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Geology and fauna, and preliminary correlation of sediments of the main Late Cenozoic sites of the Transbaikal area

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Abstract

The Pliocene and Pleistocene sediments exposed in eight sections of Transbaikalia have been correlated using geological and palynological data, together with information on fossil mammals and some paleomagnetic characteristics. The most complete sequence of fossiliferous deposits (spanning the time interval from the Middle Pliocene to the Late Pleistocene) is exposed in the Tologoi key section. The sequence was correlated with other sections primarily on the basis of mammal faunas. During deposition of the Chikoi Suite, Udunginian, Chikoian and Itantsinian faunal complexes appeared in succession. Four successive stages in mammal evolution are recognized within the Early Pleistocene.

Deposition of the Krivoyarskaya Suite proceeded throughout the time when the Tologoi faunistic complex, Ivolginian and other Pleistocene faunas followed each other in the Transbaikalian region. © 2001 Published by Elsevier Science Ltd.

1. Introduction

Transbaikalia is a part of the Central Asian mountain belt, located at 51–56°N latitude and 104–118°E longitude. Physiographically, it is characterized by a series of major ranges separated by deep intermontane depressions; elevations of the ranges increase from 1000 m in the south to 2500 m in the north. This region includes a diversity of landscapes. North-Asian Arctoboreal areas consist of mountain taiga, mountain meadow and steppe meadows. North-Asian semiarid landscapes with mountain forests and intermontane meadow-steppes, and Central Asian arid landscapes with mountain steppes and dry steppes are also present. The region features an extremely continental climate with a wide range of daily and annual air temperature fluctuations. Precipitation amounts are typically small, both in winter and summer. Sunny and bright weather dominates during winter (Transbaikalia Atlas, 1967). Such a variability of environments and climatic conditions accounts for the observed diversity of plant communities and faunas (both vertebrate and invertebrate animals).

As a part of the Baikal rift zone, the Transbaikalian region experienced a complicated geological evolution during the Pliocene and Pleistocene. Many specific features of the Late Cenozoic climates, sediments and environments are attributable to the tectonic processes. Investigations during recent decades provided new data on both fossil mammals and geology of the region. In particular, they enable us to trace faunal succession through the Middle Pliocene–Holocene (Erbajeva and Alexeeva, 2000) and to allow a tentative correlation of the Late Cenozoic deposits exposed in some Transbaikalian sections on the bases of lithology, faunas and some paleomagnetic characteristics.

2. Discussion

2.1. Lower Pliocene

Cenozoic deposition in the Transbaikalian area was strongly influenced by tectonic processes. At the beginning of the Pliocene, differentiated tectonic movements within the Baikalian rift zone and adjacent areas induced conspicuous changes in sedimentation regime. The Pliocene strata (known as the Anosov Suite) are distinct for their coarser material and wide diversity of genetic types of sediments. The Anosov Suite occurs most widely in the South Baikal depression (Logatchev, 1968, 1974; Bazarov, 1986) and is represented by conglomerates, gravels, sands, and silts.

Farther south, the central mountains of the Selenga Drainage basin experienced general upheaval at that

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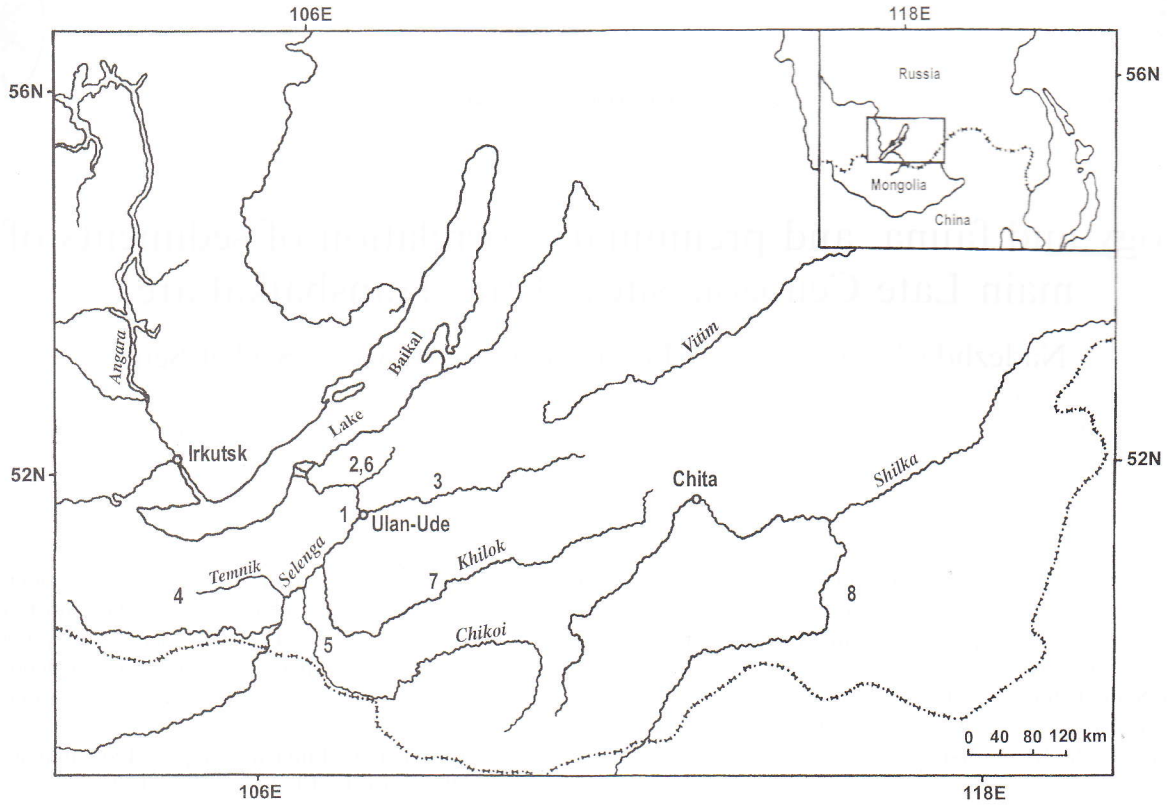

