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The Quaternary of the Urals: Global trends and Pan-European Quaternary records

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Ч52 **Четвертичный период Урала: глобальные тенденции и их отражение в общеевропейской четвертичной летописи :** материалы международной конференции INQUA-SEQS (Екатеринбург, Россия, 10–16 сентября 2014 г.). – Екатеринбург : УрФУ, 2014. – 228 с.
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В книге представлены материалы международной конференции INQUA-SEQS 2014, проводившейся в Екатеринбурге (Россия). Сообщения касаются широкого спектра вопросов, связанных с исследованиями четвертичного периода (2,6 млн лет) в Европе и Азии. На основании результатов локальных и региональных исследований авторы рассматривают проблемы стратиграфии и корреляции четвертичных отложений Уральского региона и Европы и обсуждают вопросы интеграции общеевропейских и евразийских стратиграфических схем. Особое внимание уделено вопросам палеонтологии, палеоклимата и палеосреды четвертичного периода Европы и Азии.

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L. Agafonov
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: lagafonov@ipae.uran.ru

THE OB RIVER DISCHARGE FOR THE LAST 300 YEARS: RECONSTRUCTION FROM TREE RINGS

Key words: climate change, hydrological cycle, streamflow, Ob River, West Siberia

Much attention has been paid to research on river runoff in the context of global climate change (SWIPA, 2011). Such attention is deserved because river runoff is an important component of hydrological cycle, a main constituent of the climate system. Terrestrial water-cycle processes regulating evaporation, runoff and changes in the hydrological cycle are directly linked with atmospheric processes (Chahine, 1992; Rawlins, 2010; Shiklomanov et al., 2011). Changes in the terrestrial hydrologic budget of the Northern Hemisphere influence the freshwater inflow to the Arctic Ocean (Peterson et al., 2002, 2006; McClelland et al., 2004; Mauritzen, 2012). Annual river discharge is the dominant part (38 %) of freshwater input to the Arctic Ocean (Serreze et al., 2006), and the export of river freshwater to the Arctic Ocean is about 11 % of the global river discharge (Shiklomanov, 2000).

The Ob River is one of the world's greatest rivers. Its basin ($2.9x10^6$ km^2) is the fourth largest over the world and is about the size of Western Europe. Estimates of annual discharge from the Ob Basin range from 400 km^3 to 429 km^3 and it is to 12 % or more of the annual freshwater inflow to the Arctic Ocean. Approximately 70 % of annual discharge occurs in the ice-free period from May to October, and 80 % of the annual runoff originates southward of 61º N (1152 km from the Ob estuary). Ob River discharge has the highest autocorrelation coefficient (r = 0.38) for discharge in the Northern Hemisphere for a one-year lag and there is a reliable quasi-periodicity of many-year variations in runoff (Simonov, Khristoforov, 2005). The Ob catchment basin can therefore provide great insight into global scale perturbations to the climate system.

We developed tree-ring width chronologies (larch and Siberian stone pine) for the 9 test sites (285 trees in total) along the Lower Ob River valley (64º49' N – 66º06' N). Response of tree-ring chronologies to hydro-climatic conditions were analyzed using program SEASCORR (Meko et al., 2011) to identify the seasonal hydrological and climatic signals in an annual tree-ring time series for 1936–2009. Modern interaction between the Ob discharge and air temperature over the Ob floodplain was used for understanding hydro-climatic conditions as a background.

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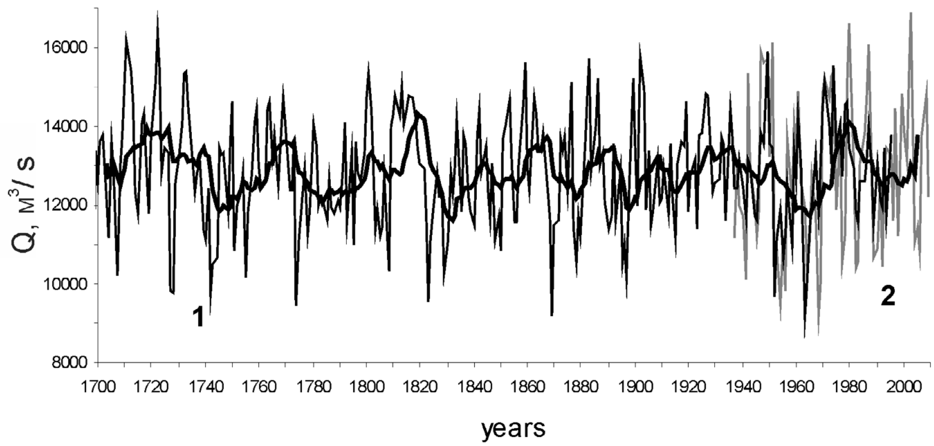

Fig. 1. Reconstruction of the Ob River discharge (1) for the period from August of previous year to July of current year and actual discharge records (2) for Salekhard gauge (287 km from the Ob River estuary). Bold line is 11-years smoothing filter for the reconstructed data

Using tree-ring chronologies we reconstructed the Ob River discharge for period from previous August to current July (that is nearly the same as hydrological year) for the last 300 years (Fig. 1). Developed reconstruction of the Ob River discharge has good correlation ($r = 0.67$, $p < 0.05$) with records from gage of "Salekhard" for 1936–1996. Our approach and results demonstrate the high potential of tree-ring chronologies to reconstruct river discharge in this region and allow interpreting hydro-climatic interactions over the Ob catchment basin.

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A.L. Alexandrovskiy [1], *E.G. Ershova* [2], *N.A. Krenke* [3]
[1] Institute of Geography, RAS
Moscow, Russia
[2] Lomonosov Moscow State University
Moscow, Russia
[3] Institute of Archaeology, RAS
Moscow, Russia
E-mail: alexandrovskiy@mail.ru

SOIL AND POLLEN RECORDS IN SOIL-ALLUVIAL SERIES OF THE MOSKVA-RIVER FLOODPLAIN

Key words: Holocene, buried soils, floodplain deposits, pollen analysis, palaeoenvironment, geoarchaeology, palaeopedology

A series of buried soils, in some cases covering the entire Holocene, have been found in floodplains of the center of the East European Plain. These soils have well developed profiles and are similar to zonal soils (Luvisols, Phaeozems). A complete scheme of the soil stratigraphy of the Moskva-river floodplain includes 7 main soils. The 4 upper soils are most common in the Moskva-river and Oka floodplains. Modern Soil 1 (last 4 centuries) is poorly developed. Soil 2 (usually Luvisol) is dated 500 cal BC – 1300 AD, it contains artifacts from archeological sites dating back to the Early Iron Age and the Middle Ages. Soil 3 (Umbrisol or Phaeozem) with Bronze Age artifacts is dated 2800–900 cal BC. Soil 4 (dark colored Phaeozem or Chernozem, dated 3500—5000 cal BC) is associated with Neolithic findings (Alexandroskiy, Krenke, 2004). In some cases the soils are divided, but more often they converge, and one can see a united soil 2–4 or even 2–6 which formed on a stable surface during practically the whole Holocene.

Lately there have been pollen studies of paleosols in the Moskva-river floodplain which contribute to the results of previous soil studies. Pollen data showed that dark-colored Soil 4 from Atlantic period, which can be attributed

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to Phaeozems, was formed under the forest-steppe vegetation (Ershova et al., 2014). Pollen data from Subatlantic Soil 2 shows some contradictions between the results obtained by palynological and palaepedological methods. Despite the forest profile of this soil (Luvisols or Albeluvisols), they contain a large amount of herb pollen, including many ruderal and cultural species. These data may reflect the late, anthropogenic, stage of the soil formation, when the floodplain landscapes could be already heavily transformed. For buried soils of Subboreal time (Soil 3) the pollen data is still scarce, because these soils are not often found in the floodplain of the Moskva-river. The analysis of Soil 3 at ZBS sites shows that it contained mainly conifer pollen, mostly spruce, despite the absence of a horizon Bt, typical for forest soils (Ershova et al., 2013).

The site RANIS (Moskva-river floodplain in the proximity of the village Nikolina Gora near Zvenigorod) contained the soils 2, 3 and 4, which are situated separately and have well-developed profiles. Soil 2 from this pit has a robust humus horizon, which is common for meadow soils. However, during the first stage of its development a horizon Bt more than 2m thick was formed, which is characteristic for most instances of Soil 2 in the Moskva-river area (Alexandrovskiy, 2008). Soil 4 has a profile that is typical for Chernozems: a black thick horizon A (Chernik) and carbonate horizons Ak and Bk. The transition from the steppe and forest-steppe stages (Chernozems) to a forest stage (Luvisols) corresponds with the formation of Soil 3 (Krenke et al., 2014). Pollen analysis of buried soils from site RANIS shows that Atlantic Soil 4 contains pollen of broadleaf trees, shrubs and herbs, while Subatlantic Soil 2 with a well developed forest profile contains mostly arboreal pollen (up to 85 % of the total), with *Picea* being the absolute dominant (up to 65 %). Pollen spectra of Subboreal Soil 3, which had no clear diagnostic features, were also absolutely dominated by spruce (Spiridonova et al., 2008). These data indicate that during the formation of Soil 3 and Soil 2 at least part of the floodplain of the Moskva-river was occupied by mixed coniferous-deciduous forests which were dominated by spruce. Pollen and radiocarbon data suggest a significant landscape transformation and expansion of spruce forests in the valley of the Moskva-river at the very early Subboreal period (between 5000 and 4500 cal BP).

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V. Astakhov[1, 2]
[1] A. P. Karpinsky Russian Geological Research Institute (VSEGEI),
St. Petersburg, Russia
[2] St. Petersburg State University
St. Petersburg, Russia
E-mail: val@nb15514.spb.edu

STRATIGRAPHIC CORRELATION OF LATE PLEISTOCENE ACROSS GLACIATED NORTHERN RUSSIA

Key words: upper Quaternary, stratigraphic correlation, glaciated Russia, geochronometry

Synchronization of Pleistocene events across northern Russia has long been problematic due to the size of the dry land extending across 70^0 of longitude. Palaeontological correlation fail to achieve reliable results because of the environmental gradient aggravated by the orographic obstacle of the Urals. The last factor is crucial for the paleobotanical comparisons which are hindered by the absence of broad-leaved trees beyond the Urals. The latest efforts are largely based on cartography and geochronometry. The cartographic correlation is performed by tracing major ice-marginal formations Baltic Sea to Central Siberia (Astakhov et al., this volume). However, paleoclimatic landmarks of distant terrains can only be correlated by geochronometry. The international studies of the last two decades have provided a multitude of dates by diverse techniques permitting to obtain correlation signals by statistic approach irrespective of the validity of each single date. For this the population of dates are organized in clusters spatially linked with major sedimentary associations with distinct paleoclimatic signatures, thus composing mutually supportive climatostratigraphic and geochronometric levels. Since the number and quality of chronometric data decreases downwards in the succession the traditional approach of starting from the oldest formations is hardly fruitful. I.e. the lowermost exposed interglacial is conventionally correlated by its palaeoclimatic characteristics with the Holsteinian. This correlation is tentatively supported in West Siberia by several dubious TL and ESR dates

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(Astakhov, 2013) but in adjacent regions where no dates are available it is no more than a conjecture.

I). Therefore, as a first step the most reliable chronostratigraphic marker should be considered. In the Russian North this is the sedimentary complex of the uppermost postglacial Pleistocene best studied by sedimentology and supplied with numerous radiocarbon dates. This complex is largely a subaerial cover consisting of loess-like silts and aeolian sands with intervening lenses of fluvial and lacustrine sediments. The paleoenvironmental signature of the complex is unambiguous: the sedimentary structures and organic remains reflect dominance of perennially frozen tundra-steppe with intervening cool interstadials in climates drier and frostier than today at lower sea levels (e.g. Hubberten et al., 2004). Hundreds of available dates allow to attach this typically periglacial association to the time span of 60 to 11 ka BP everywhere from Taimyr Peninsula in Central Siberia to the Timan Ridge in European Russia. This chronological interval is firmly based on robust estimates by parallel series of AMS radiocarbon and OSL dates supported by finds of frozen mammoth carcasses and artifacts of the early Upper Palaeolithic (Astakhov, 2014). This correlation is validated by less reliable but numerous OSL dates within the range of 100 to 60 ka derived from the underlying glaciofluvial and lacustrine deposits of the last regional glaciation (Svendsen et al., 2004).

II). The downward next correlation level is represented by the interglacial marker strata: marine, fluvial and palustrine deposits which are found in the subtill position above the Arctic Circle. Their interglacial nature is evident from warm-water aquatic fauna and arboreal pollen spectra clearly contrasting with treeless continental environments of the overlying periglacial complex. The chronometric correlation has long been ambiguous because the strata with rich organics yield only non-finite or patently incorrect finite radiocarbon dates. The latest synchronisation efforts are largely based on OSL dates (ca 75 measured samples) which on this chronological level are naturally more scattered than on the first one. The 60 dates (a couple of outliers being excluded) on exposed interglacial marine sequences are distributed within the range of 155 to 100 calendar years BP. The mean values of the OSL chronometric series are centred on 111–112 ka (river Sula, European Russia and Cape Karginsky, Yenissei Siberia), and on 133–134 ka levels (the tip of the Taz Peninsula, West Siberia) (Astakhov, Nazarov, 2010; Astakhov, 2013). These estimates, although diverging by a twenty ka, look sufficient for correlating the last interglacial of northern Russia with the Eemian *s. lato* within the MIS 5 time span. This correlation is supported by ESR dates 100 to 134 ka from marine formations of Yenissei Siberia (Katzenberger & Grün, 1985) and by U/Th dates ca 130–140 ka on shells in European Russia and thick peat on the Ob river (Astakhov, Nazarov, 2010). The stratigraphic position of this correlation level is clear from the underlying glacigenic complex of MIS 6 age widespread in the Subarctic where it is known as the northern counterpart of the Saalian (the Vychegda Till in northeastern European Russia, Taz Moraines in West Siberia). The Murukta Till of Central

Siberia, previously ascribed to MIS 4 time span, should be correlated with the Saalian because it is clearly overlain by marine sediments with the warmest (boreal-lusitanic) microfauna (Svendsen et al., 2004; Astakhov, 2013).

III). The chronometrically poorly studied interglacial formations positioned below the second glacigenic complex of the Arctic can be ascribed to a MIS 7 age in the view of the above correlation results. These are exposed marine strata with extinct mollusk *Cyrtodaria angusta* called the Kazantsevo in Siberia and the *Cyrtodaria* strata in European Russia. Similar formations with the Kazantsevo assemblage of boreal foraminifera found by boreholes below sea level on the Lower Ob (Arkhipov et al., 1994) and separated by a thick till from surficial peat deposits with dates ca 130–140 ka. West of the Urals this correlation level is supported by the thick peats with interglacial floras with U/Th and OSL dates ca 200 ka BP at Rodionovo and Seyda (Astakhov, 2013).

Table below lists major Pleistocene formations of northern Russia correlated from west to east. Interglacial formations are italicized. For data see Astakhov, 2013, 2014 and references therein.

MIS	Astron. age esti-mate, ka	Measured ages, ka BP	Lower Pechora and European northeast	Lower Ob and Yamal Peninsula	Lower Yenissei and Taimyr
2 ***3***	60–11	^{14}C=50–10; OSL=85–13 IRSL=45–13 TL=110–65	Two river terraces, aeolian sands and silts, solifluction sheets and fluvial sands with mammoth bones, Byzovaya artifacts	Syoyakha icy loess-like silts, Varyakha peaty silts, frozen mammoths	Two river terraces, Cape Sabler icy loess-like silts with peat seams, frozen mammoths
4 ***5***	100–60	OSL=105–50; TL=80–78	Upper glacial complex (Polar moraines, Lake Komi sediments)	Upper glacial complex: Kara diamictons, Sangompan varves	Yermakovo, Zyryanka, Sartan moraines, Igarka varves
	130–100	ESR=135–122; OSL=155–100; U/Th=141–130	***Sula*** *marine strata with boreal mollusks*	***Shur*** *peat, exposed marine strata with boreal fauna*	***Karginsky*** *marine and alluvial strata*
6	150–130	OSL=164–145	Vychegda glacial complex	Salehard moraines and varves	Sanchugovka and Murukta moraines
7	200–150	OSL=195–153; U/Th=240–186; TL=153; 178	***Rodionovo*** *and* ***Seyda*** *peats, Cyrtodaria marine strata*	*Buried marine strata with Kazantsevo forams*	***Kazantsevo*** *marine strata with Cyrtodaria angusta*

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V. Astakhov[1, 2], *V. Shkatova*[1], *A. Zastrozhnov*[1], *M. Chuyko*[1]

[1] A. P. Karpinsky Russian Geological Research Institute (VSEGEI)
St. Petersburg, Russia
[2] St. Petersburg State University
St. Petersburg, Russia
E-mail: val@nb15514.spb.edu

THE NEW MAP OF ICE MARGINAL FORMATIONS OF RUSSIA

Key words: ice marginal formations, correlation, Quaternary maps, glacial features, Uralian glaciation

The fundamental problem of stratigraphic correlation of genetically various sedimentary formations between numerous regions of northern Eurasia is especially acute when compiling the new Quaternary map of the Russian Federation, scale 1:2 500 000. To partially solve this problem for glaciated terrains we have performed trans-regional tracing of topographically expressed ice-marginal formations. The published (or in press) sheets of the National Geological Map of the Russian Federation, scale 1:1000000, have been used as a primary source of information. The relevant data are contained in Quaternary maps which are obligatory for each quadrangle 4^0x6^0 of the National Geological Map. They are partly Quaternary maps of the 3rd generation in the GIS-format issued in 2009–2013. Another part of the database is digitized analog maps of the 2nd generation published between 1979 and 2002.

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Satellite images and recent publications on Quaternary stratigraphy of northern terrains have been employed for correlation between ice marginal complexes of adjacent regions. The stratigraphic basis of the correlation is provided by recent and classical publications and by regional stratigraphic schemes. We also used modern reviews of older glaciations of the entire Russian North (Astakhov, 2004, 2011, 2013) and of separate regions (e.g. Demidov et al., 2006; Möller et al., 2011). Valuable stratigraphic constraints on the age of the Late Pleistocene marginal formations can be found in published results of international cooperative works in the Arctic under the aegis of European Science Foundation coordination programs (QUEEN and APEX), especially by Russian-Norwegian, Russian-German, Swedish and American projects (e.g. Forman et al., 2002; Svendsen et al., 2004; Astakhov et al., 2007). Useful information on interregional correlation of ice margins is contained in the INQUA compendium on glacial features of the world (Astakhov, 2011; Möller et al., 2011; Velichko et al., 2011). The digital maps of this edition available on the Web in scale 1:1000000 are less detailed than the standard Quaternary sheets of Russia but the interpolations suggested therein can be used for filling inavoidable gaps in the general pattern of ice margins of this formidable territory.

The result of our work is the Glaciomorphological Map of the Russian Federation, scale 1:2500000 in GIS-format the print of which is demonstrated here. The major features of the map are limits of topographically expressed and stratigraphically proven independent glacial stages: D – the Don glaciation (appr. MIS 16), S – the Moscow glaciation (Saale), W_1 – the early Weichselian glaciation (ca 80–90 ka BP), W_2 – the Middle Weichselian glaciation (ca 50–60 ka BP), W_3 – the Late Weichselian glaciation (the classical Valdai, ca 30–10 ka BP).

Minor ice limits within the area of the last Scandinavan glaciation, irrespective of their stratigraphic significance, are drawn by geomorphic reasoning along subparallel marginal complexes to mark positions of the retreating ice margin within the time span of 20 to 11 ka BP. West of the Russian border they are called either glacial phases (in Poland) or ice-marginal zones (Kalm, 2012). In Russia they were originally mapped and named in the 1960-s but in those times called \`stades\` which is confusing because no significant glacier readvances were ever proven along such lines. However, these marginal lines are useful for correlation of the Valdai glacial history with better dated late glacial events in Europe. Kalm (2012) already tried to connect the Baltic ice-marginal zones with their Russian counterparts. We followed suit with minor revisions based on recent geological mapping data.

The Glaciomorphological map also shows other features relevant to the structure of ice marginal zones. They are hummock and ridge landscapes, kame plateaus, drumlins, individual large morainic ridges and kames, detached sedimentary megablocks, outstanding glacial disturbances, ice-contact lines and huge erratics. In addition, major interpretation results, such as ice flow directions and ice stream axes, are indicated. We hope that the presented map will be helpful in sorting out the history of former ice sheets in the southeastern sector of the Scandinavian glaciation and their relations with northeastern ice sheets fed by shelf ice domes and uplands of Central Siberia. E.g., the pattern of ice limits suggest that Middle Pleistocene ice sheets, both in Siberia and in European Russia, were significantly influenced by mighty ice dispersal centers on the arctic shelves.

The importance of inter-regional comparison of mapped glacial features is especially relevant in the Urals which is the main obstacle for trans-Eurasian correlations of Quaternary formations. E.g., the pattern of large moraines on the Siberian flank of the Polar Urals has no counterpart on the European slope. This asymmetry strongly suggests the origin of these morainic loops from trans-Uralian overflow of inland ice in the late Middle Pleistocene and not from local glaciers of Weichselian times according to the conventional wisdom. Minuscule alpine glaciers of the Late Pleistocene naturally gravitated to the more humid western slope producing an Alaskan type piedmont ice sheet only in the sub-Polar Urals. The mapped pattern of tiny alpine moraines does not support the classical idea of the Urals as a substantial source of Late Pleistocene inland ice.

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V.S. Baygusheva[1], V.V. Titov[2], A.S. Tesakov[3], E.V. Syromyatnikova[4], S.V. Kurshakov[2], P.D. Frolov[3]
[1] Azov museum-reserve, Azov, Russia
[2] Institute of arid zones, Rostov-on-Don, Russia
[3] Geological institute RAS, Moscow, Russia
[4] Zoological institute RAS, St. Petersburg, Russia
E-mail: vvtitov@yandex.ru

MIDDLE PLEISTOCENE FAUNA OF VESHENSKAYA (MIDDLE DON RIVER, ROSTOV REGION, RUSSIA)

Key words: paleoecology, biostratigraphy, vertebrates, mollusks, southern Eastern Europe

The Veshenskaya locality yields fossil mammal remains for many years. The site is located in the 40–45 m high coastal cliff at the left bank of the Don River between Veshenskaya and Lebyazhenskii settlements of the Rostov region. According to different researchers, bone bearing beds are confined to sediments of second or third alluvial terraces. Three levels with fossil bones have been detected. The lower bed is at the base of the 10–12 m thick fluviatile member, at the boundary with underlying basal layered brownish-gray clay. This clay bed contains shells of freshwater molluscs. The lower fluviatile member is represented by cross-bedded white quartz sand with interbeds of gravel and clay. This level produces the highest number of large and small vertebrates bones. The second fossiliferous bed is in the bed of dark gray sandy clay at about 10–15 m above the base of the fluviatile member. This bed contains sporadic poorly preserved bones of large mammals. Both lower bone beds likely have a similar age. Upsection with erosional unconformity there occurs a 20 m thick member of yellowish fine grained rhythmic sands. It is crowned by 3–5 m thick sandy loam and light loam with buried burrowings of rodents (krotovines). According to the geological literature, this, upper, bone bed of the section yielded remains of *Marmota bobac, Citellus* sp., *Ellobius* sp., *Apodemus* sp., *Microtus oeconomus, M. (Stenocranius) gregalis, Microtus* sp., *Eolagurus luteus, Lagurus lagurus, Clethrionomys* sp., *Allactaga* cf. *jaculus*. This association is dominated by yellow lagurine and marmot. The age of the fauna was determined by Dr. N. Kazantseva as early Late Pleistocene (Mikulino = Eemian interglacial) (Study of the Quaternary deposits..., 1989).

The lower fluviatile member was dated by thermoluminescent method in the range 200–185 ka (Study of the Quaternary sediments..., 1989). These results should be, however, treated with caution.

The fauna of the lower part of the section has been previously interpreted by us as early Late Pleistocene and correlated with Mikulino (Eemian)

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interglacial (Baygusheva, 1970; Baygusheva et al., 2003, 2004). The revised faunal list contains *Sorex* sp., *Castor fiber, Spermophilus* sp., *Cricetus* cf. *cricetus, Lagurus lagurus, Microtus arvalis, Microtus agrestis, Microtus gregalis, Microtus oeconomus, Microtus* sp., *Arvicola chosaricus, Clethrionomys glareolus, Mustela nivalis, Canis lupus lunellensis, Vulpes* sp., *Ursus (Spelearctos) savini rossicus, Leo spelaea, Mammuthus primigenius* (early form), *Equus* cf. *latipes, Equus hydruntinus, Coelodonta* sp., *Cervus* cf. *elaphus, Megaloceros giganteus, Alces* sp., *Bison priscus, Saiga* cf. *tatarica*.

Molars of the water vole *Arvicola chosaricus* have undifferentiated enamel (SDQ close to 100). This is typical for Late Khasarian faunas of the Lower Volga, and correlative faunas of the second half of the Middle Pleistocene and Eemian (Mikulino) interglacial of Late Pleistocene in Central and Western Europe. The overall appearance of the fauna, including evolutionary level of steppe lagirine *Lagurus lagurus* and the vole *M. gregalis* are typical for Middle-Late Pleistocene faunas of Eastern Europe. A number of forms of large mammals common to the late Middle Pleistocene Khazar faunal unit, such as *Elasmotherium sibiricum*, and *Camelus knoblochi* are missing in this burial. Stratigraphic distribution of *Ursus savini rossicus* in the steppes of Eastern Europe was mainly limited to Middle Pleistocene.

The frequency of plates in m1 and m2 (7.5–8 per 10 cm) and the enamel thickness (2.0–2.2 mm) of the mammoth from Veshenskaya indicate the early, thick enameled form of *Mammuthus primigenius*.

The dimensions of the most numerous species of the association, the large bison, are intermediate between the values of bisons from Mosbach (Germany, Middle Pleistocene) and the Late Pleistocene *B. priscus*.

The herpetofauna of the lower fossil bed contains the common spadefoot *Pelobates fuscus* and sand lizard *Lacerta* cf. *agilis*, which are nowadays associated with steppe and forest habitats with dry soils.

The fish fauna of the lower fossil bed includes gudgeon *Gobio* cf. *gobi*, undermouth *Chondrostoma* aff. *variabile*, dace *Leuciscus leuciscus*, carp *Rutilus* aff. *frisii*, roach *Rutilus* cf. *rutilus*, rudd *Scardinius erythrophthalmus*, pike *Esox lucius*, and perch *Perca fluviatilis*. The presence of gudgeon, dace, and undermouth may indicate a relatively deep river with a swift current and a sandy bottom. The presence of roach and rudd may indicate the oxbow conditions.

The mollusc fauna obtained from the upper level of the basal clay bed contains freshwater gastropods *Valvata pulchella, Bithynia* sp., *Lymnaea (Galba) truncatula, Planorbis planorbis, Gyraulus laevis* and a bivalve Pisidiidae gen. This association represents a modern stagnophilous boreal fauna lacking any warm-water elements that indictes a temperate climate water body with a weak current.

The predominance of steppe and forest forms among terrestrial vertebrates, indicates the predominance of open and semi-open landscapes. The banks of large paleo-Don River were overgrown by floodplain forests.

This study integrates data on invertebrates and lower and higher vertebrates of the Veshenskaya locality. It is shown that the biota of the lower fossiliferous level of the site witnessed a cool and relatively arid climate. It is likely correlative to the transition from interstadial to glacial climatic phase of late Middle Pleistocene.

This vertebrate fauna of Veshenskaya is important for late Middle Pleistocene paleoecology and paleogeography of the Middle and Lower Don River region.

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E.V. Bezrukova[1], *P.E. Tarasov*[2], *P.P. Letunova*[1], *A.A. Shchetnikov*[3],
N.V. Kulagina[3], *E.V. Ivanov*[1], *O.G. Sharova*[1], *A.V. Belov*[4], *O.V. Levina*[1]

[1] Vinogradov Institute of Geochemistry,
Siberian Branch, Russian Academy of Sciences
Irkutsk, Russia

[2] Institute of Geological Sciences, Palaeontology, Free University
Berlin, Germany

[3] Institute of the Earth Crust, Siberian Branch, Russian Academy of Sciences
Irkutsk, Russia

[4] Sochava Institute of Geography, Siberian Branch, Russian Academy of Sciences
Irkutsk, Russia

E-mail: bezrukova@igc.irk.ru

LAST GLACIAL–INTERGLACIAL VEGETATION AND ENVIRONMENTAL DYNAMICS IN SOUTHERN SIBERIA

Key words: Baikal region, Late Pleistocene, Holocene, vegetation and landscapes, climate dynamics

Worldwide terrestrial and marine sedimentary archives demonstrate that the last 50-kyr interval in the Earth's history experienced a number of long- and short-term climatic oscillations (Svensson et al., 2008). High-resolution and accurately

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dated pollen and sedimentary records of the late-glacial/early Holocene interval exist for several regions of Europe (Brauer et al., 2008) and East Asia (Stebich et al., 2009), providing important insight into the environmental dynamics in the North Pacific and North Atlantic regions. However, a recent global-scale synthesis of the Holocene climatic data (Wanner et al., 2008) demonstrates a lack of palaeorecords of comparable dating quality and resolution from the vast areas of Eurasia, including Siberia and Central Asia. Southern Siberia — the region of Russia between ~80–120 °E and ~50–60 °N — consists of numerous sub-latitudinal mountain ranges and lakes, including Lake Baikal in the east. The lake sediments are one of the most promising sources of detailed palaeoenvironmental information. Numerous publications on the Lake Baikal region (e.g. Williams et al., 2001; Prokopenko et al., 2010 and references therein) presented coarse-resolution (millennial- or multi-century-scale) qualitative reconstructions of the Quaternary environments. However, little is known about glacial intervals due to the problems associated with very low pollen concentrations, poor organic content, low sedimentation rates and poor dating (Prokopenko et al., 2010). This study presents new pollen, diatom, and geochemical records from several lakes located in the vicinity of lake Baikal and aims to reconstruct regional vegetation and environmental history since ~50 kyr BP; to compare it with the oxygen isotope records from the North Atlantic and North Pacific regions; and to discuss the underlying mechanisms of the environmental change in the region.

Pollen spectra composition and reconstructed biome scores suggest predominance of a tundra–steppe vegetation and variable woody cover (5–20%) between ~47 and 30 kyr BP, indicating generally a harsh and unstable climate during this interval, conventionally regarded as the interstadial within the last glacial. The short-term climate amelioration episodes in the glacial part of the records are marked by the peaks in taiga and corresponding minima in steppe biome scores and appear synchronously with the hemispheric temperature and precipitation changes recorded in the Greenland icecores and Chinese stalagmites. Transition to full glacial environments occurred between 32 and 30 kyr BP. The interval at ~30–24 kyr BP was probably the driest and coldest of the whole record, as indicated by highest scores for steppe biome, woody coverage b5%, absence of diatoms and reduced size of the lake. A slight amelioration of the regional climate at ~24–22 kyr BP was followed by a shorter than the previous and less pronounced deterioration phase. The late-glacial (~17–11.65 kyr BP) is marked by a gradual increase in tree/shrub pollen percentages and re-appearance of diatoms. After 14.7 kyr BP the climate became warmer and wetter than ever during ~47–14.7 kyr BP, resulting in the deepening of the lake and increase in the woody coverage to 20–30 % ~14.5–14 kyr and ~13.3–12.8 kyr BP. These two intervals correspond to the Meiendorf and Allerød interstadials, which until now were interpreted as part of the undifferentiated Bølling/Allerød interstadial complex in the Lake Baikal region. The increase in tundra biome scores and pronounced change in the diatom composition allow (for the first time) the unambiguous identification of the Younger Dryas (YD) in the Lake Baikal region at ~12.7–11.65 kyr BP, in agreement with the formal definition and dating of the YD based on the Greenland NGRIP ice core records. The maximal spread of the taiga communities in the region is associated with a warmer and wetter climate than the present prior to ~7 kyr BP. This was followed by a wide spread of Scots pine, indicating the onset of modern environments.

The reconstructed pattern of changes in the regional environments demonstrates that the late Pleistocene climate dynamics in southern Siberia were more complex than previously thought, and resemble the temperature variations (e.g. Greenland interstadials and Heinrich events) expressed in the $\delta^{18}O$ record from Greenland ice and the East Asian Monsoon intensity signal in the $\delta^{18}O$ record from Chinese stalagmites.

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N.S. Bolikhovskaya[1], A.N. Molodkov[2]
[1] Faculty of Geography, Lomonosov Moscow State University
Moscow, Russia
[2] The Research Laboratory for Quaternary Geochronology, IG TUT
Tallinn, Estonia
E-mail: nbolikh@geogr.msu.ru

CHRONOLOGY AND CLIMATIC PECULIARITIES OF THE PERIOD BETWEEN CA. 94 AND 70 KA (MIS 5B–5A) INFERRED FROM PALYNOLOGICAL AND IR-OSL ANALYSES OF THE VOKA REFERENCE SECTION (SOUTH-EASTERN COAST OF THE GULF OF FINLAND)

Key words: chronology, IR-OSL dating, palynology, last interglacial, Late Pleistocene, MIS 5, palaeoclimate

Late Pleistocene is the most extensively studied period of the Quaternary geological history of Northern Eurasia. However, there remain many questions regarding chronology, landscape and climatic features of the warm and cold phases of different magnitudes and duration reconstructed for the last 130 ka. A careful consideration of this problem leads to the conclusion that there is a deep conviction that at least climatic and paleogeographic changes are appropriately reflected in temporal variation of oxygen isotope ratios (^{18}O) derived from sea-floor sediment cores (Shackleton, 1969). According to the key concept of climate change in the late Pleistocene (Mangerud, 1989) formed under the influence of deep-sea oxygen isotope curves, which are believed to directly reflect ice-volume fluctuations, the last interglacial was associated with marine isotope substage 5e lasted from about 130 ka to 117 ka. Consequently, the last glacial (Weichselian) stage started at around 117 ka (MIS 5d), and lasted nearly 100 ka, i.e. up to deglaciation that started at around 17–15 ka ago in most areas of the Northern Europe.

For the Gulf of Finland region in the south-eastern part of which the studied Voka reference section is located, detailed palynological and diatom analyses were carried out on marine and freshwater sediments from a number of famous Mikulino interglacial sections such as Mga, Siniavino, Rybarskoe, Krasnoselskoe, etc. (O.M. Znamenskaya, E. A. Cheremisinova, V.P. Grichuk, M.P. Grichuk, M.A. Lavrova, L.F. Sokolova, E.S. Malyasova, E.M. Vishnevskaya, etc.), Suur-Prangli (E. Liivrand), Peski and Põhja-Uhtyu (A. Miettinen et al.). The regional palynozones corresponding to palynozones of Mikulino interglacial deposits of the central and the northern parts of the East European

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Plain are distinguished. However, absolute dating data on Mikulino sediments from these and other sites are absent.

New palaeoenvironmental and chronological data, which may be compared and correlated with the data from the neighbouring and more distant regions, were collected from a well-exposed continuous outcrop in the vicinity of Voka village, south-eastern coast of the Gulf of Finland (59°24′52″ N, 27°35′58″ E). The outcrop, situated in a klint depression – klint bay – show an about 22-m-thick stacked sequence of sandy to clayey subaqueous deposits. This succession of water-lain sediments documents the response to climate change during the late Pleistocene. A series of infrared optically stimulated luminescence (IR-OSL) datings from the lower mostly clayey unit shows that the unit is the second half of MIS 5 in age. On the basis of the accurate IR-OSL dates obtained, age-depth model for 2.5-m-thick sediment sequence was constructed. The model covers the period from ca. 94 to 70 ka – the most controversial part of MIS 5 during which, according to many authors, the huge late Pleistocene Barents-Kara ice sheet extended along the Russian Arctic from the White Sea shores in the west (Larsen et al., 2006) to the Taimyr Peninsula in the east (Svendsen et al., 2004) attaining its maximum size as early as 90–80 ka ago when the ice front reached far onto the continent.

Representative pollen spectra derived from 35 samples from the studied unit provide convincing evidence of vegetation and climate in the study area during the period from ca. 94 ka to ca. 71 ka corresponding to standard Mikulino interglacial pollen zones M6, M7 and M8.

The characteristic Mikulino dendroflora taxa (*Juglans regia, Carpinus betulus, Tilia cordata, T. tomentosa, T.* cf. *dasystyla*, *Quercus robur, Q. petraea, Corylus avellana, Alnus glutinosa, A. incana,* etc.) typically present in the autochthonous pollen complex clearly points to interglacial climatic conditions and geological age of the deposits.

Pollen zone M6 (*Carpinus-Tilia-Quercus-Ulmus-Corylus-Pinus Haploxylon* type) in the visible part of the unit corresponds to the period of 94.2–81.6 ka. This pollen zone consists of subzones M6a-M6e that reflect certain variability of the interglacial climate (intra-interglacial climatic oscillations) during this period and a continuous succession of dominant forest formations: M6a – broadleaved coniferous forests with the predominance of pine and hornbeam; M6b – hornbeam forests with an admixture of lime, oak, ash, elm, and pine; M6c – broadleaved-coniferous forests with the predominance of pine and hornbeam and a notable participation of birch; M6d – hornbeam forests with some oak, linden, elm, and pine; M6e – broadleaved-coniferous forests with the predominance of European cedar pine, spruce, hornbeam, and the increased participation of Scots pine and birch. Two minor intra-interglacial cooling events (endothermals) were recorded between 94.2 ka and 91.0 ka and between 89.0 ka and 86.5 ka.

Deposits dated to the time interval between 81.6 ka and 71.6 ka correspond to pollen zone M7 (*Picea-Quercetum mixtum-Pinus Haploxylon* type) that reflects the phase of the predominance of European cedar pine-spruce and pine-spruce-broadleaved deciduous forests. Interval 71.6 to 71.4 ka corresponds to pollen zone M8 (*Pinus Haploxylon* type-*Pinus Diploxylon* type-*Betula*), whose spectra characterize vegetation of the final phase of the interglacial when birch-pine-Siberian cedar pine forests dominated along with sparse woodlands, with *Pinus sibirica* as dominant species, and meadow-bog communities.

During the period between 71.4 ka and 58.4 ka, the formations included tundra and forest-tundra periglacial landscapes dominated by dwarf birch (*Betula nana*, *Alnaster fruticosus*), meadow-bog formations, and Scots pine, Siberian pine, and spruce woodlands. At least five phases of vegetation and climate change have been reconstructed in the early Valdai period (ca. 71–55 ka) on the Voka site.

The specific character of interglacial landscape that existed in the study interval ranging from ca. 94 to ca. 71 ka is clearly highlighted by the data obtained by us for the middle Valdai warm and cold phases of the interval ca. 39–33 ka (Bolikhovskaya and Molodkov, 2007).

Thus, our research shows unambiguously that, in contrast with the expectations, the greater part of the late Pleistocene sequence represented in the Voka section reveals the fully interglacial conditions between ca. 94 and 71 ka. No evidence was found for glacial activity during this period.

The use of the Voka event stratigraphy as a template facilitates search for correlative horizons in the neighbouring and more remote regions.

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B.A. Borisov, V.K. Shkatova, L.R. Semenova
A. P. Karpinsky Russian Geological Research Institute (VSEGEI)
St. Petersburg, Russia
E-mail: ljudmilasemenova@mail.ru

PROPOSAL ON STRUCTURE OF THE GENERAL STRATIGRAPHIC SCALE OF THE QUATERNARY OF RUSSIA

Key words: Quaternary System, Pleistocene, Eopleistocene, Neopleistocene, stages Gelasian, Calabrian, division, subdivision

Lowering the Quaternary boundary involves changing, as soon as possible, the structure of the relevant units in the General Stratigraphic Chart (GSC) in order to use them rapidly in updating serial legends and geological mapping. The Interdepartmental Stratigraphic Committee Bureau raised the issue concerning the nomenclature of units in the corresponding GSC part for the Quaternary, but a decision on it has not been made and the issue remains controversial.

It seems appropriate to include a new unit corresponding to the Gelasian in Pleistocene division of the GSC. First, such a decision does not contradict to the Stratigraphic Code (2006, Art.III.6., Art.III.9.), secondly, the important, already familiar to geologists terminology — Eopleistocene and Neopleistocene and relevant geological stages in the Quaternary history are preserved, thirdly, Eopleistocene in the GSC for the Quaternary as before will match the Lower Pleistocene in the International Stratigraphic Chart (ISC), which is important for correlation with European units.

We propose to introduce a new unit — subdivision in the GSC structure for the Quaternary. Thus, the Eopleistocene division will have two subdivisions: the lower Eopleistocene subdivision represented by the Gelasian stage of the ISC and the upper Eopleistocene subdivision with two links as before. The lower Eopleistocene subdivision has not been split into the links so far.

Proposed structure of the GSC units for the Quaternary maintains succession with the currently existing chart at the Eopleistocene links level, which is particularly important for geological mapping.

With the introduction of subdivision in the GSC structure its maximum correlation with the ISC for the Quaternary system is achieved (see Fig. 1).

At the level of system — Quaternary and series (supradivision) — Pleistocene and Holocene, a complete correlation of the GSC for the Quaternary with the ISC is preserved as before.

Lower subseries of the ISC, as before, correspond to the Eopleistocene division of the GSC; stages comprising it, Gelasian and Calabrian, correspond to the lower and upper Eopleistocene subdivisions in the GSC.

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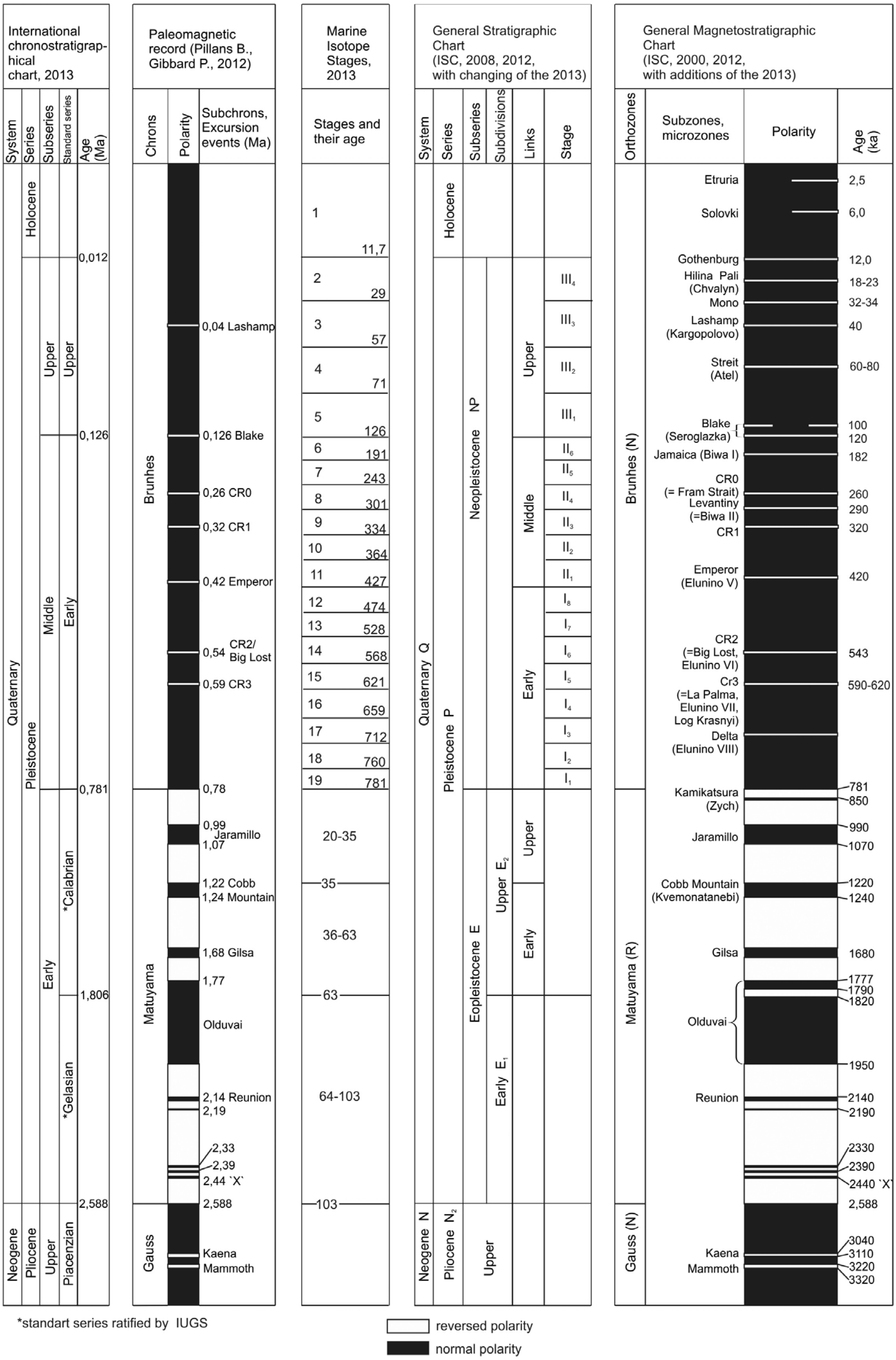

Fig. 1. General stratigraphic scale of the Quaternary of Russia suggested by the author.

Thus, introduction in the GSC structure for the Quaternary of one new unit — subdivision will ensure compliance with the ISC units for the Quaternary system, which is important when working under international programs and in compilation of international general maps.

The questions raised have to find their answers in the near future because this is due to the pressing needs of geological and cartographic production.

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A.V. Borodin[1, 2]
[1] Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
[2] Institute of Natural Science, Ural Federal University
Ekaterinburg, Russia
E-mail: bor@ipae.uran.ru

EVOLUTIONARY PATTERNS IN THE DENTITION OF ARVICOLINAE (CRICETIDAE, RODENTIA)

Key words: arvicoline rodents, teeth, phylogeny, ontogeny

Original and previously published data on dental variation in living and extinct arvicoline rodents are summarized.

Fossil record is the only source of evidence for the reality of macroevolution. At different sequential time slices there could be found the taxa, which represent the sequential steps in the formation of trait combinations inherent to the terminal taxa. Thus, we know the emergence time and sequence for particular traits and their combinations on a paleontological timescale. On the other hand, for a particular representative of a taxon (i.e., for an individual) the combination of traits is determined by preceding evolutionary stage and is formed during ontogenesis; particular traits (and/or their groups) develop non-simultaneously.

For the first time in arvicolines, the ontogenetic background of evolutionary changes in the lower incisor development and position in the mandible is revealed. Lingual position of the lower incisor relative to the tooth row in *Lemmini* and *Dictostonichini*, which distinguishes them from other arvicilines, could be regarded as a mere parallelism. Differences in the position and extent of development of incisors and lower third molars (m3) between voles and lemmings are determined by the advanced development of the m3 alveolus in *Lemmini* and *Dictostonichini*, which sets the direction for development of the incisor's alveolus along the tooth row, whereas advanced growth of incisor in

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voles precedes the development of m3 and causes the lingual development of m3 alveolus.

Development of a hypselodont tooth (roots are not formed) could be considered as a result of retardation at one of the stages of crown development (Fig. 1). Occlusal outline and shape depend significantly on the ontogenetic stage, at which this retardation starts (in upper, middle or lower portion of the crown). For example, the simplification of occlusal surface of teeth in mole voles (*Ellobius*) could be regarded as the development of a hypselodont tooth pattern, which may have resulted from the retardation of lower (basal) portion of the tooth crown.

Complication of the occlusal outline could be achieved by addition of either a new module of a crown or a new element of the same module.

An analysis of relationships between cement distribution and formation of dentin tracts in different arvicoline lineages achieving hypselodonty suggests that both cement buttresses in re-entrant angles and dentin tracts are formed at rhizodont stage of the phylogeny. Neither cement in re-entrants nor dentine tracts could be developed after the phylogenetic transition to a hypselodont tooth pattern (when the development of roots is excluded from the ontogeny).

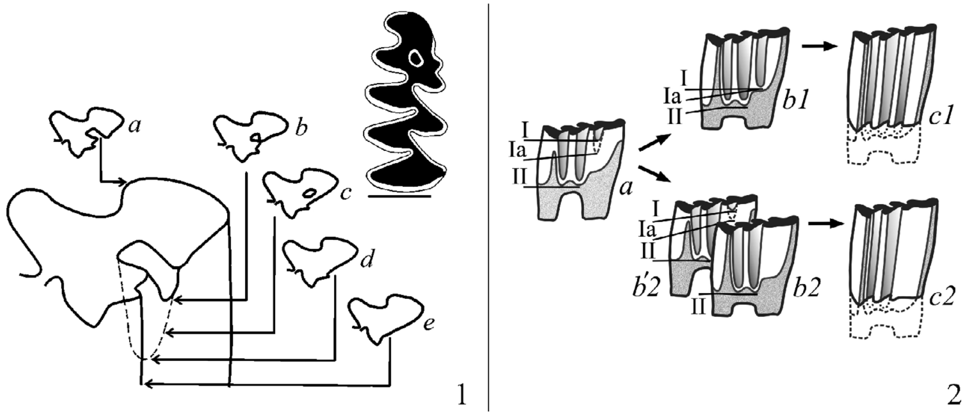

Fig. 1. A scheme of outline changes in the anteroconid portion of the first lower tooth related to the crown wear stage in *Mimomys* vole (1) and different pathways underlying the development of a hypselodont tooth in arvicolines (2), which are related to the early (*b1-c1*) or the late (*b'2-c2*) stages of crown development.

1 — The lines represent the levels of the cross-sections (stages of wear): a — the enamel fold is not closed in the islet; b-c — the stages at which the enamel islet is closed; d — the islet is worn out but the *Mimomys* fold still persists; e — "secondary simplified" anteroconid: no enamel fold and no islet is present; 2 — I — the stage of the islet closing, Ia — the stage of the islet wear, II — the lower border of the crown; *a→b1→c1* — the pathway towards hypselodonty accompanied by the complication of occlusal surface, *a→b2→c2* — the pathway towards hypselodonty accompanied by the simplification of occlusal surface; dashed line — the stages of tooth development excluded during phylogeny from the tooth ontogenesis

Based on the analysis of ontogenetic and phylogenetic pathways from a brachiodot to a hyspelodont tooth, the system of rules and constraints might be established as follows:

– Increasing hypsodonty is the one-way process with no possibility to retrieve the excluded morphogenetic stage of root development, but the occlusal surface may undergo secondary simplifications at the rhizodont stage;

– Presence of cement in re-entrant angles along with the number and position of dentin tracts is defined at the rhizodont stage and could not be changed after the transition to hypselodonty;

– Complexity of the occlusal surface could be related with the enamel folding within the same ontogenetic module of a tooth or it could be determined by the number of ontogenetic modules;

– New ontogenetic module might be developed as an additional element of the already existing tooth.

Combination of patterns underlying the formation of structural and histological elements of a tooth determines the scenario of dental evolution within the arvicoline tribes and within the particular phyletic lineages. The scenarios might be divided into the general for a subfamily (common traits for all arvicolines, which might be differently expressed in particular lineages and species) and specific scenarios inferred for a particular lineage or taxa. The former reflect the evolutionary constraints and the latter reflect the phylogenetically driven interconnections in tooth development.

Lemmini and *Dicrostonichiny* are the examples of the earliest transition to the hypsodonty and hypselodonty, which distinguishes them from other arvicolines and dates their origin back to the Pliocene. However, they show extremely different patterns of complication of the dentition, of enamel differentiation, and cement distribution. Another unique combination of traits related to hypsodonty and occlusal complexity is the tribe *Clethrionomyini*, which also differs from other arvicolines by the age of its origin. If we accept that the ancestor for all the other lineages is the genus *Promimomys* (no cement, relatively low crowns), then the two groups should be established including *Lagurini* and *Ellobius* (no cement in re-entrant angles) and *Arvicola* and *Microtus* (cement is present in re-entrant angles). Classification of arvicolines based on the scenarios of dental evolution shows similar topology with the classifications based on molecular markers.

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M.E. Bylinskaya, *L.A. Golovina*, *B.G. Pokrovskii*
Geological Institute, Russian Academy of Sciences
Moscow, Russia
E-mail: marina.012@mail.ru

PALEOENVIRONMENTS IN THE FRAM STRAIT, NORTH ATLANTIC, DURING MIS 2–6

Key words: Fram Strait, MIS 2–6, $\delta^{18}O$ records, Globigerinoides ruber, nannofossils

Several sediment gravity cores were derived in the Fram Strait during the 24th cruise of R/V Academician Strakhov in order to study the interaction of polar and Atlantic water masses that strongly varied during the Pleistocene (Dokken and Hald, 1996; Hebbeln and Wefer, 1997; Spielhagen et al., 2004). The stratigraphic interpretation of the sections is based on the studies of foraminifers, nannofossils, δ18O records, and on the accelerator mass spectrometry (AMS) ages obtained for the upper part of the recovered sediments. The dynamics of paleoceanographic conditions is additionally represented by high-amplitude variations in the ice-rafted detritus (IRD) distribution.

The Fram Strait is the key region connecting the Atlantic Ocean and the Arctic and the main way for heat and water exchange between the Arctic basin and the World Ocean. The surface waters of the strait are dominated by the cold East Greenland current transporting Arctic water to the Atlantic in the west and the warm West Spitsbergen current in the east that is the source of Atlantic water for the Arctic basin.

Sediment cores AS2417 (78º14,79' N, 05º45,75' E, water depth 1568 m) and AS2427 (78º08,14' N, 06º30,12' E, water depth 1598 m) were taken at an elevation on the western flank of the Knipovich Ridge that extends for a distance of 550–600 km southwest of Svalbard. One of the branches of the warm West Spitsbergen current runs directly above the studied area (Saloranta and Haugan, 2004). The 350- and 262-cm-long cores are composed of alternated brown and grey clays bearing ice-rafted detritus. The samples were taken at 2–3 cm intervals as 1-cm-thick slices. The number of foraminifers (>100 μm) per 1 g of dry deposit was countered and the dry weight% of material >100 μm was measured in each sample. In addition, nannofossils and diatoms were studied in the highly bioproductive intervals. AMS datings were carried out at Keck Carbon Cycle AMS Facility, University of California, using tests of *Neogloboquadrina pachyderma* sin. This planktonic species was also analyzed for stable oxygen isotopic composition. The available data permitted the stratigraphic subdivision of sediments and recognition of marine isotope stages (MIS) 2 to 6 in the sections. The microfauna and flora content varies greatly

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in the sediments studied. Several high productive (HP) intervals separated by zones extremely impoverished in organic remains are recognized.

The most part of Holocene (**MIS 1**) is missing in the cores, probably, owing to washing out of the upper semiliquid layer from the core.

MIS 2 in the cores studied is marked by one of the largest peaks of IRD and by the first maximum of plankton high productivity. According to AMS dates, this interval ranges in age from about 18 to 24 ka, i.e. approximately corresponds to the last glacial maximum. The occurrence of seasonally ice-free waters in the Fram Strait at that time was previously reported (Dokken and Hald, 1996; Hebbeln and Wefer, 1997), however, unusually warm elements were found in the interval. Along with the polar *N. pachyderma* sin, the foraminiferal assemblage includes single specimens of *Globorotalia scitula*, *G. crassaformis*, and *Globigerina falconensis*. One specimen of *Globigerinoides ruber* was encountered at the base of the HP bed. These three latter species do not occur in the modern Fram Strait and indicate a recurrent strong advection of Atlantic waters and a strengthening of the northward warm current in the Polar North Atlantic. Among nannofossils *Emiliania huxleyi, Coccolithus pelagicus, Helicosphaera carteri* and *Gephyrocapsa* spp. are identified. Consequently, during the LGM when the Svalbard shelf was covered with a glacier (Spielhagen et al., 2004), westward in the Fram Strait a strong meridional circulation occurred that resulted in ice-free conditions and a great plankton productivity.

MIS 3–4. This interval can hardly be subdivided in the cores studied; maybe only a strong peak of IRD input indicates the early MIS 3 between 40 and 50 ka (Hebbeln and Wefer, 1997). The sediments of the interval are impoverished or almost barren of calcareous plankton and are characterized by rather heavy $\delta^{18}O$ values of about 4.3 to 4.5‰ without significant oscillations. These data suggest the absence of any long-term ice-free conditions in the Fram Strait.

MIS 5 is completely recovered in core AS2427. It is marked by a greatly variable content of IRD and several HP beds. MIS 5.1 is characterized by a large amount of IRD, abundant foraminifers, and a significant light $\delta^{18}O$ excursion. Its age is confirmed by the occurrence of a bed bearing benthic *Pullenia bulloides* which is considered as a marker of stage 5.1 (and/or 5.5) in the North Atlantic (Haake and Pflaumann, 1989). Planktonic foraminifers in addition to abundant *N. pachyderma* sin, include *N. pachyderma* dex, *Globigerinita glutinata*, *Globigerina falconensis*, and at the base of the productive layer a single *Globigerinoides ruber*. Another increase in IRD and foraminiferal content is recorded in MIS 5.3. MIS 5.4 is marked by extremely low amount of IRD and foraminifers and heavy $\delta^{18}O$ values suggesting a perennial ice cover in the Fram Strait during that time span. MIS 5.5 again displays flourishing of forams, occurrence of *Pullenia bulloides*, light $\delta^{18}O$ values, and low content of IRD. These records correspond to interglacial environment. Comparison of the IRD curves compiled for the two cores revealed a hiatus in core AS2417. The latter includes only sediments of MIS 5.1—5.3. The hiatus likely resulted from a seismic event on the Knipovich Ridge.

