* sp. and *Pliolagus brachygnatus*, Rodentia: *Tamias orlovi, Spermophilus* sp., *Trogontherium minus, Castor* sp., *Sinocastor zdanskyi, Apodemus* sp., *Cricetus* sp., *Cricetulus* sp., *Prosiphneus* ex gr. *praetingi, Germanomys trilobodon, Synaptomys (Plioctomys) mimomiformis, Villanyia* ex gr. *exilis, Borsodia* sp., *Promimomys gracilis akkulaewae, Promimomys baschkirica*, and *Mimomys polonicus*. The proportion of lagomorphs in the Simbugino taphocoenosis is 10%. Insectivores and rodents are relatively diverse. However, the evolutionary level of voles is similar to that of voles from the Akkulaevo suite. Their molars also have high tracks, and teeth of *Mimomys* have external cementum. This shows that small mammals from Simbugino are comparable to the faunas from the second half of the Middle Pliocene, such as the Akkulaevo, Uryv–2, and Rebelice Krolewski faunas. However, it is hardly probable that they are synchronous. The Simbugino Fauna dwelt in different, more favourable, palaeogeographical conditions and probably belonged to an earlier phase of the Middle Pliocene (Tabl. 11).

Table 11. The stratigraphical distribution of the small mammals in the Symbugino sections

Species	Upper Pliocene		Quaternary
	Aktschagyl		Pleistocene
	Lower	Upper	Eopleistocene
	Kumurly Suite	Voevodskoye Suite	Lower link
Layers	31, 32	21	16
Mammal's horizons	Lower	Middle	Upper
Insectivora			
Sorex cf. *runtonensis* Hinton	6		
S. cf. *minutus* Linn.	2		
Sorex sp.	3		
Petenyia sp.	4		
Beremendia sp.	2		
Blarinoides mariae Sulimski	12		
Allosorex sp.	11		
Talpa sp.	24		
Desmana sp.	14		
Erinaceus sp.	7		
Lagomorpha			
Ochotona sp.	3		
Pliolagus brachygnatus	334	4	1
Rodentia			
Tamias orlovi Kowalski	8		
Spermophilus sp.	1		
Trogontherium minus Newton	4		
Castor sp.	3		
Sinocastor zdanskyi Joung	2		
Apodemus sp.		1	
Cricetus sp.	1		
Cricetulus sp.	7		
Mimomys gracilis akkulaewae Suchov	104	6	
M. baschkirica Suchov	254		
M. (Mimomys) cf. *coelodus* Kretzoi	57		
Villanyia ex gr. *exilis* Kretzoi	27		
Borsodia sp.	17		
Mimomys polonicus Kowalski	55		
Germanomys trilobodon (Kowalski)		1	
Synaptomys (Plioctomys) mimomiformis Suchov	12		
Lemini gen. ?	10		
Microtidae gen. (rootsdens without cement)	2385	35	8
Microtidae gen. (rootsdens with cement)	369	5	2
Prosiphneus ex gr. *praetingi* Teilhard	32	7	1
Carnivora			
Martes sp.	2		
Artiadactyla			
Cervus ex gr. *elaphus* Linn.	8		

Palaeomagnetic investigations (Suleimanova, 1977; Gleizer, 1983).

The Palaeomagnetic investigations of the Eopleistocene and Pliocene deposits were carried out by F.I. Suleimanova (sampled 47 levels) (Fig. 17) and I.V. Gleizer (sampled 61 levels).

The layers 2–24 show a reversed polarity and are correlated to the Matuyama palaeomagnetic Epoch. The boundary between the Matuyama and the Gauss palaeomagnetic Epochs occurs in the Middle Aktschagyl marine deposits of the layer 25. Deposits of the Lower Aktschagyl (layers 26–31) show a normal polarity and are referred to the Gauss palaeomagnetic Epoch with the two events Mammoth (?) and Kaena (?). F.I. Suleimanova concluded that layers 32–34 should be correlated to the end of the Gilbert Epoch, a period with reverse polarity. The boundary between Gauss and Gilbert must be in the Lower Aktschagyl deposits.

F.I. Suleimanova found two events in that part of the sections that is correlated to the Matuyama palaeomagnetic Epoch. One in the Upper Eopleistocene deposits (Kamikatsura?), the second in the Middle Aktschagyl deposits (Réunion?).

I.V. Gleizer also noted two events in the same part of the section, but the stratigraphical location of the events differs. The first event, correlated to the Jaramillo Event, is located in the Middle Eopleistocene deposits of layer 10 and the second one, correlated to the Olduvai(?) Event, is observed in the Lower Eopleistocene deposits of layer 16.

Problems

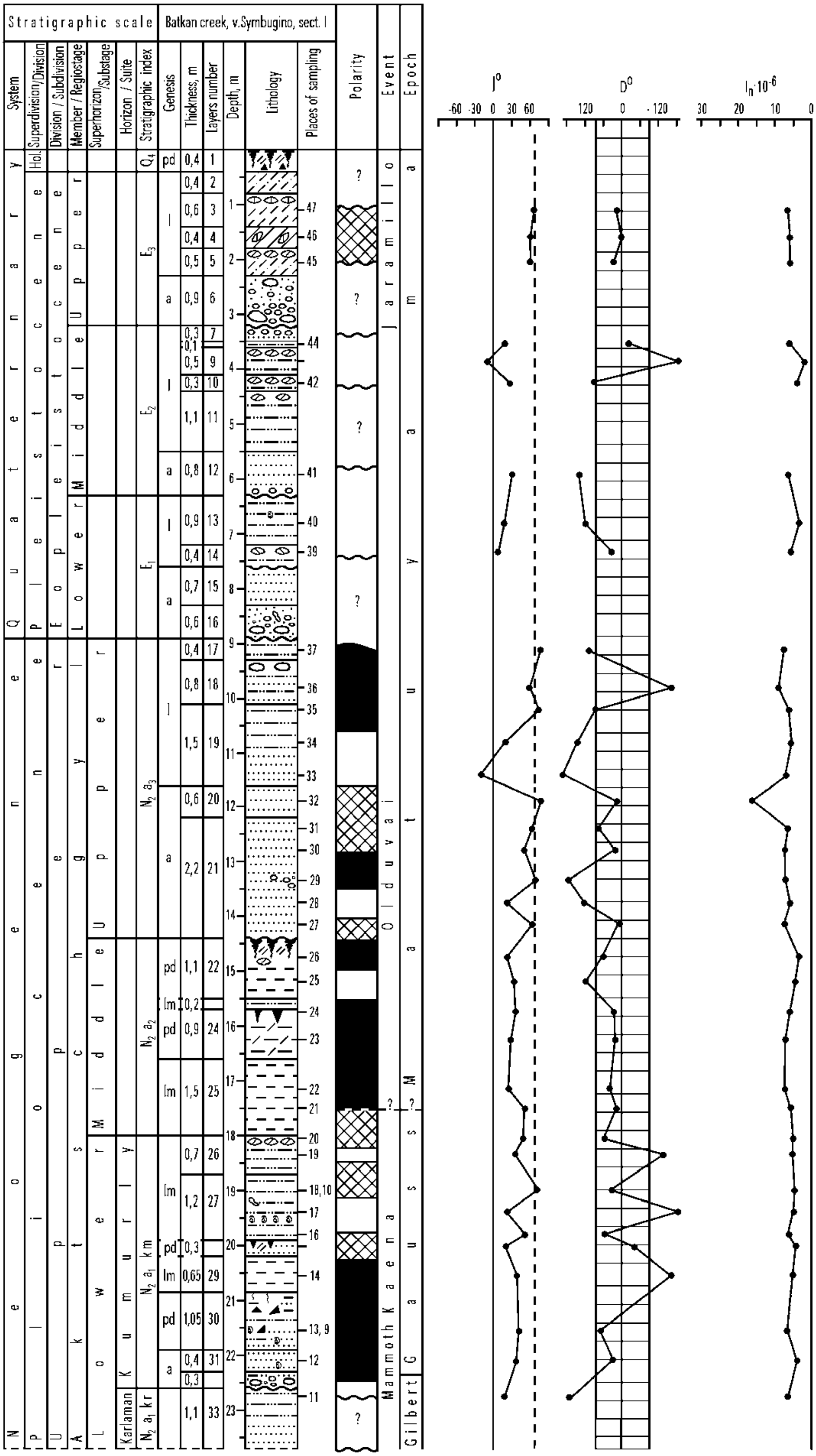
The discrepancies between the data of the two palaeomagnetical studies makes a re-investigation of the Symbugino sections necessary.

References

Yakchemovich, V. L, 1981. Pliocene stratigraphy of the Fore-Urals (in Russian). *In:* Pliocene and Pleistocene of the Volga-Urals region. Nauka (Moscow): 43–52.

Yakchemovich, V. L, Nemkova, V. K., Suleimanova, F. I., Dorofeev, P. I., Popova-Lvova, M. G., Sydnev, A. V., Chepalyga, A. L., Sukhov, V. P., Bezzubova & E. I., Rogoza, I. B., 1977. Fauna and flora of Symbugino (in Russian). Nauka (Moscow): 234 pp.

Fig. 17. The Symbugino section. Palaeomagnetic data (by F. I. Suleimanova and V.L. Yakchemovich, 1977). Legend see Fig. 10.



THE NOVO-SULTANBEKOVO SECTIONS

Location

The sections are located to the east of the village Novo-Sultanbekovo in the valley of the creek Zipanjyaz which falls into the river Kuvash (the river Belaya Basin) (Dyurtyuly Region, Bashkortostan Republic) (Fig. 1).

History

In 1959 D.N. Burakaev described, for the first time, outcrops of Aktschagylian deposits in the Dyurtyuly Region of the Bashkortostan Republic.

In 1960 V.L. Yakchemovich described the exposures of Pliocene deposits in the gully to the east of the village Novo-Sultanbekovo.

In 1965 the description of this section was published in the monograph “The Anthropogene of the Southern Urals” (Yakchemovich, 1965).

In 1975 A.V. Sydnev and E.I. Bezzubova investigated this section and described new outcrops of Pliocene and Eopleistocene deposits (Fig. 18, 19). They also collected molluscs; G.A. Danukalova identified the molluscs collected A.V. Sydnev and V.L. Yakchemovich. The identifications by A.V. Sydnev and G.I. Popov (in 1960) (the originals are lost) are included in table 12 and marked with * & **). Ostracods are identified by M.G. Popova-Lvova.

Description of the sections

The edge of the valley is at 150 m above sea level. The deposits are described from the top to the base.

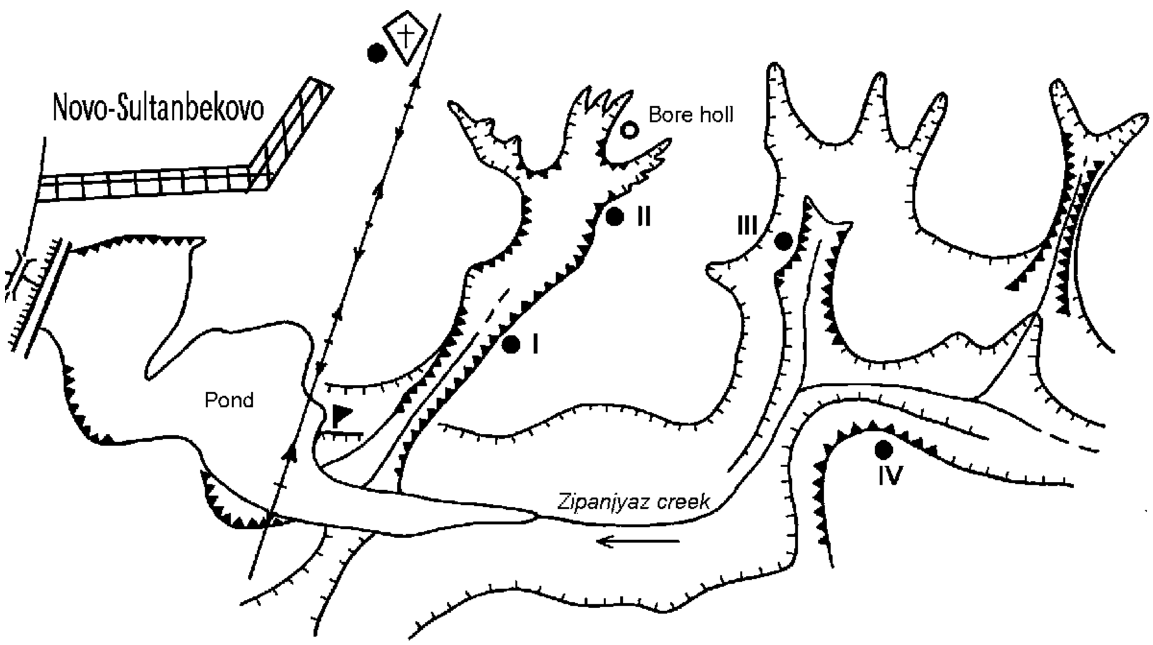


Fig. 18. Location of the sections (I–IV) in the valley of the creek Zipanjyaz near the village Novo-Sultanbekovo

Fig. 19 A, B. The Novo-Sultanbekovo locality

Section I

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

1. Soil (chernozem)……………………………………………………………………………………0,6

Pleistocene

Eopleistocene

(slope deposits, alluvial deposits – *d, a*)

2. Brownish-grey sandy loam with rounded and angulated pebbles and gravel of limestone and flint (diameter is 0,5–5 cm). Numerous pebbles and carbonate concretions occur in the lower part of the layer. The bed located on an erosional surface……………………………………………………………0,7

Erosional surface.

Neogene

Upper (?) Aktschagyl, Voevodskoye Suite

(limanian deposits – *lm*)

3. Yellowish-grey fine polymictic sands with sub rounded pebbles, marls and limestone in the upper part of the layer……………………………………………………………………………………..0,5

Middle Aktschagyl, Akkulaevo Suite

(limanian, marine deposits – *lm, m*)

lm 4. Alternation of reddish-brown clay (thickness is 15 cm) and greenish-yellow coarse-grained polymictic sands (thickness is 20 cm). Molluscs occur in clayey interbeds: *Viviparus* cf. *romaloi* Cob. (1), *Lithoglyphus* sp., *Clessiniola sp.* (5), *Dreissena polymorpha* var. *angustiformis* Kolesn. (2), *Aktschagylia subcaspia* (Andrus.), *Pisidium amnicum* (Müll.) (7) and ostracods: *Ilyocypris bradyi* Sars (2), *Cypria candonaeformis* (Schw.) (50), *Candona fabaeformis* (Fisch.) (1), *Cyprideis torosa* (Jones) (1). Marl concretions (diameter is 5–7 cm) occur in the middle part of this layer………………………………2,7

lm 5. Greenish-yellow fine polymictic bedded sands with small clayey concretions and rare shells of molluscs occur in the upper part of the layer: *Valvata naticina* Menke (1), *Aktschagylia subcaspia* (Andrus.) (2), *Pisidium amnicum* (Müll.) (6)………………………………………………………………….0,7

lm 6. An alternation of reddish-brown clay and greenish-yellow fine polymictic sands with shells of *Caspia turrita* G. Ppv. (1), *Caspiella roseni* G. Ppv. (1), *Clessiniola* sp., *Dreissena polymorpha* (Pall.) (5), *Aktschagylia subcaspia* (Andrus.) and ostracods: *Ilyocypris bradyi* Sars (2), *Cypria candonaeformis* (Schw.) (91), *Paracyprideis naphtatscholana* (Liv.) (3). There are 4 horizons with marl concretions ……….2,5

m 7. Yellow iron-stained (in the upper part of the layer) fine polymictic sands with small clayey concretions and shells of: *Viviparus turritus* V.Bog. (8), *V. achatinoides* Desh. (7+20 juv.), *V. romaloi* Cob. (10*), *Bithynia tentaculata* L. (11), *B. vucatinovici* Brus. (4), *B.* cf. *spoliata* Sabba (3), *Valvata naticina* Menke (1), *V. piscinalis antiqua* Sow. (19), *V. piscinalis* Müll. (3), *Lithoglyphus* cf. *decipiens* Brus. (10), *L.* aff. *naticoides* Fer. (2), *Clessiniola* aff. *utvensis* (Andrus.) (6*), *C. julaevi* G. Ppv. (16), ? *Scalaxis* sp. (1), *Dreissena polymorpha* (Pall.) (5), *D. polymorpha* var. *angustiformis* Kolesn. (21), *D. polymorpha* *incrassata* Andrus. (4*), *Cerastoderma pseudoedule* (Andrus.) (1), *C. dombra* (Andrus.) (9), *Aktschagylia subcaspia* (Andrus.) (13), *A. ossoskovi* (Andrus.) (17), *Unio riphaei* Popov (4*), *U.* aff. *tamanensis* Ebers. (2*), *U.* cf. *neustruevi* Andrus (4*), *U.* cf. *naphtalanicus* Andrus. (4*), *Sphaerium rivicola* L. (10), *Pisidium amnicum* (Müll.) (7) and ostracods: *Ilyocypris bradyi* Sars (3), *Cyclocypris laevis* (O. Müller) (1), *Cypria candonaeformis* (Schw.) (63), *Candona fabaeformis* (Fisch.) (2), *Limnocythere uraliensis* M. Popova (1) and *Cyprideis torosa* (Jones) (1)……………………………………………………………0,7

m 8. Greenish-grey fine polymictic sands with detritus of molluscs: *Dreissena polymorpha* (Pall.) (44), *Aktschagylia* sp. (33)……………………………………………………………………………………..0,5

m 9. Alternation of reddish-brown clay and greenish-yellow, yellow fine polymictic sand. The interbed of yellow sand (thickness is 15 cm) is located in the middle part of this layer. Molluscs present in this layer are: *Viviparus romaloi* Cob. (7*), *V. achatinoides* Desh. (50), *V. turritus* Bog. (1), *V. pseudoachatinoides* Pav. (1*), *V. baschkiricus* G. Ppv. (2), *V. proserpinae* V. Bog. (1*), *Valvata piscinalis antiqua* Sow. (11), *V. naticina* Menke (2), *V. piscinalis* Müll. (2), *Bithynia vucatinovici* Brus. (1), *Lithoglyphus* cf. *decipiens* G. Ppv. (13), *Clessiniola julaevi* G. Ppv. (31), *Dreissena polymorpha* (Pall.) (5), *D. polymorpha* (Pall.) var. *angustiformis* Kolesn. (41), *D. isseli* Andrus. (3), *Aktschagylia subcaspia* (Andrus.) (27), *A. ossoskovi* (Andrus.) (4), *Sphaerium rivicola* Lam. (107), *Pisidium amnicum* Müll. (5), *Unio riphaei* Popov (2*), *U. tertius* V. Bog. (2*), *U. neustruevi geometrica* Andrus. (3*), *U.* cf. *nicolaianus* Brus. (1*), *Unio* sp. (9*)…………………………………………………………………………………………..1

m 10. Gravels with flint, limestone, quartz and sandstone pebbles (diameter is 0,5–3 cm) and greenish-yellow fine polymictic sands. Interbeds of reddish-brown clay occur in the upper part of the layer (thickness is 1–3 cm). Mollusc shells are numerous: *Succinea* sp. (1), *Pupilla mutabilis* Steklov (1*), *Vallonia* sp. (1), *Armiger crista* L. (1), *Planorbis planorbis* L. (4), *Viviparus romaloi* Cob. (120*), *V. turritus* V. Bog. (10), *V. achatinoides* Desh. (4), *V. pseudoachatinoides* Pavl. (5*), *V. baschkiricus* G. Ppv. (3), *V. sinzovi* Pavl. (1*), *V. proserpinae* V. Bog. (8*), *Viviparus* sp. (21), *Bithynia spoliata* Sabba (48), *B.* cf. *vucatinovici* Brus. (14), *B. tentaculata* L. (55), *Valvata piscinalis antiqua* (Sow.) (192), *V. piscinalis* Müll. (50), *V. naticina* Menke (346), *Lithoglyphus* sp. (cf. *decipiens)* (219), *Clessiniola* aff. *utvensis* (Andrus.) (1*), *Clessiniola* sp. (numerous), *Caspia* sp. (numerous), *? Scalaxis* sp. (1), operculum (1), *Dreissena polymorpha* (Pall.) (6), *D. polymorpha* (Pall.) var. *angustiformis* Kolesn. (240), *D. isseli* Andrus. (4), *Cerastoderma pseudoedule* (Andrus.) (5), *C. dombra* (Andrus.) (22), *Aktschagylia subcaspia* (Andrus.) (280), *A. ossoskovi* (Andrus.) (26), *Unio riphaei* Popov (156*), *U.* aff. *andrussovi* Popov (4*), *U.* aff. *hybrida* V. Bog. (1*), *U.* cf. *tertius* V. Bog. (1*), *U. lenticularis* Sabba (13*), *U.* ex gr. *transvolgensis* (2*), *Unio* sp. (12*), *Sphaerium* cf. *rivicola* L. (148), *Pisidium amnicum* Müll. (63), *P. supinum* A.Sch. (1) and ostracods: *Cypria candonaeformis* (Schw.) (16), *Cyprideis torosa* (Jones) (4). Observed thickness is………….3,5

The base of the section.

Section II

The section located in 150 m upstream from the section I on the left bank of the valley (fig. 18, 20). The edge of the valley is at 150 m above sea level.

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

1. Soil (chernozem) with a lumpy structure and roots of plants………………………………………0,5

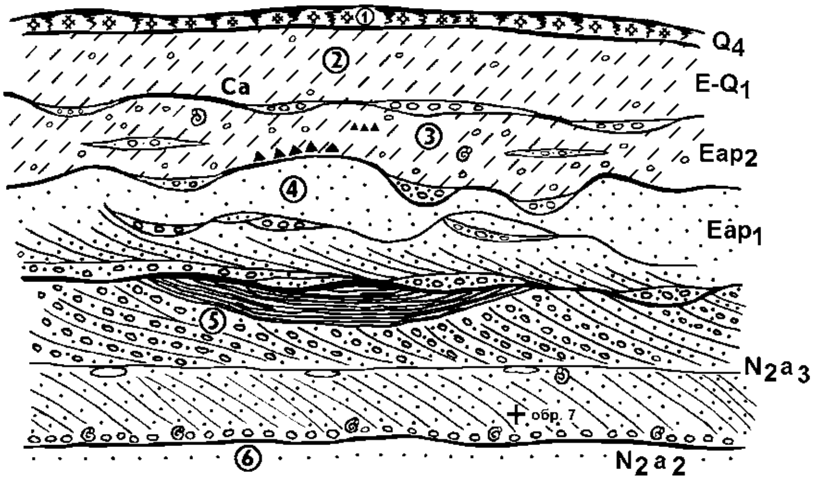


Fig. 20. Fragment of layers of section II near the village Novo-Sultanbekovo

Pleistocene

Eopleistocene – Lower Neopleistocene

(slope deposits – *d*)

2. Brown porous carbon-bearing loam with columnar jointing……………………………………….0,5

Middle (?) Eopleistocene

(slope and surface deposits – *d, el*)

3. Reddish-brown carbon-bearing loam with limestone pebbles and flints (diameter is 0,5–1,5–2 cm), angulated fragments of limestone (5×10 cm) and pebble lenses (10×40 cm). Greenish-brown polymictic poorly sorted sands with flint pebbles located in the base of the layer on the erosional base…………..6

Lower (?) Eopleistocene

(slope-alluvial deposits – *d, a*)

4. Reddish-brown and brown gravels with flint, marl, quartz, limestone and sandstone pebbles with lenses of greenish-yellow coarse and inequigranular sands with shell detritus: *Dreissena* sp., *Valvata* sp., *Caspia* sp. The gravels are cross-bedded (angle is 20°) and with sinuous bedding. Gravels with sands and detritus form the base of the layer…………………………………………………………………………...0,6

Erosional base / Sedimentary break.

Neogene

Upper (?) Aktschagyl, Voevodskoye Suite

(alluvial deposits – *a*)

5. Greenish-grey iron-stained medium grain-sized polymictic cross-bedded sands (angle is 45°) with pebbles and shell cdetritus: *Viviparus pseudoachatinoides* Pavl. (1*), *V. romaloi* Cob. (5*), *Valvata sp., Aktschagylia* sp., *Dreissena polymorpha* (Pall.) (5), *Caspia* sp., *Clessiniola* sp. Detritus, molluscs, flint pebbles (diameter is 2 cm) occur in the lower part of this layer………………………………………0,8

Erosional surface.

Middle Aktschagyl, Akkulaevo Suite

(limanian, alluvial deposits – *lm, a*)

6. Greenish-yellow fine polymictic bedded sands. Two reddish-brown clayey beds (thickness is 2 cm and 0,2 cm) with marl concretions and shells of *Unio* sp., Aktschagylian gastropods occur in the middle part and in the lower part of the layer. Molars of voles were also found…………………………………..1,7

7. Grey fine- and middle grained polymictic sands with a iron-stained upper part…………………...0,3

8. Greenish-yellow iron-stained fine polymictic sands with lenses and interbeds (thickness is 3–5 cm) of reddish-brown clay. Marl concretions and detritus of *Unio* sp., *Potomida* sp.; gastropoda were also found in this layer. The observed thickness is……………………………………………………...2,9

The bottom of the valley.

Section III

The edge of the valley is at 130 m above sea level.

Quaternary

Holocene

(subaerial deposits – *pd*)

1. Soil (chernozem) with a lumpy structure……………………………………………………….0,25

Neogene

Middle Aktschagyl, Akkulaevo Suite

(limanian, alluvial deposits – *lm, a*)

2. Grey sands with flint and limestone pebbles, pockets of reddish-brown clay and flint pebbles in the lower part of the layer………………………………………………………………………………0,7

Erosional base/Sedimentary break.

3. Greenish-yellow fine polymictic sands with pockets and lenses of reddish-brown clay and isolated fragments of molluscs: *Caspia* sp., *Clessiniola* sp…………………………………………………1,7

4. Grey middle-grained polymictic sands (the same as layer 7 of section II). The observed thickness is…0,3

Slope deposits………………………………………………………………………………………3

Section IV

The section is located 200 m to the south of section III on the left bank of the valley (Fig. 18). The edge of the valley is 142 m above sea level.

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

1. Soil (chernozem) with a lumpy structure and roots of plants………………………………………0,3

Pleistocene

Eopleistocene – Lower Neopleistocene

(slope deposits – *d*)

2. Brown porous loam with pebbles of limestone, sandstone and flints……………………………0,6

Lower (?) Eopleistocene

(slope-alluvial deposits – *d, a*)

3. Grey poorly sorted polymictic sands with lenses of numerous pebbles of limestone and flints and with organic detritus. Reddish-brown clay (thickness 0,3 m) located in the lower part of the layer…………1

Neogene

Upper (?) Aktschagyl, Voevodskoye Suite

(alluvial deposits – *a*)

4. Grey polymictic iron-stained medium- and fine grained, cross-bedded sands with thin interbeds of silt and organic detritus……………………………………………………………………………0,7

Middle Aktschagyl, Akkulaevo Suite

(limanian, alluvial deposits – *lm, a*)

5. Greenish-yellow polymictic medium- and fine grained sands with lenses and interbeds of reddish-brown clay and organic detritus: *Valvata* sp., *Aktschagylia* sp., *Dreissena* sp., *Caspia* sp., *Clessiniola* sp……2

6. Alternation of reddish-brown clay with marl concretions and greenish-grey fine polymictic cross-bedded sands……………………………………………………………………………………..1,7

7. Greenish-yellow polymictic fine sands with organic detritus: *Valvata* sp., *Aktschagylia* sp., *Dreissena* sp., *Caspia* sp., *Clessiniola* sp……………………………………………………………………3,2

8. Gravel with pebbles of flint, marl, reddish-brown clay and limestone and a matrix of brown inequigranular sands. Numerous fragments of shells were found: *Unio* sp., *Viviparus* sp., *Valvata* sp. The observed thickness is……………………………………………………………………………..3

The base of the section.

The correlation between the Novo-Sultanbekovo sections is shown on the Figure 21.

Molluscs (Tabl. 12, Plates I–IV)

The Middle Aktschagylian mollusc complex from the marine deposits: *Succinea* sp. (1), *Pupilla mutabilis* Steklov (1), *Vallonia* sp. (1), *Armiger crista* L. (1), *Planorbis planorbis* L. (4), *Viviparus romaloi* Cob. (137*), *V. turritus* V. Bog. (19), V. *achatinoides* Desh. (81), *V. pseudoachatinoides* Pavl. (6*), *V. baschkiricus* G. Ppv. (5), *V. sinzovi* Pavl. (1*), *V. proserpinae* V. Bog. (9*), *Viviparus* sp. (21), *Bithynia spoliata* Sabba (51*), *B.* cf. *vucatinovici* Brus. (19), *B. tentaculata* L. (66), *Valvata piscinalis antiqua* (Sow.) (221), *V. piscinalis* Müll. (55), *V. naticina* Menke (349), *Lithoglyphus* sp. (cf. *decipiens)* (242), *L.* aff. *naticoides* Fer. (2), *Clessiniola* aff. *utvensis* (Andrus.) (7*), *C. julaevi* G. Ppv. (47), *Clessiniola* sp. (numerous), *Caspia* sp. (numerous), ?*Scalaxis* sp. (2), operculum (1), *Dreissena polymorpha* (Pall.) (60), *D. polymorpha* (Pall.) var. *angustiformis* Kolesn. (302), *D. isseli* Andrus. (7*), *D. polymorpha incrassata*

Andrus. (4*), *Cerastoderma pseudoedule* (Andrus.) (6), *C. dombra* (Andrus.) (31), *Aktschagylia subcaspia* (Andrus.) (320), *A. ossoskovi* (Andrus.) (47), *Unio riphaei* Popov (162*), *U.* aff. *andrussovi* Popov (4*), *U.* aff. *hybrida* V. Bog. (1*), *U.* cf. *tertius* V. Bog. (3*), *U. lenticularis* Sabba (13*), *U.* ex gr. *transvolgensis* (2*), *U.* aff. *tamanensis* Ebers. (2*), *U.* cf. *neustruevi* Andrus (4*), *U. neustruevi geometrica* Andrus. (3*), *U.* cf. *naphtalanicus* Andrus. (4*), *U.* cf. *nicolaianus* Brus. (1*), *Unio* sp. (21*), *Sphaerium* cf. *rivicola* L. (265), *Pisidium amnicum* Müll. (75), *P. supinum* A. Schm. (1).

Table 12. The stratigraphical distribution of molluscs in the Novo-Sultanbekovo sections

Species	Neogene			
	Aktschagyl			
	Middle Aktschagyl			Upper Aktschagyl
	Akkulaevo Suite			Voevodskoye Suite
Section	I			II
Layers	10	7–9	4–6	5
1	2	3	4	5
Succinea sp.	1			
Pupilla mutabilis Steklov	1			
Vallonia sp.	1			
? *Scalaxis* sp.	1	1		
Armiger crista L.	1			
Planorbis planorbis L.	4			
Bithynia tentaculata L.	55	11		
B. spoliata Sab.*	48	3		
B. vucatinovici Brus.	14	5		
Valvata piscinalis antiqua Sow.	192	30		
V. piscinalis Müll.	50	5		
V. naticina Menke	346	3	1	
Valvata sp.				x
Lithoglyphus sp. (cf. *decipiens)*	219	23	x	
L. aff. *naticoides* Fer.*		2		
Clessiniola julaevi G. Ppv.	numerous	47		
Cl. aff. *utvensis* (Andrus.)*	1	6		
Clessiniola sp.			5+x	x
Caspia turrita G. Ppv.*, **			1	
Caspia sp.	numerous			x
Caspiella roseni G. Ppv.*			1	
Viviparus baschkiricus G. Ppv.	3	2		
Viviparus romaloi Cob.*	120	17	1	5
V. turritus V. Bog.	10	9		
V. achatinoides Desh.	4	77		
V. pseudoachatinoides Pavl.*	5	1		1
V. sinzovi Pavl.*	1			
V. proserpinae V. Bog.*	8	1		
Viviparus sp.	21			
0perculum	1			
Dreissena polymorpha (Pall.)	6	54	5	5
D. polymorpha (Pall.) var. *angustiformis* Kolesn.	240	62	2	

1	2	3	4	5
D. incrassata Andrus.*		4		
D. isseli Andrus.*, **	4	3		
Cerastoderma pseudoedule (Andrus.)*	5	1		
C. dombra (Andrus.)	22	9		
Aktschagylia subcaspia (Andrus.)	280	60	2+x	
A. ossoskovi (Andrus.)	26	21		
Aktschagylia sp.		33		x
Unio riphaei Popov*	156	6		
U. aff. *andrussovi* Popov*	4			
U. aff. *hybrida* V. Bog.*	1			
U. cf. *tertius* V. Bog.*	1	2		
U. lenticularis Sabba*	13			
U. ex gr. *transvolgensis**	2			
U. cf. *neustruevi* Andrus.*		7		
U. aff. *tamanensis* Ebers.*		2		
U. cf. *naphtalanicus* Andrus.*		4		
U. cf. *nicolaianus* Brus.*		1		
Unio sp.	12	9		
Sphaerium cf. *rivicola* L.	148	117		
Pisidium supinum A. Schm.**	1			
P. amnicum Müll.	63	12	13	

Legend:

light grey	1–10 specimens
grey	11–20 specimens
dark grey	21–30 specimens
very dark grey	31–50 specimens
black	> 50 specimens

The Middle Aktschagylian mollusc complex from limanian deposits: *Caspia turrita* G. Ppv. (1), *Caspiella roseni* G. Ppv. (1*), *Viviparus* cf. *romaloi* Cob. (1), *Lithoglyphus* sp., *Clessiniola* sp. (10), *Valvata naticina* Menke (1), *Aktschagylia subcaspia* (Andrus.) (2), *Dreissena polymorpha* (Pall.), *Dreissena polymorpha* (Pall.) var. *angustiformis Kolesn.* (2), *Pisidium amnicum* (Müll.) (13)

The Upper Aktschagylian mollusc complex from limanian deposits: *Viviparus pseudoachatinoides* Pavl. (1*), *V. romaloi* Cob. (5*), *Valvata* sp., *Caspia* sp., *Clessiniola* sp., *Aktschagylia* sp., *Dreissena polymorpha* (Pall.) (5).