Fig. 1. The position of the main Late Cenozoic localities of Transbaikalia: 1—Tologoi, 2—Zasukhino, 3—Dodogol, 4—Udunga, 5—Beregovaya, 6—Klochnevo I, 7—Ust'-Obor, and 8—Gryazi.

time, resulting in river incision into an older Paleogene planation surface. Erosional terraces 100–140 m above the present streams are found in many valleys. Ochre and red beds of various geneses were deposited in intermountain basins and valleys of the Selenga, Khilok, Chikoi, Itantsa and other rivers. Fluvial ochre-coloured sediments, taken to be an analogue of the Anosov Suite, are deeply weathered gravels including sands of different thickness (10–15 to 120–140 m) overlain by red beds. The latter are dated to the Middle Pliocene, on the basis of mammal fauna. Therefore, the underlying ochre beds may be attributed to the Early Pliocene (Bazarov, 1968, 1986).

2.2. The Middle Pliocene

This interval was marked by the development of depressions in the drainage basins of Ivolga, Uda (depressions in the middle and lower reaches), Khilok, and other rivers. Red sediments (clays, loams and sandy loams with gravel and fragments of local rocks) accumulated during that time are identified as the Chikoi Suite. Its thickness varies from 5 to 6 m on valley slopes, and to 50 m and more in the central parts of depressions (Ravsky, 1961, 1972; Ravsky et al., 1964; Bazarov, 1968, 1986).

The Chikoi Suite has been studied in a number of sections with fossil mammal remains including Udunga, Tologoi, Beregovaya, Klochnevo I, Klochnevo II, Dodogol, Zasukhino and Gryazi (for location map see Fig. 1), (Florensov, 1960; Logatchev, 1968, 1974; Alexandrova et al., 1963; Bazarov, 1968, 1986; Ravsky, 1972; Bazarov et al., 1976; Imetkhenov and Kalmykov, 1990). It has been found that the sediments exposed in these locations contain mammal assemblages of different ages, representing successive stages in faunal evolution during the Middle and Late Pliocene.

The oldest sediments of the Middle Pliocene Chikoi Suite are described in the Udunga location (the Temnik River valley at the base of Khambinsky Ridge). There are three sedimentary units recognized in the sediments infilling an old gully (Fig. 2D):

- The lower unit—boulders, gravel and sand, apparent thickness up to 1 m.
- The middle unit (corresponding to the Chikoi Suite)—dark brown sandy loam with admixture of clay (the lower part) and reddish-brown loam and clay with rock debris and grus (the upper part); total thickness is up to 6–7 m. The unit yielded numerous fossil remains of large and small mammals of the Udunginian fauna (Kalmykov, 1992).