MIS 6 is recognized only in core AS2417 below the stratigraphic gap. The deposits include three large and one minor HP beds. The interval is characterized by a high proportion of IRD and the presence of coal particles that are common for MIS 6 sediments in the Fram Strait (Hebbeln and Wefer, 1997; Spielhagen et al., 2004). The upper HP bed yields single tests of relatively warm-water plankton *Globigerinita glutinata, Globigerina falconensis, G. bulloides* and *G. calida* juv. Nannofossils include *Emiliania huxleyi, Coccolithus pelagicus, Gephyrocapsa* spp. and *Ceratolithus cristatus*. The following HP bed contains foraminifers *G. falconensis, G. bulloides* and *G. quinqueloba*. Finally, the third HP layer in the discussed interval is marked by the occurrence of scarce *G. falconensis* and *G. bulloides*. The relationship between the carbonate plankton and IRD distribution of this stage strongly resembles the analogous curves for core PS1535 located slightly westward at the same latitude (Spielhagen et al., 2004). Though the age estimation of this part of core AS2417 is difficult owing to the lack of radiometric ages, we believe that this interval is referred to MIS 6, among other things, due to the greater number of IRD compared to the upper horizons, absence of Pullenia bulloides, and similarity with the corresponding interval of core PS1535.

The lowermost in the core bed with high productive plankton is characterized by a considerably lesser amount of tests but is marked by the occurrence of the most warm-water species. Single specimens of Globigerinoides ruber and pink-colored Globigerina rubescens were identified there. The northernmost point of occurrence of the latter known by now is the DSDP Site 410 (45°31' N) in the Atlantic Ocean (Bylinskaya et al., 2002). However, the heavy $\delta^{18}O$ values contradicts its assignment to MIS 7.

Consequently, according to the available data, the sediments recovered by cores AS2417 and AS2427 approximately correspond to the last 180 ka. The occurrence of beds with abundant carbonate plankton during glaciations and interstadials indicate seasonally ice-free waters in the western Fram Strait even in the coldest Late Quaternary intervals, and the findings of single tests of subtropical species, a continuous inflow of Atlantic water to the polar latitudes.

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N.M. Chairkina
Institute of History and Archaeology UrB RAS, Ekaterinburg, Russia
E-mail: chair_s@mail.ru

PEAT-BOG SITES OF THE TRANS-URALS

Key words: Archaeology, peat-bogs, Holocene, Trans-Urals

Peat-bog sites represent a specific source of information, which is kept due to the unique ability of peat and sapropel to collect and preserve organic remains. Multi-proxy records in peat bogs include archaeological, paleontological, geological, etc. sequences, the conditions and time span of which are determined by physiographic conditions of a particular region and by environmental and climatic factors. Such sites were formed during different periods of the Holocene, when the conditions favored eutrophication of lakes, paludification of settled riparian areas and preservation of cultural layers in peat deposits. Peat bog sites are situated on the eastern slope of the Urals in the forest zone of the Trans-Urals, which is subdivided orographically into the foothills and the peneplain. This area encompasses several natural climatic zones and has specific relief, hydrographic and geological features, which determine the peculiarities and age of peat-bog formation in northern, southern, mountainous and plain regions.

Nowadays, more than 60 peat-bog sites from the Mesolithic to Late Bronze Age (about 9 300–1 300 years BC) are discovered and partially studied in the study area. Cultural layers of the early Iron Age are rare and not enough informative. Source materials and interpretability of the peat-bog sites in the Trans-Urals are nonequivalent. They provide evidences for determining the chronological position of archaeological cultures, reconstructing the ancient economy and religious practice, exploring the environment and revealing variation in the models of adaptation of ancient societies to the climate change during the Holocene.

The finds in the peat-bog sites of the Transurals include household items, hunting and fishing tools; buildings, and works of art made of organic materials, which are usually not preserved in cultural layers of the archaeological sites of other types; tableware ceramics and tools of stone and metal. Specificity and local colour of the transuralian sites, which define their place in the world archaeological heritage, is determined by the presence of religious objects with the complexes of wooden buildings accompanied by zoomorphic, ornithomorphic, anthropomorphic sculptures.

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J. Chlachula[1, 2], *Yu. B. Serikov*[3]
[1] Institute of Geoecology and Geoinformation, Adam Mickiewicz University
Poznan, Poland
[2] Laboratory for Palaeoecology, Tomas Bata University
Zlín, Czech Republic
[3] Department of History, Nizhniy Tagil' State Academy
Nizhniy Tagil, Russian
E-mail: Altay@seznam.cz

GEOLOGY AND CHRONOLOGY OF PLEISTOCENE CULTURAL RECORDS IN THE CENTRAL URALS

Key words: Middle Palaeolithic, Upper Palaeolithic, stone industries

The Urals and the adjacent regions located at the easternmost limits of Europe at the geographic borderline with the northern Asia/West Siberia are of major relevance for comprehension of the culture-historical trajectories and environmental contexts of early peopling to this still marginally explored territory. Complex Quaternary transformations of regional natural settings due to climate change controlled timing and dynamics of the Palaeolithic occupation in the central mountain zone, foothills and adjoining Fore-Ural and Trans-Ural plains. The Urals' Palaeolithic peopling, likely encompassing a time interval surely well over the currently documented ca. 0.5 Ma, is seen as a complex process governed by changing palaeoclimate, palaeogeography and palaeoecology regional configurations. The diversity of archaeology records provides proofs of a long prehistory of human peopling to this Russian territory. The earliest presence of humans is indicated by simple core-and-flake ("pebble-tool") industries, representing the most prolific cultural evidence associated with old (Early and Middle) Pleistocene alluvial formations (terraces in the Kama and presumably the Pechora River basins) and linked to the Middle Palaeolithic inhabitation of the western Urals foothills and the intermountain valleys The geo-contextually well-fixed Middle Palaeolithic records in the Central Urals are found in stratified 5–20 m-thick loess-palaeosol sections sealing numerous lithic inventories and anthropogenically articulated large fossil fauna remains (Pavlov et al., 1995). The Urals' palaeoenvironmental (geological and biotic) proxy data point to existence of productive ecosystems from the late Middle Pleistocene and the early Late Pleistocene, particularly the Last Interglacial Stage (Stefanovskiy, 1997). The sub-aerial geological contexts, delivering a variety of cultural materials, provide witness to several stages of early occupation. Archaeology and palaeontology materials are primarily sealed in fossil pedogenic horizons (brow forest and chernozemic parkland-steppe palaeosols) assigned to MIS 7–5–3 (Chlachula, 2010).

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Contrary to the Fore-Urals (the western Ural foothills and the upper Kama basin) with the highest density of the (open-air) Middle Palaeolithic localities, the sites distributed further east are still rather sporadic. This may be explained by the absence of the massive wind-born (loessic or sandy) sedimentary formations, providing a regional geo-chronology control and preserving plentiful Palaeolithic inventories in stratified sequences on the Eastern European Plains as well as in southern Siberia, but also by active former erosional processes associated with the Middle-Late Pleistocene neotectonics and the glacial-interglacial geomorphic relief modelling. Other limiting factors are the site visibility in the forested landscape and the actual site preservation potential affected by past (primarily MIS 4) cover sediment denudation. In contrast to the Fore-Ural regions, the time-equivalent human occupations in the central mountain valleys and the Trans-Ural foothills can be anticipated in cave settings and in diverse polygenetic geo-contexts, respectively. Shallow geological position of mapped archaeological horizons at most of the Pleistocene Trans-Ural sites situated in active slope settings or exposed on the present surface hinder their exact chronological assessment. Some indices of the pre-Upper Palaeolithic peopling of the central mountain regions come from cave sites in the Chusovaya River valley and from the genetically rather varied Late Quaternary geological formations distributed on the eastern slopes of the central Ural Mountain range and the adjacent valleys draining the western margin of the West Siberian Plain. The Chusovaya canyon-shaped valley and its tributary valleys, transecting the Central Ural's mountain range NE-SW, were the principal corridor for the following Middle and Upper Palaeolithic migrations from western (Fore-Ural) plains into the eastern (Trans-Ural) West Siberian territory. Except for the mountain karstic limestone formations, the Middle Palaeolithic habitat traces in the eastern Ural's foothills are distributed in shallow alluvial and colluvial deposits of the Leba, Neiva and Tara River valleys, delivering 12 investigated pre-Upper Palaeolithic sites (Serikova, 2001; Serikov and Chlachula, 2014), with most of these found in the proximity of rocky raw materials outcrops (silicified ruff/porphyry) used for the lithic industry production (Fig. A1, Appendix 1). Diagnostic technological attributes of the employed Levallois and bifacial stone flaking techniques with corresponding lithic artefact inventories afford some means for the pre-Upper Palaeolithic age-assessment. Although many early site are likely obliterated by the past gravity slope erosion processes trigged by the Pleistocene climate variations, the presently documented cultural evidence illustrates a cultural behavioural adjustment to the Pleistocene Central Urals ecosystems in the context of the progressing Middle/Late Pleistocene cultural development. The more recent (Upper and Final Palaeolithic) geoarchaeological sites (^{14}C-dated to 28–11 ka BP) mapped along the margin of the West Siberian Plains (the Sosva River Upper Palaeolithic Complex) are dominantly associated with fine-grained (silty clay) alluvial floodplain deposits formed in an open and seasonally inundated palaeolandscape during the Last Glacial in the West Siberian tundra-steppe/tundra-forest habitats (Chlachula and Serikova, 2011). The site establishment in open and seasonally inundated periglacial settings, delivering rich large fauna remains, principally mammoth, further demonstrates a successful adjustment of people during the expansion process into the northern and formerly ice-covered Arctic territories.

Current investigations on the Middle and Upper Palaeolithic in the north-central (Trans-)Urals deliver new information on chronology and natural conditions of the initial colonization of these territories expanding further into the sub-polar and eastern regions of the northern Eurasia. The Pleistocene ecosystem transformation processes, evolutionary cultural trends and Palaeolithic behavioural adaptation patterns under specific material-technological conditions are together with documentation of the sequenced climatic events stored in geological records are the main objectives of present multidisciplinary geoarchaeology studies. The long-term research focus is detailing contexts, chronostratigraphy and palaeoecology of single occupation sites and their regional cultural linkage with other (southern and western) areas of the Ural. This area along the westernmost limits of West Siberia is of major significance for understanding cultural adaptations to the north Eurasian Pleistocene natural environments and mapping the early human dispersal into the sub-Arctic regions of NE Europe and West Siberia. Geo-contexts of the investigated archaeological sites and complex stratified sections point to the pronounced Quaternary environmental dynamics and relief transformations. The glacial-interglacial cycles affected spatial dispersal of people from the south-eastern regions of the European continent and possibly from SW Siberia as well. Although still rather sporadic, the initial Middle Palaeolithic (Neanderthal?/early Homo sapiens) occupation of these territories is assumed to go back to the (late) Middle Pleistocene, as archaeologically manifested by expedient core-and-flake industries encountered in large quantities on the western (Fore-Urals) plains. A major pre-modern cultural expansion on the frontiers of Europe and north-central Asia is assumed during the Last Interglacial (130–74 ka BP) in a natural context of mixed forests and parkland-steppes that represented the dominant Urals' Middle Palaeolithic occupation ecosystems in the mountain regions and on the adjoining western and eastern plains, respectively. Mosaic biotopes are anticipated in the open valleys geologically built by karstic limestone formations delivering evidence of multilayer cave site occupations. Most of the present Trans-Ural open sites are found in patterned positions near local rocky outcrops used for lithic industry production by employing the Levallois and bifacial stone flaking techniques suggesting specific natural adaptation strategies. Apart from the biotically rich central montane and the eastern foothill regions, a gradual human infiltration into the neighbouring West Siberian Plain is assumed prior to the Last Glacial. Absence of thick and chronologically determinant sedimentary (loess-palaeosol) formations such as those in the Kama and Pechora Basins in the areas west of the Urals, incorporating rich Middle Palaeolithic and associated fossil fauna records may account for a limited number of the discovered Pleistocene occupation sites in the Trans-Ural region. This, in conjunction with dynamic palaeo-geomorphic processes, controlling early site preservation, represent the main constrains for documentation of the pre-Upper Palaeolithic peopling in the Urals' central mountain regions and the eastern foothills. The climate trends causing activation of periglacial and gravity-slope/gelifluction processes are seen as a limiting factor in preservation of the former open-air pre-Upper Palaeolithic localities. Despite this, because of the unique geomorphologic configuration and palaeo-environmental conditions, the Central Urals and Trans-Urals territory are of major potential for the future Palaeolithic geoarchaeology research.

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M. Coltorti [1], *P. Pieruccini* [1], *J. Vandenberghe* [2]

[1] Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, University of Siena Italy

[2] Department of Quaternary Geology and Geomorphology, Vrije Universiteit Amsterdam, The Netherlands

E-mail: pieruccini@unisi.it

ALLUVIAL STRATIGRAPHY AND FLUVIAL DYNAMICS AT THE LATE PLEISTOCENE-HOLOCENE TRANSITION IN THE ITALIAN APENNINES

Key words: Late Pleistocene, Holocene, fluvial sediments, fluvial dynamics, Glacial-Interglacial climatic changes, Italy

The Apennine mountain chain extends along the Italian peninsula and is affected by tectonic uplift since the Early Pleistocene with rates up to 0,7 mm/yr in the highest part of the chain where the relief is locally well above 2000 m a.s.l. Glacial landforms (cirques, valleys and related deposits) were modeled at the highest altitudes during the Glacial periods, particularly well documented

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for the Late Pleistocene. Also the rivers preserve within their valleys Late Pleistocene and Holocene alluvial successions tens of meters thick. During the Late Pleistocene the valley floors underwent to continuous aggradation due to high supply of sediments by the slopes. The deposition led to the creation of a single paired alluvial terrace that is found within all the valleys across the peninsula. The greater thickness of sediments are found where the catchment reached higher elevations and the slopes were affected by strong degradation due to glacial or cryonival processes. The chronology of the Late Pleistocene alluvial sedimentation span back to the late MIS 4-early MIS 3, at the very limit of the ^{14}C method. Sediments supply and sedimentation rates increase during the LGM and the later part of MIS 2. The Stadial sedimentation is characterized by gravelly dominated braided fluvial systems both on the floodplain and in prograding alluvial fans from lateral valleys; Interstadials are characterized by fine- dominated anastomosing river systems with sandy-silty and peaty floodplains, still in aggrading valley floors. During the LGM, between 28 and 15 ka, the sedimentation is therefore characterized by the superposition of horizontally bedded gravelly bars deposited within shallow and broad channels. Deeper and more confined gravelly channel fillings are characteristic of the uppermost part of the Late Pleistocene successions passing upward to overbank fines containing buried truncated immature palaeosols. The overbank fines are the latest phases of river aggradation before the beginning of the valley down-cutting, a phenomena related to the Holocene climatic amelioration and that affected the entire peninsula. The Holocene fluvial model is typical of meandering fluvial systems. The progressive river down-cutting led, during the Early-Mid Holocene, to the creation of a flight of unpaired alluvial terraces. Therefore during the Holocene facies architecture, facies models and fluvial dynamics were driven by the strong and rapid decrease of sediments provided by the slopes to the valley floors following the transition from rexistatic to biostatic conditions at the onset of the Interglacial.

The chronology of the rivers downcutting and the amount of the river's channel deepening has been constrained by sedimentology and stratigraphy supported by radiocarbon dates. The chronology was assessed dating organic palaeosoils and molluscs within the overbank sediments found in the uppermost part of the Late Pleistocene-Early Holocene alluvial terraces along the Marchean valleys draining toward the Adriatic side. In the mountain sector of the valleys (i.e. Musone, Tenna, Fiastrone rivers etc.) channels and valeys deepening of about 25–30 m are documented after 9000 y BP with values decreasing progressively moving toward the coastline.

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M. Coltorti, P. Pieruccini
Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, University of Siena
Italy
E-mail: coltorti@unisi.it

TECTONICS, CLIMATE AND FLUVIAL SEDIMENTATION: THE PLEISTOCENE RECORD OF CENTRAL ITALY

Key words: Pleistocene, Holocene, fluvial sediments, fluvial dynamics, climatic changes, Italy

A classic and since long time fashioned sedimentary and geomorphological model considers coarse-grained sedimentation within rivers usually associated with tectonic movements, both areal and linear (i.e. uplift and faults). The stratigraphy of Quaternary fluvial successions their architectures and the cycles of sedimentation are revised for Central and Northern Apennines, in Italy. A comparison is also made with the Holocene to present-day sedimentary architecture and river dynamics in the more elevated and tectonically active sectors of the chain where strong vertical uplift and faulting is recorded and therefore constitute an actualistic model for the older sediments. The Apennine mountain chain, well above 2000 m asl, is subject to vertical uplift with different rates in different areas. Early Pliocene coastal deposits on top of the higher part of the chain (Abruzzi Apennines) indicate uplift rates up to 0,7 mm/yr in the last 3,5 Ma. To the east, the hilly Periadriatic basin, Early Pleistocene marine deposits are uplifted up to 0,4–0,5 mm/yr. In the western side of the Apennines the uplift rates since the Late Pliocene are ca. 0,2–03 mm/yr (Cetona-Chianti Ridge, Tuscany Region). In this sector the Early Pleistocene uplift was partially balanced by west dipping NW-SE trending high angle normal faults that generated horsts and grabens (Tiber and Arno Basins, Gubbio, Norcia, L'Aquila, Sulmona, etc.). Since the Early Pleistocene in the Peninsula the deposition of thick coarse-grained sediments down to the edges of the continental escarpment was associated with the cold stages. Glacial and crionival processes at higher elevations generated aggrading alluvial fans and braidplains along the trunk valleys that were later dissected generating thick paired terraces. Interstadials were characterised by a thinner and fine-grained sedimentation associated to a change of fluvial styles even at higher elevations. River incision characterises the Interglacials, despite the rising sea level, generating a flight of thin unpaired terraces. However, in many valleys cut in limestone ridges after a major incision at the Glacial-Interglacial transition thicker sedimentation was locally represented by calcareous tufa and travertines. The continental platform was drowned by the rising sea level that was responsible for the unconformity that partially eroded the record of the older cold stages. The stabilization of

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the sea-level lead to the deposition of mostly fine-grained sediments across the continental platform. Along the steeper slopes of the Apennines, including those generated by Pleistocene normal fault activity, and at the feet of the present-day active faults escarpments the sedimentation is almost absent under the present day Interglacial conditions. Also very fast fault reactivations, (ca. 80 cm 1915 Avezzano earthquake) did not influence fluvial sedimentation. Therefore, the long-term uplift and faulting is responsible for the creation of mountain ridges that constitute the source for sediments and tectonic basins that generated the accommodation space for the accumulation of thick terrestrial successions. However, during the Quaternary and at the scale of Glacial-Interglacial cycles, despite the ongoing tectonic activity, fluvial coarse-grained facies and architecture were always climatically driven. The Holocene fluvial record cannot be considered a good actualist example for Interglacial fluvial sedimentation because since the Neolithic it was strongly influenced by human induced changes in terms of slope degradation and related sediment supply to the valley floors.

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G. Danukalova, A. Yakovlev, E. Osipova
Institute of Geology, Ufa Scientific Centre, Russian Academy of Sciences
Ufa, Russia
E-mail: danukalova@ufaras.ru

BIOSTRATIGRAPHICAL CHARACTERISTIC OF THE LOWER NEOPLEISTOCENE DEPOSITS OF THE SOUTHERN URALS REGION

Key words: biostratigraphy, Pleistocene, Southern Urals

Lower Neopleistocene deposits of the Southern Urals region are located at the base of the river valleys and are subdivided in Minzitarovo, Baza, Tanyp, Atasevo and Chusovskoy (=Sultanaevo suite) horizons which are equal to the climatolites.

Minzitarovo horizon is represented by deluvial and lacustrine deposits (Minzitarovo). Thickness is 1–3.9 m (Yakhemovich et al., 1983; Yakhemovich et al., 1988). The palynological spectra permanently contain pollen of Picea, *Pinus, Betula, Artemisia*, miscellaneous herbs, and Chenopodiaceae. Large mammals in the deposits of the Minzitarovo horizon are presented by the *Archidiskodon trogontherii* Pohlig (Yakhimovich et al., 1985).

Baza horizon is represented by alluvial pebble and sand with thin layers of grey clay in the upper part (Chui-Atasevo I), by lacustrine aleurite, sand

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and clay (Sultanaevo, borehole 1). Thickness is 0.5–8.25 m. The Baza time corresponded to a new phase of hydrographic network incision and accumulation of fluvial sediments (Yakhimovich et al., 1983, 2000; Danukalova et al., 2002). The landscapes of that time were dominated by herbaceous, miscellaneous-warmwood communities with subordinate birch forests with an admixture of broad-leaved and coniferous trees (Yakhimovich et al., 1987; Danukalova et al., 2002). The terminal Baza time was characterized by the wide development of dark coniferous taiga with an insignificant admixture of *Betula, Tilia,* and *Fraxiuns* representatives. Freshwater basins were populated by ostracods, including *Eucypris dulcifons* and *Ilyocypris bella*; the latter species appeared for the first time in the Caspian region during the Bakuan time (Yakhimovich et al., 1988). Molluscs were represented by terrestrial and freshwater species (Osipova, Danukalova, 2011). Small mammals of that time belonged to the Tiraspol faunal assemblage (Danukalova et al., 2002). Finds of *Mimomys intermedius* Newton, *M. pusillus* Mehely, and *Microtus* ex gr. *hintoni-gregaloides* indicate an Early Pleistocene (up to the Don time) age of host sediments.

Tanyp horizon is represented by lacustrine and deluvial brown loam, clay and alluvial sand (Chui-Atasevo V), and gravel (Sultanaevo, Karmaskaly). Thickness is 0.45–4.23 m.

The Tanyp time was characterized by the cessation of erosional activity and activation of slope denudation with an accumulation of eluvial-talus sediments (Yakhimovich et al., 1987; Danukalova et al., 2002). Molluscs were represented by terrestrial and freshwater species (Osipova, Danukalova, 2011). The assemblage of freshwater ostracods includes cold-resistant species (Yakhimovich et al., 1983, 1988), which appeared in the Cisuralia region during the Pliocene; they are missing from post-Neopleistocene sediments. Pollen and spore spectra are compositionally close to those from the Bakuan Horizon; however, they are less diverse with respect to miscellaneous herbs, Asteraceae, and Chenopodiaceae (Yakhimovich et al., 1987). The pollen spectra are dominated by herbaceous forms: *Artemisia*, miscellaneous, and Chenopodiaceae. Arboreal plants are characterized by the pollen of *Betula* with subordinate broad-leaved and coniferous forms. In the terminal Tanyp time, the abundance of herbaceous pollen decreases. Among arboreal pollen, *Picea excelsa* Link. has become dominant, being accompanied by single *Abies* grains. The initial Tanyp time was characterized by the development of herbaceous-warmwood steppes with broad-leaved birch forests, which were subsequently replaced by dominant taiga groupings, which tolerate cold climatic conditions.

Atasevo horizon is represented by alluvial pebble, sand and gravel (Chui-Atasevo I), and lacustrine loam (Karmaskaly). Thickness is 0.35–3.5 m. In the Atasevo time, when erosion was reactivated, fluvial sediments were uplifted and they are now observable in the lower parts of third terraces above the floodplain in the lower reaches of the Belaya River (Danukalova et al., 2002). The palynological spectra from these sediments are similar to their counterparts of the Baza time, demonstrating an alternation of dominant herbaceous and arboreal forms; the role of the latter pollen increases in its terminal phase

(Yakhimovich et al., 1987). The arboreal spectrum is dominated by *Betula*, which is accompanied by *Tilia, Quercus, Carpinus, Ulmus, Fraxinus, Pinus*, and *Picea* pollen. Herbaceous pollen characterizes miscellaneous and *Artemisia* forms. Chenopodiaceae are represented by species populating saline soils. The spectra include also pollen of aqueous and sporiferous plants. The landscapes were represented by broad-leavedbirch forests and meadow-steppes. The climate was relatively warm (probably warmer than the Baza time). Soils were locally subjected to salinization. The assemblage of small mammals includes *Mimomys pusillus* Mehely, *M. intermedius* Newton, and *Arvicola mosbachensis* Schmid., represented by rootless molars larger then the teeth of *Mimomys,* and *Lagurus transiens* Janossy (Danukalova et al., 2002). The assemblage of molluscs included terrestrial and freshwater species (Osipova, Danukalova, 2011). The occurrence of stenothermic-thermophilic *Dolerocypris fasciata* (O. Müll.) among the ostracods indicates warm climatic conditions (Yakhimovich et al., 1988).

Chusovskoy horizon (=Sultanaevo suite) is represented by lacustrine and deluvial loam, clay and aleurite (Sultanaevo). Thickness is 0.5–3.5 m (Danukalova, 2010). In the Chusovo time, the climate became colder. The region hosted a system of freshwater basins at that time and it was characterized by intense slope processes with the formation of eluvial-talus sediments. The herbaceous-Chenopodiaceae steppes, which covered spacious open areas, were subsequently replaced by coniferous-birch forests with an admixture of broad-leaved trees (Yakhimovich et al., 1983). The molluscan communities were composed of terrestrial and freshwater inhabitants of slightly fluvial to stagnant basins (Osipova, Danukalova, 2011). Ostracods are represented by freshwater species with abundant stenothermic-thermophilic *Cyclocypris serena* (Koch), *Candona rectangulata* Alm., and *C. neglecta* Sars (Yakhimovich et al., 1983, 2000; Danukalova et al., 2002).

During cold epochs (Minzitarovo, Tanyp, and Chusovo time), the snow cover was clearly developed in the mountains and on the plains, where it could locally be preserved also during the summer seasons. In the Chusovo time, high mountainous summits (Iremel, Zigal'ga, Yamantau) were covered by snow patches (Yakhimovich et al., 1970). The glacial periods were marked by the formation of loess-like sediments of fluvial-talus (Danukalova and Eremeev, 2006) and likely eolian genesis. The Early Neopleistocene was characterized by a relatively stable tectonic regime (Puchkov, 2002).

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M. Dergacheva[1, 2], *O. Nekrasova*[3], *A. Uchaev*[3]
[1] Institute of Soil Science
and Agrochemistry of Siberian Branch of Russian Academy of Sciences
Novosibirsk, Russia
[2] Biological Institute of Tomsk State University
Tomsk, Russia,
[3] Ural Federal University named after the First President of Russia B. N. Yeltsin
Ekaterinburg, Russia
E-mail: mid555@yandex.com

SARYKUL' PALEOSOL IN BATURINO QUARRY (SOUTHERN URALS, RUSSIA)

Key words: paleosol, humic acids, paleoenvironment, Sarykul' Formation, Southern Ural

In all exposed sides of the previously developed Baturino coal quarry (Southern Urals) the paleosol that crowns the Sarykul' Formation is clearly seen. This buried paleosol looks like Chernozem and has dark gray color humus thickness, high density, lumpy-nutty structure, widespread rapid lash (violent effervescence) from HCl, as well as the presence of desiccation wedges.

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Upper humified horizon of this soil [A] has a thickness of up to 40 cm and the relative accumulation of humus substances. The content of total organic carbon (TOC) in it is 0.54–0.63%, which is high for Eopleistocene-Early Pleistocene paleosols. The presence of such characteristics have been the motive for conducting more detailed humus substances studies of this horizon, samples of which were selected by a continuous column every 10 cm.

The system of humic substances is a component that creates the soil's memory (Dergachev, 1997, 2008) and serves as a reliable indicator used for paleogeographic condition reconstruction of Pliocene-Holocene paleosols time formation (Dergacheva et al., 2000). To identify specificity of composition, structure and properties of humic acids and their correlation with other humus components humic acid's preparations were isolated with the help of traditional method, but without a rigid cleaning with application of strong mineral acid (6 n HCl, HCl + HF and others).

Characteristics of the elemental composition, spectral properties in the ultraviolet, visible and infrared regions were obtained. The peculiarities of fluorescence spectra and the ratio of humic acids with another component of humus – fulvic acids (C_{HA}:C_{FA}) were studied. Soil mass consists of sandy loam: the share of coarse and fine sand is 29–32%, the share of coarse dust does not exceed 9%. Redistribution of silt particles inside the studied column has not been revealed. Change in the magnetic susceptibility of the horizon soil mass testifies in favor sinlitogenic model of its formation.

The content of total organic carbon has a relatively low value in the bottom 20 cm thicker horizon compared to the top. The bottom part has a more alkaline reaction and differs by the increased amount of carbonates, as well as the characteristics of humic acids and their relationship with other components of humus – fulvic acids and humins. The ratio of humic acid carbon to fulvic acid carbon differs in these strata upon 0.1–0.5. The extinction coefficients of humic acids are similar. It testifies a single zonal direction of soil formation during the formation of strata horizon.

The color coefficients by Welte (E_{465}:E_{665}) clearly divide the horizon under investigation into two parts, taking into account other characteristics of humic substances, and reflect relatively more moisture conditions in the initial period of the horizon formation. A similar difference between the upper and lower parts of the humus horizon is reflected in such characteristics of humic acids as elemental composition, IR – spectra as well as the first moment of their fluorescence spectra.

Thus, according to the obtained characteristics of soil mass material composition and composition, structural characteristics and properties of humic acids and their correlations with other elements of humic substance system, humus horizon was formed in changing environmental conditions.

Comparison of close age paleosols on Olkhon island (Lake Baikal, Eastern Siberia), in the coastal outcrop section Volodarka on the Ob river (West

Siberia) and Baturino quarry (Southern Ural) showed their specificity and differences with continental Eurasia paleosols of other Pleistocene periods, that presumably can be used for long-distance chronocorrelations.

This fact requires further research in the direction of expansion of the number of similar objects, distributed in different conditions of continental Eurasia.

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Y. Dublyansky[1], O. Kadebskaya[2], M. Luetscher[1],
H. Cheng[3], I. Chaykovskiy[2], Ch. Spötl[1]
[1] University of Innsbruck, Institute of Geology and Paleontology
Innsbruck, Austria
[2] Mining Institute of Ural branch of RAS
Perm, Russia
[3] Xi'an Jiaotong University, School of Human Settlement and Civil Engineering
Shaanxi, China
E-mail: olikad@mi-perm.ru

PRELIMINARY DATA ON THE PLEISTOCENE HISTORY OF PERMAFROST IN CENTRAL URALS (RUSSIA) DERIVED FROM CRYOGENIC CAVE CARBONATES

Keywords: cryogenic calcite, speleothem, permafrost, paleoclimate, U/Th dating

Modern permafrost covers ca 24% of the land surface in the Northern Hemisphere. When it thaws, permafrost releases CO_2 and CH_4 providing a positive feedback to the natural greenhouse effect. Understanding the response of permafrost to long-term climate change requires knowledge of past permafrost conditions, but natural archives are scarce. Recently, Vaks et al. (2013) used cave carbonates (speleothems) as a tool to date past permafrost in Eastern Siberia during the past ~500 kyr. "Common" vadose speleothems (stalactites, stalagmites, flowstones) form when meteoric water seeps through the vadose zone into caves. When permafrost develops, the temperature in the vadose zone drops below 0°C. As a result, both water flow and speleothem growth cease. U/Th dating of common speleothems, thus, provides a chronological framework of episodes when there was no permafrost at a cave site, whilst hiatuses in speleothem growth may possibly indicate permafrost conditions.

The speleothem approach has an inherent uncertainty related to the fact that the cessation of speleothem growth may be caused by reasons other than permafrost development (i.e. drought, change in hydrology of the vadose zone, soil erosion, etc.). In this study we explore a novel archive, cryogenic cave carbonates (CCC), whose precipitation occurs at the freezing point due to

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freezing-induced concentration of solutes (Žák et al., 2008). CCC is therefore an indicator of the developing or degrading permafrost conditions, when the cave temperature fluctuates very close to 0°C.

Unusually large CCCs (diameters up to 40 mm) were recently found in a number of caves of the Ural Mountains, Russia (Chaykovskiy et al., 2014). These samples provide a unique opportunity to investigate past changes in the regional permafrost distribution. In this paper we focus on Rossiyskaya Cave, located on the western slope of the Central Ural at 58°49'N and 57°36'E. The cave is developed in Lower Carboniferous (Visean) limestone. Its length is 1450 m and the vertical extent is 72 m. The temperature in the cave is 3–5°C. The Gulliver chamber, where the studied samples were found, is located in the remote northern part of the cave, 370 m from entrance, at a depth of 47–55 m from the topographic surface.

11 samples from Rossiyskaya Cave reveal a variety of shapes and sizes ranging from mm-sized crystal aggregates to cm-sized spheroids. Most of these formations show surface corrosion features suggesting temporary flooding of the cave passage after the cave ice retreated, an interpretation which is consistent with the clayey sediment in which they were embedded.

Chaykovskiy et al. (2014) reported five U/Th analyses, indicating that the formation of CCC concretions in three Ural caves occurred between 13.4 and 125.3 ky BP. In this study we report 14 additional U/Th analyses from four samples of CCC from Rossiyskaya Cave, which expand the time of CCC formation back to ca. 700 kyr BP. The available U/Th ages of CCCs suggest that the Central Ural was subject to permafrost conditions during Marine Isotope Stages 2, 6, 12, and 16 (Fig. A2, Appendix 2). For some of the younger samples the dating errors are small enough to reveal that these CCC formed during Terminations I, II, and V. Larger errors in dating older samples do not allow precise attribution of CCC formation to a specific climate stage.

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T.V. Fadeeva
Mining Institute, Ural Branch, Russian Academy of Sciences
Perm, Russia
E-mail: fadeeva.tatyana@mail.ru

INSECTIVOROUS MAMMALS (EULIPOTYPHLA) IN THE PERM PRE-URALS DURING THE LATE PLEISTOCENE AND HOLOCENE PERIODS

Key words: Insectivorius mammals, Late Pleistocene, Holocene, Perm Pre-Urals

Excavations (1999–2012 years) of karst cavities and rock deposits, situated in the Perm Pre-Ural region (Aleksandrovsk-Gubakha, 58º55'–59º31'N) provided rich collections of fossil vertebrates dated back to the Late Pleistocene and Holocene. These collections included rather numerous partial and complete maxillae and mandibles of fossil insectivorous mammals. The samples are stored and catalogued in the Mining Institute (MI) of the UB RAS, Perm, Russia. Species are determined by mandibles (see Table).

The most ancient finds of insectivorous mammals from the explored territory presumably refer to the Mikulino. The discovered fauna includes the bone remains of the white-toothed shrew *Crocidura* cf. *leucodon*, the hedgehog *Erinaceus* sp., mole *Talpa* cf. *europaea*, four species of shrews, the major part of which is presented by the bones of the Eurasian shrew *Sorex araneus*. In general, the list of small mammals of this period, except for the *Sylvaemus flavicollis, Hystrix brachiura, Crocidura* cf. *leucodon*, coincides with the modern list, consisting mostly of the boreal species.

The insectivorous fauna of the first half of the Late Pleistocene until the end of the middle Valdai megainterstadial (Bryansk) in most cases consists of the tundra shrew (*Sorex tundrensis*) only. A number of the mandible morphometric characteristics of the fossil tundra shrews found in the Perm Urals region are close to those of the modern tundra species of Russia's European North. This form is characterized by a smaller size compared to the forest form (Bobretsov et al., 2008). The associated fossil rodents of this period are lemmings (*Dicrostonyx gulielmi, Lemmus sibiricus*), narrow-skulled voles (*Microtus gregalis*) and Middendorff's vole (*Microtus middendorffii*) found in large quantities. The tundra species existed together with the steppe species (*Lagurus lagurus, Cricetulus migratorius, Ochotona pusilla*) in the non-analog late glacial heterogeneous environments.

In the late glacial sediment along with the tundra shrew bone remains, there was discovered a mandible of the Eurasian least shrew (*Sorex minutissimus*).

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The rodents of this period are represented by very numerous remains of cryoxerophilic species *Dicrostonyx torquatus* (dominant) and *Microtus gregalis* and by the individual bones of the steppe species.

In the sediments of the late Dryas a tundra shrew is still a dominant species, the major part of the rodents is presented by collared lemmings and narrow-headed voles in a ratio of 1: 1. During the periods of warming (bølling-allerød) the list of insectivorous mammals on the explored territory changes dramatically: there were found the remains of the Eurasian shrew (*Sorex araneus*), even-toothed shrew (*Sorex isodon*), Laxmann's shrew (*Sorex caecutiens*) and pygmy shrew (*Sorex minutus*), the remains of the tundra shrew were not found. The bones of narrow-headed vole are the most common among the rodent remains, the co-dominant species are the collared lemming (*Dicrostonyx* sp.) and the tundra vole (*Microtus oeconomus*).

TABLE. The summarized quantity of mandibles (teeth – Erinaceus sp.) of fossil insectivorous mammals from fossiliferous sediments of various periods (+ + — species-dominant). 1 — Mikulino, ~ 126–115 ka BP (Makhnevskaya Ledyanaya Cave, intact sediments); 2 — Early –middle Valday, >34 ka BP (Grotto Rasik, B30–32); 3 — Middle Valdai, 34–24 ka BP (Makhnevskaya-2 Cave, 8–9; Dolgogo Kamnya-3 Cave, 7); 4 — Last Glacial Maximum, 24–17 ka BP; 5 — Lateglacial transition, 17–12,7 ka BP (Rasik, B22–28; A18–21); 6 — Oldest Dryas-Bølling-Allerød Interstadial, 12,7–10,95 ka BP (Rasik, B20–21; A16–17; Verkhnegubakhinskaya Cave, 6–7; 9; Dolgogo Kamnya-1 Cave); 7 — Younger Dryas, 10,95–10,15 ka BP (Rasik, B15–18); 8 — Preboreal period, Early Holocene, 10,15–9,0 ka BP (Rasik, A13–14; Koziy); 9 — Boreal period, Early Holocene 9,0–8,0 ka BP (Rasik, B13–14); 10 — Atlantic and subboreal periods, Middle Holocene, 8,0–2,5 ka BP (Rasik B, A 8–12; Verkhnegubakhinskaya Cave 3–5; Bolshaya Makhnevskaya Cave); 11- Subatlantic period, Late Holocene, 2,5–0,2 ka BP (Rasik A7, B1–4; Verkhnegubakhinskaya Cave 1–2; Lazarevskiy)

	1	2	3	4	5	6	7	8	9	10	11
Sorex minutissimus	-	-	-	not found	+	-	-	-	-	+	-
Sorex minutus	+	-	-		-	+	-	-	-	+	-
Sorex caecutiens	+	-	-		-	+	-	+	-	+	+
Sorex tundrensis	-	++	++		++	++	++	++	+	-	-
Sorex isodon	+	-	-		-	+	-	+	-	+	+
Sorex araneus	++	-	-		-	+	+	+	-	++	++
Sorex sp.	-	+	+		-	+	-	+	-	+	+
Neomys fodiens	-	-	-		-	-	-	-	+	-	-
Crocidura cf. *leucodon*	+	-	-		-	-	-	-	-	-	-
Erinaceus sp.	+	-	-		-	-	-	-	-	-	-
Talpa sp. *europaea*	+	-	-		-	-	-	-	-	+	+
Σ	35	21	32		17	42	49	29	2	909	13

In the younger Dryas the tundra shrew is numerous again. Single remains of the Eurasian shrew were found. The collared lemming is practically extinct, the tundra vole is numerous and the narrow-headed vole dramatically dominates the rodent fauna.

The Early Holocene was the last period of the tundra shrew domination among the insectivores on the explored territory of the Perm Pre-Urals. In the Middle Holocene the Eurasian shrew became the dominant species.The list of insectivorous mammals was similar to the contemporary one and included six species of shrews (*Sorex araneus, Sorex isodon, Sorex caecutiens, Sorex minutissimus, Sorex minutes, Neomys fodiens*) and the mole. The wood vole was dominant among the rodents. Since that period, the remains of the tundra shrew were not found among the fossil insectivores. There is no information about the existence of this species at these latitudes. According to our data (the sediments of the Dyrovatiy Kamen cave on the Vishera River) this species is not found also in the Middle and Late Holocene in the higher northern latitudes of the region. Today the *Sorex tundrensis* is not present in the reserved area "Preduralie" (Kishertsky district) and in the Dobryansky district. All the information from literature about the capture of the tundra shrew in the Perm Pre-Urals region refers to the territories of mountain-taiga subzones (Chusovoy (Samokhvalov et al., 2010) and Lysva areas (Dolgov, 1985)).

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M. Fiebig[1], S. Braumann[1,2], K. Decker[3], P. Haeuselmann[4],
E. Hintersberger[3], J. Lomax[5], C. Luethgens[1], S. Neuhuber[1], J.M. Schaefer[2]
[1] University of Natural Resources and Life Sciences, Institute of Applied Geology
Vienna, Austria
[2] Columbia University, Lamont-Doherty Earth Observatory
Palisades, New York, United States
[3] University of Vienna, Department of Geodynamics and Sedimentology
Vienna, Austria
[4] Institut Suisse de Speleologie et de Karstologie
La Chaux-de-Fonds, Switzerland
[5] University of Giessen, Institute of Geography
Giessen, Germany
E-mail: markus.fiebig@boku.ac.at

NEW INVESTIGATIONS OF QUATERNARY DEPOSITS IN THE VIENNA BASIN (AUSTRIA)

Key words: terrace stratigraphy, neo tectonic, sedimentary basin, Optical Stimulated Luminescence, cosmogenic isotopes, Burial Age Dating, European Alps, Vienna Basin

The Vienna Basin is situated at the border between the European Alps and the Western Carpathians. The basin was formed during the Miocene and is framed by Austroalpine units and Rhenodanubian Flysch. The basin infill consists of up to 5.6 km thick marine and terrestrial deposits. After closure of the pull apart-basin, uplift started in the area and caused basin inversion with fluvial dissection and formation of terrace staircases (e.g., Decker et al., 2005).

The modern river Danube enters the Vienna Basin on the western side through the transverse valley of Klosterneuburg and leaves the basin in the east through the portal of Hainburg. On its way through the basin the Danube not only passes areas characterized by uplifted terraces of different elevations but also flows through recently subsiding areas (Hinsch et al., 2005).

Because of the complex tectonic behavior of the modern Vienna Basin area the depositional ages of the Quaternary sediments deposited inside the subsiding Quaternary sub-basins as well as of those sediments building up the elevated fluvial terrace are difficult to determine and needs assistance by numerical dating. First results from Optically Stimulated Luminescence (OSL) dating using the infrared stimulated signal from feldspar mineral point to ages between 200 and 300 ka for two terrace accumulations on different topographic levels: the Upper Terrace ("Gaenserndorfer Hochterrasse") and the next higher elevated terrace – interpreted as a kind of cover gravel unit ("Deckenschotter-Terrasse von Schloss Hof"). This accordance in age for two different terrace levels contradicts the model of the classical Alpine terrace stratigraphy and poses the question of how the difference in elevation developed.

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From a geochronological point of view, a cross-check of two independent dating methods to corroborate the obtained results for the above-mentioned age range is highly desirable. An attempt to test the first results from OSL-datings is ventured by measuring the content of the cosmogenic isotopes Al^{26} and Be^{10} in cobbles from both terrace accumulations (see fig. A3, Appendix 3). Each sample for cosmogenic nuclide determination consists of several individual cobbles. Each of these cobbles is investigated and measured separately, so that different histories of individual cobbles may reveal a more robust and detailed database for the reconstruction of the depositional history of the whole sedimentary unit.

Although it was already possible to develop more detailed ideas about younger fluvial sediments of the Danube in the Vienna Basin by means of OSL-dating (e. g. Fiebig et al., 2009) the overall knowledge about the Quaternary history of sedimentation and erosion in the Vienna Basin is fragmentary. The application of independent dating methods will hopefully serve to close this gap in knowledge in the course of further research projects like the current FWF-project P23138-N19.

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Ch. Huang, F. Zhang
Department of Geography, Shaanxi Normal University
China
E-mail: cchuang@snnu.edu.cn

HOLOCENE EOLIAN LOESS-SOIL STRATIGRAPHY AND CLIMATE CHANGE OVER THE MIDDLE YELLOW RIVER BASIN OF CHINA

Key words: Holocene, loess, peleosol, climate, human impact

High-resolution investigations of Holocene loess accumulation and soil formation, including field observations, physico-chemical analysis and OSL dating, were carried out over the Loess Plateau in the middle Yellow River basin. The results show that the development of loess-soil profiles has kept pace

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with the land surface growing because of incessant eolian dust accumulation. The early Holocene climatic amelioration from about 11,500 a BP resulted in continuously intensifying chemical differentiation through time. The uplands have turned to soil formation since about 8500 a BP. An Ustic Isohumisol (Chernozem) with a well-developed Ah horizon was formed during the mid-Holocene Climatic Optimum, in which fully developed chemical differentiation is represented by the depletion of carbonates and the relative enrichment of less mobile and immobile elements, which has been enhanced further by the destruction of clastic minerals and the production of secondary clay minerals. The process of this soil formation continued for about 5400 years and ended at about 3100 a BP because of climatic decline. During the late Holocene, a major pedogenic regression is represented by the accumulation of fresh loess and the growing topsoil in which carbonates and other solubles are retained and the concentrations of the less mobile and immobile elements are reduced. This has resulted from climatic aridity and the intensified dust storms and dust falls. Surface process and land-use change have also affected soil formation over the upland plateau. Reworked loess components were incorporated into surface soil during the early Holocene due to increased runoff and the resultant erosion-redeposition. The upland landscape was stabilized largely during the mid-Holocene. Charcoal preserved in the soil has recorded human firing of the landscape intermittently during the Neolithic and the early Bronze Age. The soil formation was not much affected by human activities during the mid-Holocene. Aridity from 3100 a BP onward has resulted in climatic instability, which has caused increased runoff and active erosion-redeposition over the gentle uplands. The incorporation of the reworked loess components has worsened the pedogenic regression of the late Holocene. Large-scale land clearance with fire and land reclamation for cereal cultivation extended to the uplands to about 2150 a BP. An agricultural landscape with terraced-field systems for dry farming has been fully established to about 1500 a BP and the present topsoil has formed and has been cultivated intensively since then.

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Y.Y. Khrunyk[1], A.R. Koporikov[1], V.D. Bogdanov[1], A.V. Borodin[1, 2]
[1] Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
[2] Institute of Natural Science, Ural Federal University
Ekaterinburg, Russia
E-mail: juliakhrunyk@yahoo.co.uk

GENETIC VARIABILITY OF BURBOT, *LOTA LOTA,* AND THE CONNECTION OF THE MAIN HOLARCTIC RIVER BASINS IN THE QUATERNARY

Key words: Lota lota, mtDNA control region, climate change, Ob River, Irtysh River

Climatic oscillations during the Pleistocene ice ages affected species' geographical distribution and abundance, which could be expected to have genetic consequences (Hewitt, 2004). Burbot (Lota lota, Linneus, 1758), the Holarctic freshwater gadoid, was restricted within glacial refugia peripheral to the ice sheets and depended on aquatic habitats during post-glacial dispersal, and, therefore, serves as an excellent model to study the impact of glaciations. The distribution of burbot mitochondrial haplotypes, revealed in previous studies, suggests that Western Siberia most likely was a transit region, through which burbot could spread from Europe to Siberia during the post-glacial period (Van Houdt et al., 2005). Previously, it was suggested that the distribution of burbot in Siberian rivers began after the Dneprovsk glaciation dated to 300,000–250,000 BP (Svetovidov, 1948; Tyulpanov, 1967). Indeed, paleontological data points to the importance of Western Siberia as one of the key regions in the formation of Eurasian biota during the Quaternary period (Borodin et al., 2001; Borodin et al., 2013). Importantly, the finding of burbot ancient bones at Chembackchino-94A (lower reach of Irtysh River, TL age — 650,000±110,000 years) (Borodin et al., 1998) is one of the oldest findings ever made in Eurasia. This therefore indicates that the Ob-Irtysh River basin could play much more important role in the formation of Lota biodiversity compared to the mere extrapolation of genetic data, obtained for the localities in Eurasia and North America.

The objective of the present study was to determine the diversity of the non-coding mtDNA control region among burbot populations inhabiting Western Siberia.

The left half of the mtDNA control region was sequenced for 116 burbot samples from several localities of the Ob-Irtysh River basin including the Irtysh River at Tobolsk, Severnaya Sosva, Voykar, Sob, Khodyta (tributaries of the Ob River), the Taz River and the Ob River at Karantinskiy island. Sequencing has revealed that the mtDNA control region is highly variable in this species. Indeed,

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28 haplotypes were observed in the 116 individuals analyzed. Fig. 1 represents median joining network covering burbot control region haplotypes from two lineages, L. l. lota and L. l. maculosa, together with sequences, derived from the Western Siberian localities. Most of the control region haplotypes, revealed in the Ob-Irtysh River basin, fall into Eurasian and Beringian haplogroups. Our data show that 78 out of 116 control region sequences represent haplotypes, revealed earlier, such as EB30, EB35, EB43, EB44 and EB41 (Van Houdt et al., 2005). Not surprisingly, the majority of samples belong to the EB30 haplotype (55 samples), which is one of the central Eurasian haplotypes and the habitat of which covers not only European (the Isar, the Vistula), but also Asian (the Lena) rivers, as well as Lake Baikal. The ratio of this haplotype is 47%. Besides, 11 samples have Beringian haplotype EB41, which is found in the Kurenjoki and Porkkala Bay in Finland. This haplotype, also named as Xi1, was observed in large quantities in the Irtysh River in the North-Western China (Fang et al., 2013). 21 new haplotypes from the Ob-Irtysh River basin were named as WS 1–21 (Western Siberian). Among 21 new haplotypes, WS1, is the most widely distributed and was found in samples from the Sob River (3 sequences) and the Irtysh River at Tobolsk (4 sequences). This haplotype, together with its derivative haplotypes, WS2, WS3 and WS21, form a separate haplogroup. 17 sequences demonstrated singular haplotypes. The distribution of separate haplogroups coincides with major river basins (Fig. A5, Appendix 4). It is best shown for the haplotypes from the Mississippi, Missouri and Amur. However, also in Eurasia and Alaska a group of haplotypes are specifically found only in separate river basins, which reflects the Quaternary history of the species.

Our data indicate that studies on burbot phylogeography are incomplete and require further research, focused on genetic analyses of burbot inhabiting central part of Eurasia, in particular the Western Siberian Plain and the Eastern European Plain.

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D. Kisieliene, M. Stancikaite, V. Šeirienė, G. Gryguc, R. Skipityte
Institute of Geology and Geography, Nature Research Centre
Vilnius, Lithuania
E-mail: kisieliene@geo.lt

LATE-GLACIAL CLIMATIC EVENTS AND CHRONOLOGY OF ENVIRONMENTAL DEVELOPMENT IN SOUTH EAST LITHUANIA

Key words: Late glacial, early Holocene, chronology, biostratigraphy, pollen, plant macrofossils, ^{18}O isotope, Lithuania

The multiproxy data (pollen, plant macrofossils, stable $\delta^{18}O$ and $\delta^{13}C$ isotope, magnetic susceptibility, grain-size and loss-on-ignition measurements (LOI) and AMS ^{14}C dating) obtained from the sediments exposed in Zervynos-1 outcrop in south east Lithuania have allowed reconstruction of the Lateglacial environmental changes and enabled possible correlation of detected changes with regional and global ones. A chronology of the sediment sequence was established on the basis of AMS ^{14}C dates, biostratigraphy and correlation of $\delta^{18}O$ and NGRIP $\delta^{18}O$ isotope curves.

The results of investigation suggest the formation of the bottom-most part of the investigated gyttja took place at about 14067–14271 cal yr BP that could roughly be correlated with the earliest stages of the Late Weischelian Interstadial i.e. Böling warming or GI-1e event according to Lowe et al. (2008). These sediments are characterized by very few palaeobotanical remains, but lithological proxies suggest the some stabilisation of sedimentation regime in the basin where sand particles were exchanged with increased amount of clay and silt and organic constituent together with $CaCO_3$ rises as well.

Further analysis of collected data confirms short-lasted deterioration of environmental situation recorded at the depth of 142–149 cm. Palaeobotanical data i.e. increasing representation of NAP including *Artemisia*, Chenopodiaceae and Poaceae, and higher input of sand into the sediment bed as well as changing amount of organic and $CaCO_3$ constituent in the sediments suggest instability of environmental regime that could be attributed to GI-1d event or Older Dryas cooling.

Starting at the depth of 142 cm drop in sand input and increasing number of organic constituent suggests stabilization of the surface and consolidation of vegetation cover considering pollen record. Predominance of AP pollen in spectra indicates formation of open forest where pine played a leading role as pollen values >50% indicate local dominance of this tree (Huntley, Birks, 1983). Meanwhile birch was represented rather sporadically as only pollen values over 25% can indicate local birch dominated woodland (Huntley, Birks, 1983).

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Subsequently, supply of allochthonous material from the catchment decreased and as a result, the increasing value of recorded $CaCO_3$ must have originated from the lake itself, suggesting increasing productivity of the basin. A drop in the $\delta^{18}O$ curve to more negative values recorded at the onset of the interval may indicate a rise in the evaporation rate likely caused by higher mean temperature, a probability that is in a positive correlation with palaeobotanical data. In turn described shifts point to the climatic amelioration that could be correlated with the onset of Alleröd warming or GI-1c event (Lowe et al., 2008) dated back to 13700 cal BP in the territory of Lithuania.

Approaching the upper part of the gyttja bed changing trends of the pollen curves indicate some thinning of the vegetation cover and opening of the landscape subsequently. In the vegetation structure representation of pine decreased as pollen number in spectra is lower in comparison with the previous interval. Number of NAP pollen increased indicating formation of open grasslands with high number of light-demanding *Juniperus*. Simultaneous gradual rise of the $\delta^{18}O$ curve suggests some deterioration of the climatic regime including increasing aridity that is in agreement with palaeobotanical record. Rising input of terrigenous matter and drop in $CaCO_3$ representation could be related with intensive erosional processes, destruction of the soil cover and decreasing productivity of the lake itself. Deposition of the gyttja was interrupted at about 13400 cal BP. Similar changes in biota structure and oxygen isotope composition have been correlated with the Gerzensee oscillation or GI-1b event in Europe (Lotter et al., 1992).

Deposition of the sandy gyttja indicates some stabilization of sedimentary environment. However facts i.e. low organic content and rather intensive input of the sand into basin point to high erosional rates. As the portion of mineral matter in the sediments increased, suggesting high supply of allochthonous material from the catchment, the increasing representation of recorded $CaCO_3$ must have originated from this source mainly. Simultaneous changes recorded in the pollen signal suggest formation of a new vegetation type in area. On the one part vegetation became sparse as numerous light-demanding species i.e. *Juniperus*, *Hippophaë* and etc. were recorded, on the other part occurrence of new tree taxa i.e. *Picea* points to the start of formation of dense vegetation structure. Increasing representation of spruce in pollen record indicates occurrence of this tree on a local scale as the 1–5% pollen threshold was chosen to trace local expansion of the spruce (Giesecke, Bennett, 2004, Latalowa, van der Knaap, 2006). Sand overlaying the bed of sandy gyttja was deposited in rather severe climatic conditions as is seen in pollen data as number of AP pollen declined and NAP increased in number. Terrigenous matter became the predominating type of the material deposited suggesting intensive erosional processes and minor leaching of the surrounding beds. At the same time $\delta^{18}O$ records well correlate with NGRIP $\delta^{18}O$ isotope curves showing trends typical for GS-1.

Data obtained from the Zervynos-1 sequence indicate instability in vegetation composition and sedimentation regime, suggesting cooler and warmer intervals as well as humidity changes during the lateglacial in the area. These variations could be correlated with climatic events fixed in Greenland ice cores, European lacustrine and Atlantic Ocean sediments during the Lateglacial period (Yu and Eicher, 2001).

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M. Klimowicz, *P. Socha*, *A. Nadachowski*

Department of Palaeozoology, Institute of Environmental Biology, University of Wrocław Poland

E-mail: m.klimowicz@uni.wroc.pl

RODENTS AS INDICATORS OF A STEPPE BIOME DEVELOPMENT IN LATE MIDDLE AND LATE PLEISTOCENE OF POLAND

Key words: rodents, Pleistocene, steppe biome, climate, palaeoecology, Microtus gregalis, morphometry, biostratigraphy

Biome is defined as a part of the biosphere with specified type of climate, vegetation, faunal assemblage and soils. Its species composition of flora and fauna can be different, depending on the geographical location of the biome. The physiognomic similarity of the organisms and their assemblages, not

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their genetic relationships, is one of deciding factors that qualifies various areas to the same biome, as well as the common type of climate and the abiotic environment. The steppe biome appears in all areas, which climate is characterized by a *steppic* bioclimatic variant (Stp). Characteristic features of this variant are: the *Continentality Index* higher than 18 (Ic>18), the summer quarter rainfall more than 1.2 times that of the winter quarter [Ps>1.2Pw], the *Ombrothermic Index* falls within 0.1 and 4.6 [0.1<Io<4.6] and, at least during one summer month, the rainfall in mm (Psi) is two and half times lower than the temperature [Psi<2.5Tsi]. According to those indices, the steppe biome can be recognized nowadays only in the northern hemisphere, within four climate zones. It includes steppes and steppe – forests in Eurasia and the extensive prairies or wooded prairies in North America, both within the Temperate zone; also the Mediterranean xeric and desert vegetation-types and the tundra and forest tundra formations of the Boreal and Polar zones (Worldwide Bioclimatic Classification System, 1996–2009).

The presence of seven rodents species representative for steppe biome (*Microtus gregalis* (Pallas, 1779), *Lagurus lagurus* (Pallas, 1773), *Cricetus cricetus* (Linnaeus, 1758), *Cricetulus migratorius* (Pallas, 1773), *Allactaga major* (Kerr, 1792), *Spermophilus superciliosus (*Kaup, 1839) and *Spermophilus citelloides* (Kormos, 1916)) was confirmed in late Middle and Late Pleistocene sediments of Poland (Nadachowski, 1989, Kowalski, 2001, Socha, 2014). The occurrence of *Lagurus lagurus*, *Allactaga major* and *Spermophilus superciliosus* is restricted only to temperate cold and dry climate zone. The rest of steppe species inhabits another climate zones. *M. gregalis* occurs additionaly in cold and humid climate (boreal) and within the arctic zone. *Spermophilus citelloides* and *Cricetulus migratorius* populate the cold and humid climate zone and the mediterranean variant of subtropical climate zone. *Cricetus cricetus* occurs in temperate cold and humid climate (Hernández Fernández, 2001). The species, that is constantly and most numerously represented in fossil steppe rodents assemblages, is narrow-headed vole *M. gregalis.* Other species are uncommon and appear occasionally in Pleistocene sediments.