Problems

Pliocene deposits of the Novo-Sultanbekovo sections must be palynologically and palaeomagnetically studied.

References

Danukalova, G. A., 1996. Bivalves and Aktschagylian stratigraphy (in Russian). Nauka (Moscow): 132 pp. (Plate XXII – *Aktschagylia subcapia* Andrus, transitional form from *A. subcaspia* to *A. ossoskovi* Andrus; pp. 51, 54).

Yakchemovich, V. L, 1965. Anthropogene deposits of the Southern Fore-Urals (in Russian). *In*: Anthropogene of the Southern Urals. Nauka (Moscow): 36–53 (description of the section – pp. 26–27).

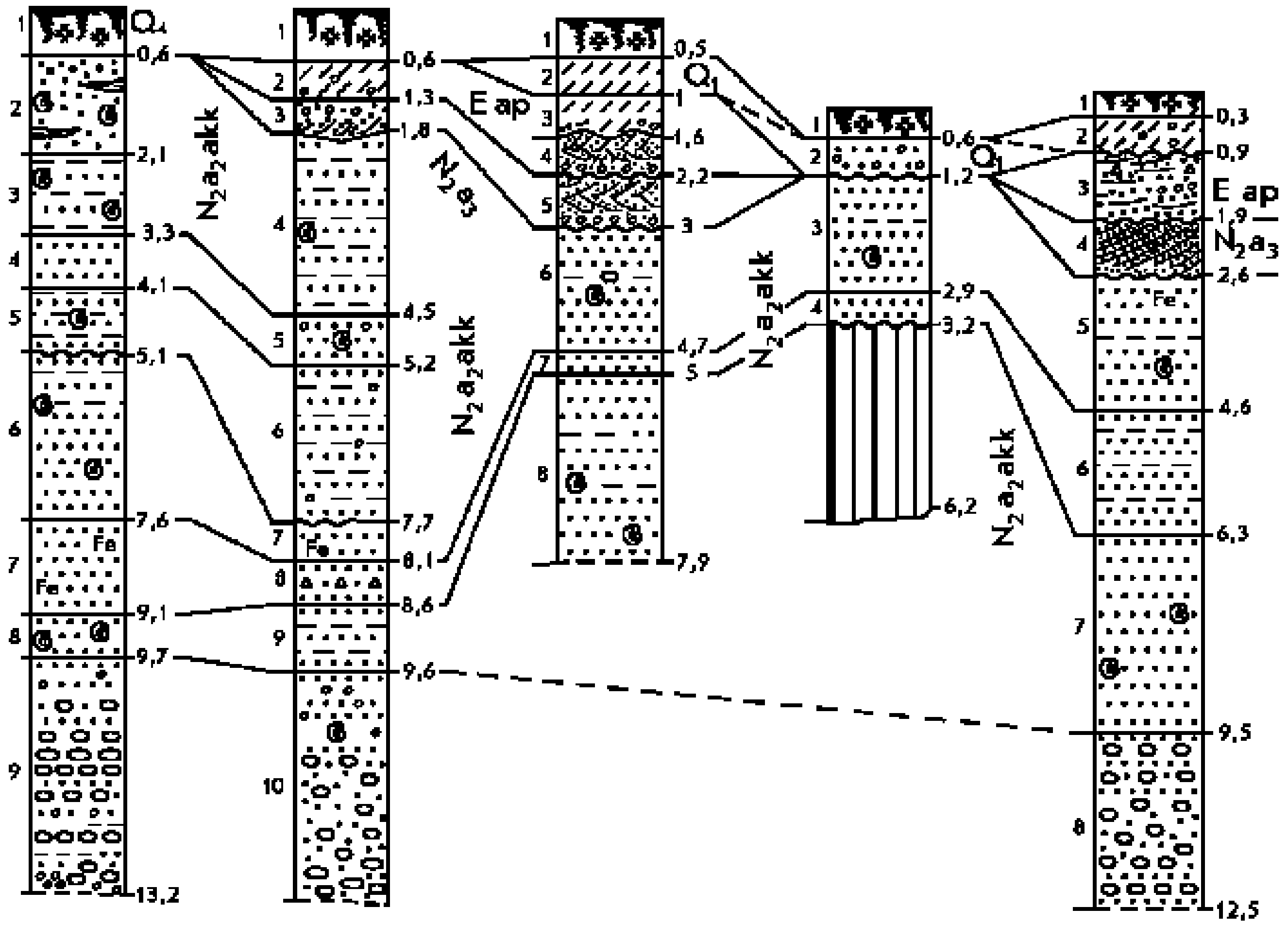


Fig. 21. The correlation between the Pliocene and Quaternary deposits exposed in the sections near Novo-Sultanbekovo

1 – section published by V.L.Yakchemovich, 1965; 2 – section I; 3 – section II; 4 – section III; 5 – section IV

Plate I. Molluscs from the Novo-Sultanbekovo sections

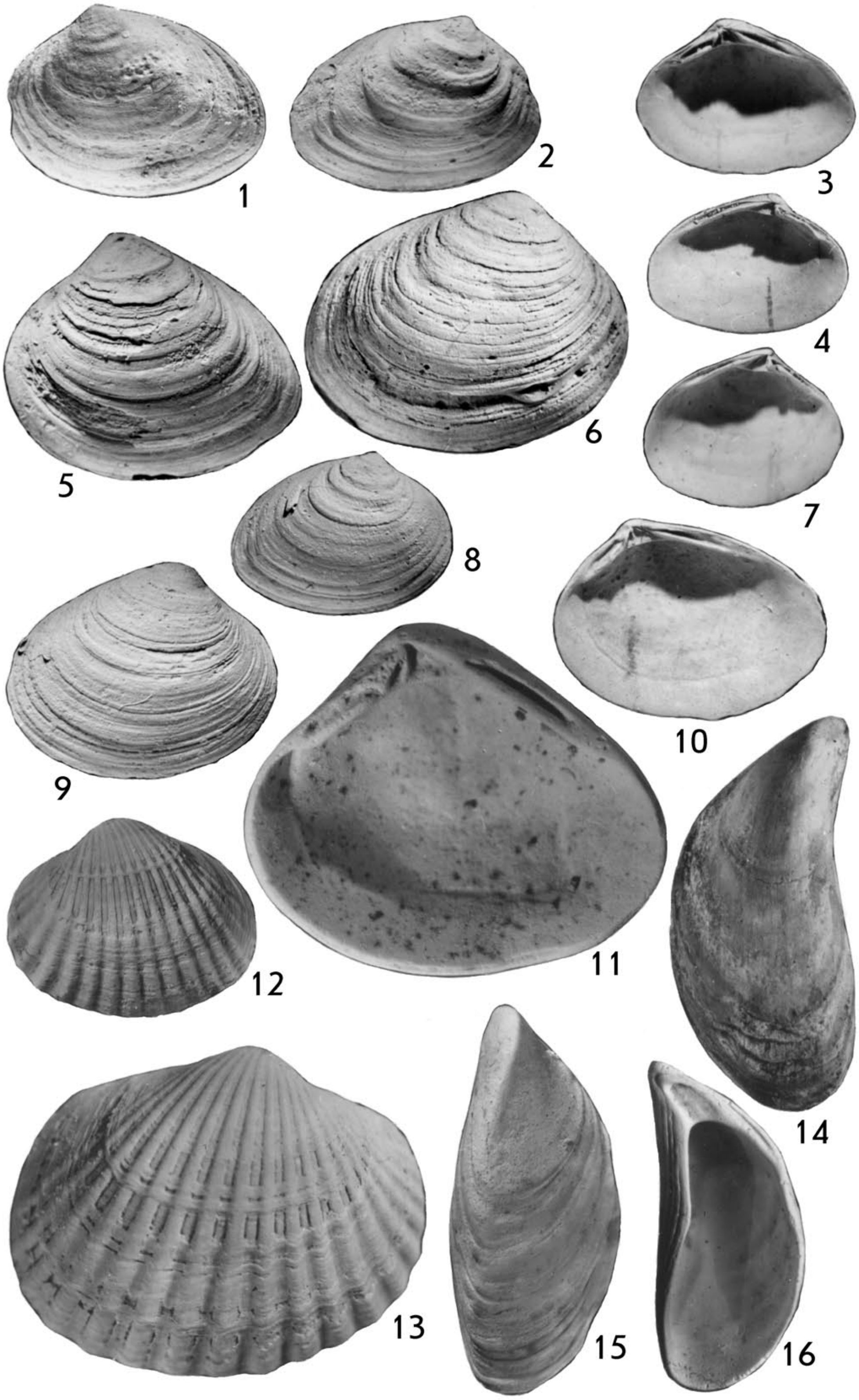


Plate II. Molluscs from the Novo-Sultanbekovo sections

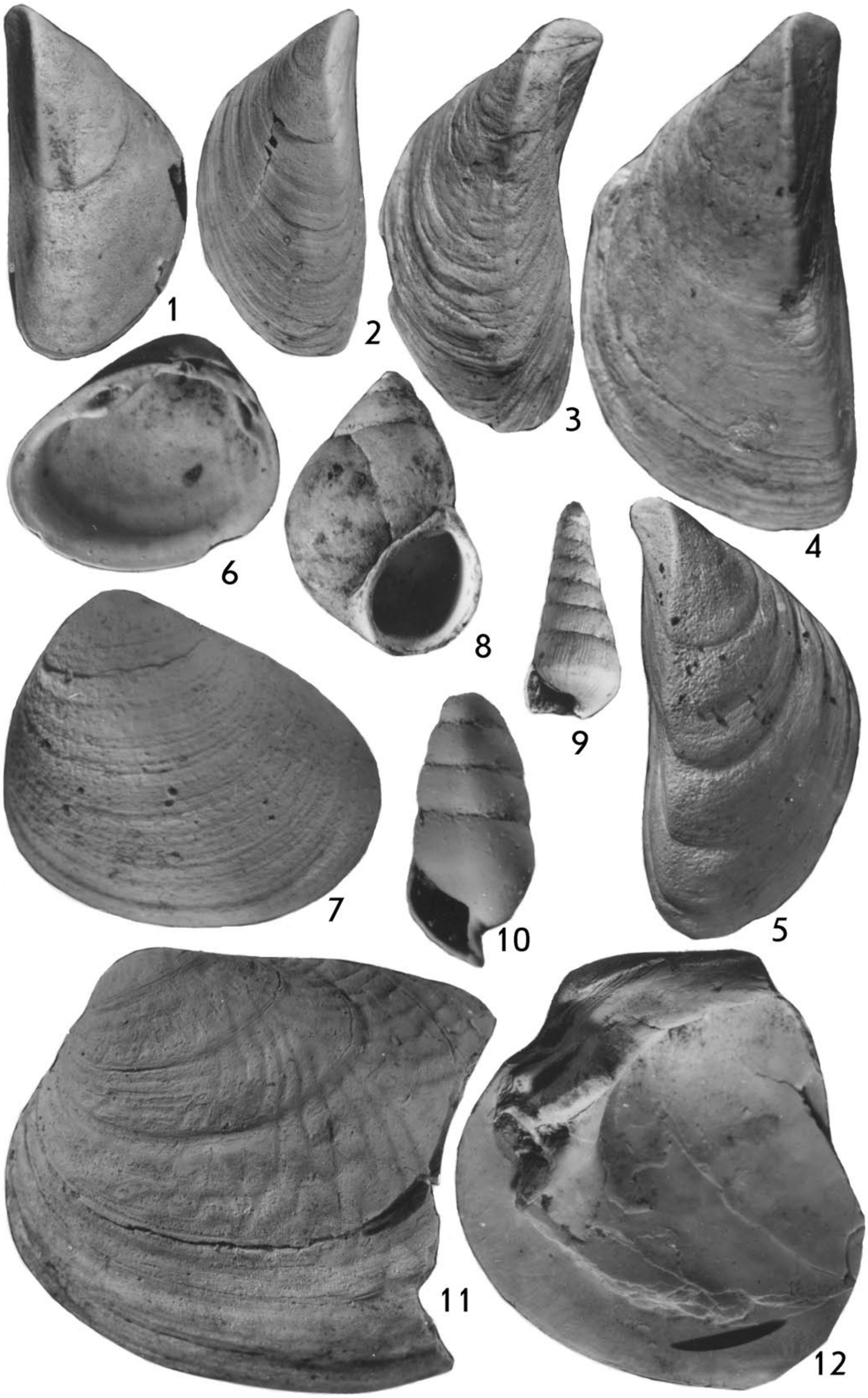


Plate III. Molluscs from the Novo-Sultanbekovo sections

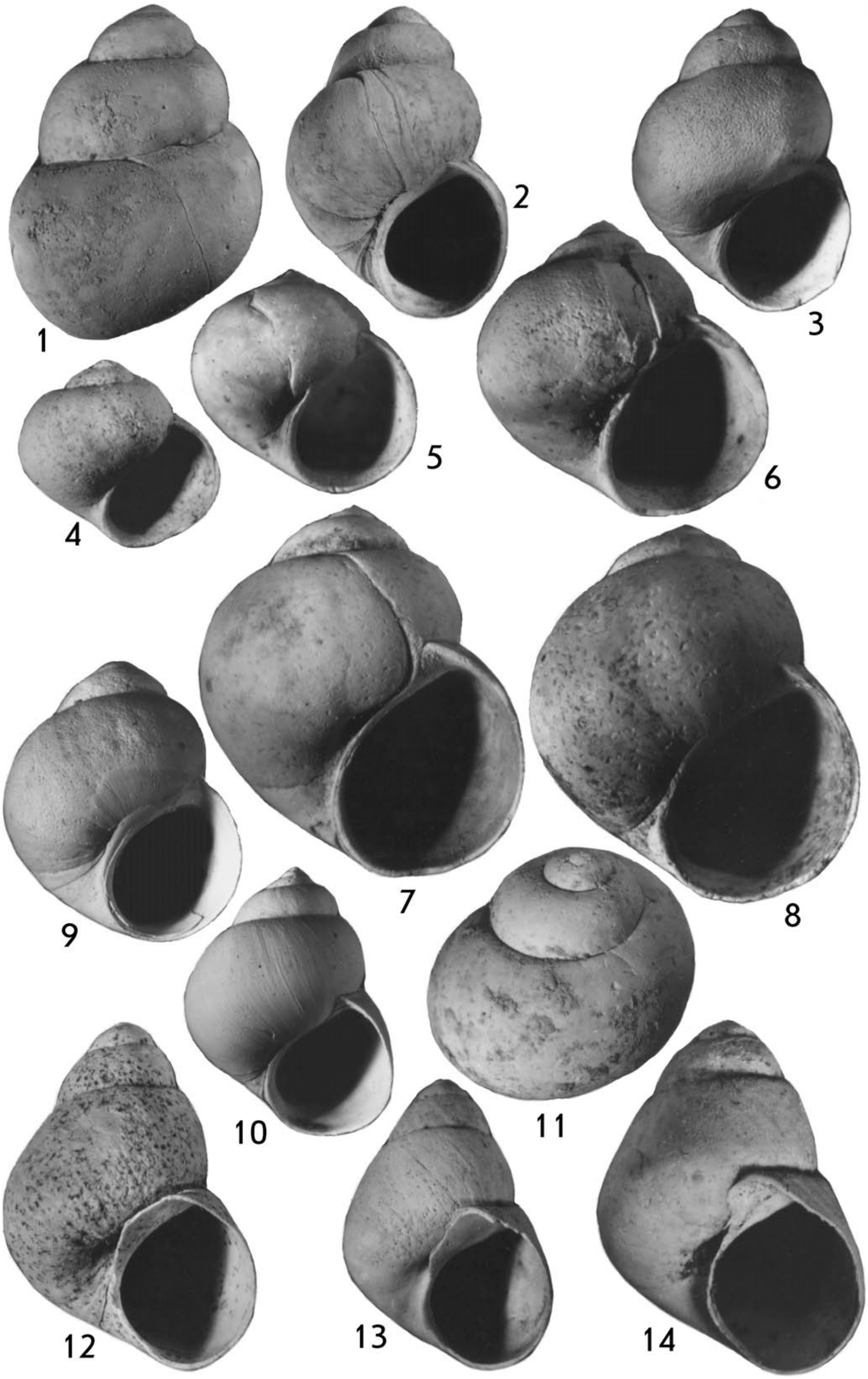


Plate IV. Molluscs from the Novo-Sultanbekovo sections

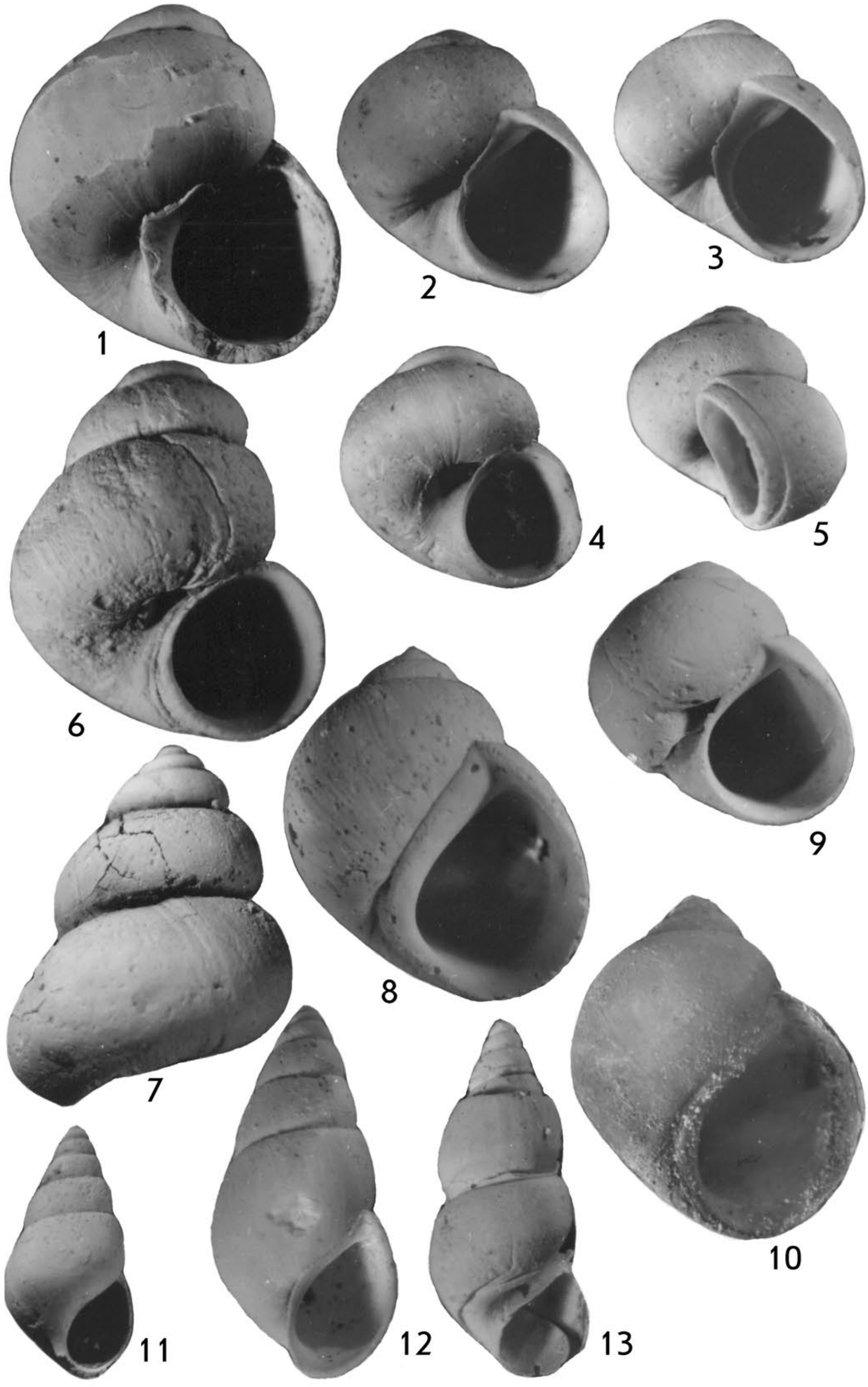


Plate I. Molluscs from the Novo-Sultanbekovo sections

Fig. 1–4. *Aktschagylia subcaspia* (Andrus.), Aktschagyl regiostage. 1 – IG № 4/1, ×3, left valve from the outside; 2 – IG № 4/2, ×3, right valve from the outside; 3 – IG № 4/3, ×3, right valve inside; 4 – IG № 4/4, ×3, left valve inside. 1, 4 – section I, layer 9; 2, 3 – section I, layers 9–10.

Fig. 5, 6, 11. *Aktschagylia subcaspia* (Andrus.), transitional form to *A. ossoskovi* (Andrus.), Aktschagyl regiostage. 5 – IG № 4/5, ×3, left valve from the outside; 6 – IG № 4/6, ×3, right valve from the outside, 5 – section I, layers 9–10; 6 – layer 6 (1960) sample 182; 11 – IG № 4/11, ×6, right valve inside, section I, layer 10.

Fig. 7–10. *Aktschagylia ossoskovi* (Andrus.), Aktschagyl regiostage. 7 – IG № 4/7, ×3, left valve inside; 8 – IG № 4/8, ×3, right valve from the outside; 9 – IG № 4/9, ×3, right valve from the outside; 10 – IG № 4/10, ×3, right valve inside. 7, 8 – section I, layer 9; 9, 10 – section I, layers 9–10.

Fig. 12, 13. *Cerastoderma dombra* (Andrus.), Aktschagyl regiostage. 12 – IG № 4/12, ×2,5, left valve from the outside; 13 – IG № 4/13, ×8, right valve from the outside. 12 – layer 9 (1960), sample 183; 13 – layer 6 (1960), sample 182.

Fig. 14–16. *Dreissena isseli* Andrus., Aktschagyl regiostage. 14 – IG № 4/14, ×2,5, right valve from the outside; 15 – IG № 4/15, ×2,5, left valve from the outside; 16 – IG № 4/16, ×2,5, right valve inside. 14, 16 – section I, layer 10; 15 – section I, layer 9.

1–16 – Bashkortostan, village Novo-Sultanbekovo.

Plate II. Molluscs from the Novo-Sultanbekovo sections

Fig. 1, 2. *Dreissena polymorpha* (Pall.), Aktschagyl regiostage. 1 – IG № 4/17, ×2,5, left valve from the outside; 2 – IG № 4/18, ×2,5, right valve from the outside; 1, 2 – section I, layer 9.

Fig. 3–6. *Dreissena polymorpha* (Pall.) *var. angustiformis* Kolesn., Aktschagyl regiostage. 3 – IG № 4/19, ×2,5, right valve from the outside; 4 – IG № 4/20, ×2,5, right valve from the outside; 5 – IG № 4/21, ×2,5, left valve from the outside; 3–6 – section I, layer 9.

Fig. 6, 7. *Pisidium supinum* A. Schm., Aktschagyl regiostage. 6 – IG № 4/22, ×6, left valve inside, section I, layer 10; 7 – IG № 4/23, ×8, left valve from the outside, section I, layer 4.

Fig. 8. *Bythynia tentaculata* L., Aktschagyl regiostage, IG № 4/24, ×4, view from aperture's side, section I, layer 10.

Fig. 9. *?Scalaxis* sp., Aktschagyl regiostage, IG № 4/25, ×4, view from aperture's side, section I, layer 10.

Fig. 10. *Pupilla mutabilis* Steklov, Aktschagyl regiostage, IG № 4/26, ×4, view from aperture's side, section I, layer 10.

Fig. 11, 12. *Potomida neustruevi geometrica* Bog., Aktschagyl regiostage, 11 – IG № 4/27, ×2, left valve from the outside; 12 – IG № 4/28, ×2, left valve inside; 11, 12 – section I, layer 9.

1–12 – Bashkortostan, village Novo-Sultanbekovo.

Plate III. Molluscs from the Novo-Sultanbekovo sections

Fig. 1–3. *Viviparus baschkiricus* G. Ppv, Aktschagyl regiostage. 1 – IG № 4/29, ×2,5, view from the opposite aperture's side; 2 – IG № 4/30, ×2,5, view from aperture's side; 2 – IG № 4/31, ×2,5, view from aperture's side. 1–3 – section I, layer 10.

Fig. 4–11. *Viviparus achatinoides* Desh., Aktschagyl regiostage. 4 – IG № 4/32, ×4, view from aperture's side; 5 – IG № 4/33, ×4, view from aperture's side; 6 – IG № 4/34, ×4, view from aperture's side; 7 – IG № 4/35, ×4, view from aperture's side; 8 – IG № 4/36, ×4, view from aperture's side; 9 – IG № 4/37, ×2,5, view from aperture's side; 10 – IG № 4/38, ×2,5, view from aperture's side; 11 – IG № 4/39, ×4, view from the top. 4, 9–10 – section I, layer 9; 5–8, 11 – section I, layer 10.

Fig. 12–14. *Viviparus tiraspolitanus* (Pavlov), Aktschagyl regiostage. 12 – IG № 4/40, ×2,5, view from aperture's side; 13 – IG № 4/41, ×2,5, view from aperture's side; 14 – IG № 4/42, ×4, view from aperture's side. 12–14 – section I, layer 10.

1–14 – Bashkortostan, village Novo-Sultanbekovo.

Plate IV. Molluscs from the Novo-Sultanbekovo sections

Fig. 1–3, 9. *Valvata naticina* Menke, Aktschagyl regiostage; ×8, view from aperture's side. 1 – IG № 4/43, 2 – IG № 4/44, 3 – IG № 4/45, 9 – IG № 4/51. 1 – section I, layer 4; 2, 3 – section I, layer 9; 9 – section I, layer 10.

Fig. 4, 5. *Valvata piscinalis* Müll., Aktschagyl regiostage; ×8. 4 – IG № 4/46, view from aperture's side; 5 – IG № 4/47, вид сбоку. 4, 5 – section I, layer 9,

Fig. 6, 7. *Valvata piscinalis antiqua* Sow., Aktschagyl regiostage; ×8. 6 – IG № 4/48, view from aperture's side; 7 – IG № 4/49, вид со стороны, обратной устью. 6, 7 – section I, layer 9.

Fig. 8, 10. *Lithoglyphus acutus* Cob., Aktschagyl regiostage; ×8, view from aperture's side. 8 – IG № 4/50; layer 10 (1960); 10 – IG № 4/52; section I, layer 9.

Fig. 11, 12. *Clessiniola julaevi* G. Ppv., Aktschagyl regiostage; ×10, view from aperture's side. 11 – IG № 4/53, 12 – IG № 4/54. 11, 12 – section I, layer 9.

Fig. 13. *Caspiella roseni* G. Ppv. (?), Aktschagyl regiostage. IG № 4/55, ×10, view from aperture's side; section I, layer 6.

1–13 – Bashkortostan, village Novo-Sultanbekovo.

THE BAZITAMAK SECTION

Location

The Bazitamak section is located on the left bank of the river Baza (the left tributary of the river Belaya) near the village Bazitamak (Ilishevo Region, Bashkortostan Republic) (Fig. 1).

The top of the terrace is approximately at 88 m above sea level and its base is at 61 m. The entire thickness of terrace deposits is 17 m.

History

In 1967 A.V. Sydnev described the section for the first time during the geological mapping of the area. In 1980–83 this locality was studied by V.L. Yakchemovich, A.V. Sydnev, G.A. Danukalova, A.G. Yakovlev, P.I. Dorofeev (St. Petersburg) and F.Yu. Velichkevich (Minsk).

Pollen and spores were studied by L.I.Alimbekova (Ufa), carpological remains by P.I. Dorofeev (St. Petersburg) and F.Yu. Velichkevich (Minsk). Ostracods were investigated by M.G. Popova-Lvova (Ufa), mollusks by G.A. Danukalova (Ufa) and small mammals by A.G. Yakovlev (Ufa). Palaeomagnetical investigations were done by F.I. Suleimanova (Ufa) (Yakchemovich *et al.*, 1987).

Description of the section

The following layers were identified starting from the edge of the terrace (Fig. 22).

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

1. Soil (chernozem), perforated by roots of plant……………………………………………0,6–0,8

Pleistocene

Lower Neopleistocene

Oka Horizon (?)

(lacustrine-slope, periglacial deposits – *ld pgl*)

2. Light brown silt macroporous loam with black manganese precipitation………………………..3,8–4

3. Greyish-brown massive loam with gravel and sandy lenses in the lower part……………………..0,8

Chui-Atasevo Horizon, Middle subhorizon

(slope-alluvial periglacial deposits – *d, a (pgl)*)

4. Alternation of horizontally bedded layers of loams, gravel and sand (thickness of interbeds is 5–20 cm)………………………………………………………………………………………..1

Chui-Atasevo Horizon, Lower subhorizon

(alluvial deposits – *a*)

5. Gravel with small rounded pebbles of flint and quartz with a matrix of loam. Molluscs occur: *Limnaea stagnalis* L. (7), *Galba truncatula* Müll. (1), *Planorbis planorbis* L. (1), *Coretus corneus* L. (2), *Paraspira*

spirorbis L. (5), *Gyraulus laevis* Alder (30), *Hippeutis riparius* Westler (2), *Valvata piscinalis antiqua* Sow. (2), *V. piscinalis* Müll. (10), *V. pulchella* Müll. (14), *Viviparus* sp. (30), *Bithynia tentaculata* L. (4), *B.* aff. *leachi* (Schep.) (1), *Lithoglyphus naticoides* Ferus. (3), *Clessiniola julaevi* G. Ppv (15), *Unionidae* (2 fragments), *Corbicula fluminalis* Müll. (1), *Pisidium amnicum* Müll. (6), *P.* aff. *cosertanum* Poli (4), *Dreissena polymorpha* (Pall.) (35), *? Scalaxis* sp. (1), *Succinea pfeifferi* Rossm. (16), *Pupilla muscorum* L. (10), *Vallonia costata* Müll. (33), *Vitrea crystallina* Müll. (3), operculum (14). Small mammal: Lagurini gen. (4), *Eolagurus* sp. (1), *Mimomys (Cromeromys)* ex gr. *intermedius* Newton (1) and bones of frogs were found……………………………………………………………………………………………..0,8

Erosional base / Sedimentary break.

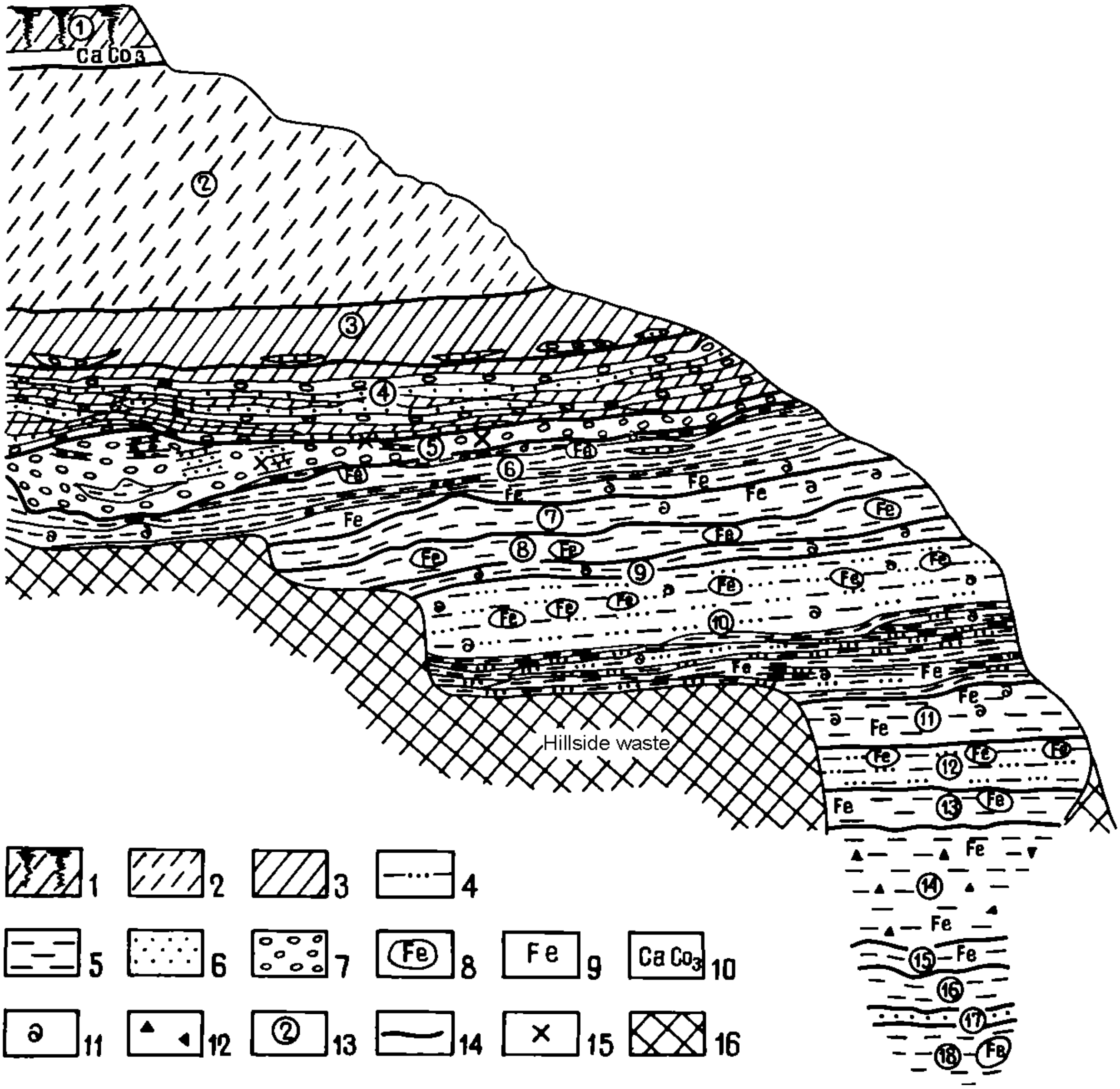


Fig. 22. Pliocene – Pleistocene deposits of the Bazitamak section (by G.A. Danukalova and A.G. Yakovlev, 1982–1983). Legend: 1 – soil; 2 – loam; 3 – dense loam; 4 – silt; 5 – clay; 6 – sand; 7 – gravel; 8 – siderit concretions; 9 – iron-staining; 10 – carbonatization; 11 – molluscs shells; 12 – organic remains; 13 – number of the layer; 14 – boundaries of the lithological strata; 15 – small mammal remains; 16 – hillside.