The morphometrical analysis of 175 m1 of *M. gregalis* from Biśnik Cave (Kraków-Częstochowa Upland, Poland) was undertaken. The research material was divided into two groups representing late Middle (50 specimens) and Late (125 specimens) Pleistocene. The t-Student test was applied to examine the differences between groups. Results of analysis proved significant morphometric differences between populations of *M. gregalis* from late Middle and Late Pleistocene. The mean value of maximum length of tooth occlusal surface (L) (van der Meulen, 1973) was 2.71 mm for whole population, 2.61 mm for the Late Middle Pleistocene sample and 2.75 mm for the Late Pleistocene sample. Morphometric differences of L value between examined samples are statistically significant (t-Student test df=173, p=0,000). The increase of mean value of maximum length of *M. gregalis* M_1 occlusal surface is observed through late

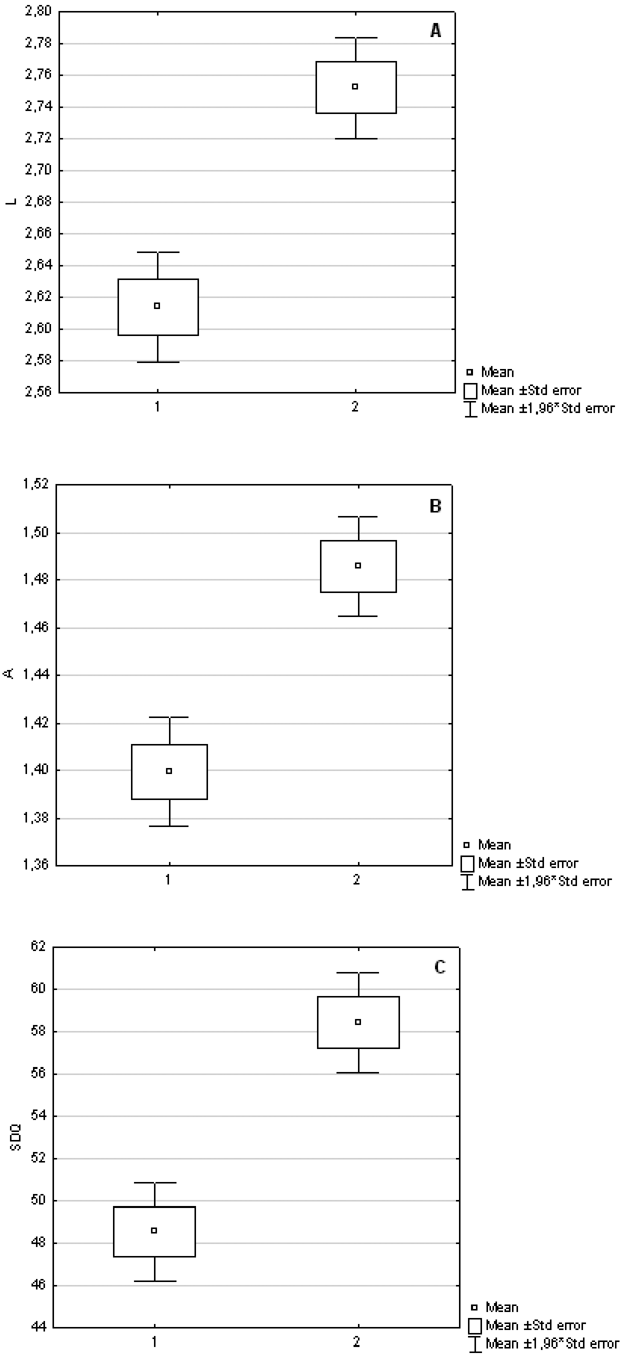

Fig. 1. Metric variability of m1 of the narrow-headed vole *Microtus gregalis* from Biśnik Cave. 1 — Late Middle Pleistocene population, 2 — Late Pleistocene population, A — variability of maximum length of occlusal surface (L), B — variability of anteroconid length (A), C — variability of mean values of the relative enamel thickness quotient (SDQ)

Middle to Late Pleistocene period. Similar morfometric changes were observed for anteroconid length value (A). The mean value of A parameter was 1.46 mm for whole population, 1.40 mm for the late Middle Pleistocene sample and 1.49 mm for the Late Pleistocene sample. Mean value of anteroconid length increases in time and shows statistically significant differences between populations of *M. gregalis* from late Middle and Late Pleistocene (t-Student test df=173, p=0,003). The mean A/L coefficient value counts 0.54 and does not change through studied period. Measurements of the relative enamel thickness quotient (SDQ) (Heinrich, 1982) based on 147 m1 of *M. gregalis* indicates, that there are significant morphometric differences between late Middle (39 specimens) and Late (108 specimens) Pleistocene populations (t-Student test df=145, p=0,000). Value of the SDQ coefficient increases in time and counts 48.54 for the late Middle, and 58.42 for the Late Pleistocene samples. All those differences (Fig. 1) suggest, that the narrow-headed vole can be used for biostratigraphical studies and — due to its constant and numerous presence in fossil assemblages — also for stratigraphical correlation of sediments.

Received results of measurements indicate the morphometrical variability of m1 *M. gregalis* during the late Middle and Late Pleistocene period. Those differences can be correlated with expansion of various forms of this species in Poland territory during the Pleistocene. In late Middle Pleistocene the migration from continental climate areas, which are inhabited nowadays by a subspecies *M. gregalis gregalis* (Pallas, 1779), was predominating. In Late Pleistocene, migrations of both *M. gregalis gregalis* and *M. gregalis major* (Ognev, 1918) took place, depending on periodic changes of the climate.

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T. van Kolfschoten[1], *K. Kuijjer*[1], *C. Turner*[2], *B. Urban*[3]
[1] Leiden University, Faculty of Archaeology
Leiden, The Netherlands
[2] Quaternary Environments Group, Dept. of Geography, University of Cambridge
UK
[3] Leuphana University Lüneburg, Institute of Ecology, Subject Area Landscape Change
Lüneburg, Germany
E-mail: t.van.kolfschoten@arch.leidenuniv.nl; kikikuijjer@gmail.com

THE SCHÖNINGEN MIDDLE PLEISTOCENE SEQUENCE: A BROADER PERSPECTIVE

Key words: late Middle Pleistocene, mammalian biostratigraphy, Schöningen

Rescue excavations in the Schöningen open-cast mine (Lower Saxony, Germany), carried out since the 1980s, have led to the discovery of multiple Lower Palaeolithic sites. In 1995, the locality became world-famous for the discovery of Palaeolithic wooden throwing spears at the site Schöningen 13 II-4 (known as the 'spear horizon'), found in association with lithic artefacts and a bone assemblage largely composed of horse remains. Apart from its archaeological significance, the Schöningen open-cast mine is well known for its extensive Quaternary glacial–interglacial sequence, spanning the period from the Elsterian Stage to the present, which has been studied at length. Still, there is ongoing debate on the position of the Middle Pleistocene deposits exposed at Schöningen, and — as a consequence — on the age estimate of the spear horizon and the other Palaeolithic sites from the open-cast mine. This debate focusses on three related issues: a) the interpretation of the stratigraphic sequence exposed at Schöningen and its organic contents, (b) the debate surrounding the age of the Holsteinian Interglacial and its correlation with the marine isotope record, and (c) the debate on the number of interglacials between the Elsterian and the Saalian glaciations.

Three different models have been published (Kuijjer, 2014). Mania investigated the Quaternary geological sequences exposed between 1992 and 2008 and he assigns the oldest Palaeolithic find horizon to the Holsteinian Interglacial, which he correlates with MIS 13 (Mania, 1995; Mania, Thieme, 2007). Both Urban (1995, 2007) and van Kolfschoten (2012, 2014) assume that the oldest find horizon has a Holsteinian age, however, they correlate the Holsteinian Interglacial with MIS 11. Meyer (2012), Bittmann (2012) and Lang (Lang, Winsemann 2012; Lang et al., 2012) also assign the oldest Palaeolithic deposits to the Holsteinian but they assume a correlation of the Holsteinian Interglacial with MIS 9.

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The faunal record is very numerous comprising both larger and smaller mammals. The oldest faunal remains are found in the Schöningen Channel I deposits (Schö 13 I) that overlie the Elsterian glacial deposits. The assemblage represents at least 11 different mammalian taxa; the assemblage does not include indicators for exclusive glacial or interglacial conditions. The Channel II deposits yielded a number of faunal assemblages dating to the second half of the Reinsdorf Interglacial (Urban, 1995). The faunal assemblages from Channel II (Schö 13 II) levels 1–5 demonstrate a period of changing climate, spanning the transition from an interglacial optimum (base) to the beginning of the following cold stage (top). The faunal changes are, however, small. The Reinsdorf Interglacial mammalian record includes relict species such as *Sorex* (*Drepanosorex*) sp. and *Trogontherium cuvieri*. Their occurrence as well as the evolutionary stage of the *Arvicola* molars from Schöningen Channel II are biostratigraphical markers that indicate that the faunas have a post-Elsterian age; they are younger than the faunas from sites such as Boxgrove (UK), Miesenheim I, Mauer and Mosbach (Germany) and older than late Middle Pleistocene faunas from sites such as Maastricht–Belvédère (The Netherlands) and Weimar-Ehringsdorf (Germany). The Reinsdorf fauna from Schö 13 II, however, clearly demonstrates that the Reinsdorf Interglacial fauna postdates faunas from post-Anglian, Hoxnian (MIS 11) assemblages from sites such as Barnham and Beeches Pit (van Kolfschoten 2012, 2014).

The interregional correlation of the mammalian data indicates an age estimate of around 300ka (MIS 9) for the spear horizon (Schönigen 13 II-4), and an age estimate of around 400ka (MIS 11) for the oldest archaeological site from the open-cast mine (Schöningen 13 I).

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I. Korkina
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: korkina@ipae.uran.ru

SURFACE SOILS AND PALEOSOLS OF ROCK-SHELTER SVETLYI (THE MIDDLE URALS)

Key words: paleosols, humus, humic acids, Holocene, environment changes reconstruction, soil forming conditions, soddy-calcareous soils, gray-humus soils, Rendzic Leptosols

The buried Holocene soils and surface soils of rock-shelter Svetlyi were investigated with the aim to reconstruct paleoenvironment and reveal the regional particulates of soil evolution in Holocene.

The rock-shelter Svetlyi is situated on the right riverside of the Serga River. The site lies within the west-ural zone of folding of the Middle Urals. According to soil-geographical zoning the area of research relates to Demid-Serginsky soil region of the Preural subtaiga soil province (Gafurov, 2008). The region is characterized by increased moisture and moderate warm conditions. Hydrothermal coefficient varies from 1.6 to 1.8.

Soils within paleontological excavation were described. Surface soil at the east wall of the excavation is represented by soddy-calcareous soil or gray-humus soil (in agreement with "Classification...", 2004) or Rendzic Leptosol (in agreement with WRB). Profile at the south wall is subdivided into three parts, upper borders of which are allocated to the morphologically defined humus horizons: Soil I, Soil II, Soil III. Thickness and structure of buried humus horizons (76–95 cm and 127–135 cm) indicate that they had undergone a long

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time humification in the past as surface horizons. The upper 20 cm of Soil III is represented by modern gray-humus horizon followed by stratified deposits (Gray-humus stratozem on buried soil). The main elementary soil forming processes in studied soils are litter formation, humus formation and leaching.

Soils contain 10% — 80% fragments of parent rock — devonian limestones. The fine earth effervescence with 10% HCl was present from the depth of 5 cm at the south wall and from the depth of 40 cm at the east wall. Granulometric composition of fine earth is heaved from the top to down: from sandy loam to clay. The lower part of the profile is represented by deluvial and alluvial-deluvial sediments, and the top part — by colluvial sediments.

Soils are alkaline (Table). For available phosphorus and sulfur accumulative type of profile distribution is typical. This type is observed in buried soils and in the surface soil at east wall. Fluctuations of their content over the profile of Soil III mean gradual formation of the deposits or initial heterogeneity of the sediments.

Organic carbon distribution over the profile corresponds to morphological features, more higher values are found in the surface and buried humus horizons AY or AU (Table). Composition and properties of humus provide the most complete

TABLE. Physicochemical characteristics of soils of rock-shelter Svetlyi

Horizon		Depth, cm	pH_{H2O}	P_2O_5, mg/kg	SO_4^{2-}, mg/g	TOC*, %	C_{ha}*,% of TOC	C_{fa}*,% of TOC	C_{ha}:C_{fa}
South wall									
Soil III	AY1	0–5	-	-	-	-	-	-	-
	AY2	5–19	8.08	22.1	1.14	7.32	37.9	16.2	2.34
	RY1	19–35	8.35	23.8	0.82	3.42	26.6	19.5	1.36
	RY2	35–47	8.48	18.0	1.07	3.13	29.5	16.5	1.79
	RY3	47–66	8.50	28.0	0.80	2.15	27.2	19.1	1.42
	RY4	66–76	8.43	17.2	1.03	2.84	33.2	17.0	1.95
Soil II	[AU1]	76–85	8.60	10.2	1.08	4.74	50.9	13.4	3.79
	[AU2]	85–95	8.56	8.5	0.58	5.27	46.5	13.2	3.53
	[BI1]	95–105	8.54	7.6	0.43	1.16	46.4	20.9	2.23
	[BI2]	105–115	8.68	6.8	0.42	1.02	42.3	19.4	2.18
	[BC]	115–127	8.39	6.5	0.42	1.05	42.3	15.4	2.75
Soil I	[AY]	127–135	8.52	6.8	0.52	1.57	40.9	11.8	3.46
	[AYB]	135–142	8.62	8.7	0.44	0.90	34.1	16.6	2.05
	[BC]	142–152	8.72	7.1	0.38	0.39	10.0	37.1	0.27
East wall									
RY1ao		0–10	7.58	35.4	1.59	17.05	43.3	23.9	1.81
RY2ao		10–40	7.90	27.5	1.02	16.14	48.5	10.0	4.84
RY3		40–50	8.16	11.9	0.97	8.00	42.8	12.7	3.36

**TOC- total organic carbon, C_{ha} — carbon of humic acids, C_{fa} — carbon of fulvic acids.*

information about the bioclimatic conditions of soil formation. Pedohumic method of investigation of buried soils and diagnostics of paleoenvironment was proposed and developed by M.I. Dergacheva (1997, 2000).

It should be noted the high values of humic acid's and fulvic acid's ratio (C_{ha}:C_{fa}) in the studied soils, especially at the east wall (4,84–1,81), for which we don't found analogs among modern soils of the region. Therefore, in further analysis the change of the humus characteristics over the profiles has greater importance than absolute values.

In contrast to buried soils in the surface soils at the both walls the higher concentrations of "free" humic and fulvic acids (HA-1, FA-1) are revealed. Lower content of this fraction in soil at the south wall (3.81–2.65% of TOC) in comparison with those at the east wall (7.43–3.02%) and also more weakly expressed sod-formation process, humus accumulation and leaching of the carbonates can be explained by it's younger age due to rejuvenation of soil surface. Optical density of humic acid's extracts ($Ec,^{mg/ml}$ 465 nm= 10.41–11.26) is close to those in soddy-podzolic and soddy-calcareous soils.

Within **Soil I** humate type of humus of the upper horizons (127–152 cm) with high optical density of the himic acid's extracts ($Ec, ^{mg/ml}$ 465 nm = 17.46) abruptly changed by fulvate type with low optical density (5.55) in deeper horizon. Based on soil morphology, composition and spectral properties of humus we can assume the polygenetic structure of Soil I. The lowest layer (>142 cm) formed under very cold and wet conditions (this layer is characterized by the presence of Late-Pleistocene fauna (Smirnov et al., 2008)), and upper horizons (127–142 cm) — under moderate thermal and waterlogged conditions, close to those of middle-south taiga. The last period of formation of this Soil became a little warmer and drier.

Soil II is classified as dark-humus calcareous soil. It is subdivided into two layers each of which has specific features not repeated over the entire investigated deposits. In the upper layer (humus horizon [AU]) high values of TOC, C_{ha}:C_{fa} ratio, the highest humic acid's sum and optical density of humic acid's extracts (15.68–18.37), exceeding the values in modern soils, are revealed. The earlier period of operating of Soil II was humid, but quite warm (95–127cm). Environmental conditions during forming of the upper horizons were the most favorable for humification — the warmest and the driest in comparison with conditions of pedogenesis of enter profile, including modern. According to paleogeographic data such conditions were formed in the Atlantic period of the Holocene (the Holocene Optimum).

Deposits within **Soil III** are complicate with respect to humus and chemical properties. In general parameters of humus in the layer 19–76 cm characterize conditions with deficiency of heat and increased moisture. Fluctuations of all properties reflect complex genesis of this deposits: existence of unclear morphologically expressed buried horizons and probably redeposited fragments of relict humus horizons.

During the period of formation of studied sediments paleoenvironment varied significantly, resulting in a change of soil type. General trend of climate change registered with soil properties do not contradict the paleontological data. According humus characteristics it is possible to distinguish zones that are poorly detected morphologically but reflect fluctuation within long periods.

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O.P. Korsakova[1], V.V. Kolka[1], L.R. Semyenova[2]
[1] Geological Institute, Kola Science Centre, Russian Academy of Sciences
Apatity, Murmansk reg., Russian
[2] A.P. Karpinsky Russian Geological Research Institute (VSEGEI)
St. Petersburg, Russia
E-mail: korsak@geoksc.apatity.ru

LATE NEOPLEISTOCENE STRATIGRAPHY ACCORDING TO THE SEDIMENT SUCCESSIONS FROM EASTERN KOLA PENINSULA, PONOY RIVER VALLEY

Key words: stratigraphy correlation, marine units, interglacial, Kola Peninsula

The sediment successions from extreme Eastern Kola Peninsula are one of key object for solution of Late Pleistocene stratigraphy question with the Late Interglacial strata. The main questions posed today in a regional context are the stratigraphic position of the marine units named Ponoy and Strel'na Beds (the denomination after Ponoi and Strel'na river valleys with the key stratigraphic sections). Coastal Kola was affected by several marine inundations during the Late Pleistocene. The spice and time position of marine deposits associated with the Interglacial Boreal transgression of the Ponoy Beds in the coastal Kola Peninsula were relatively coordinated in northern Europe. The Ponoy

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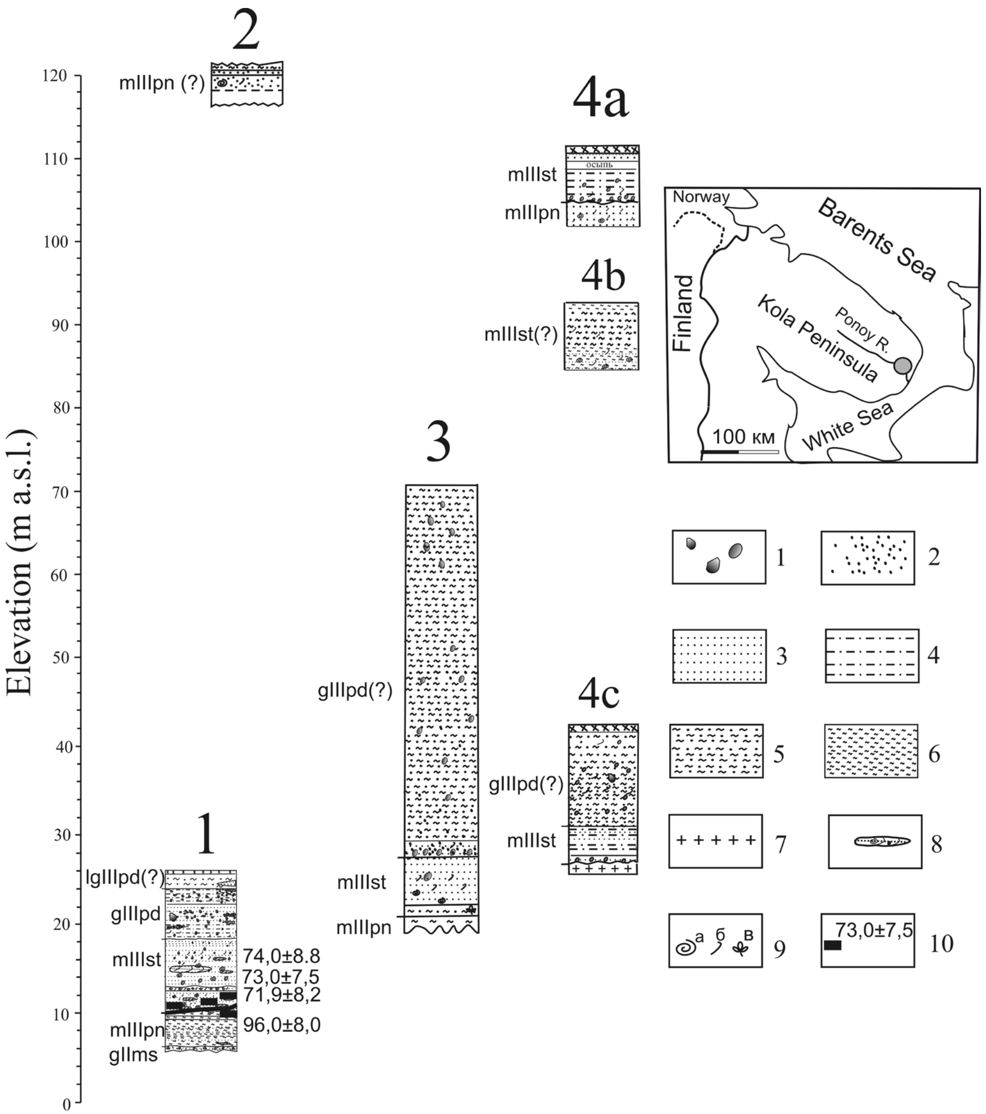

Fig. 1. The sediment successions from Eastern Kola Peninsula, Ponoy River Valley (sections 2–4 are plotted according to description from (Gudina, Yevzerov, 1973). The stratigraphic units are drawn by indexes: gIIms — Moskovian/Saalian till; Upper Neopleistocene units: mIIIpn — Mikulinian/Eemian marine Ponoi Beds, mIIIst — Early Weischelian marine Strel'na Beds, gIIIpd — Podporozh'e/Early Weischelian till). 1 — boulders, pebble; 2 — gravel; 3 — sand; 4 — sandy loam; 5 — loam; 6 — clay; 7 — pre-Quaternary rocks; 8 — sandy lenses; 9 — detritus and intact molluscan shells ((a) and (b)), plant remains (c); 10 — sampling sites for geochronological dating (numbers designate the sediment age)

Beds deposits are considered to accumulate in Interglacial relatively warm-water marine basin (Cudina, Yevzerov, 1973; Korsakova et al., 2004) and composed from regression series of sediments (clay or compact loams, sandy loams overlapped fine-grained sands). The Strel'na Beds associated with Early Weichselian cold-water marine transgression in coastal Kola was discussed by many researchers. The deposits are represented by sands, sandy loams, loams, and clays that overlapped the Ponoi Beds deposits. The latest data (Molodkov, Bolikhovskaya, 2002, 2010; Korsakova et al., 2004, Gusev, Molodkov, 2012 and others) indicate the marine event in Eurasian North during the Eemian and Early Weichselian (marine isotope stage (MIS) 5). The key stratigraphic section in the Ponoy River valley has been study to recognize the correlation between the Ponoy and Strel'na Beds.

The fieldwork was carried out for 2 weeks during summer of 2007. To obtain the data, the traditional geological methods used in field research were applied: mainly sampling and structural, sedimentological, and geological investigations of the deposits exposed in the right bank of the Ponoi River lower reach, opposite the former Ponoy village. Lithology-stratigraphy study was carried out and the previous investigations data referred from (Gudina, Yevzerov, 1973) were taking into account (Fig. 1). The four samples was date by A.N. Molodkov at the Institute of Geology, Tallinn University of Technology using ESR and OSL methods. The spore-pollen study was carried out by E.S. Pleshivtseva.

The obtained data show that the Ponoi Beds from the key stratigraphic section with two-part structure (Gudina, Yevzerov, 1973) was formed not only during Eemian (Boreal) marine transgression but also during Early Weichselian (Belomorian after (Lavrova, 1960)) transgression (MIS 5a-d). According to the available palinological and, mainly, geochronological data the upper sandy part of the sediment unit (section 1, interval 11–16 m above sea level on Fig. 1) traditionally attributed to the Ponoi Beds accumulated in the Early Weichselian marine basin under relatively cold and damp climate conditions. These sediments have to be attributed to another marine unit referred to in literature as the Strel'na Beds (Gudina and Yevzerov, 1973). The data evidence the lover clay part of the Ponoy Beds sediments (section 1, interval 7–11 m above sea level on Fig. 1) accumulated in the Interglacial marine basin until 96 ka under relatively warm water and climate conditions. Both of the Ponoy and Strel'na Beds marine sediments have to be correlated with the long-term marine reservoir existing during Last Interglacial (MIS 5) in the White Sea depression. These marine units sandwiched between glacial sediments.

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P.A. Kosintsev
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: kpa@ipae.uran.ru

ELASMOTHERIUM (*ELASMOTHERIUM SIBIRICUM* FISHER, 1808): NEW DATA ON THE PERIOD OF EXISTENCE AND GEOGRAPHIC RANGE

Key words: Elasmotherium, Late Pleistocene, fauna, geographic range, biostratigraphy, Ural, West Siberian

Elasmotherium sibiricum Fisher von Waldheim, 1808 is a typical species of the Early-Middle Pleistocene fauna in Asia and Eastern Europe (Schvyreva, 2014), though it may have lived in the Late Pleistocene (Kosintsev, 2010). New evidence in favor of this hypothesis has been obtained so far. From 2011 through 2013 several new locations of the Late Pleistocene faunas comprising Elasmotherium remains were studied.

Location Voronovka (55° 27'N, 65° 20'E). 357 bones have been found there. They belong to *Panthera spelaea*, *Mammuthus primigenius*, *Equus ferus* (*E.* cf. *gallicus*), *Coelodonta antiquitatis*, *Elasmotherium sibiricum*, *Rangifer tarandus*, *Bison priscus*, and *Saiga tatarica*. Radiocarbon dates have been obtained on mammoth and bison bones: 41000±650, SOAN-5643; 17200±150, SOAN-5644.

Location Borovlyanka (56° 48'N 62° 52'E). We have found 92 bones belonging to *Mammuthus primigenius*, *Equus ferus* (*E.* cf. *gallicus*), *Coelodonta antiquitatis*, *Elasmotherium sibiricum*, *Rangifer tarandus*, and *Bison priscus*.

Location Golubkovskoe (57° 56'N, 63° 30'E). 22 bones have been found there. They belong to *Mammuthus primigenius*, *Equus ferus* (*E.* cf. *gallicus*), *Coelodonta antiquitatis*, *Elasmotherium sibiricum*, and *Bison priscus*.

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Location Belaya-Sterlitamak (51° N, 58° E). We have found 14 bones there belonging to *Mammuthus primigenius*, *Equus ferus* (*E.* ex gr. *latipes-gallicus*), *Coelodonta antiquitatis*, *Elasmotherium sibiricum*, and *Bison priscus*.

Location Tobolsk (58° N, 68° E). Elasmotherium bone has been identified in the collection of bones gathered at different locations in the vicinity of the town of Tobolsk. This collection consisted of 153 bones belonging to *Mammuthus primigenius*, *Equus ferus* (*E.* cf. *gallicus*), *Coelodonta antiquitatis*, *Elasmotherium sibiricum*, *Rangifer tarandus*, and *Bison priscus*. It is the most northern finding of the remains of this species.

Species composition of the faunas associated with Elasmotherium bones shows that all of them are of the Late Pleistocene age. All the abovementioned locations are of alluvial type, therefore, the Elasmotherium bones may have been found in a redeposited condition belonging to more ancient deposits. However, in each location the bones are of the same fossilization type. The same is true for the Elasmotherium bones. No traces of redeposition of the Elasmotherium bones have been found in any of these locations, which indicates concurrent burial of the Elasmotherium bones and the bones of other species and enables dating the Elasmotherium bones back to the Late Pleistocene.

Radiocarbon dating of the Elasmotherium bones from these locations will show whether Elasmotherium lived in the Late Pleistocene. The samples for dating were handed over to the Center for Isotope Research, Groningen University, Groningen, Netherlands in 2012.

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P.A. Kosintsev, V.V. Gasilin, D.O. Gimranov
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: GasilinV@yandex.ru

CARNIVORES OF THE URALS IN THE LATE PLEISTOCENE AND HOLOCENE

Key words: Carnivora, Urals, Pleistocene, Holocene, fauna, geographic range, stratigraphy

The Urals is a biogeographical region with overlapping geographic ranges of European, Siberian, and Palaearctic faunal complexes representatives, located on the border between Europe and Asia. It crosses tundra, taiga and steppe natural zones. 19 carnivore species representing 4 families (Canidae, Ursidae, Mustelidae, Felidae) live here now. *Neovison vison* Schreber, 1777 and *Nyctereutes procyonoides* Gray, 1834 were acclimated here in the first half of the XXth century. Carnivore remains found in the Urals date to the Early Pleistocene (Stefanovsky, Borodin, Strukova, 2003).

In our work we aim to study the history of carnivore fauna of the Urals in the Late Pleistocene and Holocene. For that purpose we determine species composition of the carnivore fauna in the Northern, Middle and Southern Urals in different periods of the Late Pleistocene and Holocene, distributional limits of different species, describe the time of species appearance and disappearance in the Urals fauna, identify chronological and geographical carnivore complexes in the Urals, evaluate feasibility and usability of carnivores for biostratigraphy of the Late-Pleistocene and Holocene deposits in the Urals.

We used both published (Bachura, Kosintsev, 2007; Kosintsev, 2007; Kosintsev, Bachura, 2013; Kuzmina, Sablin, Tsiganova, 1999; Ponomarev et. all, 2013) and new data. The approach representing order Carnivora is based on the works by A.Aristov, G.Baryshnikov (2001) and D.E.Wilson, D.M.Reeder (2005).

Paleozoological material represents three types of locations: alluvial, archaeological, and cave. We studied faunas dated by radiocarbon and archaeological methods, as well as data on carnivore species composition from 287 locations situated in the Urals between 51 and 64° North latitude. 8 chronological periods have been studied: MIS 5e, MIS 5a-d – MIS 4, MIS 3, LGM, LGT, early MIS 1, middle MIS 1, and late MIS 1. Analysis of the chronological and geographical distribution of the bone remains of each carnivore species has been performed.

Analysis of distribution of the remains of different carnivore species in time and space allowed us to distinguish several groups of species. Group 1 includes

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the species that inhabited the Urals from the Late Pleistocene till modern times and whose geographic ranges underwent only slight changes through this period: *Canis lupus* L., 1758, *Vulpes vulpes* L., 1758, *Ursus arctos* L., 1758, *Gulo gulo* L., 1758, *Mustela erminea* L., 1758, *Mustela nivalis* L., 1766. Group 2 comprises the species that inhabited the Urals through the Late Pleistocene and Holocene and whose geographic ranges considerably contracted: *Vulpes lagopus* L., 1758, *V. corsac* L., 1768, *Martes zibellina* L., 1758, *Mustela eversmanii* Less., 1827, *Crocuta crocuta spelaea* Goldfuss, 1823 (contracted in the late MIS 3). Group 3 comprises the species that became extinct in the Late Pleistocene: *Ursus spelaeus* Rosenmüller, 1794 and *Ursus savini* Andrews, 1922, *Panthera spelaea* Goldfuss, 1810 (in the late MIS 3 and late MIS 2, respectively). Group 4 includes the species whose geographic range might have fluctuated: they appeared and disappeared from the Urals fauna composition during the Late Pleistocene and Holocene: *Lutra lutra* L., 1758, *Meles meles* L., 1758, *Mustela lutreola* L., 1761, *Lynx lynx* L., 1758. Group 5 consists of those species that inhabited the Urals only through one relatively short period: *Cuon alpinus* Pall., 1811, *Ursus thibetanus* G. Cuvier, 1823, *Martes foina* Erxleben, 1777. Group 6 comprises the species that appeared in the Urals in the Holocene: *Meles leucurus* Hodgson, 1847, *Martes martes* L., 1758, *Mustela putorius* L., 1758. *Mustela sibirica* Pall., 1773 comes here in the XXth century.

Distributional limits of certain species lay in the Urals. Here we have the northernmost locations of the Late Pleistocene remains of some species: *C. alpinus* (55ºN), *V. corsac* (57ºN), *U. thibetanus* (59º30'N), *U. savini* (59º30'N), *U. spelaeus* (62ºN), *M. meles* (59º30'N), *M. zibellina* (59º30'N), *M. eversmanii* (62ºN), *M. lutreola* (55º30'N), *L. lynx* (59ºN), and *C. crocuta spelaea* (57º30'N). Eastern limit of the *U. spelaeus* geographic range lay in the Urals in the Late Pleistocene (its remains were found only on the western slope of the Urals with no remains found on the eastern slope). In the Holocene the Urals is the extreme north-eastern location of *M. foina* (53º05'N, 56º36'E), *M. eversmanii* (58º10'N, 61º20'E), and *M. lutreola* (62º00'N, 58º05'E).

Species of the Palaearctic faunal complex have always dominated the carnivore fauna composition of the Urals. In the Late Pleistocene Asian faunal complex comprised *C. alpinus*, *U. thibetanus*, *M. zibellina*, with only the latter being permanent inhabitant. European faunal complex in the Late Pleistocene was represented by *U. spelaeus, M. meles*, *M. lutreola,* with only *U. spelaeus* being constantly present in the fauna. In the Late Pleistocene European and Asian species were equally represented in the carnivore fauna of the Urals. In the Holocene European faunal complex comprised five species (*M. meles*, *M. foina, M. martes, M. putorius, M. lutreola)*, while Asian comprised, only one (*M. zibellina)*. In the beginning of the Late Holocene *M. leucurus* came here, replacing *M. meles*. In the Holocene European species in the fauna composition were much more numerous than Asian ones.

Several chronological and geographical variants of carnivore faunas have been distinguished for the Late Pleistocene and Holocene. Biostratigraphic value is attributed to *U. thibetanus* typical of the MIS 5e fauna, *U. savini, U. spelaeus* and *C. crocuta spelaea* (MIS 5–MIS 3), *P. spelaea* (MIS 5–MIS 2), *M. leucurus, M. martes* and *M. putorius* (MIS 1), *M. sibirica* (modern fauna). Such species as *C. alpinus*, *V. lagopus*, *M. foina*, *C. crocuta spelaea* play an important role for regional stratigraphy.

The history of the carnivore fauna in the Urals can be divided into the following principal stages: the MIS 5 fauna with *U. thibetanus*, *M. meles* and *M. lutreola*; the MIS 5a-d – MIS 4 – MIS 3 fauna with *U. savini, U. spelaeus* and *C. crocuta spelaea*; the MIS 2 fauna with *P. spelaea* and *V. lagopus,* the MIS 1 fauna with *M. martes*, *M. putorius,* and modern fauna with *M. sibirica*. The changes in the terraneous carnivore fauna occurred all through the Late Pleistocene and Holocene till modern times.

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A.Y. Krotova-Putintseva,
A. P. Karpinsky Russian Geological Research Institute (VSEGEI)
St. Petersburg, Russia
E-mail: avacha2001@rambler.ru

ONCE AGAIN ABOUT THE EARLY VALDAIAN GLACIATION

Key words: Upper Pleistocene, Early and Late Valdaian glaciations, LGM, Russian Plain

The study area, located in the north-west of the Russian Plain, was covered by glaciers not less than 6 times (Fig. A6, Appendix 5).

In process of the State Geological Map of Quaternary deposits' compilation at 1:1 000 000 scale (third generation), O-37 (Yaroslavl) sheet and its correlation in the western border with published map of O-36 sheet a problem had arisen. Relief-forming glacial deposits of the Early Valdai were mapped on O-36 sheet within the Mologa-Sheksna Lowland (Verbitskiy et al., 2012), which is contradict to present notions that extent of the Early Valdaian glaciation was less than Late Valdaian one in the North-Western and Central regions of the East European Platform (see Regional stratigraphic schemes in Resolution..., 1986). That is why, issue of the Early Valdaian (Podporozhje) glaciation raised once again.

In the northern part of the investigated territory lacustrine and bog sections of the Mikulino (Eemian), Early and Middle Valdai, which are not overlaid by till, were detected as a result of geological mapping at 1:200 000 and 1:50 000 scales with high amount of boring and application of pollen and radiocarbon-dating analyses (Gey et al., 2000). Sections with the Middle Valdai deposits covered by till are found in the western slope of the Kubenskoye Lake depression and in Belozersko-Kirillovskye Ridges only, and time of the Late Glacial Maximum according to ^{14}C and OSL dating is estimated at 18000 years (Lunkka et al., 2001).

There are numerous sections of the Mikulino interglacial deposits, which are not overlaid by till, in the central and southern parts of the study territory in the area of Moscovian (Warthe) glaciation. Since 1940s discussion about the extent and margins of the Early Valdaian glaciation was due to the fact that in some sections the Mikulino deposits are covered by "till-like" loam and sandy loam with gravel, pebble and boulder deposits, which some researchers consider as Early Valdai till, while others — as deluvium (slide-rocks) and solifluction sediments.

"Till-like" sediments, overlaying the Mikulino deposits, were investigated in the area of Klinsko-Dmitrovsk Ridge, Borisoglebskaya Highland,

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Ovenistchenskaya Highland and the Rybinsk Volga Region (Povolzhje). Results of the State geological mapping at 1:200 000 scale (first and second generation) and of own field investigations indicate, that "till-like" sediments occur only at the foot of the slopes, however they are absent in the central parts of depressions. "Till-like" sediments are characterized by small thickness, lower density in comparison with glacial sediments, and also by ordered orientation of clastic material. This is indicative of deluvial- solifluction genesis of these deposits (e.g. Alekseev et al., 2000; Fetischeva, 1977; Artemjeva, 1998). More over, glacial landforms, with the Mikulino sediments in their hollows, have smoothed surface, gentle slopes, leveled eskers and kames, highly branched river network. This landforms' morphology indicates its older age in comparison with Valdaian landforms, which are characterized by "freshness" of topography.

Thereby, at the end of 20 century it was established that study area was covered only by the Late Valdaian glacier during the Upper Pleistocene. Margin of its extent is controlled, on the one hand, by the presence of till, which covers the Middle Valdai deposits, on the other hand, by numerous sections of the Mikulino, the Early and Middle Valdai interglacial sediments, which are not overlaid by till. Absence of the Early Valdaian till on the territory was confirmed in the process of the Quaternary deposits map's compilation for O-37 sheet. This corresponds to modern notions (for references see Shik, 2014).

In conclusion it should be noted, that revision of the existed regional stratigraphic schemes should based on results of comprehensive geological survey with appropriate volume of field, boring and laboratory investigations.

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E.A. Kuzmina, N.G. Smirnov, A.I. Ulitko
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: Lenii1@yandex.ru

NEW DATA ON THE HOLOCENE SMALL MAMMAL COMMUNITIES FROM URAL-SAKMARA INTERFLUVE, SOUTHERN URALS

Key words: small mammals, South Urals, Holocene

Ural-Sakmara interfluve is a southern territory of extremity of Ural mountains. It is characterized by hummock-ridge-hilly relief, arid climate, steppe vegetation. It is bordered by forests of the mountain ridge of the Urals to the north and dry steppes and semideserts of Mugodzhar mountains to the south. The investigation of Holocene stage of the small mammal communities history was focused on fossil materials from caves: Chernorechka, Chernorechka-2; and subfossil materials made by eagle-owls activity on rock shelters Verbluzhka, Verbluzhka-2 (Orenburg region, Russia). Rodents and small lagomorphs were determined by cheek teeth — about 6 thousand elements in total. Loose deposits from Chernorechka cave (51º32´N, 56º43´E) contain 3 layers: 1 — black humus loamy sand with big quantity of multi-sized not-rounded detritus minerals (capacity till 0,3 m), late Holocene; 2 — taupe faintly humus loamy sand (capacity 0,4–0,5 m), more earlier phases of the Holocene; 3 — hazel loamy soil (maximum depth — 0,8 m), early Holocene — the end of Late Pleistocene(?). The core of the fauna of the most ancient 3 layer is formed by steppe and yellow steppe lemmings and narrow-skulled vole as in adjacent northern-east territory of the South Trans-Urals during Late Pleistocene time (Kuzmina, 2009). In upper layers 1 and 2 mole vole and common vole became dominant species. Yellow steppe lemming is on the third place of domination though it absent in the nowadays fauna of the Ural-Sakmara interfluve. This species as known was broadly distributed on the north of arid territories of North Eurasia in Late Pleistocene and greatly reduced its western part of the area during the Holocene time. Nowadays yellow steppe lemming inhabits eastern part of Zaisan depression (Kazakhstan), the north of China, eastern Khangai, Goby and Mongol Altay (Mongolia) (Gromov, Erbajeva, 1995).

Common species of the layers 1 and 2 are: steppe lemming, narrow-skulled vole, common hamster, forest voles from the group bank vole–northern red-backed vole, mice from the group small forest–field, steppe pika, Eversmann hamster. Species with fluctuating dynamics are: root vole, water and field voles, grey hamster, big and small sousliks, birch mouse, big and little jerboa, steppe

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marmot. Little jerboa *Alactagulus pumilio* which is a marker of desert and semidesert conditions is presented in all layers of Chernorechka including the most upper parts. Present fauna of Ural-Sakmara interfluve exclude this species, though it's inhabits more southerner territories of Mugodzhar mountains.

Also 2 species of the modern European small mammal fauna — garden dormouse and yellow-necked mouse — are present in the 2 layer as rare ones. Garden dormouse is absent in the modern fauna of the Ural-Sakmara interfluve but it's marked as rare species for adjacent more forest-covered northern-west and west territories of Orenburg region (Chibilev et al., 1993). Yellow-necked mouse is present in modern fauna of Ural-Sakmara interfluve also as rare species (Chibilev et al., 1993). Yellow-necked mouse recorded in series of Holocene sites on the western slope of the South Urals (Danukalova, 2010; Yakovlev, 2003). Simultaneous presence of *Eliomis quercinus* and *Apodemus flavicollis* was discovered previously only in Holocene Sim fauna (Smirnov, 1990) on the western slope of the South Urals. Our investigation showed that the area of cohabitation of these two species arranged southerner then previously known data, in Ural-Sakmara interfluve at 51°N in the south extremity of Ural mountains. Our finding of *Eliomis quercinus* in Chernorechka cave is the most southern-east point in the area history of this species.

Materials from Chernorechka-2, Verbluzhka, Verbluzhka-2 fixed disappearance of steppe and yellow steppe lemmings, little jerboa, grey hamster and root vole from the community composition during the time stages closed to contemporary. Narrow-skulled vole periodically disappeared from fauna composition and *Rattus* sp. on the contrary appeared. In Chernorechka-2 common hamster and *Sicista* sp. get into the core of communities in conjunction with common vole and mole vole. The same three species (besides birch mouse) dominated in subfossil materials from Verbluzhka and Verbluzhka-2. The share of forest voles, water vole and mice increased.

It is shown that the share of mesophilic species increased from ancient to modern layers on the background of xerophilic elements decreasing in small mammals communities. This tendency adjusts with the fixed fact of mesophytisation increase of steppe ecosystems of North Eurasia (Dinesman, 1999) through Holocene time to up-to-dateness.

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A.V. Lagunov, E.I. Veisberg
Ilmen State Reserve, Ural Branch, Russian Academy of Sciences
Miass, Russia
E-mail: lagunov@mineralogy.ru

HOLOCENE HISTORY OF *CARABUS KARPINSKII* (KRYZHANOVSKIJ ET MATVEEV, 1993) ENDEMIC TO THE SOUTHERN URALS

Key words: ground beetle, Carabus karpinskii, Carabus odoratus, Holocene, area

Carabus karpinskii is endemic of the highlands of the Southern Urals, it is relict species, which preserved here after the end of the Ice Age. It inhabits on the highest mountains of the axial part of the Southern Urals, found on ridges Urenga, Zigalga, Yamantau, Nurgush, Iremel (Lagunov, 2005). Species is included in the Red Book of the Russian Federation (the application) and the Red Book of the Chelyabinsk region (category 2, vulnerable).

Carabus karpinskii is taxonomically close to ground beetle *Carabus odoratus septentrionalis* Breuning, 1932 (Kryzhanovskij, Matveev, 1993). *Carabus odoratus* Motschulsky, 1844 is boreal-montan species, having main area in eastern Siberia (Kryzhanovskij, 1983). The area is clearly relict and consists of multiple isolates (Kryzhanovskij et al., 1995). The species is devided to more than 20 subspecies: *C. o. antropovi* Shilenkov, 1996 (Tuva, East&West Tannu-Ola Mt.); *C. o. baeri* Menetries, 1851 (NC,NE Siberia, Yenisey to Kolyma River, S-part of Taymyr Peninsula); *C. o. bargusinicus* Shilenkov, 1996 (Barguzinsky Mt.); *C. o. chaffanjoni* Lesne, 1898 (arctic E-Siberia Verchyanskaya Mt. area); *C. o. chlebnikovae* Obydov, 2005 (Severo-Baykalsk area); *C. o. czernyscheviellus* Obydov, 2002 (Chita, Nerchisko-Kuengsky Mt.); *C. o. dabanensis* Shilenkov, 1996 (Irkutsk, Khamar-Daban Mt.); *C. o. divnoensis Obydov*, 2006 (Krasnoyarsk); *C. o. dohrni* Gebler, 1847 (Kuznetsky Alatau);

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C. o. irkoutskensis Lapouge, 1915 (Midle Siberia, Irkutsk);*C. o. jacuticus* Obydov, 2002 (Yakutiya, Vostochnaya Khandyga River); *C. o. kamtchatensis* Breuning, 1942 (Kamchatka, Penzhinskaya Guba); *C. o. krugeri* Obydov, 1999 (Tuva Akad. Obruceva Mt.); *C. o. magadanicus* Obydov, 1999 (Magadan); *C. o. martjanovianus* Obydov, 1999 (West Sayan Mts., Sayanogorsk); *C. o. odoratus* Motschulsky, 1844 (Baykal Lake CE-cjast, Khamar-Daban Mt.);*C. o. putoranicus* Obydov, 2002 (NE-Siberia, Putorana plateau); *C. o. septentrionalis* Breuning, 1932 (Pechera Plain, Circumpolar and Polar Urals, Northern West Siberia); *C. o. taskylensis* Obydov, 2002 (Tuva, Taskyl Mt.); *C. o. viridilimbatus* Motschulsky, 1859 (SE-Siberia & Far East, Barguzin Mt., Amur; CE-Siberia; S of Yakutsk). Obviously, the original area of *Carabus odoratus* was significantly shifted to the south during glaciations (after the tundra and tundra-steppe zones) and was reduced in interglacial periods, retreating to the north and leaving enclaves in tundra sites of large mountain sites. During the last glaciation, the species has penetrated to the Southern Urals, where it has formed mountain enclave, in which subsequently new species *Carabus karpinskii* originated. Thus, the approximate age of this species is about 11 thousand years.

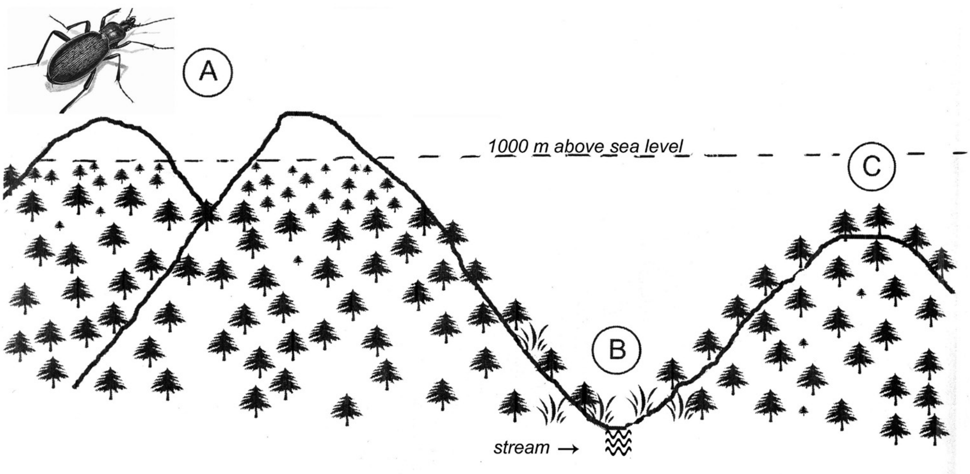

Fig. 1. Main habitat types *Carabus karpinskii* in the Southern Urals. A — basic relict habitats in the mountain tundra and rock streams at an altitude of 1000 m above sea level; B — temporary multiyear micropopulations groups in the valleys at the foot of the mountains; C — depressive habitats on mountaintops below 1,000 m asl under the forest canopy

Modern finds after 2005 indirectly confirm this scenario. So, *Carabus karpinskii* was discovered on the outskirts of the village Tyulyuk (ie, at the foot of Mt. Iremel):13–14.06.2007, 2 males and 1 female, Chibilev E. leg. The second discovery was made at the foot of Mt. Nurgush in midstream of river Kalagaza: 2 pc., 17.07. 2011, Lagunov A.& Veisberg E. leg. We assume that in spring some of beetles can be washed away by the powerful streams of meltwater from mountain tundra and rocky scree into the intermountain valleys. Probably, temporary population groups periodically arise here, which, in our opinion, are unstable and exist only a few seasons (Lagunov, 2011). The most interesting finding of *Carabus karpinskii* is on Alexander hill (near Zlatoust), at an altitude of about 760 m asl (ie outside of the tundra zone): 14 pc., 4–11.07.2013, Zvezdin D. leg. The greatest height of this mountain is 843 m, the top is covered with trees (birch, spruce, mountain ash), the tundra is absent, and there are outcrops of rocks. This is probably depressive enclave, which will be reduced with futher climate warming (Fig. 1).

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K. Lasberg
Institute of Ecology and Earth Sciences, University of Tartu
Estonia
E-mail: katrin.lasberg@gmail.com

CHRONOLOGY OF THE LATE WEICHSELIAN GLACIATION IN THE SOUTHEASTERN SECTOR OF THE SCANDINAVIAN ICE SHEET

Key words: SIS, LGM, Baltic ISC, Karelian ISC, glaciation, chronology

This study examines the chronology of Late Weichselian glaciation, maximum extent of Scandinavian Ice Sheet (SIS) and its glacial advance and decay dynamics in western part of the East European Plain. The study area encompasses the SE sector of the SIS between the Baltic Sea and the Last Glacial Maximum (LGM) position in the western part of the East European Plain (Fig. A7, Appendix 6).

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The Late Weichselian glaciation is most extensively studied; however chronological data are unevenly distributed and the timing of the advance of the last SIS and its arrival to maximum extent and deglaciation are continuously debated. This has necessitated the revision of the chronological data. In current study the behaviour of the SIS during the Weichselian Glaciation on East European Plain is discussed through the collection, review and synchronization of all available chronological data (^{14}C, OSL, TL, ^{10}Be). As two different ice streams were operating during the Late Weichselian in the western part of the East European Plain and the last SIS did not reach the LGM synchronously, the study area was tentatively divided into two parts — western part as Baltic ice stream complex (ISC) area and eastern part as Karelian ice stream complex (ISC) area, where ages and ice sheet dynamics were analysed separately. Based on time-distance diagrams developed for each part of study area, an overall chronology for the last SIS advance was established; deglaciation chronology in conjunction with the current understanding of the ice-flow pattern was defined and overall rates of ice-sheet advance and recession were discussed.

The last SIS in the west, in the Baltic ISC area, reached the western shores of Latvia not before 26 OSL ka, central Lithuania not before 25.6 cal. ^{14}C ka BP and southern Lithuania not before 24.7 cal. ^{14}C ka BP. In the east, in the Karelian ISC area, the last SIS reached the southern shores of the Gulf of Finland not before 21 OSL ka and central Latvia not before 19.6 OSL ka. The last SIS reached close to the LGM position in the western part of the study area, in NW Belarus not earlier than 22.6 cal. ^{14}C ka BP and in the eastern part of the study area, in NE Belarus not earlier than 19.1 cal. ^{14}C ka BP. Based on the chronology it can be concluded that while the SIS reached its maximum extent in the eastern part of study area, the SIS was already decaying in the western part. Deglaciation in the Baltic ISC area started not earlier than 22.6 cal. ^{14}C ka BP. By 14.2 ^{10}Be ka, the entire area between the LGM position in NW Belarus and the western shores of Latvia was deglaciated. In the Karelian ISC area, the last SIS recession started not earlier than 19.1 cal. ^{14}C ka BP. By 13.3 cal. ^{14}C ka BP, the whole area between the LGM position in NE Belarus and the southern shores of the Gulf of Finland was ice-free. The mean calculated linear advance rate of the last SIS in the western part of the study area was 110 m a^{-1}, and about three times faster in the eastern part, at 330 m a^{-1}. Also the last SIS recession rate in the study area was faster in the east than in the west, 170 and 50 m a^{-1}, respectively.

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J.-P. Lefort [1], J.-L. Monnier[1], G. Danukalova[2]
[1] Université de Rennes 1, Campus de Beaulieu, Laboratoire d'Archéosciences
Rennes cedex, France
[2] Institute of Geology, Ufimian Scientific Centre, Russian Academy of Sciences
Ufa, Russia
E-mail: lefort38@yahoo.fr, danukalova@ufaras.ru

THE ICELANDIC BASALTS: AN "EXOTIC" CONTRIBUTION TO THE PLEISTOCENE BEACH DEPOSITS OF WESTERNMOST EUROPE. HOW THEY GROUNDED IN FRANCE

Key words: Basalt boulders, ice-rafts, katabatic winds, Coriolis forces, Gulf Stream

It is known for years that many micro-granites, red granites and basaltic boulders can be collected on the Ushant and Molène Island beaches (Chauris and Hallégouët, 1989). Other basalts and trachy-andesites have been collected along the west-facing coast of Brittany down to Ré island (Gabis, 1955). Since these rocks neither exist on the islands nor on the continent in western France, they have been always considered as "exotic" (Didier and Jonin, 1966). No outcrop of these types of rocks has ever been found offshore. An origin from ice-rafted debris has been suggested (Hallégouët and Van Vliet-Lanoë, 1989). Ages ranging between 3.6 and 1 Ma have been obtained by K/Ar dating on boulders of olivine basalts (Bellon et al., 1988) sampled on Ushant Island. These authors suggested an origin in Iceland because of the remarkable similarities in age.

There are many evidences that the Weichselian ice cap was not reaching the southern coast of England and was far from Brittany during the Late Glacial Maximum. However, marine surveys (Scourse et al., 2009) show that the southern extension of the Celtic Sea ice floe was located at less than 180 km from the Ushant Island. The western edge of this ice floe, which was linking with the Iceland ice floe (Coutterand, 2007) was fragmenting and melting at the contact with the warmer seawater. It is now known that katabatic winds were playing a major role in the creation of polonies and in the icebergs calving processes (Bromwich and Kurtz, 1984) by pushing the ice rafts towards the south. We suggest that ice-rafts which were sometimes transporting boulders or pieces of volcanic rocks from Iceland were pushed by these katabatic winds towards the South. However, during their long migration the ice-rafts were submitted to Coriolis forces, which deviated their course toward the East. This propagation towards the south was not contradicted by the opposite flow of the northern branch of the Gulf Stream which was almost inactive because of the modification of the solar-terrestrial coupling at that time (Mörner, 2011). This variation was responsible for a huge amount of cold water coming from the

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melting ice floe. After a maximum transfer of 1000 kilometres (the theoretical maximum effect of the katabatic winds) these drifts were catch by the southern branch of the Gulf Stream which was running towards the East.

Since the grounding of the ice-rafted mainly occurred during low-stands of the sea, the Icelandic basalts were first deposited at a depth deeper than the actual beaches. It is only during a latter transgression that they were rounded and transported towards the Ushant and other islands as suggested by the angulated fragments of basalts found at 10° West.

It is interesting to note that the accumulation of basalts and trachy-andesites found on the westernmost shore of the Brittany Peninsula almost always accumulated in bays open to the northwest, which suggests a conjugate control of the drifts by the Gulf Stream and by the winds blowing from the North or the Northwest. These katabatic winds coming from the British Ice Sheet were also responsible for the accumulation of loess deposits onshore in Brittany and Normandy (Lefort et al., 2013).

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A. Lemanik, A. Nadachowski, P. Socha
Department of Palaeozoology, Institute of Environmental Biology, Wrocław University
Wrocław, Poland
E-mail: anna.lemanik@uni.wroc.pl

BIOSTRATIGRAPHIC IMPORTANCE OF ROOT VOLE (*MICROTUS OECONOMUS*) IN PLEISTOCENE OF POLAND

Key words: Microtus oeconomus, Microtus malei, morphometry, SDQ, biostratigraphy

The remains of root vole *Microtus oeconomus* (Pallas, 1776) are common in the sediments of late Middle and Late Pleistocene age in Poland. In Europe this species is characterized by a distinct morphological change of the first lower molar in time. On the basis of the observed differences, two species were recognized (*Microtus malei* Hinton, 1923 and *Microtus oeconomus)* e.g. in England and France. However, the taxonomic position of these forms is not clear. According to Chaline (1972) they constitute two species, while Nadachowski (1991) is of the opinion that both forms have the rank of subspecies within the same species – *Microtus oeconomus*. Morphology of m1 is changing from the late Middle to Late Pleistocene. In the late Middle Pleistocene morphotypes "*malei*" prevail, while in the Late Pleistocene morphotypes "*oeconomus*" predominate.

Research on m1 of *Microtus oeconomus* was conducted on material from Biśnik Cave and Deszczowa Cave in Poland. The material comes from layers of clear stratigraphic position (Nadachowski et al., 2009, Krajcarz et al., 2014, Socha, 2014). Morphological analysis of m1 was based on a scheme proposed by Nadachowski (1991). It assumes that morphotypes "*malei*" are characterized by the wide connection between triangles T5 and T6, and the more advanced development of BSA4 compared to LSA5. Another morphotype, unusual for "*oeconomus*", and represented in the material, is morphotype "*nivalis*". It is characterized by the lack of connection between T5 and T6. Measurements were made on the teeth based on the scheme of van der Meulen (1973), and the relative enamel thickness quotient (SDQ) was calculated according to the method proposed by Heinrich (1990).

In the late Middle Pleistocene sediments of Biśnik Cave morphotypes "*malei*" and "*nivalis*" predominated (about 70%), and in the Late Pleistocene morphotype "*oeconomus*" (more than 70%) (chi kwadrat 635.33; df = 68; p = 0.000) prevailed. Also in layers deposited in the late Middle Pleistocene of Deszczowa Cave, the "*malei-nivalis*" morphotypes represented about 80–85% of the material, while in the Late Pleistocene, the morphotype "*oeconomus*" was the most common.

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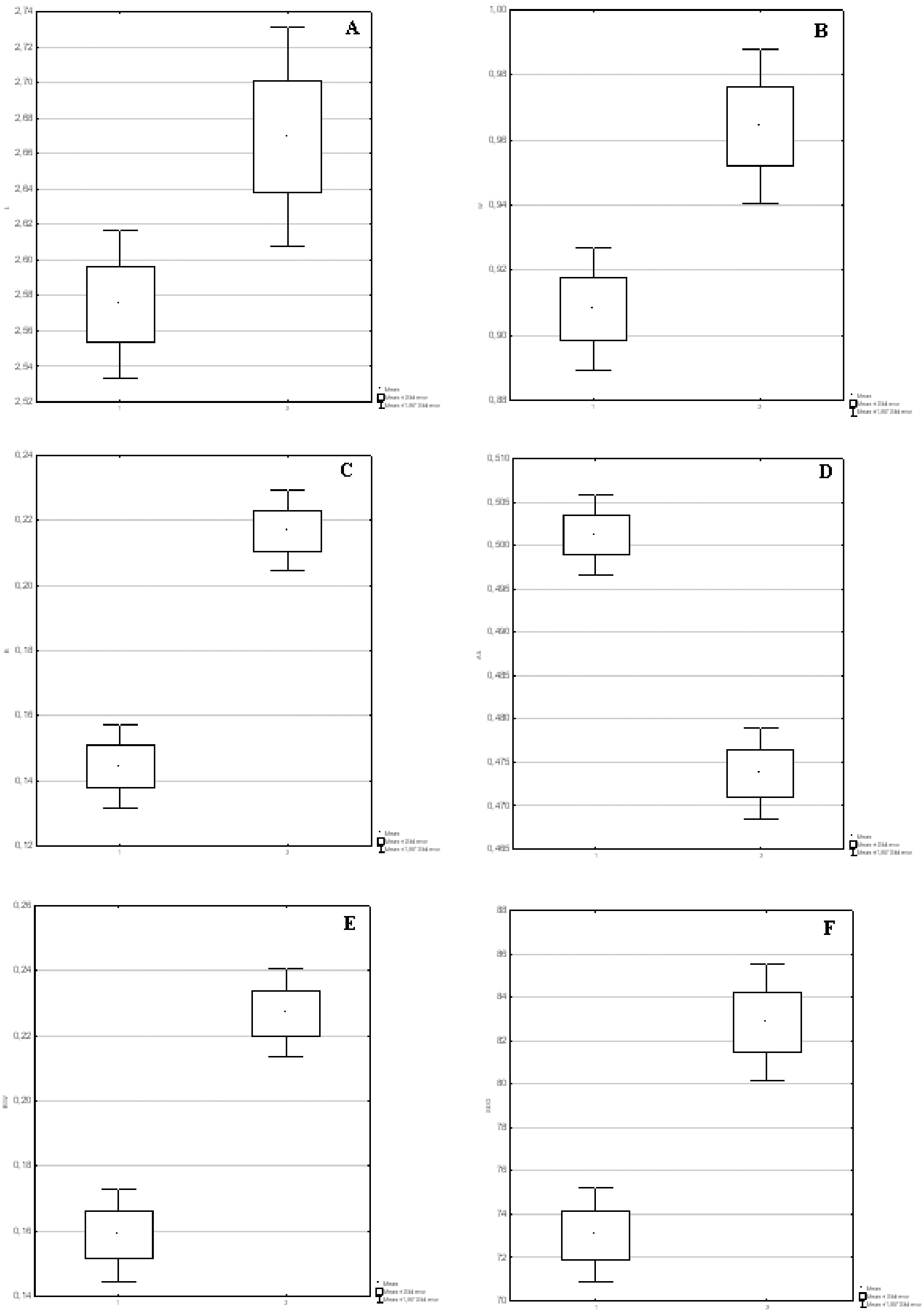

Fig. 1. Metric variability of m1 of *Microtus oeconomus* from Biśnik Cave. 1 — late Middle Pleistocene population, 2 — Late Pleistocene population, A — length of occlusal surface (L); B — van der Meulen (1973) measurement W; C — van der Meulen (1973) measurement B; D — A/L ratio, E — B/W ratio, F — mean values of the relative enamel thickness quotient (SDQ)

Metric analysis was performed on 60 m1 of the root vole from Biśnik Cave. The results of the analysis indicated the existence of statistically significant differences between populations from the late Middle and Late Pleistocene. Mean values of measurements of the maximum length of the occlusal surface (L) and the width of the anteroconid (W) have been lower in the late Middle Pleistocene (mean 2.58 mm and 0.91mm), and higher in the Late Pleistocene (mean 2.67 mm and 0.96 mm) (t-Student's test df = 57, p = 0.01 and t-Student's test df = 58, p = 0.000, respectively) (Fig. 1). The values of the B parameter increase from the late Middle Pleistocene (mean 0.14 mm) to the Late Pleistocene (mean 0.22 mm) (t-Student's test df = 59, p = 0.000). The mean value of the A/L ratio has been higher in the late Middle Pleistocene (0.5), and lower in the Late Pleistocene (0.47) (t-Student's test df = 57, p = 0.000). The ratio B/W increases in time (t-Student's test df = 57, p = 0.000). In the late Middle Pleistocene, the mean value is 0.16, and in the Late Pleistocene – 0.23. Mean values of the relative enamel thickness quotient (SDQ) indicate a statistically significant difference between the late Middle and Late Pleistocene (t-Student's test df = 60, p = 0.000). The mean of this index for teeth coming from the Middle Pleistocene has been lower (73.04) in comparison to the mean SDQ values from the Late Pleistocene (82.84) (Fig. 1). This trend is opposite to the trend observed in water vole *Arvicola amphibius* (Linnaeus, 1758) for which the mean values of the SDQ decrease in time.

The obtained results confirmed the presence of distinct morphometrical changes in m1 of the root vole from late Middle and Late Pleistocene. The observed differences may be used as biostratigrafic markers, which in connection with the abundance of this species in cave sediments enable an accurate stratigraphic correlation of deposits.

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P.P. Letunova[1, 2], N.V. Kulagina[3], O.G. Sharova[1, 2], E.V. Bezrukova[1, 2], A.P. Vinogradov[1]
[1] Institute of Geochemistry SB RAS, Irkutsk, Russia
[2] Institute of Archaeology and Ethnography SB RAS, Novosibirsk, Russia
[3] Institute of the Earth Crust SB RAS, Irkutsk, Russia
E-mail: letunova@igc.irk.ru

FOREST ECOSYSTEM HISTORY OF SOUTH EASTERN SIBERIA OVER THE HOLOCENE

Key words: Baikal region, current interglacial, woodlands, dark coniferous forests, light-needled trees

In spite of the fact that the Holocene climate sustained growth and development of modern society, there is still surprisingly little systematic knowledge on the Holocene environment and climate. Therefore it is highly important to concentrate our efforts on the study of our nearest past in order to understand natural environmental variability. To achieve this it is necessary to seek new and high-quality records of environmental dynamics over the current interglacial — Holocene.

The present paper discusses several fine-resolution, ^{14}C-dated pollen records of the Holocene environmental changes in south East Siberia. Since the boreal taiga forest currently is the predominant vegetation type in the Eastern Siberia the dynamics of wooden vegetation, particularly interrelation between its two basic dark- and light-coniferous complexes, can be considered in reconstructions as an indicator of the regional environment.

The subjects studied are situated on different shores of Lake Baikal or not far away from the lake. The majority of pollen records have been obtained from lacustrine sediments or from peat deposits. Diatom analysis of lacustrine sediments and peat botany studies were also applied to support reconstruction results based mainly on pollen data. All sediment sections were dated by either AMS or by conventional radiocarbon method. The Holocene lower chronological boundary in the south Eastern Siberia was identified by direct dating of palaeogeographic events recorded in the sediments of small lakes (Bezrukova et al., 2010). This boundary was dated as back as to 11.7–11.6 ky

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BP (thousand years before present) and corresponds well to its chronological level in the global stratotype from Greenland ice sheet and records from other regions (Walker et al., 2009).

Modern climate in the south Eastern Siberia is continental, and in several localities even as extra-continental. Forest (taiga) vegetation type where summer green (*Larix*), evergreen (*Pinus sibirica-Picea obovata-Abies sibirica*) and eurythermic conifers (*Pinus sylvestris*) along with leaf woody taxa *(Betula-Populus*) predominate. Steppe and forest-steppe are considered to be extra-zonal vegetation, and occupy small limited areas. Sub-alpine shrubby associations of *Pinus pumila, Duschekia fruticosa, Betula middendorfii* are typical in the upper mountainous vegetational belt at 1500 – 1800 m a.s.l.

North-eastern shore of Lake Baikal

Reconstruction of the environment and climate dynamics demonstrates that woody vegetation, consisting mainly of dark-coniferous spruce trees was available here already 13–11.5 ky BP. Persistent rising in light-coniferous forests of *Pinus sylvestris* and *Larix* and frequent fluctuations of forest vegetation in common were characteristic landscapes features between 11.5–6 ky BP. Several events of forest expansion occurred ~ 11–10, 9.5–8.5 7.5–6. ky BP in this area, while short periods of their reduction concentrated ca. 11, 9.8, 8.5, 7.5. and 6.5 ky BP. Since ca. 6.55 ky BP the trend in the light-coniferous forest accompanied by the dark-coniferous taiga persisted.

Lake Baikal north-western shore

Pollen record describing vegetation dynamics over the last 9.2 ky demonstrates forest predominating ca. 9.2–8, 7–6, 4.2–3.5 ky BP. Nevertheless, several short time spells centered around 7.5, 5.8, 4.5 ky BP reveal reduction in woody areas. Since ca. 7 ky BP a widening of the light-needled taiga forest started.

Lake Baikal southern shore

Persistent process of woody cover began here at ca. 10.5 ky BP being nearly simultaneous with gradual increase of the light-needled associations and reduction in the dark-needled once. Maximal spread of forest vegetation on the southern lake's shore took place ca. 7 – 3.5 ky BP.

Lake Baikal eastern shore

Substantial development of woody vegetation consisting of dark-coniferous *Picea obovata* and *Abies sibirica* trees occurred in this area 13–12.7 ky BP. Following reduction of forested areas took place between ca. 12.7 – 11.7 ky BP. Since ca. 10.5 ky BP the onset of stable trend in forest vegetation expansion and predominance was observed in regional pollen records. Light- and dark-coniferous pollen ratio values demonstrate the first Early Holocene maxima of the light-coniferous complex at ca. 10.5 – 9.5 ky BP, short time spell in its decrease and new expansion is observed since ca. 9 ky BP towards the present.

More detailed absolute dating results for the regional records along with better temporal resolution will allow resolving the problem of inter-regional correlation and understanding deeply the causes controlling environment dynamics in the south Eastern Siberia.

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G. Linke [1], M. Frechen [2]
[1] Geological Research Hamburg, Germany
[2] Leibniz Institute for Applied Geophysics, Hannover, Germany
E-mail: Gerhard.Linke@alice-dsl.de, manfred.frechen@liag-hannover.de

CORRELATION OF THE TOBOLIAN INTERGLACIAL (LOCATION KRIVOSHEINO/OB RIVER BANKS, NORTH OF NOVOSIBIRSK) WITH THE HOLSTEINIAN INTERGLACIAL (NORTHERN MIDDLE EUROPE), BASED ON ^{230}TH/U ACTIVITY RATIO, THERMOLUMINESCENCE MEASUREMENTS (TL), AND AMINO ACID RACEMIZATION

Key words: stratigraphy, pleistocene, absolute dating, northern Germany, West-Sibirian plain

Since the work of Gottsche, C. (1897) and Hallik, R. (1960), Hamburg is a classic region for the Holstein-research. The former proved its position as an independent Interglacial, the latter explained its position in relation to the Eemian by means of palynology. These deposits are widespread in the Hamburg area (125 sq km) and include a complete transgression sequence, up to the transgression maximum.

Early 80s was a reworking of this sedimentary sequence (Linke, 1983). As the result of which was the Hamburg area and the lower Elbe region, declared at a meeting of INQUA Sub-Commission for European Quaternary Stratigraphy, Hamburg as type region for the Holstein Interglacial.(Jerz, Linke, 1987).

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After a contact during the INQUA Conference Moscow 1982, a cooperation started with the Geological Institute Novosibirsk / Akademgorodok. It was the aim, to date the Siberian Tobolian and to clarify his relationship with regard to the Holsteinian. For this purpose the classical Tobol-Ob-shore outcrops north of Novosibirsk (Woronovo, Kireewckoe, Kosjulino, Vertikos, Krivosheino, Prochorkino) were visited on several expeditions and the last three localities sampled. The material was processed in Leibniz Institute for Applied Geophysics, Hannover, with the Uranium series dating ^{230}Th/U, with TIMS and OSL analysis.

Unfortunately, only Krivosheino was datable. The obtained ages vary between 209 and 248 ka. So the Tobolian corresponds to the Holsteinian at the site Hamburg-Dockenhuden Bo.qho4. and both Interglacials therefore correlate with MIS 7.

Today there are a number of Interglacial deposits on the territory of the Northern Germany pollenanalytical and numerically processed. They will be presented and discussed, together with the results of the qho4 research drilling and of Amino Acid treated Holsteinian molluscs, with regard to the Tobolian.

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P. Lomp[1], M. Rattas[2]
[1] University of Tartu, Department of Geology
Tartu, Estonia
[2] Tallinn University of Technology, Institute of Geology
Tallinn, Estonia
E-mail: pille.lomp@ut.ee

CARBONATE CEMENTS IN GLACIAL SEDIMENTS: IMPLICATIONS FOR PALAEOHYDROLOGIC CONDITIONS AND GLACIAL CHRONOLOGY

Key words: calcite cementation, micromorphology, Late Glacial, O–C isotopic composition, ^{14}C dating

Secondary carbonate precipitates occuring as a cement in primary unconsolidated glacial sediments can form either during glacial time or during subsequent non-glacial conditions by a variety of mechanisms that lead to dissolution and reprecipitation of carbonates. Carbonate cementation has been recorded from several places in Estonia, Latvia and Lithuania in glaciofluvial sand and gravel as well as in glaciolacustrine clay complex accumulated during the Late Weichselian deglaciation about 18–12 ka BP. Cementation is observed as laterally continuous layers, vertical piles/patches and small rounded or irregular concretions in otherwise unconsolidated sediments.

In coarser gravel matrix the cement occurs mostly as a carbonate crust or fringe (<1 mm) around the detrital grains, occasionally acting like a glue sticking clasts together. In finer sandy-silty facies the cement is distributed uniformly in the matrix filling almost overall intergranular porespace as a massive cement between coarser particles. The cement is exclusively composed of low-Mg calcite appearing angular equant to elongated rhombohedron and scalenohedral or prismatic calcite crystals from micrite (≤4 μm) to sparite (≥10 μm). Precipitation of micritic cement is often considered to be the first stage creating a substrate to successive cementation. The crystal size increases towards the centre of intergranular voids and micritic calcite rims grade into microsparitic and sparitic elongated crystals.

General successions of cementation often demonstrate a variety of textures, which would imply that the formation of cement can take place in changing, even at micro-scale, hydrologic and/or climatic conditions attributed to drainage, fluctuations in the water table and triggering mechanism of precipitation. The occurence of laterally cemented layers, vertical piles/patches and small concretions indicate different hydrologic conditions during the formation of the cement in each site. The cementation occurs in conditons of elevated

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supersaturation of water permeating through sediments. The precipitation of the cement could have taken place in a low-energy water-saturated phreatic environment, which is often supported by microsparite and sparite calcite crystals prevailingly forming the cement. Additionally, the cementation could be obtained to precipitating from infiltrated water permeating downward through the sediments or even from vertically upward flowing water if the water is under pressure and flowing upward toward a discharge area in the ground. Since there are no textural differences between cemented piles and adjacent unconsolidated sediments, seasonally frozen sediments or discontinuous permafrost has been discussed to be a factor influencing the water flow and formation of restricted cemented zones between frozen sediment sections.

The chemistry of cold-climate carbonates is controlled by the isotopic composition of the parent water from which calcite precipitation occurred and temperature at which the precipitation took place. The $\delta^{18}O$ values (-12,4 to -5,6‰ VPDB) of the cement indicate that the parent water does not directly represent the influx of glacial meltwater, but was more controlled by the $\delta^{18}O$ of groundwater, surface waters and meteoric water. More variable $\delta^{13}C$ values (-17,7‰ to -0,2‰ VPDB) of the cement indicate a mixture of various source of carbon and different precipitation mechanism, like dissolved atmospheric CO_2 or CO_2 degassing, dissolution of primary carbonates, evaporation and influence of organic matter.

The time of the precipitation of inorganic cold-climate carbonates could be determined by using radiocarbon dating method. Our studies attempt to estimate the time of carbonate precipitation and their relation to ice-marginal positions for using ^{14}C datings of secondary carbonates in the general chronology of glacier regression. Obtained radiocarbon datings of the cement show occasionally the relation with ice-marginal zones and precipitation close to the ice margin or little after the ice retreat. However, some ages are relatively older/younger compared to the ordinary datings of the ice-marginal positions. Older ages, especially in cements occuring in glacial deposits rich of carbonate debris, could have been affected by $^{12}C/^{13}C$ ratio of older carbon from the carbonate bedrock or by the dissolution of these bedrock carbonates. Significantly younger ages could be related to contamination by younger carbon in an open system.

Considering the sedimentary setting, micromorphology, isotopic composition and radiocarbon datings the precipitation of the carbonate cement probably occured in late glacial time close to the retreating ice margin or somewhat later in non-glacial contions in early Holocene. The solute-bearing waters from which the precipitation occured were enriched in light isotopes, probably mixed with meteoric and surface waters and somewhat affected by atmospheric and biotic factors. The spatial distribution of the cement forming piles, layers and concretions is attributed to specific hydrologic enivronment in limited areas either precipitation in low-energy water conditions or related to meteoric waters percolating in the sediments. The cementation is suggested to be a local process presumably controlled by local hydrologic conditions (water-level changes, water-driving processes, barriers to water flow) at relatively different time period in each studied site.

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E. Loseva
Institute of Geology, Komi Sci. Center, Ural Branch of RAS
Syktyvkar, Russia
E-mail: loseva@geo.komisc.ru

FOSSIL DIATOMS IN THE NORTH OF WESTERN URALS AND BOLSHEZEMELSKAYA TUNDRA

Key words: fossil diatoms, complexes, ecology, Western Urals, Bolshezemelskaya tundra

The authentic data on fossil diatoms are known from the Late Cretaceous.

The fossil diatom complexes of different age were discovered in the North of Western Urals and Bolshezemelskaya tundra beginning the Late Cretaceous. In contrast on the eastern slope of the Urals and Western Siberia, the information about distribution of Cretaceous deposits in this region is very poor and still less about diatoms of the same age.

The first mentions about possible inclusions of diatoms into Upper Cretaceous of Western Urals (Inta river) are found in the work of T.G. Ponomarev (1939). Later N.I. Strelnikova (1974) listed Cretaceous diatoms in Inta town region – marine species of Centrophyceae genera *Melosira* (*Paralia*), *Stephanopyxis* (*Costopyxis, Pyxidicula*), *Coscinodiscus*, *Triceratium, Hemiaulus*, *Goniothecium, Gladius*, *Pterotheca,* etc.

The authentic Palaeogene deposits in the region are rare too. The diatom complexes are known in few locations – in the Kara (Paj-Khoj), Laya (Bolshezemelskaya tundra), Lemva (North of Western Urals) rivers basins, in accordance with G.K. Shibkova, T.F. Kozyrenko, T.A. Afanasjeva, T.V. Oreshkina. There are many species common with Cretaceous. Characteristic are specimens of genera *Paralia*, *Coscinodiscus*, *Stephanopyxis*, *Hyalodiscus*, *Pyxilla, Grunowiella* (*Sceptroneis)*, *Pyxidicula*, *Craspedodiscus, Brightwellia,* etc.

The Pleistocene deposits are in the region everywhere. The diatom assemblages from these deposits, marine and freshwater, were studied in many sections (Loseva, 1992, 2000). Diatom composition in the sections depends first of all on the forming conditions, but not of the deposit's age, as soon as the diatoms changed very few in structure and valve morphology during Pleistocene

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(about 2 million years). Usually the age of the deposits is determinated thanks to another methods and to complexes stratigraphical position.

The most ancient Pleistocene (Eopleistocene) marine assemblages were found in the marine 'Kolva' Suite in the Bolshezemelskaya tundra (Pechora, Shapkina, Kolva river basins). They combine more than 200 taxa, 75% from which are the inhabitant of littoral and neritic marine zones. The Centrophyceae genera *Paralia, Thalassiosira, Chaetoceros, Raphoneis, Actinoptycus,* etc. are prevalent by numbers. The sublittoral bottom-planctonic (semi-benthic) *Paralia sulcata* (Ehr.) Cl. is the most abundant. The planktonic-oceanic *Actinocyclus curvatulus* Janish, *A. ochotoensis* Jousé, *Thalassiosira nidulus* (Temp. et Brun) Jousé, the neritic *Thalassionema nitzshioides* (Grun.) Hust. and the epiphytic *Raphoneis rhombica* (Grun.) Andrews are estimated as 'very frequent'.

The freshwater complexes of the same age are described in Kara (Paj-Khoj) and Moreyu (near the Khajpudyrskaya inlet) river basins. They combine about 450 Quaternary taxa whis several Pliocaene species. The Centrophyceae genera (*Aulacoseira, Cyclotella, Stephanodiscus*) and Pennatophyceae (*Fragilaria, Navicula, Achnanthes,* etc.) are prevalent by numbers (especially *F. brevistriata* Grun.) Species *Aulacoseira granulata* (Ehr.) Sim., *Stephanodiscus hantzschii* Grun., *Achnanthes lanceolata* (Ag.) Ehr., and others dominate too.

Middle Pleistocene marine diatom assemblages were studied in Middle Timan. They combine about 330 taxa, 73% from which are marine species. The Centrophyceae genera *Paralia* (*P. sulcata,* and others), *Detonula* (*D. confervacea* (Cl.) Gran, Pennatophyceae *Thalassionema* (*T. nitzschioides*), *Navicula* (*N. distans* W. Sm., and others), etc. dominate. The freshwater assemblages of the same age are studied from near the Khajpudyrskaya inlet region (Moreyu river) and Bolshezemelskaya tundra (Shapkina and Pechora river basins). They combine more than 340 taxa. Dominants are the Centrophyceae *Aulacoseira distans* (Ehr.) Sim., Pennatophyceae *Tabellaria flocculosa* (Roth.) Kütz., etc.

Upper Pleistocene diatom assemblages were studied from the lower Shapkina river. Here downstairs of section a mixed flora with more than 110 taxa was found, one third of which is marine and brackish. Semi-benthic *P. sulcata* and benthic *Delphineis surirella* (Ehr.) Andrews, *Nitzshia navicularis* (Bréb.) Grun., *Raphoneis amphiceros* Ehr., *Diploneis interrupta* (Kütz.) Cl. dominate, as soon as higher only freshwater complex was found. It contains 230 taxa. *Hantzschia amphyoxys* (Ehr.) Grun., *Neidium affine* (Ehr.) Pfitzer, *Pinnularia viridis* (Nitzsch) Ehr. *Stauroneis phoenicenteron* Ehr., and others dominate.

As a whole, Pleistocene marine and freshwater diatom florae in the North of Western Urals and Bolshezemelskaya tundra consist of more than 900 taxa and characterize all interglacial horizons. Glacial horizons contain only redeposited fragments of ancient, mainly Palaeogene marine, diatom frustules.

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D.G. Malikov
National Research Tomsk State University
Tomsk, Russia
E-mail: knight_1991@mail.ru

THE LARGE MAMMALS OF NORTH-MINUSINSK BASIN IN THE LAST GLACIAL PERIOD

Key words: large mammals, biodiversity, North-Minusinsk basin, Last Glacial period

The North-Minusinsk basin is located in the south central Siberia, boundaries of the basin are Eastern Sayans (in the east), Kuznetsky Alatau (in the west), Batenevsky (in the south) and Solgonsky (in the north) hills (Fig. 1). The region is the part of the zoogeographical border between the Western and Central Siberian subdomains of Euro-Siberian domain (Rogacheva, 1988). For this reason, the region has repeatedly been studied by various scientists (e.g. Gromov, 1948; Vangengeim, 1977; Kuzmin, 2011), but full-fledged research on Quaternary mammalian fauna has not yet been conducted. At present time the generalized species composition of Pleistocene mammals in the region has not been published. To solve this problem N.D. Ovodov (2009) described species composition of mammals in Karga stage (59 000–24 000 y.a.) on the basis of cave sites with the Khakass republic territory. However, these data are also insufficient.

In the North-Minusinsk Basin there are many sites containing the mammalian remains at Sartan age (24 000–11 000 y.a.). These sites are both alluvial and Paleolithic sites. In this abstract the list of large mammals species from these sites is given. Based on the analysis of published data (Abramova, 1979; Ovodov, 1992; Motuzko et al., 2010; Kuzmin, 2011), the fauna is set, the author date included as well (the collections of paleontology museum of the Tomsk State University and zoological museum of the Khakass State University).

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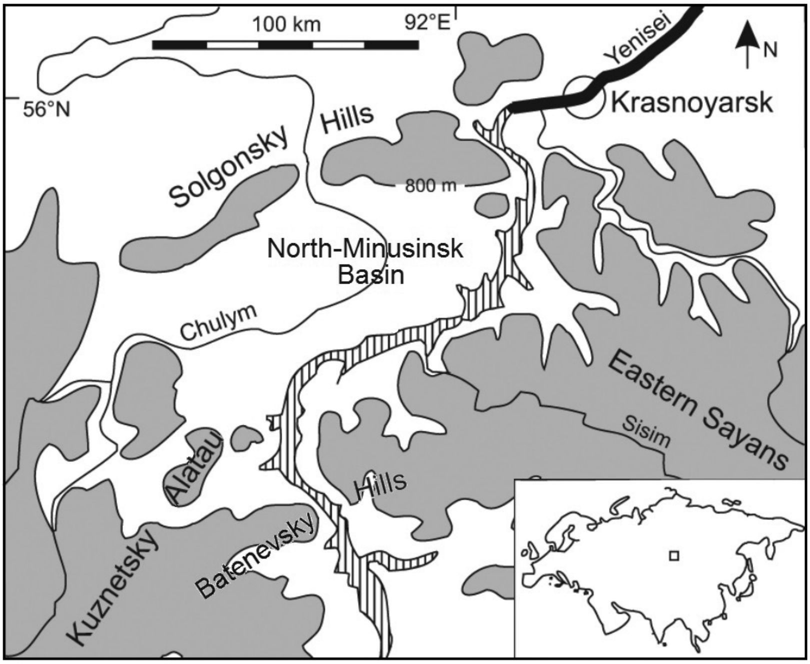

Fig. 1. North-Minusinsk basin in the map of Eurasia

Currently there exist 27 species of large mammals that lived in the region during the Sartan age. These mammals are related to 6 Orders (marked with the sign "†" are species that don't inhabit the region at the time being): Lagomorpha – *Lepus tolai*†, *Lepus tanaiticus*†; Rodentia – *Marmota baibacina*†; Carnivora – *Canis lupus*; *Alopex lagopus*†; *Vulpes vulpes*; *Ursus arctos*; *Ursus savini rossicus*†; *Gulo gulo*; *Meles meles*; *Crocuta spelaea*†; *Panthera spelaea*†; Proboscidea† – *Mammuthus primigenius*; Perissodactyla† – *Equus* ex gr. *germanicus-gallicus*; *Equus hemionus*; *Equus ovodovi*; *Coelodonta antiquitatis*; Artiodactyla – *Sus scrofa*; *Cervus elaphus*; *Capreolus capreolus*; *Megaloceros giganteus*†; *Alces alces*; *Rangifer tarandus*; *Bos* sp.†; *Bison priscus*†; *Saiga borealis*†; *Ovis ammon*. The dwelling of other five species during of this period is still controversial – *Cuon alpinus*, *Uncia uncia*, *Otocolobus manul*, *Moschus moschiferus* and *Ovis nivicola*.

At the turn of the Pleistocene-Holocene in the most parts of the boreal zone there was a crisis of mammoth steppe ecosystem. As a result, in the mammalian fauna the drastic restructuring happened – the most part of big herbivore either became extinct, or their distribution and abundance decreased to a minimum. The territory of the North-Minusinsk Basin is not exception. Of the 10 species of order Artiodactyla that inhabited this area in the Last Glacial period, up to the present only 6 species surrived (though occasionally there are 3 species), of 9 species of Carnivora only 5 conserved (4 species are scarce). Representatives of the two orders – are Proboscidea and Perissodactyla is totally extinct.

A characteristic feature of all extant species is dwelling in forest and mountain taiga landscapes (Sokolov, 1979; Vasilchenko, Smirnov, 2010), while in the steppes landscapes a hare is the largest, wild herbivorous animal.

The modern fauna of large mammals of the North-Minusinsk Basin has lost its Pleistocene shape. Many species of steppe habitats became extinct, while the majority of the forest mammals survived through the Pleistocene-Holocene boundary. Most likely it is caused by the change of landscape-climatic conditions in the neighboring regions, which led to the disruption of migration routes of animals. Steppe plant communities that have survived in the basin at present (Kuminova, 1976), were not able to maintain the stability of the mammoth fauna.

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A. Markova
Institute of Geography RAS, Moscow, Russia
E-mail: amarkova@list.ru

EUROPEAN SMALL MAMMAL FAUNAS DURING THE END OF EARLY PLEISTOCENE – THE BEGINNING OF THE MIDDLE PLEISTOCENE

Key words: small mammals, Early Pleistocene, Middle Pleistocene, Europe, evolution, correlation

Several stages in small mammal development were distinguished in European small mammal faunas correlated with the end of Early Pleistocene (the end of Matuama palaeomagnetic Epoch) and the first half of the Middle Pleistocene (1,07 –0,70 ma).

Small mammal faunas correlated with Jaramillo palaeomagnetic (1,07–0,99 ma) event includes remains of *Mimomys savini, M. pusillus, Clethrionomys sokolovi,* advanced *Allophaiomys*, *Borsodia fejervaryi, Prolagurus pannonicus, Lagurodon arankae* and *Eolagurus argyropuloi*. The presence of archaic representatives of endemic genus *Iberomys (I. huescarensis)* were characteristic to Iberian faunas of this interval. It is important to mention, that in the faunas steadily correlated with the Jaramillo palaeomagnetic event were not found the voles of *Terricola, Stenocranius* and *Pallasiinus* genera. The Eastern European faunas of this evolution level were desribed as **Kairian (=Ostrogozhskian)** faunas of small mammals (Markova, 2007). In Western Europe the similar faunas are compared with Biharian, with the "Colle Curti" phase in Italy and with the "*Allophaiomys lavocati"* stage in Spain (Masini, Sala, 2007, Cuenca-Bescós et al., 2012) (Fig. 1).

The next phase presents the faunas with the first representatives of subgenera *Stenocranius (S. hintoni*) and *Microtus (Terricola*) sp. The core of these faunas constitutes from *Mimomys savini, M. pusillus* and *Allophaiomys pliocaenicus nutiensis*. By the materials of Eastern Europe these faunas were described as **Morozovkian** faunas (Alexandrova, 1976, Markova 1998). Their localities are in the Matuama Epoch. Possibly, the fauna of Untermasfeld (Germany) with the primitive vole *Microtus thenii* (Maul, 2001) could be correlated with Morozovkian one or even with more evolved faunas.

More advanced faunas were distinguished by the first appearance of *Microtus* ex gr. *oeconomus (=M. ratticepoides*). The core of these faunas includes steppe and yellow lemmings *Prolagurus pannonicus* and *Eolagurus argyropuloi* and *Microtus (Stenocranius) hintoni*. Also a few *Mimomys savini* and *Allophaiomys pliocaenicus nutiensis* remains were found in these faunas. These faunas correlated with the end of Matuama and were described as **Petropavlovkian** ones (Alexandrova,

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1973, Markova, 1998). These faunas are close to Trichera Dolina (TD5-TD6 layers) one in Atapuerca region (Spain) (Cuenca-Bescós et al., 2001).

The faunas with the first appearance of *Microtus arvalinus* and *Prolagurus posterius* (Shamin locality, Markova, 1992) are also correlated with the very end of Matuama. These faunas close to Early **Tiraspolian** ones in Eastern Europe and to many Western European faunas such as Kärlich C in Germany (Kolfschoten, Turner, 1996), Sant-Arcangelo in Italy (Masini et al., 2005), El Chaparral in Spain (López-García et al., 2012) and others.

The rooted voles of *Mimomys* genus are also presented in the localities correlated with the beginning of Brunhes normal magnetic Epoch. The steppe lemmings are presented in this interval by *Prolagurus posterius* and *P. pannonicus*. More significant quantity of *Microtus* species is characteristic to this time.

The first appearance of new species was more or less synchronous in Western and Eastern Europe. However we have the difficulties with correlation of Eastern and Western European faunas, because the representatives of *Prolagurus* – *Lagurus* linage (which are very important for Eastern European biostratigraphy) are practically absent in Western Europe. Only palaeomagnetic data together

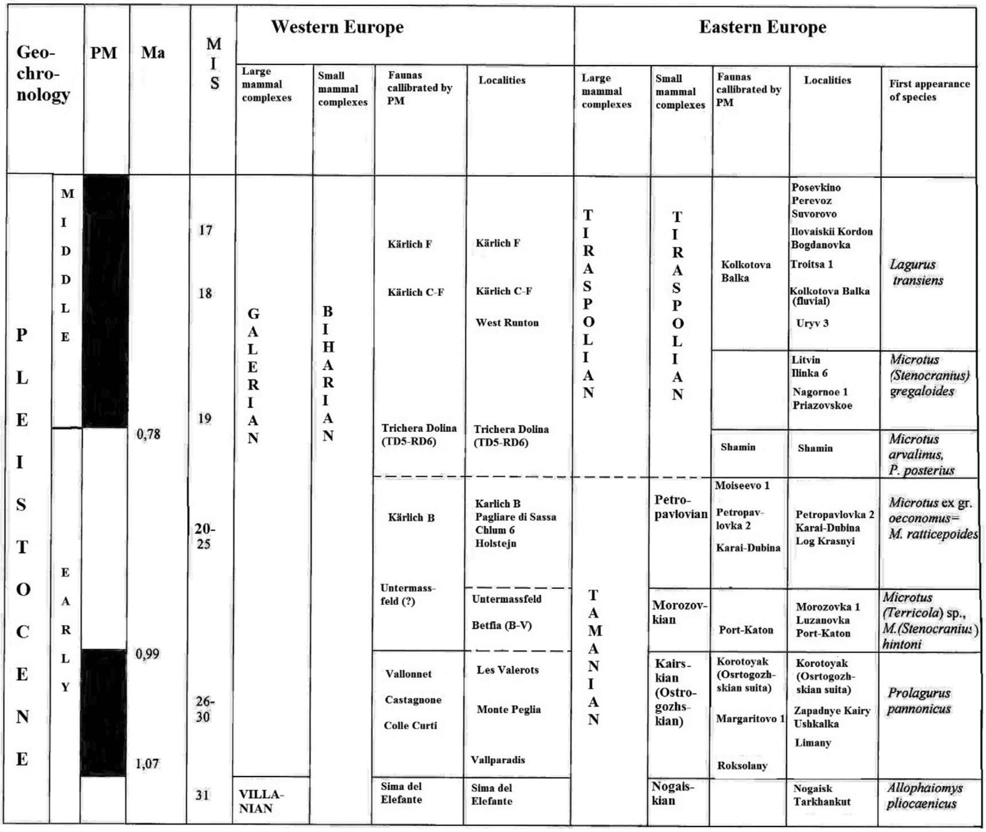

Fig. 1

with small mammal materials can help with the distinguishing of the age of the localities. The morphological diversity of *Allophaiomys* teeth which widely used by Western and Eastern European palaeontologists is very important. However sometimes the localities with very few remains of this species compared against each others what could be resulted in wrong conclusions.

Analysis of Early — Middle Pleistocene small mammal remains, particularly Arvicolinae, gives the unique material, which helps to elucidate the evolution in different phylogenetic lineages, to date the deposits which includes the bone localities (what is very important to this interval for which practically unknown absolute dates), to compare the faunas from the different region of Europe and also to help to reconstruct the paleoenvironments.

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E.A. Markova[1], *T.V. Strukova*[1], *A.V. Borodin*[1, 2]
[1] Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
[2] Institute of Natural Science, Ural Federal University
Ekaterinburg, Russia
E-mail: e.markova@ipae.uran.ru

SMALL MAMMALS AS INDIRECT BIOTIC MARKERS FOR CLIMATE DYNAMICS ASSESSMENT IN THE CENTRAL PART OF NORTHERN EURASIA

Key words: Micromammals, palaeoecology, Late Pleistocene, Holocene

We summarize the clues which the micromammal fossil record offers to climate-driven biotic shifts in the central part of northern Eurasia during the Late Pleistocene — Holocene and give some results of neontological studies aimed to increase the quality of palaeoecological reconstructions based on small mammals. Spatial and temporal dynamics of environmental conditions in the central part of northern Eurasia from the Late Pleistocene to the present day is considered on the basis of the analysis of micromammal assemblages from about 60 cave sites in the Polar, Northern, Middle and Southern Urals (see Borodin et al., 2013 for the list of localities). Comparisons to the present-day fauna are made using the zoological specimen database (museum of the Institute of Plant and Animal Ecology UrB RAS). In this study we primarily focus on arvicoline rodents because of their wide distribution, high abundance and the most complete fossil record in the study area (as compared to other micromammal groups).

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During the time span chosen for analysis the arvicoline fauna of the study area has been represented by living species. To establish ecological groups of arvicolines (17 species known in the study area from the Late Pleistocene to the present day) we undertake an analysis of ecological requirements across the species' ranges (thermoneutral temperature intervals, dietary adaptations, and habitat requirements for nesting, breeding, survival and dispersal — based on published data) and compare the results to the existing classifications of arvicolines used for palaeoecological purposes. Physiological data suggest that intraspecific variability of thermoneutral zones, effectiveness of thermoregulatory mechanisms and similarity of critical temperatures among the arvicoline species make it not possible to use temperature features for palaeoecological inferences. Ecological data suggest that across the modern ranges the most stable (conservative) requirements of arvicolines are the characteristics of nesting and breeding microhabitats, which could be described in terms of humidity and vegetative cover. For some species, dietary adaptations might be used to specify the vegetative cover (when a particular plant group is known to limit the distribution or seasonal survival of a species). The 17 arvicoline species might be considered as indicators of 10 types of microhabitat, which differ by humidity, openness and vegetative cover (Fig. A8, Appendix 7).

To reveal the spatio-temporal variability of the microhabitat conditions in the Southerm, Middle, Northern and Polar Urals we calculate the occurrence of the microhabitat groups of arvicolines in the fossil datasets (divided into the Early, Middle and Late Holocene subsets) and in the modern dataset represented by the live trapping data for the last 50 years (about 350 capture locations). Only presence-absence data are used for analysis; relative frequencies and repeated sampling data are excluded from consideration to avoid biases related to sampling effort.

The figure shows that in the Urals from the Early Holocene to the present the proportion of mesophyte habitats (the species of both open (groups 4–5) and closed habitats with arboreal vegetation (groups 6–7)) has significantly increased. The proportion of species related to open wet habitats (group 1) shows a slight increase towards the present day, whereas the proportion of the inhabitants of open xeric habitats (groups 8–10) has drastically decreased. The figure also illustrates a steep decline in the abundance of the species related to moss-cover (group 3).

The results presented here confirm that arvicoline rodents may serve as indirect markers of climate-driven biotic shifts in time and space and clarify the biotic parameters, which might be reconstructed based on the ecological requirements of the modern species. Novelty of the approach is determined by setting the classification criteria narrower than usual. Biome affinities (e.g. 'tundra species', 'steppe species') and direct interpretations of the preferred climatic variables (e.g. 'cold-loving species') are excluded from the classification in favor of the direct microhabitat characteristics related to a combination of humidity and vegetative land cover, which limits the present-day distribution or survival of a particular species.

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L. Marks[1, 2], *D. Gałązka*[1], *B. Woronko*[2]
[1] Polish Geological Institute – National Research Institute
Warsaw, Poland
[2] Department of Climate Geology, University of Warsaw
Warsaw, Poland
E-mail: leszek.marks@pgi.gov.pl

STRATIGRAPHY OF THE LAST PLEISTOCENE GLACIAL PERIOD IN POLAND

Key words: Weichselian, climate, ice wedges, Glacial episodes, loess, Poland

Interpretation of climate change during the last glacial stage of Late Pleistocene in Poland has been mostly focused on glacial/periglacial phases and intervening warmer episodes (interstadials) indicated mostly by fluvial deposits or rarely, by biogenic sediments. Much less climatic information has been known for the most severe episodes of Early and Middle Vistulian (Weichselian) in a non-glacial area. It has not been until recently when this information gap started to be partly filled up with substantial data. In general, the last glacial stage in Poland has been traditionally subdivided into two cold intervals (Lower and Upper Plenivistulian, roughly corresponding to MIS 4 and 2), preceded by Early Vistulian (MIS 5d-a) and separated by Interplenivistulian (MIS 3), the last one characteristic for its milder but instable climatic conditions.

The most complete sequence of deposits of the last glacial stage is best known from the Lower Vistula valley region that is a type area of the Weichselian in Europe. In this region the Eemian marine deposits (MIS 5e) are overlain by 4–5 tills that have been ascribed to different glacial phases within the last cold period. Based on recent investigations most widespread of these glacial episodes were correlated with Late Weichselian Glaciation, comprising Leszno (Brandenburg), Poznań (Frankfurt) and Pomeranian ice sheet advances and dated at 24, 20 and 16 ka BP respectively (Marks, 2012). They were preceded by

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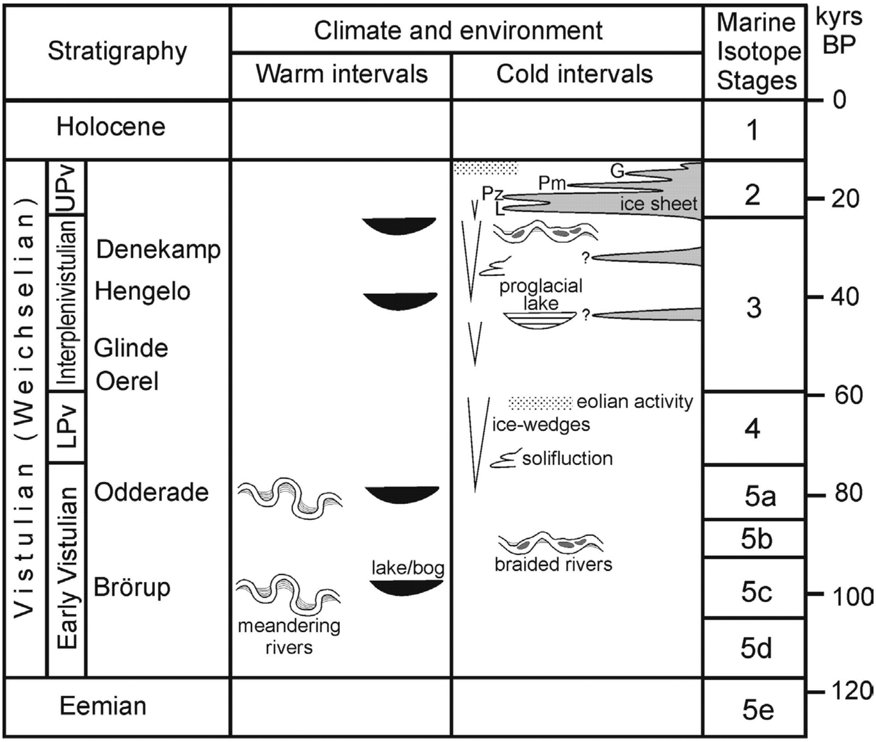

Fig. 1. Vistulian (Weichselian) stratigraphy, climate and environmental changes in Poland; LPv — Lower Plenivistulian, UPv — Upper Plenivistulian; glacial phases: L — Leszno (Brandenburg), Pz — Poznań (Frankfurt), Pm — Pomeranian, G — Gardno

limited ice sheet advances at about 29–35 ka BP and presumably also 45–50 ka BP. The latter is indicated by a huge series of ice-dam lake sediments of the so-called Chełmno Clays in the vicinity of Grudziądz in the Lower Vistula valley region.

Loess-soil sequences of southern Poland supply with most complete information on climate change during the Vistulian (Jary, 2007). Horizons of periglacial structures record extreme climatic conditions (more severe eastwards) or/and their rapid changes, therefore they can be, similarly as paleosoils, local or regional stratigraphic markers, making correlation with a deep-sea record possible. In the Upper Plenivistulian there are several depositional cycles in loess, indicated by gradual or rapid passing of coarse-grained loess into a finer-grained one. It was found that severe climatic conditions were responsible for relatively high deposition rate of coarse-grained loess. During warmer episodes aeolian accumulation was small, limited to fine-grained loess, whereas initial pedogenesis resulted in development of poor gleyey horizons.

The post-Eemian non-glacial sequence in northern Poland is indicated by fluvial activity characteristic at first for temperate climatic conditions and expressed by floodplain and ox-bow lake deposition, interrupted occasionally by deposition of anastomosing rivers of a cool climate (Marks et al., 2014). The following, more severe climatic conditions with low temperatures and decreased precipitation could initiate intensive aeolian processes (Rychel et al., 2014) and most probably, they were connected with aggradation of permafrost that started to be stable at -5.5º to -8ºC. Such very cold episodes were replaced occasionally by wetter ones, when vast solifluction could be stimulated in a thick seasonal active layer in a superficial layer of permafrost. The solifluction moved down-slope huge amounts of surficial deposits that had been earlier transformed in periglacial environment. In eastern Poland such soliflucted deposits have been cut with two generations of ice wedges (Dzierżek & Stańczuk, 2006), characteristic for severe subarctic conditions (Woronko et al., 2013) as ice-wedge polygons in a coarse substrate develop at mean annual temperatures below -8 to -6ºC (Péwé, 1966). Initial sand infilling of the older generation of ice wedge casts was TL-dated to 49±7 to 43±7 ka (Heinrich event H5). This event could correspond to Middle Vistulian ice sheet advance in northern Poland, expressed by widespread glaciolacustrine deposition of the Chełmno Clays in the Lower Vistula valley region. Sand infilling of the second ice wedge generation was TL-dated to 23±4 ka that fitted to the Last Glacial Maximum (Heinrich event H2). Milder climate during the interval between these two periglacial episodes was represented by a fluvial environment. Final termination of the Late Pleistocene was expressed by aeolian depositon that terminated close to the Pleistocene/Holocene boundary.

Summing up, the climate of the last Pleistocene glacial period in Poland has been significantly influenced by development or decay of the Scandinavian ice sheet. The climate was not stable, with numerous warmer and cooler episodes of varying magnitude. Early Vistulian has been indicated by fluvial activity characteristic for temperate climate and expressed by floodplain and ox-bow lake deposition. Such temperate river activity could be interrupted occasionally by deposition of anastomosing rivers, active in a cool climate. The following, more severe climatic conditions with low temperatures and decreased precipitation were most probably connected with aggraded permafrost and could initiate intensive aeolian processes and development of ice wedges. They were interrupted by more wet episodes and seasonal development of an active layer in a ground when solifluction moved down-slope huge amounts of surficial deposits that had been transformed earlier in a periglacial environment.

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A. Nadachowski[1], *G. Lipecki*[1], *U. Ratajczak*[2], *K. Stefaniak*[2], *P. Wojtal*[1]

[1] Institute of Systematics and Evolution of Animals, Polish Academy of Sciences Kraków, Poland

[2] Department of Palaeozoology, Institute of Environmental Biology, Wrocław University Wrocław, Poland

E-mail: nadachowski@isez.pan.krakow.pl

DISPERSAL EVENTS OF SAIGA ANTELOPE (*SAIGA TATARICA*) IN CENTRAL EUROPE IN RESPONSE TO THE CLIMATIC FLUCTUATIONS IN MIS 2 AND THE EARLY PART OF MIS 1

Key words: climate change, Saiga, migrations, LGM, Late Glacial

Saiga (*Saiga tatarica*), which today is a specialist steppe herbivore adapted to long-distance migrations in massive herds, appeared at irregular intervals in Late Pleistocene Europe. Palaeontological evidence indicates that *Saiga tatarica* belongs to the so-called "*Mammuthus—Coelodonta*" faunal complex (Kahlke, 1999) confirmed by the fact that its most extensive geographical distribution occurred within the Last Glacial period (Kahlke, 2013). The taxonomic status of Pleistocene saiga is still widely debated (e.g. Baryshnikov and Tikhonov, 1994; Khalke, 1999; Campos et al., 2010). According to Baryshnikov and Tikhonov (1994) the Late Pleistocene saiga is a distinct species *Saiga borealis* which includes the living subspecies *S. b. mongolica* that inhabits Western Mongolia.

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Another recent species is *Saiga tatarica* present in Kalmykia (south Russia), Kazakhstan and NW Uzbekistan. However, analyses of mitochondrial genetic diversity suggest that the Late Pleistocene *S. borealis* does not constitute a distinct species (Campos et al., 2010) in spite of some morphological differences in the skull (Baryshnikov and Tikhonov, 1994).

The special ecological requirements of this antelope limited the number and timing of dispersal events. Seasonal migrations and dispersal events depend on availability of food in summer and the thickness of snow in winter as they are unable to cope with even moderate snow cover (Bannikov, 1961). Saiga antelopes are plains animals, non-territorial and nomadic, gathering in massive herds of many thousands before migrations.

In the Late Pleistocene saiga never colonized the southern parts of the Balkan Peninsula, nor did they reach the Apennine and Iberian Peninsulas, because the mountain ridges of the Carpathians, Alps and Pyrenees acted as barriers to further southward migrations. During the Weichselian Inter-Pleniglacial (MIS 3) there are no dated records of saiga in Central Europe. The absence of the species in this interval is surprising especially as *Saiga tatarica* was present in Western and Central Europe during the Saalian Complex (Kahlke, 1992). The absence of records can be partly explained by insufficient sampling or saiga migration routes that avoided the area, e.g. south of the Carpathians. However, in general the factors restricting its range in MIS 3 remain unclear.

In MIS 2 and the Late Glacial saiga was able to colonize Central Europe at least three or four times and Western Europe at least twice. As indicated by direct dating, during Late Glacial Maximum (LGM), especially the extreme stadial phase of GS-3 (Svensson et al., 2006), saiga antelope is entirely absent from Central Europe. The initial migration of *Saiga* into the eastern part of Central Europe is recorded around GI-2 (ca. 23.5 – 23.0 cal ka BP), a relatively mild but short period. The three direct dates obtained for this study from Mamutowa and Deszczowa Caves in Poland coincide with the GI-2 warming. The most successful second migration dates to a relatively mild period, the post-LGM Greenland Stadial-2b, from ca. 19.0 to 16.0 cal ka BP when saiga reached southern France (Dujardin and Tymula, 2005; Castel et al., 2010) and northernmost Spain (Alvarez-Lao and Garcia, 2010). In the studied area this migration event is recorded at three sites (Jasna, Stajnia and Komarowa Caves) from ca. 16.7 to 16.1 cal ka BP, at the end of the Pleniglacial, coinciding with the rise of temperature at around the GS-2b – GS-2a transition. During the last Pleniglacial cooling (GS-2a), before the abrupt warming GI-1e in the Late Glacial, saiga withdrew from the area for the second time.

The Late Glacial began with an abrupt increase of temperature from ca. 14.7 to 14.0 k cal a BP during, the GI-1e interval (Bølling) (Steffensen et al., 2008). This important climatic change remodelled plant and animal communities. Mammoths finally withdrew from the area north of the Sudetes and Carpathian mountains (Nadachowski et al., 2011) whereas other species survived, in reduced numbers, or only temporally withdraw to refugial areas. Saiga antelope belongs to the last category. During Greenland Interstadial-1d (Older Dryas), ca. 14.0 cal ka BP, saiga reached England (Hedges et al., 1989).The return of saiga to eastern Central Europe is confirmed by the Słupianka record, during the short cold period around 14.0 k cal a BP (GI-1d), between the Bølling and Allerød. In the first part of the Allerød (GI-1c_3) saiga once more seems to have reduced its range. The last immigration event (recorded from Maszycka Cave) took place in the next cooling phase within the Allerød, ca. 13.5 cal ka BP (GI-1c_2). It appears that saiga was not able to widen its range to the west during the Younger Dryas (GS-1), the last cold phase of the Pleistocene, in spite of development of vegetation cover suitable for this herbivore. However, the evidence from early part of MIS 1(Late Glacial) needs further studies, since it may just be an absence of data.

In MIS 2 dispersal events of saiga took place in warmer intervals while in the Late Glacial they occurred only during cooler episodes.

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O. Nekrasova[1], *A. Uchaev*[1], *M. Dergacheva*[2, 3]

[1] Ural Federal University named after the First President of Russia B. N. Yeltsin
Ekaterinburg, Russia
[2] Institute of Soil Science and Agrochemistry of Siberian Branch
of Russian Academy of Sciences
Novosibirsk, Russia
[3] Biological Institute of Tomsk State University
Tomsk, Russia

E-mail: o_nekr@mail.ru

SOME CHARACTERISTICS OF BATURINO QUARRY BURIED LATE HOLOCENE SOIL (SOUTHERN URALS, RUSSIA)

Key words: paleoenvironmental reconstructions, Late Holocene, Southern Urals, buried soil, forest-steppe

In order to understand in what direction the modern natural environment will change, it is necessary to know its previous trend, especially in the Holocene period, as at this particular time there was a final formation of flora and fauna modern status and a rapid development of human society. The border location of the Urals concerning the climate makes paleoclimate research in this territory especially topical.

Object of research is Late Holocene soil, covered by a modern embankment of Baturino quarry (Southern Urals) formed on lake sediments. Average air temperature of the coldest month of the object arrangement's territory is equal to minus 16ºC, the warmest one – to plus 18–19ºC. The sum of active air temperatures is about 2000ºC. Average annual air temperature of the area is equal to 1,4ºC. The annual amount of precipitation varies from 410 to 450 mm. The listed characteristics correspond to the climate of the forest-steppe zone.

The presence of all characteristic horizons ([A]–[AB]–[B]–[BC]), humus horizon depth equal to 25 cm and the depth ratio 1:1 of horizons [A] and [AB] allow attributing this soil to the chernozem series. The results of analysis of soil particle size distribution revealed redistribution of silt fraction in soil profile

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and its accumulation in the upper part of the horizon [B]. Soil sampling was done every 7–10 sm in boarder of visible horizons.

Humus horizon is uniformly saturated with organic carbon, which contain is about 3.5%, it corresponds to the high-level accumulation. Its content is reduced to 0.15% down the soil profile.

The maximum value of the magnetic susceptibility falls on humus horizon (2.72×10^{-6} SGSE/g), the minimum – on the horizon [BC] (1.09×10^{-6} SGSE/g). Magnetic susceptibility values correlate with the content of total organic carbon in the upper 75 cm of the soil layer. Their decreasing character diagnose its automorphic soil formation conditions.

The carbonate content in the buried humus horizon is 2.3–2.5% in the underlying thicker they accumulated 5–8 times more. A maximum of carbonates is in the horizon [B].

pH of the aqueous extract of buried soil increases with depth. In the humus horizon they have maximum values 6.34–6.61, the reaction of the soil solution lower sequence profile is in the area of alkaline values (8.32–8.88).

Compared with modern zonal soils territory location of the quarry buried soil has the higher content of magnesium in soil absorbing complex. Probably it is connected with the hydromorphism process in the past, contributing to increasing the share of Mg^{2+} in the structure of exchange cations.

Based on morphological and physical-chemical characteristics of Baturino quarry buried soil it can be assumed that it functioned actively in the forest-steppe conditions, in favor of which the presence of all emerging in these conditions horizons, the redistribution of silt in soil profile and the position of the maximum accumulation of carbonates indicate. Further investigation of humus and humic acid characteristics of this soil will allow for a more detailed natural environment paleoreconstruction of its functioning period with the help of pedohumus method (Dergacheva, 1997).

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P.A. Nikolskiy[1], V.V. Titov[2], A.S. Tesakov[1], I.V. Foronova[3], V.S. Baygusheva[4]
[1] Geological Institute, Russian Academy of Sciences
Moscow, Russia
[2] Institute of Arid Zones
Rostov-on-Don, Russia
[3] Sobolev Institute of Geology and Mineralogy Siberian Branch
Russian Academy of Sciences
Novosibirsk, Russia
[4] Azov museum-reserve, Azov, Russia
E-mail: wberingia@gmail.com

TWO EARLY BIHARIAN MORPHOTYPES OF MERIDIONALOID ELEPHANTS, *ARCHIDISKODON MERIDIONALIS* (NESTI, 1825), RECOVERED FROM SARKEL (LOWER DON AREA, SOUTHERN EUROPEAN RUSSIA)

Key words: biostratigraphy, mammals, meridionaloid elephants, Archidiskodon meridionalis, Latest Villafranchian, Early Biharian, Sarkel, Lower Don, European Russia

Latest Villafranchian/Early Biharian fauna of the newly discovered Sarkel locality (47°42'N, 42°12'E, Lower Don area, southern European Russia), that includes "meridionaloid" elephants as well as diverse and stratigraphically significant small mammals, becomes a very important biostratigraphic reference level for southern Eastern Europe. Two morphotypes of fossil elephants, *Archidiskodon meridionalis* cf. *tamanensis*, have been recovered from the site in clear stratigraphic and biostratigraphic context (Nikolskiy, Tesakov, 2003; Dodonov et al., 2007; Tesakov, 2008; Baygusheva, Titov, 2012). The Sarkel fauna not only helps to clarify biostratigraphic interpretations of "southern elephants" (genus *Archidiskodon*) that are strongly influenced by the accuracy of relative and/or absolute age determination (Nikolskiy et al., 2014), but also it confirms the occurrence of two divergent forms of elephants in Latest Villafranchian/Early Biharian of East Europe, that is a key important pattern of early evolution of elephants belonging to Mammuthini tribe.