Neogene

Upper Pliocene

Lower Aktschagyl

Kumurly suite

(lacustrine, alluvial deposits – *l*, *a*)

6. Light yellowish-brown bedded silty clay. Molluscs were collected in the upper part of the layer: *Limnaea stagnalis* L. (1), *Radix* cf. *ovata* Drap. (18 juv.), *Planorbis planorbis* L. (20), *Coretus corneus* L. (1), *Spiralina vortex* L. (2), *Gyraulus laevis* Alder (41), *Acrolox lacustris* L. (4), *Viviparus* sp. (cf. *V. viviparus)* (1 fragment + 2 juv.), *Bithynia tentaculata* L. (28 + 35 juv.), *B.* aff. *leachi* (Schepp.) (6), *Valvata piscinalis* Müll. (14), *V. pulchella* Müll. (233), *Dreissena polymorpha* (Pall.) (76), operculum (91). In the lower part of the layer: *Bithynia tentaculata* L. (10), *Valvata piscinalis* Müll. (6), *V. pulchella* Müll. (7), *Dreissena polymorpha* (Pall.) (1), operculum (56). Ostracods were found at a depth 7,5 m (sample 14): *Ilyocypris bradyi* Sars (2), *I. manasensis* Mand. (2), *Cyclocypris laevis* (O. Müll.) (1), *Cypria candonaeformis* (Schw.) (1), *C. pseudoarma* M. Popova (1), juvenile *Candonen* (72); and at a depth of 8,5 m (sample 17): *Ilyocypris bradyi* Sars (5), *Cypria pseudoarma* M. Popova (5), *Candona combibo* Liv. (5), *C.* aff. *rostrata* Br. et Norm. (5), juvenile *Candonen* (229), *Eucypris famosa* Schn. (1) and *Metacypris cordata* Br. et Roberts. (6)……………………………………………………………………………………………1,3

7. Light grey silty clay with large shells of *Gyraulus laevis* Alder (1), *Hippeutis complanatus* L. (2), *Viviparus* sp. (7 fragments), *Bithynia tentaculata* L. (31), *Valvata piscinalis* Müll. (7), *V. pulchella* Müll. (17), *Pisidium amnicum* Müll. (7), operculum (127) and ostracods (depth 8,9 m, sample 18) *Ilyocypris* aff. *bella* Scharap. (2), *Cypria pseudoarma* M. Popova. (1), juvenile *Candonen* (11)……………………0,5

8. Light brown silty clay with large (10 × 6 × 4 cm) and small (1–1,5 cm) siderite concretions in the lower part of the layer. Ostracods were found at a depth of 9,1 m (sample 19): *Ilyocypris bradyi* Sars (2), *Cyclocypris laevis* (O. Müll.) (1), *Cypria pseudoarma* M. Popova (1), juvenile *Candonen* (36) and *Metacypris cordata* Br. et Roberts. (2)…………………………………………………………………..0,5

9. Dark grey iron-stained clay with shells of freshwater molluscs: *Planorbis planorbis* L. (1 fragment), *Gyraulus laevis* Alder. (2), *Viviparus* sp. (fragment), *Bithynia tentaculata* L. (20), *B. vucatinovici* Brus. (2), *Bithynia sp.* (fragment), *Valvata pulchella* Müll. (90), *Valvata* sp. (fragment), operculum (45) and ostracods at the depth 9,6 m (sample 21): juvenile *Candonen* (3)…………………………………………..0,2–0,3

10. Brownish-grey bedded silt with large siderite concretions (15×10×4, 7×6×3 cm) and interbeds of silt brownish-grey clay in the lower part of the layer. Molluscs were found in the lower part of this layer: *Planorbis planorbis* L. (2), *Coretus corneus* L. (2), *Bithynia tentaculata* L. (59), *Valvata piscinalis* Müll. (51), *V. pulchella* Müll. (46), *Dreissena polymorpha* (Pall.) (1), *Pisidium amnicum* Müll. (1), operculum (25). Ostracods were found at the depth 10 m (sample 22): *Ilyocypris bradyi* Sars (3), *I. gibba* (Ramd.) (1), *Cyclocypris laevis* (O. Müll.) (2), *Cypria candonaeformis* (Schw.) (2), *C. pseudoarma* M. Popova (2), juvenile *Candonen* (197); at the depth 11 m (sample 24): juvenile *Candonen* (4); at the depth 11,5 m (sample 25): juvenile *Candonen* (5)…………………………………………………………………...2,1

Sedimentary break.

Karlaman Suite

(lacustrine, alluvial deposits – *l*, *a*)

11. Black iron-stained clay with organic remains and numerous shells: *Limnaea stagnalis* L. (1), *Planorbis planorbis* L. (1), *Gyraulus laevis* Alder (41), *Hippeutis riparius* Westler (1), *Viviparus mangikiani* V. Bog. (252), *V. baschkiricus* G. Ppv. (4), *Viviparus* sp. (35), *Bithynia tentaculata* L. (768), *B. vucotinovici* Brus. (120), *B.* aff. *leachi* (Schepp.) (2), *Valvata piscinalis* Müll. (55), *V. naticina* Menke (82), Unionidae

(2 fragments), *Dreissena polymorpha* (Pall.) (7), *Pisidium amnicum* Müll. (20), operculum (191) and ostracods (depth 12 m, sample 26) *Ilyocypris inermis* Kauf. (4), *Cypria pseudoarma* M. Popova (1), juvenile *Candonen* (4)……………………………………………………………………….0,8–0,9

12. Light greyish-brown silt with rare large siderite concretions (diameter 12 cm). A iron-stained brown interbed (thickness 6 cm) is located in the middle part of the layer. Ostracods are rare, they came from a depth of 12,8 m (juvenil *Candona* (1)) and from a depth of 13,2 m (juvenile *Candonen* (5))……...0,7

13. Light brown iron-stained clay with ostracods (at a depth of 13,5 m): *Ilyocypris bradyi* Sars (1), *Cyclocypris laevis* (O. Müll.) (4), *Cypria pseudoarma* M. Popova (4), juvenile *Candonen*................0,3

14. Black bedded iron-stained clay with organic remains. Ostracods were found at a depth of 13,9 m: *Ilyocypris manasensis* Mand. (13), *Cyclocypris laevis* (O. Müll.) (25), *Cypria pseudoarma* M. Popova (81) and juvenile *Candonen* (62); at a depth of 14,3 m: *Ilyocypris manasensis* Mand. (1), *Cyclocypris laevis* (O. Müll.) (1), *Cypria pseudoarma* M. Popova (18) and juvenile *Candonen* (6); at a depth of 14,8 m: *Cypria pseudoarma* M. Popova (17) and juvenile *Candonen* (13)……………………………………1,3

15. Brown clay with pochets of limonite (diameter is 1–5 cm)……………………………………….0,2

16. Light brownish-grey iron-stained clay……………………………………………………………..0,5

17. Greenish-grey fine sand………………………………………………………………………...0,2

18. Grey iron-stained clay, with large siderite concretions. The observed thickness is…………………1

Base of the section.

Vegetation

A *Picea* taiga forests with *Pinus, Tsuga, Abies* a low percentage of *Ulmus, Tilia, Alnus* and *Quercus* grew in the region during deposition of the Karlaman Suite (Fig. 23). A *Picea* taiga forests with *Pinus, Tsuga, Abies* a low percentage of *Ulmus, Tilia, Alnus* and *Quercus* grew in the region during deposition of the Karlaman Suite (the carpological data, Tabl. 13).

This type of vegetation that occurred in the surrounding of the village Bazitamak is similar to the Symbugino flora from the upper part of the Karlaman layers. This association of plants were present in the Fore-Urals at the end of the Karlaman period.

The composition of the Kumurly plant community, formed during the first part of the Kumurly period, is like the Karlaman one. Only the proportion of *Picea* is higher. The Karlaman and Kumurly floral associations are of the Late Kinel type.

Pleistocene deposits in the Bazitamak section yielded only a low number of isolated pollen.

Ostracods

Two ostracod complexes were described from the Lower Aktschagylian deposits of the section Bazitamak (Tabl. 14).
The Karlaman complex (layers 11–14): *Ilyocypris bradyi* Sars, *I. manasensis* Mand., *Cyclocypris laevis* (O. Müll.), *Cypria pseudoarma* M.Popova ets. It became colder to the end of the Karlaman period.

The Kumurly complex (layers 6–10). The composition of this complex was similar to the Karlaman complex: *Ilyocypris, Cypria, Candona, Eucypris* ets. *Ilyocypris gibba* (Ramd.), *Metacypris cordata* (Br. et Rob.), *Cypria candonaeformis* (Schw.), *Candona* aff. *rostrata* Br. et Norm., *C. combibo* Liv. and *Eucypris famosa* Schn. were not found in the Karlaman layers.

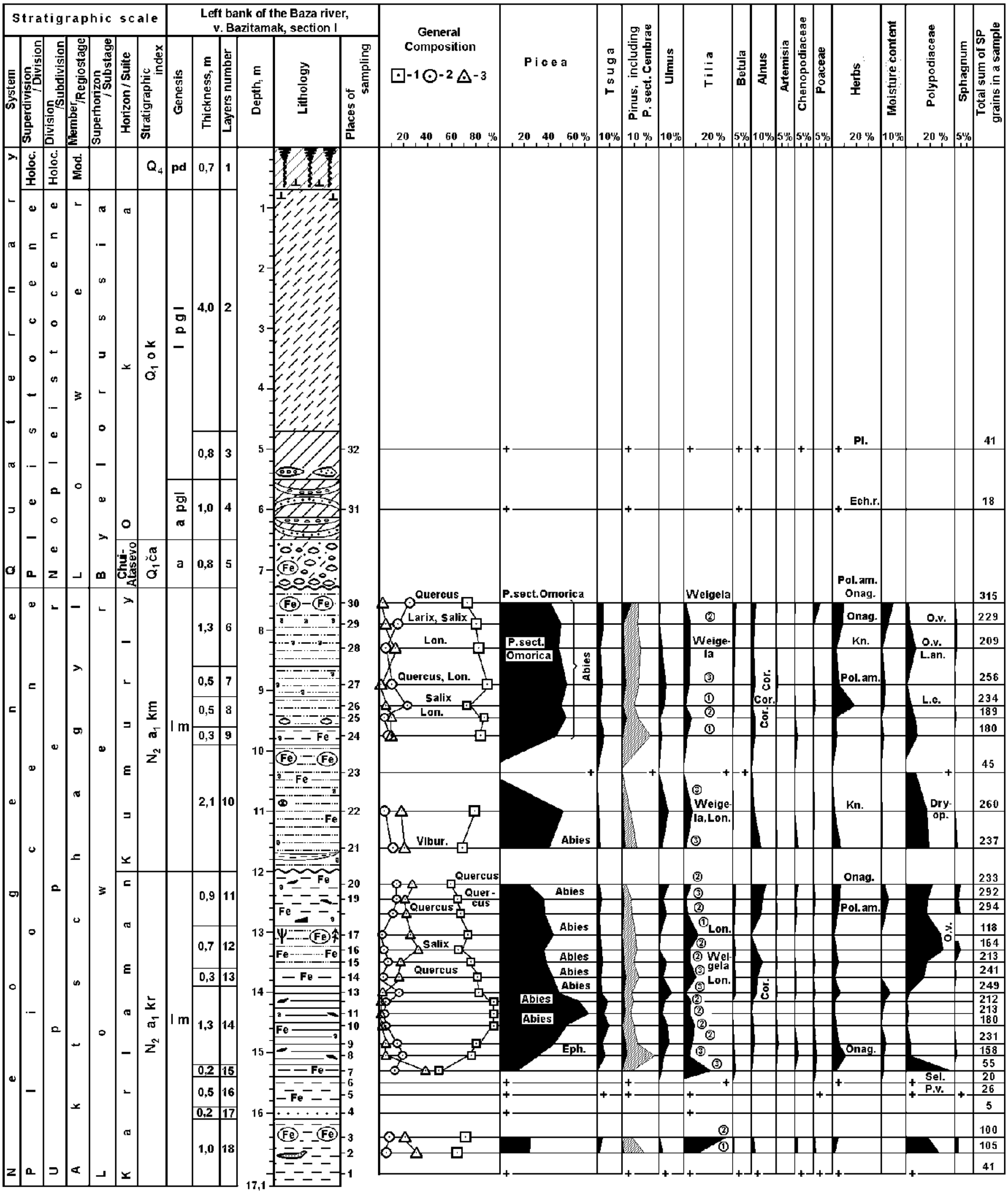


Fig. 23. The Bazitamak section and a pollen diagram (by V.L.Yakchemovich, A.V. Sydnev, G.A. Danukalova, A.G. Yakovlev, L.I. Alimbekova). Legend see Fig. 5.

Table 13. Botanical remains of the Karlaman deposits, the section Bazitamak (by P.I. Dorofeev)

Species	Lower Aktschagyl, Karlaman Suite	
	layer 11	layer 14
1	2	3
Chara sp.		1,2, numerous oospores
Bryales gen.		3 branches
Salvinia tuberculata Nikit.	numerous	numerous
Salvinia glabra Nikit.		numerous
Azolla pseudopinnata Nikit.		20 megaspores
Selaginella pliocenica Dorof.		1 megaspore
Picea sp.		1,5 seeds
Juniperus sp.	1	
Sparganium noduliferum C. et E. Reid.	16	
S. cf. *neglectum* Beeby		32 fruits
S. ex gr. *microcarpum* (Neum.) Čelak.	4	
Typha lipetskiana Dorof.	1	
Typha pliocenica Dorof.		1 seed
Typha sp.	2	30 tegmens
Potamogeton ex gr. *perfoliatus* L.	numerous	
P. pectinatus L.		3 endocarps
P. cf. *borysthenicus* Dorof.		numerous
P. cf. *acutifolius* Link.		numerous
P. cf. *trichoides* Cham. et Schlecht.		numerous
P. coloratus Vahl		numerous
P. tataricus Dorof. et Weliczk.		numerous
Potamogeton sp.	numerous	
Najas major-pliocenica Dorof.	numerous	
Caulinia reticulata Dorof.	numerous	
C. pliocenica Dorof.	numerous	53 seeds
C. cf. *calceolata* C. et E. Reid.		14 seeds
C. lanceolata C. et E.Reid.	numerous	
C. scrobiculata Dorof.	numerous	
Caldesia cylindrica (E.Reid.) Dorof.		numerous
Alisma tennicarpa Dorof.	numerous	
Alisma sp.	15	
Sagittaria cf. *sagettifolia* L.	numerous	
Butomus cf. *umbellatus* L.	3	2 seeds
Stratiotes intermedius (Hartr) Chandl.	3	5 seeds
Hydrocharis morsusranae L.		9 tegmens
Cyperus pseudoglomeratus Dorof.	60	
C. ex gr. *glomeratus* L.		5 fruits
Scirpus cf. *komarovii* Roshev.	numerous	numerous
S. cf. *melanospermus* C. A. Mey		numerous
S. cf. *tertiarius* Dorof.		numerous
S. cf. *desonlavii* Kresz.	34	
S. cf. *atrovirens* Ait.	1	
S. tricantis Dorof.	numerous	
Eleocharis cf. *palustris* (L.) R. Br.	60	
E. pseudoovata Dorof.	24	3 fruits
E. reticulata Dorof.	29	

1	2	3
Carex ex gr. *panciflora* Lightf.	24	
Carex sp.	numerous	numerous
Lemna cf. *minor* L.	1	
Aracispermum cf. *compressum* Dorof.	5	
Leitneria sp.	fragment	
Araceae (Epipremnum ?)		2
Betula alba L.	2	
Betula sp.		2
Alnus sp.		1
Morus tanaitica Dorof.	1,5	9
Chenopodium rubrum L.	5	15
C. album L.		10
Rumex cf. *maritimum* L.	numerous	1
Thlaspi arvense L.		2
Pseudoeuryale ex gr. *nodulosa* C. et Reid.		5
P. cf. *tatarica* Dorof. et Kip.		13
Polygonum pliocenicum L.	numerous	numerous
P. cf. *dumetorum* L.	1	2
P. cf. *bistorta* L.		3
P. ex gr. *aviculare* L.		13
P. cf. *maritimum* L.		38
Urtica pliocenica Dorof.	5	
U. cf. *dioica* L.	numerous	
Urtica sp.		numerous
Pilea tatarica Dorof.	1	
P. pusilla Dorof.		12
Ceratophyllum ex gr. *demersum* L.	12	
Ranunculus pseudofeammulus Dorof.	15	
R. tanaiticus Dorof.	4	
R. sceleratoides Nikit.	numerous	numerous
Ranunculus sp.		1
Thalictrum sp.		1,5
Aldrovanda eleanorae Nikit.		10
Tilia ex gr. tomentosa Moench		1
Paliurus sp.		1
Potentilla pliocenica E. Reid.	25	
Potentilla sp.	11	
Decodon ex gr. *globosus* (L. et E. Reid) Nikit.	numerous	numerous
Hypericum tertiaerum Nikit.	34	25
H. lucens Dorof.	38	
H. ex gr. *coriaceum* Nikit.	numerous	4
Hypericum sp.		numerous
Myriophyllum cf. *ussuriensis* Kom.	13	
M. praespicatum Nikit.	1	
M. cf. *verticillatum* L.	1	
Myriophyllum sp.		numerous
Hippuris parvicarpa Dorof.	numerous	
Hippuris sp.		1
Lysimachia heterosperma Dorof.	7	
Stachys sp.	3	
Stachys palustre L.		1

1	2	3
Lycopus sp.	4 fruits, 25 nuts	numerous
Teucrium cf. *polium* L.		3
Mentha cf. *pulegium* L.	3	
M. arvensis L.	6	
Mentha sp.		3
Verbena (?) sp.		1
Thymus sp.	6	
Physalis alkekengi L.	2	
Physalis cf. *alkekengi* L.		5
Sumbucus cf. *racemosa* L.	5	
S. cf. *nigra* L.		1
Carnifoliaceae	19	
Trichosanthes fragilis E. Reid.	0,5	1
Taraxacum tanaiticum Dorof.	1	
Valerianella sp.		numerous
Eupatorium cannabinum L.	fragment	fragment
Carduus acanthoides L.		17
Carpolithus sp. *(? Hydrilla)*		numerous

Legend:

0,5–5 specimens; 6–15 specimens; 16–30 specimens; 31–60 specimens; numerous specimens

Table 14. The stratigraphical distribution of the ostracods in the section Bazitamak

Species	Neogene	
	Upper Pliocene	
	Aktschagyl	
	Lower Aktschagyl	
	Karlaman Suite	Kumurly Suite
Ilyocypris bradyi Sars	1	12
I. manasensis Mand.	14	2
I. gibba (Ramd.)		1
I. inermis Kauf.	4	
Ilyocypris aff. *bella* Scharap.		2
Cyclocypris laevis (O. Müll.)	30	4
Cypria candonaeformis (Schw.)		3
C. pseudoarma M.Popova	121	10
Candona combibo Liv.		5
C. aff. *rostrata* Br. et Roberts.		5
juvenile Candonen	200	557
Eucypris famosa Schn.		1
Metacypris cordata Br. et Roberts.		8

Legend:

1–5 specimens; 6–15 specimens; 16–30 specimens; > 100 specimens

Eucypris famosa, *Candona combibo*, *Candona* aff. *rostrata* are cold-resistant species characteristic for the Middle Aktschagyl assemblages in the territory of the Fore-Urals. These species indicate the onset of a period with cold climatic conditions.

Molluscs (Tabl. 15, Plates V–VI)

Freshwater molluscs of the Karlaman Complex (layer 11): *Limnaea stagnalis* L. (1), *Planorbis planorbis L.* (1), *Gyraulus laevis* Alder (41), *Hippeutis complanatus* L. (1), *Viviparus mangikiani* V. Bog. (252), *V. baschkiricus* G. Ppv. (4), *Viviparus* sp. (35), *Bithynia tentaculata* L. (768), *B. vucotinovici* Brus. (120), *B.* aff. *leachi* (Schepp.) (2), *Valvata piscinalis* Müll. (55), *V. naticina* Menke (82), Unionidae (2 fragments), *Dreissena polymorpha* Pall. (7), *Pisidium amnicum* Müll. (20), operculum (191).

The species composition of the Kumurly Complex (layers 6–10) is similar to the one of the Karlaman Complex: *Limnaea stagnalis* L. (1), *Radix* cf. *ovata* Drap. (18 juv.), *Planorbis planorbis* L. (21), *Coretus corneus* L. (1), *Spiralina vortex* L. (2), *Gyraulus laevis* Alder (44), *Hippeutis complanatus* L. (2), *Acrolox lacustris* L. (4), *Viviparus* sp. *(*cf. *V. viviparus)* (7 fragments + 2 juv.), *Bithynia tentaculata* L. (89 + 35 juv.), *B.* aff. *leachi* (Schepp.) (6), *B. vucotinovici* Brus. (2), *Bithynia* sp. (fragment), *Valvata piscinalis* Müll. (27), *V. pulchella* Müll. (347), *Valvata* sp. (fragment), *Dreissena polymorpha* (Pall.) (77), *Pisidium amnicum* Müll. (7), operculum (319).

Lower Neopleistocene Complex: *Limnaea stagnalis* L. (7), *Galba truncatula* Müll. (1), *Planorbis planorbis* L. (1), *Coretus corneus* L. (2), *Paraspira spirorbis* L. (5), *Gyraulus laevis* Alder (30), *Hippeutis riparius* Westler (2), *Valvata piscinalis antiqua* Sow. (2), *V. piscinalis* Müll. (10), *V. pulchella* Müll. (14), *Viviparus* sp. (30), *Bithynia tentaculata L.* (4), *B.* aff. *leachi (Schep.)* (1), *Lithoglyphus naticoides* Ferus. (3), *Clessiniola julaevi* G. Ppv (15), *Unionidae* (2 fragments), *Corbicula fluminalis* Müll. (1), *Pisidium amnicum* Müll. (6), *P.* aff. *cosertanum* Poli (4), *Dreissena polymorpha* (Pall.) (35), ? *Scalaxis* sp. (1), *Succinea pfeifferi* Rossm. (16), *Pupilla muscorum* L. (10), *Vallonia costata* Müll. (33), *Vitrea crystallina* Müll. (3), operculum (14). Shells of *Clessiniola julaevi* G. Ppv. were redeposited from the Aktschagylian deposits.

Plate V. Mollusks from the Section Bazitamak

Fig. 1–11. *Viviparus mangikiani* Bog., Lower Aktschagyl, Karlaman Suite. 1–11 – IG № 2/1–11, ×2, age variability of the shell form, apertural view; Bashkortostan, Bazitamak, layer 11.

Fig. 12–15. *Viviparus baschkiricus* G. Ppv., Lower Aktschagyl, Karlaman Suite. 12–15 – IG № 2/12–15, ×2, age variability of the shell form, apertural view; Bashkortostan, Bazitamak, layer 11.

Plate VI. Mollusks from the Section Bazitamak

Fig. 1, 3. *Bithynia vucotinovici* Brus., Lower Aktschagyl, Karlaman Suite. 1, 3 – IG № 2/16, 2/18, ×3,5, apertural view.

Fig. 2, 4. *Bithynia ex gr. tentaculata-vucatinovici*, Lower Aktschagyl, Karlaman Suite. 2 – IG № 2/17, 4 – IG № 2/19, ×4, apertural view.

Fig. 5. *Bithynia tentaculata* L., Lower Aktschagyl, Karlaman Suite. 6 – IG № 2/20, ×4, apertural view.

Fig. 6. *Bithynia cf. tentaculata* L., Lower Aktschagyl, Karlaman Suite. 6 – IG № 2/21, ×4, apertural view.

Fig. 7. *Valvata pulchella* Studer., Lower Aktschagyl, Karlaman Suite. 7 – IG № 2/22, ×10, a – apertural view; b – view from the top, c – umbonal view.

1–7 – Bashkortostan, Bazitamak, layer 11.

Table 15. The stratigraphical distribution of molluscs in the section Bazitamak

Species	Neogene		Quaternary
	Upper Pliocene		Pleistocene
	Aktschagyl		Neopleistocene
	Lower Aktschagyl		Lower Neopleistocene
	Karlaman Suite	Kumurly Suite	Chui-Atasevo Horizon
Succinea oblonga Drap.		6	
S. pfeifferi Rossm.			16
Vitrea crystallina Müll.			3
? *Scalaxis* sp.			1
Pupilla muscorum L.			10
Vallonia costata Müll.			33
Limnaea stagnalis L.	1	1	7
Radix ovata Drap.		18	
Galba truncatula Müll.			1
Planorbis planorbis L.	1	21	1
Paraspira spirorbis L.			5
Spiralina vortex L.		2	
Gyraulus laevis Alder.	3	44	30
Coretus corneus L.	4	1	2
Hippeutis complanatus L.		2	
H. riparius Westler	1		2
Acrolox lacustris L.		4	
Bithynia tentaculata L.	768	182	4
B. vucatinovici Brus.	120	2	
B. aff. *leachi* (Schep.)	2	6	1
Bithynia sp.	198	numerous	
operculum	191	319	14
Valvata pulchella Müll.	22	347	14
V. piscinalis Müll.	55	27	10
V. piscinalis antiqua Sow.	29	19	2
V. naticina Menke	82		
Valvata sp.		numerous	
Lithoglyphus naticoides Ferus.			3
Clessiniola julaevi G. Ppv.			15
Viviparus baschkiricus G. Ppv.	4		
V. mangikiani V. Bog.	252		
Viviparus sp.	35	9	30
Dreissena polymorpha (Pall.)	7	77	35
Unionidae	2		2
P. amnicum Müll.	20	7	6
P. cosertanum Poli			4
Corbicula fluminalis Müll.			1

Legend:

1–10 specimens; 11–20 specimens; 21–30 specimens; 31–50 specimens; > 50 specimens

Plate V. Mollusks from the Section Bazitamak

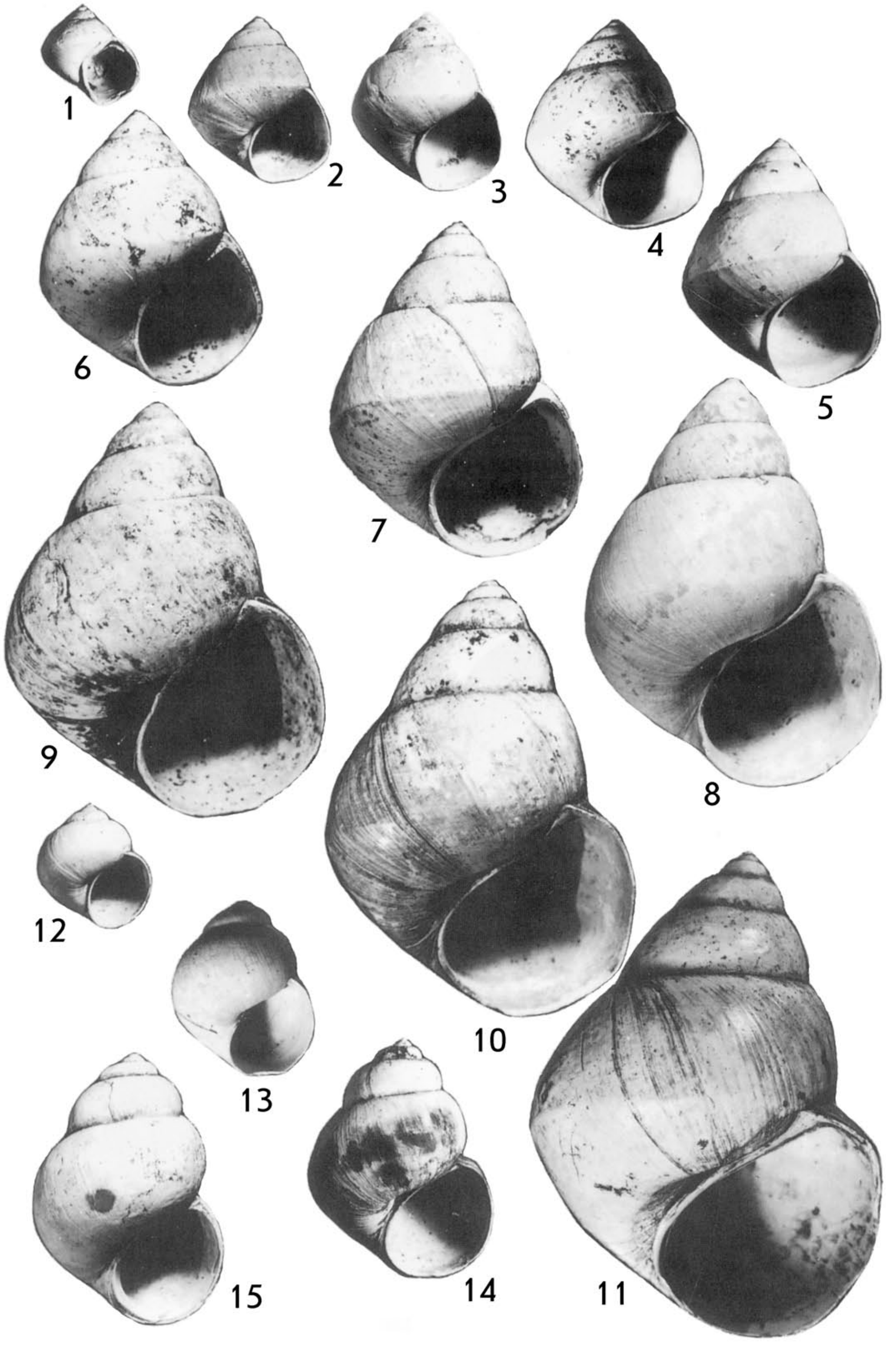
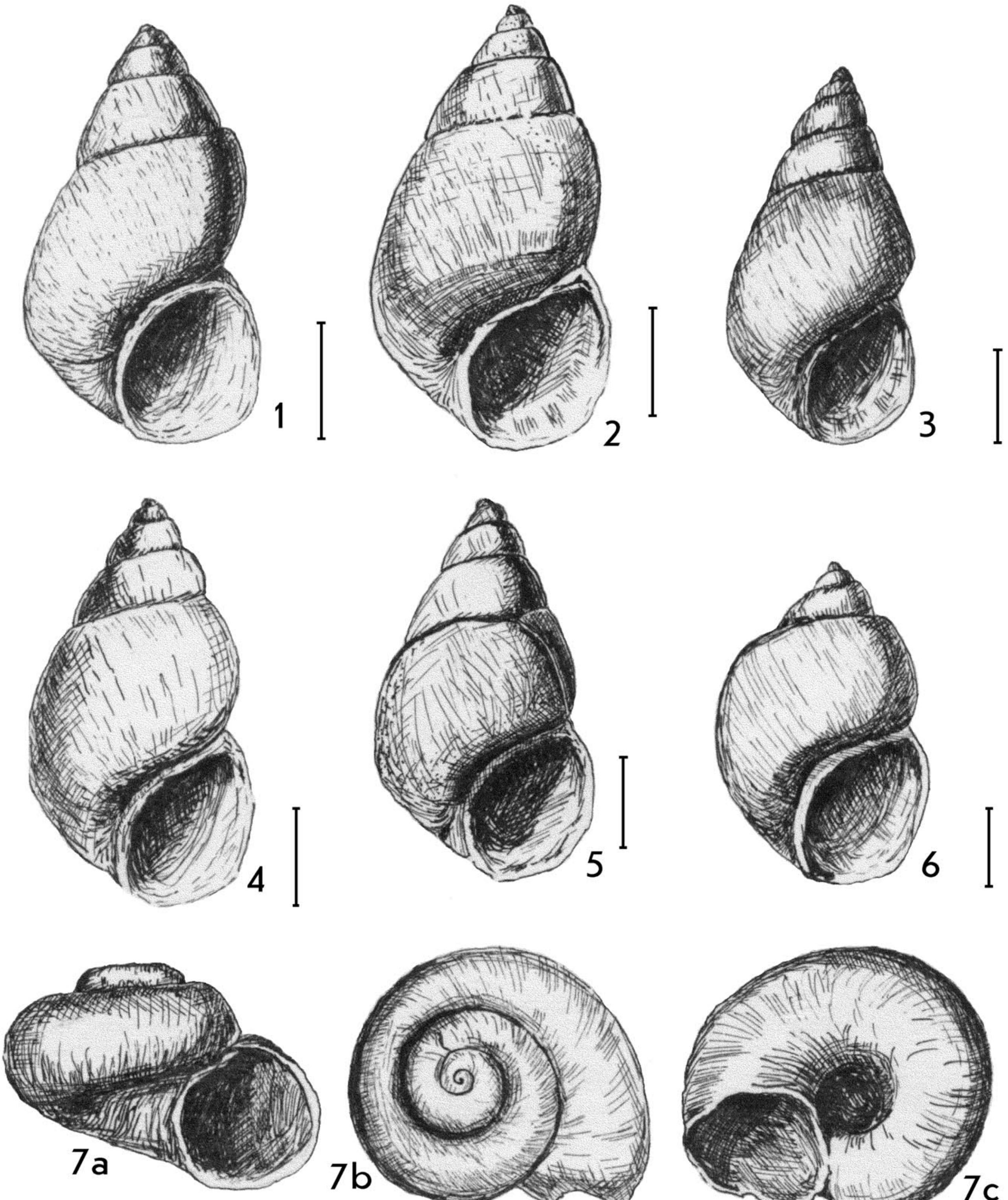


Plate VI. Molluscs from the Section Bazitamak



Palaeomagnetic investigations

The palaeomagnetic investigations were carried out by F.I. Suleimanova (1987, 1992) (Fig. 24).