The Sarkel locality have been discovered in 2001. In this site, fossiliferous fluvial crossbedded grey sands up to 4 m thick (Sarkel beds), outcrop along the steep northern bank of the Tsymla Reservoir near Sarkel settlement. The Sarkel beds unconformably overlay the blue Eocene clays and are overlaid by Early Pleistocene greenish brown sandy-clays crowned by paleosoil, altogether up to 6 m thick, followed by Middle-Late Pleistocene loams and loesses, up to 2–5 m thick (Nikolskiy, Tesakov, 2003; Dodonov et al., 2007). The Sarkel

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beds have been shown to be reversely magnetized and referred to the late Matuyama Chron (Dodonov et al., 2007). The large mammals represented in Sarkel by detached postcranial fragments and teeth, small mammals, mostly by isolated teeth, and occasionally by mandibles and postcranial elements. The faunal list currently includes: *Archidiskodon meridionalis* cf. *tamanensis*, *Equus* sp., *Stephanorhinus* sp., *Elasmotherium* sp., *Cervalces* (*Libralces*) sp., Cervidae indet., *Pontoceros* sp., Bovidae indet., *Bison* sp., *Martes* sp., *Sorex* ex gr. *araneus*, *Sorex* cf. *minutissimus*, ?*Drepanosorex* sp., *Beremendia fissidens*, Erinaceidae gen., *Talpa* cf. *minor*, *Desmana* sp., *Lepus* sp., *Ochotona* sp., *Ochotona* ex gr. *pusilla*, *Trogontherium* sp., *Sicista* sp., *Pygeretmus* cf. *brachydens*, *Allactaga* sp.1, *Allactaga* sp. 2, *Plioscirtopoda stepanovi, Apodemus* sp., *Spermophilus* sp., *Spalax minor, Cricetus nanus, Allocricetus ehiki, Cricetulus* sp., *Eolagurus argyropuloi adventus, Prolagurus pannonicus, Lagurodon arankae, Allophaiomys pliocaenicus, Mimomys pusillus, Mimomys intermedius, Clethrionomys hintonianus, Ellobius (Bramus) tarchancutensis, Ellobius (Ellobius)* sp.

The Sarkel small fauna is dominated by advanced *Allophaiomys pliocaenicus*, *Lagurodon arankae*, and *Prolagurus pannonicus*, and it is correlated to the Calabrian stage of the Early Pleistocene, or to early Biharian. The fauna belongs to the local Tamanian faunal assemblage, and the regional zone MQR8 (Pevzner et al, 2001). The age of the fauna is therefore estimated between 1.2 and 0.9 Ma.

The following remains of *Archidiskodon meridionalis* cf. *tamanensis* have been recovered from Sarkel locality: 1M3, 7m3, 1M2, 5m2, fragmented tusks – 2, limb bones – 8, ribs and vertebrae – 7. The lamellar frequency of the studied *Archidiskodon* teeth varies from 4.5 to 5.5, and the enamel thickness – from 2.5 to 3.2, corresponding to respective parameters of the type series of *Archidiskodon meridionalis tamanensis* from Sinyaya Balka, and somewhat overlaping values of *Archidiskodon meridionalis meridionalis* from Upper Valdarno. The key important fact is that all evolutionary significant morphometric parameters of Sarkel elephants demonstrate clear bimodal distribution exactly as it appears in *Archidiskodon meridionalis tamanensis* from Sinyaya Balka. Taking into account the close ages of both fauna but the totally different geologic and taphonomic environments in Sarkel and Sinyaya Balka we suggest that two forms of meridionaloid elephants, primitive and derived, existed in southeastern Europe somewhat between 1.2 and 0.9 Ma.

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N.K. Panova, T.G. Antipina

Institute Botanic Garden, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia

E-mail:natapanova@mail.ru

LATE GLACIAL AND HOLOCENE ENVIRONMENTAL HISTORY ON THE EASTERN SLOPE OF THE MIDDLE URAL MOUNTAINS, RUSSIA

Key words: Holocene, peat bog, pollen analysis, radiocarbon data, archeological site, lithology formation, vegetation, climate changes

Region of study is situated on the eastern slope, Middle Urals, elevated ca.250–300 m a.s.l. Modern vegetation dominates south-taiga type pine and birch-and-pine forests, sometimes added with spruce. The climate is temperate-continental, with moderate-cold winters and moderate-warm summers.

In order to reveal the Holocene dynamics of nature environments, peat-bog sediments were examined using pollen and botanical analyses; added with radiocarbon dating of samples.

First pollen studies with radiocarbon dating of peat-bogs in the Middle Urals were performed by Khotinsky (1977). This study presents results of study of 14 lake-derivative peat-bog sections underlain by sapropel layers (0.5 — 4.0 m thick). Studies were held mainly in cooperation with archeologists, who examined the sites with peat/sapropel-included cultural layers, usually understood as tails of riparian and island-located sites or settlements. The deepest Holocene sediments including the late-glacial layers were found in the peat-bog near the Peschany-lake (56º 54' N, 60º 19' E), and also in Shighirsky (57º 21' N, 60º 08' E) and Gorbunovsky (57º49' N, 59º 57' E) peat-bogs, the

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latter two having revealed several dozens of archaeological sites. Pollen-analyzed were 4 sections in the Shighirsky peat-bog (Shighirsky A, Shighirsky bog settlement, Varga 2 and Varga-borehole) and 2 sections in the Gorbunovsky one (named Beregovaya 2 and VI Razrez), having demonstrated cultural layers of the Mesolithic till the Early Iron Age (Panova, 2000, 2011; Panova, Antipina, 2007; Panova et al., 2008; Antipina et al., 2013; etc.).

Complex investigation of peat-bogs situated on the Middle Urals eastern slope allowed to reveal features of stratigraphy, dynamics of peat-bog development, characters of environment changes due to ancient human activities.

In the Late Glacial time (over 10000 yrs ago), the place of modern peat bogs was occupied by cold water pools surrounded with mainly non-forested communities of herbs and bushes showing dominance of sagebrushes, chenopodians, grasses, sedges, forbs, birch and willow shrubs, combined with insular spruce-and-larch open woodlands.

With heat increase during the Preboreal beginning, lakes were occupied by algae and different zooplankton species, sapropels' deposition started. The first Mesolithic site (Beregovaya 2) of the Gorbunovsky peat-bog was shown to correspond to this interval. The Preboreal second half was cold and wet, marked for higher water level in lakes. The Preboreal regional vegetation showed domination of spruce-and-larch open woodlands with admixture of birches.

The Boreal time was warmer again, marked for the spread of pine-and-birch forests; sapropels accumulation in lakes continued. The second Mesolithic settlement (Beregovaya 2) was aged to the Boreal beginning (ca. 9000 ^{14}C yrs B.P.).

The third settlement of the late Mesolithic was referred to the late Boreal time and the beginning of the Atlantic (8300–8000 ^{14}C yrs B.P.), when at the conditions of significantly warm and dry climate there were marked wide-spread pine forests; lake levels turned lower, and peat formation started in the riparian part of the Gorbunovsky peat-bog.

During the Atlantic first half, broad-leaved tree species were shown to appear. Water level in pools grew lower and swamping of the Shighirsky lake started. First Neolithic settlements of the Gorbunovsky and Shighirsky peat-bogs are dated to the Atlantic beginning (ca. 7500 yrs B.P.).

The Atlantic second half was more humid, participation of spruce and broad-leaved trees in forests was shown to increase. In the process of peat-bogs development, the stage was shown to change from fen peat formation to that of high-bog peat type. Neither signs of human activities were found there, probably due to extreme flooding of the area.

At the boundary of the Atlantic and Subboreal intervals, the climate was shown to change toward cold and arid. Ground water level decreased, and trees appeared on bogs, the pines dominating. Environmental conditions changed again to favor humans in their occupation of bog areas. Early-Subboreal sediments of the site Beregovaya-2 revealed artifacts of the Eneolithic age. The Subboreal was the interval corresponding to the Eneolithic and Bronze-aged cultural layers revealed in the sites VI Razrez, Shighirsky A, Shighirsky bog settlement and the site named Razboynichy ostrov found in the Karas'ye-ozersky peat bog. The artifacts were found mainly within boundary layers between those of sapropel and peat. Mid-Subboreal climate was more mild, favoring spread of spruce-and-pine forests with admixture of broad-leaved trees. After the climate turned colder in the late Subboreal, the broad-leaved tree species reduced their numbers, and taxa variety in forests turned poorer. During the Sub-Atlantic, modern-type pine forests were formed.

Structures of sections, sediments' composition, lithological transition ages all evidence that sedimentology conditions might differ significantly in distinct sections, even within a same bog system. Thus bog formation process developed not uniformly in different parts of the Shighirsky lake. Sapropel replacement by peat in distinct sections presented different dates: ca. 7500, 6300, 4500 ^{14}C yrs B.P. All these time intervals were marked for climate aridity growth. One can understand that paludification of a lake starting from water level descent, might be caused not only by climate conditions but also depending upon local features of lake bottom micro-relief, features of hydrology and sedimentology. Formation of cultural layers in peat-bogs is also referred mainly to warm and arid climatic intervals when ground water levels decreased favoring human activities to develop bog areas.

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E. Petrova, *L. Linkina*
Kazan (Volga Region) Federal University
Kazan, Russia
E-mail: helengeo@mail.ru, larisa.linkina@mail.ru

TO THE QUESTION OF BOUNDARIES AND COMPOSITION OF GELASIAN STRATUM IN THE MIDDLE VOLGA REGION

Key words: Stratigraphy, Neogene-Quaternary boundary

According to the ICS Resolution dated 2012 [1] the time interval of a Quaternary system is widened up to 2,6 million years; the Gelasian Stratum was included to the Quaternary system as the lower subdivision of Eopleistocene. According to the time period Chistopolian, Akkulaevian, and Biklyanian substages conventionally are related to the Gelasian Stage within the Middle Volga Region. Thus, nowadays the conventional lower boundary between Neogene and Quaternary systems lies between regional subdivisions: Sokolian and Chistopolian substages, which earlier belonged to the unified Akchagyl regio-stage of the Neogene system. The upper boundary of Gelasian stratum is between Biklyanian and Omarian substages, which form the unified complex of depositions, sediments' accumulation of which occurred on the period of Akchagylian basin regression.

G.I. Goretsky marked out ***the Chistopolian substage*** in the Lower Kama depositions in the region of Chistopol City. The sediments are mainly represented by clays of lacustrine-alluvial and lagoonal genesis. G.I. Popov determined here: *Viviparus* cf. *pseudoachatinoides, Valvata* aff. *serpens* Sabba, *V. sibinensis* Sabba, *V. piscinalis* (Műll.) var. *uistopolitana*. Pop, *V. vanciana* Tourn., *Bithynia* aff. *croatica* Brus [2]. From the palynological viewpoint a frequent change of palynocomplexes, mentioned by different authors, is a characteristic of sediments of the Chistopolian substage, which is stipulated by climate changes. The boundary between Sokolian and Chistopolian substages are characterized by the change of broad-leaved pine spruce palynocomplex for predominately pine one. In the first half of the Chistopolian period coniferous forests interchanging for either pine trees, that characterize drier periods or spruce trees, representing the growth of humidity, were spread on the territory. The appearance of the palynocomplex with high content of pollen of broad-leaved species proves some warming. At the final stage spruce forests were spread again on the territory.

Chistopolian sediments are characterized by reciprocal magnetization and are correlated with r-Matuyama orthozone. The boundary between Sokolian and Chistopolian substages can be traced by the boundary of orthozones

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of n-Gauss and r-Matuyama. In a number of sections the lower boundary of Chistopolian substage is correlated with the beginning of positive episode. Paleomagnetic data allow us to match Chistopolian layers and Zilim-Vasilyev layers in the Cis-Ural Region.

The Akkulayevian substage has been mentioned in this rank by V.L. Yakhimovich for the Cis-Ural Region [3]. Represented as lagoon-and-marine lumps, clays predominate in the majority of the sections of the sediments; sands are of subordinate value. The substage sediments are well marked by marine fauna: bivalve mollusks Cerastoderma, Mactra and gastropod Cerithium. Spruce complex gives palynological characteristic of the substage. The sediments are reciprocally magnetized and compared with the epoch of Matuyama (Reunion episode) and are simultaneous to Akkulayevian layers of the Cis-Ural Region [3].

Biklyanian and Omarian sediments were firstly studied and marked as substages by G.I. Goretsky [2] in the region of the Lower Kama. He characterized them as sediments of Akchagyl desalinated basin of regression stage, herewith the Biklyanian substage was considered as belonging to the Upper Akchagyl and Omarian to Absheron. Though later on he mentioned that the Omarian substage in the sections of the Lower Kama can correspond to the Upper Akchagyl. Ye.A. Bludorova, N.L. Fomichyova [4] and K.V. Nikolayeva [5] shared this point of view, ascribing the Omarian substage to regressive phase of the Upper Akchagyl.

In the cross-sections the ***Biklyanian substage*** is represented by sandy aleurites in the lower part and by gray, dark-gray clay of almost black color in the upper part. V.V.Silantyev determined the mollusks from the substage: *Viviparus sinzovi* Pavl., *V. turritus* Bog., *Valvata piscinalis* (Műll.), *V. cristata* Műll., *Pisidium amnicum* (Műll.), *Dreissena polymorpha* (Pall.), and L.A.Stepanov marked out the ostracods: *Candoniella subellipsoida* (Schar.), *Cyclopris laevis* (Műll.), *Cypria candonaeformis* (Schw.) and others [6]. The Biklyanian substage is characterized by spruce pine and grass palynocomplex, where shrubs and herbage pollen predominate [7, 8]. They are well-compared with VIIIa – grass-pine-birch palynocomplex, described by Ye. N. Ananova [2] and with XIV – spruce-pine-birch palynocomplex by Ye. A. Bludorova and K.V. Nikolayeva [5]. It lets us say that in the period of formation of these depositions the climate of the Middle Volga Region was dry and cool or even cold.

In the Omarian substage L.S. Korotkevich, V.V. Zauer, T.A. Kuznetsova, N. Ya. Kats and S.V. Kats [2] marked out a broad-leaved pine-spruce complex. In general spruce pollen predominates in the complex, but there is also much pollen of pines, hemlock and broad-leaved wood. The Omarian complex was formed, according to the authors, in relatively warm and humid climate conditions. Later on Ye.A. Bludorova and K.V. Nikolayeva [6] described four palynocomplexes in the Omarian depositions in the outcrop near Omarsky

Pochinok settlement and the authors supposed that it might be connected with relation of the upper part of Biklyanian formations to the Omarian substage.

As for the paleomagnetism, Biklyanian depositions were correlated with r-Matuyama orthozone of reciprocal magnetization from the beginning of the Reunion direct magnetization up to the beginning or the middle of the Olduvai episode; Omarian depositions are characterized by direct magnetization and correlated with the Olduvai episode. In the Cis-Ural region the Biklyanian substage is simultaneous to the depositions of the lower part of the Voivode substage [9]. Yu. P. Balabanov stated that stratigraphic location of subzone of the Olduvai direct polarity is fixed on the boundary of the Upper Akchagyl (Biklyanian substage) and Eopleitocene [8]. However, the hypsometrical position of the Omarian substage itself in the examined sections of the Lower Kama, where it is broken off at the absolute marks of + 90–100 m, is still disputable. In the key section absolute marks of deposition occurrence of the Omarian substage are put on the level higher than +145 m; since Omarian depositions were formed during the final phase of the basin regression in its borderland, they cannot be found in the central parts of the basin at the marks lower than +110 m, that is correspondent to the upper level of the Biklyanian substage. Thus, a precise boundary between two complexes of depositions, nowadays characterizing the upper boundary of the Gelasian stratum has not been determined either with the use of paleontological or paleomagnetic data.

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N.V. Pogodina, *Yu.A. Yakovleva*
Ural Federal University named after the First President of Russia B.N. Yeltsin
Ekaterinburg, Russia
E-mail: Pogodina2004@mail.ru

ARVICOLINE FAUNA OF ZVERINOGOLOVSKOYE LOCALITY (PLIOCENE-EARLY EOPLEISTOCENE, SOUTHERN TRANSURALS)

Key words: Arvicolidae, Pliocene-Early Eopleistocene, Southern Transurals

The Transurals region is important for reconstruction of the faunal history of the Palearctic and for direct correlations of European and Siberian stratigraphic schemes, because it is situated between the Ural Mountains and the West-Siberian Plain. The only source of information on the late Pliocene — earliest Eopleistocene history of small mammals in this region is the materials from the Zverinogolovskoye locality.

Several publications have considered the geological structure of the locality and small mammals fauna composition (e.g., Stefanovskii, Pogodina, 2005; Pogodina, Strukova, 2013). New remains of micromammals from bed sands (exposure 109) were found during the field campaign in 2013. More than 150 rhizodont arvicoline molars were studied. The new material has allowed to describe an arvicoline teeth morphology in more details than ever before.

The large number of molars were identified as belonging to four species: *Borsodia praehungarica* Schevtschenko, 1965, *Pitymimomys baschkiricus* Suchov, 1970, *Mimomys hintoni* Fejfar, 1961, *Mimomys* cf. *reidi* Hinton, 1910. Also species *Pliomys* sp., *Pitymimomys* ex gr. *inceptor* Tesakov, 2003, *Mimomys* ex gr. *hajnackensis* Fejfar, 1961, *Mimomys polonicus* Kowalski, 1960 were recognized. This spesies indicate the time range from the early Late Pliocene to the beginning of the Early Eopleistocene (MN16a- MN17) age.

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L.V. Popova
National Taras Shevchenko University of Kyiv, Faculty of Geology
Kyiv, Ukraine
E-mail: popovalv@mail.ru

EVOLUTIONARY LINEAGE OF *SPERMOPHILUS SUPERCILIOSUS – S. FULVUS* (RODENTIA, SCIURIDAE) IN THE QUATERNARY OF THE DNIEPER AREA: AN ABILITY OF A BIOSTRATIGRAPHICAL IMPLICATION

Key words: ground squirrels, Pleistocene, Holocene, Dnieper Area

Spermophilus superciliosus, a large extinct ground squirrel, was known from the end of the late Middle Pleistocene of Poland (Socha, 2014), the Dnieper Area (Popova, 2008) and Crimea until the Holocene. Origin of *S. fulvus* from *S. superciliosus* (Gromov at al., 1965) is one of the few convincing phylogenetic events for fossil *Spermophilus*. *S. superciliosus* was also a single ground squirrel, which fossil remains are identified without considerable difficulties; as it is evidently larger then all other contemporary *Spermophilus* species. It is larger just to such a degree as it is demanded by Hutchinson's rule to avoid a competition with other species of the genus; and due to it we have quite a clear idea about the species niche. The first appearance of *S. superciliosus* at the second half of Saalian glaciation suggests a climatic influence on the speciation event. Body size increase must be a winning strategy under such conditions; similarly to recent northern species *S. undulatus* and *S. parry*, which are large. Relative primitivity of tooth morphology was emphasized by Gromov for *S. superciliosus* and its descendant *S. fulvus*. These traits made generalists in feeding strategy out of the representatives of the lineage and gave them steadiness to subsequent climatic changes.

S. superciliosus has been perceived by palaeotheriologists to be a typical periglacial species with so certainty that previous records of its existence during the Holocene have been forgotten. Only recent finding of subfossil *S. superciliosus* remains in Kostianets make me look over early Pidoplichko's papers, where large desert-steppe ground squirrel was mentioned as living even in the beginning of XX century.

All the listed above makes the evolutionary lineage *S. superciliosus*–*S. fulvus* the most promising to elucidate a scale and a direction of interspecific variation of tooth system, in order to retrace its changes over time. The method of dealing with variation of ground squirrel teeth is the same as for specific determination of their fossils. It consists in occurrence frequency calculation for occlusive surface cusps. There is nothing especially new, except necessity to

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carry in mind all studied characters simultaneously, which can be accomplish using discriminant analysis or so as it has been shown on fig. 1.

S. superciliosus samples studied here are *S. superciliosus palaeodesnensis* (Novgorod-Seversky, Yerki and Borodaevka sites together, the Late Pleistocene, about 20 ky BP); Khalepia (the most ancient among known *S. superciliosus* within the Dnieper area, from the deposits of so called periglacial terrace, the late Saalian time (Popova, 2008)); and Kostianets (Tcherkassky region, the Late Holocene).

At first sight, it seems that occurrence frequencies of cusps within studied fossil samples (Fig. 1.2, 1.4) vary in a random way. To overcome it and to interpret these variations the specific patterns of bunodonty for a number of recent *Spermophilus* species had to be designed previously. These patterns demonstrate difference among the recent species, and hereinafter they are used as a scale. Compared with them, bunodonty pattern of *S. fulvus* is really archaic (Fig. 1.1, 1.3), especially as concerns to lower teeth.

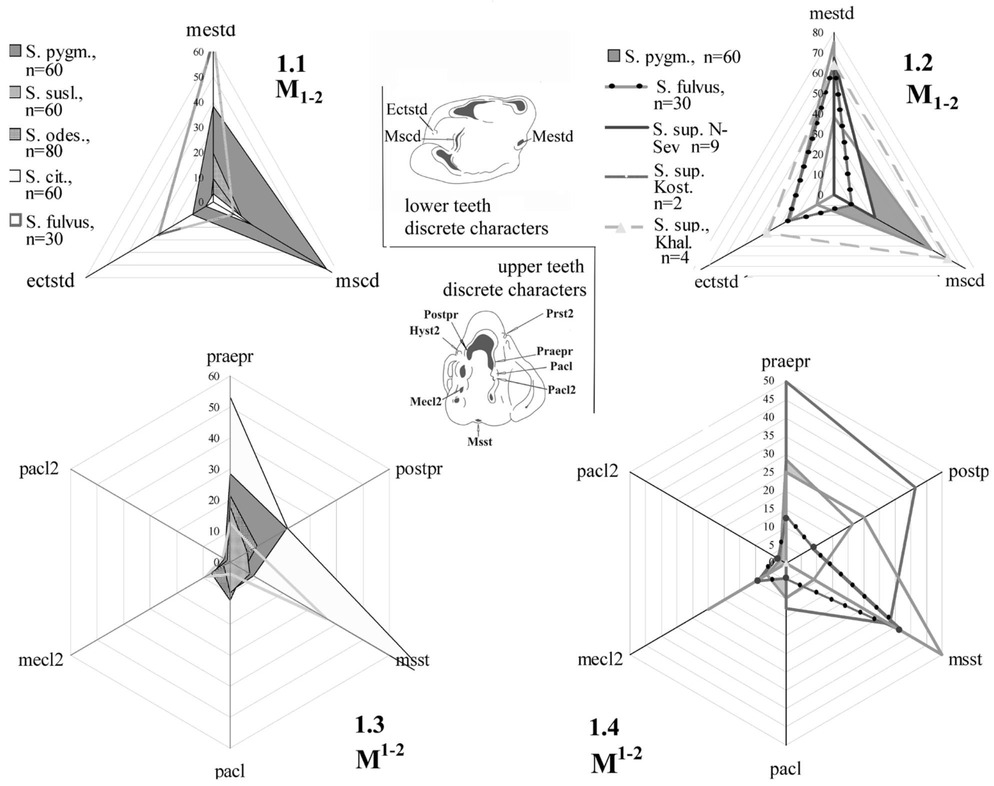

Fig. 1. Bunodonty patterns of lower (M_{1-2}) and upper (M^{1-2}) *Spermophilus* molars in recent (1.1, 1.3) and fossil (1.2, 1.4) samples. Bunodonty patterns of recent *S. fulvus* and *S. pygmaeus* are retained also on fig.1.2, 1.4, as a scale. Abbreviation "n" is a number of observations of a character presence/absence

Similarly to *S. fulvus*, high frequency of mesostiles (mesostilids) is the most constant trait of *S. superciliosus*. However, even these frequencies are characterized with coefficient of variation up to 20%, and don't show any signs of a chronoclinal variation all the same.

Really, the Holocene Kostianets ground squirrel, which is the closest to *S. fulvus* in time, is more bunodont than the Late Pleistocene *S. s. palaeodesnensis*. At the same time, a proper shape of bunodonty pattern (not frequencies, but their relation) of Kostianets remains closely resembles *S. fulvus* (Fig. 1.2, 1.4). Rekovets supposed that the Late Pleistocene *S. superciliosus* of the Middle Dnieper area is distinct from *S. s. palaeodesnensis*, and should be classified as *S. s. fulvoides*. Kostianets remains prove this opinion.

Though other characters of lower and upper teeth are even more variable, a fulvoid pattern of bunodonty has to be concluded for *S. superciliosus*: high frequency of mesostiles and mesostilids; low frequency of mesoconids. Another important trait is the presence of ectostilids and especially parastiles, which are very rare in the recent species but *S. fulvus*.

If *S. superciliosus* specific bunodonty pattern is like that, a question arouses: why *S. superciliosus palaeodesnensis* is so different? *S. s. palaeodesnensis* completely lacks of ectostilids, and is closer to *S. pygmaeus* than to *S. fulvus* (Fig. 1). Oddly enough, it has to be explained by environmental influence, despite of teeth are believed to be non-modified and slowly evolving. There were two *Spermophilus* species in Novgorod-Seversky fauna: *S. superciliosus* and *S. severskensis*, and both of them share mentioned complex of characters. The reason is a tooth self-sharpening; and as a result, additional surfaces of wearing, angular to the main one, were formed. To enable this process, tooth enamel is evidently thickening, and as a result, basements of protoconids and hypoconids in *S. s. palaeodesnensis* are so broadened, that there is no space between them to put in an ectostilid. Other *S. s. palaeodesnensis* occlusive surface peculiarities are connected with mentioned self-sharpening phenomenon too, which is an adaptation to the periglacial environment.

S. superciliosus of Khalepia doesn't have thickened enamel; however, this form was preadapted to development of self-sharpening teeth. A specific trait of hypoconid occurs in all studied samples, a kind of a heel, stretching from the hypoconid upper third outside and forward (i.e., at the place of the ectostilid). Additional surfaces of wearing, if formed, will take just this area. So, it implies that in fact ectostilids were presented in all studied samples of the species, sometimes as a part of hypoconid basement only. Difference between *S. superciliosus* of Khalepia and other studied forms of *S. superciliosus* is evident and this Middle Pleistocene form of the species seems to be of subspecies status.

Generally, forming of well-recognizable subspecies, both geographical and chronosubspecies is characteristic for *S. superciliosus*; together with absence of stable evolutionary trends. Therefore, just the chronotaxa should be used for biostratigraphical implication of the species.

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M.S. Proborukmi, B. Urban

Institute of Ecology, Subject Area Landscape Change, Leuphana University Lüneburg, Germany

E-mail: Maria.S.Proborukmi@stud.leuphana.de

PALYNOLOGICAL RECORD OF THE QUATERNARY DEPOSITS OF GARDING-2 RESEARCH DRILL CORE, NORTH-WEST GERMANY

Key words: high-resolution palynology, biostratigraphy, Quaternary climate change, coastal environment

A 240 m long core of Garding-2 research drilling, in the German North Sea coastal area of Garding has been investigated. Palynological, palaeoecological and geochemichal analyses have been carried out to determine the relative age, environmental characteristics and climate conditions of the deposits.

The core consists of intercalated coarse-grained glacial deposits with four fine-grained layers at 189–182 m, 148–92 m, 81–73 m and 20–1 m (Fig. A9, Appendix 8).

Tertiary deposits are identified below the Pliocene-Pleistocene boundary around 182.99 m, dated to about 2.58 Ma (Suc et al., 1997; Rio et al., 1998; Gibbard et al., 2010) as suggested from the last appearance of pollen of several Upper Pliocene taxa such as: *Taxodium*, *Sequoia*, cf. *Liquidambar* and cf. *Nyssa* (Fig. A9, Appendix 8). Above the estimated boundary, a cooler and drier phase is observed and marked by higher percentages of *Pinus*, Ericales, Poaceae, *Sphagnum* and total nonarboreal pollen. The Lower Pleistocene sediments accumulated in a slightly acid, low to poor salinity swampy environment with fluvial influence, demonstrated by high percentages of Ericaceae, *Sphagnum*, *Salix* and *Ulmus* in the 189–182 m depth interval.

A series of temperate and cooler periods with fluvial characteristics were recorded between 148–92 m. These sediments accumulated under very acid-

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slightly acid and very low to moderate saline conditions in a coastal swampy area as suggested by high percentages of *Myrica*, Ericaceae and *Sphagnum* representing the local vegetation and by the dominance of *Pinus*, *Picea*, *Salix*, *Betula* and *Quercus* in the surrounding mixed deciduous forest.

The beginning of a warmer and moister period at 119.5 m is indicated by increasing values of *Pinus*, *Picea*, *Quercus*, *Ulmus*, Ericaceae and total arboreal pollen. The last occurrence of *Tsuga* (Fig. A9, Appendix 8) at about this depth suggests that the deposit belongs to the period between the Early and Middle Pleistocene, MIS 19 (Channel et al., 2004). *Pterocarya* pollen also occurs through the section suggesting that this interval is not younger than the Holsteinian interglacial (Urban et al., 2011).

A depositional gap below 80.29 m occurs on top of Elsterian till and glaciofluvial sediments (Fig. A9, Appendix 8). At 81–73 m depth, brown coal lenses and reworked Early Pleistocene pollen such as *Tsuga*, *Carya* and *Sequoia* are observed in association with interglacial pollen markers such as *Quercus*, *Fraxinus*, *Tilia*, *Ulmus*, *Alnus*, *Pterocarya*, *Fagus*, *Picea* and *Pinus*. Findings of foraminifera test linings and dinoflagellate cysts together with variation of pH, soluble salt and carbonate content indicate fluctuating shallow marine environmental conditions.

Holocene sediments are observed on top of a hiatus (Fig. A9, Appendix 8) resulting from a strong marine transgression at about 20 m depth (Zhang et al., 2014). The pollen diagram shows relatively high amounts of *Tilia*, *Corylus*, *Quercus*, *Betula* and *Pinus* with occurrences of *Fraxinus* and *Ulmus*, between 19.79 m and 16.40 m pointing to the late Atlantic chronozone. High values of *Sphagnum* and Polypodiaceae, presence of *Myriophyllum* and low percentages of heliophilous herbs indicate back swamp conditions while remains of *Pediastrum* sp. and riparian taxa such as *Alnus* and *Salix* in some layers, indicate a nearby freshwater river. Existence of dinoflagellate cysts and foraminifera test linings from 19.80 to 17.05 m and from 12.52 m onwards with occurrences of *Elphidium* sp., *Nonion* sp., *Ammonia* sp. and *Operculina* sp., suggest a fluctuating shallow marine environment with tidal influence.

The first Holocene occurrences of *Fagus* at 15.97 m and *Carpinus* at 16.40 m with decreasing amount of *Corylus* at 16.04 m reveal the beginning of the Subboreal about 5660 years BP. Agricultural activities became more substantial from about 2500 years BP at 11.27 m as the amounts of Cerealia and heliophilous herbs increase and percentage of total arboreal pollen decrease. A high sedimentation rate is estimated around 2.90 mm/yr and caused a progressively shallower depositional environment from open marine to coastal back swamp.

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A.Yu. Puzachenko, A.K. Markova
Institute of Geography, Russian Academy of Sciences
Moscow, Russia
E-mail: puzak1@irambler.ru

MAMMAL DIVERSITY DURING THE PLEISTOCENE–HOLOCENE TRANSITION IN EASTERN EUROPE

Key words: Eastern Europe, Holocene climatic optimum, mammal diversity, Pleistocene Last Glacial Maximum, Pleistocene-Holocene transition

Fossil record data on the mammal diversity and species richness are of importance for the reconstruction of the evolution of terrestrial ecosystems during the Late Pleistocene – Holocene transition. In Eastern Europe, the transformations during the Pleistocene-Holocene transition consisted mainly in changes in zonal structure and local fauna composition (Markova, Kolfschoten, 2008). We investigated the species richness and the analogues of the α-, β- diversity indexes of large and medium size mammals for 13 climate-stratigraphic units dating to the Late Pleistocene and the Holocene, from the Hasselo Stadial (44–39 kBP) to the Subatlantic period and the present day. The following climate-stratigraphic units cover the time interval of our study: the Hasselo Stadial (^{14}C uncalibrated conventional dates, 44 to 39 kBP, HAS); the Hengelo Interstadial (38 (39) to 36 kBP) (HEN); the Huneborg Stadial (36 to 33 kBP, HUN); the Denekamp (= Bryansk) Interstadial (33 to approximately 25 kBP) (DEN); the Valday (=Weichselian) maximum cooling (24 to 17 kBP) (LGM), the Late Glacial (or Deglaciation) (17 to 12.4 kBP) (LGT); the Bølling and Allerød Interstadials separated by the Middle Dryas cooling

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(12.4–10.9 kBP) (BAIC); the Younger Dryas Stadial (10.9–10.2 kBP) (YD); the Preboreal warming (10.2–9.0 kBP) (PB); the Boreal period (9–8 kBP) (BO); the Atlantic period (8–5 kBP) (AT); the Subboreal period (5–2.5 kBP) (SB); and the Subatlantic period (2.5–0 kBP) (SA). The biological diversity of the Last Glacial Maximum (LGM) and the Holocene thermal optimum was investigated in more detail using information about all mammalian taxa (PALEOFAUNA database, Markova (1995)).

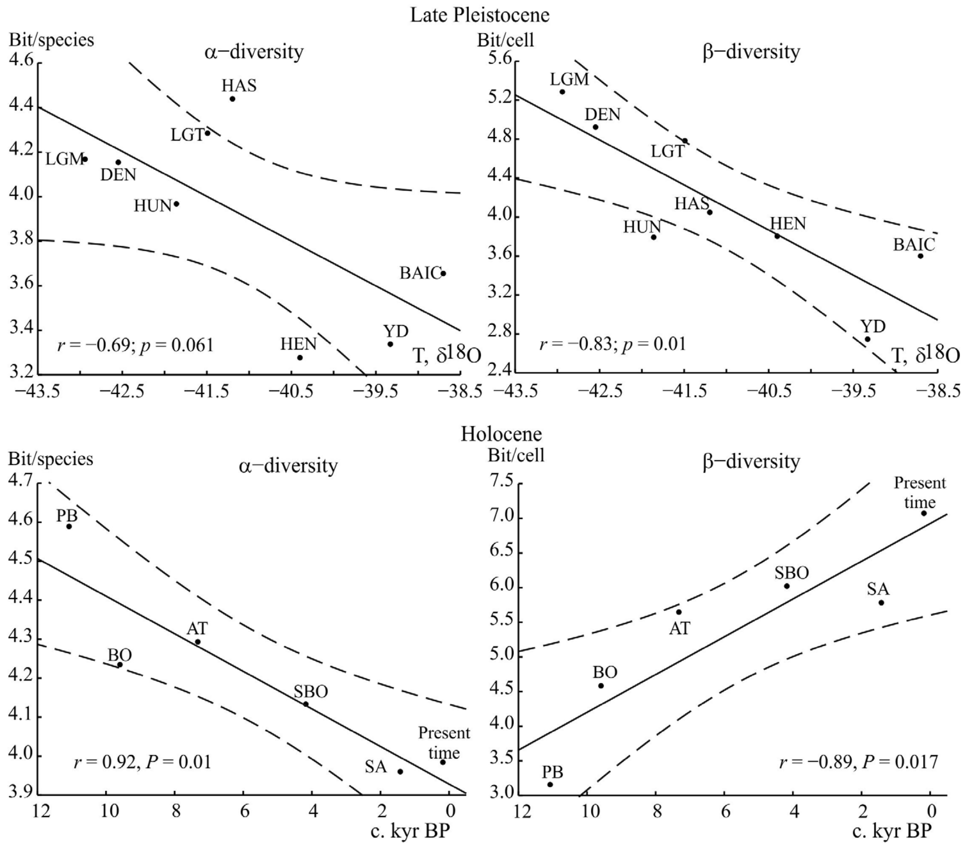

Fig. 1. α-, β- diversity in different climate-stratigraphic units of Late Pleistocene and Holocene age in Eastern Europe. In the Late Pleistocene, both indexes are correlated negatively with temperature (T, $\delta^{18}O$). In the Holocene, α- diversity decreased after a rapid increase in the Preboreal time, but β- diversity increased. Both indexes changed independently from the climate changes during the Holocene

The study revealed several East European "centers" with a high mammal diversity, which are relatively stable during the Pleistocene-Holocene transition: during the Late Pleistocene maximum cooling, they were the Carpathians, the Crimea Mountains, the South Urals and the Central Russian Upland; in the

Atlantic time of the Holocene, they were every mountainous region, including the Caucasus. The orientation of the boundaries between the large geographical mammal assemblages depended, particularly in the northwestern part of Eastern Europe, on the expansion of the Scandinavian ice sheet.

The α-, β- diversity values show only a negative correlation with the temperature conditions during the Late Pleistocene, the period that is characterized by the so-called "Mammoth Fauna" complex (Fig. 1). For the Holocene faunas the diversity indexes are nearly independent from physical environmental conditions; the α- diversity index decreased and the β- diversity index increased. Nowadays the relatively low α-diversity and high β-diversity indexes in Eastern Europe are referred to the decrease of the population number of some forest species in historical time and the increase of the dominance of unspecialized species or the species connected with intra-zonal ecosystems.

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S.-C. Rădan[1], *S. Rădan*[2]
[1] Geological Institute of Romania
Bucharest, Romania
[2] GeoEcoMar
Bucharest, Romania
E-mail: sc.radan@yahoo.com

THE GEOMAGNETIC RECORDING MEDIUM FROM WESTERN DACIC BASIN (ROMANIA) DISTURBED BY COAL PALAEO-FIRES: PLEISTOCENE PORCELLANITES WITHIN PLIOCENE LIGNITE – CLAY SEQUENCES; MULTI-PROXY EVIDENCE

Key words: post-depositional thermal perturbation, magnetic susceptibility, natural remanent magnetisation, magnetostratigraphy, thermo-mineralogy, magnetic anomaly

We can consider that the rocks, defined by assemblages of ferromagnetic or ferrimagnetic minerals dispersed within a matrix of paramagnetic and diamagnetic minerals, represent the "magnetic recording medium" ("**m.r.m.**").

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As regards the sedimentary rocks, which constitute the "**m.r.m.**" from the western Dacic Basin (WDB) (southwestern Romania), their magnetic properties are mainly controlled by the composition of the original detritic minerals and the character of the subsequent diagenetic changes. During the time, among the processes which take place, the rock weathering and the temperature-induced changes (*e.g.*, by palaeo-coal fires; Rădan, Rădan, 2013) are most significant in causing modifications in (magneto)mineralogy and geochemistry. To detect subtle changes, a multi-disciplinary approach is required. For the "**m.r.m**." constituted by Pliocene "coal bearing formations" investigated in the WDB, an integrated rock(palaeo)magnetic and petrological-mineralogical-geochemical study was carried out.

These Pliocene deposits have the characteristics of a clayey-sandy detrital series with coal intercalations deposited in an environment associated with the final phase of the foredeep silting up. So, lignite-clay doublets are commonly present. The palaeogeographic framework allowed the sedimentation of the mineralogically inhomogeneous clay fraction.

The intervention of "porcellanites" within the structure of the "recording medium", *i.e.* the "coal bearing formations", is easily observed in the lignite quarries (Rădan, Rădan, 2013, and the references therein), they commonly showing the consistence and the colour of the bricks (Fig. A10,b, Appendix 9). We have also identified "clinkers" (with slaggy or vitreous texture, marked vesicularity and dark color), and "porcelanite-like clays" (thermo-mineralogically slightly-affected clays). These "new rocks" are produced by baking, sometimes by melting/fusing during intermitent burning of certain coal beds (with petrographic-mineralogic availability for autoignition), processes wich take place near surface, usually when the lignite beds are to be exposed to erosion. During burning, temperatures which can exceed 1000^0C are reached, leading to clear thermo-mineralogical consequences. Changes of the main constituent elements of the **m.r.m**. are produced. The mineralogical and geochemical features were affected.

The "original"/"fresh" clays, which are unaffected by heating, are characterized by clay minerals, and non-clay minerals (Rădan, Rădan, 2013, and the references therein). The rock-magnetic signal has a low amplitude. The initial magnetic susceptibility rarely exceeds $75\times10^{-6}\times4\pi$ SI; the magnetic fabric is a primary depositional sedimentary fabric. The total natural remanent magnetisation (NRM) shows low and very low intensity values, generally below 1 mA/m, rarely exceeding 30 mA/m.

The mineralogical signature recovered from the thermally affected rocks (porcellanites and clinkers) shows modified mineral assemblages or even newly formed ones, such as hematite, cristobalite, trydimite, mullite, spinel, cordierite, and likely magnetite (an example is given in Fig. A10, d, Appendix 9). Temperatures, starting from 250°C and sometimes as high as 1200°C occurred due to paleo-coal fires. These temperatures exceeded the Curie point of ferromagnetic (*s.l.*) minerals. Therefore, the NRM was modified. Subsequent cooling caused the porcellanites to acquire an important thermoremanent magnetization (TRM). High to very high intensity values (an example, in Fig. 1c), mostly between 1 and 7 A/m, occasionally reaching 7982 mA/m, were recorded. The NRM direction was also modified, usually showing a normal polarity (an example, Fig. A10, c, Appendix 9), in a position that is close to the zone where the actual geomagnetic field direction is located.

These important changes which occurred within the **m.r.m.** are reflected by strong magnetic anomalies detected in the Lupoaia-Motru area: ΔT amplitudes up to 1880 nT were measured (three magnetic profiles, in Fig. A10, a, Appendix 9).

The palaeomagnetic signal shows the essential modifications suffered by the m.r.m. due to the post-depositional perturbations as a result of the natural palaeofires in the coal (Rădan, Rădan, 2013, and the references therein). Thermally unaffected clays, characterizing the original state of the m.r.m., recorded reversed polarity, whereas the porcellanites, characterizing the modified state of the m.r.m., showed normal polarity of the geomagnetic palaeofield. The former polarity zone (related to the time of clay deposition) is assigned to the Gilbert Chron, namely, C2Ar Subchron (4.187– 3.596 Ma), whereas the latter (related to the time when clay was baked by naturally burning coal fires) is assigned to the Brunhes Chron (0.781–0.00 Ma) of the latest astronomically tuned Neogene time scales, ATNTS 2004/ ATNTS 2012. Thus, the palaeogeomagnetic signature recovered from porcellanites, porcellanite-like clays, and clinkers, and the evolution of the conditions of the sedimentary basin constrain the time of coal-seam burning to the Middle-Upper Pleistocene.

This study shows that rocks spatially situated in an adjacent position, in the same stratigraphic horizon, or in a superposed position where they are up to 10 m apart, actually at the level of the coal bed X, differ in age by about 3.5 Ma. This is explained by the anomaly that occurs within the geomagnetic palaeofield record as a consequence of the thermal perturbation produced by underground coal fires, during the Middle-Upper Quaternary, inside a m.r.m. zone represented by Upper Pliocene cyclic lignite-clay sequences.

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S.-C. Rădan[1], S. Rădan[2], I. Catianis[2], A. Scrieciu[2]
[1] Geological Institute of Romania
Bucharest, Romania
[2] GeoEcoMar
Bucharest, Romania
E-mail: sc.radan@yahoo.com

TOWARDS ASSESSING THE POTENTIAL FOR STRATIGRAPHIC STUDIES IN THE DANUBE DELTA GEO-ENVIRONMENTS BY USING MAGNETOSUSCEPTIBILITY AND LITHOLOGICAL RECORDS RETRIEVED FROM RECENT SEDIMENTS

Key words: sediment core, bottom sediment, magnetic susceptibility records, lithological profiles, Romania

Based on a large data base of magnetic susceptibility (**MS**; **k**) measurements on surficial sediments from lakes and channels of the Danube Delta (at least annually sampled during the 1976–2014 time interval), and on the **MS** and lithological (**LITHO**) records achieved for a number of sediment cores extracted from the most important deltaic geo-environments (with special reference to the 2006–2014 period), the assessment of the stratigraphic potential of the integrated **MS** – **LITHO** characteristics for this singularly interesting area is self-evident.

The surficial/bottom sediments (taken with grab-samplers) give information from the first ca. 20 cm beneath the water/sediment interface, while the sediment columns (provided by a Hydro-Bios type core sampler) were extracted from up to ca. 60 cm depth. Most papers have mainly dealt with the **MS** and **LITHO** signatures recovered from surficial sediments (see Rădan & Rădan, 2011, for a brief overview and references), but during the last years, it has been started publishing articles particularly dedicated to the sediment cores extracted from specific deltaic subunits/depressions (e.g., Meşteru – Fortuna Depression; Rădan et al., 2013). In Fig. A11, Appendix 10, the magnetosusceptibility records obtained for five sediment cores, collected from two lakes (i.e., Babina and Matiţa) located in the northeastern part of the Danube Delta, are illustrated. We have also performed the associated **LITHO** profiles, showing the variation with depth along the respective cores of the three main lithological components: siliciclastic/mineral/detrital fraction (*SIL*), total organic matter (*TOM*), and carbonates (*CAR*). The correlation coefficients calculated for pairs of k values and **LITHO** contents, or pairs of **LITHO** component contents attest, in most cases, a feasible lithological support for the magnetosusceptibility records retrieved from the investigated geo-environments. Particularly, high and very

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high positive correlations for *SIL* vs. **MS**, and, correspondingly, high and very high negative correlations for *TOM* vs. **MS**, were achieved.

The integrated magneto-lithological study has resulted in the detection, in several sediment cores, of some marine deposits located very close of the water/sediment interface. Besides, the anthropogenic influence on some lakes was also inferred from the **MS** data analysis. On the other hand, in a favourable case, the sedimentation rate was possibly to be determined on the basis of the magnetosusceptibility model carried out for a sediment core (Rădan et al., 2013).

The **MS** – **LITHO** data provided by the sediment cores are very important in the context of deciphering the spatial and temporal evolution of the deltaic geosystem. Actually, the present paper is specially dedicated to assess the capabilities of the magnetosusceptibility and lithological records for stratigraphic studies in the Danube Delta geosystems. Even the use of the **MS** as a correlation tool is positively discussed in the literature, in a series of cases to match the **k** peaks identified in some cores within a lake or in several cores from different lakes (an example in Fig. A11, Appendix 10) is difficult to really carry out (e.g., Trodahl, 2010, and references therein). In order to fulfill the stratigraphic goal, the **MS** records must be supplemented with data provided by other proxy parameters.

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U. Ratajczak[1], K. Stefaniak[1], A. Nadachowski[2]
[1] Department of Palaeozoology, Institute of Environmental Biology, Wrocław University
Wrocław, Poland
[2] Institute of Systematics and Evolution of Animals, Polish Academy of Sciences
Kraków, Poland
E-mail: nadachowski@isez.pan.krakow.pl

REMAINS OF *SAIGA TATARICA* (LINNAEUS, 1766) FROM THE QUATERNARY DEPOSITS OF EMINE-BAIR-KHOSAR CAVE (CRIMEA) AND OTHER LOCALITIES OF UKRAINE AND POLAND

Key words: Saiga tatarica, Late Glacial, migrations

More than 330 remains of *Saiga tatarica* (Linnaeus, 1766) were found during the exploration of Emine-Bair-Khosar Cave (Crimea). The species is among the most abundant in palaeontological record. The remains included all parts of the skeleton. The saiga skeletons in the deposits of Emine- Bair-Khosar were nearly completely preserved which is a unique situation. The species was found in all the studied profiles from the Holocene through the Bug glaciation (LGM, MIS 2) to various periods of the Vytachiv interglacial (MIS 3) (Ridush et al., 2013). Based on the morphometric analysis and comparison with the literature data it was concluded that the measurements of the saiga from Emine-Bair-Khosar were the most similar to those of the remains of a similar age from Palaeolithic localities from the Crimea and Ukraine, and larger than *Saiga tatarica* from the Eemian site Binagady. The measurements were in most cases somewhat larger than those of the recent saiga. The few specimens from Pavucha Cave (Crimea) were similar in size to the recent saiga from Kazakhstan which may indicate their Holocene age (Fig. A12, Appendix 11) (Alekperova, 1955; Bibikova & Starkin, 1985, Baryshnikov et al., 1990). In Poland few saiga remains were found in 8 localities in the Kraków-Częstochowa Upland. Their measurements were mostly within the upper range of variation of the Crimean specimens (Fig. A12, Appendix 11). Based on the analyses, the specimens from Cave IV on Mt. Biröw, Deszczowa and Stajnia caves, earlier assigned to saiga, chamois and/or ibex represent no doubt *Saiga tatarica* (Kowalski, 1958; Baryshnikov & Tikhonov, 1990; Lasota-Moskalewska, 1985; Nadachowski et al., 2009; Stefaniak et al., 2009; Urbanowski et al., 2010). The saiga is associated with steppe and was among the species which abundantly migrated from Asia and eastern Europe to central and western Europe during the glacial periods. The migrations were short-lasting, especially at the end of the Pleistocene. The climate warming and forest expansion at the end of the Pleistocene the saiga retreated ultimately from central and western Europe (Nadachowski et al., this volume).

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L.I. Rekovets, O.M. Kovalchuk, V.I. Demeshkant
Wroclaw University of Environmental and Life Sciences
Wrocław, Poland
E-mail: leonid.rekovets@up.wroc.pl

ULTRASTRUCTURE OF THE TOOTH ENAMEL OF VOLES (ARVICOLIDAE, RODENTIA) AND THE POSSIBILITY OF ITS USE IN BIOSTRATIGRAPHY

Key words: enamel, structure, Pliocene, Pleistocene, Arvicolidae

Study of the mammalian tooth enamel ultrastructure is a relatively new direction promising for purposes of taxonomy, systematics and phylogeny and also for the evolutionary morphology, diagnostics and biostratigraphy. The last

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one was proposed and recently justified (Rekovets, Dema, 2013). It was found that the pre-Pleistocene step of arvicolids forming (Mio-Pliocene) reflects the staging in the formation of tooth morphology and enamel structure clearly as compared to the later period of their evolution, when such morphology formed as a stable structure. Use of the similar data on enamel is more effective for the Late Neogene biostratigraphy versus Pleistocene, that can be caused by the duration of these stages.

Morphological bases of the tooth enamel ultrastructure of mammals were elaborated by Wighard von Koenigswald in the second half of the XX century, and later developed by other authors, such as Mors, Martin, Stefen, Clemens, Kalthoff, Pfretzschner, Sander, Rekovets. Species of the family Arvicolidae were the most studied group among mammals. Morphology of their tooth enamel with its tripartite structure (radial, tangential and lamellar layers), became the basis for a comparative ultrastructural characteristics of enamel in other forms. Various morphological types of the enamel layers were highlighted and details of their structure were characterized (Koenigswald, 1997).

The structure of each layer consists of prisms, stacked on the non-prismatic matrix IPM (Koenigswald, 1980). Features of the mutual arrangement of prisms and matrix (linear, mesh, twisted, tilted) indicate the level of evolutionary advancement (progressive/primitive), the nature of food-mastication adaptations, the role of enamel as a single functional structure during the chewing a food, as well as the taxonomic significance of this character.

The results of our studies on the tooth enamel ultrastructure in Arvicolidae were analyzed in terms of the evolution of taxa and their adaptiogenesis aimed at improving the mechanism of the plant food mastication in the steady trend towards arid climate in the Late Neogene. These changes are manifested in the process of enamel morphogenesis directed towards the evolution of the more complex structure — lamellar enamel (HSB-uniserial) with a defined structure (weave) of its elements. It is shown that the appearance of the enamel layer on the certain stage of evolution in Arvicolidae, and the complexity of its structure is not so clearly consistent with the stratigraphic levels. The structural complexity of enamel is associated with certain taxa and their place in the phylogenetic lineages. This is well demonstrated by our studies on the molars of mole rats (Spalacidae), when representatives of the *Anomalomys* genus from the Late Miocene localities (MN 9) of Ukraine have considerably more complicated (progressive) enamel structure in comparison with later (Pliocene) one, and especially versus the modern mole rat groups (Rekovets et al., in press).

Our studies also confirmed the general trend of changes in the structure of tooth enamel over time, as directed on the appearance of additional (or specific) layers at certain stages of evolution, and also on the ultrastructural complication of them. At the same time there were two parallel processes — the emergence and complexity that characterize levels of evolutionary advancement of groups, particularly in certain monophyletic lines, their stratigraphic confinement and paleoenvironmental conditions.

For example, monolithic and diverse family Arvicolidae represents almost one clade. Their ancestral forms from the late Miocene (*Baranomys*, probably *Baranarviomys*), tend to have only the radial enamel layer. The follow-time *Promimomys* genus from the early Pliocene has two additional layers — a very primitive enamel of tangential and lamellar type. Genus is the ancestral to the *Mimomys* (Ruscinian and Khaprovian faunas), which has progressive types of these enamel layers. *Arvicola* genus (Pleistocene) has a very perfect type of lamellar enamel. It can be argued that enamel type in one phyletic line corresponds to the specified stratigraphic level.

These characteristics are also typical for the Pliocene-Pleistocene Lagurini (*Borsodia* vel *Villanyia—Prolagurus—Lagurus*), Microtini (*Mimomys—Allophaiomys—Microtus*) with division of the last one in the Pleistocene onto subgeneric groups with specific enamel peculiarities, and also for the anagenetic lines *Eolagurus*, *Lemmus*, *Dicrostonyx* etc. (Koenigswald, Tesakov, 1997). It is also lesser shared to other groups — Castoridae, Spalacidae and Ochotonidae from the Mio-Pliocene and Pleistocene.

Enamel ultrastructure as a morphological feature, along with other signs, may be approved in the justification and biostratigraphy of Pliocene and Pleistocene s.l. Similar morphological features of the teeth were used by Vangengeim et al. (2001, 2008), Krokhmal (2008), and others.

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O.V. Rudenko[1], V. Yenina[1], E.E. Taldenkova[2]
[1] Orel State University, Orel, Russia
[2] Faculty of Geography, Lomonosov Moscow State University, Moscow, Russia
E-mail: olrudenko2011@yandex.ru

NEW PALEOFLORISTIC DATA FROM HOLOCENE BOTTOM SEDIMENTS OF THE LAPTEV SEA OUTER SHELF AND CONTINENTAL SLOPE

Key words: pollen, non-pollen palynomorphs (NPP), outer shelf, continental slope, Laptev Sea

Late Quaternary terrestrial sediments from lakes and peat lands of the Laptev Sea hinterland, that archiving various bioclimatic proxies, are most commonly used to reconstruct local to regional environmental changes (e.g. Andreev et al., 2011; and references therein; Kienast et al., 2011; Melles et al., 2012; Andreev and Tarasov, 2013 and references therein) and discuss vegetation history (e.g. Pisaric et al., 2001; Müller et al., 2010) and northern tree-line dynamics (e.g. MacDonald et al., 2000, 2008). By contrast, marinopalynological data from the Laptev Sea region are still rare (e.g. Naidina and Bauch, 2001, 2011; Rudenko et al., 2014). Here we present new results of palynological study of undisturbed surface sediments and 25–25-cm long multicore sections, recovered from the outer shelf and continental slope of the Laptev Sea in 2012 during ARK27–3 expedition (Fig. 1).

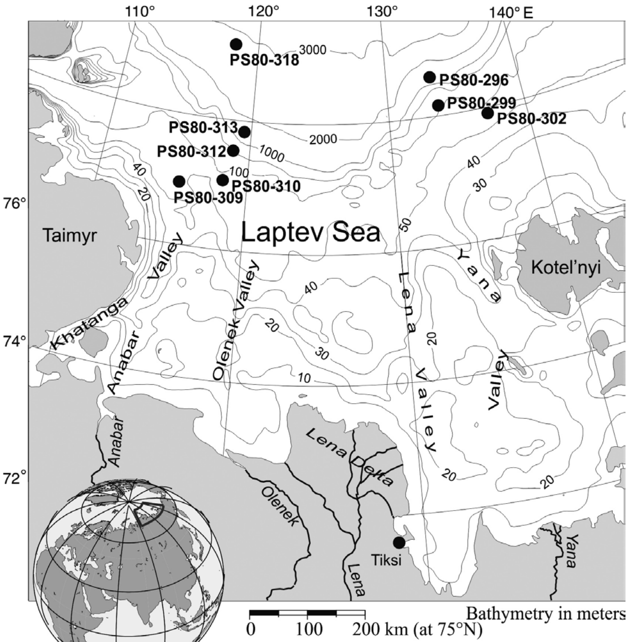

Fig. 1. Bathymetric map of the Laptev Sea showing the location of coring sites

8 multicore sec-tions were sampled continuously in 2-cm slices. Samples (3–5 g of dry sediment) were processed using standard HF technique (Berglund and Ralska-Jasiveczowa, 1986). Where possible, not less than 100–150 pollen

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grains of Holocene age were counted and spores were tallied in addition. Non-pollen palynomorphs (NPP), including spores, fresh-water green algae colonies, acritarchs, foraminifera linings and cysts of dinoflagellates, pointing to normal marine environments, were tallied separately. Besides, 42 taxa were classified as Pre-Quaternary reworked microfossils and counted in addition. Their relative frequency (from 14,5 to 22,6%) was calculated based on total sum of palynomorphs.

<u>Pollen and NPP in surface sediment layer.</u> Pollen and NPP in proper concentration were registered only in 3 of 8 analyzed surface sediments. They all originate from outer shelf (PS-80–302, PS-309 and PS-80–310, water depth 57, 60 and 193 m, respectively). We managed to count more than 100 grains only in one of the rest 5 samples from continental slope (PS-80–299, water depth 774 m).

Concentration of microfossils within the outer shelf varies from 18,1x10^3 to 134,7x103 grains per gram of dry sediment. It decreases dramatically depending on the depth and does not exceed 2–4,9x10^3 grains/g within the continental slope, where pollen of Mesozoic conifers and Pre-Quaternary spores dominates microfossil assemblage, pointing to a high bottom abrasion and a strong impact of turbidity. In the eastern part of outer shelf, pollen of dwarf birches, sedges and cereals is the most frequent among pollen assemblage of Holocene age, whereas pollen of Siberian pine dominates the surface pollen spectra from the western part.

Easy-floating spores of Polypodiaceae and *Shagnum* dominate the spores group. Single spores of Siberian club mosses (*Selaginella sibirica, S. rupestris*) and arctic mosses (*Lycopodium appressum, L. pungens*) were also registered.

Freshwater green algae group with *Pediastrum kawraiskii* being the permanent dominant, indicate the influence of the river runoff on the shelf and continental slope ecosystems. Total amount of freshwater algae does not exceed 5–12% among NPP. Cysts of dinoflagellates, rare acritarchs of genus *Halodinium* and numerous foraminifera linings comprise marine microphytoplankton group dominated by coldwater species *Islandinium minutum* and related morphotypes. Rare indicative species, such as *Spiniferites elongatus, Nematosphaeropsis labyrinthus* and much more numerous *Operculodinium centrocarpum* give evidence for the influx of Atlantic-derived waters (ADW) into the Laptev Sea outer shelf and continental slope.

<u>Distribution of pollen and NPP in PS-80–302 multicore sediment sequence.</u> Concentration of microfossils in this multicore is the highest one and the pollen spectra are the most complete and diverse, that's why the results of pollen analysis are the most reliable and informative. Three local pollen zones (LPZ) are distinguishable on pollen diagram. LPZ-1 (22–11 cm) features with tree and shrub pollen (AP) predominance (64–80%). Pollen of *Betula nana*-type (20–36%) co-dominates with *Pinus* sub. gen. *Haploxylon* (20% in the lowermost part of the section). The share of pollen of other long-distantly transported conifers, such as spruce and European pine, culminates at 2 and

12%, respectively. Percentage of conifers dramatically decreases up to 0–1% to the top of the zone.

LPZ-2 (11–8 cm) shows the significant increase in variety of arctic tundra motley grass and percentages of cereals (more than 20%) and sedges (up to 16%), thus indicating the rising productivity of local vegetation, perhaps, due to certain climate amelioration. Relative frequency of pollen of tundra dwarf shrubs, such as *Betula nana*-type and *Dusheckia fruticosa* rises up to 40% and 11%, respectively, whereas, pollen of conifers almost disappears to the top of the LPZ-3 (8–0 cm). The share of marine dinocysts among NPP averages at 22–61% in the lowest part of the sediment sequence (6–22 cm interval) and, afterwards, decreases dramatically to 2% in 6–0 cm interval of the section, thus signalizing the establishing of unfavorable environments.

Thus, according to own pollen data and taking into account the low sedimentation rates in the region (Bauch et al., 1999) and history of coastal vegetation (Andreev et al., 2011), studied sediments are likely to have accumulated in the late Holocene.

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T.V. Sapelko[1], V.V. Deryagin[2]
[1] Institute of Limnology Russian Academy of Sciences, St.-Petersburg, Russia
[2] Chelyabinsk State Pedagogical University, Chelyabinsk, Russia
E-mail: tsapelko@mail.ru, vderyagin@mail.ru

POLLEN CORRELATIONS FROM LAKE SEDIMENTS OF THE SOUTHERN URALS AND WESTERN EUROPE

Key words: biostratigraphy, palynology, paleoclimate, lakes sediments, Late—Glacial—Postglacial period

We present the history of vegetation in the context of climate change in Southern Ural from 14,000 cal. B.P. to the present day. The results are based on research of pollen records from lakes sediments. Lake sediments are the best records for paleoreconstruction.

Reconstructed vegetation history according to the pollen analysis of lake sediments was correlated in regional level. We correlated pollen data from the lakes Uvildy, Zaboinoye, Bolshoy Kisegach, Bolshoy Argajash, Malyi Argajash, Serebry, Sharopay and other. Also there were analyzed surface samples of the studied lakes. Pollen data covers a significant part of Late — Glacial-Postglacial time. The pollen spectra of Late Glacial period are characterized by high (40–50%) of herbs plants. Pollen of *Artemisia,* Chenopodiaceae and Poaceae are dominates. Postglacial period is characterized by the predominance of trees vegetation. The main tree species of Holocene were the *Pinus* and *Betula*. These results were correlated with the pollen data on the Middle and Polar Urals (Tarasov et. al, 1996; Panova et. al, 2003; Lapteva, 2013).

Comparing the pollen data of the Southern Ural and Western Europe we showed changes and similarity in the vegetation and climate development during Late Pleistocene and Holocene.

The vegetation and climate changes on South Ural may be related to large-scale Holocene climate dynamics in the Western Europe region, and our data of Ural's lakes are compared to palaeoclimatic proxy records from lakes sediments of North-Western Russia, Estonia, Poland, Finland, Sweden and other (Seppä et. al., 2000; Davis et. al., 2003; Punning J-M et. al., 2003; Borzenkova et. al., 2005; Sapelko &Kapanen, 2012 and other).

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V. Šeirienė[1], T. Rylova[2], V. Baltrūnas[1], A. Karabanov[2],
I. Savchenko[2], B. Karmaza[1], D. Kisielienė[1], J. Paškauskaitė[1]
[1] Nature Research Centre, Institute of Geology and Geography
Vilnius, Lithuania
[2] Institute for Nature Management National Academy of Sciences of Belarus
Minsk, Belarus
Email: seiriene@geo.lt

PLEISTOCENE CHRONOSTRATIGRAPHICAL CORRELATION OF LITHUANIA AND BELARUS

Key words: stratigraphy, correlation, Pleistocene, Belarus, Lithuania

During the scientific collaboration in the frame of the bilateral project "Geological correlation and palaeoenvironmental reconstructions of the cross-border area of Belarus and Lithuania" the new attempts were made to correlate the Pleistocene sediment layers in the light of new data. As a result the Pleistocene chronostratigraphical correlation chart of Lithuania and Belarus is presented. Despite many efforts to ascertain the right stratigraphical

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position of Pleistocene sediment layers a lot of indeterminations still exist in both countries.

More than 2000 sediment sections in territory of Belarus were revised and it was concluded that four glacial and three interglacial horizons could be ascertained in the Pleistocene thickness (Rylova et al., 2005). All of them stretches in the considerable area and has reliable stratigraphic criterions. Glacial horizons: Narevian, Berezinian, Pripetian and Poozerian could be correlated respectively with Dzūkija, Dainava, Medininkai and Nemunas. Interglacial horizons Belovezhian, Alexandrian and Muravian correlate well with Turgeliai, Butėnai and Merkinė. Correlation of other sediment layers is more complicated.

The recent complex studies of Pleistocene thickness of Lithuania enabled some corrections of stratigraphaphic position of sediment layers. Palaeomagnetic investigations capacitated to detect the Brunhes/Matuyama boundary and Jaramillo subchron in Daumantai and Šlavė sections. These findings contributed to some changes in the stratigraphy of the Lower Pleistocene of Lithuania (Baltrūnas et al., 2013; 2014). In Belarus area Brunhes/Matuyama boundary was detected below the Narevian till in the Brest horizon (Sanko, Moiseev, 1996). In relation with the lowering of the Pleistocene/Pliocene boundary to 2.6 Ma, the sediments of the Olkhovskian, Dvoretskian and Brestskian horizons in Belarus are considered as Lower Pleistocene. They could be correlated with the Anykščiai and a part of the Daumantai layers. Though, the lowermost part of the Pleistocene sediment thickness is still the most problematic for the stratigraphy and correlation.

The Middle Pleistocene marker horizons are Butėnai (Lithuania) and Alexandrian (Belarus) interglacials. Stratigraphical position of Vindžiūnai, Snaigupėlė interglacials and Kalviai glacial is under discussion because of its very local distribution and absence of reliable stratigraphic criterions. On the view of palaeontologists the subdivision of Belovezhian horizon into three units: Belovezhian and Mogilovskian interglacials separated by Nizhninski glacial (Velichkevich et al., 1996), makes reliable the correlation of the Turgeliai interglacial in Lithuania with Mogilovskian.

Narevian horizon of Belarus could be correlated with Dzūkija in Lithuania.

The Upper Pleistocene marker horizons are Merkinė (Lithuania) and Muravian (Belarus) interglacial sediments. Nemunas glacial horizon correlates well with the Poozerian horizon in Belarus. More detail subdivision of the Upper Pleistocene deposits is possible, but remains still problematic in both countries.

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V.L. Semerikov, S.A. Semerikova, M.A. Polezhaeva, P.A. Kosintsev
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: semerikov@ipae.uran.ru

PHYLOGEOGRAPHY OF SIBERIAN CONIFERS BASED ON CYTOPLASMIC AND NUCLEAR DNA MARKERS

Key words: biogeography, cpDNA, mtDNA, glacial refugia, Larix, Abies, AFLP, West Siberia

Genetic variability of species carries the imprints of its demographic history. As a result the analysis of genetic diversity of particular species can uncover the historical signal of past population dynamic, location of refugia, routs of migration and hybridizations. Pleistocene glaciations are the major historical factor affecting genetic diversity of species of boreal and temperate biota of Europe and North America. Siberia was not affected by Pleistocene glaciations as much as the North America or Western Europe, however, Northern parts of western and central Siberia were covered with ice sheet during several Pleistocene glaciations. In these time periods tree vegetation was limited not only due to ice sheet itself but also due to large ice-dammed lakes and due to inhospitable climate. One of the most intense glaciations taking place 270–290 kyr extended south approximately to 60 lat. Another strong ice advance happened 130–190 kyr and reached about 62–63 N (Volkova et al., 2002). More latter glaciations were much more limited and did not affected most of West and Central Siberia. According to paleodata the open landscapes dominated in West Siberia during Late Pleistocene. However, presence of boreal trees could not be excluded. For example, a number of macrofossils dated from the last glacial maximum, was found in the north of West Siberia.

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Here we present the results of the studies of genetic variability of Siberian larch *Larix sibirica* (Semerikov et al., 2013) and Siberian fir *Abies sibirica* (Semerikov, Semerikova, 2006, 2007, 2011) – two conifers widely distributed in Northern Eurasia although characterized by contrasting ecological niches. The aim of the study was to describe a phylogeographic pattern and to suggest likely scenarios of the colonization of the present geographic ranges of both studied species including possible areas of the Pleistocene refugia, routs of migrations and to estimate age of major demographic events for *L. sibirica*. Samples of leaves were collected from populations across the whole ranges. Genetic markers include four mitochondrial DNA fragments and five chloroplast DNA microsatellites for *L. sibirica*; allozymes, two chloroplast microsatellites and AFLP markers for *A. sibirica*.

The geographic distribution of 20 mtDNA haplotypes of *L. sibirica* was strongly structured. Spatial Analysis of Molecular Variation (SAMOVA) recognized the next distinct population groups:

South Sajan area and Khangai Mts of Mongolia;
Altai and Tien-Shan Mts.;
Baikal area;
Urals;
Northern foothills of Sajan Mts and most of the West Siberia north.

We believe this pattern suggests the migrations of larch out of isolated refugia where trees survived during some cold and dry Pleistocene epochs. Likely locations of these refugia are the mountain areas of Southern Siberia and Urals. On the same time the similarity between North Siberia and populations of the northern slope of Sajan Mts indicate the role of the latter area in the recolonization of the north. The geographic distribution of chloroplast DNA variation was uninformative but that of mitotypes clearly indicates that the southernmost populations, located in Mongolia and the Tien-Shan and Sayan Mountain ranges, had a very limited contribution to the current populations of the central and northern parts of the range.

SAMOVA analysis delineates a few small population groups in the north of West Siberia. The plausible explanation is a migration out of small populations survived recent unfavorable interval (perhaps LGM) locally in cryptic refugia.

Allozyme and AFLP data in *A. sibirica* (Semerikov, Semerikova, 2006, 2007, 2011) also indicate phylogeographic structure compatible with migration out from several refugia located in South Urals, Baikal area, Sajan and Altai. Allele composition and chloroplast DNA variation of the Northern Urals and West Siberia Plain suggests migration from several putative refugia into this colonized territory.

For further study of the demographic history and biogeography of Siberian *Larix* species, we used Approximate Bayesian Computation approach for estimation of some demographic parameters of four species: *L. sibirica*, *L. sukaczewii*, *L. gmelinii* and *L. cajandery* (Semerikov et al., 2013). Coalescent simulations based on five chloroplast DNA microsatellite loci genotyped in 900 individuals of L. *sibirica* and 500 individuals of *L. gmelinii* and *L. cajanderi* give the estimates of the age of population growth corresponds to 500000 for *L. sibirica* and 1500000 years for *L. gmelinii*. That means that major population bottlenecks in a history of these species took places much before the LGM and likely were associated with some Middle Pleistocene glaciation.

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S.A. Semerikova, V.L. Semerikov
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: s.a.semerikova@ipae.uran.ru

MOLECULAR PHYLOGENY AND BIOGEOGRAPHIC HISTORY OF FIRS (*ABIES*, PINACEAE) BASED ON AFLP MARKERS AND CYTOPLASMIC DNA SEQUENCE DATA

Key words: biogeography, phylogeny, Abies, cpDNA, mtDNA, AFLP

The genus of firs (*Abies* Mill.) represents one of the most extensive and complex groups of conifers, comprising about 50 species widespread in the Northern Hemisphere. These evergreen conifer trees are important key elements of the boreal and temperate mountain forests as well as taiga forests of plains in Siberia and North America. The *Abies* is also one of the most taxonomically complex conifer genera, because of great variability of their morphological traits and an important role of interspecific hybridization in the evolution of

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this group. The biogeography of firs, as well as the history of their speciation and dispersal, deserves special interest.

This study included 39 *Abies* taxa representing the main lineages of the evolution of the genus. Phylogenetic analyses based on the usage of three differently inherited in Pinaceae genomic regions — paternal chloroplast DNA (cpDNA), maternal mitochondrial (mtDNA) and bipaternally inherited nuclear DNA. Phylogenetic reconstruction was performed using the nucleotide sequences of several regions of cpDNA of the total length of 5580 bp and the three regions of mtDNA with the total length of 5226 bp. For the AFLP (amplified fragment length polymorphism) analysis we used six pairs of selective primers, 87 accessions of 39 taxa were genotyped for 497 polymorphic loci.

The resulting cpDNA phylogeny supports more than 30 clades (Bayesian tree) and six major fir lineages, and describes the relationships among them (Semerikova, Semerikov, 2014a). AFLP phylogenetic tree mainly confirms the results of cpDNA analysis; however, AFLP tree splits the Asian clade into two big groups — northeastern Asian and southeastern Asian, which was not observed in the cpDNA tree.

In comparison with cpDNA clades the mtDNA and AFLP lineages are stronger associated with geography. The mtDNA network consisted of two branches; the first one represented all American species plus three Asian, and the second branch included the remaining Eurasian species. Within these clusters, the mitotypes formed nine major groups, generally corresponding to the clades of the cpDNA and AFLP phylogenies, but the relationships of these groups were significantly different. It is assumed that the incongruence between the cpDNA and mtDNA is due to introgression and the capture of alien species mtDNA during hybridization and thus contains information about past migrations (Semerikova, Semerikov, 2014b).

On the basis of phylogenetic reconstruction the most likely biogeographical scenarios were offered. All cytoplasmic and nuclear gene trees support North American origin of the extant *Abies*. Calibrations of the divergence times based on paleobotanical data and on the estimation of the mutation rate of cpDNA in the Pinaceae, gave similar results (Semerikova, Semerikov, 2014a). Basal clades of modern *Abies* were separated at the border between the Oligocene and Miocene (about 22 MYA, with a range starting from the Middle Oligocene, HPD95% = 18–27 MYA)). The Bering Land Bridge can be considered as the only migration route between the continents. The first migration wave occurred from America to Asia, and further on, to the Mediterranean. Age of separation of the Mediterranean firs corresponds to Miocene. During the latter part of Miocene, the reverse migration from Asia to America occurred, which gave rise to “boreal” lineage of American fir species.

According to the results of the phylogenetic study dispersal events between North America and Eurasia could be multiple and bidirectional. Group of “boreal” northern North American species has a sister position with the Euro-

Asian clades both in cpDNA and AFLP phylogenetic trees. According to AFLP, "boreal" North America group is closer to the northeastern Asia group. On the other hand, mitotypes related to the "American" branch of mtDNA network were observed in the some Asian species, which grow in the northwestern part of the Pacific arch, on the line of possible migrations between the two continents. One of the last such migration could occur in the Pliocene — early Pleistocene.

A number of extant, highly differentiated *Abies* taxa are found in the west of North America. Concerning the other centers of *Abies* modern diversity, radiation of species is assumed to occur recently. Age of diversification within the Mediterranean, Mesoamerican, and most of Asian fir groups was estimated as the Pliocene- Pleistocene.

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O.G. Sharova[1]*, E.V. Bezrukova*[1]*, A.A. Shchetnikov*[2]*, P.P. Letunova*[1]*,*
N.V. Kulagina[2]*, E.V. Sheifer*[3]*, I.A. Filinov*[2]*, E.V. Ivanov*[1]*, O.V. Levina*[1]
[1] Vinogradov Institute of Geochemistry, Siberian Branch,
Russian Academy of Sciences
Irkutsk, Russia
[2] Institute of the Earth Crust, SB RAS
Irkutsk, Rusia
[3] Siberian Institute of Plant Physiology and Biochemistry, SB RAS
Irkutsk, Russia
E-mail: sharova@igc.irk.ru

VEGETATION AND CLIMATE CHANGES IN THE SENTSA RIVER VALLEY(EAST SAYAN HIGHLAND) IN THE MIDDLE-LATE HOLOCENE

Key words: Zhom-Bolok volcanic plateau, environmental shifts, Holocene

Lava streams and volcanoes of the Zhom-Bolok plateau in East Sayan Highland (at Tuva — Buryatia border) represent the largest manifestation of the Holocene volcanic outpourings in Central Asia (Yarmolyuk et al., 2003). The

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chronology of volcanic eruptions still remains obscure. It is known only that lava outpourings here were multiphase, began in postglacial time, at least since 7000 years ago, and proceeded up to the last millennium (Ivanov et al., 2011). Volcanic events were accompanied by the catastrophic natural phenomena — formation and breaks of large dammed lakes. In the upper riches of the Zhom-Bolok river valley some of such dammed lakes still exist. The Zhom-Bolok river valley adjoins to the Sentsa river valley where peat bogs developed. Multiproxy study of the deposits of one of such peat bogs was carried out by means of pollen, peat botany, and ^{14}C dating methods. This work is aimed at detailed reconstruction of regional/local environment, climate, and vegetation changes in the upper riches of the Sentsa river valley as well as at the definition of the chronological frame for natural events since the second half of the Holocene. The environment reconstruction results presented here are the first for this unique lava plateau.

Sentsa peat bog (1405 m a.s.l.) was named after Sentsa river. Peat core was extracted in August, 2013, using the Russian corer. A 61-cm long sediment sequence was obtained. Herbaceous communities consisting of grass Poaceae, sedge Cyperaceae family members along with sphagnum moss *Sphagnum* prevail in local vegetation. Heather shrubs of Ericaceae form small patches, while single willows *Salix* and dwarf birches *Betula* sect. *Nanae* constitute strongly rarefied shrubby layer. The peat bog is surrounded with the larch *Larix sibirica*. Siberian spruce *Picea obovata* trees also were met.

The Sentsa peat core was opened and cut at 1-cm intervals at the Vinogradov Institute of Geochemistry of the Siberian Branch of the Russian Academy of Sciences, and 1 см^3 peat from each sample was prepared for pollen analysis at Institute of the Earth Crust SB RAS by the standard technique (Faegri and Iversen, 1989). In total, 61 samples have been analyzed. Pollen, spores and other NPPs were identified with the aid of published pollen keys and atlases (van Geel et. al, 2003; Kupriyanova, Alyoshina, 1978; Bobrov et al., 1983) and a modern reference collection stored at the Vinogradov Institute of Geochemistry SB RAS. Two bulk sediment samples were submitted to the Novosibirsk Center of Geochronology of Cenozoic for conventional ^{14}C age determination. All radiocarbon dates were calibrated using the online version of CalPal-2007 calibration software and the CalPal-2007-Hulu calibration curve (Danzeglocke et al., 2008). All ages are expressed in cal. ka BP (before 1950 AD). The age value of basal layer is ca. 4723 calibrated years. Peat botanical composition data, concentration of microscopic charcoal particles provides additional information for more robust environmental reconstruction.

Pollen record of the Sentsa peat deposits reflects considerable changes in regional and local vegetation composition of this area in the middle-late Holocene. Through the first stage from ca. 4.7 cal. ka BP to ca. 2 cal. ka BP the boreal forest consisted of Siberian and Scots pines dominated regional vegetation while Siberian fir, larch, and Siberian spruce in particular, were the main taxa in local forests. High values of Siberian spruce pollen and stomata support rather dense spruce trees stands in the vicinity of study site. All proxy records indicate cool and wet climate at that time interval.

Considerable expansion of sedge communities on peat surface over the second stage since ca. 2 cal. ka BP to ca. 0.75 cal. ka BP could indicate somewhat rise of local water level and bog eutrophication. Local water lever rise could be responsible for the local forest reduction around Sentsa bog, particularly, for fir, larch, and spruce retreat. Decline in spruce, larch, and fir pollen content along with stomata disappearance and peat botany composition data support this idea. Scots and Siberian pine persisted in regional taiga forest.

Next stage of profound shift in regional/local vegetation cover took place ca. 0.75 cal. ka BP and was characterized by short spread of larch and birch trees in local vegetation. But most striking event at that time was a sharp decline of Siberian pine forest. Proxy data suppose complex mechanism caused that event. Significant rise of charcoal particles concentration may indicate big fire events resulted in local larch forest destruction. It is also believed that the regional climate changes might also have ontribute to the reorganization of regional vegetation composition what is supported by dramatic decrease of Siberian pine pollen, which is known to be well dispersed by wind. Hence, sharp fall of Scots and Siberian pine pollen and increase in dwarf pine *Pinus pumila* pollen percentage may give an evidence of significant drop of pine trees upper limit caused by decrease in atmospheric precipitation values and increase in climate continentality superimposed on fire. Since 0.75 cal. ka BP sedge communities formed dense cover on the bog surface, indicating high local water level. Elevated charcoal particles concentration values occurred when the bog surface became dry, confirming by low sedge pollen abundance and reflecting frequent changes in the Sentsa bog hydrological state.

It is likely that big fire events might have been caused by the Zhom-Bolok plateau volcano eruptions which could lead to local and even regional forest destruction. To examine that hypothesis geochemical, lithilogical, mineralogical results from the new sedimentary archives from the Zhom-Bolok plateau, supported by detailed age model are needed.

The Sentsa peatbog pollen, peat botany, charcoal records reflect a highly dynamic history of vegetation and environment in the upper Sentsa river valley since ca. 4.7 cal. ka BP. The results demonstrate that vegetation changes mighty have been climatically driven, but fire and volcanic disturbances play also a central role in the forest dynamics during the middle-late Holocene.

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A.O. Sizikova, *V.S. Zykina*
Sobolev Institute of Geology and Mineralogy, Siberian Branch,
Russian Academy of Sciences
Novosibirsk, Russia
E-mail: sizikova_a@ngs.ru

CORRELATION OF THE LATE PLEISTOCENE LOESS-PALEOSOL SEQUENCE OF SW SIBERIA AND DYNAMICS OF ITS FORMATION

Key words: loess-paleosol sequence, West Siberia, grain size, sand quartz grain morphoscopy

Late Pleistocene loess-paleosol sediments are widespread on the south of West Siberia. The structure of loess-paleosol sequence reflects the periodicity of conditions of paleosol and loess formation, which linked to humidity and temperature changes (Zykina and Zykin, 2008). According to the stratigraphic scale (Zykina and Zykin, 2008, 2012) Late Pleistocene loess-paleosol sequence of West Siberia consists of three Late Pleistocene loess layers: the Bagan, the Eltsovka and the Tulino. Both the Bagan loess and the Eltsovka one are a part of Sartan horizon and equal to MIS-2 (Bassinot et al., 1994). The first one lies directly under the Modern soil, and the second lies on deposits of the Karga

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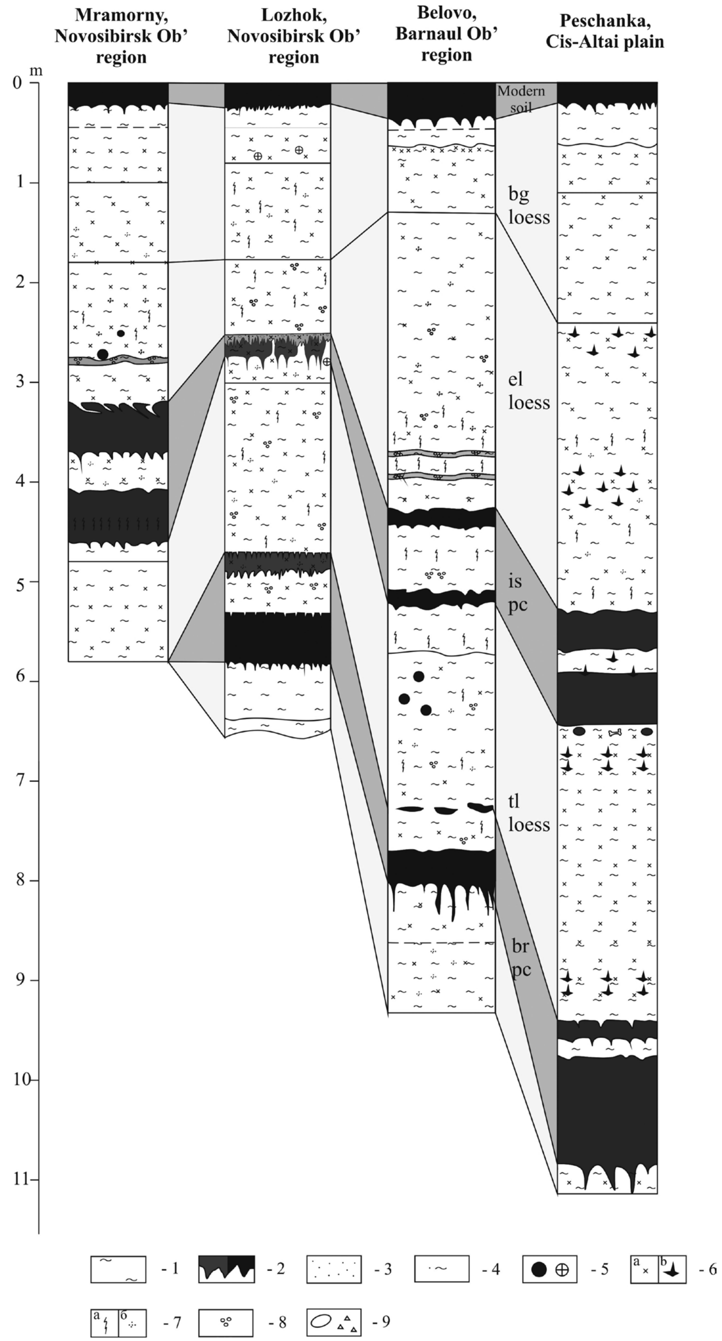

Fig. 1. Correlation of Late Pleistocene loess-soil sections of Priobie Loess Plateau and Cis-Altai Plain. 1 — loess, 2 — humus horizon, 3 — sand, 4 — sandy loam, 5 — krotovinas, 6 — neoformations: a — carbonates, b — gypsum, 7 — neoformations: a — Fe, b — Mn, 8 — gleying, 9 — rock debris pebbles, boulder. bg –Bagan loess, el –Eltsovka loess, tl –Tulino loess, is pc — Iskitim pedocomplex, br pc — Berdsk pedocomplex

interstadial (MIS-3). According to the stratigraphy scale there is the Sumino paleosol between them, but in studied sections it is absent. The Tulino loess correlates with MIS-4 and lies on the Berdsk pedocomplex, which consists of two paleosols (MIS-5c,e). This study includes Late Pleistocene loess-paleosol sections of Priobie Loess Plateau (Lozhok, Marble, Belovo) and Cis-Altai Plain (Peschanka). All stratigraphic units are presented in these sections.

The correlation of studied sections (Fig.1) shows that depth of occurrence of almost each stratigraphic layer and its thickness are in direct relation with the distance of section from supposed source material area (Kazakhstan and Barabinsk lowland). Thus, in prevailing wind direction from Novosibirsk Ob region to Altai foothill the thickness of layers and the depth of occurrence are raised. Also, in grain-size distribution the content of coarse-silt fraction is increased by sections in the same direction. It is supposed to depend on section location relative to source material area.

Sand quartz grain morphoscopy (Velichko and Timireva, 1995) revealed that studied layers were formed by eolian processes. It is confirmed by all-round micropitted texture of grain surface, sufficiently high coefficient of roundness and degree of surface dullness. In sections of Priobie Loess Plateau in direction to Cis-Altai Plain the wind treatment on grain surface is more developed. It can also be linked with location of section relative to source material area and, so, with more prolonged handling of quartz grains in the air stream. Also cryogenic processes took part in their formation: there are typical conchoidal fractures on surface of the majority of grain. Such fractures were formed as a result of desquamation. The maximal amount of such grains is observed in the Bagan loess (MIS-2) and minimal – in the Tulino loess (MIS-4). It is associated with frequency of seasonal freezing during that time. It can be evidence that in the 2^{nd} half of Sartan Glaciation on the south of West Siberia were the coldest and driest conditions that was favorable for wide development of eolian activity. The presence of cryogenic processes is also confirmed by annular distribution of mineral part in micromorphological structure of loess. These facts prove that these Late Pleistocene loess layers were formed in conditions of periglacial environment (dry cold deserts).

Loess accumulation rates were calculated for studied section of Priobie Loess Plateau and Cis-Altai Plain. The data obtained show an increase of rates during the Late Pleistocene from MIS-4 to MIS-2. The intensification of environmental conditions is also confirmed by results of grain-size analysis and sand quartz grain morphoscopy.

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N.G. Smirnov, E.A. Kuzmina, E.P. Izvarin, Y.E. Kropacheva
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: nsmirnov@ipae.uran.ru

STEPPE SPECIES OF SMALL MAMMALS IN PLEISTOCENE AND HOLOCENE COMMUNITIES OF NORTH EURASIA

Key words: small mammals, Northern Eurasia, steppe

Finds of steppe mammal fossils in the Pleistocene-dated sediments situated significantly northward and westward from their modern areas are used as markers indicating to certain events in climate and landscape dynamics. Spreading of these mammals northwards is of special interest as regarded to be in relation with the idea that cold sandy deserts showed wide distribution in northern Eurasia during the Pleistocene terminal (Velichko et al., 2011). Information is also important to understand the directions and rates of dynamics of ecological niches the species at study.

Material. Data for the North Ural region were generalized from both private collections of authors and previous publications (Teterina, 2009); they include 17 sites with total of 43000 small mammal molars identified. From the Middle Urals, 36 of sites and 200000 molars were examined (Smirnov et al., 2014). For the South Trans-Urals, the figures made 5 sites and 23000 molars (Kuzmina, 2009). At the Irtysh-river low reaches, 10 sites were examined and 8000 small mammal molars had been identified (Smirnov et al., 1986).

The steppe haymaker and the narrow-skulled vole are members of steppe complex. However, species identifications of haymaker fossils found in the Northern and especially Pre-Polar Ural regions need special attention and justification, as another species, *Ochotona hyperborea*, is more probable to be found there. To distinguish the two species, one needs to analyze at least good-preserved low jaws.

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The narrow-skulled vole is a species now inhabiting both steppes and tundra zone. While analyzing fossil communities found beyond modern area limits it is impossible to estimate their habitats accurately enough, only as "open" or "non-forested" areas. It is known, that the species is quite variable in concern to meso- or xerophilic demands. In the studies of "mixed" — hyperboreal late-Pleistocene fauna communities, when animal species are grouped according to certain zonal complexes, the narrow-skulled vole was isolated as a personal category. The analysis also included the species which are without questions concerned as members of steppe complex: *Allactaga major, Spermophilus major, Lagurus lagurus, Eolagurus luteus, Cricetulus migratorius, Allocricetulus eversmanni, Ellobius talpinus, Ochotona pusilla*.

Results. Dated to the Late Pleistocene time, the northernmost sites (North Ural) were registered for *L. lagurus* (60°30'N), *Cr.migratorius* (60°30'N), *Spermophilus* sp. (59°40'N). These remains were found in 2–3 sites, rare or very rare in proportions. Of all steppe species, only *O. pusilla* was marked even farther to the north (62°N); these animals store up dry grasses kept in relief depressions, thus deep burrows are not needed.

At latitude 59–61° N, at the Irtysh-river down-streams and its affluent Dem'yanka-river, 10 sites have been excavated containing Late-Pleistocene small mammal remains. *Ochotona* molars were marked in all collections, souslik fossils — in 4 sites, and sagebrush vole remains — in 6 sites, with their proportions low enough. The major part of remains was identified to the narrow-skulled voles, Siberian and hoofed lemmings.

Middle Urals (extended between 59–56° N) is a piece of southern part of fluctuating Pleistocene areas characteristic of many steppe species. Combined to the tundra elements, fossil communities there included all steppe complex species found farther to the north, and also molars of *Eolagurus luteus, Allactaga major, Allocricetulus eversmanni*. Thus, practically all the species now inhabiting the Trans-Urals steppes, during the Late Pleistocene time were spread significantly northerner, being registered in the Middle Urals and even in the North Urals. Only *Ellobius talpinus* revealed no northward shifting in the Urals, practically not changing its resident area part, obviously due to intimate adaptations to life within soil layer rich with plant roots.

Examination of by-pair correlations between frequency figures marked for small mammal remains in 61 Holocene and Late-Pleistocene sites in the Middle Urals showed that 6 species of open habitats form a correlation pleiad. *M. gregalis* reveals significant positive correlarion to all other species, *Dicrostonyx torquatus* — with all species except *Ochotona*. *Cr. migratorius* showed correlation with 3 species: narrow-skulled vole, sagebrush vole and hoofed lemming; *Lagurus lagurus* — with narrow-skulled vole, *Dicrostonyx sp*. and grey hamster. *Lemmus sibiricus* was positively correlated only with *Dicrostonyx* sp. and *M. gregalis*; *O. pusilla* — only with *M. gregalis*. These relations are in correspond to spatial niches occupied by the species during

Late Pleistocene time. Distribution of the steppe complex species according to the level of their Pleistocene shifting northwards differs from the Holocene pattern and from the modern one.

In the South Trans-Urals, within the territory of residential distribution of steppe fauna, the fauna taxa lists remained practically constant, but proportions between species and species groups were marked to vary. During the Late-Pleistocene time, sagebrush voles dominated in numbers, while *M. gregalis* turned dominant in Holocene. That is, when the narrow-skulled vole possessed maximal by area fluctuating part of its range in the north and west, its percentages in the range resident part were lower than those of other species. *Lagurus* numbers demonstrated just the opposite pattern. Interval of its domination in communities of residential steppes coincides in time with its most northward expansion. In the Trans-Urals, late-Pleistocene time was marked for climate aridity and occurrence of some semi-desert animal species.

The obtained data on small mammal fossils from the North Urals or West Siberia revealed not a single species concerned to sandy habitats. Such species were not registered in the adjacent regions, too. The nearest finds of Pleistocene rodent remains associated to deserts are located in the South Trans-Urals and in Mugodzhar mountains.

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P. Socha
Department of Palaeozoology, Institute of Environmental Biology, University of Wrocław, Poland
E-mail: sochap@biol.uni.wroc.pl

RODENT COMMUNITIES AS INDICATORS OF CLIMATE DYNAMICS IN POLAND DURING LATE MIDDLE AND LATE PLEISTOCENE

Key words: rodents, Pleistocene, climate, palaeoecology

Reconstruction of climatic conditions was based on rodent assemblages originating from a sequence of sediments dated from late Middle Pleistocene (MIS 8) to the end of Late Pleistocene (MIS 2) and Holocene (MIS 1), from caves and a shelter located in the Kraków-Częstochowa Upland (caves Biśnik, Deszczowa, Komarowa, shelter Krucza Skała), and in the Pieniny Mts (Obłazowa Cave) (Valde-Nowak et al., 2003, Nadachowski et al., 2009, Socha 2009, 2014, Stefaniak et al., 2009).

The climatic conditions in the environs of these locations were reconstructed, based on qualitative and quantitative models of bioclimatic analyses of mammal faunas proposed by Hernández Fernández (2001a,b). In order to determine the climatic conditions, the climatic restriction index (CRI=1/n; n — number of climatic zones inhabited by the species) was used to calculate the bioclimatic component (BC=[ΣCRI] x 100/S; S — number of species in the analysed assemblage). The results served as the basis to calculate discriminant functions of the greatest probability of occurrence of the assemblage in one of the climate types. The BC values were subject to multiple linear regression and used to determine the values of the following 11 climatic factors:: T-Annual mean temperature, Tmin-Mean temperature of the coldest month; Tmax-Mean temperature of the warmest month; Tp-Annual positive temperature; Mta-Mean annual thermal amplitude; It-Thermicity index; Itc-Compensated thermicity Index; VAP-Vegetative activity period; FVAP-Free vegetative activity period; P-Annual total precipitations; D-Drought length months Hernández Fernández (2001a,b). The assemblages from these locations included rodent species found today mainly in the following climates: typical temperate (main vegetation type: nemoral broadleaf–deciduous forest), arid–temperate (main vegetation type: steppe to cold desert); cold–temperate- boreal (main vegetation type: boreal coniferous forest- taiga), arctic (main vegetation type: tundra). The analyzed assemblages were dominated by species of the temperate climate with nemoral broadleaf–deciduous forest as the main vegetation type.

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The reconstructed mean monthly temperatures ranged from -6.3°C to +5.7°C. The lowest values of the mean monthly temperatures which fluctuated from -6.3°C to +4.4° C, were obtained from Deszczowa Cave and the highest values which ranged from +0.5°C to +5.0°C, were obtained from Biśnik Cave and Krucza Skała shelter.

The warmest month temperatures ranged from +5.1°C to +18.1°C. The lowest values of the warmest month temperatures which fluctuated from +5.1°C to +9.6°C were obtained in the Late Pleistocene and Holocene layers in Deszczowa Cave and Krucza Skała shelter. The highest values, ranging from +15.0°C to +18.1°C, were obtained from the Middle Pleistocene layers from Biśnik Cave and the Late Pleistocene and Holocene layers from Komarowa Cave, Krucza Skała shelter and Obłazowa Cave.

The coldest month mean temperatures ranged from -22.1°C to -1.1°C. The lowest value of this parameter, fluctuating from -22.1°C to -18.1°C, were observed in some Late Pleistocene layers of Komarowa Cave, Obłazowa Cave and Krucza Skała shelter. In most localities the mean value of this parameter ranged from -14.0°C to -10.0°C. The highest values of this parameter fluctuated from -6.0°C to -1.0°C and were obtained from the Middle Pleistocene layers in Biśnik Cave and the Late Pleistocene and Holocene layers of Biśnik Cave, Komarowa Cave and Krucza Skała shelter.

The mean annual thermal amplitude ranged from 15.9°C to 33.1°C. In the late Middle Pleistocene the values of this parameter fluctuated from 21.2°C to 26.6°C. The highest values of this parameter were found in the Late Pleistocene layers and fluctuated between 25.2°C and 33.1°C. However, in layers deposited in the final period of the late Pleistocene (MIS 2) and the Holocene they were the lowest and ranged from 15.9°C to 20.9°C.

The values of total annual precipitation (P) fluctuated between 366 mm and 1467 mm. In most localities the values of this parameter changed significantly over time. Only in layers from Obłazowa Cave they fluctuated between 641 mm and 886 mm.

The analysis of bioclimatic parameters made it possible to determine the most probable type of climate and changes in climatic conditions. Most values of 11 climatic parameters reconstructed from rodent communities indicates changes in palaeoenvironments from the Late Middle to the Late Pleistocene and the Holocene The results of quantitative and qualitative bioclimatic analysis indicates that the rodent communities are good indicators of climate dynamics in the late Middle and Late Pleistocene.

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P. Socha
Department of Palaeozoology, Institute of Environmental Biology, University of Wrocław
Poland
E-mail: sochap@biol.uni.wroc.pl

RODENT BIODIVERSITY IN THE MIDDLE AND LATE PLEISTOCENE OF POLAND

Key words: rodents, Pleistocene, biodiversity, palaeoecology

More than twenty five rodent species from the late middle and the Late Pleistocene and Holocene were found in Poland. They come mainly from the caves of the Kraków-Częstochowa Upland, Pieniny Mts and Świętokrzyskie Mts. Most of the described assemblages derive from deposits of different phases of the last glaciation. The reconstruction of rodent biodiversity was based on mammal assemblages from caves and a rock shelter located in the Kraków-Częstochowa Upland (caves Biśnik, Deszczowa, Komarowa, shelter Krucza Skała), and in the Pieniny Mts (Obłazowa Cave) and dated as the period from late Middle Pleistocene (MIS 8) to the end of Late Pleistocene (MIS 2) and Holocene (MIS 1) (Valde-Nowak et al., 2003, Nadachowski et al., 2009, Socha 2009, 2014, Stefaniak et al., 2009). For two locations (Biśnik Cave and Deszczowa Cave) it was possible to trace the qualitative and quantitative changes in the rodent faunas from the late middle to the end of Late Pleistocene.

The indices used in the studies were: species richness (Margalef index), overall species diversity (Shannon-Wiener index) and similarity (Jaccard index) between the assemblages from different layers within the localities and between

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the localities. Changes in the species composition were traced on the background of deposits of various age, in the context of their geographical location, as well as qualitative and quantitative composition, depending on climatic conditions reconstructed for the studied locations. Arvicolidae constituted the dominant group of rodents in the analysed assemblages; representatives of other rodent families were less frequent.

The Margalef index values for the rodent assemblages fluctuated from 0.72 to 4.3. In Biśnik Cave the mean values ranged from 2.0 to 2.6 for the ratios obtained for assemblages from late Middle Pleistocene, beginning of Late Pleistocene and Late Pleistocene layers. In Deszczowa Cave the values of Margalef index fluctuated from 1.12 to 2.24. Mostly, they ranged between 1.19 and 2.0. The highest values were observed in the layers deposited in end of Late Pleistocene. The values of Margalef index (1.12–1.48) from the late Middle Pleistocene layers from Deszczowa Cave were smaller compared to the late Middle Pleistocene layers of Biśnik Cave (2.03–2.62). The values of Margalef index from the Late Pleistocene layers from the analysed localities were very variable. They varied from 0.72 to 4.3. Only in the Late Pleistocene layers of Obłazowa Cave the range of values of Margalef index was very small (generally ranging between 1.14 to 1.58).

The overall species diversity (Shannon-Wiener index) varied through time from 0.69 to 2.37. The highest values from late Middle Pleistocene were observed in the layers of Biśnik Cave (1.87–2.23). In analogous layers of Deszczowa Cave the values did not exceed 2.22. In the Late Pleistocene layers the variation of the values of Shannon-Wiener index was very wide. The highest values of the, falling in the range from 2.21 to 2.37, were obtained for Late Pleistocene and Holocene layers from Biśnik Cave and Krucza Skała shelter. Relatively high values were also found for the assemblages from layers dated as the late Middle Pleistocene. The lowest values were characteristic of layers dated as the Late Pleistocene.

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M.V. Sotnikova
Geological Institute, Russian Academy of Sciences
Moscow, Russia
E-mail: sotnikmarina@yandex.ru

A CANIDAE ASSEMBLAGE FROM THE KURUKSAY FAUNA (SOUTHERN TAJIKISTAN) AS THE REFLECTION OF THE MOST IMPORTANT EVENTS THAT OCCURRED AT THE BEGINNING OF EARLY PLEISTOCENE IN CENTRAL ASIA

Key words: Carnivora (Canidae), biostratigraphy, biochronological events, systematics, Early Pleistocene, Tajikistan, Central Asia

The primary Eurasian events that occurred at the beginning of the Pleistocene were: loess-paleosol accumulations coinciding with the appearance of abundant Equus in the Palearctic biogeographic region. Both events are reflected in the geological position and mammalian composition of the Early Pleistocene Kuruksay fauna of Central Asia (Vangengeim et al., 1988; Sotnikova et al., 1997). In southern Tajikistan this fauna is represented in the Kuruksay site and in the Obigarm and Tutak localities, which occur at the base of loess-paleosoil series. Paleomagnetic data indicate that these fossil sites fall in the lower part of the Matuyama Chron with the estimated age around 2.2–2.4 Ma. It is believed that the geochronological position of these mammalian sites coincides with the beginning of regional loess sedimentation. The latter is interpreted as an indication of the onset of climatic aridization (Dodonov, 2002).

The Kuruksay fauna is composed of rodents, primates, rhinos, elephants, giraffes, camels, and various cervids and bovids. But the main characteristics of Kuruksay fauna is the predominance of horses over all other mammals (Vangengeim et al., 1988). Among carnivores *Pliocrocuta perrieri* is the most abundant and occurs along with *Nyctereutes megamastoides*, coyote-sized *Canis kuruksaensis*, wolf-sized *Canis etruscus, Ursus etruscus, Chasmaporthetes lunensis, Lynx issiodorensis, Acinonyx pardinensis, Homotherium crenatidens* and *Megantereon cultridens* (Sotnikova, 1989; Sotnikova et al., 1997). This carnivore assemblage fits well to a common Middle Villafranchian carnivore association

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of Europe known from the St-Vallier in France and Puebla de Valverde in Spain. The only difference is the absence of *Canis*-like forms in the latter faunas.

Initially the small canid from Kuruksay was assigned to *Canis*, because its original description was published well before the naming of the genus *Eucyon* (Sotnikova 1989; Tedford, Qiu, 1997). The large form was not studied at all as it was found much later, but this canid was mentioned as *Canis etruscus* in Sotnikova, Dodonov, Pen'kov (1997). In recent years, the opinion on the systematic status of *Canis* members of the Kuruksay fauna has changed. The small canid *Eucyon kuruksaensis* and a large one *Canis* cf. *brevicephalus* were identified there. So to date, the most characteristic property of the Kuruksay carnivore assemblage is the presence of two unusual forms of Canini (Sotnikova, Rook, 2010).

The analysis has revealed that *E. kuruksaens* (= *Canis kuruksaens* sensu Sotnikova, 1989) actually belongs to the genus *Eucyon*. It has characters lacking in the true *Canis* but possessed by *Eucyon*. Among them there are a fan-shaped form of the supra-occipital shield and the lack of a transverse cristid uniting the m1 entoconid and hypoconid. In cranial length this form is close to *E. zhoui* from Pliocene of China but differs from it in very long premolars. *E. kuruksaens* differs from other Mio-Pliocene eucyon's species in a longer P4 relative to M1 and transversely extended M1. Their upper carnassial bears a taller paracone and metacone, more-developed parastyle, cusp-like metaconule, and concave outline of labial cingulum. According to the teeth morphology, *E. kuruksaensis* is more advanced towards the *Canis* group than all the Eurasian *Eucyon* and *Eucyon*-like species known to date.

The second wolf-sized canid from Kuruksay is here defined as *Canis* cf. *brevicephalus* since in size and LP1/LM1+LM2 ratio it fits well the type series of *C. brevicephalus* from Longdan fauna of China. Several species of wolf-sized members of the genus *Canis* have been described in the Early Pleistocene of China, namely, *Canis chihliensis*, *Canis palmidens* in the Nihewan fauna (nearly 1.8 Ma) and *C. teilhardi*, *C. longdanensis* and *C. brevicephalus* in the Longdan fauna aged of 2.2 Ma (Qiu et al., 2004; Qiu, 2006). Although all above mentioned taxa are comparable in size, the Kuruksay form differs from all of them by having a relatively small P4 and unusually widened M1 and wide and not reduced M2. The presence of transversely extended molars in this specimen indicates the primitive nature of the large canid from Kuruksay.

According to Qiu (2006), the beginning of the Pleistocene correlated with the pre-Olduvai Matuyama (2–2.5 Ma), was a significant time of faunal turnover in Asia. One of the important events of this period was the diversification of Canidae (especially their *Canis* members), which rapidly flourished and became dominant in the carnivore community in the central part of Asia (Sotnikova, Rook, 2010).

In the Early Pleistocene, the canid forms new to Eurasia had mostly short stratigraphic intervals. Similar taxa are represented in the Kuruksay fauna by *E. kuruksaensis* which was one of the latest and highly advanced members of *Eucyon* clade, and by *Canis* cf. *brevicephalus* who is here characterized as the most primitive form among wolf-sized Early Pleistocene canids.

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V.V. Stefanovskii[2], E.V. Zinoviev[1], T.V. Strukova[1], S.S. Trofimova[1], P.A. Kosintsev[1]

[1] Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia

[2] Open joint-stock company "Ural Geological Survey Expedition"
Ekaterinburg, Russia

E-mail: zin62@mail.ru

BIOSTRATIGRAPHY OF THE LATE PLEISTOCENE DEPOSITS IN THE SITE OF NIZHNYAYA TAVDA (WESTERN SIBERIA, RUSSIA)

Key words: large mammals, small mammals, insect fauna, pollen, plant macrofossils, vegetation, climate, alluvium, West Siberian, Late Pleistocene

A multy-proxy stratigraphic analysis of the exposure of Nizhnyaya Tavda is undertaken and paleoenvironmental conditions of the Late Pleistocene in the Western Siberia are reconstructed based on paleontological data. The exposure is situated on the right bank of Tavda River, in its lower reaches (57°40′N, 66 10′E). The cliff is 12–15 m high and stretches for 1.6 km. Fluvial complexes of the second and first above-floodplain terraces exposed in the cliff are overlain by lacustrine, eolian and deluvial deposits. Deposits of the second above-floodplain terrace are formed of stream bed facies, old-riverbed facies, and

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periglacial floodplain facies of flooding events. First above-floodplain terrace deposits are represented by stream bed and floodplain facies.

Radiocarbon dates are based on bone remains collected on the bank outcrops. A total of 16 dates are obtained and fall into three time spans: beyond recognition (7 dates), 40–25 kyr (4 dates), 22–19 kyr (5 dates).

Riverbed facies of the lower fluvial package lie below the water level, and are not yet characterized by biostratigraphic data. Old riverbed clays of the middle package are characterized by spore-pollen spectra and paleoentomological findings. The pollen spectrum reflects periglacial forest-steppe communities — pine-birch forests and herbaceous communities with *Artemisia* (up to 40%), Chenopodiaceae (12%) and mesophytes (10–18%). Spores of Athyrioideae make up 8–12, *Lycopodium* and sphagnum moss (up to 2%). Insect fauna comprises arcto-boreal species (*Diacheila polita*, *Pterostichus brevicornis*, *Tachinus brevipennis*), steppe species (*Aclypaea bicarinata, A. sericea*, *Poecilus ravus*) and those related to arboreal vegetation (*Notiophilus reitteri*, *Callirus*). It characterizes floodplain forests and open landscapes with patches of arboreal vegetation on flat interfluves (plakors), and suggests cool and dry climate conditions.

Periglacial floodplain facies of sands in the upper part of the alluvium of the second terrace are characterized by a micromammal assemblage of disharmonious type, with steppe and tundra species (*Microtus gregalis*, *Lagurus lagurus* and *Microtus oeconomus* predominate). Mollusk fauna comprise holarctic freshwater species *Valvata pulchella*, *Amesoda solida*, *Anisus acronicus*, *Euglesa nitida*, *E. hibernica*, *E. subtruncata*. Plant macrofossil analysis suggests local conditions of floodplain forests with spruce (*Picea obovata*) and birch (*Betula* sect. Albae). Insect fauna and pollen spectrum reflects cool arid conditions of sedimentation. Periglacial floodplain facies of sands in the upper part of the alluvium of the second terrace are dated back to Ermakovo stage (MIS-4).

Alluvium of the first above-floodplain terrace consists of the lower stream bed facies and the upper floodplain facies. Radiocarbon date of 27400±335 BP (SOAN-4534) is obtained for plant detritus from the stream bed sands of the lower part. Deposits are characterized by disharmonius micromammal fauna. Entomological complexes characterize floodplain forests with pine and spruce, and with pine forest patches and steppe-like areas on plakors. Plant macrofossil complex reflects floodplain forests with spruce, pine, larch and steppe-like patches on slopes with *Euphorbia, Allium*. The pollen spectrum suggests pine forests with birch (*Pinus sylvestris* (50–70%), *Betula* sp. (14–28%)) and open areas with herbaceous communities (*Artemisia* (28%), Chenopodiaceae (10%), mesophytes (8%)).

Radiocarbon date of 24820±750 BP (SOAN-4535) is obtained for plant detritus from the upper floodplain facies of the old-riverbed clays. A forest-steppe pollen spectrum comprises arboreal plants *Betula* sp. (20%), *Alnus* (12%), *Pinus* (10%), herbaceous plants dominated by xerophytes (32%), mesophytes (20%), and spores of Athyrioideae (8%). Insect fauna reflects floodplain forests with open landscapes with forest patches in the interfluves. In the plant macrofossil complex, the cryophilic species *Betula nana* and *Rumex sibirica* appear. Reconstructed climate conditions are cool and dry. Paleobotanical and paleoentomological data suggest relatively favorable conditions during the period of alluvial sedimentation in the MIS-3 optimum with a cooling tendency towards the end of the interstadial.

Covering complex of sediments is represented by greenish-grey silts with a paleosol. The pollen spectra are of periglacial forest-steppe type, with the predominance of herbaceous cummunities. Arboreal species include *Pinus* (12–16%), *Betula* sect. Albae (14–18%), *Alnus* (10–12%), *Salix* (2–4%), herbs — *Artemisia* (26%), Chenopodiaceae (8–10%), and mesophytes (8–14%)). Larch pollen appears in the spectra (2%), as well as Ericales (6–10%), and spores of Polypodiaceaea (8–12%), *Lycopodium* and *Sphagnum* (up to 2%). The spectra reflect the beginning of MIS-2.

A total of 1824 bones of large mammals was found on the bank outcrops, and then identified to species. All species are typical for the Late Pleistocene of the Urals and Western Siberia (Kosintsev, 2007; Kosintsev, Vasilyev, 2009). Radiocarbon dates and species composition suggest that the remains characterize the large mammal fauna of the region during MIS-4, MIS-3 and MIS-2. No species of the fauna typical for the optimum of MIS-5e is found. Species composition is as follows: *Mammuthus primigenius* — 49%; *Bison priscus* — 25%; *Equus ferus* — 13%; *Coelodonta antiquitatis* — 7%; *Ursus arctos*, *Cervus elaphus*, *Rangifer tarandus* — 1% each. Other species — *Lepus timidus, Castor fiber, Canis lupus, Ursus savini, Gulo gulo, Panthera spelaea, Megaloceras giganteus, Alces alces, Saiga tatarica, Ovibos moschatus* constitute less than 1%. The species composition is typical for open and semi-open landscapes with forest vegetation in the river floodplains.

Thus, open and semi-open landscapes with the predominance of herbaceous communities prevailed during the second half of the Late Pleistocene in Tavda River basin. Arboreal vegetation (primarily spruce, pine and birch) was patchily distributed and occurred on flat interfluves (plakors) and in floodplains. Climate was cool and dry. Plant community dynamics reflected some climatic fluctuations: forest-steppe landscapes with *Artemisia* and *Chenopodium* associations on plakors and spruce-pine-birch forests in floodplains prevailed during cool and arid time, whereas the areas covered by pine forests and steppe-like associations increased during the warm arid time. In general, the Late Pleistocene development of vegetation and fauna (insects and mammals) in the Tavda River basin followed the same pattern as it is known for the synchronous floras and faunas of the Urals and Western Siberia (Krivonogov, 1988; Arkhipov, Volkova, 1994; Zinovyev, 2003, 2007; Shpansky, 2006; Kosintsev, 2007; Kosintsev, Vasilyev, 2009; Lapteva, 2009).

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H. Thiemeyer, *S. Peters*
Institute of Physical Geography, Goethe-University Frankfurt
Germany
E-mail: thiemeyer@em.uni-frankfurt.de

LANDSCAPE AND SOILS AROUND THE PREHISTORIC SITE OF KAMMENYJ AMBAR

Key words: landscape, soils, Bronze Age, periglacial slope deposits, Trans Ural

About the microregion around the Bronze Age settlement Kamennyj Ambar which is situated in the valley of the Karagajly Ajat, only a few studies exist concerning mainly the archaeology of kurgans in the proximity of the settlement (Epimakhov, 2007), or are of geological interest dealing with regional sediment deposits in the entire area (Tevelev et al., 2007). However, there are certain similarities to the better known Arkaim-region in terms of geology, landscape development, and pedogenesis.

The Southern Urals are flanked in the east by the Transural Peneplain which stretches over 200 km towards the Siberian lowland. The relief was formed by denudation with typical gently undulating plains and low hills (Černjanskij, 1999) of Mesozoic-Tertiary age dipping slightly eastward, which subsequently was dissected during Pleistocene periglacial climatic conditions by wide valleys with gently inclined slopes. The weathering zones consist of kaolinite-

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and mica-bearing saprolite, which in parts reaches the surface today and whose uppermost layer was dislocated.

Given the long lasting periglacial history, the pre-quaternary basement is covered by a surprisingly thin layer of quaternary sediments. They mostly derived from deeply weathered underground rocks (saprolite); further, a loess-containing loamy cover is widespread largely overlaying the older basement. Up to now, we hardly found deposits of in-situ loess. The almost absent loess cover, as assumed in the Russian literature, might be due to prevailing deluvial processes during times of loess drift (cf. Nikolaev, 1999). However, in our opinion deluviation under periglacial conditions always played the dominant role, preventing the formation of noteworthy loess deposits, or quickly carried them off again. By mapping, we found that in some flat watershed positions thin loess deposits are preserved which were not reworked and removed by deluviation.