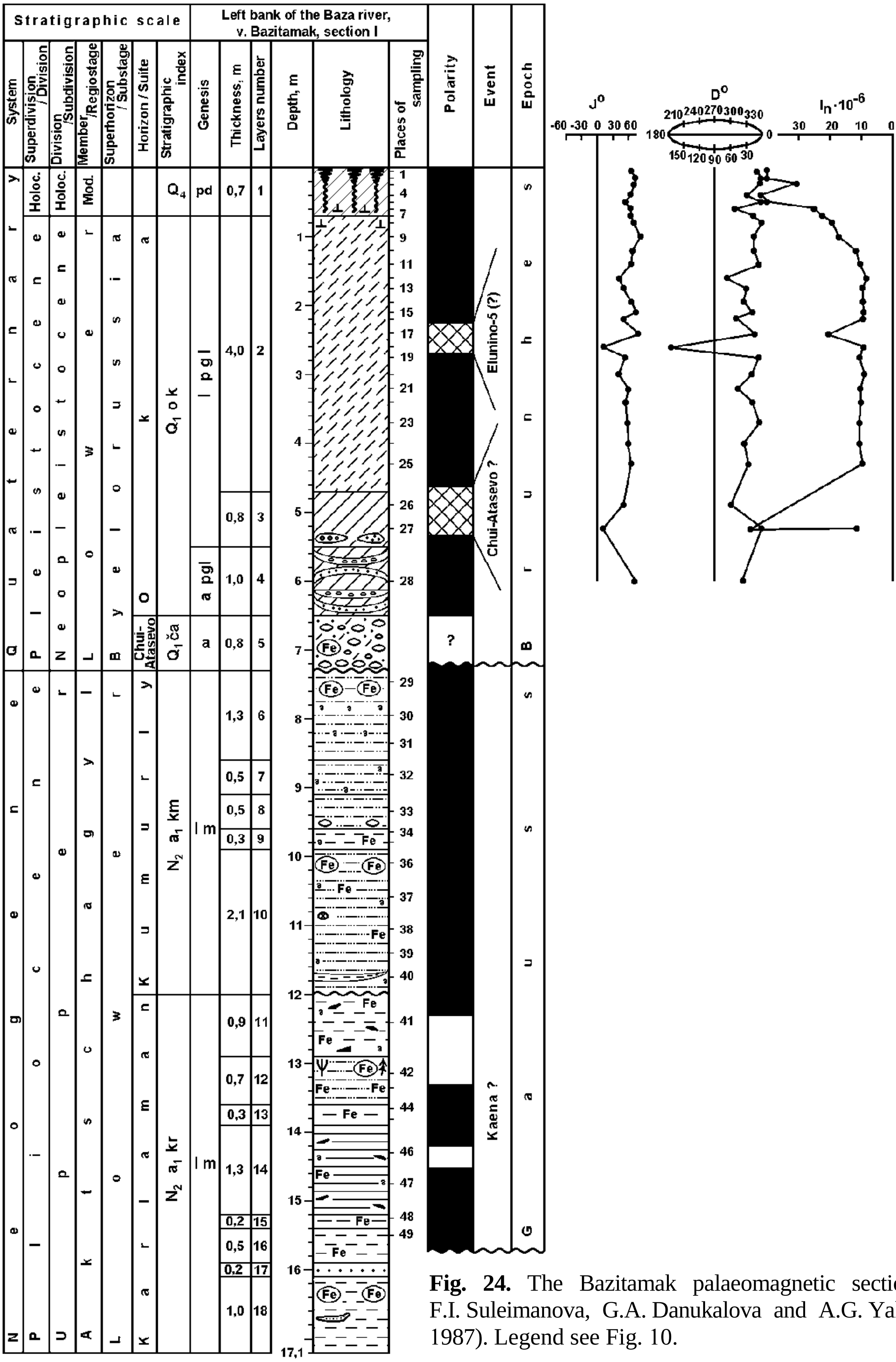


Fig. 24. The Bazitamak palaeomagnetic section (by F.I. Suleimanova, G.A. Danukalova and A.G. Yakovlev, 1987). Legend see Fig. 10.

Seventeen meters of deposits were sampled in detail; 49 stratigraphical levels are investigated (28 with a Pleistocene age, 21 with a Pliocene age)

F. I. Suleimanova found in the Pleistocene deposits (correlated to the Brunhes Epoch) two parts with magnetic anomalies separated by a part with a normally magnetic signal. The author called this anomaly “Chui-Atasevo” and correlated it with the Elunino–5 Event with an age of 470 ka.

The magnetical polarity of Pliocene deposits is mainly normal; these deposits are correlated to the Gauss palaeomagnetic Epoch. F. I. Suleimanova found in the Pliocene part of the sections two minor fluctuations and correlates these to the Kaena and Mammoth Events.

References

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Yakchemovich, V. L, Danukalova, G. A. & Yakovlev, A. G., 1998. Mollusks and small mammals from Pliocene deposits of the Middle Volga region, Russia. *In:* Mededelingen Nederlands Instituut voor Toegepaste Geowetenschappen TNO, 60: 375–416 (*Viviparus mangikiani* V. Bog., *V. bashkiricus* G. Ppv. – plate 8, pp. 385, 386).

THE CHUI-ATASEVO SECTIONS

Location

The sections are located on the left bank of the river Baza near the village Chui-Atasevo (Ilishevo Region, Bashkortostan Republic) (Fig. 1).

History

In 1876 Mr. Kessler bought the sample with fish impressions which was found by peasant Pavel Porogin (the village Chagandy) and sent it to the Geological Department of the Kazan State University.

F.N. Chernyshev (1887) was the first who described deposits with Pliocene fish impressions exposed near the village Chui-Atasevo. In 1923 G.V. Vakhrushev collected these Pliocene fish impressions (1960). Fish impressions were determined by L.S. Berg as Clupeidae.

In 1956 A.P. Rozhdensvensky and I.P. Varlamov described alluvial deposits which are situated above the Pliocene sediments and collected molluscs. A.G. Eberzin identified the molluscs as and referred them to the Lower Pleistocene. V.L. Yakchemovich visited the section in 1960 and collected molluscs (identified by G.I. Popov). V.P. Sukhov collected small mammal remains from these deposits in 1965 and 1968–1969 (Sukhov, 1976).

In 1982 V.L. Yakchemovich, G.A. Danukalova, A.G. Yakovlev, V.P. Sukhov and F.I. Suleimanova cleaned, described and sampled five sections on the left bank of the river Baza. They collected small mammal remains and molluscs (Fig. 25–27). A.G. Yakovlev took more small mammal samples in 1985.

The small mammal remains were identified by A.G. Yakovlev and V.P. Sukhov (Ufa), the molluscs by G.A. Danukalova (Ufa), the ostracods by M.G. Popova-Lvova (Ufa) and the pollen and spores by V.K. Nemkova and L.I. Alimbekova (Ufa). Palaeomagnetical investigations were done by F.I. Suleimanova (Ufa).

Description of the sections

The terrace deposits on the left bank of the river Baza were studied from the village Chui-Atasevo to the mouth of the river (Fig. 28). The following layers were described.

Section I

The section is located in the gully downstream of the village Chui-Atasevo. The top of the terrace is approximately at 83 m above sea level and its base is at 62 m. The thickness of terrace deposits is approximately 21 m.

Quaternary

Holocene – Q_4

(subaerial deposits – *pd)*

Thickness, m

1. Soil (chernozem) fine a blocky, perforated by roots of plants…………………………………….. 0,5

Pleistocene

Middle Neopleistocene

Kaluga Horizon – Q_2^2

(slope periglacial deposits – *ld(pgl)*)

2. Dark brown dense loam……………………………………………………………………………..0,6

3. Yellowish-brown silty loam…………………………………………………………………...1,2

Likhvin Horizon – Q_2^1

(subaerial deposits – *pdl)*

4. Dark grey sandy loam……………………………………………………………………... 0,3

5. Traces of the soil. Light grey sandy loam with humic wedges (the length is 0,8 m)……………….0,8

Lower Neopleistocene

Oka Horizon – Q_1 *ok*

(lacustrine deposits – *l)*

6. Yellowish-brown iron-stained silt……………………………………………………...1,2–1,5

7. Yellowish-brown horizontally bedded silt with interbeds of fine sand……………………………1,2

Chui-Atasevo Horizon – Q_1 *ča*$_3$

(alluvial deposits – *a (rf, pt)*)

8. Grey, yellowish-grey poorly sorted cross-bedded sand with interbeds and lenses of gravel with freshwater molluscs (*Unio* sp.). Remains of small mammals were also found in these deposits: *Sorex* sp. (4), *Lepus* sp. (1), *Ochotona* sp. (24), *Citellus* sp. (10), *Clethrionomys* sp. (5), *Prolagurus (Prolagurus)* cf. *posterius* Zazhigin (6), *Lagurus trasiens* Janossy (13), Lagurini gen. (66), *Mimomys (Microtomys) pusillus* Mehely (3), *Mimomys (Gromeromys) intermedius* Newton (23), *Mimomys* sp. (108), *Arvicola mosbachensis* Schmidtgen (15), *Allophajomys pliocaenicus* Kormos (1), *Microtus (Pitymys) hintoni-gregaloides* (30), *Microtus (Stenocranius) gregalis* Pall. (5), *Microtus* ex gr. *arvalis* Pall. (19), *Microtus (Microtus) oeconomus* Pall. (14), *Microtus* sp. (368)…………………………………………………3,5

Sedimentary break.

Chui-Atasevo Horizon – Q_1 *ča*$_1$

(alluvial deposits – *a (rf)*)

9. Grey iron-stained horizontally bedded gravel with interbeds of pebbles and pebly sand, with shells of *Viviparus* sp. The following small mammals were found: *Clethrionomys* sp. (2), *Prolagurus (Prolagurus)* cf. *posterius Zazhigin* (2), Lagurini gen. (3), *Mimomys (Gromeromys)* ex gr. *intermedius Newton* (10), *Microtus (Pitymys) hintoni-gregaloides* (1), *Microtus* ex gr. *arvalis* Pall. (2)………………………..1,5

Erosional base/Sedimentary break.

Neogene

Middle Aktschagyl

(limanian deposits – *lm*)

10. Blueish-grey dense clay. The upper 30 cm of this bed is yellowish-brown in colour. The observed thickness is……………………………………………………………………………………. 10

Fig. 25. The section Chui-Atasevo I

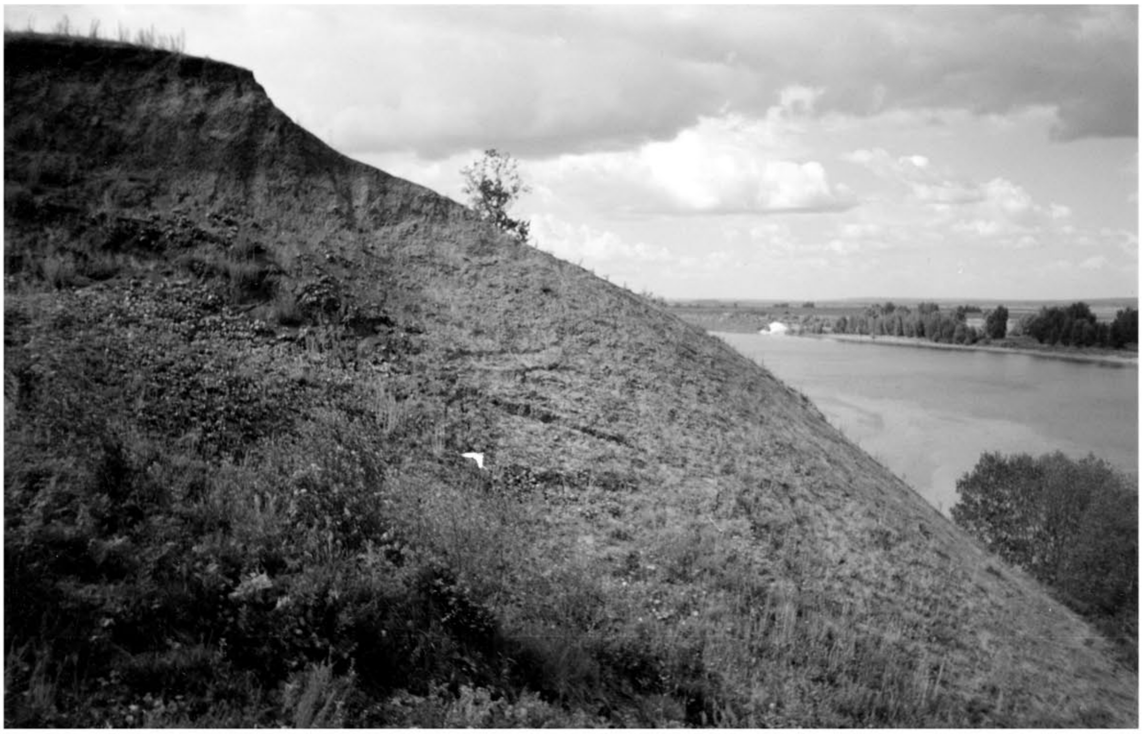

Fig. 26. The section Chui-Atasevo V

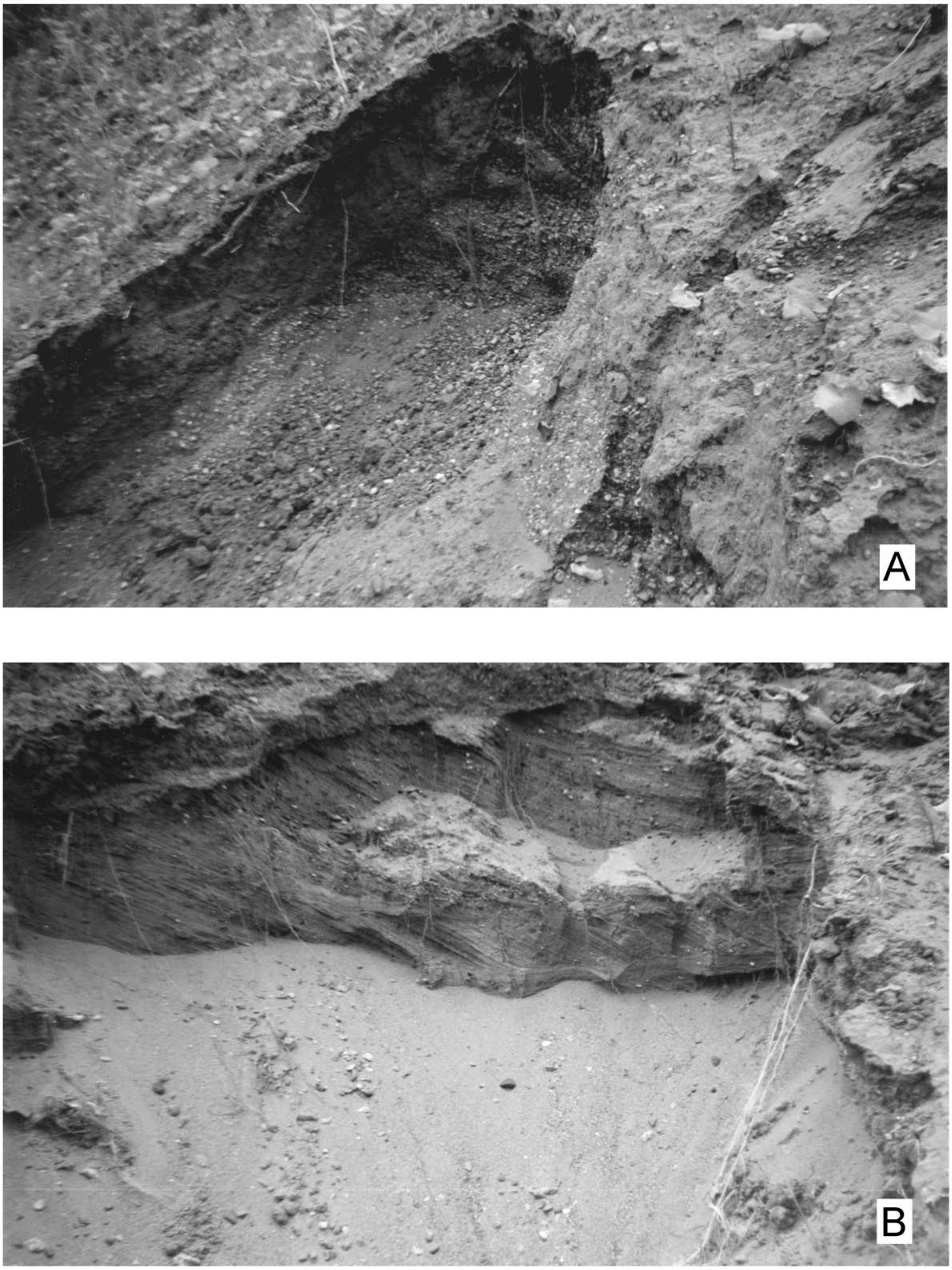

Fig. 27. The section Chui-Atasevo V (fragments of the Eopleistocene deposits)

Section II

The section located 300 m downstream of section I on the left bank of the valley near the spring at the upper boundary of Pliocene clay.

The following deposits occur under the lower soil (similar to layer 5, section I).

Quaternary

Pleistocene

Middle Neopleistocene

Likhvin Horizon – Q_2^1

(subaerial deposits – *pd*)

Thickness, m

1. Dark brown humic silty soil……………………………………………………………………...0,6

2. White carbonaceous illuvial bed………………………………………………………….0,3–0,4

Lower Neopleistocene

Oka Horizon – Q_1 *ok*

(lacustrine deposits – *l)*

3. Brown silty thin-bedded clay……………………………………………………………………….1,1

Chui-Atasevo Horizon – Q_1 *ča*$_3$

(alluvial deposits – *a (rf, pt)*)

4. Brownish-grey polimictic horizontally-bedded sand with in lower part pebbles (thickness of interbed is 40 cm)……………………………………………………………………………………………….1,2

5. Gravel in brown pebbly clayey sand (alluvium formed in gullies)…………………………………0,7

Erosional base / Sedimentary break.

Chui-Atasevo Horizon – Q_1 *ča*$_1$

(alluvial deposits – *a (rf, pt)*)

a (pt) 6. Brownish-grey polymictic fine clayey sand with pebble lenses……………………………..1,4

a (pt) 7. Alternation of layers with greyish-brown iron-stained sands (thickness is 0,5–2 cm) and layers of brown clayey silt……………………………………………………………………………………0,3

a (rf) 8. Horizontally-bedded fine-grained gravels with and alternation of brownish-grey and yellow iron-stained interbeds (thickness is 3–10 cm)……………………………………………………………1,4

9. Yellow iron-stained bedded fine-grained gravels with black manganese interbeds………………0,25

10. Bedded fine-grained gravels with an alternation of brownish-grey (thickness is 4–10 cm) and yellow iron-stained (thickness is 1–7 cm) interbeds……………………………………………………………..0,3

11. Brownish-grey fine-grained gravels in brownish-grey polymictic sands…………………………1,6

Erosional base / Sedimentary break.

Neogene

Middle Aktschagyl

(limanian deposits – *lm*)

12. Dark grey clay. The upper part of the layer is iron-stained and yellow in colour. The observed thickness is……………………………………………………………………………………………2

Section III

Section III is 7–10 m downstream from the section II near the spring. The following layers can be observed starting from the edge of the terrace.

Quaternary

Holocene – Q_4

(subaerial deposits – *pd)*

Thickness, m

pd 1. Soil (chernozem) fine a blocky, perforated by roots of plants……………………………...0,7–0,8

ld 2. Dark brown dense loam with humic wedges (the length is 0,2 m)………………………...0,2–0,25

Pleistocene

Middle Neopleistocene

Moscow Horizon – $Q_2\,m$

(periglacial slope deposits – *ld, pd (pgl))*

ld 3. Brown dense loam with in the upper part carbonaceous precipitations and concretions (diameter is 2 cm) in the upper part…………………………………………………………………………...1,2

pd 4. Dark greyish-brown silty loam (soil)…………………………………………………………1,2

ld 5. Brownish-yellow macroporous loam with manganese precipitation……………………………1,7

Chekalino Horizon – Q_2^3

(subaerial deposits – *pd(pgl))*

6. Dark greyish-brown loam (soil) with rare manganese and carbonaceous precipitation………………1

Kaluga Horizon – Q_2^2

(periglacial deposits – *ld(pgl))*

7. Multi-coloured (light grey, brown, yellow iron-stained) loam with manganese precipitation……..1,2

8. Brown macroporous loam with manganese and rare carbonaceous precipitation…………………1,5

9. Greyish-brown loam…………………………………………………………………………...1,4

Likhvin Horizon – Q_2^1

(subaerial deposits – *pd)*

10. Black soil with carbonaceous precipitation……………………………………………………..1,5

Lower Neopleistocene

Oka Horizon – Q_I *ok*

(lacustrine deposits – *l)*

11. Brownish-grey silt with humus and carbonate………………………………………………….1,2

Chui-Atasevo Horizon – Q_I *ča*$_I$

(alluvial deposits – *a (rf, pt)*)

a (pt) 12. Greyish-brown fine clayey sand partly iron-stained…………………………………0,65

a (pt) 13. Brownish-grey polymictic cross-bedded (angle is 15°) middle-, and fine sands with a few mammalian remains: *Ochotona* sp. (1), *Mimomys (Cromeromys) intermedius* Newton (2) and *Microtus* sp. (1)………………………………………………………………………………...0,5–0,6

al (rf) 14. Gravels in greyish-brown polymictic sands with *Pisidium*, *Planorbis*, *Sphaerium* and fragments of *Unio* sp……………………………………………………………………………….0,05

15. Gravelly sands with shells of freshwater molluscs and mammalian remains: *Ochotona* sp. (2), *Citellus* sp. (2), *Sicista* sp. (1), *Myospalax* sp. (1), *Clethrionomys* sp. (6), *Lagurus transiens* Janossy (1), *Mimomys (Cromeromys) intermedius* Newton (24), *Microtus (Pitymys) hintoni-gregaloides* (2), *Microtus (Stenogranius) gregalis* Pall. (2), *Microtus* ex gr. *arvalis* Pall. (4), *Microtus* sp. (71)…………...0,2–0,3

The following molluscs from layers 14–15 were identified: *Unio* sp., *Sphaerium rivicola* Lam. (28), *Pisidium amnicum* Müll. (17), *Planorbis planorbis* L. (22), *Paraspira spirorbis* L. (13), *Gyraulus laevis* Alder (10), *Bithynia tentaculata* L. (5), *Lithoglyphus* sp. (1), *L. decipiens oblongus* G. Ppv. (41), *Valvata pulchella* Müll. (5), *V. piscinalis* Müll (10), *V. piscinalis antiqua* Sow. (2), *V. naticina* Menke (16), *Viviparus* sp. (1), *V. baschkiricus* G. Ppv. (?) (8), *Stagnicola palustris* L. (34), *Succinea oblonga* Drap. (18), *Vallonia pulchella* Müll. (7), *Vallonia costata* Müll. (2), *Pupilla muscorum* L. (4), *Zenobiella rubiginosa* A. Schm. (5) and *Cochlicopa lubrica columna* Cles. (2).

16. Cross bedded gravels with coarse, light yellow sands……………………………………….0,3

a (pt) 17. Light yellow horizontally-bedded middle-grained sand with pebbles…………………….0,35

a (rf) 18. Gravels in cross-bedded sands with mammalian remains: *Mimomys (Cromeromys) intermedius* Newton (6), *Microtus* ex gr. *oeconomus* Pall. (1), *Microtus* sp. (2)……………………………….0,3

a (rf) 19. Grey and yellowish-grey gravel with pebbly sandy interbeds. *Prolagurus (Prolagurus) posterius* Zazhigin (1), *Mimomys (Mimomys) pusillus* Mehely (3), *Mimomys (Cromeromys) intermedius* Newton (2), *Mimomys* sp. (3) were collected from this layer……………………………………………..2,4

Section IV

Section IV is located in the gully 100 m downstream from Section III.

Quaternary

Pleistocene

Lower Neopleistocene

Chui-Atasevo III Horizon – Q_I *ča*$_3$

(lacustrine deposits – *l*)

Thickness, m

l 1. Alternation of grey polymictic middle-grained sands, pink-brown silty clay and yellow iron-stained clayey silt (thickness of the interbeds is 3–7 cm). The observed thickness is………………………..2

Erosional base / Sedimentary break.

Chui-Atasevo I Horizon – Q_1 *ča*$_1$

(alluvial deposits – *a (rf, pt)*)

a (pt) 2. Yellow fine- to medium sands with *Mimomys* sp. (3) и *Microtus* ex gr. *oeconomus* Pall. (1)…...0,3

a (rf) 3. Gravel in yellow fine- to medium sand with pebbles……………………………………...0,2

Erosional base / Sedimentary break.

Lower Eopleistocene

(alluvial deposits – *a (rf)*)

4. Stratified gravels in yellow, greyish-brown iron-stained sands with lenses of loam, sand, and small pebbles. Boulders (with a diameter up to 18 cm) occur in the lower part of the layer………………..4,2

5. Limonite crust…………………………………………………………………………...0,08–0,1

Erosional base / Sedimentary break.

Neogene

Middle Aktschagyl

(limanian deposits – *lm*)

6. Dark grey dense clay. The upper 40 cm of this bed are yellowish-brown in colour. The observed thickness is……………………………………………………………………………………1,5

Section V

The section is located 60 m downstream from the mouth of the river Baza on the left bank terrace under the village Marjino. The top of the terrace is at approximately 92 m above sea level and its base is at 74 m. The thickness of the alluvial deposits is 18 m. The total thickness of the deposits is 30 m. The following deposits occur, starting from the top of the terrace.

Quaternary

Holocene – Q_4

(subaerial deposits – *pd, ld (pgl))*

Thickness, m

pd 1. Dark brown soil………………………………………………………………………..0,3–0,4

ld (pgl)B 2. Dark brown loam…………………………………………………………….0,6–0,8

Pleistocene

Middle Neopleistocene

Kaluga Horizon – Q_2^2

(lacustrine-slope periglacial deposits – *ld(pgl))*

3. Dark brown loam with carbonate……………………………………………………….0,4–0,6

4. Brown loam with columnar jointing and with iron-staining in the lower part (10 cm)……………4–5

Likhvin Horizon – Q_2^1

(subaerial deposits – *lh)*

5. Greyish-brown loam………………………………………………………………………1,1–1,2

Lower Neopleistocene

Chui-Atasevo II Horizon – Q_1 *ča*$_2$

(lacustrine-slope periglacial deposits – *l, ld (pgl)*)

6. Brown blocky loam with iron-staining……………………………………………………0,6–0,8

7. Light brown massive clay with in the upper part a horizon of carbonaceous concretions (diameter is 7–10 cm) in the upper part……………………………………………………………………………2

8. Light greyish-brown bedded loam……………………………………………………………….0,6

9. Greyish-yellow polymictic fine sand…………………………………………………………...0,18

10. Yellowish-brown clay……………………………………………………………………………..0,1

11. Yellowish-grey polymictic fine sand………………………………………………………...0,1

12. Yellowish-brown micro-bedded loam with in the upper part a horizon of carbonaceous concretions (diameter is 5–7 cm)………………………………………………………………………………….0,65

Chui-Atasevo I Horizon – Q_1 *ča*$_1$

(alluvial deposits – *a (rf, pt)*)

a (pt) 13. Yellowish-grey polymictic fine- and middle-grained sands with pebble lenses (thickness is 3–5 cm)…………………………………………………………………………………………...1,4

a (pt) 14. Yellowish-grey polymictic fine- and middle-grained sand…………………………………0,4

15. Bedded gravels…………………………………………………………………………………….0,6

16. Massive gravels in yellowish-grey polymictic sands……………………………………………..1

17. Brown and light yellow horizontally-bedded gravels……………………………………………..0,6

18. Greenish-grey gravels in polymictic sands………………………………………………………..1,2

19. Multi-coloured gravels: black manganese (thickness is 5–7 cm), yellowish-red (thickness is 2–3 cm) and yellow (thickness is 7–10 cm)…………………………………………………………………...0,75

20. Brownish-grey bedded gravels with interbeds of light grey and yellow polymictic sands (thickness is 5–15 cm)……………………………………………………………………………………...1,25

Mammal remains were collected in layers 13, 15, 16: *Mimomys (Gromeromys) intermedius* Newton (1), *Mimomys (Microtomys) pusillus* Mehely (1), *Mimomys* sp. (3), *Microtus (Pitymys) hintoni* Kretzoi (1), *Microtus (Microtus) oeconomus* Pall. (1), *Microtus* sp. (4).

Erosional base / Sedimentary break.

Permian deposits. The observed thickness is……………………………………………………..12 m

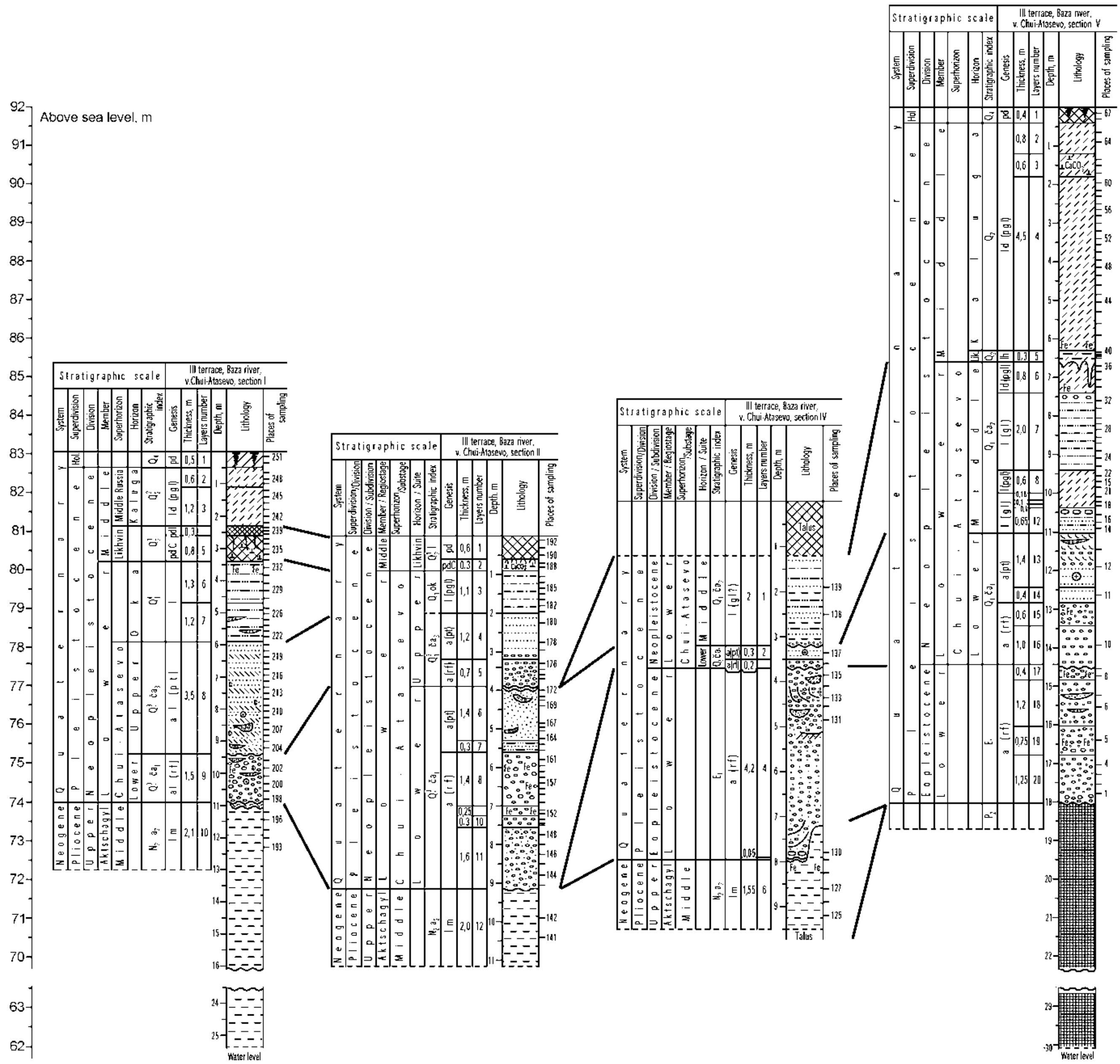

Fig. 28. Correlation between the Chui-Atasevo sections (by V.L. Yakchemovich, G.A. Danukalova, A.G. Yakovlev and V.P. Sukhov, 1983)

Vegetation (Fig. 29–32)

Palynological investigations indicate that *Picea-Pinus* taiga forest with a low percentage of *Betula*, *Tilia* and *Alnus* dominated during the Middle Aktchagylian and herbs dominated in the more open areas.

In the Early Eopleistocene a forest-steppe biocoenosis predominated. Scattered patches of *Betula* forest with broad-leaved trees occurred in the herbaceous-*Artemisia* steppe. During the early part of the Chui-Atasevo period there was an alternation of steppe with herbaceous-*Artemisia* associations and *Betula* forests with broad-leaved trees. The climate was warm and dry. The soils show a marked saltenrichment. During the middle Chui-Atasevo period the vegetation changed to a taiga forest. The climate became colder and more humid. The Late Chui-Atacevo period is characterised by the occurrence of a broad-leaved-*Betula* forests and a grassland-steppe. The climate was warm, probably warmer than during the early Chui-Atacevo. The soils show a marked saltenrichment.