The slopes of the wide-spanned valley in the wider surrounding of Kamennyj Ambar are structured by numerous flat tributary valleys. They usually have a yellow-brown loam fill and show in their lower parts gully-like linear erosion features. In addition, Chernozem-derived sediments can be found in the valley fills which had been relocated by water. The shallow slopes are covered by thin Quaternary cover beds. These contain strongly weathered coarse components originating from the underground and indicating a solifluidal genesis of the cover beds. The degree of weathering of the autochthonous components increases towards the water divide where the cover beds consist almost completely of pre-Quaternary saprolite.

The flood plain possesses an internal structure, which can be identified on the basis of vegetation and channel patterns and weakly pronounced terrain edges on the Lower Terrace. Already excavated kurgans south of the river are for instance positioned on older parts of the Lower Terrace or on flat Pleistocene alluvial fans. The Lower Terrace of the Karagajly Ayat is composed of layers of sand and gravel, which are covered by Pleistocene high-flood loam, considerably fluctuating in thickness.

Decalcified Haplic Chernozems are prevalent soils in the fills of the tributary valleys, at the lower slopes of the Karagajly Ajat-valley and in the loams of the low terrace. In the decalcified parts of many soil profiles clay cutans and coatings can be observed. Thus, following decalcification, clay translocation appeared. These soils were identified as Luvic Chernozems with humus-rich topsoils depleted in clay due to mobilization and downward dislocation. On the shallow slopes, Haplic or Mollic Regosols are developed in thin cover beds. In deeper ones Haplic Phaeozems and Haplic Cambisols can be found. The soils have a very dense rooting zone. Upslope, the depth of the humus horizons decreases. The layer succession of the near-surface underground and the associated soil formations were examined along a catena crossing a tributary valley at the lower northern slope approx. 450 m north of the excavation side

Kamennyj Ambar (Fig. A13, Appendix 12). The depth of the cover beds on the slopes increases towards the valley floor. In the soils of the Lower Terrace varying salt contents can be found, which occasionally almost reach the surface. In these places Mollic Solonetz were identified.

Cross sections of the excavation site in Kamennyj Ambar revealed differing influences of the past settlements on soil formation. While Chernozems have developed in the fillings of younger pit houses, usually Terric Regosols and Terric Solonetz were found in the layers of the older Sintashta culture. The Chernozem formation in the relicts of the younger settlement phase (presumably Srubno-Alakul Culture after Koryakova & Epimakhov, 2007) demonstrates the resemblance of pre- and post-settlement soil formation, assuming the substrate being similar to a natural one. Nevertheless it must be investigated, why in the Sintashta-layers no genesis of Chernozems has taken place.

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M.P. Tiunov
Institute of Biology and Soil Science,
Far Eastern Branch of Russian Academy of Sciences
Vladivostok, Russia
E-mail: TIUNOV@biosoil.ru

MYOSPALAX PSILURUS — A RELIC OF THE SOUTHEASTERN OUTSKIRTS OF THE MAMMOTH FAUNA

Key words: North China Zokor, Late Pleistocene, Holocene, distribution, Far East Russia

It has relatively recently been shown based on genetic and craniometric data that zokors inhabiting the Primorsky and Zabaikalsky Regions belong to two different species, *Myospalax psilurus* (Milne-Edwards, 1874) and *M. epsilanus*

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(Thomas, 1912) (Puzachenko et al., 2011). The North China Zokor, *M. psilurus*, mostly inhabits stepped meadows. It is a rare endemic species of Eastern Asia that can be found in northeastern China and southern part of the Russian Far East. In Russia, the North China Zokor currently inhabits only four small isolated areas in the southwestern part of the Khanka plain (Fig. 1). The total number of this species in this area is less than 500. The species is inscribed on the Red Lists of the International Union for Conservation of Nature and Natural Resources, Russian Federation and Primorsky Region as a subspecies of *M. p. epsilanus*. It is considered to be a typical representative of the Mongolian-Daurian fauna that used to inhabit only the lowland areas of the Khanka plain. The main reason for the decline in its population size was land plowing.

Examination of the fossil samples collected from cave deposits in the Primorsky Region demonstrated that the habitat of the North China Zokor in the Late Pleistocen–Holocene was much larger. Bone remains of this species were found at the following locations:

1. Sukhaya cave located in Skalistaya Mountain, 5 km away from Barabash village in the southern Primorye, Khasansky district (110 m above sea level). When identifying the bone remains of animals found there during archeology excavations in 1998 (Kononenko et al., 2002), a zokor mandible was discovered in the third lithological unit of the exploratory shaft at a depth of 0.55–0.50 m. Sporopollen analysis showed that this unit corresponds to the Betula-Corylus-Pinus palynozone. The estimated

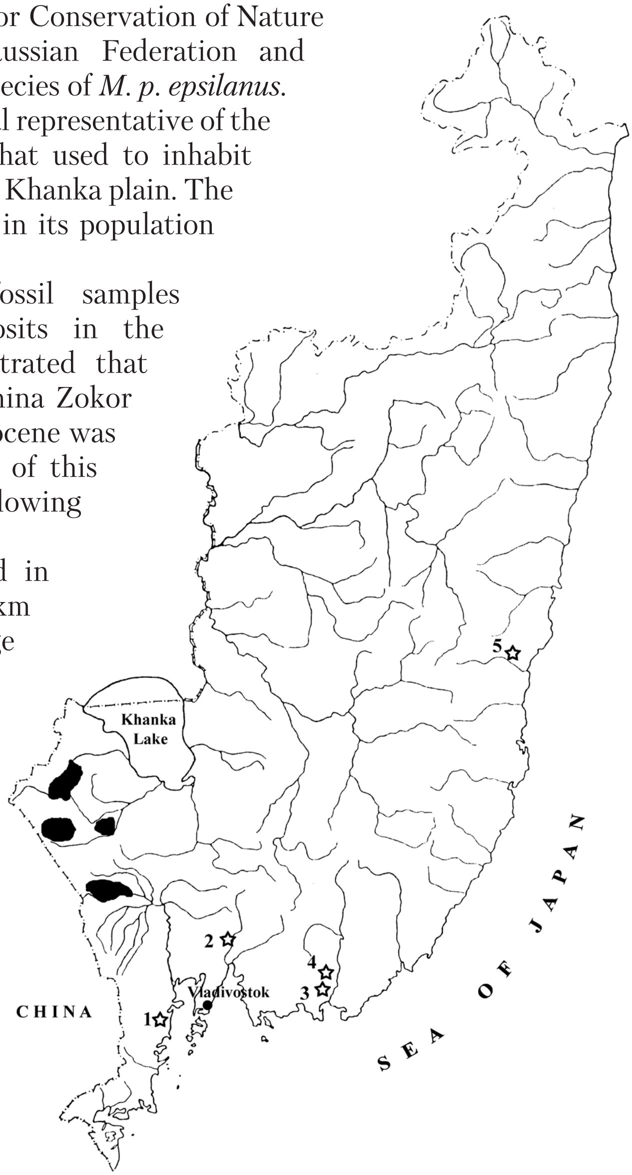

Fig. 1. Contemporary distribution of *Myospalax psilurus* (black areas) and the North China Zokor fossil samples (stars) in Primorsky Region

age is the early Boreal or mid-Preboreal period (9700–9300 years ago). The estimated age is the Pre-Boreal and Boreal phases of the Holocene Epoch (10500–7500 years ago).

2. Cave of Young Speleologists is located on the northern slope of Zhadov Mountain 1.5 km northeastwards away from Sudoverf village. The cave entrance is located 40 m away from the crest, under a rocky wall. The absolute altitude of the entrance is 228 m; the relative height above the level of the Artemovka River is 178 m. Individual teeth of the zokor were discovered at a depth of 0.60–0.35 m.

3. Bliznets cave resides in the southern slope of the Lozovy Ridge, a branch of the Sikhote-Alin Range, 25 km northwards from the city of Nakhodka. The entrance is located 300 m above sea level on the 40–50° slope. The entrance hole of Bliznets cave, with excavations carried out in its bottom, is a natural trap for numerous animals. Individual teeth of the zokor were found at a depth of 3.3–3.2 m (Alekseeva, 1986). The estimated age is the Subboreal phase of the Holocene (4800–2000 years ago) (Tiunov, 1997).

4. Medvezhiy Klyk cave resides in the Lozovy Ridge, 2.5 km away from Bliznets cave at a height of 465 m above sea level. The cave is a vertical karst cavity. Individual teeth of the zokor were found almost at all depths in the cave deposits. The age of the host deposits varies from 40,000 to 2000 years.

5. Tetukhinskaya cave is located northwards of the city of Dalnegorsk, deep in Late Triassic limestones. The cave entrance is located 410 m above sea level. Individual teeth of the zokor were found almost at all depths of cave deposits except for several upper horizons. The age of the uncovered deposits was estimated to be 30,000–3000 years.

The explored caves are located in the medium-altitude forest area 5–7 km away from the valleys of large rivers.

The excavations of bone fossils of the zokor in locations that currently belong to the typical forest zone of the southern Primorsky Region attest that open forest-steppe and steppe landscapes were more abundant in this area in the Late Pleistocene and Holocene. Meanwhile, it should be mentioned that bone remains of forest species are predominant in the layers where bone fossils of the zokor were found. This fact means that open landscapes were not predominant but were rather abundant at least along the river valleys and southern slopes of mountains. The disappearance of the zokor in the greatest area of the Primorsky Region over the past several millennia is obviously associated with degradation of its main habitats and prevalence of forest vegetation in these areas. The presence of bone fossils of the zokor in units corresponding both to warm and cold periods of the Late Pleistocene indicates that the previously existing ecosystem was stable. Kalyakin (2014) believes that it degraded only after the main edificators (proboscideans and large ungulates) had disappeared.

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M. Toker[1], A.M. Celal Şengör[2], S. Krastel[3],
F. Demirel-Schlüter[4], F. Niessen[5]

[1] Yuzuncu Yıl University, Department of Geophysical Engineering, Zeve Campus
Van, Turkey

[2] Istanbul Technical University, Eurasia Institute of Earth Sciences, Ayazaga Campus
Maslak-Istanbul, Turkey

[3] Leibniz Institute for Marine Sciences (IFM-GEOMAR)
Kiel, Germany

[4] University of Bremen, Department of Geosciences
Bremen, Germany

[5] Alfred Wegener Institute for Polar and Marine Research
Bremerhaven, Germany

E-mail: tokermu@gmail.com

THE PLIO-QUATERNARY DEFORMATION OF THE LAKE VAN BASIN (EASTERN ANATOLIA) FROM MULTI-CHANNEL SEISMIC REFLECTION PROFILES

Key words: Eastern Anatolia, Lake Van, Plio-Quaternary, Deformation, Faulting, Sedimentation

The Eastern Anatolia orogeny is the one of the best special areas along the Alp/Himalayan orogenesis in which to study deeper lake basins during collision and post-collisional periods (Fig. A14, Appendix 13). Lake Van is dome-shaped basin that lies in a tectonic depression formed through a combination of normal and strike-slip faulting and thrusting (Fig. A14). This faulting causes regional volcanism, earthquakes and hydrothermal activity. The geographic position of the lake is restricted to a critical region where the Afro/Arabian Plate from S

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meets the Eurasian Plate from N and E. The lake is near the Karlıova tectonic plate triple junction and this allows fluids from the Earth's mantle to accumulate in Lake Van and the nearby crater lake of the Nemrut volcano. The lake and the surrounding areas are of special interest since they are located almost above the rifting of an inferred slab-break off or above the edge of the lithospheric delamination. The lake also indicates an orogenic paradigm, strongly implicating a post-collisional crust-forming process in Turkic-type orogens. The unusual structural emplacement and basinal obliquity of Lake Van means there are complicated tectonic interactions with unstable structural trends around the lake which give dramatic examples of the ongoing deformational evolution of the Lake Van.

Although the extensive geophysical research has been carried out by various teams on diverse topics and in different areas in E-Anatolia, an overall understanding of the properties of Lake Van and the surrounding area is still lacking. The different types of problems that arise in the research concerning the Lake Van basin offer challenges to the Quaternary scientific community. Understanding the Quaternary deformation and basin formation has spawned a scientifically rich multidisciplinary on-going observational and theoretical efforts involving the Eastern Turkey Seismic Experiment (ETSE-Project, 2003) and the International Continental Scientific Drilling Program-PaleoVan-2004 project (ICDP, PaleoVan-2004). In this study, we have compiled all available ICDP seismic reflection data across Lake Van basin given in Fig. A14 to show the structural elements and deformational features of the Lake Van. We have plotted deformational map of the lake and superimposed on the morpho-physiographic map in Fig. A15, Appendix 13, to show the cross-cutting structures with basin-bounding faults as given in the next sections;

Folding and faulting: the fold structures were clearly seen in the seismic sections. In the N-limit of the central Tatvan basin, close to the N-margin, the upper part of the sedimentary section seems to have developed as a positive flower structure, with a reverse rather than normal sense of movement (Fig. A15). It forms fold structures, which increase in amplitude upwards through the section. The seismic sections are interpreted as showing that the Plio-Quaternary structure of the area was developed in a transtensional tectonic regime in W-margin, while the tectonic regime was transpressional in N-margin (see Fig. A15). The depositional sequences in N-margin are seen to thin towards the flank of the NE-Erek delta. These sequences onlap the flanks of this extended delta (low-angle delta progradation). This shows that the NE-Erek delta is a growth structure during the deposition of all the sedimentary units in the basin.

The sedimentary cover of the central Tatvan basin is folded in a simple fashion. These folds are interpreted as distinguished by being overlain by unfolded beds and underlain by folded beds, due to sedimentary slumping. The N-margin boundary fault is vertical or steeply dipping and fall into two sets, one divergent strike-slip, and the other convergent strike-slip, trending E-W. Both sets of faults cut across dipping beds and are therefore probably later than the folding.

Basin subsidence: the fault-controlled episodic sequences of turbiditic events and debris flow along all the margin boundaries of the lake suggest that subsidence is not uniform throughout the basin, with greater subsidence and thick sediments in the Deveboynu and the Varis spur zone subbasins (Fig. A15). As shown in Fig. A15, due to the strong regional uplift in the Çarpanak spur zone, together with the NE-Erek delta (formation of angular unconformity), uneven asymmetric subsidence and rapid sedimentation are the greatest in the central Tatvan basin and subbasins. The greatest thickness of sediments is found in the central part of Tatvan basin (approx. 600 m thick) and the sediments thin out over the S-margin (approx. 350 m thick). With continuing subsidence, but a decrease in sediment supply, a major transgression might have occurred at some time in the Pleistocene period, so that deposits were spread across the delta surface, as in onlapping sequences in NE-Erek delta (Fig. A15). At the time of maximum transgression, sedimentation extended toward the E and NE to reach the delta well beyond the bounds of the Tatvan basin (NE-Erek delta). It may be assumed that differential and asymmetric subsidence continued during the deposition of Plio-Quaternary sediments, which marks a transgressive phase. This is followed by the delta sediments (Quaternary), representing the period of maximum transgression.

Block uplift and angular unconformity surface: angular unconformity were clearly seen through the seismic sections, suggesting that the delta sediments are eroded from developing uplifted structures (Deveboynu peninsula and Çarpanak spur zone) and deposited locally in the subbasins (Fig. A15). There is a unconformity surface locally developed in the uplifted fault block of the Çarpanak province, covering the whole area of the NE-Erek delta (Fig. A15). The younger, probably Quaternary-aged sediments rest on the older rocks with an angular unconformity, but towards the central Tatvan basin, this unconformity disappears. This surface extends along the whole NE-Erek delta and is buried toward the gulf of Erçiş further N (Fig. A15). The angular unconformity between the Quaternary and the Pre-Quaternary rocks could be considered to be a well-exposed surface in the early stages of the development of internal subbasins (Deveboynu and Varis spur zone) of the lake. These subbasins are infilled by erosion products derived locally from the basement uplifts (Deveboynu peninsula and Çarpanak spur zone) in an extensional or transtensional phase. These seismic sections show that these depocentres during the deposition of the Quaternary sediments are situated in areas which later became the sites of uplifted blocks. It is assumed that the uplift and erosion of Çarpanak province probably in the latest Miocene-earliest Pliocene provided a source of sediments for the subbasins. These deposits above the angular unconformity are probably overlain by Pleistocene to Recent alluvial deposits. Evaluation of the angular unconformity surface considering the seismic data proposes that the whole of the Çarpanak area (also with NE-Erek delta) is uplifted and exposed to subaerial erosion, probably with a landscape of significant relief (Fig. A15). This process supplied large quantities of terrigenous sediment to the extensional and transtensional subbasins. At the same time, the lake region itself underwent major subsidence. Prograding sediments overwhelmed the basement banks as sediment supply exceeded the rate of subsidence, built out to form a continental shelf and a continental slope towards the E and NE (Fig. A15).

The Central Tatvan basin: the fault-controlled block geometry of the central Tatvan basin is illustrated in the seismic sections. The Tatvan basin bathymetrically shows regular and straight lineaments at the accommodation zones, which are associated with the N-, S- and W-margin boundary faults (Fig. A15). This basin terminates at faults with the same orientation. The margins of the central Tatvan basin in W and S seem to be covered by intrusive-extrusive activity (Fig. A15). Although not clearly observed, it could be considered that S-limit of the central Tatvan basin is bounded by a broadly widening transtensional shear zone through S-margin, parallel to the Muş suture complex. The S-margin boundary, at the S-end of central Tatvan basin, is a complicated structural feature, characterized by active intrusions and a passive collapsed dome-cone complex (Fig. A15). The overall geometry and basement structure of the central Tatvan basin is interpreted as a rhomboidal wedge-block between the margin boundary faults as a result of local extension and transtension. The sequence of events which can deduced from the time-rock relationships is that the earliest stage was a period of local extension and the formation of an asymmetric block structure. It is possible that the deformation with strike-slip faulting and oblique compression caused the activation of the normal faults and formation of the fold structure in the basin, probably occurring during the Plio-Quaternary period. The central Tatvan basin is thus considered to have originated as a tilted wedge-block (e.g., half-graben) in the Late Pliocene, during the same phase of extension in which the subbasins were formed in the lake.

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V.G. Trifonov [1], V.P. Lyubin [2], E.V. Belyaeva[2], V.A. Lebedev[3],
Ya. I. Trikhunkov [1], A.S. Tesakov [1], A.N. Simakova [1],
R.V. Veselovsky [4], A.V. Latyshev [5], Kh. Meliksetian [6],
S.L. Presnyakov [7], T.P. Ivanova [1], D.V. Ozhereliev [8],
D.M. Bachmanov [1], S.E. Artyushkov [4], S.M. Lyapunov [1]

[1] Geological Institute of the Russian Academy of Sciences (RAS)
Moscow, Russia
[2] Institute of History of Material Culture of the RAS
St. Petersburg, Russia
[3] Institute of Geology of Ore Deposits, Petrography,
Mineralogy and Geochemistry of the RAS
Moscow, Russia
[4] Geological Faculty, Lomonosov's State University
Moscow, Russia
[5] Institute of Physics of the Earth of the RAS
Moscow, Russia
[6] Institute of Geosciences of the Armenian National Academy of Sciences,
Yerevan, Armenia
[7] Centre of Isotopic Research,
A. P. Karpinsky Russian Geological Research Institute (VSEGEI)
St. Petersburg, Russia
[8] Institute of Archaeology of the RAS
Moscow, Russia

E-mail: trifonov@ginras.ru, jarsun@yandex.ru

EARLY PLEISTOCENE OF NORTH-WEST ARMENIA: STRATIGRAPHY, ARCHAEOLOGY AND TECTONICS

Keywords: Gelasian, Calabrian, K-Ar dating, residual magnetic polarity, mammal fossils, pollen analysis, Early and Middle Acheulian, volcanism, tectonic uplift

The Quaternary stratigraphy and tectonic development of the southern Javakheti Upland and the adjacent Upper Akhurian and Lori uplifted basins in NW Armenia (Lesser Caucasus) as well as geological position of the early and middle Acheulian lithic industries within the Lower Pleistocene deposits are under consideration. The studies of sedimentary sections and their relationships, the petrological and geochemical correlation of volcanic lavas and tuffs, the K-Ar dating of volcanic rocks and the SIMS U-Pb dating of tuffs, the examination of obtained fossils and the pollen analysis, and the determination of residual magnetic polarity of volcanic rocks and clastic sediments have been used to compile the stratigraphic scheme and to estimate the age of volcanic and sedimentary units.

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The low-mountain topography was differentiated in low ridges and basins by the beginning of Quaternary. The eruptions of moderately alkaline basalts and basaltic andesites evened the topography of the Upper Akhurian and Lori basins in the Gelasian. The lava flows spread along major river valleys for tens of kilometers. At the late Gelasian, the eruptions of basaltic trachyandesites, trachyandesites, and trachydacites supplemented and later replaced the basaltic eruptions (Lebedev et al., 2008). The latter dammed the Akhurian River flowing to the south to the Shirak Basin and the upper Akhurian River found the new outlet to the east via the valley-like depression of the Karakhach Pass to the Dzoraghet-Debed valley. The relatively course-grained tuffaceous-clastic Karakhach unit was deposited in the basins during the Olduvai subchron (not earlier than 1.9–1.85 Ma) and the earliest Calabrian. The unit consists mostly of poorly sorted and semi-rounded alluvium of temporary streams. The water transit between the Upper Akhurian and Lori basins was interrupted later because of starting uplift of the Karakhach Pass. Volcanic activity renewed in the southern Javakheti Upland and the Upper Akhurian Basin surroundings for a short time in the early Calabrian (~1.7 Ma). The pulse of acid tuff explosions was expressed in the southern Lori Basin in the middle Calabrian (1.5–1.4 Ma). The terminal Calabrian and earliest Middle Pleistocene sedimentation (~1–0.5 Ma) occurred in stagnant waters, partly lacustrine conditions. This was expressed by the formation of a relatively fine-grained Kurtan unit. During the last ~0.5 Ma, the region underwent the flexure-fault deformation and tectonic uplift at 350–800 m. The climate became more continental.

The epoch of formation of the Karakhach unit was characterized by medium height mountain topography and humid climate. At that epoch, not later than 1.85 Ma, the region was occupied by the earliest hominines producing lithic industries of the Early Acheulian aspect (Belyaeva, Lyubin, 2013). They contained handaxes and other macro-tools, made of local trachydacite and basalt (sites of Karakhach, Muradovo, and Agvorik). Early appearance and special features of these industries may suggest their autochthonous origin. This might be caused by specific features of the local rocks, namely natural plating of trachydacite and basalt to tabulated fragments that gave a possibility to make such macro-tools. The Middle Acheulian artifacts were found in the Kurtan I section of the Kurtan unit. They are also made of local volcanic rocks and generally demonstrate technological and morphological features succeeding to the local Early Acheulian tradition, but have also some similarities to the simultaneous Middle Acheulian industry of the Latamna site in Syria.

Apart form Armenia, the archaeological records of early hominine habitation in the Arabian-Caucasus region at the end of the Olduvai subchron and during the earliest Calabrian were found in Syria (the Orontes and Euphrates river valleys) (Trifonov et al., 2013), the south-eastern Turkey (the Euphrates valley), and the southern Georgia (Dmanisi site in the Mashavera River valley). All theses areas were similar with the East African motherland of the earliest hominines by two specific landscape features. They are, first, tectonic valley-like depressions with lakes, streams and other water sources and, second, volcanic manifestations that preceded or were approximately synchronous with the early hominines. Presence of water and fertile soils that were enriched by volcanic products backed the vegetation favourable for herbivorous mammals. The abundant resources of mammalian herbivores attracted predators, including the hominines.

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C. Turner[1], B. Urban[2], T. van Kolfschoten[3]

[1] Quaternary Environments Group, Dept. of Geography, University of Cambridge UK

[2] Leuphana University of Lüneburg, Institute of Ecology, Subject Area Landscape Change Lüneburg, Germany

[3] Leiden University, Faculty of Archaeology

E-mail: chassturner@aol.com

THE SCHÖNINGEN MIDDLE PLEISTOCENE SEQUENCE: PALAEOENVIRONMENT AND DATING

Key words: late Middle Pleistocene, biostratigraphy, Holsteinian Interglacial, Reinsdorf Interglacial, Schöningen

The long-term archaeological excavations in the Schöningen open-cast mine (Lower Saxony, Germany (Thieme, 1997)) have been accompanied by various geo-biological investigations since 1983. A biostratigraphical framework for the subdivision of the Quaternary deposits from the glaciated part of North Western Germany, ranging from the Younger Middle Pleistocene to the

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Holocene, was established by the investigation of numerous profiles, often exposed only for a short time during mining (Urban, 2007, Urban et al., 2011). As the sedimentary interglacial-glacial deposits of Schöningen lie in a definite stratigraphic position above Elsterian deposits and both intercalate and overlie Saalian glacial deposits, the site provides a key link between the unglaciated and glaciated areas in Western Central Europe.

It is not only since the discovery of the palaeolithic hunting spears (Thieme, 1997) that the stratigraphic position and correlation of the Holsteinian, Reinsdorf and Schöningen interglacial deposits in the Schöningen mine are a matter of dispute (Urban, 2007; Kuijjer, 2014). There seems to be chronometric age evidence for a correlation between Holsteinian deposits within the type site area and MIS 9 (Geyh, Müller, 2007); however, further evidence of such a correlation needs to be discussed in light of prior and recent bio-geological results of the oldest archeological horizon of the sites Schöningen 13 I (1994, 1996) and Schöningen 13 I DB (2008) as well as the excavations at Schöningen 12 (2009), all unpublished so far and 13 II. One of the crucial criteria is the great palynological discrepancy between the Holsteinian pollen spectra of the Northern Mining field and those of the Reinsdorf Interglacial, with deposits that have recently been dated to ca. 300 ka (Th/U Sierralta et al., 2012, Urban et al., 2011).

Schöningen 12 II and 13 II deposits (Reinsdorf Interglacial) show great disparities compared with the classical Holsteinian pollen zones (Müller, 1974). A significant difference between the Holsteinian pollen sequences of the northern mining field and those of the adjacent profiles of Schöningen 13 I and 13 I DB of the southern mining field and the Reinsdorf interglacial pollen spectra lies within the quantitative and temporal appearance of *Abies* and *Carpinus*. Whereas *Abies* occurs less frequent than *Carpinus* during the Reinsdorf Interglacial, an opposite pattern characterises the pollen flora and deposits of sites Schöningen 13 I and 13 I DB (southern mining field) and deposits of the northern mining field assigned to the Holsteinian. Those observations combined with further lithological evidence and chronometric age determinations (Schöningen 13 I – 300–400 ka: Richter, Thieme, 2012; Reinsdorf Interglacial (Schöningen 13 II) – ca. 300 ka: Urban et al., 2011, Sierralta et al., 2012) stresses the need for a reconsideration of the (chrono) stratigraphic position of the archaeological find horizons of Schöningen, which are assigned to the Holsteinian by many authors without reliable chronometric evidence and with a disregard for the biostratigraphic discrepancies.

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A.I. Ulitko
Institute of Plant and Animal Ecology Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: ulitko@ipae.uran.ru

STRATIGRAPHY OF SEDIMENTS AND MAMMALS IN THE KARST CAVES IN THE IRGINA RIVER VALLEY (MIDDLE URALS)

Key words: stratigraphy, taphocenosis, mammalian fauna, Middle Urals

One of the important conditions for the study of the fauna's history in a certain area is the presence of well-stratified sediments containing representative taphocenoses. In the southwestern part of the Middle Urals, most of these sediments are known in the southern and eastern parts of Krasnoufimsk forest-steppe (Smirnov, 1993). The northern part of it is insufficiently studied. During the field expeditions to the Irgina River valley organized by IPAE UB RAS in 2009–2010 the new localities of Holocene mammals were described and studied by the author. Below there are data on stratigraphy, taphonomy and mammalian species composition of these localities.

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Rock-shelter Ust-Log-1. It is located in 1.5 km from the village of Ust-Log, Suksun district of the Perm Krai, on the right bank of the Irgina river, a tributary of Sylva river, at the base of a limestone cliff at a height of about 70 m above the shore line. Entrance into the shelter, 1.6 m wide, is oriented to the south-west. Depth of the shelter is 1.1 m. A pit, 1 square m in area and 55 cm deep, was laid in the central part of the shelter.

Layer 1. Grey sandy humus loam with rubble. It contains a lot of remains of small mammals, birds, fish, reptiles and amphibians. According to the taphocenosis' species composition and preservation of the material, its accumulation took place during the nesting of eagle-owls. Of mammals, except the bones of rodents, in the layer there are remains of *Vulpes vulpes*, *Lepus timidus*, *Mustela erminea* and *Talpa europaea*.Thickness of the layer 1 is 4 cm. Radiocarbon analysis showed the age of 2664 ± 100 years (SPb-920).

Layer 2. Dark grey, brownish strong humus loam contains rounded gravel and plenty of vertebrate remains. Taphocenosis was formed during the nesting of eagle-owls. Of mammals, except rodents, the layer contains *Lepus timidus*, *Vulpes vulpes*, *Martes* sp., *Mustela nivalis*, *Mustela erminea* and *Talpa europaea*. Thickness is 26 — 30 cm. The layer formation time corresponds to the Subboreal period of the Holocene based on the stratigraphic position.

Layer 3. Grey sandy loam with rubble and remains of vertebrates, including *Lepus timidus* and *Mustela erminea*. Radiocarbon date obtained from the bones of rodents is 5370 ± 70 years (SPb-807).

Fauna of large mammals from sediments of the cave consists of polyzonal and forest species, and forest characterizes the conditions that existed in the study area during the second half of the Holocene.

Nizhneirginsky Grotto is located on the left bank of the Irgina River, on the outskirts of the village Nizhneirginskoe, Sverdlovsk region. Grotto is located in a limestone cliff 70 meters above the river. Width of the entrance is 3.2 m, height — 3–3.5 m, length — 4 m. Loose sediments are studied on an area of 1.75 square meters. Thickness of sediments is 0.5 m. In the western wall there is a hole of *Vulpes vulpe*s.

Layer 1 is represented by black, humus sandy loam with fine gravel. Thickness is 5–7 cm. The layer contains some remains of birds, small mammals and *Lepus timidus*.

Below there lies a layer of reddish brown sandy loam with gravel (layer 2). Thickness is from 7 to 12–15 cm in the center of the grotto. On the transverse profiles there is a noticeable protrusion of the sediments of the layer 2 into the underlying layer 3. Here, the concentration of bones is the highest. Further analysis of bone material showed that at the beginning of the formation of the layer 2 the grotto was used for nesting by avian predators like eagle-owl *Bubo bubo*, and the underlying layer in the middle of the grotto was partially dug up and deepened. Layer 2 contains a large number of bones of vertebrates, especially rodents. Other mammals are represented by six species — three polyzonal (*Lepus timidus*, *Vulpes vulpes* and *Mustela nivalis*), and three forest species — *Talpa europaea*, *Ursus arctos* and *Mustela erminea*. Radiocarbon age of the layer is 2650 ± 70 years (SPb-915).

Layer 3. Light grey, brownish sandy loam, up to 25 cm thick, with gravel and boulders. The layer contains a large amount of vertebrate remains.

In the western part of the excavation, below the layer 2, which is the thinnest here, at a depth of 0.1–0.15 m there lays the light brown sandy loam (sublayer 3A). In the wall it replaces the layer 3, and closer to the central part it wedges into the layer 3, in the form of lenses. Probably in the western wall of the grotto there is a crack through which the grotto has developed. Sediments of the sublayer 3A were removed via this crack from the internal cavities of the rock and then mixed with humus loam from outside the grotto to form the layer 3 during one of the Holocene sub-periods. Then, as a result of the activity of birds and four-legged predators the bone material accumulated in the sediments. Large mammals are represented by eight species. Among them are three polyzonal species — *Lepus timidus*, *Canis lupus* and *Vulpes vulpes*. Number of forest species increased to four due to the appearance of *Martes* sp., and one intrazonal species — *Castor fiber*. A series of radiocarbon dates obtained from the bone remains of small mammals found in this layer ranges from 2945 ± 80 years (SPb-809) to 3770 ± 100 years (SPb-914).

Taphocenoses comprise mostly rodents. Besides, there are bones and teeth of large mammals, as well as the remains of birds, fish and amphibians. Most of the bones of large mammals are highly fragmented. The fauna and conservation of fossil remains indicate that they come form the pellets of birds. It is possible that sometimes the grotto served as a den for mammalian predators.

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V. Valdayskikh[1], *T. Zhdanova*[2], *D. Filimonova*[1]
[1] Ural Federal University named after the First President of Russia B. N. Yeltsin
Ekaterinburg, Russia
[2] Institute of Plant and Animal Ecology Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: v_vald@mail.ru

SOME FEATURES OF 4-MILLENIUM BURIED SOILS OF ZAURALYE (TRANS-URALS)

Key words: paleoenvironmental reconstructions, Bronze Age, Zauralye, steppe, buried soils

A comparative analysis of morphological and physico-chemical parameters of buried soils near Kamennyi Ambar settlement (Russia, Chelyabinsk region, typical steppe, age is estimated at 4000 years) with those of background soils of Holocene age was performed for paleoclimatic reconstructions. Also similar archaeological site's buried soils of Bronze Age a bit to the north were studied: on the border of forest and steppe and in coniferous subtaiga of Zauralye and Western Siberia.

Carbonate horizon of buried soils of the settlement of Kamennyi Ambar lies higher than the corresponding horizon of background soils (32 and 37 cm, respectively). CO_2 content of carbonates in the ancient soil was 2.51–3.16%, while in the corresponding background soil horizons it was estimated at 1.75–2.25%. The humus horizon of buried soils was slightly greater than that of the background (14 and 12 cm, respectively), the total carbon content in the uppermost layer of humus at the time of burial appeared to be higher (up to 4.80±0.54%), than in the background soils (up to 3.56%), but it decreased sharply over the profile.

In the fractional composition of humus the values C_{HA}/C_{FA} of buried soils (1.30±0.12) were higher than in the upper oversaline horizons of background soils (0.54–0.94). Taking into account the other parameters (total soluble salt content up to 0.214%, exchangeable sodium content up to 587.72 mg/100 g) in the buried horizon [A_1] the absence of oversaline horizon in buried soils may be assumed.

Based on all morphological parameters, the content and composition of soluble salts, the content and profile difference of total carbon, the fractional and group composition of humus, the optical densities of humic acids, it can be concluded that the studied buried soils formed under the conditions different from the current ones. Apparently, one can speak of a greater aridity in the period when these soils were formed both in modern typical steppe, and at

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the sites of the same age on the border of modern forest-steppe and steppe and coniferous subtaiga where similar regularities were pronounced.

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L.E. Yalkovskaya[1], P.A. Sibiryakov[1], A.V. Borodin[1, 2]
[1] Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
[2] Institute of Natural Science, Ural Federal University
Ekaterinburg, Russia
E-mail: lida@ipae.uran.ru

FOSSIL FINDS AND MOLECULAR PHYLOGEOGRAPHY OF THE SIBERIAN FLYING SQUIRREL (*PTEROMYS VOLANS* L., 1758)

Key words: Holocene, Late Pleistocene, mtDNA, phylogeography, Pteromys volans, fossils

The presence of species with well-defined ecological characteristics in fossil assemblages is widely used as an indicator for indirect verification of the Quaternary paleoenvironmental and paleogeographic reconstructions. One of such indicator species is Siberian flying squirrel (*Pteromys volans* L., 1758), which inhabits spruce-dominated boreal forests throughout the whole coniferous forest zone of Eurasia from Finland and the Baltic Sea to the Eastern Siberia and Korean Peninsula, Sakhalin Island and Hokkaido Island (Nowak, 1999). The data on origin of modern *P. volans* and on its expansion in coniferous forest zone of Eurasia are scarce.

Remains of *P. volans* in paleontological materials, as a rule, are not numerous, which is determined by ecological characteristics of the species. Finds of *P. volans* greatly vary in age. Appearance of flying squirrels on considerable territory (Belarus, the Urals, Western Siberia, Yakutia) is associated with time of formation of the modern coniferous forest zone in the second part of the Holocene, which was confirmed by ^{14}C dating (Kosincev, Bachura, 2013; Yakovlev et al., 2005; Smirnov, 1994; Boeskorov, 2005). Known finds of *Pteromys* in Far East and in Pre-Baikal region are older: 30–24 kyr ago and 13.8–14.2 kyr ago (Panasenko, Tiunov, 2010), as well as 33 kyr ago (Ovodov, 2003). Remains of *P. volans* in Late Pleistocene sediments were found together with those of the species, which disappeared from this territory in the Holocene. The most ancient finds of flying squirrel are known from Altai caves, which are famous due to the finds of Denisova hominin: from 24 to 34.5 kyr, layer 2 in Logovo Gieny

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Cave (Chikisheva et al., 2007); 29200±36 – 50000±12000, 69000±17000; 171000–282000 layers 11, 14.2, 19.1, 22 in Denisova Cave (Derevyanko et al., 2003). Even if we exclude the oldest radiothermoluminescent dates obtained for the layers 14 and 22 due to their uncertainty (http://antropogenez.ru/location/240/), the age of the finds exceeds 40 kyr.

Development of molecular-genetic methods has promoted the phylogeographic approach for reconstruction of species history and for exploration of population differentiation (Oshida et al., 2000, 2005; Lee et al., 2008). However, until recently no molecular-genetic data on *P. volans* from significant territory of the central part of the species range (the Urals and Western Siberia) were available for analysis of the species' phylogeographic structure.

We identified 4 haplotypes (cyt b) of *P. volans* in the Middle Urals (on the western mountainside and two localities on the eastern mountainside) and compared the existing phylogeographic data, including our own materials, with the paleontological data on the distribution of this species.

Haplotypes of *P. volans* from the Middle Urals fit into Northwestern Eurasia subclade of Northern Eurasia clade (Oshida et al., 2000, 2005). Obtained results are in agreement with the latest phylogeographic inferences on *P. volans* (Lee et al., 2008): the center of species origin was in Southeastern Asia (high genotypic diversity of *P. volans* in this region and the presence of haplotypes of nearly all phylogroups). The Hokkaido clade is well differentiated that might be a result of the earlier isolation of the island population. The divergence within Northern Eurasia clade took place later. Finally, Northwestern Eurasia subclade diverged in a short time to spread out over the large territory from the Baikal Lake to the western boundary of the present day species range.

According to paleontological and molecular-genetic data, the common tendencies of higher haplotype diversity and the earliest dating of the fossil finds of *P. volans* near the hypothesized center of species origin (Southeastern Asia and Far East) could be revealed. However, the age of the earliest fossil remains of flying squirrels found in Altai contradicts the age of the Altai population of the flying squirrel inferred from the molecular data. Modern *P. volans* in Altai and in the Urals belong to the same subclade, Nothwestern Eurasia, which is genetically homogeneous and is supposed to be the youngest one. This contradiction is possibly concerned with the absence of genetic succession between modern *P. volans* and *Pteromys* found in the Pleistocene faunas of Altai and Baikal region. The obtained results suggest that there were several waves of expansion of *P. volans* in Northern Eurasia. Modern species range (at least in its western part) is a result of the last wave of expansion and was formed in a single moment on a geological time scale (during the last 6 kyr). If this suggestion is confirmed, the presence of *P. volans* in the fossil assemblages of some geological periods in Altai, Baikal region and Far East might be considered as an indicator of the faunal exchange between these territories and the Southeastern Asia. Future investigations in this area of research are important for inferring environmental circumstances, faunal interrelations and early human migrations among the regions of Asia and within the Northern Eurasia, and also for verifying the hypothesis of migration of Denisova hominins from Southeastern Asia to Altai.

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A. Zastrozhnov[1], *G. Danukalova*[2], *D. Zastrozhnov*[1], *S. Popov*[3]
1 A. P. Karpinsky Russian Geological Research Institute (VSEGEI)
St. Petersburg, Russia
[2] Institute of Geology, Ufimian scientific centre RAS
Ufa, Russia
[3] Palaeontological institute RAS, Moscow, Russia
E-mails: zast@vsegei.ru; danukalova@ufaras.ru

THE MAIN MATTERS OF STRATIFICATION FOR LOWER VOLGA NEOPLEISTOCENE, RUSSIAN FEDERATION

Key words: Pleistocene, Lower Volga, stratigraphy

The study area is located in the south-east margin of the Russian Platform. Sea basins, existed within the territory of present-day Caspian Sea, had been developing for Cenozoic in a transgressive-regressive regime there.

The Lower Volga Neopleistocene sections have been attracting geologists' attention for 100 years. They are easily accessible, well exposed along 350 km and contain fossils of large and small mammals, amphibians, molluscans, seeds and palynoflora, with isotopic and paleomagnetic data.

The sections were studied by a number of researchers (Pravoslavlev, 1903–1939; Zhukov, 1945; Gromov, 1935; Grichuk, 1952–1954; Fedorov, 1957, 1978; Vasilyev, 1961; Moskvitin, 1962; Goretsky, 1966; Shkatova, 1973; Sedaykin, 1988; Schepetnov, 1989; Svitoch and Yanina, 1975–2009). Over the last years the sequences exposed there were correlated with isotope-oxygen stages (Shkatova, 2006; Yanina, 2009).

At the present time FGUP "VSEGEI" carries out geological mapping works of 1:200 000 scale within L-38-XI, XII map sheet where these classic Neopleistocene sections are situated. It is worth noting the stratigraphic scheme of Quaternary successions of Lover Volga Region was established by the Interdepartmental Stratigraphic Committee (ISC) of USSR in 1980's, thus, there is necessity in making upgraded stratigraphic basis for improving of geological certainty and quality of Quaternary deposits maps.

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Our studies of the sections done in 2008–2013 as well as analysis of previous researches allow summarizing following main problematic points of stratification for the region, and existing stratigraphic schemes as a result:

1. Ambiguous interpretation of Bakunian, Singilian, Khazarian (lower and upper), Atelian and Khvalynian successions, their presence or absence in described observation points.

2. An absence of precise tying of observation points in the process of description and definition of new Quaternary units.

3. Different approaches to identification of index species of molluscs and the term "species" itself, what led to setting of new taxons.

This difference often aggravated by schematic description of outcrops and stratigraphic columns and definition of species without adduction of description and images, is occasionally quite significant.

Hence, despite wealth of data, the matters of stratification of these sections, sometimes called as reference for Pleistocene Stratigraphic Scheme of Northern Eurasia, still remain speculative.

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A. Zastrozhnov[1], *V. Shkatova*[1], *Y. Minina*[1], *Y. Gusev*[2], *M. Chuyko*[1] *and V. Astakhov*[1,3]
[1] A. P. Karpinsky Russian Geological Research Institute(VSEGEI)
St. Petersburg, Russia
[2] All-Russia Research Institute for Oceanic Geology (VNIIOkeangeologia)
St. Petersburg, Russia
[3] St. Petersburg State University
St. Petersburg, Russia
Email: zast@vsegei.ru

THE NEW QUATERNARY MAP OF THE RUSSIAN FEDERATION, SCALE 1:2 500 000

Key words: Quaternary deposits, map of Russia, GIS

The new Quaternary Map of the Russian Federation and adjacent seas of 2010 was for the first time compiled in GIS format. The Map is the result of digital processing of geological data accumulated since the publication the Quaternary Map of the USSR, scale 1:2 500000 (Ganeshin, 1973). The Quaternary Department of VSEGEI collected and analysed data for the continent and VNIIOkeangeologia was responsible for surrounding and internal seas.

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The major data source were maps of Quaternary formations of the standard set for each quadrangle $4x6^0$ obligatory for the National Geological Map, scale 1:1000 000 (2^{nd} and 3^{d} generations) compiled prior to 2009. The lower boundary of the Quaternary system was drawn at 1.8 Ma level, although now in Russia the internationally ratified level of 2.6 Ma is adopted. The map was first renovated in 2013 using data of 30 new digital sheets of the National Map of the 3^{d} generation, scale 1:1000000. Further renovation commenced in 2014 when 40 new standard Quaternary sheets of the 3^{d} generation were added.

The legend of the Map is built on the traditional stratigraphic-genetic principle in the matrix form. The left part of the matrix presents the stratigraphic base of the Map. The first left column shows the International Chronostratigraphic Chart as presented at the International Congress on Stratigraphy in Lisbon, Portugal, 2013. The second column is the Quaternary palaeomagnetic record attached to the International Timescale 2012 (Pillans & Gibbard, 2012). The third column features the formal Chronostratigraphic Scale of Quaternary adopted in Russia in 2008 with 18 chronostratigraphic subdivisions, the lower boundary being at 1.8 Ma. The indices of this chart are employed in the described new Map. The last column of the left part of the legend is the Magnetostratigraphic Scale of Russia, 2000–2012, chronologically corrected according to the international palaeomagnetic record used for International Chronostratigraphic Chart 2012. On the whole the left part of the legend provides correlation of the stratigraphic subdivisions of the new Russian map with the European chronostratigraphy.

The rest of the matrix are columns of basic mapped units which are genetic types of deposits and their paragenetic associations. These units sorted by their ages altogether amount to ca 340. Other symbols related to geomorphic and palaeogeographic information — hatches, lines and out of scale signs — are pasted over coloured polygons of the stratigraphic-genetic background. Such signs reflect karst features, slides, slumps, avalanches, mud volcanoes, etc. They also designate ice limits, sea transgressions, permafrost boundaries, active faults and cover formations which are too thin for colour presentation at this scale.

The accompanying materials are schemes of structure-formation regionalization, correlation of regional units (in the form of marginal insets), Glaciomorphological Map in scale 1:2 500000, and a set of maps in scale 1:5000000 showing ore deposits, precious and semi-precious stones, potable and technological water resources. The database also includes catalogues of key sections and mineral deposits. The Map is supplied by Explanatory Note.

The new Map of Quaternary formations of the Russian Federation is an information-analytical system and a graphic representation of the modern level of geological knowledge about this huge area (Fig. A16, Appendix 14).

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V.S. Zazhigin
Geological Institute, Russian Academy of Sciences
Moscow, Russia
E-mail: zazhvol@gmail.com

THE GENUS DICROSTONYX (MICROTINAE, RODENTIA) FROM LATE EOPLEISTOCENE AND EARLY NEOPLEISTOCENE OF EAST SIBERIA

Key words: Rodentia, Dicrostonyx, taxonomy, phylogeny, Eopleistocene, Early Neopleistocene, East Siberia

Species of the genus *Dicrostonyx* have inhabited the Subarctic zone of Eastern Siberia since Eopleistocene to Recent. *D. compitalis* Zazhigin was widely distributed here in Late Eopleistocene. Its remains were recovered from many localities in lower reaches of Yana, Indigirka, and Kolyma rivers above the Arctic Circle. The later *D. renidens* Zazhigin was found in several Olyorian localities from Bolshaya Chukochya and Krestovka rivers. Numerous specimens of *D. simplicior* Fejfar were recovered from the lower Neopleistocene layers near the famous Yana Paleolithic archaeological site. This species was also found in lower reaches Aldan River in Central Yakutia. The morphological transformations of *Dicrostonyx* molars through time suggest the existence of the following lineage in East Siberia: *D. compitalis* — *D. renidens* – *D. simplicior,* that was succeed by *D. henseli* Hinton — *D. torquatus* Pall. in middle—late Neopleistocene. Along with the main lineage leading to the modern *D. torquatus,* a late Early Neopleistocene site on the Khomus-Yuryakh River has yielded a different morphotype of molars. It belongs to a new species of a different lineage likely leading to *D. hudsonius* Pall.

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E.V. Zinovyev[1], R.Yu. Dudko[2], A.A. Gurina[2], K.A. Tsepelev[2],
S.E. Tshernyshev[2], A.A. Legalov[2]
[1] Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
[2] Institute of Systematics and Ecology of Animals, Siberian Branch RAS
Novosibirsk, Russia
E-mail: zin62@mail.ru

FIRST RECORDS OF THE SUB-FOSSIL INSECTS FROM QUATERNARY DEPOSITS IN THE SOUTHEASTERN PART OF WESTERN SIBERIA

Keywords: paleoecology, sub-fossil insects, Late Pleistocene, Holocene, paleo-environment, Southern West Siberia

Despite intensive study of Quaternary insects in Northern Hemisphere, some regions are still blank spots one the map of investigations. One of them is the south-eastern part of Western Siberia. This work presents preliminary results of the study of sub-fossil insect remains from this area. Insect remains were found during field works in August 2012 and July-August 2013 in 9 sites situated in the central and southern part of steppe area in Altai and in the central part of Novosibirsk region. Layers with sub-fossil chitin were detected at following places: Aley river valley and its tributaries – Kizikha and Ust'yanka rivers, Ob river near Kalistratikha village (Altai area) and Chik river near Bun'kovo village (Novosibirsk area). Those are the first occurrences of the sub-fossil insects from Quartenary layers in the south of Western Siberia, which allows expanding the geography of paleoentomological investigations in the territory of Northern Eurasia and connecting these data with the results of investigations made in the Urals, central and northern parts of Western Siberia, west Kazakhstan and low reaches of Volga river (Zinovyev, 2008, 2011, Bidasko, Proskurin, 1987).

The most ancient are the layers uncovered at the left bank of the Ob river near Kalistratikha village (Kolmanovo district of Altai area). Insect data were extracted from the buried soils in the bottom of 40-m ravine; this layer has two thermoluminescence dates: 69±7 yr BP for the upper one and 85±8 yr BP for the lower one (Arkhipov, 1997). Insect complex consists of ground beetles, carrion beetles and other groups, more detailed information is not obtained yet.

Localities situated in Kizikha and Ust'yanka rivers are preliminary dated by the final part of the Late Pleistocene, insect data are found in grey and blue clays with plant debris in the bottom of river banks. The most abundant insect material is obtained for Ust'anka-2 site. On the basis of the predominance of the species associated with modern xerophilous steppe ecosystems, the absence of cold-resistant and dendrobiont species and a small amount of the hydrophilic

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insects we can reconstruct the open steppe landscapes with the presence of wet meadows and salt-marshes. Most insect species found in Ust'yanka-2 site inhabit modern steppes of Kazakhstan while any connections with Altai and Sayan steppe faunas are not detected. Insect complex found in Ust'yanka-1 site is similar to insect fauna of Ust'yanka-2 locality (situated in 100 m from each other), but characterized by depleted species diversity.

Insect complex of Kizikha-1 site allows reconstructing open landscapes with wet meadows on the basis of predominance of weevil *Otiorhynchus politus*, presence of single steppe insects of beetles enable to propose local steppe communities located on slopes. Cold climate conditions were confirmed by the finding of subarctic ground beetle *Amara torrida*. *Hygrophilous* and halophilic insects are not found here. Insects found in Kizika-2 locality reflect the presence of dry tundra-steppe landscapes, while hygrophilous species *Zacladus geranii, Otiorhynchus politus*, etc. allow reconstructing wet meadows located in flood-plain of a river.

Two sites are preliminary dated to the Holocene. The first (Zakharovo) site, situated at Aley river, is attributed to this period according to the geomorphologic level of the floodplain terrace. Moreover, species found here are not found in Pleistocene layers but are known to inhabit these territories at present (weevils *Otiorhynchus velutinus* and *Cycloderes pilosulus* etc.). A small sample of insects was described from Gilevo site (left bank of Aley river), it includes steppe species such as weevil Otiorhynchus velutinus.

The northern point, Bun'kovo (Chik river, Novosibirsk district) is dated to the end of the Late Pleistocene based on radiocarbon dating (11550 ± 125 yr BP; SOAN-8806) (Tshernyshev et al., 2013). Insect fauna of this site is characterized by the large amount of steppe species (*Otiorhynchus karkaralensis, Aclypaea sericea*, etc.) and may be determined as tundra-steppe type.

Thereby these sites may characterize the wide chronological interval from the beginning of the Late Pleistocene to Holocene, but it is necessary to make radiocarbon dates for investigated layers; we have only one ^{14}C date made for Bun'kovo site. In most localities steppe species are dominating, the most abundant beetle is weevil *Otiorhynchus karkaralensis*; other species of Otiorhynchus genus are abundant too. In some localities halophilic insects are found too, these insects may reflect an arid climate. Single faunas, which may detect cool climate conditions, were found in Kizikha-1 site. The subsequent radiocarbon dating allows correlating this material with synchronous insect faunas from the central and northern parts of Western Siberia.

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E.V. Zinovyev
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences
Ekaterinburg, Russia
E-mail: zin62@mail.ru

DISJUNCTIVE AREAS OF INSECTS AS A REFLECTION OF ENVIRONMENTAL PECULIARITIES OF NORTHERN EURASIA IN THE PLEISTOCENE AND HOLOCENE

Keywords: paleoecology, sub-fossil insects, Late Pleistocene, Holocene, paleoenvironment, Southern West Siberia

Disjunctions of modern areas of some beetle species may be considered as an evidence of their continuous areas during certain periods of the Pleistocene. These disjunctive areas may be divided into two groups: latitudinal-zonal and longitudinal. First group includes arctic and subarctic, steppe and nemoral insects. In some cases these species inhabit extrazonal biotopes (such as isolated steppe areas or mountain-tundra communities in boreal zone). An example of steppe species is dark beetle *Oodescelis polita*, which inhabits dry slopes with steppe vegetation in boreal forests of the Middle Urals. An example of disjunctions in arctic species is ground beetle *Amara alpina* found in high mountain tundras of the Northern and Southern Urals. Other disjunctions cannot be explained by the existence of extrazonal biotopes, such as ground beetle Polystichus connexus. Modern area of this beetle covers steppe zone from West Europe to South Altai; isolated occurrences known in middle taiga zone (Sovetskoe settl., Khanty-Mansiysk Autonomous Okrug — Ugra) and in forest-tundra (Salekhard, Yamalo-Nenets Autonomous Okrug) (Zinoviev, Olshwang, 2003; Samko, 1932). The most revealing example of such

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distribution is ground beetle *Carabus sibiricus* distributed in the northern part of steppe zone from Middle Russia to South Yakutia; moreover, this beetle inhabits mountain tundras of Northern Urals and plain tundras of South Yamal (Kryzhanovskij et al., 1995; Zinoviev, Olshwang, 2003). Disjunctions of these species may indicate their wider distribution during cold and dry periods of the Late Pleistocene, when open tundra-steppe landscapes existed over the vast territories of Northern Eurasia. Other species which have disjunctive areas are nemoral beetles, living in broad-leaved forests of Europe and Caucasus, but keeping isolate sites in South Urals and Altai Mountains (*Carabus exaratus, Rhysodes sulcatus, Dendroxena quadrimaculata, Rosalia alpina*). It is possible that these species inhabited broad-leafed forests, existing in wide territories of the Central Part of North Eurasia during Eemian Interglacial (130000–115000 yr BP). One of the evidences of continuity of such a belt is the occurrence of sub-fossil remains of trubkovich *Phymatopoderus latipennis* (living now in broad-leaved forests of the Far East) in Eemian (Mikulino) layers of Belorussia (Nazarov, 1986). Another group of disjunctive areas may be determined as longitudinal; these species have modern East Siberian distribution. This group includes such beetles as *Carabus hummeli, C. vietinghoffi*, which have disjunctions in the Polar Urals and South Yamal (Kryzanovskij et al., 1995; Andreeva, Eryomin, 1991), these species might inhabit periglacial landscapes of the Central part of Northern Eurasia during the Late Quaternary. It is possible, that these beetles belong to arctic, subarctic and non-analogue insect faunas, typical for the Late Pleistocene of the Urals and West Siberia. So, analysis of modern disjunctive areas of some beetle species allows suggesting their presence in Pleistocene faunas correlated with both cool periods of the Quaternary and with interglacials, in particular, with the time of wide distribution of broad-leaved forests.

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V.S. Zykin, V.S. Zykina
Sobolev Institute of Geology and Mineralogy Siberian Branch
Russian Academy of Sciences
Novosibirsk, Russia
E-mail: zykin@igm.nsc.ru

STRATIGRAPHY AND CHANGES OF ENVIRONMENT AND CLIMATE IN THE LATE CENOZOIC OF WESTERN SIBERIA

Key words: stratigraphy, environment, climate, Late Cenozoic, Western Siberia

Western Siberia is one of the few areas of the world where the continental Upper Cenozoic is very completely represented, there are detailed paleontological sequences, and where abundant data are available for dating. This provides an opportunity for a reliable reconstruction of environmental changes. The Upper Cenozoic deposits of Western Siberia are unique archives containing substantial information on the environmental evolution of this territory. The Pliocene record of West Siberian Plain is composed of lacustrine, river and subaerial deposits. The most peculiar feature of the southeastern part of the plain is a loess-soil sequence, which is highly valuable as it reflects climatic changes in the Quaternary. The climatic record obtained by the analysis of the loess-soil sequence correlated with the oxygen isotope scale of oceanic sediments and other global records of climate.

Currently received new data on the structure, composition, distribution, geochronology, biostratigraphy and paleomagnetism of the Late Cenozoic deposits of Western Siberia allowed us to refine considerably the stratigraphical sequence, define main stratigraphical boundaries, correlate major regional events with global ones, reveal in more detail the sequence of biotic, geologic and climatic events, carry out paleogeographic reconstructions of certain temporal periods.

As for degree of completeness of reflection of geological, paleobiological and paleoclimatic events, the composite section of the West-Siberian Pliocene is one of the most complete sequence for the continental Pliocene. This sequence distinctly reflects global climatic changes. Pliocene deposits have lateral and vertical stratification and distinct cycle structure. Changes of zoogeographic structure fauna of freshwater mollusca is the best suited for paleoclimatic reconstructions due to high sensitivity of freshwater mollusca to alterations of environmental temperature. The Pliocene of West Siberia is divided into Early Pliocene (about 5.3–3.4 Ma) with a warm climate and Late Pliocene (3.4–2.6 Ma) with a relatively cool climate.