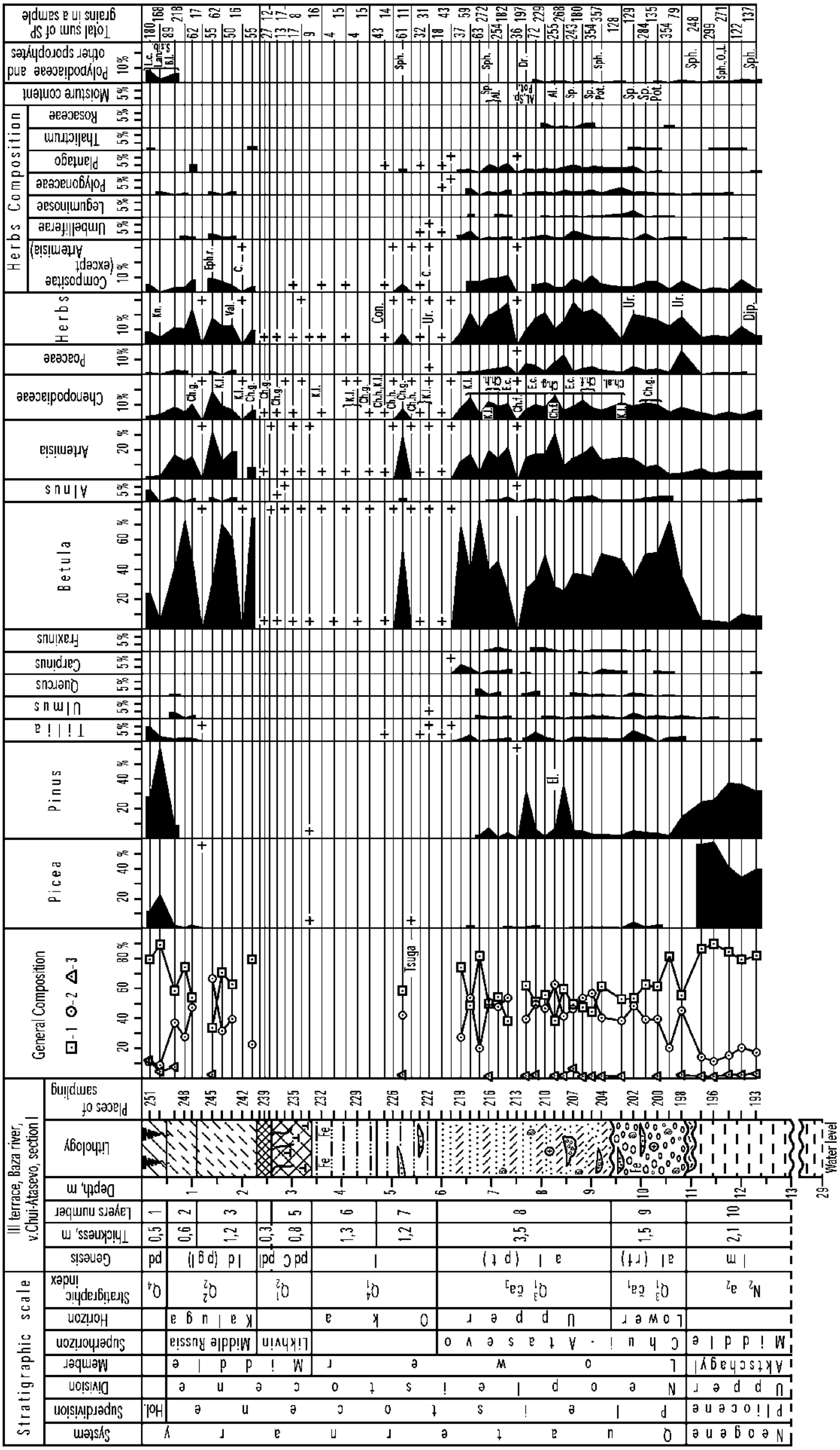

Fig. 29. Chui-Atasevo section I and pollen diagram (by V.L. Yakchemovich, A.V. Sydnev, G.A. Danukalova, A.G. Yakovlev and L.I. Alimbekova). Legend see Fig. 5.

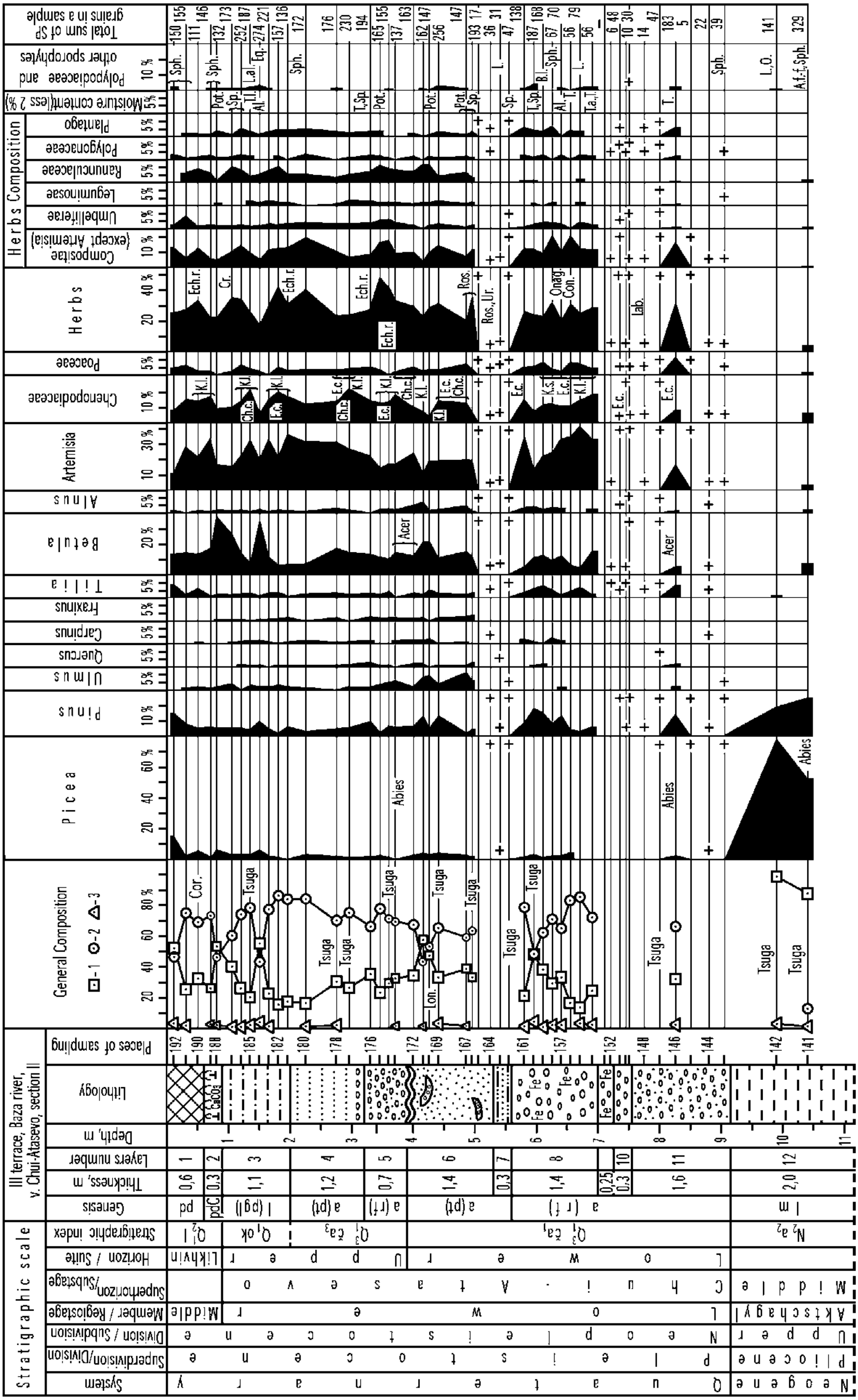

Fig. 30. Chui-Atasevo section II and pollen diagram (by V.L. Yakchemovich, A.V. Sydnev, G.A. Danukalova, A.G. Yakovlev and L.I. Alimbekova). Legend see Fig. 5.

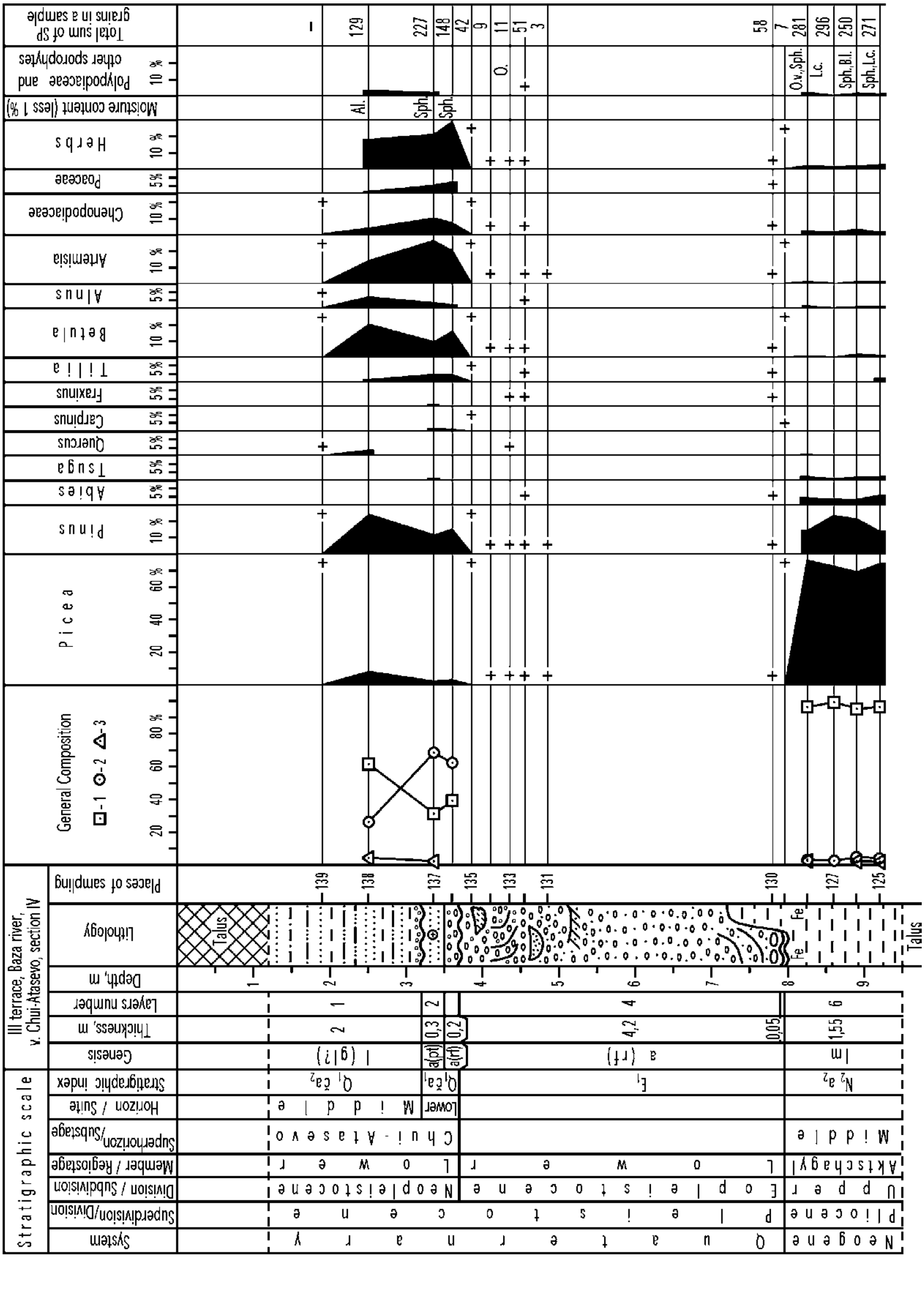

Fig. 31. Chui-Atasevo section IV and pollen diagram (by V.L.Yakchemovich, A.V.Sydnev, G.A. Danukalova, A.G. Yakovlev and L.I. Alimbekova). Legend see Fig. 5.

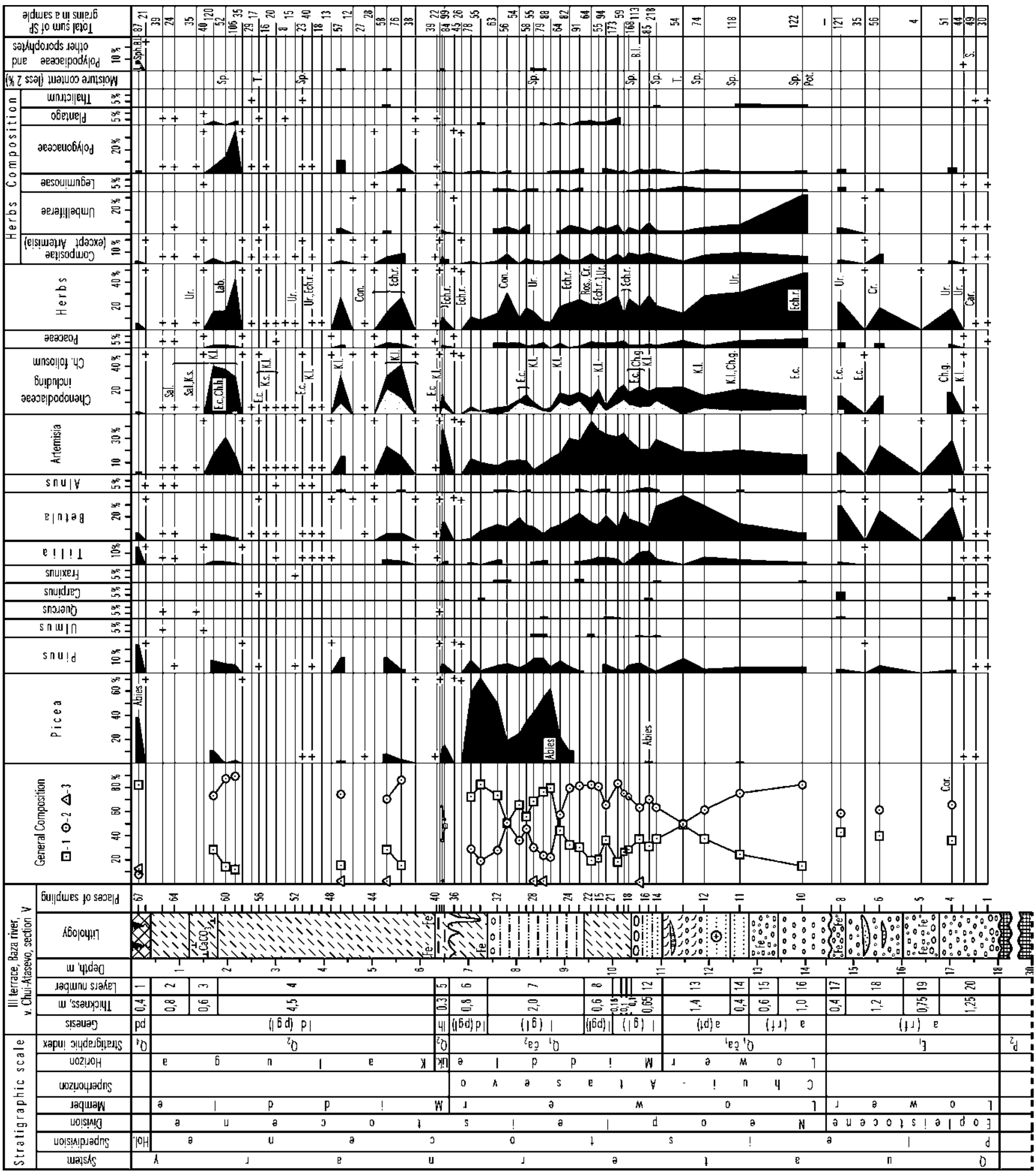

Fig. 32. Chui-Atasevo section V and pollen diagram (by V.L. Yakchemovich, A.V. Sydnev, G.A. Danukalova, A.G. Yakovlev and L.I. Alimbekova).

Legend see Fig. 5.

Rare pollen and spores occur in the Oka deposits: *Betula* and some grassy plants (*Artemisia*). It is assumed that periglacial landscapes existed in the Fore-Urals.

Herbaceous plants (mainly *Artemisia*), *Picea* and small a quantity of broad-leaved trees pollens dominated the botanical record from the Likhvin deposits and *Artemisia*-Chenopodiaceae-herbaceous associations dominated during the Middle Neopleistocene Kaluga episode.

Molluscs

The early Chui-Atasevo complex is characterised by a dominance of freshwater molluscs and a few land hydrophylic species (Tabl. 16).

Table 16. The stratigraphical distribution of the molluscs in the Chui-Atasevo sections

Species	Quaternary		
	Pleistocene		
	Lower Neopleistocene		
Horizon	Chui-Atasevo III	Chui-Atasevo I	Chui-Atasevo I
Sections	I		III
Layers	8	9	14–15
Succinea oblonga Drap.		1	18
Vallonia costata Müll.			2
V. pulchella Müll.			7
Pupilla muscorum L.			4
Cochlicopa lubrica columna Cles.			2
Zenobiella rubiginosa A.Schm.			5
Stagnicola palustris Müll.		2	34
Planorbis planorbis L.		2	22
Paraspira spirorbis L.			13
Gyraulus laevis Alder.			10
Viviparus achatinoides Desh.		8 + fragments	8
Viviparus sp.		3 juv.	1 fragment
Valvata pulchella Müll.			5
V. piscinalis (Müll.)			10
V. piscinalis (Müll.) *antiqua* Sow.			2
V. naticina Menke			16
Bithynia tentaculata L.			5
Bithynia sp.		1 fragment	
Lithoglyphus decipiens oblongus G. Ppv.		5	41
Lithoglyphus sp.			1 fragment
Unio sp.	Fragments	Fragments	Fragments
Sphaerium rivicola L.		23	28
Pisidium amnicum Müll.		4	17

Legend:

1–10 specimens; 11–20 specimens; 21–30 specimens; 31–50 specimens; > 50 specimens

Ostracods (Tabl. 17)

The early Chui-Atasevo complex (sections I, III) consists of: *Ilyocypris bradyi* Sars, *I. pibba* (Ramd.), *I. bella* Scharap., *Cypria curvifurcata* Klie, *Candona neglecta* Sars, *C. rostrata* Br. et Norm., *Candona* juv., *Eucypris dulcifons* Dieb et Pietr. and *Cyprideis torosa* (Jones).

The middle Chui-Atasevo complex (sections V) is characterised by cold-resisting ostracods and is composed of species which occur in the early Chui-Atasevo complex together with *Ilyocypris* cf. *decipiens* Masi, *Cyclocypris laevis* (O. Müll), *C. ovum* (Jurine), *C. triangula* Neg., the cold-resisting *Candona neglecta* Sars, *C. fabaeformis* (Fisch.), *Cytherissa lacustris* Sars, *Limnocythere usenensis* Karm., numerous *Denticulocythere* cf. *scharapovae* (Schw.), *D. caspiensis* Neg., *Cyprideis torosa* (Jones) and *Paracyprideis naphtatscholana* (Liv.).

The late Chui-Atasevo complex (section I) includes: *Ilyocypris, I. biplicata* (Koch), *I.* aff. *getica* Masi, *Cyclocypris triangula* Klie, *Cypria curvifurcata* Klie, *C. tambouensis* Mandel., *Candona candida* (O. Müll.), *C. neglecta* Sars, *C.* juv., *Dolerocypris fasciata* (O. Müll.), *Cytherissa lacustris* Sars, *Denticulocythere* cf. *scharapouae* (Schw.), *Cyprideis torosa* (Jones).

The Oka complex (sections I, III) is rich in species: *Cyclocypris ovum* (Jurine), *Cypria curvifurcata* (Klie), *Candona candida* (O. Müll.), *Cytherissa lacustris* Sars, *Denticulocythere* cf. *scharapovae* (Schw.), numerous stenothermic cold-resisting *Cyclocypris serena* (Koch), *Candona rectangulata* (Alm), *C. neglecta* Sars and rare *Sclerocypris*? aff. *clavata* (Baird), *Paralimnocythere compressa* (Br. et Norm.) etc.

The Likhvin complex (section V) was poor in ostracods; only a few specimen of the following species: *Ilyocypris bradyi* Sars, *I. gibba* (Ramd.), *I. bella* Scharap., *Candona neglecta* Sars, *Denticulocythere dorsotuberculata* (Neg.).

The Kaluga complex (section V) consists of a small quantity of *Ilyocypris bradyi* Sars, *I. decipiens* Masi, *I. bella* Scharap., *I. biplicata* (Koch) and numerous stenothermic cold-resisting *I. inermis* Kauf., *I.* aff. *getica* Masi, *Cyclocypris ovum* (Jurine), *Candona neglecta* Sars, *Candona* juv., *Eucypris dulcifons* Dieb. et Pietr. and *Denticulocythere dorsotuberculata* (Neg.).

Table 17. The stratigraphical distribution of the ostracods in the Chui-Atasevo sections

Species	Quaternary									
	Pleistocene									
	Eopleis.	Neopleistocene								
Link	Lower	Lower							Middle	
Horizons		Chui-Atasevo I		Chui-Atasevo II		Chui-Atasevo III	Oka		Likhvin	Kaluga
Sections	IV	I	III	V		I	I	III	V	
1	2	3	4	5	6	7	8	9	10	11
Ilyocypris bradyi Sars	16	2	2	21	39	23	6	10	2	4
I. gibba (Ramd.)	11	5	2		7	9	10	6	1	
I. decipiens Masi	4	1			10	4				1
I. cf. *decipiens* Masi					33		9			
I. bella Scharap.		1	1		1	28	11	2	4	60
I. biplicata (Koch)						3				1
I. manasensis Mandel.	16									
I. inerims Kauf.										3
I. aff. *inermis* Kauf		1				2				
I. aff. *getica* Masi			2			3	99	1		

1	2	3	4	5	6	7	8	9	10	11
Cyclocypris laevis (O. Müll.)					2		141			
C. ovum (Jurine)				1	1		19			1
C. serena (Koch)							23	5		
C. triangula Neg.					14	1				
C. aff. *triangula* Neg.	34									
Cypria candonaeformis (Schw.)	3	151								
C. pseudoarma M. Popova	166									
C. curvifurcata Klie	11	19	1		4	33	17	26		
C. tambovensis Mandel.						3	2			
Candona candida (O. Müll.)						1	1			
C. combibo Liv.	5									
C. neglecta Sars		1		4	29	9	14	2	1	1
C. fabaeformis (Fisch.)					1		14			
C. rostrata Br. et Norm.		1			1		56			
C. aff. *rostrata* Br. et Norm.	5									
C. rectangulata (Alm)							65			
Candona juv.	2	12		38	172	19	951	4		6
Eucypris famosa Schn.	1									
Eucypris dulcifons Dieb. et Pietr.		1		5						6
Dolerocypris fasciata (O. Müll.)						2				
Cytherissa lacustris Sars					1	8	4			
Metacypris cordata Br. et Rob.	8									
Limnocythere usenensis Karm.				1	7					
Denticulocythere scharapovae (Schw.)	1									
D. cf. *scharapovae* (Schw.)				95	191	36	51			
D. dorsotuberculata (Neg.)									4	2
D. caspiensis Neg.				16	4		2			
Paralimnocythere compressa (Br. et Norm.)							1			
Cyprideis torosa (Jones)					7	2				
Paracyprideis naphtatscholana (Liv.)					1					

Legend:

Light grey	Medium grey	Dark grey	Black
1–5 specimens	6–15 specimens	16–30 specimens	> 30 specimens

Small mammals (Tabl. 18)

The faunas of section I, layer 8, 9 and section III and layer 15 are of Early Pleistocene age. *Mimomys pusillus* Mehely, *Mimomys intermedius* New., *Prolagurus (Prolagurus)* cf. *posterius* Zazhigin, *Lagurus transiens* Janossy and grey field-voles of the subgenus *Pitymys* were identief.

The fauna of section I, layer 8 is peculiar because of the presence *Arvicola mosbachensis* Schmidtgen, together with the typical Early Pleistocene species *Mimomys intermedius* New., *Mimomys pusillus* Mehely, *Prolagurus (Prolagurus)* cf. *posterius* Zazhigin and *Lagurus transiens* Janossy. The fauna of Section I layer 8 is younger than the fauna of the Early Tiraspol complex (localities Karai-Dubina, Petropavlovka 2); the fauna is similar to the associations from Uryv 3, Novokhopersk, Ilovaisky Cordon, Shamin and Klepky. The faunas from the localities Vyatkino and Kolkotova Balka are younger. It is assumed that the faunas Chui-Atasevo I and III reflect two different stages of the Early Pleistocene faunal history; two stages that are separated by a long cold episode that predates the Oka glaciation.

Table 18. The stratigraphical distribution of the small mammals in the Chui-Atasevo sections

Species	Quaternary		
	Pleistocene		
	Lower Neopleistocene		
Horizons	Chui-Atasevo I		Chui-Atasevo III
Section	III	I	I
Layer	15	9	8
Sorex sp.			6
Talpa sp.			3
Lepus sp.			1
Ochotona sp.	2		46
Spermophilus sp.	1		3
Cricetus sp.		3	
Myospalax sp.	1		14
Sicista sp.	1		
Allactaga sp.			1
Clethrionomys ex gr. *glareolus* Schreber (M_1, M^3)	1	1	16
Cl. (? ex gr. *glareolus* Schreber) (M_1, M^3)			7
Clethrionomys sp.	7	1	31
Prolagurus (Prolagurus) cf. posterius Zazhigin (M_1, M^3)		1	6
Lagurus transiens Janossy (M_1, M^3)	1		17
Lagurini gen.		3	77
Eolagurus luteus praeluteus Schevtchenko			7 (incl. 1M_1)
Lemmus sp.		1	
Arvicola terrestris L.			
Mimomys (Cromeromys) intermedius Newton (M_1, M^3)	1	2	23
M. (Microtomys) pusillus Mehely (M_1, M^3)	4		26
Mimomys sp.	17	8	
Arvicola mosbachensis Schmidtgen			30 (incl. 4M_1, 2M^3)
Allophajomys pliocaenicus Kormos (M_1)			2
Microtus (Pitymys) hintoni Kretzoi (M_1)		1	30
M. (P.) gregaloides Hinton (M_1)	4		44
M. ex gr. *malei - huperboreus* (M_1)	1	1	11
M. ex gr. *arvalis - agrestis* (M_1)	4	1	24
M. (Stenocranius) gregalis Pallas (M_1)	1		11
M. ex gr. *oeconomus* Pallas (M_1)	2		17
Microtus sp.	71	23	469

Palaeomagnetic investigations

Section I (Suleimanova, 1987, 1992) (Fig. 33). The total thickness of studied deposits is 11 m. The sampling was detailed; 46 stratigraphical levels were investigated. The section shows a normal polarity and is correlated to the Brunhes palaeomagnetic Epoch. F. I. Suleimanova found intervals with palaeomagnetic anomalies in the Kaluga and Chui-Atasevo horizons.

Section II (Suleimanova, 1987, 1992) (Fig. 34). The total thickness of studied deposits is 4 m. 15 stratigraphical levels were investigated. The section shows a normal polarity and is correlated to the Brunhes Epoch.

Section III (Suleimanova, 1987, 1992). 26 stratigraphical levels were investigated. F.I. Suleimanova found intervals with anomal polarity in the deposits of the Chui-Atasevo horizon. The section shows a normal polarity and correlates to the Brunhes Epoch.

Section V (Suleimanova, 1987, 1992) (Fig. 35). The total thickness of studied deposits is 18 m. The sampling was detailed; 67 stratigraphical levels were investigated. The section shows a normal polarity and is correlated to the Brunhes palaeomagnetic Epoch. F. I. Suleimanova found an interval with anomalous polarity in deposits of the Kaluga Horizon and correlated this interval with the Chagan Event.

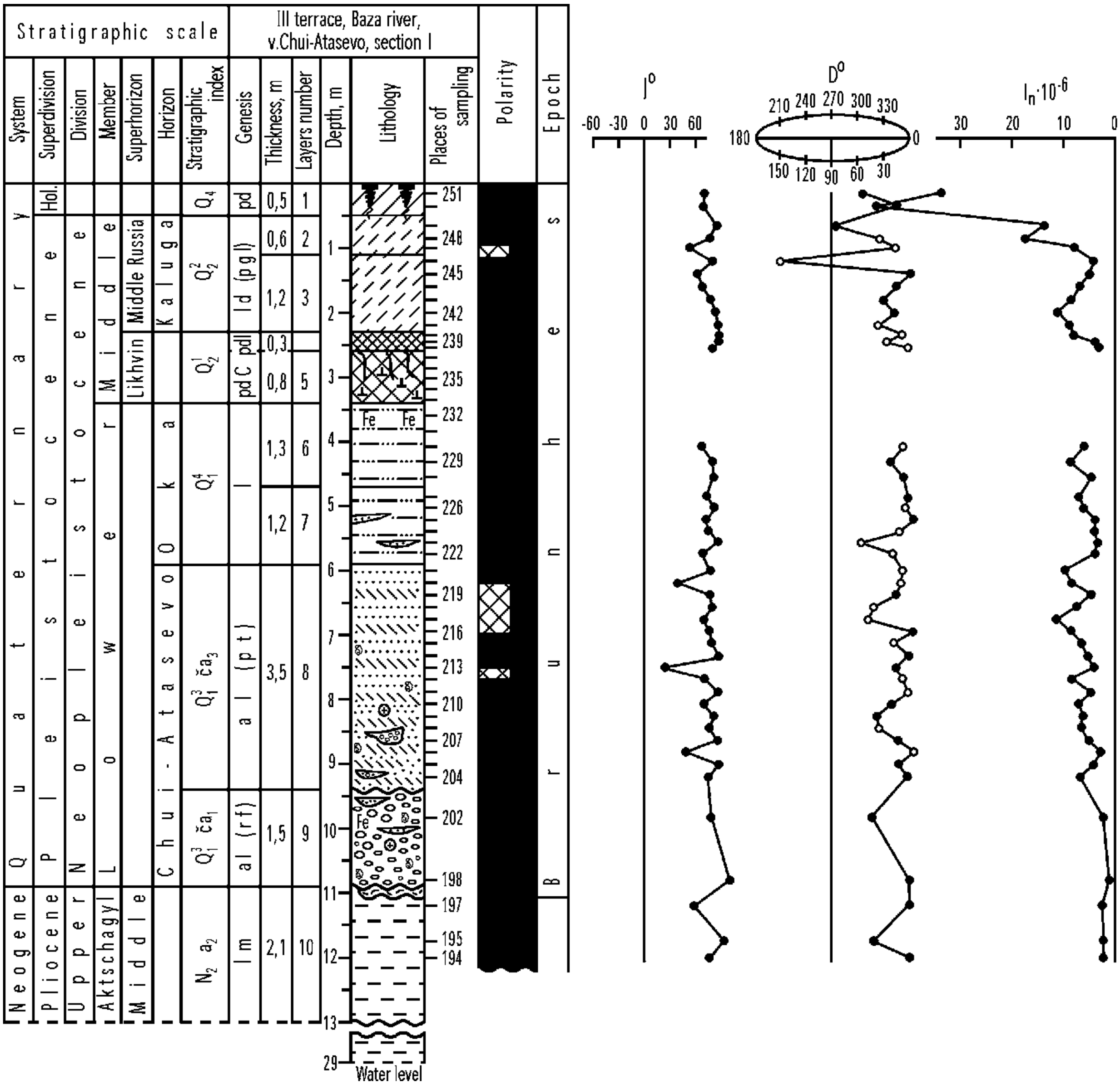

Fig. 33. The Chui-Atasevo palaeomagnetic section I (by F.I. Suleimanova, V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev, 1987). Legend see Fig. 10.

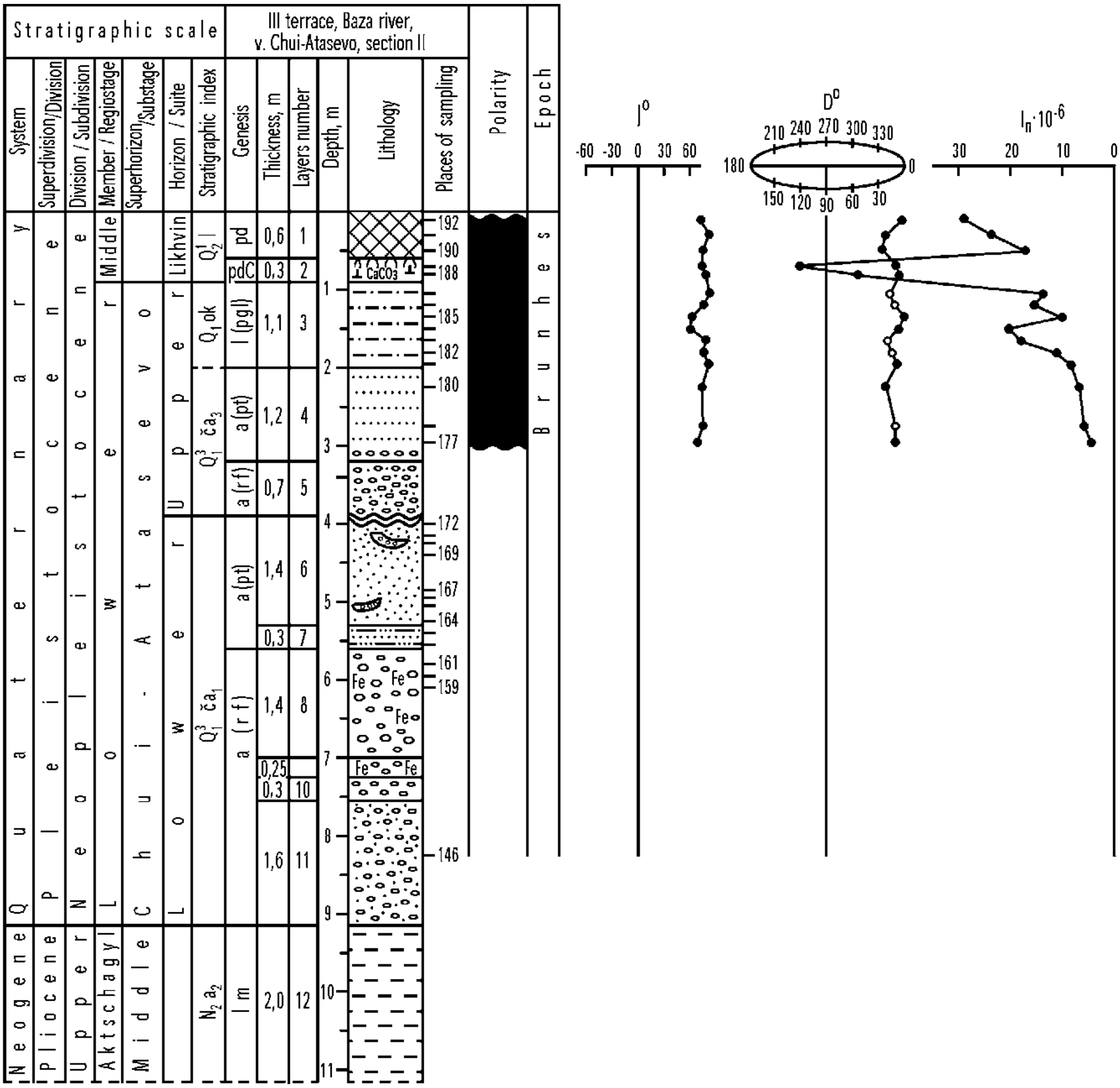

Fig. 34. The Chui-Atasevo palaeomagnetic section II (by F.I. Suleimanova, V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev, 1987). Legend see Fig. 10.