The Early Pliocene is characterized by a relatively stable continental sedimentation under river, lake and subaerial conditions. The Lower Pliocene Formations have complete cycles that is closed by montmorillonite

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clays with compact soils. At that time, a sufficiently well-developed, little entrenched drainage system with northward runoff existed at absolute heights considerably higher than the low water level of the modern rivers oriented toward the high ocean level. The soils in the south of the plain were formed under a high level of graundwater according to the type of compact soils. The mammalian fauna corresponds to that of the Ruscinian of the Western Europe (Zykin et al., 2007). The fresh-water mollusca fauna is characterized by the wide distribution of thermophilic Indo-Chinese and West Siberian endemic genera of East Asiatic origin.

At the boundary of Early and Late Pliocene, about 3.3–3.2 Ma, the climate in the southern West Siberia became considerably colder and, probably, drier. The result was a radically restructured biota. Nearly all thermophilic species of fresh-water mollusca (10 genera) became extinct. The malacofauna acquired the Palaearctic character. The Ruscinian fauna of mammals was replaced by the Villafranchian fauna with no vole-toothed hamsters. The generic composition of shrews was drastically reduced and *Mimomys* voles became quite abundant (Zykin et al., 2007). The Upper Pliocene Formations have imperfect cycles of river sedimentation. The recognized climatic event is in agreement with the climate cooling documented in both marine and continental settings in various regions of the world by drastic changes in biota. Those events coincided with uplift of the Tibet, Himalaya, Tien Shan, Altai, the increase in tectonic aktivity in many regions.

One of the most debatable issues of the Quaternary stratigraphy concerns the boundary between the Neogene and the Quaternary systems. The Quaternary, as accepted by International Union for Quaternary Research and proposed by the International Commission on Stratigraphy in 2009 year begins at 2.58 Ma. As a result, a large segment of the Pliocene has been included into the Quaternary. This decision complicate the identification of the accepted boundary in various regions of the world, especially in inland areas. In Northern Asia, the only section which is well-documented paleontologically and where the Gauss-Matuyama boundary was detected is the section on the Irtysh River near Lebjazhie village. In this section, near this boundary, the Lower Villafranchian mammal fauna was replaced by the Middle Villafranchian one (Zykin et al., 2007). The freshwater molluscs complex along with recent West Siberian species includes only one early Pliocene endemic species *Borysthenia pronaticina* (Ldh.) and indicates a significant climate cooling. Among not numerous ostracodes remains of Irtysh Formation of the section first appearance of the widespread in West Siberia Pleistocene species *Limnocythera vara*. The changes in flora composition (Volkova, 1977) indicate humidization and cooling of climate.

Loess-soil deposits are widespread over a vast territory of West and Middle Siberia, from 50° to 61°N and 70° to 100°E. Their overall thicknesses are a few tens of meters (up to 120 m) with an age range of more than 800 kyr. Thick loess layers in the loess-soil sequence of Western Siberia alternate with pedocomplexes (soil complex) consisting of two or three soils with thin loess interbeds between them. The Middle and Late Pleistocene Western Siberian loess-soil sequence is one of the most significant terrestrial palaeoclimate archives in the Northern Asia. West Siberia loess sediments, deposited during Lower and Middle Pleistocene, occupy uplift territories — the CisAltai plain, Altai low mountains river valleys, west slopes of Salair and the Kuznetsk depression. During the Late Pleistocene loess distribution expanded abruptly, it developed widely in West Siberian plain and Kazakhstan.

Middle and Late Pleistocene loess-soil sequence of West Siberia consists of rhythmically alternated thick layers of loess and complexes of fossil soils consisting of two or three soils with thin loess horizons. The structure of pedocomplexes in the West Siberian loess-soil sequence well reflect the structure of global odd warm stages consisting of closely spaced warm events interfered with brief cold intervals. The complete loess-soil sequence from West Siberia includes ten soil complexes alternated with thick loess layers. Soil formation mostly occurred in periods of weak circulation, whereas loess deposition was associated with active wind transport when the air was thickly saturated with dust. The presence in microstructure of loess indications of cryogenic processes and traces of aeolian treatment on quartz grains evidence that loess layers were formed by wind in cold conditions. The loess deposition in the Siberia was accompanied by the formation of large deflation surfaces and closed deflation basins in an environment of cold deserts. Fossil soils of pedocomplexes formed during warming periods of the Pleistocene. Spectral analysis of frequency-dependent magnetic susceptibility time series revealed a periodicity corresponding to the orbital cycles of eccentricity (100-kyr cycles), obliquity (40-kyr cycles), and precession (23-kyr cycles). Interregional correlation of climatostratigraphic horizon of the full Pleistocene loess-soil sequence of Siberia with coeval units loess regions of Asia was established synchronism of arid and humid stages both in zone of west-to-east motion of the atmoshpere and in the monsoon circulation zone. The lower soils of all pedocomplexes as a rule have the more thick profiles, and were thus deposited during the longest and warmest interglacial periods. The comparison of interglacial soils with modern soils, formed in similar geomorphological conditions, reveals larger thicknesses of interglacial Late and middle Pleistocene soils and more less thicknesses of the Holocene soil horizons. The obtained data evidence that large interglacials, including the last interglacial were more prolonged than Holocene. It seems that Holocene represent the initial phase of continuous warming.

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S.V. Zykov, M.A. Fominykh, T.V. Strukova
Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Science
Ekaterinburg, Russia
E-mail: svzykov@yandex.ru

DENTAL MICROWEAR IN LATE QUATERNARY RODENTS: METHODOLOGICAL ISSUES IN THE ANALYSIS OF *CLETHRIONOMYS* AND *SYLVAEMUS*

Key words: microwear analysis of molars, diet reconstruction, rodents, Holocene

Dental microwear in fossil mammals is used to reconstruct their diet and also to make inferences about paleoenvironments (Lewis et al., 2000; Rodrigues et al., 2009; Oliver et al., 2014). This study focused on rodents with different type of dental system: voles with flat occlusal surface of hypsodont molars and mice with bunodont molars. We analyzed the dental microwear of modern/fossil *Cl. glareolus* (n=16/5) and *S. uralensis* (n=18/5) from the Middle Urals localities using scanning electron microscope TESCAN VEGA3 (IPAE UrB RAS) at the same ×1560 magnification. We studied modern samples first (voles and mice were captured in the dark coniferous forest, in the same biotopes) (Fominykh, Zykov, 2012). Based on that, the method was approved on the fossil samples from the Mironovskaya-III cave (layer 6, radiocarbon date: 5340±80 years BP (Ki-15494)).

All types of the microwear scars (pits and scratches) of the hypoconid and entoconid enamel found on molars of modern bank voles and Ural field mice were also found on sub-fossil Holocene specimens. But the difficulties of morphological diagnostics of isolated molars of *Cl. glareolus–Cl. rutilus* and *A. agrarius–S. uralensis* and poor state of enamel surface preservation in sub-fossil specimens complicated our study. Correct interpretation of microwear patterns and diet reconstruction of modern and Late Quaternary rodents (voles and mice) require further study. Therefore, we examined the main methodological issues in dental microwear analysis with our sub-fossil specimens and make the methodological proposals to address those issues (Table).

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TABLE. Methodological issues and proposals in the microwear analysis of dental enamel in Late Quaternary and modern rodents

METHODOLOGICAL ISSUES	METHODOLOGICAL PROPOSALS
Irregular distribution of the microwear patterns on the enamel surface in juvenile rodents with not yet formed occlusal surface (in voles) or with the pointed cusps (in mice)	If the samples consist of the different categories of molars, the age variation of the occlusal surface should be taken into account in microwear analysis of the modern and sub-fossil rodents
Reduced size of fossil samples when only specific elements of the occlusal surfaces or a particular tooth should be analyzed	To reveal which molars and molar elements could be used to examine the microwear, you should analyze the distribution of microwear patterns on different molars in modern rodents. That will allow you to study the differences of enamel microwear among different elements of a tooth row and to determine their relevance in analysis of the fossil samples (especially, with the poor state of preservation of the fossil remains)
Identification of microwear types on the rodent enamel surface (received during the lifetime or the mechanical damage as a result of the predator or because of the fossilization conditions)	To determine the microwear type and the cause of damage of the rodents' tooth enamel, you should study the modern specimens with identification of microwear scars (indirect diet estimation) and to compare the results with the stomach content data (direct diet estimation) in modern rodents as well as in the samples from pellets and prey remains. The results of these studies can serve as a basis for the analysis of sub-fossil specimens
Interpretation and diet reconstruction for modern and Late Quaternary rodents	Analysis of the diet preferences in modern rodents including the geo-botanical data and the stomach content data with seasonal diet changes could be used to reveal the microwear patterns on the molar enamel depending on diet and, in particular, on the predominating type of food. The data from the analysis will allow one to reconstruct the diet of the modern and Late Quaternary rodents

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APPENDICES
(COLOR FIGURES)

ПРИЛОЖЕНИЯ
(ИЛЛЮСТРАЦИИ В ЦВЕТЕ)

Appendix 1

GEOLOGY AND CHRONOLOGY OF PLEISTOCENE CULTURAL RECORDS IN THE CENTRAL URALS

J. Chlachula, Yu. B. Serikov (p. 32)

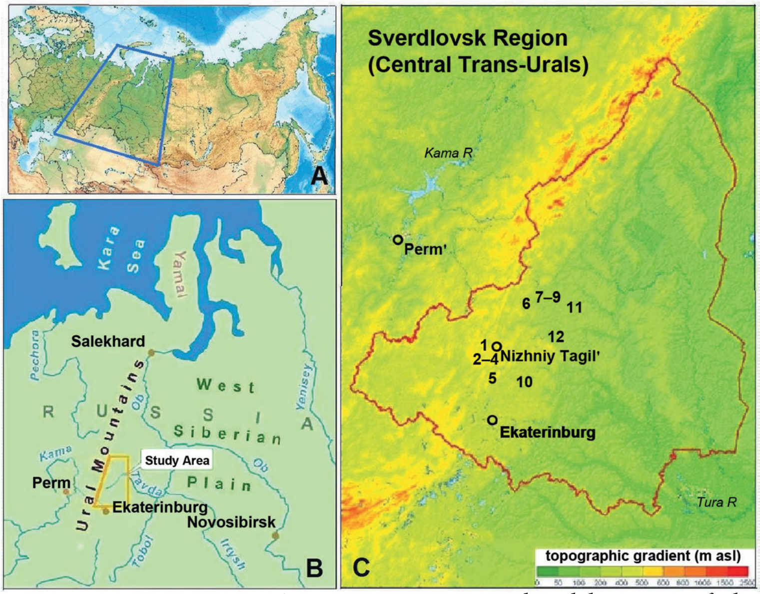
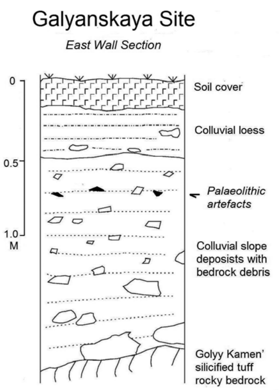
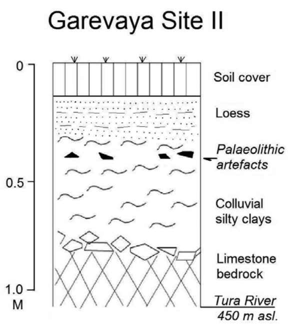
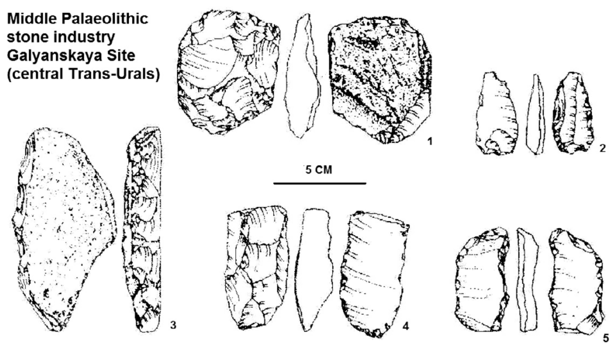


Fig. A1. (A) Geographical location of the territory discussed in the text; (B) Location of the central Trans-Urals study area; (C) Regional distribution of the investigated Middle Palaeolithic sites in the central Trans-Urals (Sverdlovsk Region) – (1) Galyanskaya; (2–4) Golyy Kamen' Locality (sites Golyy Kamen' shikhan, Golyy Kamen' III, Golyy Kamen' workshop site); (5) Gorbunovskiy Torfianik – Beregovaya III; (6) Garevaya II; (7–9) Ural'skiye Zori Locality (sites Ural'skiye Zori III, V, Ural'skiye Zori Boloto); (10) Ambarka I; (11) Prokop'evskaya Salda VI; (12) Nizhnaya Salda Site (a potential Middle Palaeolithic record)







PRELIMINARY DATA ON THE PLEISTOCENE HISTORY OF PERMAFROST IN CENTRAL URALS (RUSSIA) DERIVED FROM CRYOGENIC CAVE CARBONATES

Y. Dublyansky, O. Kadebskaya, M. Luetscher, H. Cheng, I. Chaykovskiy, C. Spötl (p. 43)

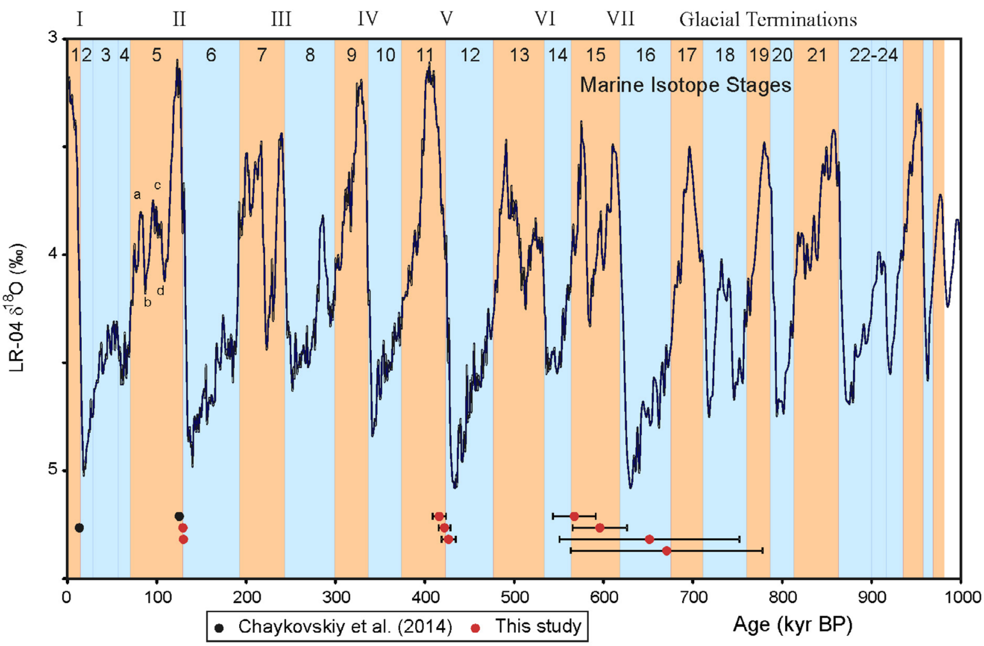


Fig. A2. The ages of CCC from Rossiyskaya Cave, Ural Mountains, plotted on the deep-sea oxygen isotope curve (Lisecki and Raymo, 2005). Error bars are 1σ (too small to be shown graphically for younger samples)

Appendix 3

NEW INVESTIGATIONS OF QUATERNARY DEPOSITS IN THE VIENNA BASIN (AUSTRIA)

M. Fiebig, S. Braumann, K. Decker, P. Haeuselmann, E. Hintersberger, J. Lomax, C. Luethgens, S. Neuhuber, J. M. Schaefer (p. 48)

Fig. A3. Gravels of two terraces with different fluvial base levels are displayed in this figure. The left photo shows gravelly deposits of the Gaenserndorfer Hochterrasse containing a crystalline boulder with a maximum diameter of about 50 cm (please compare spade for size). Above the boulder a diagonal aligned sandy unit is visible. On the right side of the boulder a group of cobbles was deposited. The right photo shows sediments of the subsequent higher fluvial level – the so called Schloss Hof Terrasse Again, a crystalline boulder of comparable size (about 50 cm maximum diameter – please see small metallic dustpan on the right side of the boulder) with a group of cobbles in its vicinity is exposed. Both cobble groups have been sampled for measurement of cosmogenic isotope content. The combined analysis of two differently decaying isotopes (^{10}Be and ^{26}Al) may help to assess the depositional age of the terrace sediments

THE ICELANDIC BASALTS: AN "EXOTIC" CONTRIBUTION TO THE PLEISTOCENE BEACH DEPOSITS OF WESTERNMOST EUROPE. HOW THEY GROUNDED IN FRANCE

J.-P. Lefort, J.-L. Monnier, G. Danukalova (p. 80)

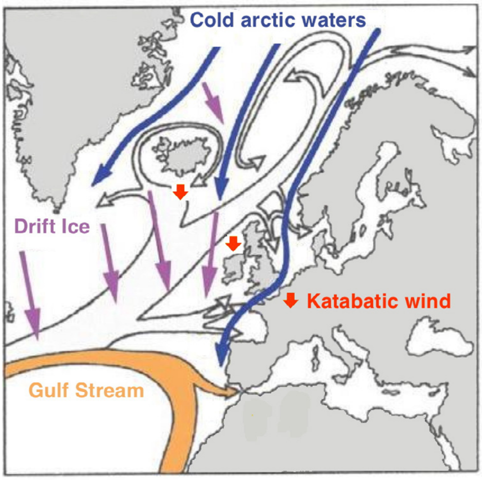


Fig. A4. Image of some of the various parametres responsible for an Eastward drift of the Icelandic ice rafts during Pleistocene times

Appendix 4

GENETIC VARIABILITY OF BURBOT, *LOTA LOTA*, AND THE CONNECTION OF THE MAIN HOLARCTIC RIVER BASINS IN THE QUATERNARY

Y.Y. Khrunyk, A.R. Koporikov, V.D. Bogdanov, A.V. Borodin (p. 51)

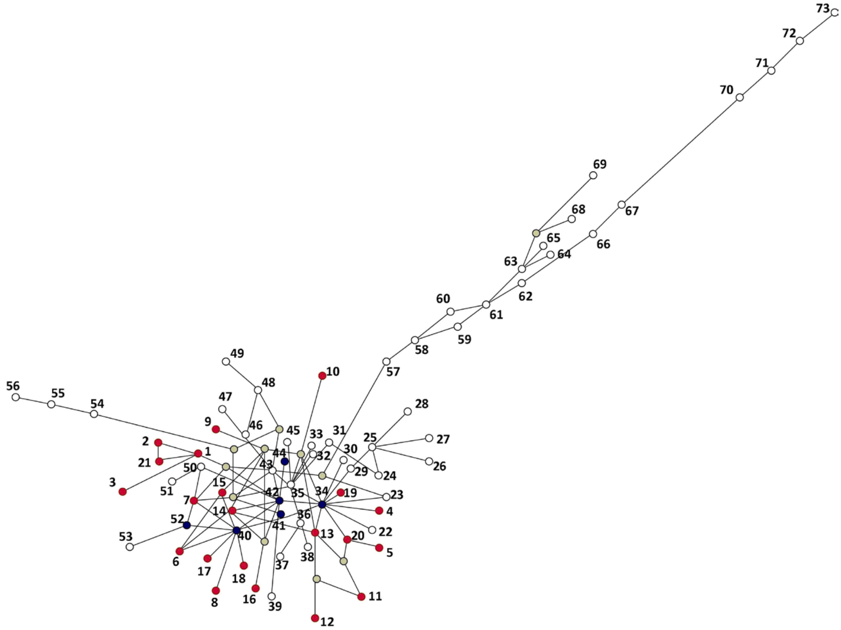


Fig. A5. Median joining network representing the genealogical relationships between 73 mitochondrial control region haplotypes of burbot (*Lota lota*). Lengths of lines are proportional to genetic distances between haplotypes. 21 new haplotypes (WS1-WS21), revealed in the Ob-Irtysh River basin, are highlighted in red and marked by numbers 1–21, respectively. Hypothetical haplotypes are shown in grey. Blue circles demonstrate haplotypes from the NCBI, which were revealed in the Ob-Irtysh River basin. White circles show the rest of NCBI haplotypes, used in this analysis. Together with new WS haplotypes, the star-like Eurasian cluster includes Western European haplotypes EB00, EB02, EB03, EB04 (numbers 25, 28, 26 and 24, respectively), Northern European haplotypes EB10, EB11, EB12, EB13, EB14, EB15, EB16, EB17 (numbers 35, 45, 33, 31, 32, 36, 37, 38, respectively), Beringian haplotypes EB41, EB43, EB44, EB45, EB20, EB21, EB22, EB23 (numbers 40, 52, 44, 39, 46, 43, 47 and 48, respectively), Eurasian haplotypes EB30, EB32, EB33, EB34, EB35 (numbers 34, 30, 22, 23, 41, respectively), and Alaskan haplotypes EB42, EB50 (numbers 50 and 53 respectively). Five more NCBI haplotypes, which belong to the Eurasian cluster, are marked by the following numbers: 27 (the Seine River), 29 (the Vistula River), 42 (from Russia), 49 (Lake Constance) and 51 (Xj3 haplotype from the Irtysh River in China). The Amur cluster includes three haplotypes Amur 1–3 (numbers 54–56), found in the Duobuku'er River, which is the tributary of the Amur River. Another cluster corresponds to *L. l. maculosa* lineage and includes Mississippi (numbers 57–65, 99, 102), Missouri (numbers 95–98) and Pacific (numbers 110, 111) haplotypes

Appendix 5

ONCE AGAIN ABOUT THE EARLY VALDAIAN GLACIATION

A.Y. Krotova-Putintseva
(p. 72)

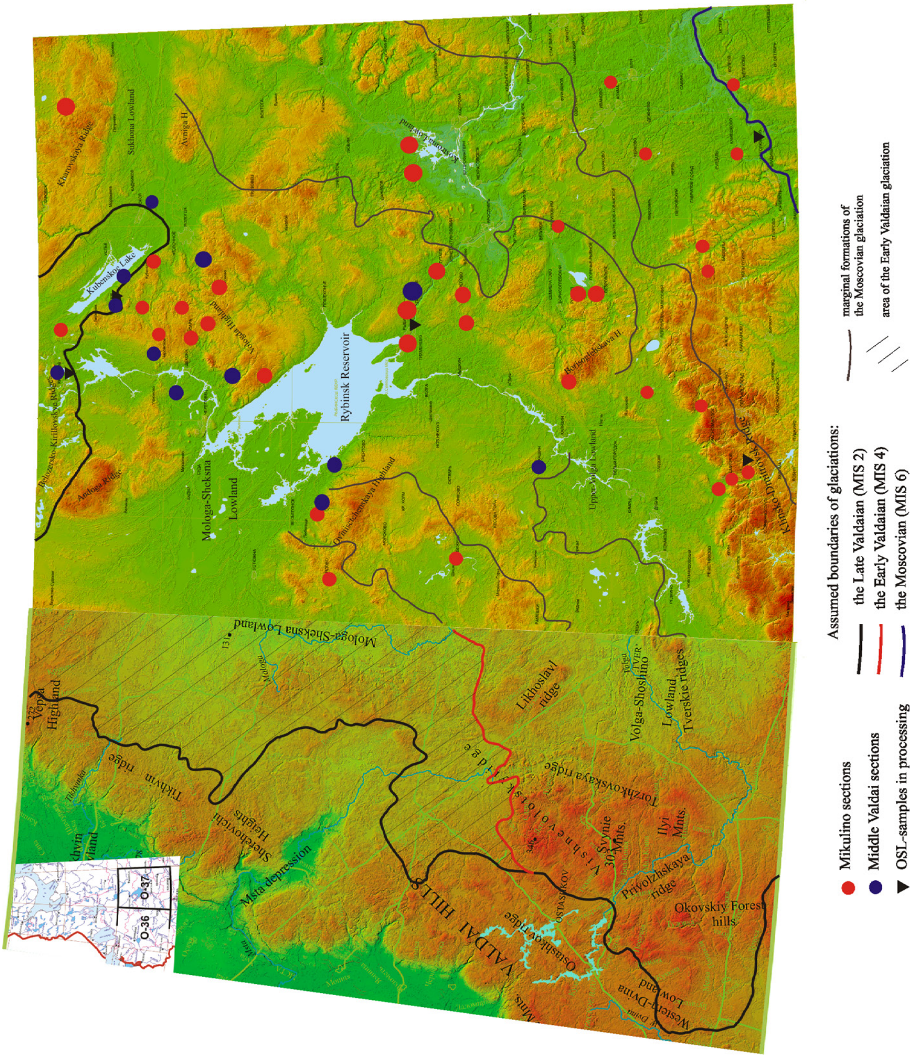


Fig. A6. Sections of the Upper Pleistocene interglacial deposits and glaciations' boundaries

CHRONOLOGY OF THE LATE WEICHSELIAN GLACIATION IN THE SOUTHEASTERN SECTOR OF THE SCANDINAVIAN ICE SHEET

K. Lasberg (p. 78)

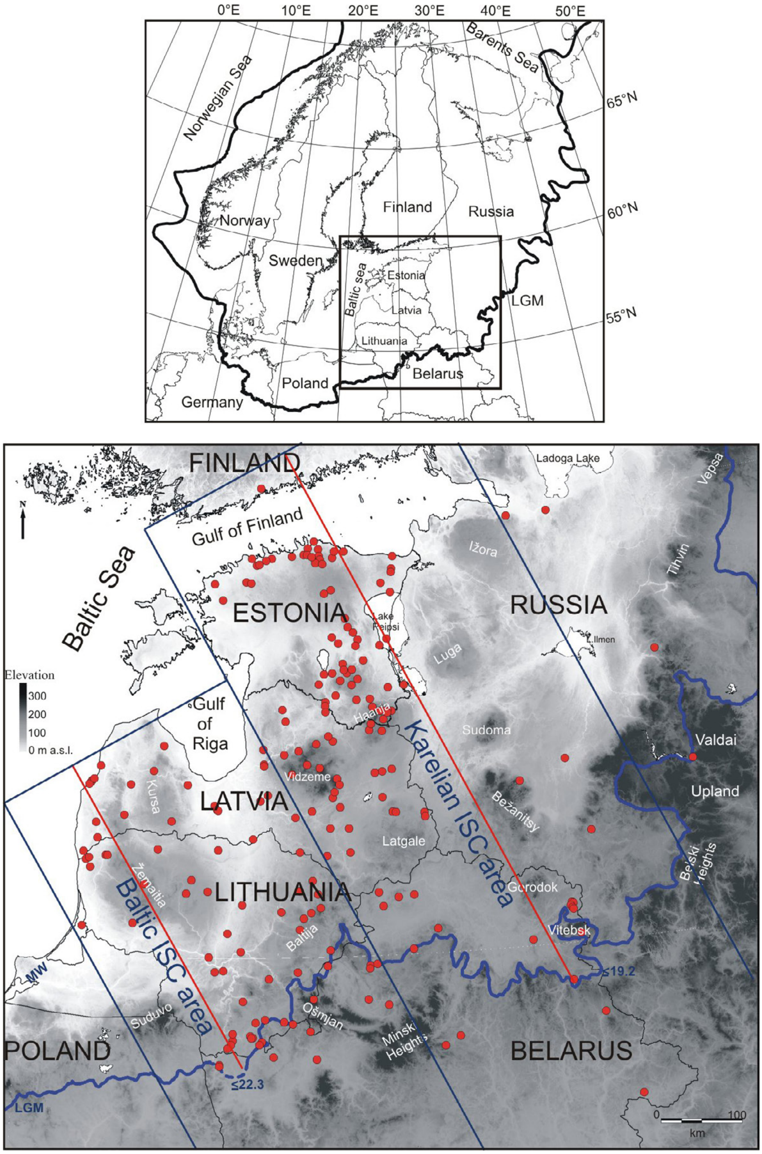


Fig. A7. Map showing the maximum extent of Late Weichselian glaciation in Fennoscandia and on the East European Plain (Ehlers & Gibbard, 2004; Ehlers et al., 2012; Kalm, 2012) together with indication of the study area. Baltic ISC area in the west and Karelian ISC area in the east are used to simplify the data handling in the study area. Ages of the LGM are based on Rinterknecht et al. (2007). The red line denotes the azimuth line as the general direction of ice flow and the red dots show sites with available chronological data

Appendix 7

SMALL MAMMALS AS INDIRECT BIOTIC MARKERS
FOR CLIMATE DYNAMICS ASSESSMENT IN THE CENTRAL PART
OF NORTHERN EURASIA

E.A. Markova, T.V. Strukova, A.V. Borodin (p. 98)

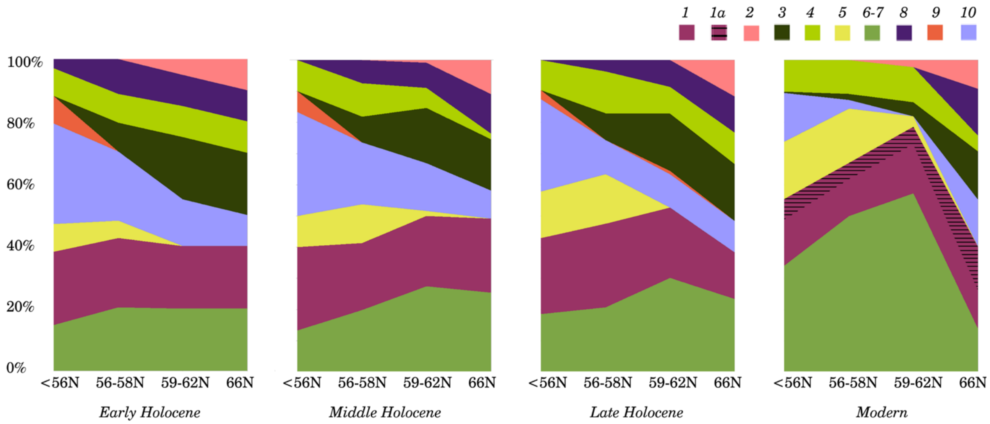


Fig. A8. Latitudinal and temporal occurrence (in percentage) of the microhabitat groups of arvicoline rodents in the Ural Mountains based on the analysis of the databank of fossil assemblages from the cave sites (see Borodin et al., 2013 for the list of localities) and the database of modern arvicolines captured during the last 50 years (zoological museum of IPAE UrB RAS). Latitudes: 51–56° N — Southern Urals, 56–59° N — Middle Urals, 59–62° N — Northern Urals, 66–68° N— Polar Urals. Radiocarbon dates: Early Holocene — 8100–10600 years BP, Middle Holocene — 7380–3060 years BP, Late Holocene —1470–612 years BP). 1–10 — microhabitat groups according to humidity/openness/vegetative cover: 1. Wet to wet-mesic (intrazonal)/open to semi-open/ herbaceous cover (1 — native species *Arvicola terrestris* and *Microtus oeconomus*, 1a — *Ondatra zibethicus* introduced in 20th century); 2. Wet-mesic to mesic/open to semi-open/herbaceous cover (*M. middendorffi*); 3. Wet to mesic/open to closed/moss cover (*Lemmus sibiricus, Myopus schisticolor*); 4. Mesic to wet-mesic/open to semi-open/swardy or tussocky herbaceous cover (*M. agrestis*); 5. Mesic/open to semi-open/ herbaceous cover (*M. arvalis obscurus, M. rossiaemeridionalis*); 6. Mesic/closed or semi-closed/woody cover (*Clethrionomys rutilus, C. glareolus*); 7. Mesic to dry-mesic/closed or semi-closed/woody cover (*C. rufocanus*); 8. Xeric to mesic/open to semi-open/ grass-and- shrub cover (*Dicrostonyx torquatus*); 9. Xeric to mesic/ open to semi-open/ sagebrush cover (*Eolagurus luteus*); 10. Xeric/open/herbaceous cover (*Ellobius talpinus, M. gregalis, Lagurus lagurus*)

PALYNOLOGICAL RECORD OF THE QUATERNARY DEPOSITS
OF GARDING-2 RESEARCH DRILL CORE, NORTH-WEST GERMANY

M.S. Proborukmi, B. Urban (p. 120)

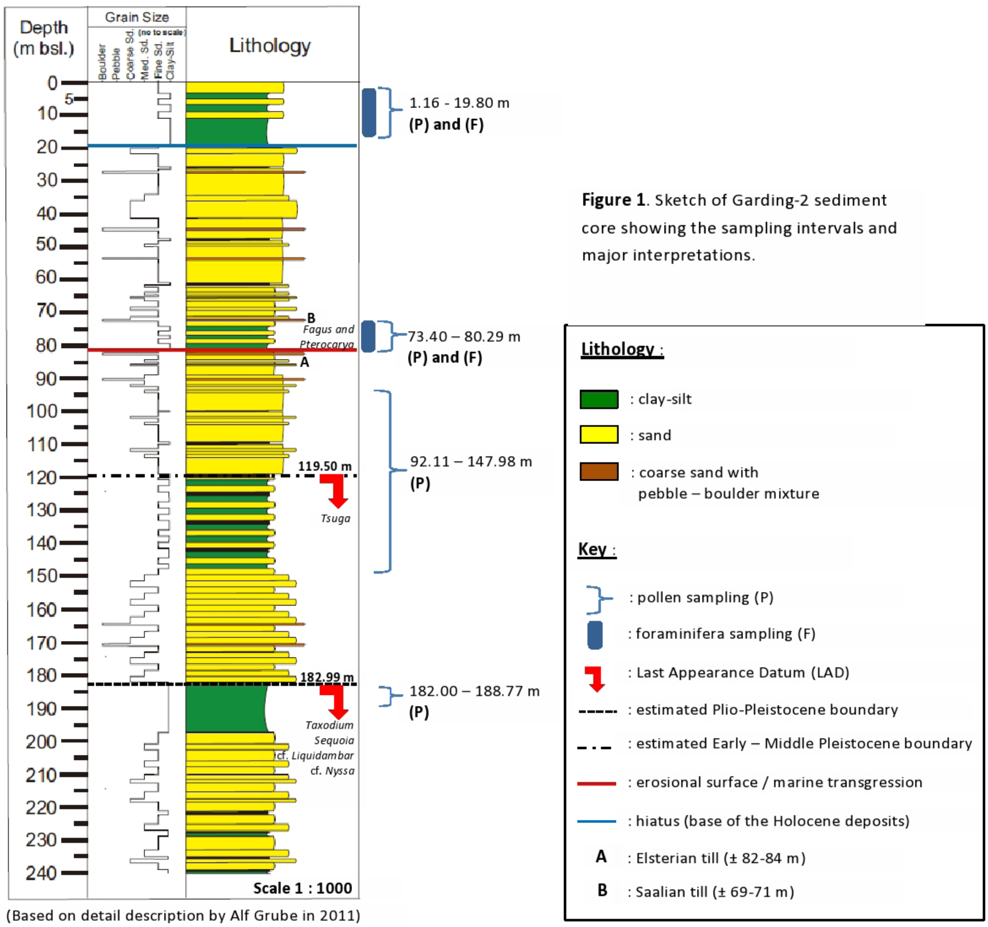


Fig. A9. Sketch of Garding-2 sediment core showing the sampling intervals and major interpretations

Appendix 9

THE GEOMAGNETIC RECORDING MEDIUM FROM WESTERN DACIC BASIN (ROMANIA) DISTURBED BY COAL PALAEO-FIRES: PLEISTOCENE PORCELLANITES WITHIN PLIOCENE LIGNITE – CLAY SEQUENCES; MULTI-PROXY EVIDENCE

S.-C. Rădan, S. Rădan (p. 124)

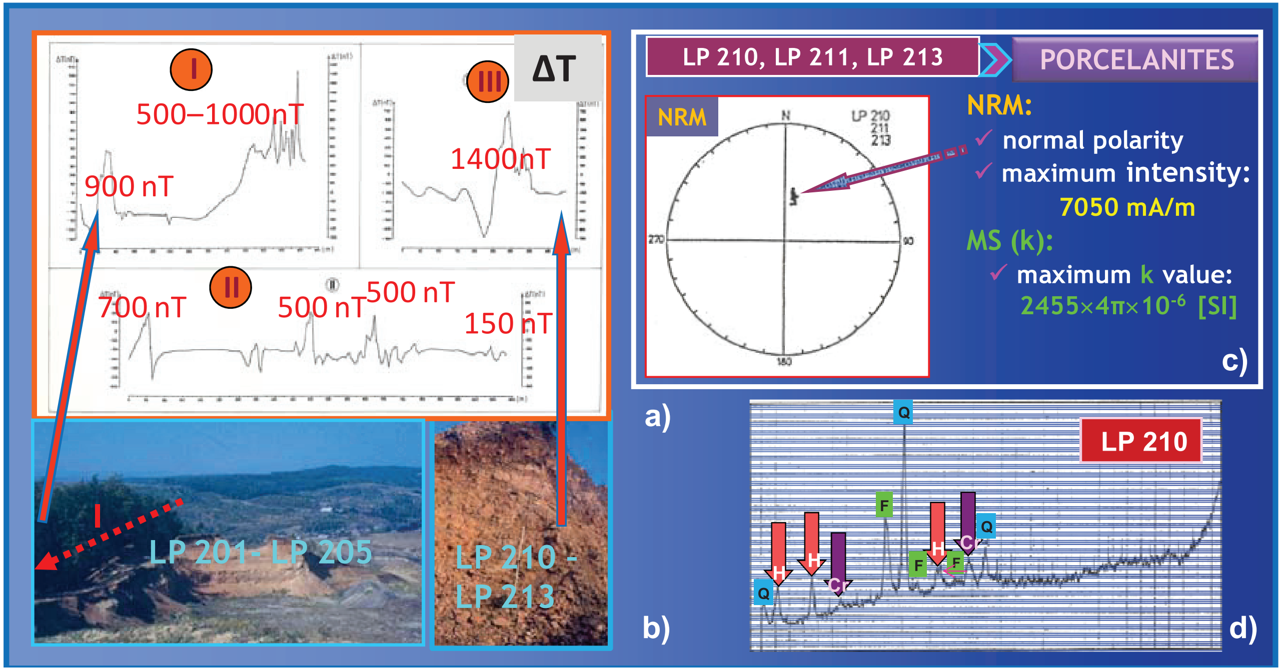


Fig. A10. Multi-proxy evidence for the **m.r.m.** disturbed by palaeofires in the Lupoaia – Motru zone (LMZ), WDB. *a*) Magnetic anomalies (ΔT amplitudes, in red) produced by the **m.r.m.** changes in the area with coal deposits (LMZ, WDB); *b*) Photos of porcellanite outcrops, and location of a magnetic profile. The red dashed arrow in the left photo is a path segment of recorded magnetic profile I, that revealed a 900 nT magnetic anomaly in the vicinity of the porcellanite sampling site (Fig. 1a, **I**); *c*) Stereogram of the Natural Remanent Magnetisation (NRM) direction and some rock-magnetic characteristics of porcellanites from the eastern Lupoaia quarry (sampling site, in Fig. 1b, the right photo); *d*) X-ray diffractogram recorded for a porcellanite collected from the eastern Lupoaia lignite quarry (sampling site, in Fig. 1b, the right photo). Q — quartz; F – feldspars; Cr – cristobalite; H – hematite

Appendix 10

TOWARDS ASSESSING THE POTENTIAL FOR STRATIGRAPHIC STUDIES IN THE DANUBE DELTA GEO-ENVIRONMENTS BY USING MAGNETOSUSCEPTIBILITY AND LITHOLOGICAL RECORDS RETRIEVED FROM RECENT SEDIMENTS

S.-C. Rădan, S. Rădan, I. Catianis, A. Scrieciu (p. 127)

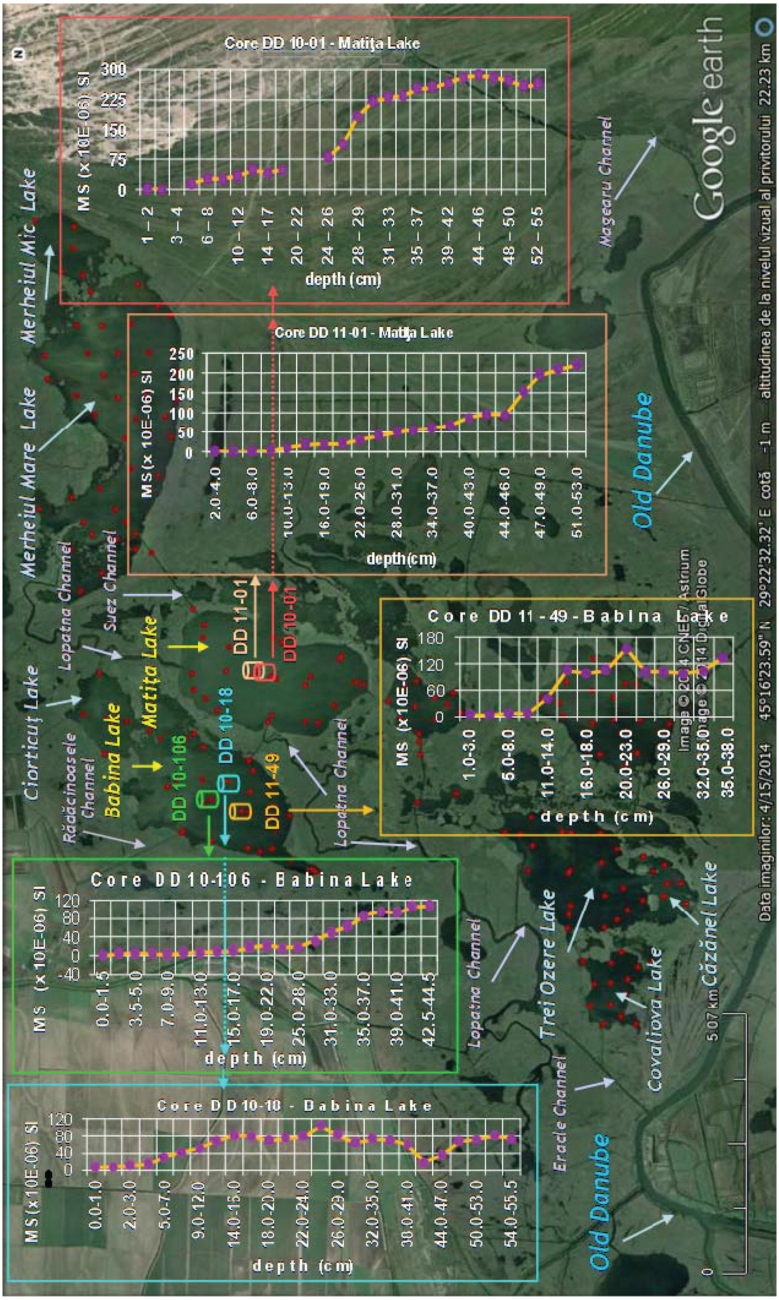


Fig .A11. An example of magnetosusceptibility (MS) records achieved for five sediment cores collected from two lakes of the Matița – Merhei Depression (i.e., Babina L. and Matița L.), northeastern Danube Delta (Romania). *Legend.* The red points located on the map within the lakes and along some channels denote the grab sampling stations. The coloured cylinders drawn within the Babina and Matița lakes mark the sampling sites for the sediment cores

Appendix 11

REMAINS OF *SAIGA TATARICA* (LINNAEUS, 1766) FROM THE QUATERNARY DEPOSITS OF EMINE-BAIR-KHOSAR CAVE (CRIMEA) AND OTHER LOCALITIES OF UKRAINE AND POLAND

U. Ratajczak, K. Stefaniak, A. Nadachowski (p. 129)

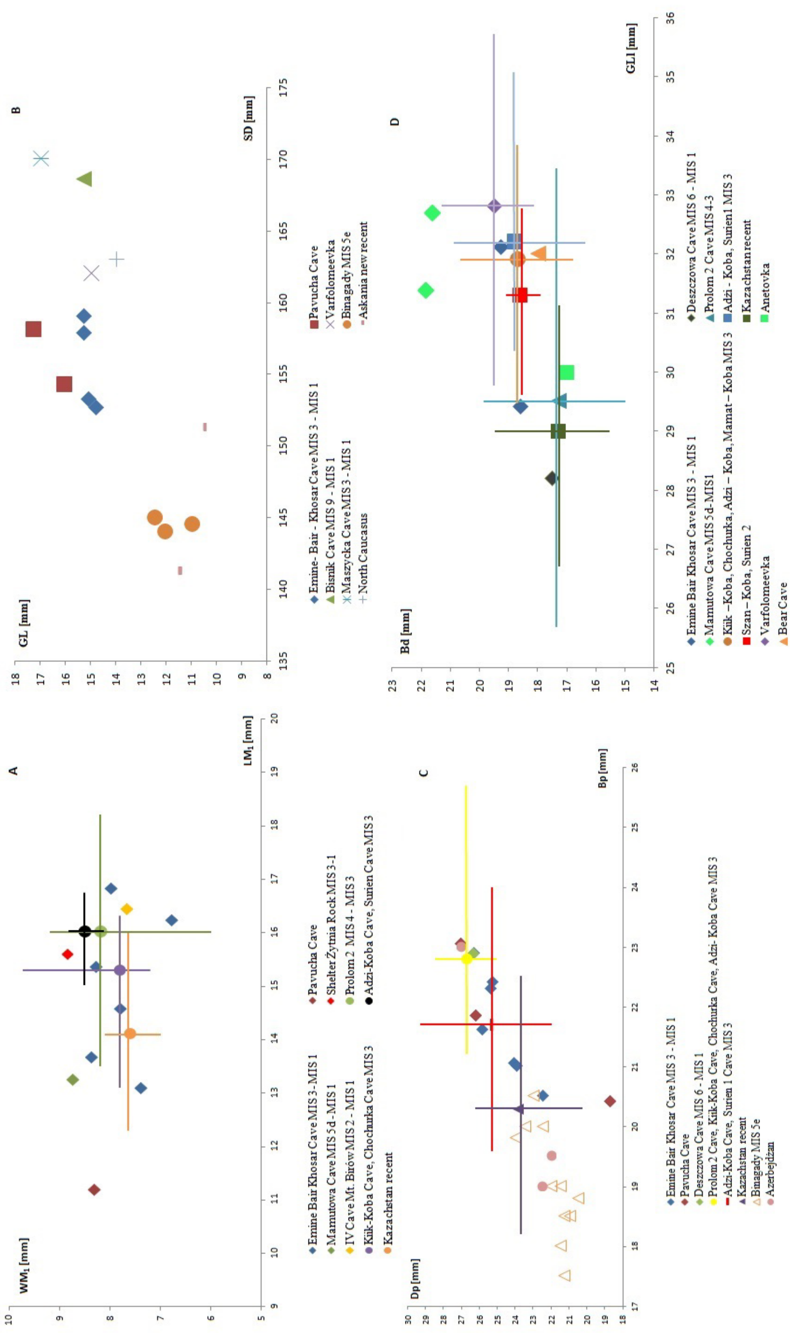


Fig. A12. Variation of some measurements in *Saiga tatarica*. A – length to breadth ratio in M1 measured near the base of the crown; B – greatest length to smallest breadth ratio of the diaphysis of metacarpus; C – greatest depth to smallest breadth ratio of proximal epiphysis of metatarsus; D – breadth of the distal end to great length ratio of the lateral half of the talus

LANDSCAPE AND SOILS AROUND THE PREHISTORIC SITE OF KAMMENYJ AMBAR

H. Thiemeyer, S. Peters (p. 161)

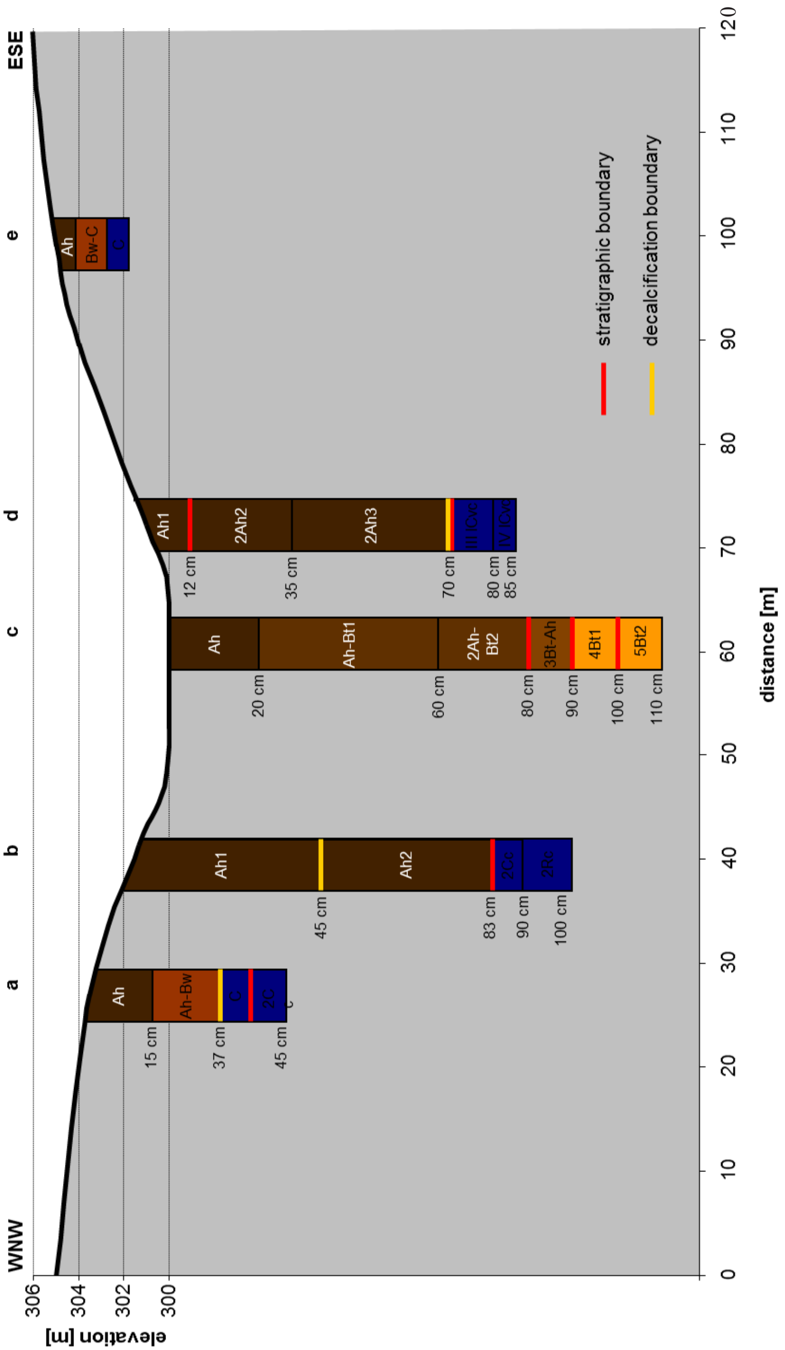


Fig. A13. Catena crossing a tributary valley at the northern slope of the Karagajly Ajat valley

Appendix 13

THE PLIO-QUATERNARY DEFORMATION OF THE LAKE VAN BASIN (EASTERN ANATOLIA) FROM MULTI-CHANNEL SEISMIC REFLECTION PROFILES

M. Toker, A.M. Celal Şengör, S. Krastel, F. Demirel-Schlüter, F. Niessen
(p. 166)

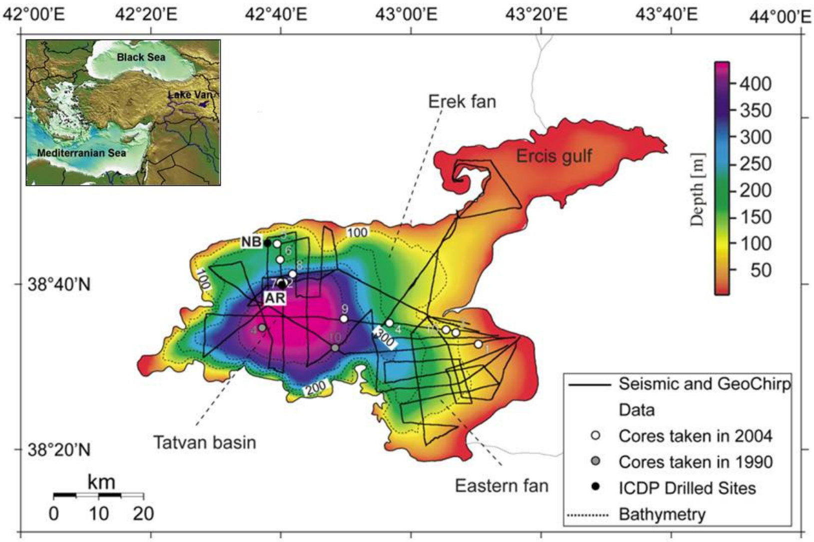


Fig. A14. Lake Van is a dome-shaped basin, which lies in a tectonic depression formed through a combination of normal and strike-slip faulting and thrusting

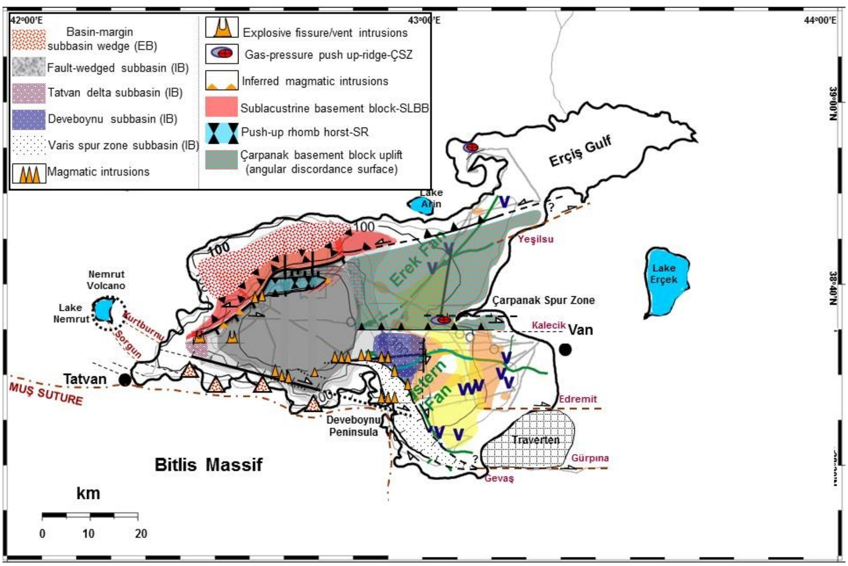


Fig. A15. Deformation map of the lake superimposed on the morpho-physiographic map

THE NEW QUATERNARY MAP OF THE RUSSIAN FEDERATION, SCALE 1:2 500 000

A. Zastrozhnov, V. Shkatova, Y. Minina, Y. Gusev, M. Chuyko, V. Astakhov
(p. 181)

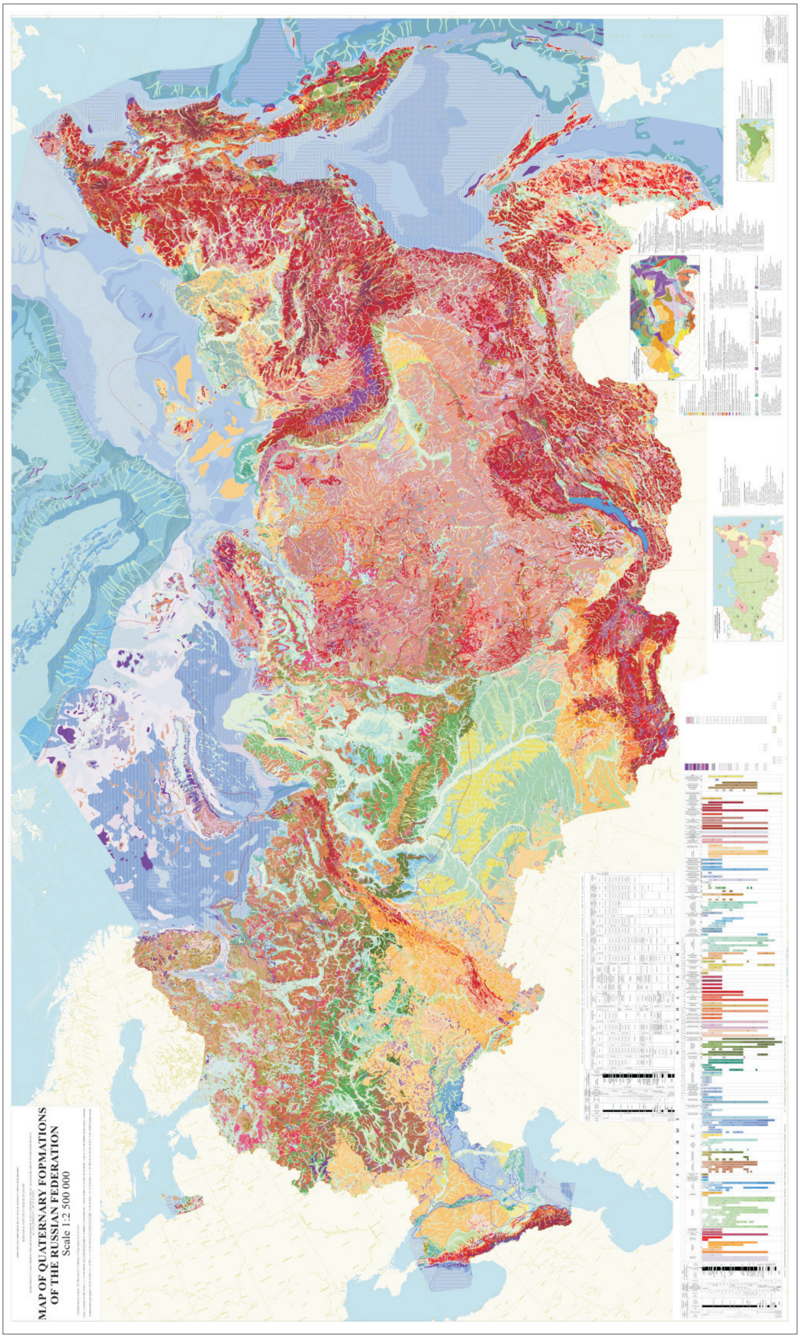


Fig. A16. The new Quaternary Map of the Russian Federation, scale 1:2 500 000

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Материалы международной конференции INQUA-SEQS

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