Problems

The composition of the small mammal fauna from section I, layer 8 is remarkable and it is difficult to draw conclusions about the age of the fauna. Molars of the genus *Mimomys* are common and remains of *Prolagurus posterius* Zazhigin and *Arvicola mosbachensis* Schmidtgen are also identified. Faunas with *Arvicola mosbachensis* Schmidtgen and without *Mimomys* are well known from deposits with a Likhvin Interglacial age. Molars referred to *Arvicola terrestris* L. from Chui-Atasevo section I, layer 8 look more archaic than those with a Likhvin age: the degree of differentiation of the enamel corresponds to that of the *Mimomys* molars.

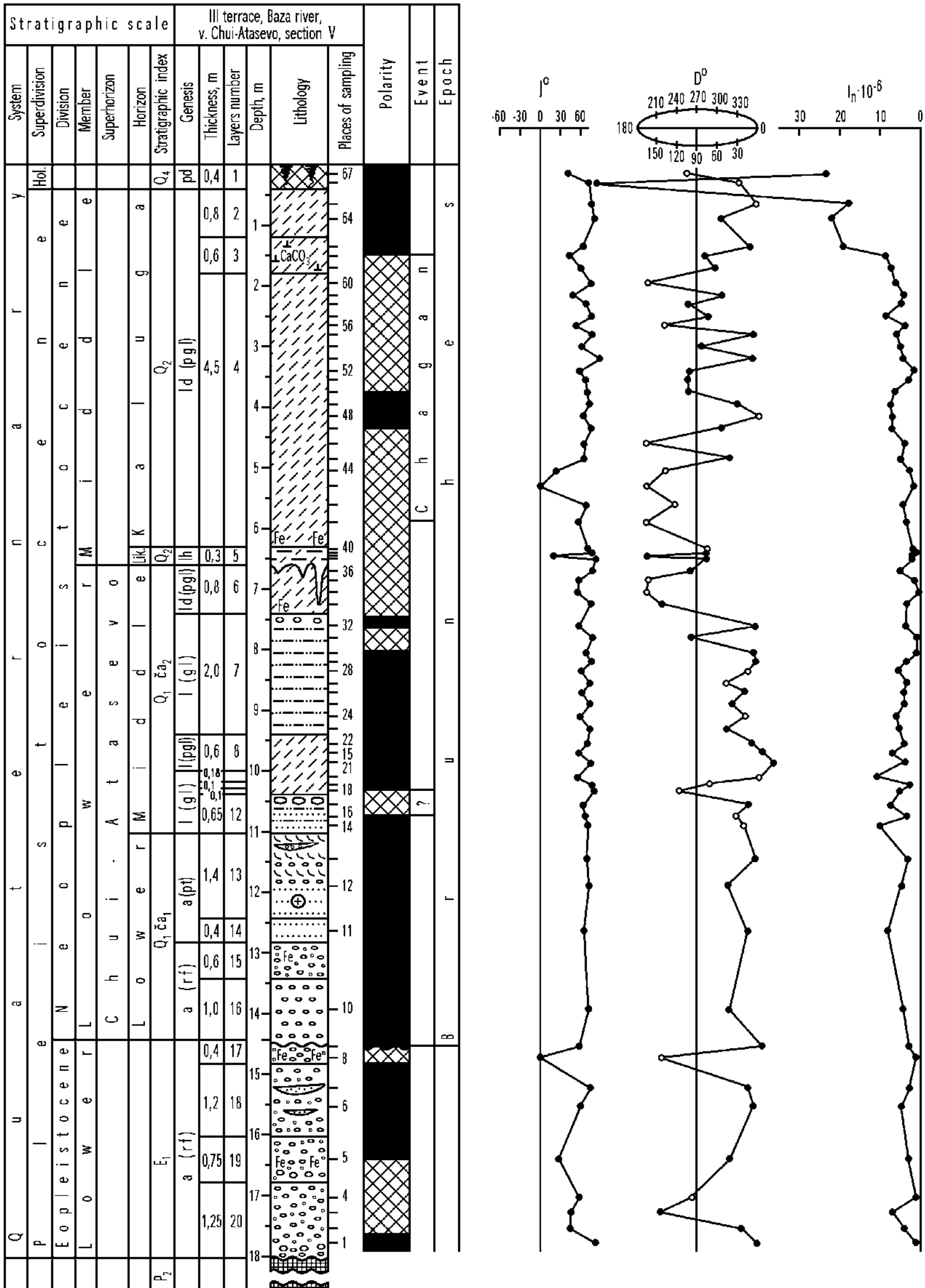

Fig. 35. The Chui-Atasevo palaeomagnetic section V (by F.I. Suleimanova, V.L. Yakchemovich, G.A. Danukalova and A.G. Yakovlev, 1987). Legend see Fig. 10.

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THE ILENKA SECTIONS

Locality

The sections are located in the valley Ilenka between the villages Iltyuganovo and Aktyuba (Karmaskaly Region, Bashkortostan Republic) (Fig. 1).

The Pliocene and Pleistocene deposits occur here as multi-storied terraces (Fig. 36, 37).

History

In 1977 V.L. Yakchemovich, M.G. Popova-Lvova, A.G. Petrenko, Yu.M. Petrov and V.A. Koblov studied the sections.

In 1979, 1986, 1987 V.P. Sukhov, A.G. Yakovlev and G.A. Danukalova collected small mammal remains and molluscs.

The small mammal remains were identified by A.G. Yakovlev and V.P. Sukhov (Ufa), the molluscs by G.A. Danukalova (Ufa), the ostracods by M.G. Popova-Lvova (Ufa) and the pollen and spores by L.I. Alimbekova (Ufa).

Description of the sections

Section I

The section is located on the right bank of the river Ilenka 200–300 m upstream from the bridge. The following layers are identified in the section (Fig. 38).

Neogene

Upper Pliocene

Middle Aktschagyl

(limanian deposits – *lm (mal)*)

Thickness, m

1. Gravels with roots of plants changed by soil formation…………………………………………….0,4

2. Light brown (with a pink tint) clayey thin laminated silt. The thickness of light grey and yellow fine sandy interbeds is 0,1–3 cm……………………………………………………………………...0,5

3. Light coloured ferruginous gravel with large sub angular pebbles (diameter 2–10 cm) of limestone (80 %) and flint and quartz (20 %)…………………………………………………………………..0,2–0,5

4. Clayey silt (similar to the silt of the layer 2) with a sinuous lens (thickness is 20–30 cm) of coarse gravel……………………………………………………………………………………………..1,2

5. Fine gravel similar to the gravel of the layer 3………………………………………………0,2–0,4

6. Light grey silt with thin interbeds of sand, fine and coarse gravel with ostracods: *Ilyocypris bradyi* Sars (31), *Candona* sp. (1), juvenile *Candonen* (40), *Cytherissa lacustriformis* M.Popova (45), *C. torulosa* (M.Popova) (19), *Prolimnocythere inderica* (Scharap.) (8), *P. inderica kumurliensis* (M.Popova) (39), *P. tenuireticulata* (Suz.) (2), *Loxoconcha varia* Suz. (4), *Cyprideis torosa* (Jones) (6)...................0,4–1

7. Fine and middle gravel with interbeds of sand and silt (thickness is 2–5 cm) and with iron staining in the upper part of the layer……………………………………………………………...0,6–0,9

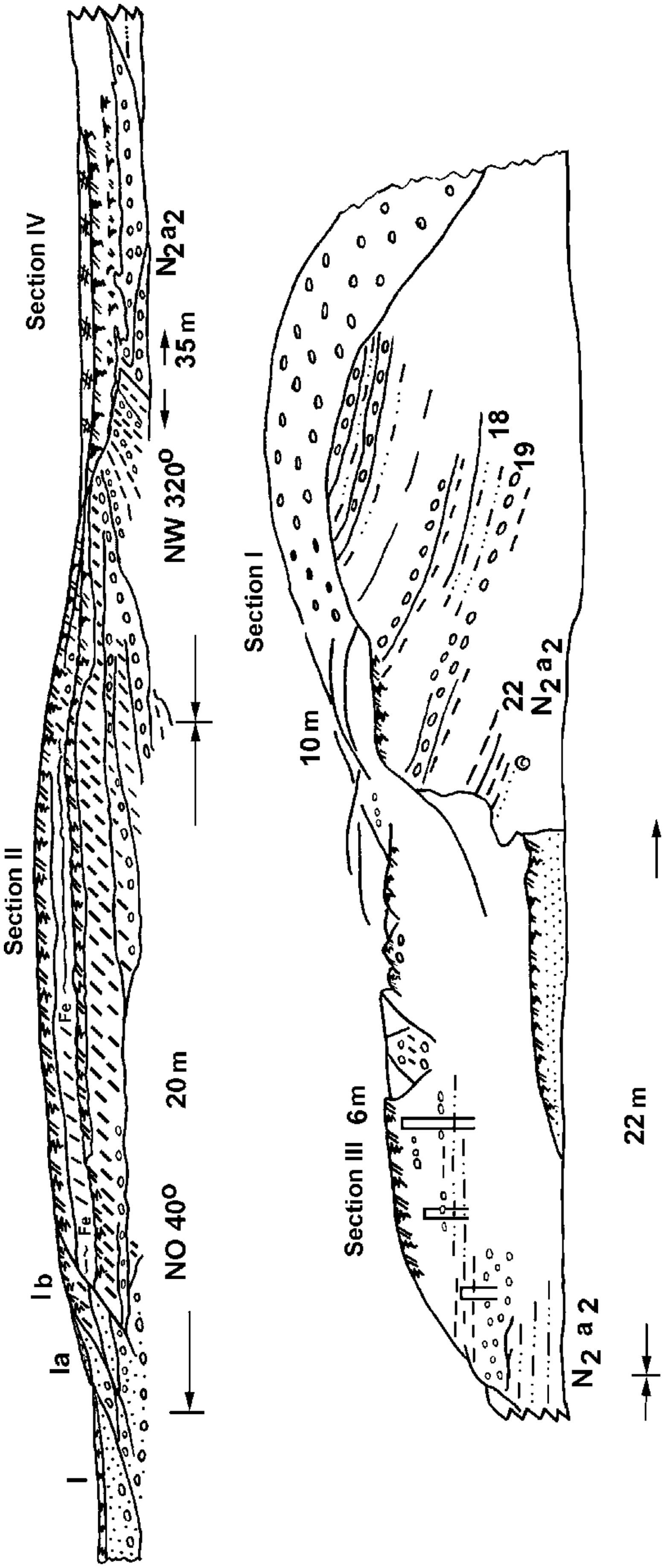

Fig. 36. Scheme of the terraces and the location of the sections in the valley Ilenka

Fig. 37. Panoramic view on the Ilenka sections

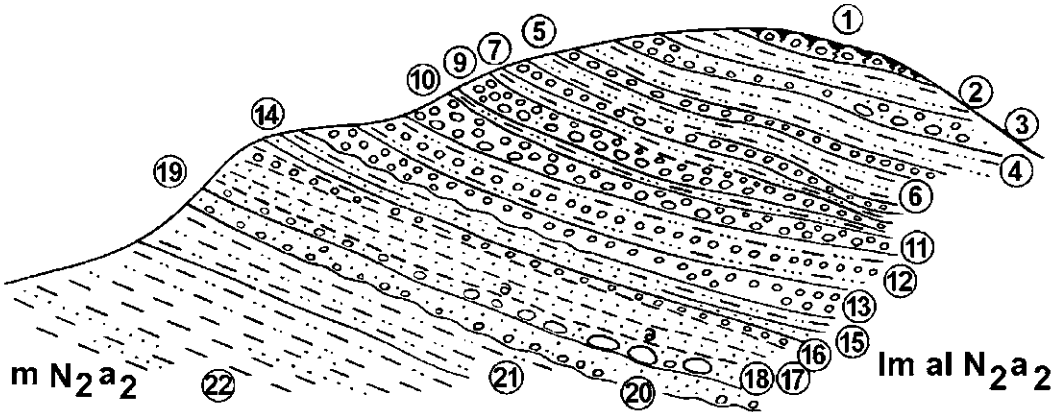

Fig. 38. The Ilenka Section I

8. Silt with thin interbeds (thickness is 7 cm) of iron-stained gravel……………………………….0,4

9. Fine iron-stained gravel with four silty interbeds (thickness is 2–5 cm)…………………………0,7

10. Light grey thin bedded clayey silt with ostracods: *Ilyocypris bradyi* Sars (25), *Candona neglecta* Sars (3), juvenile *Candonen* (29), *Cytherissa lacustriformis* M. Popova (5), *Prolimnocythere tenuireticulata* (Suz.) (7), *P. inderica* (Scharap.) (6), *P. inderica kumurliensis* (M. Popova) (98), *Loxoconcha varia* Suz. (2) and *Cyprideis torosa* (Jones) (1)……………………………………………………….0,15–0,2

11. White middle gravel with rare gastropods *Valvata* cf. *piscinalis* Müll. (4 juv. fragments), *Valvata* sp. (1 fragment) and ostracods *Ilyocypris bradyi* Sars (1), *Candona neglecta* Sars (1), *Cytherissa lacustriformis* M. Popova (1)……………………………………………………………………………………1

12. Alternation of silt and gravel (thickness is 2–5 cm) with ostracods *Ilyocypris bradyi* Sars (21), juvenile *Candonen* (12), *Cytherissa lacustriformis* M.Popova (1), *Prolimnocythere inderica* Scharap. (6), *P. inderica kumurliensis* M.Popova (41), *Loxoconcha varia* Suz. (1) and *Cyprideis torosa* (Jones) (1)……..1,2–1,5

13. Gravels with interbeds (thickness is 5 cm) of brown silty clay in the lower part and with *Ilyocypris bradyi* Sars (2), *Cytherissa lacustriformis* M. Popova (1) and *Loxoconcha varia* Suz. (1)………0,8–0,9

14. Greyish-brown silt thin laminated clay with interbeds of silt and fine grained iron-stained sand. Interbeds (thickness is 3–4 cm) of yellow gravel with brown sand occur in the middle part of the layer. Rare gastropods *Valvata* cf. *piscinalis* Müll. (1 juv. fragment), *Clessiniola* sp. (cf. *julaevi* G. Ppv.) (1) and ostracods *Ilyocypris bradyi* Sars (4), juvenile *Candonen* (19), *Cytherissa lacustriformis* M. Popova (37), *C. torulosa* M. Popova (16), *Leptocythere litica* Liv. (1), *Prolimnocythere inderica* Scharap. (4), *P. inderica kumurliensis* M. Popova (31) and *Loxoconcha varia* Suz. (3) occur……………………..0,4

15. Brownish-grey middle-grained polymictic sand with thin (2 cm) interbeds of gravel and with ostracods *Ilyocypris bradyi* Sars (11), juvenile *Candonen* (26), *Cytherissa lacustriformis* M. Popova (3), *C. torulosa* M. Popova (1), *Prolimnocythere inderica* (Scharap.) (27), *Prolimnocythere inderica kumurliensis* M. Popova (13) and *Loxoconcha varia* Suz. (1)……………………………………………………0,4

16. Alternation of thin bedded brownish-grey aleuritic clay and fine shingle (thickness of interlayers is 2–10 cm) with ostracods *Ilyocypris bradyi* Sars (7), juvenile *Candonen* (16), *Cytherissa lacustriformis* M.Popova (25), *C. torulosa* M.Popova (12), *Prolimnocythere tenuireticulata* (Suz.) (2), *P. inderica* Scharap. (32) and *Loxoconcha varia* Suz. (1)……………………………………………………0–1,2

17. Alternation of grey clay, greyish-brown silts and yellow fine sand (the thickness of the interbeds is 1–4 cm). Molluscs *Clessiniola* cf. *julaevi* G. Ppv. (24), *Clessiniola* sp. (22), *Valvata* sp. (cf. *piscinalis* Müll.) (10) and ostracods *Ilyocypris bradyi* Sars (34), *Candona neglecta* Sars (1), juvenile *Candonen* (24), *Candona parallela* G. Müll. (3), *Cytherissa lacustriformis* M. Popova (136), *C. torulosa* M. Popova (49), *Prolimnocythere tenuireticulata* (Suz.) (53), *P. inderica* Scharap. (1), *P. inderica kumurliensis* M. Popova (5), *Loxoconcha varia* Suz. (29) were identified……………………………………………………0,8

18. Alternation of yellow, brownish-grey fine sand and brownish-grey aleuritic clay (thickness of interlayers is 3–7 cm) with mollusks *Clessiniola julaevi* G. Ppv. (42), *Valvata piscinalis* Müll. (6), *V. pulchella Müll.* (1), *Dreissena polymorpha* (Pall.) (2), *Pisidium amnicum* Müll. (6) and ostracods *Ilyocypris bradyi* Sars (45), juvenile *Candonen* (11), *Eucypris* sp. (1 juv.), *Cytherissa lacustriformis* M.Popova (42), *C. torulosa* M.Popova (14), *Mediocytherideis apatoica* (Schw.) (2), *Prolimnocythere tenuireticulata* (Suz.) (17), *P. inderica* (Scharap.) (54), *P. inderica kumurliensis* M.Popova (49), *Loxoconcha varia* (Suz.) (17), *Cyprideis torosa* (Jones) (19 Alternation of yellow, brownish-grey fine sand and brownish-grey silty clay (the thickness of the interbeds is 3–7 cm) Molluscs *Clessiniola julaevi* G. Ppv. (42), *Valvata piscinalis* Müll. (6), *V. pulchella Müll.* (1), *Dreissena polymorpha* (Pall.) (2), *Pisidium amnicum* Müll. (6) and ostracods *Ilyocypris bradyi* Sars (45), juvenile *Candonen* (11), *Eucypris* sp. (1 juv.), *Cytherissa lacustriformis* M. Popova (42), *C. torulosa* M. Popova (14), *Mediocytherideis apatoica* (Schw.) (2), *Prolimnocythere tenuireticulata* (Suz.) (17), *P. inderica* (Scharap.) (54), *P. inderica kumurliensis* M. Popova (49), *Loxoconcha varia* (Suz.) (17) and *Cyprideis torosa* (Jones) (19) occur………………………………1,2

19. Gravels with large boulders and pebbles……………………………………………………..1,5

20. Greyish-brown sand with iron-stained interbeds with molluscs *Clessiniola julaevi* G. Ppv. (4) and ostracods *Ilyocypris bradyi* Sars (41), juvenile *Candonen* (30), *Cytherissa lacustriformis* M. Popova (33), *C. torulosa* M. Popova (8), *Mediocytherideis apatoica* (Schw.) (1), *Prolimnocythere tenuireticulata* (Suz.) (5), *P. inderica* (Scharap.) (5), *Loxoconcha varia* Suz. (6) and *Cyprideis torosa* (Jones) (49)……….0,5

Sedimentary break.

Middle Aktschagyl

(marine deposits – *m*)

21. Brown silty clay and iron-stained interbeds with molluscs *Valvata pulchella* Müll. (1 fragment), *Clessiniola julaevi* G. Ppv. (82), *Dreissena* sp, ?*Scalaxis* sp. and ostracods *Ilyocypris bradyi* Sars (140), *Cypria candonaeformis* (Schw.) (4), *Candona neglecta* Sars (1), juvenile *Candonen* (8), *Cytherissa torulosa* M. Popova (4), *Mediocytherideis apatoica* (Schw.) (1), *Prolimnocythere tenuireticulata* (Suz.) (7), *P. inderica* (Scharap.) (127), *Loxoconcha varia* Suz. (22), *Cyprideis torosa* (Jones) (997)………..1

22. Grey silty clay with molluscs *Valvata* sp. (1 juv.), *Clessiniola julaevi* G. Ppv. (48), *Aktschagylia subcaspia* (Andrus.) (4), *Dreissena* sp. (5) and ostracods *Ilyocypris bradyi* Sars (111), *Cypria candonaeformis* (Schw.) (373), juvenile *Candonen* (45), *Cytherissa torulosa* M. Popova (21), *Mediocytherideis apatoica* (Schw.) (8), *Prolimnocythere inderica* (Scharap.) (617), *P. tenuireticulata* (Suz.) (60), *Denticulocythere producta* (Jask. et Kaz.) (5), *D. scharapovae* (Schw.) (3), *Loxoconcha varia* Suz. (29), *Cyprideis torosa* (Jones) (505). Interbeds (thickness is 2–3 cm) of light grey fine sand occurred in the lower part. The observed thickness is……………………………………………………………………………..2

Talus…………………………………………………………………………………………1,5

Water level / base of the section.

Section II

The section is located on the right bank of the river Ilenka in 300 m downstream of the section I. The upper part of the section was observed in the western side of the gully (Fig. 36).

Quaternary

Holocene – Q_4

(subaerial deposits – *pd)*

Thickness, m

pd A 1. Dark grey soil with rare small pebbles of flint and limestone, with fossil burrows (diameter is 4–5 cm) filled by the same loam that occurs in layer 2……………………………………………..0,2

pd AB 2. Dark brownish-grey loamy soil with carbonate and pebbles (flint, quartz, limestone)…….0,15

Pleistocene

Lower-Upper**(?)** Neopleistocene

(subaerial deposits – *pd B*)

3. Dark greyish-brown dense loam with carbonate and fossil burrows (diameter is 10 cm) filled by soil sediments from the layer 1…………………………………………………………………….……0,2

Upper Eopleistocene

(lacustrine, lacustrine-subaerial deposits – *l pd B l*)

4. Brown with pink tint silty loam with rare small concretions of carbonate…………………………0,3

5. Laminated silty clay (thickness of interbeds is 3–5 cm) with carbonate and fossil mole burrows (diameter is 6–10 cm)……………………………………………………………………………………...0,35

6. Reddish-brown polymictic fine clayey sand with small lenses of detritus (*Dreissena* sp.)………...0,2

pd B l 7. Reddish-brown iron-stained loam (hydromorphic soil) with ostracods: *Ilyocypris bradyi* Sars (23), *Candona* sp. (2), juvenile *Candonen* (4), *Eucypris famosa* Schn. (1), *Eucypris* sp.$_1$, *Eucypris* sp.$_2$, *Prolimnocythere tenuireticulata* (Suz.) (2), *Denticulocythere scharapovae* (Schw.) (1), *Loxoconcha varia* Suz.* (1). White marl concretions (the length is 20 cm) occur in the lower and middle part of the layer..0,45

Lower Eopleistocene

Davlekanovo Horizon, upper subhorizon – *E ap$_2$ dv$_2$*

(lacustrine-subaerial deposits – *pd l*)

8. Brownish-green clay with interbeds (thickness 3–4 cm) of clayey silt with wedges filled by red coloured soil (width 4–8 cm)……………………………………………………………………………..0,25

Davlekanovo Horizon, upper (?) subhorizon – *E ap$_2$ dv$_1$*

(lacustrine-subaerial deposits – *pd B l*)

9. Reddish-orange clay (hydromorphic soil) with ostracods: *Ilyocypris bradyi* Sars (32), *Ilyocypris inermis* Kauf. (57), *Ilyocypris* aff. *inermis* Kauf. (17), *Ilyocypris* aff. *biplicata* (Koch.) (1), *Cypria*

* Redeposited Aktchagylian species

candonaeformis (Schw.) (1), *Candona* aff. *visenda* Schn. (1), *Eucypris famosa* Schn. (34), *Eucypris* sp. (7), *Zonocypris membranae* Liv. (1), *Prolimnocythere tenuireticulata* Suz. (4), *P. chabarowensis* M. Popova (1), *Denticulocythere producta* (Jask. et Kaz.) (3), *Loxoconcha varia* Suz.* (5), *Cyprideis torosa* (Jones) (5). The fine gravel (thickness 2–10 cm) and yellowish-grey clayey silt occur at the base……………………………………………………………………………………………….0,4

Sedimentary break.

Dema Horizon, upper subhorizon – $E\ ap_1\ d_2$

(lacustrine deposits – *l*)

10. Greyish-orange iron-stained clay with ostracods *Ilyocypris bradyi* Sars (36), *Ilyocypris inermis* Kauf. (2), *Cyclocypris laevis* (O. Müll.) (2), *Cypria candonaeformis* (Schw.) (1), *Candona parallela* G. Müll (11), *Candona* sp. (1), *C. balatonica* Daday (1), juvenile *Candonen* (38), *Eucypris famosa* Schn. (4), *Prolimnocythere tenuireticulata* (Suz.) (1), *Denticulocythere scharapovae* (Schw.) (1), *D. producta* (Jask. et Kaz.) (1) and large carbonate concretions (10×5 cm, 20×5 cm)……………………………..0,3

11. Greyish-brown iron-stained clay with molluscs *Dreissena polymorpha* (Pall.) and ostracods *Ilyocypris bradyi* Sars (5), *Cypria candonaeformis* (Schw.) (5) and *Cyprideis torosa* (Jones) (2)………………0,2

12. Yellowish-grey laminated (thickness is 1–5 cm) fine- and middle-grained sand with *Ilyocypris bradyi* Sars (9), *Ilyocypris inermis* Kauf. (5), *Cypria candonaeformis* (Schw.) (63), *Prolimnocythere tenuireticulata* (Suz.) (3), *Cyprideis torosa* (Jones) (1). The horizon of carbonaceous concretions (thickness is 5 cm) located in the middle part of the layer. Under this horizon the sand becomes yellow, clayey and iron-stained (thickness is 7 cm)……………………………………………………………………….0,4

Dema Horizon, lower subhorizon – $E\ ap_1\ d_{1\text{-}2}$

(lacustrine-subaerial, alluvial deposits – *pd B, l, a*)

13. Light greenish-grey carbonaceous iron-stained clay (hydromorphous soil) with gastropods: *Succinea oblonga* Drap. (26), *Vallonia costata* Müll. (11), *Valvata pulchella* Müll. (1 fragment), *Vertigo* cf. *substriata* Jeff. (1), *Clessiniola* sp. (4) and ostracods *Prolimnocythere inderica* (Scharap.) (1)…………………0,2

a 14. Light grey bedded (the order of lamination is 5–20 cm) fine gravel with pebbles of angulated limestone (95%) and a matrix of un-sorted coarse polymictic clayey sand. Shells of *Pisidium* sp. occurred……………………………………………………………………………………………..1,4

Sedimentary break.

Neogene

Upper Aktschagyl

Voevodskoye Suite – $N_2\,a_3\,vv$

(limanian, lacustrine, alluvial, lacustrine-subaerial deposits – *lm, l, a, pd l*)

15. Greyish-yellow laminated silt with thin interbeds (thickness 2 cm) of yellowish-grey siltyclay and pebble lenses (thickness 15 cm). Otracods: *Ilyocypris bradyi* Sars (3), *Ilyocypris inermis* Kauf. (4), *Cypria candonaeformis* (Schw.) (4), juvenile *Candonen* (6), *Prolimnocythere tenuireticulata (Suz.)* (6), *P. inderica* (Scharap.) (5), *Denticulocythere producta* (Jask. et Kaz.) (4) *Paracyprideis naphtatscholana* (Liv.) (180)……………………………………………………………………………………1,8

16. Alternation of yellowish-grey and grey clays, light brown micro-laminated silt and yellow fine clayey sand (the order of lamination is 1–2 cm) with ostracods *Cypria candonaeformis* (Schw.) (2), *Cyprideis torosa* (Jones) (12), *Prolimnocythere tenuireticulata* (Suz.) (1). Also large iron-stained concretions occurred (length is 4–7 cm)……………………………………………………………………1,2

al 17. Light brownish-grey clayey thin-bedded sand with interbeds of gravel in the base (thickness 2 cm) and and with juvenile *Candonen* (2)…………………………………………………………………..0,6

l 18. Alternation of thin laminated light grey clay, yellow fine sand with rare *Cypria candonaeformis* (Schw.) (1) the order of lamination is 1–5 mm……………………………………………………..0,4

al 19. Light yellow laminated iron-stained fine- and medium-grained sand with thin (thickness 1 cm) interbeds of grey clay and ostracods *Cypria candonaeformis* (Schw.) (2), *C. pseudoarma* M. Popova (1), juvenile *Candonen* (4) and *Cyprideis torosa* (Jones) (3)…………………………………………...0,6

Sedimentary break.

pd B l 20. Dark greenish-grey clay (hydromorphic soil) with rare flint pebbles…………………….0,15

Middle Aktschagyl

Akkulaevo Suite – $N_2\,a_2$ *akk*

(limanian deposits – *lm, l*)

21. Greenish-grey iron-stained fine clayey sand with gravel at the base (thickness 0–15 cm) and with ostracods juvenile *Candonen* (2) and *Loxoconcha varia* Suz. (2)……………………………………1,2

Sedimentary break.

22. Yellowish-brown polymictic fine clayey sand with small pebbles (with a diameter of less than 1,5 cm)…………………………………………………………………………………………...1

23. Greyish-brown horizontally bedded fine polymictic sand with thin interbeds of grey clay (thickness 2–3 cm) and yellow sand (thickness 1–2 cm). Detritus beds with *Clessiniola* sp. (4) and ostracods *Ilyocypris bradyi* Sars (125), *Ilyocypris* aff. *inermis* Kauf. (66), *Cypria candonaeformis* (Schw.) (1140), *C. pseudoarma* M. Popova (10), *Candona neglecta* Sars (8), *Candona neglecta* juv. (420), *Cytherissa torulosa* M. Popova (9), *Prolimnocythere tenuireticulata* (Suz.) (2), *P. inderica* (Scharap.) (323), *Cyprideis torosa* (Jones) (1230) and *Loxoconcha varia* Suz. (2)……………………………………………………………...0,9

24. Light greyish-brown fine polymictic sand. The observed thickness is…………………………...3

Section III

The section III located in the III over floodplain terrace on the right bank of the river Ilenka between the bridge and section I (Fig. 39). A Holocene soil and Upper Neopleistocene deposits (strip 0) cover more ancient deposits of the IV–V (?) floodplain terrace (strip1).

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

1. Black soil with plant roots and rare pebbles……………………………………………………..0,2

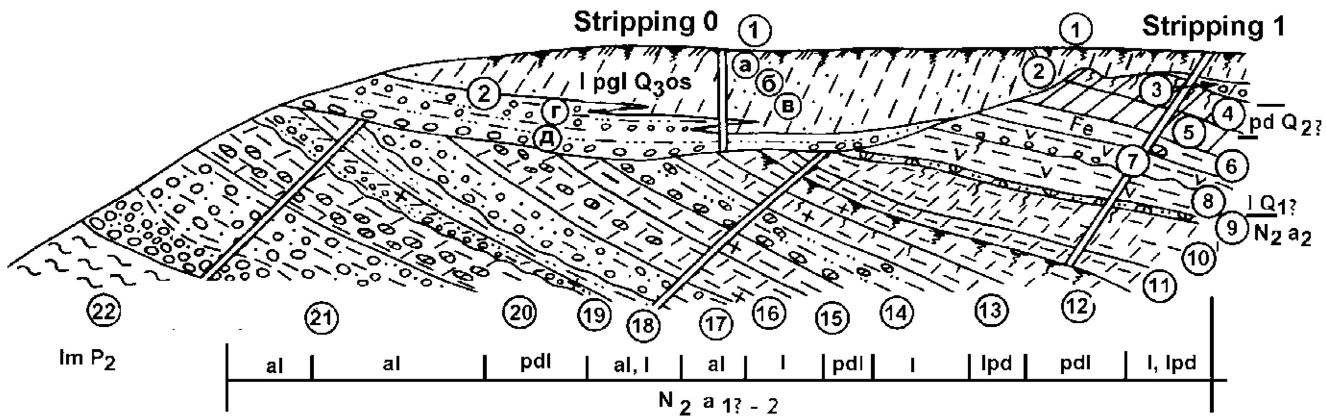

Fig. 39. The Ilenka Section III, strip 0, 1

Pleistocene

Upper Neopleistocene

Ostashkovo Horizon – Q_3^4 *os*

(lacustrine-periglacial deposits – *l pgl* (*pd AB*, *B*))

pd AB 2. Yellowish-brown loam with a humic-rich upper part…………………………………...0,25

pd B 3. Yellowish-brown carbonaceous macroporous loam with pebbles, mole burrows (diameter is 6 cm) filled by soil…………………………………………………………………………………………0,3

Middle (?) Neopleistocene – $Q_{2?}$

(lacustrine deposits – *l (pd BC)*)

4. Greyish-brown loam with white carbonaceous concretions (diameter less than 3 cm) with a precipitation of manganese……………………………………………………………………………………..0,6

Lower (?) Neopleistocene – $Q_{1?}$

(lacustrine deposits – *l*)

5. Dark brown dense loam with fossil mole burrows (diameter 7–8 cm) filled with loam of layer 4…….0,7

Sedimentary break.

6. Light iron-stained clay (yellow, greyish-brown) with limestone concretions (diameter less than 3 cm)…………………………………………………………………………………………...0,4

7. Dark greyish-brown iron-stained clay with cristallized gypsum…………………………………...0,4

Sedimentary break.

8. Clay similar to the clay of layer 7 with fossil mole burrows and ostracods *Ilyocypris bradyi* Sars (500), *I. gibba* (Ramd.) (49), *Candona rectangulata* Alm. (2), juvenile *Candonen* (8), *Limnocythere* aff. *sanctipatricii* Br. et. Rob. (1)……………………………………………………………………….0,8

Neogene

Upper Pliocene

Middle Aktschagyl

(limanian deposits – *lm rf*)

9. Greenish-grey silt with limestone concretions (size is 10×30 cm) and molluscs: *Succinea* sp. (1 fragment), *Vallonia costata* Müll. (13), Lymnaeidae (7), *Limnaea* (?) sp. (1 juv.), *Radix* sp. (21 juv.), *Galba* sp. (28), *Planorbis planorbis* L. (5), *Anisus vortex* (L.) (1), *Gyraulus gredleri* var. *rossmaessleri* Auersw. (103), *Armiger crista* (L.) (3), *Armiger crista* var. *inermis* Lindh. (1), *Valvata pulchella* Müll. (26 juv.), *V. piscinalis* (Müll.) (5), *V. cristata* Müll. (1), *Viviparus* sp. (1 juv.), *Bithynia* sp. (1 juv.), operculum (5), Gastropoda (1), *Dreissena polymorpha* (Pall.) (126), *Sphaerium* cf. *rivicola* Lam. (1 juv.), *Pisidium amnicum* Müll. (29 juv.), *Aktschagylia subcaspia* (Andrus.) (3). Small mammal remains are rare………………………………………………………………………………………...0,15–0,3

Lower (?) – Middle Aktschagyl

(lacustrine, alluvial deposits, soils – *l pd, a*)

l pd 10. Reddish-brown dense loam (soil) with small carbonaceous concretions (diameter 0,1–1 cm), rare sub-rounded pebbles and fossil mole-burrows (diameter 6 cm)……………………………………1

l 11. Dark reddish-brown loam with rounded pebbles of flint and sandstone………………………...0,4

l pd B 12. Reddish-brown dense loam with fossil mole-burrows (diameter is 5–6 cm) and rodents remains………………………………………………………………………………………..0,5–0,85

l pd 13. Dark reddish-brown loam with precipitation of hydrous ferric oxide, with manganese oolithes, pebbles of quartz and flint. Small mammal remains are rare………………………………………….0,4

l 14. Light brown silty clay with numerous limestone concretions (diameter 2–15 cm) and ostracods *Ilyocypris bradyi* Sars (1), *Eucypris famosa* Schn. (1), *Candona combibo* Liv. (1), *Denticulocythere* aff. *schweyeri* Karm. (1) and *Cyprideis torosa* (Jones) (3)……………………………………………..0,5–1

lpd 15. Dark reddish-brown carbonaceous dense loam (hydromorphic soil) with gravels with flint and quartz and with ostracods *Ilyocypris bradyi* Sars (3), *Cytherissa lacustriformis* M.Popova (1), *Denticulocythere* aff. *schweyeri* Karm. (2) and *Cyprideis torosa* (Jones) (24)…………………………………………..0,6

l 16. Light pinkish-brown iron-stained dense loam with fossil mole-burrows (diameter 6 cm), filled with reddish loam at the top and with thin interbeds of fine gravel at the base. Three horizons of large calcareous concretions (diameter 20 cm) occur in the middle part of the layer. Molluscs *Pisidium* sp. and *Dreissena* sp. and ostracods *Ilyocypris bradyi* Sars (5), *Cypria candonaeformis* (Schw.) (1), *C. pseudoarma* M. Popova (4), *Denticulocythere scharapovae* (Schw.) (3), *Prolimnocythere tenuireticulata* (Suz.) (1) and *Cyprideis torosa* (Jones) (30) were collected………………………………………………………………….1,2

al 17. Gravel of Permian deposits with red clay, brown sand and at the base a horizon of limestone concretions (size 10×30 cm). A layer of black manganese gravel (thickness 1–2 cm) occurs at the base…...1

l 18. Reddish-brown thin laminated silty clay with thin (thickness is several mm) interbeds of sand, fine pebbles of brown clay, black flint and grey limestone. Molluscs: *Succinea* sp. (1 fragment), *Vallonia costata* Müll. (380), *Pupilla muscorum* (L.) (40), *P.* cf. *mutabilis* Steklov (5), ?*Scalaxis* sp. (1 fragment), *Valvata piscinalis* Müll. (1), *Clessiniola julaevi* G. Ppv. (6 fragments), *Dreissena polymorpha* (Pall.) (22 fragments) and *Aktschagylia subcaspia* (Andrus.) (42)………………………………………….0,45 *a* 19. Alternation of reddish-brown loam, brown poorly sorted sands with small pebbles and molluscs *Vallonia costata* Müll. (24), *Clessiniola julaevi* G. Ppv. (1), Gastropoda (3), *Dreissena polymorpha* (Pall.) (1). Clayey and lenses of pebbles occur at the base. Small mammal remains were found at the top…...0,25

pd l 20. Reddish-brown silty dense loam with a precipitation of manganese, rare pebbles and two horizons of calcareous concretions (width is 3–10 cm, length is 10–40 cm)…………………………………...0,8

al 21. Poorly sorted gravels with small rounded and sub-rounded pebbles of black and light coloured flints, quartz, limestone and quartzitic sandstone and a matrix of greenish-grey clayey sand is………….1,6–2

Sedimentary break.

Middle Permian deposits. The observed thickness is…………………………………………………1,2

Section IV (II floodplain terrace)

Quaternary

Holocene

(subaerial deposits – *pd*)

Thickness, m

pd A 1. Black soil……………………………………………………………………………...0,2

Upper Neopleistocene

(subaerial, deluvial, lacustrine deposits – *pd, d, l*)

d 2. Light brown loam with thin interbeds of re-deposited dark grey soil…………………………….0,2

pd A_1 *l* 3. Dark brownish-grey soil……………………………………………………….0,2–0,25

pd A_2 *l* 4. Black soil with small pebbles of flint and quartz……………………………………...0,4

l 5. Dark grey loam with small pebbles at the base…………………………………………………0,2

Middle (?) Neopleistocene

(subaerial, lacustrine deposits – *pd, l*)

pd l 6. Dark grey hydromorphic soil with pebbles and iron staining…………………………………0,2

l 7. Dark grey loam with pebbles and pebble-lens at the base (thickness less than 7 cm)…………...0,15

Lower (?) Neopleistocene

(subaerial, alluvial-deluvial, alluvial deposits – *pd l, a-d, a(rf),*)

pd A l 8. Black hydromorphic soil……………………………………………………………..0,2

ad 9. Alternation of gravels (thickness is 15 cm) and dark brownish-grey loams (thickness is 3–7 cm) with brownish-grey poorly sorted polymictic sand…………………………………………………0,6

a(rf) 10. Gravel with medium- and large sized pebbles of quartz, flint, limestone…………………...0,6

Sedimentary break.

Neogene

Upper Pliocene

Middle Aktschagyl

(alluvial, limanian deposits – *a, lm*)

a 21 (11). Gravel with greenish-grey fine polymictic sand and rounded and sub-rounded pebbles of quartz, black and coloured flint and grey limestone……………………………………………………………..0,7

Sedimentary break.

lm 22 (12). Light yellow silt with thin interbeds (thickness up to 1 cm) of light grey clay. Ostracods: juvenile *Candonen* (1), *Cyprideis torosa* (Jones) (1) occur. The observed thickness is………………0,4

In the western part of the 2^{nd} floodplain terrace a fault (?Neogene in age) with an angle of 30–40° East has been observed in the layer 11. The following deposits cover the gravel of layer 11 (from the base to the top):

Neogene

Upper Pliocene

Middle Aktschagyl

(lacustrine deposits – *l*)

Thickness, m

20 (1). Light grey silty clay with juvenile *Candonen* (7)……………………………………………...0,2

Quaternary

Pleistocene

Eopleistocene

(alluvial, lacustrine deposits – *a(rf, pr), l)*

a(rf) 19 (2). Gravel with of rounded pebbles and with brownish-grey polymictic sand………………0,7

l 18 (3). Brownish-pink silty clay with ostracods *Ilyocypris bradyi* Sars (7), *I.* aff. *inermis* Kauf. (1), *Candona neglecta* Sars (1), *Candona neglecta* juv. (71) and *Prolimnocythere tenuireticulata* (Suz.) (5)…0,4

a(pr) 17 (4). Yellow polymictic fine sand with thin clayey interbeds……………………………...0,1

a(rf) 16 (5). Fine laminated gravels with pebbles, brown sand and clay………………………………..1

l 15 (6). Pinkish-brown clay with ostracods *Darwinula stevensoni* (Br. et Rob.) (2), *Ilyocypris bradyi* Sars (31), *I.* aff. *inermis* Kauf. (22), juvenile *Candonen (C. neglecta)* (53). At the base occurs a horizon of large marl concretions (size 5×5 – 15×10 cm)……………………………………………………...0,5

l 14 (7). Yellow iron-stained silty clay…………………………………………………………….0,15

l 13 (8). Greenish-grey clay with sandy interbeds (thickness is 5 cm). Ostracods: *Ilyocypris bradyi* Sars (5), *I.* aff. *inermis* Kauf. (10), *Candona combibo* Liv. (1), juvenile *Candonen* (9), *Prolimnocythere tenuireticulata* (Suz.) (5), *P. chabarowensis* M.Popova (6) and *Cyprideis torosa* (Jones) (150)……..0,6

l 12 (9). Yellow iron-stained clay…………………………………………………………..0,05–0,3

l 11 (10). Light grey silty clay……………………………………………………………………0,2

Vegetation

The Aktschagylian deposits were not rich in pollen. Spectra indicating a *Picea*-forest with a small percentage of *Pinus* are known from the lower part of the Middle Aktschagylian deposits (Section I).

During the Early Eopleistocene (Dema Suite) coniferous-deciduous forests with large open areas, covered by grassland-steppe associations dominated.

In the Upper Eopleistocene deposits only rare spores and pollen were found (Fig. 40–44).

Ostracods

The Early Aktschagylian ostacod complex from Section III is characterized by the typical Aktschagylian brackish water species *Prolimnocythere tenuireticulata* (Suz.) and *P. scharapovae* (Schw.).

The Middle Aktschagyl (Akkulaevo time) complex is characterized by numerous typical marine and brackish water species *Prolimnocythere tenuireticulata* (Suz.), *P. inderica* (Scharap.), *Cytherissa torulosa* M. Popova, *Loxoconcha varia* (Suz.), *Cytherissa torulosa*, *Leptocythere litica* and numerous fresh water species *Cypria*, and euryhaline *Cyprideis torosa* (Jones). During the regression the impoverishment of the ostracod fauna has been registered: marine species disappeared and rare, freshwater and brackish water species occurred: *Ilyocypris*, *Candona* and *Cytherissa*.

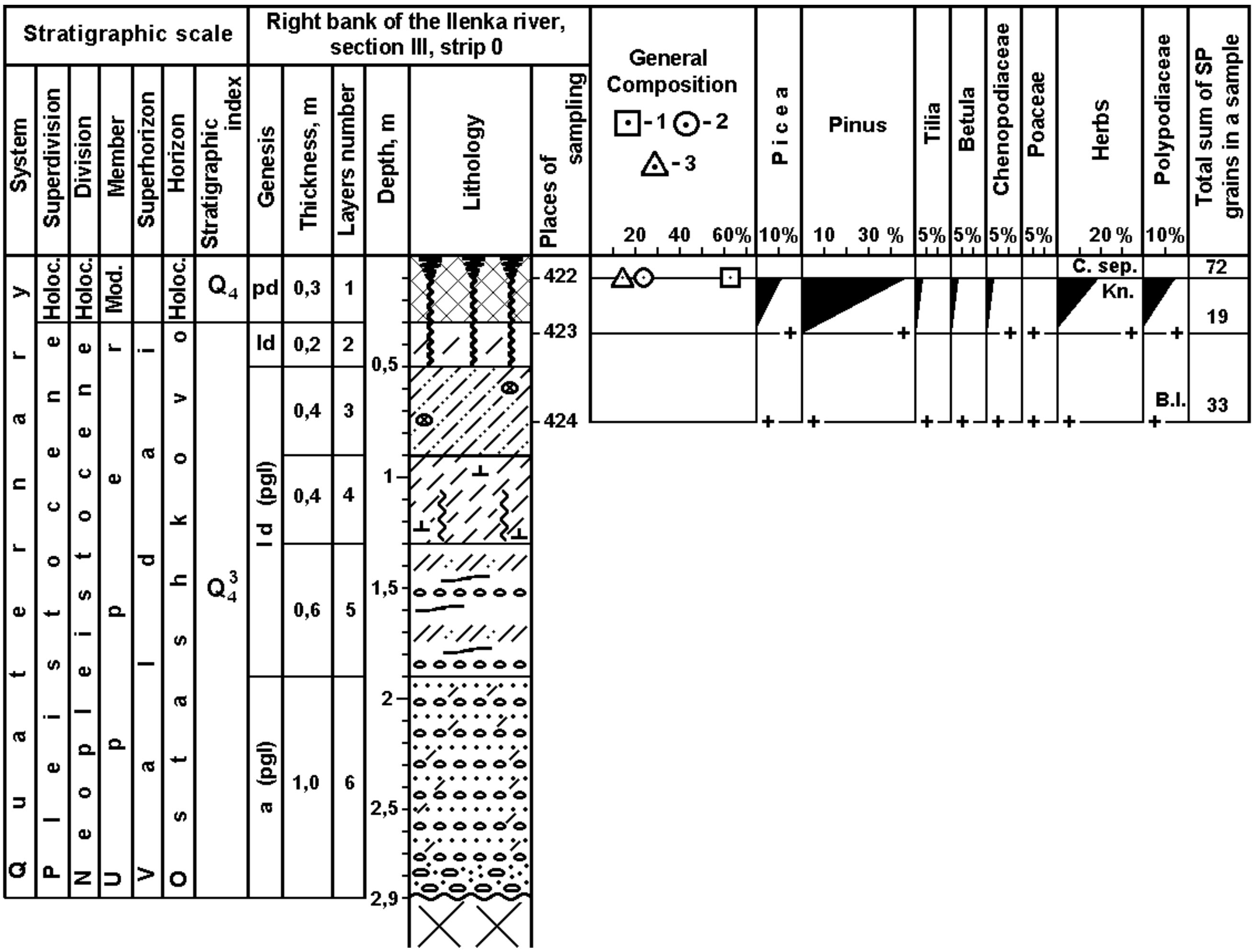

Fig. 40. Ilenka Section III (strip 0) and pollen diagram (by V.L. Yakchemovich and L.I. Alimbekova). Legend see Fig. 5 .

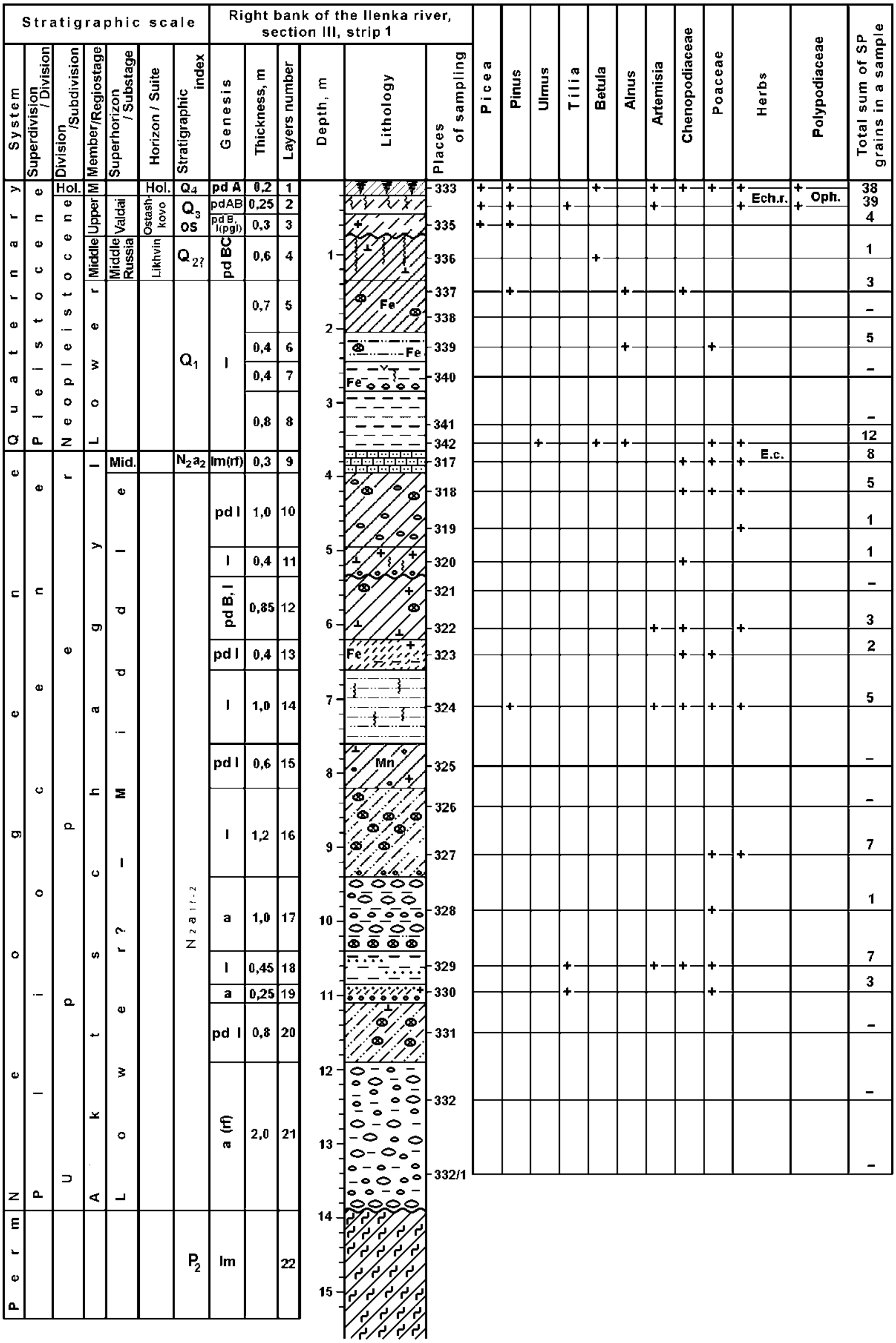

Fig. 41. Ilenka Section III (strip 1) and pollen diagram (by V.L. Yakchemovich and L.I. Alimbekova). Legend see Fig. 5 .

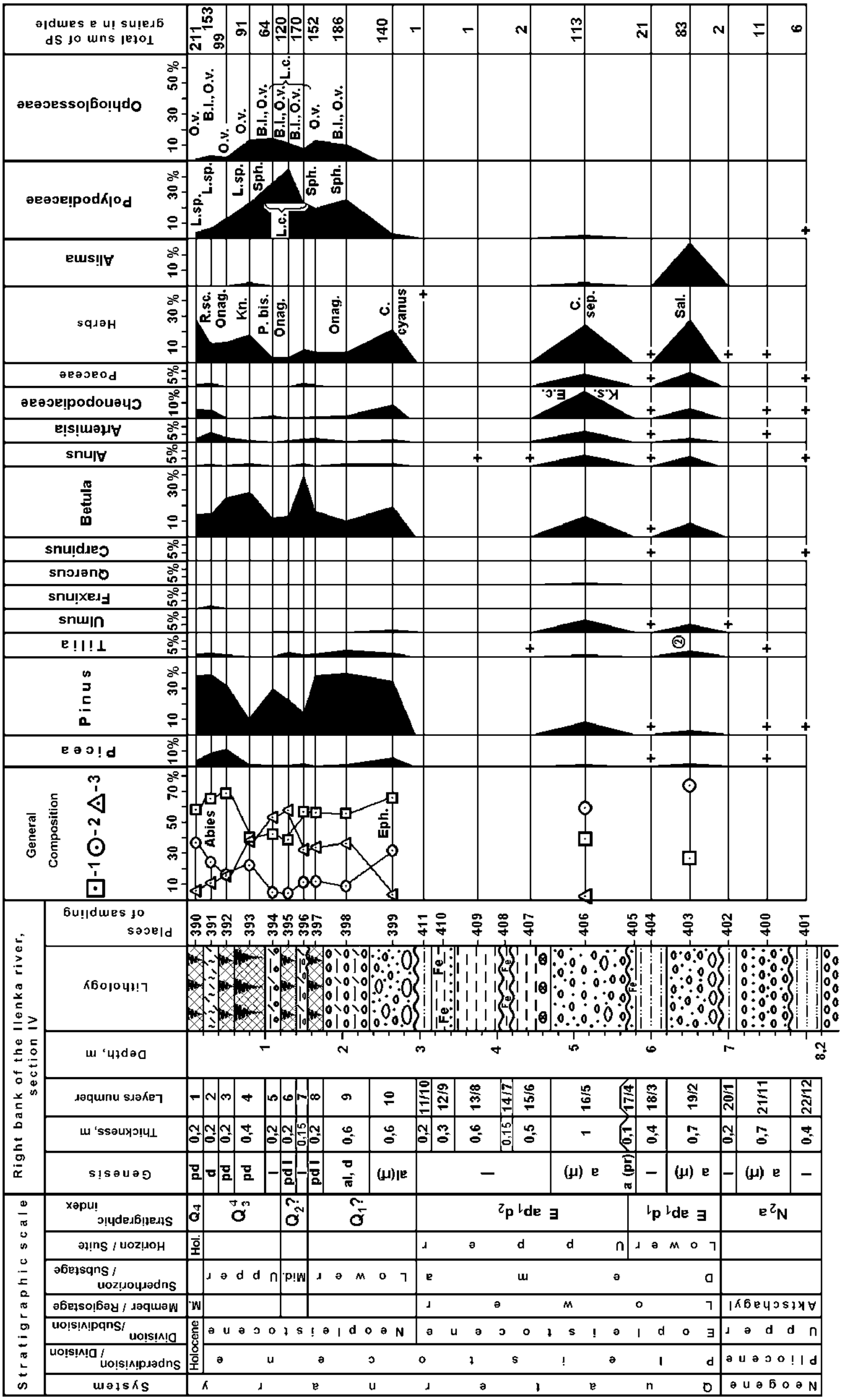

Fig. 42. Ilenka Section IV and pollen diagram (by V.L. Yakchemovich and L.I. Alimbekova). Legend see Fig. 5.

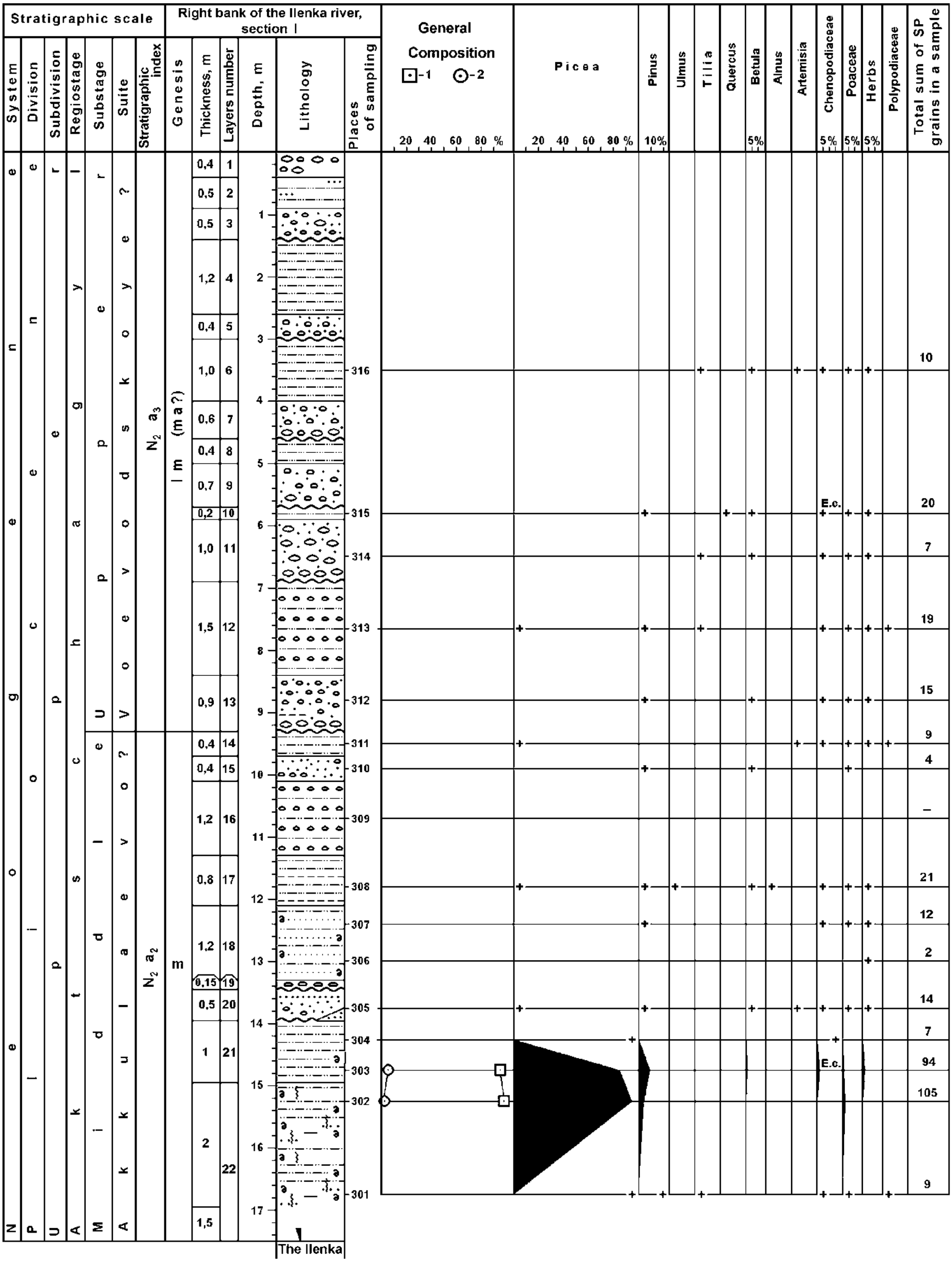

Fig. 43. Ilenka Section I and pollen diagram (by V.L. Yakchemovich and L.I. Alimbekova). Legend see Fig. 5.

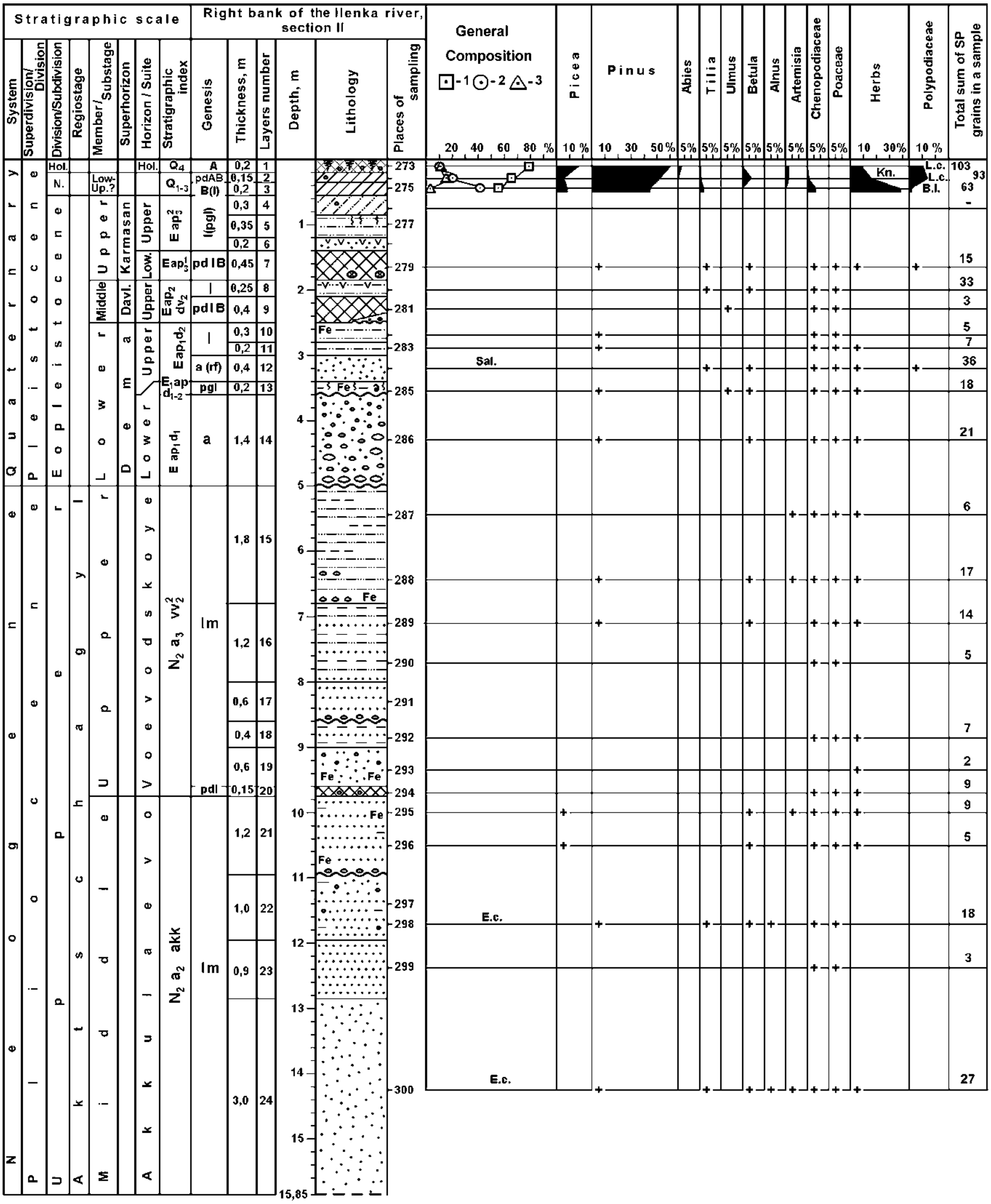

Fig. 44. Ilenka Section II and pollen diagram (by V.L. Yakchemovich and L.I. Alimbekova). Legend see Fig. 5.

During the onset beginning of the Late Aktschagyl (Voevodskoye time) rare fresh water and euryhaline ostracods occurred. Brackish water species and *Loxoconcha varia* appeared during the Late Voevodskoye, then marine and brackish water species disappeared and the role of fresh water species increased.

The early Dema ostracod complex (Section II) contains freshwater species. The late Dema complex (Early Eopleistocene) consists of freshwater species *Darwinula stevensoni* (Br. et Rob.), *Ilyocypris bradyi* Sars, brackishwater species *Prolimnocythere tenuireticulata* (Suz.), *P. chabarowensis* M. Popova and cold-resisted species *Ilyocypris inermis.*

The late Davlekanovo ostracods (Early Eopleistocene) fauna is characterized by numerous stenothermic species *Ilyocypris inermis, Ilyocypris bradyi* and cold-resisted species *Denticulocythere producta* (Jask. et Kaz.).

The Late Eopleistocene (Early Karmasan time) ostracods fauna contains fresh water species with a wide geographical range.

Only rare cold-resisted species: *Ilyocypris bradyi* Sars, *I. gibba* (Ramd.), *Candona rectangulata* (Alm.) and some others occur in the Lower Neopleistocene deposits. Other Pleistocene deposits have no ostracods. (Tabl. 19).

Molluscs

In the deposits of Middle-Lower Aktschagyl age *Succinea* sp. (1), *Pupilla muscorum* L. (40), *Pupilla cf. mutabilis* Steklov (5), *V. piscinalis* Müll. (1), ?*Scalaxis* sp. (a left-rotated gastropod) (1), *Dreissena polymorpha* (Pall.) (22), *Dreissena* sp., *Pisidium* sp. and *Aktschagylia subcaspia* (Andrus.) (42) have been found.

The Middle Aktschagylian complex contains: *Succinea oblonga* Drap. (1), *Vallonia costata* Müll. (13), *Limnaea* sp. (8), *Radix* sp. (21), *Galba* sp. (28), *Planorbis planorbis* L. (5), *Anisus vortex* L. (1), *Gyraulus gredleri* Alder. var. *rossmaessleri Auers.* (103), *Armiger crista* (L.) (3), *Armiger crista* (L.) var. *inermis Lindh.* (1), *Viviparus sp.* (1), *Valvata piscinalis* Müll. (24 *juv*.), *V. pulchella* Müll. (28), *Valvata cristata Müll.* (1), *Valvata sp.* (1), *Bithynia* sp. (1), operculum (5), *Clessiniola julaevi* G. Ppv. (188), *Clessiniola* sp. (22 juv.), Gastropoda (4), ?*Scalaxis* sp. (2), *Dreissena polymorpha* (Pall.) (162), *Dreissena* sp. (6), *Sphaerium rivicola* Lam. (1), *Pisidium amnicum* Müll. (35) and *Aktschagylia subcaspia* (Andrus.) (7).

Shells of *Succinea oblonga* Drap. (26), *Vertigo* sp. (cf. *substriata)* (1), *Vallonia costata* Müll. (11), *Valvata pulchella* Müll. (1), *Clessiniola julaevi* G. Ppv. (4) are rare in the Eopleistocene deposits (Tabl. 20).

Small mammals

Small mammals are rare in the Ilenka sections. Nevertheless the presence of two species of the genus *Mimomys (M. reidi* Hint. and *M. pliocaenicus* F. Maj.*)* and the presence of *Prosiphnaeus* sp. together with the absence of field-voles with un-rooted molars, indicate an Aktchagylian age; the fauna correlates to the Khaprov small mammal complex. (Plate VII, Tabl. 21).

References

1. Danukalova, G. A., Yakovlev, A. G., Alimbekova, L. I., Popova-Lvova, M. G., 2001. The key stratigraphical Pliocene-Quaternary section Ilenka (Southern Fore-Urals) (in Russian). *In*: Geological Collection, 2 (Informational materials). Gilem (Ufa): 95–110.

Table 19. The stratigraphical distribution of ostracods in the Ilenka sections

Species	Pliocene					Quaternary				
	Upper					Pleistocene				
	Aktchagyl					Eopleistocene				Neopleistocene
	Lower - Middle	Middle			Upper	Lower			Upper	Lower
Suite / Horizon		Akkulaevo			Voevodskoye	Dema		Davlekanovo	Karmasan	
Subsuite / Subhorizon					Upper	Lower	Upper	Lower		
Section	III	I	II	IV	II	II, IV	II, IV	II	II	III
Darwinula stevensoni (Br. et Rob.)							2			
Ilyocypris bradyi Sars	9	467	125		3	7	86	32	23	500
I. gibba (Ramd.)										49
I. inermis Kauf.					4		7	57		
Ilyocypris aff. *inermis* Kauf.			66			1	32	17		
Ilyocypris aff. *biplicata* (Koch.)								1		
Cyclocypris laevis (O. Müll.)							2			
Cypria candonaeformis (Schw.)	1	377	1140		9		69	1		
C. pseudoarma M. Popova	4		10		1					
Candona neglecta Sars		6	8			1				
C. neglecta juv.			420			71		53		
C. combibo (Liv.)	1						1			
C. parallela G. Müll		3					11			
C. balatonica Daday							1			
Candona aff. *visenda* (Schn.)								1		
Candona rectangulata Alm.										2
juvenile *Candonen*		260	2	8	12		47		4	8
Candona sp.		1					1		2	
Eucypris famosa Schn.	1						4	34	1	
Eucypris sp.		1						7	2	
Zonocypris membranae Liv.								1		
Paracyprideis naphtatscholana (Liv.)					180					
Cytherissa lacustriformis M. Popova	1	329								
C. torulosa M. Popova		144	9							
Mediocytherideis apatoica (Schw.)		12								
Leptocythere litica Liv.		1								
Prolimnocythere tenuireticulata (Suz.)	1	144	2		7	5	9	4	2	
P. inderica (Scharap.)		887	323		5	1				
P. inderica kumurliensis (M. Popova)		276								
P. chabarowensis M. Popova							6	1		
Denticulocythere producta (Jask. et Kaz.)		5			4		1	3		
D. scharapovae (Schw.)	3	3					1		1	
Denticulocythere aff. *schweyeri* Karm.	3									
Limnocythere aff. *sanctipatricii* Br. et Rob.										1
Cyprideis torosa (Jones)	113	1563	1230	1	15		153	5		
Loxoconcha varia (Suz.)		116	4							

Legend: 1–5 specimens; 6–10 specimens; 11–25 specimens; 26–100 specimens; > 100 specimens

Table 20. The stratigraphical distribution of the molluscs in the Ilenka sections

Species	Neogene		Quaternary
	Upper Pliocene		Pleistocene
	Akchagyl		Eopleistocene
	Lower-Middle	Middle	Lower
Suite / Horizon		Akkulaevo	Dema
Section	III	I, III	II
Succinea oblonga Drap.			26
Succinea sp.	1	1	
Pupilla muscorum L.	40		
Pupilla cf. *mutabilis* Steklov	5		
Vertigo substriata (Jeffr.)			1
Vallonia costata Müll.		13	11
Limnaea sp.		8	
Radix sp.		21	
Galba sp.		28	
Planorbis planorbis L.		5	
Anisus vortex L.		1	
Gyraulus gredleri var. *rossmaessleri* Auers.		103	
Armiger crista (L.)		3	
Armiger crista (L.) var. *inermis* Lindh.		1	
Valvata pulchella Müll.		28	1
V. piscinalis Müll.	1	26	
V. cristata Müll.		1	
Valvata sp.		2	
Viviparus sp.		1	
Bithynia sp.		1	
operculum		5	
Clessiniola julaevi G. Ppv.	6	176	
Clessiniola sp.		23	4
Gastropoda		1	
? *Scalaxis* sp.	1	1	
Dreissena polymorpha (Pall.)	22	128	
Dreissena sp.	+	6	+
Sphaerium rivicola Lam.		1	
P. amnicum Müll.		35	
Pisidium sp.	+		+
Aktschagylia subcaspia (Andrus.)	42	7	

Legend:

light grey	1–10 specimens
medium grey	11–20 specimens
dark grey	21–30 specimens
very dark grey	31–50 specimens
black	> 50 specimens

Plate VII. Small mammals of the Ilenka section (by A. G. Yakovlev, 2001)

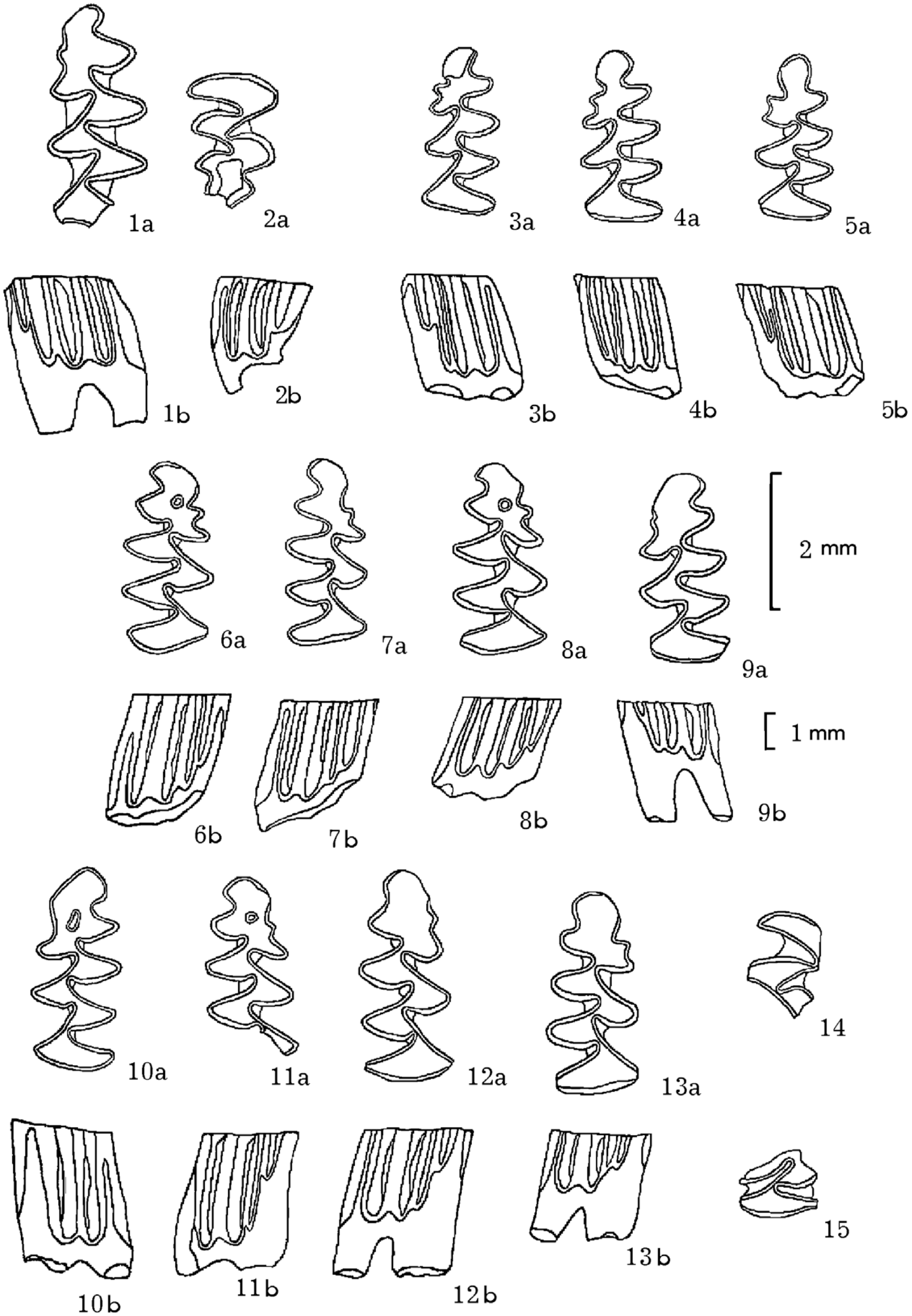

Table 21. The stratigraphical distribution of the small mammals in the Ilenka sections

Species	Neogene			Quaternary	
	Upper Pliocene			Pleistocene	
	Aktschagyl			Eopleistocene	Neopleistocene
	Middle				Lower
Section	III	III	III	IV	III
Layer	10	16	17	13 (8)	7
Ochotona sp.				2	
Sicista sp.		2			
Cricetulus sp.		1			
Allocricetulus sp.				1	
Prosiphnaeus sp.		5		4	1
Mimomys pliocaenicus F. Major				2	
Mimomys reidi Hinton		12		2	
Mimomys sp.	1	65	1	10	2
Lemmus gen.				2	

To Plate VII:

1, 2 – *Mimomys pliocaenicus* F. Major (Ilenka, Section IV, layer 13).

3–13 – *Mimomys reidi* Hinton (Ilenka, Section III, layer 16).

14, 15 – Lemmus gen. (Ilenka, Section IV, layer 13).

1, 3–13, 15 – M_1; 2 – M^3; 14 – M^2. a – occlusal view; b – buccal side.

1, 2, 4, 14, 15 – collection of A. G. Yakovlev (1988);

3, 5–13 – collection of V. P. Sikhov (1979).

THE SHULGAN-TASH (KAPOVA) CAVE

Location

The cave is located on the western slope of the Southern Urals in the upper course of the river Belaya, 30 km downstream of Starosubkhangulovo, the centre of the region (Fig. 1). The cave is formed in Devonian and Carbonian limestone. The entrance of the cave is at a distance of about 150 m from the river Belaya and at a height of 7–8 m above the average water level. The total length of the investigated part of the cave is 2 km (Fig. 45).

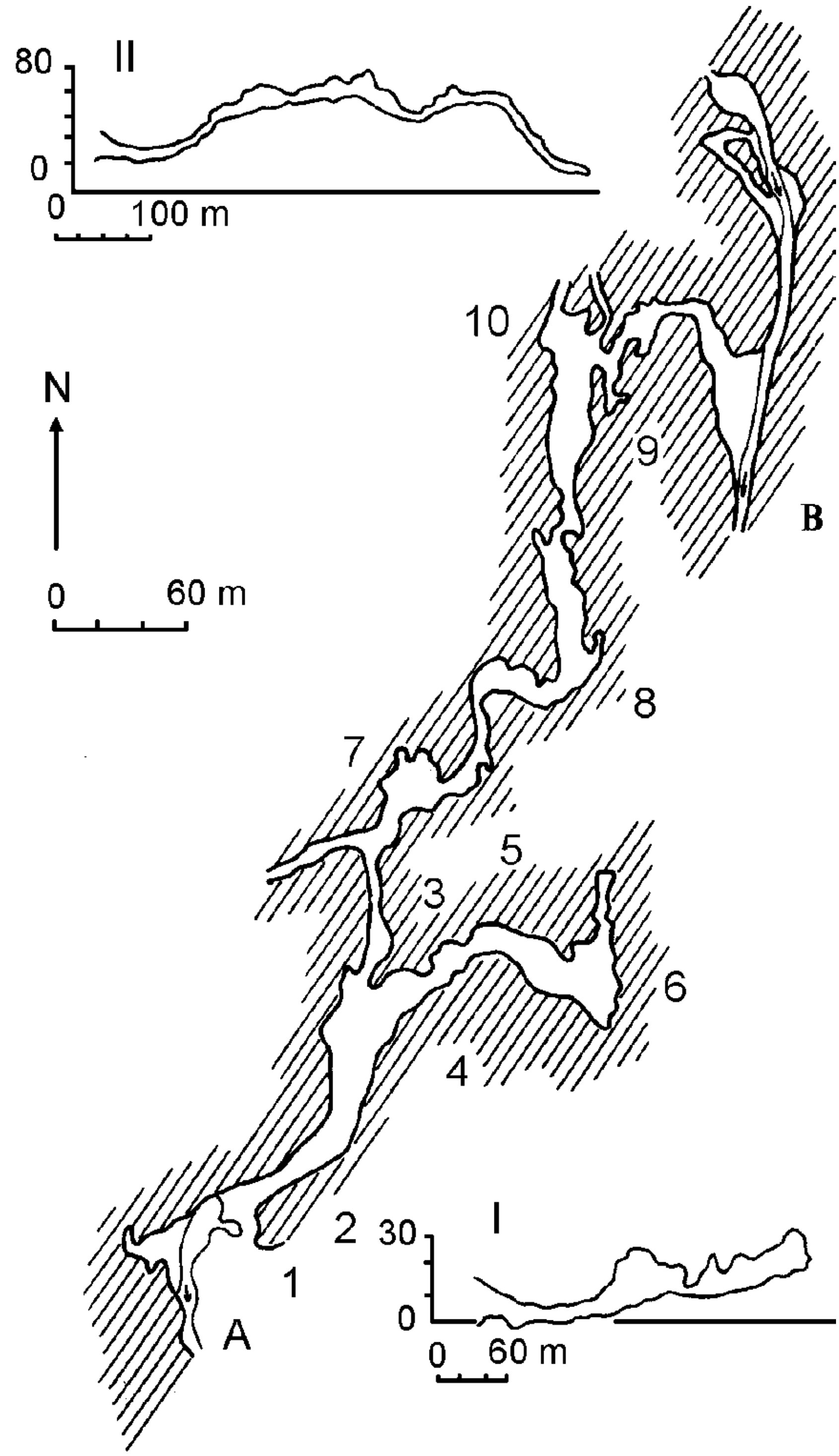

Fig. 45. The Shulgan-Tash cave.

A plan (by V.E. Shchelinsky, 1989).

Legend: A, B – Shulgan River; 1 – entrance to the cave; 2 – Main Gallery; 3 - Foyer ; 4 – Domed Hall; 5 – Hall of Signs; 6 – Hall of Chaos; 7 – Hall of Paintings; 8 – Diamond Hall; 9 – Rainbow Hall; 10 – Crystal Hall; I – a longitudinal profile of the first level; II – a longitudinal profile of the second level of the cave.

History

In 1760 P.I. Rychkov described the cave for the first time and in the XVIII century I.I. Lepekhin investigated the cave. The cave was visited by D. Sokolov, I. Zanevsky and F. Simon in the XIX century. In the twenties of the XX century G. V. Vakhrushev (1936, 1960) investigated the cave and concluded that the cave dates from The Upper Pleistocene. In his opinion, the formation of the first level in the cave took place at the same time as the accumulation of the first fluvial terrace above the floodplain of the river, between the end of the Late Pleistocene and the Middle Holocene (14000–5000 years ago).

In 1959 A.V. Ryumin discovered the rock paintings in the cave and in 1961–86 O.N. Bader (St.Petersburg) studied the cultural layer and the paintings. I.K. Kudryashov and E.D. Bogdanovich (1966) from the Bashkirian State University made a series of vertical sections and a plan of a cave. V.L. Yakchimovich (Bader, 1965) investigated the area around the cave, using a theodolite survey and concluded that the two levels in the cave must be older than the Late Pleistocene. The geologists V.A. Lider and A.G. Cybul'kin studied unconsolidated deposits of the cave.

From the eighties on the archaeologist V.E. Shchelinsky (St. Petersburg) carried out further investigations. Mammals remains from the cultural layer were identified by I.R. Kuzmina and N.I. Abramson (St. Petersburg) and pollen and spores were studied by G.M. Levkovskaya. Yu.S. Lyakhnytscky (St. Petersburg) did spelaeological investigations, V. V. Kochegura (St. Petersburg) did palaeomagnetical studies.

Description of the exploring shaft

V.E. Shchelinsky made a shaft through the first level of the cave in the "Hall of Signs". The following layers are described from the top to the bottom (Fig. 46).

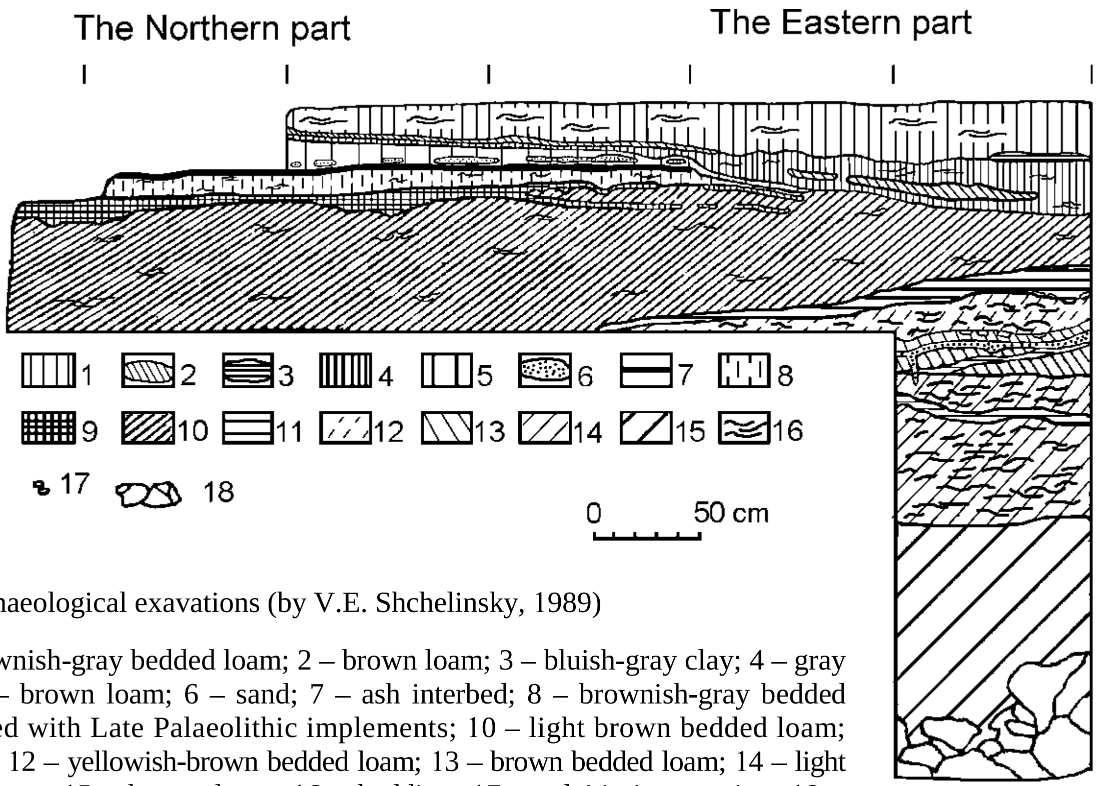

Fig. 46. The archaeological exavations (by V.E. Shchelinsky, 1989)

Legend: 1 – brownish-gray bedded loam; 2 – brown loam; 3 – bluish-gray clay; 4 – gray bedded clay; 5 – brown loam; 6 – sand; 7 – ash interbed; 8 – brownish-gray bedded loam; 9 – the bed with Late Palaeolithic implements; 10 – light brown bedded loam; 11 – brown clay; 12 – yellowish-brown bedded loam; 13 – brown bedded loam; 14 – light brown bedded loam; 15 – brown loam; 16 – bedding; 17 – calcitic incrustation; 18 – limestone blocks.

Quaternary

Holocene – Upper Pleistocene

(slope deposits – *d)*

Thickness, m

1. Brownish-grey thin bedded clayey dense loam……………………………………………...0,1–0,2

2. Pale brown unstratified loam…………………………………………………………...0,02–0,05

3. Grey dense clay. Only present in the eastern wall of the shaft……………………………………0,05

4. Grey thin-bedded dense clayey loam. In the eastern wall of the shaft the thickness of this layer is larger than in the western wall. Lenses of pale brown loam located in the interval between 0,1–0,18 m from the top……………………………………………………………………………...0,02–0,3

5. Greyish-brown thin-bedded dense clayey loam with thin interbeds of the light sand at the base. On the eastern wall of the exploring shaft this interbeds disappeared…………………………0,02–0,17

6. Brownish-grey thin-bedded clayey dense loam with two thin interbeds of black and reddish-brown colours…………………………………………………………………………………….0,02–0,13

7. Light brown thin-bedded loam with iron-staining. The cultural layer lies on top of the surface of this layer; it is well represented in the northern wall. Ash and coal from the cultural layer have C14 dates of 14680±150 (LE–2443) and 13930±300 (GIN–4853)……………………………………………0,6

8. Pale brown clay present in the eastern wall…………………………………………………0,02–0,18

9. Yellowish-brown thin-bedded dense clayey loam…………………………………………..0,1–0,2

10. Brown bedded dense clayey loam with vertical joints filled by sand. The interbed of white sand located in the interval 0,02–0,05 m from the boundary of the upper layer. The interbed of yellowish-brown iron-stained clay located in the interval 0,08–0,17 m from the upper boundary……………………..0,15–0,3

11. Brown bedded dense clayey loam with interbeds the clay in the upper part……………………...0,8

12. Brown unstratified dense loam with ash and coal dissemination……………………………….0,7–1

13. Large limestone's blocks……………………………………………………………………..0,5

The cultural layer is grey and dark grey in colour with precipitations of red ochre, with ash and coal, fragments of the stalactites, limestone blocks and rock debris. The cultural layer was discovered in the "Hall of Signs", 210 m from the cave entrance at a depth of 0,5 m in the upper part of the light brown bedded loam (layer 7). The thickness of the layer varies from 2–3 cm (in the eroded parts) to 10–12 cm. The upper boundary of the layer is sharp, the cultural layer is covered by light loam. The lower boundary of the cultural layer is more gradual.

The total thickness of the studied deposits is approximately 3,5 m.

Archaeology

Today more than 50 colour pictures are known from Kapova Cave; pictures of animals (mammoths, horses, bison, rhinoceros), geometrical figures and partially removed spots (probably fragments of pictures). Red or violet-brown ochre was used to make the pictures. The pictures are of Late Palaeolithic age and are correlated with the cultural layer in the cave. The protection of the pictures is bad.

Artefacts are known from the cultural layer: 193 fragments, 3 pebble implements, 7 bone implements, 17 beads and pendants, fat-oil burning clay lamp, 15 ochre fragments, 1 limestone block with a fragment of a mammoth picture (Fig. 48, 49).

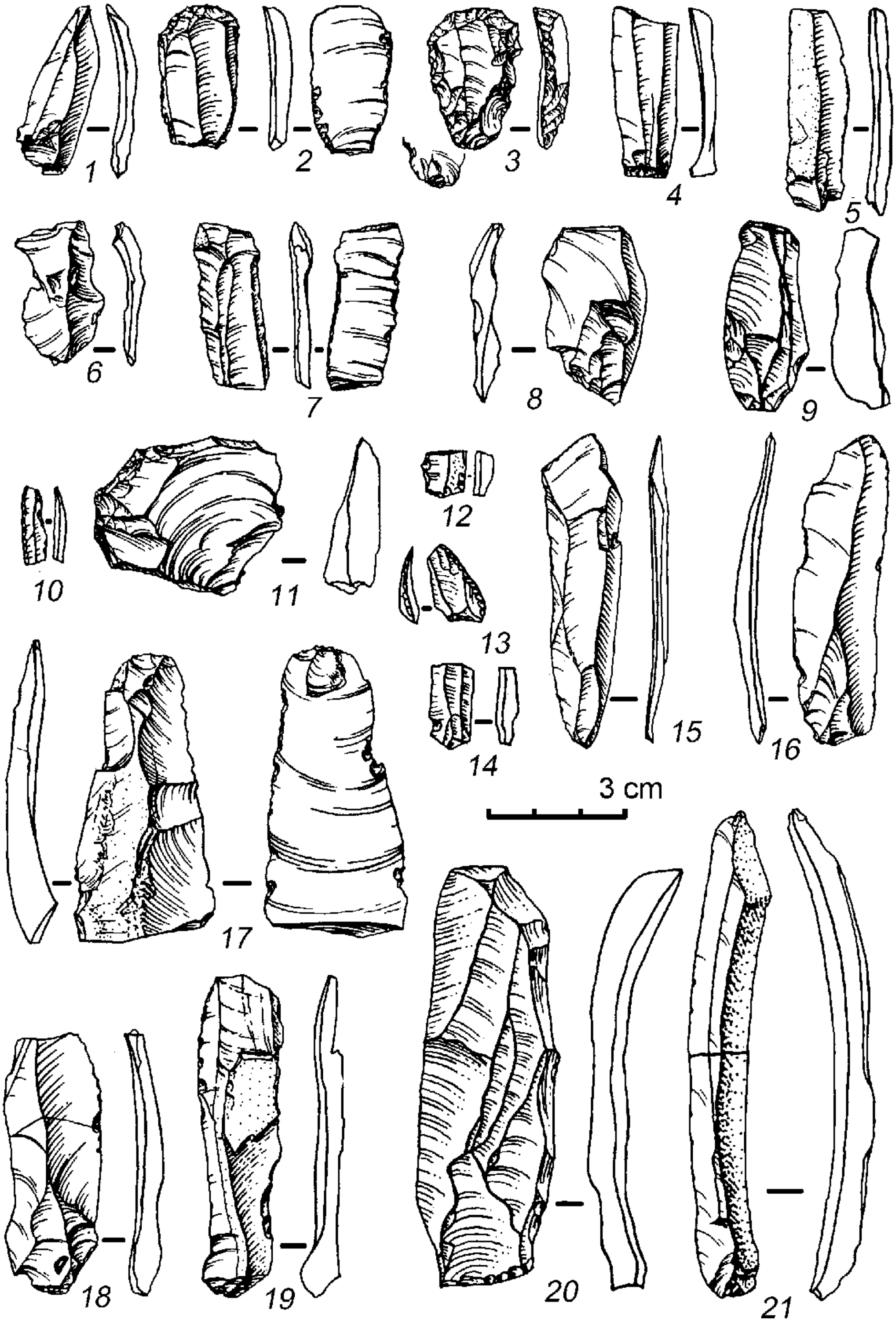

Fig. 47. The archaeological artifacts (by V.E. Shchelinsky, 1989)

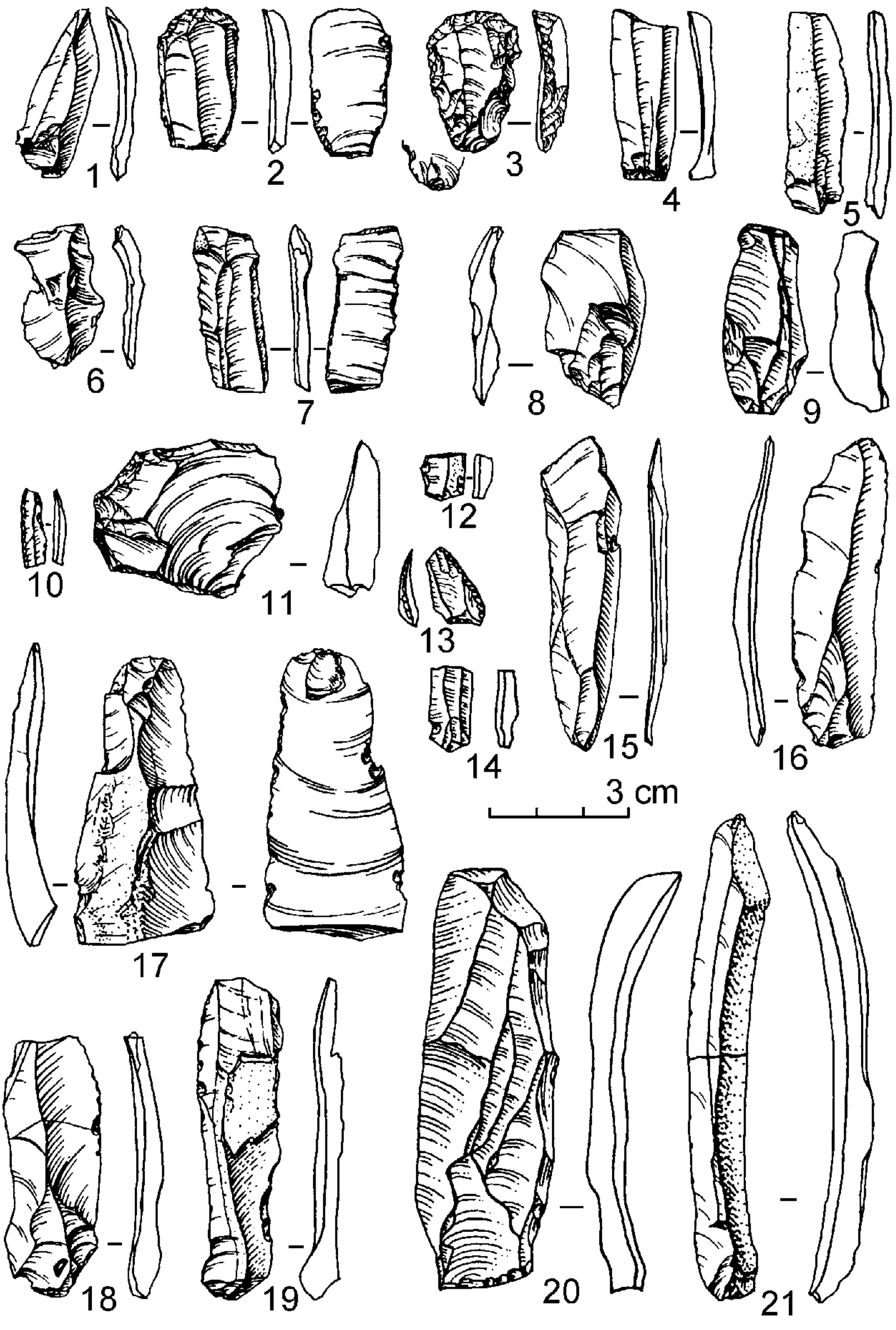

Fig. 48. The archaeological artifacts (by V.E. Shchelinsky, 1989)

Radiocarbon data

The ash/coal from the cultural layer have a C^{14} age of 14680±150 (LE–2443) and 13930±300 (GIN–4853) years.

Vegetation

Two different sets of palynological data were published by V.E. Shchelinshy (1989, 1997).

V.E. Shchelinshy (1989) wrote: tree pollen (50–60 %) are dominant in the cultural layer; grass pollen occur for no more than 40 % and spores for no more than 20 %. The most common tree is pine (up to 30 %). The proportion of fir or birch pollen is much smaller. Only isolated grains of broad-leaved trees such as oak and elm were encountered. The grass pollen assemblage consists of periglacial plants, xerophytes and isolated specimens of mesophylous herbs. This particular assemblage seems to include representatives of tundra, forest and steppe associations. The assemblage is, in many aspects similar to the vegetation that existed in the Russian plains during the Late Pleistocene/ Holocene deglaciation. V.E. Shchelinshy (1997) wrote: Tree pollen – 30 %, grass and shrub pollen – 66 %, spores – 4 %. *Picea* pollen dominated with the proportion of 56 %. Pollen of *Pinus silvestris*, *Betula nana*, *Larix*, *Juniperus* are identified. Compositae of the *Aster* type (3 species) dominated the grass shrub pollen. The vegetation was open; only rare trees occurred.

Small mammals

The following species were found in the cultural layer and in the deposits above (Tabl. 22).

Table 22. Small mammals from the cultural layer of the Shulgan-Tash cave

Species	Quaternary		
	Upper Neopleistocene		Upper Neopleistocene – Holocene
	Cultural layer		layers1–6
	Quantaty of bones	Quantaty of individuals	Quantaty of bones
Lagomorpha	80		
Lepus sp.		3	
Ochotona sp.		1	
Sorex sp.			1
Epteslicus nilssjni Keys. et Blas.			1
Myotis sp.			1
Marmota bobac Mull.	8	1	
Cricetulus migratorius Pall.	2	2	1
Clethrionomys glareolus Schreb.			3
Lagurus lagurus Pall.	16	4	1
Dicrostonyx torquatus Pall.	4	1	
Microrus gregalis Pall.	34	5	1
Microtus arvalis Pall.	1	1	
Microtus oeconomus Pall.			1

Large mammals

The following species been found in the cultural layer and in the deposits above (Tabl. 23).

Table 23. Large mammals from the cultural layer of the Shulgan-Tash cave

Species	Quaternary	
	Upper Neopleistocene	
	Cultural layer	layers 1–6
	Quantaty of bones	
Ursus spelaeus Rosen et Hein.	2	
Alopex lagopus L.	2	
Vulpes vulpes L.	2	
Capreolus capreolus L.		160

Species composition of the Late Pleistocene large mammal fauna indicate the occurrence of dry steppe vegetation.

Palaeomagnetic investigations

Shchelinsky (1989) wrote: the palaeomagnetic investigation indicate two oscillations in the geo-magnetic field. Both oscillations were found beneath the cultural stratum. The one near the bottom of the section is likely to have an age of 40000–42000 years, whereas the other one (in the middle of the section) appears to be 24000–26000 years old. The cultural layer is deposited above the later oscillation (Data from V.V.Kochegura).

Problems

Unfortunately we must admit that the cave deposits were not studied biostratigraphically in great detail.

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