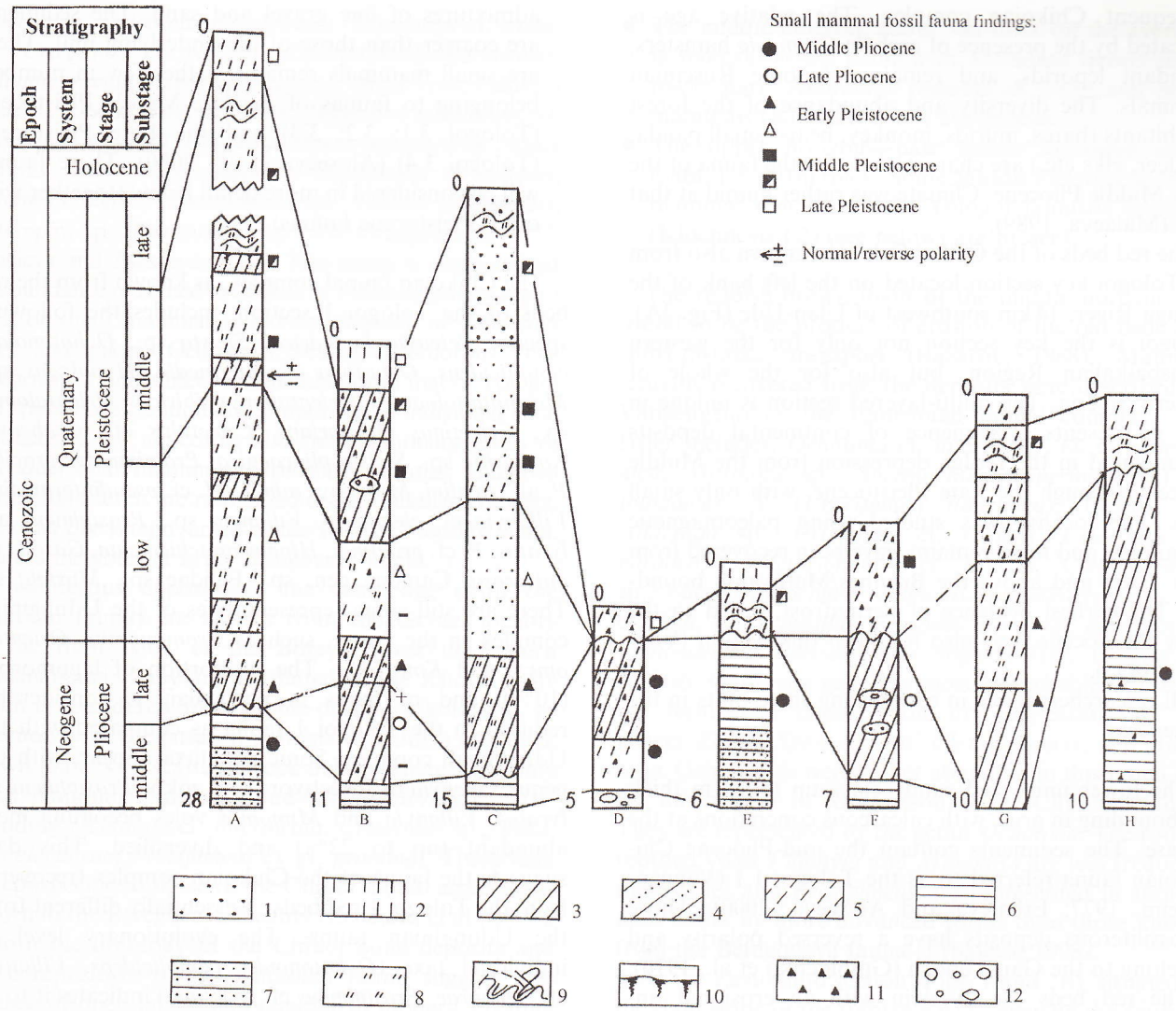

Fig. 2. The correlation of Late Cenozoic sediments exposed in the main Transbaikal localities: A—Tologoi, B—Zasukhino, C—Dodogol, D—Udunga, E—Beregovaya, F—Klochnevo I, G—Ust'-Obor, and H—Gryazi. Legend: 1—sand, 2—loess sandy-clay, 3—sandy-clay, 4—alternation of sands and sandy-clay, 5—sandy-loam, 6—clay, 7—alternation of sands and clays, 8—traces of carbonatization, 9—unit deformations, 10—fossil soils, 11—debris, and 12—gravels.

- The upper unit up to 1.5 m thick—sands and sandy loams with abundant rock debris and grus. The unit lies on eroded surface of the reddish-brown loams of the middle unit. Mammal remains recovered from the unit include those of a jerboa similar to modern *Allactaga sibirica*.

The Udunginian faunal complex includes *Hypolagus multiplicatus*, *H. transbaicalicus*, *Ochotonoides complicidens*, *Ochotona* sp., *Kowalskia* sp., *Gromovia* sp., *Cricetinus* sp., *Orientalomys* cf. *sibiricus*, *Promimomys gracilis*, *P.* cf. *stehlini*, *Prosiphneus* cf. *praetingi*, *Villanyia* ex gr. *eleonorae*, *Mimomys* cf. *minor*, *Parapresbytis eohanuman*, *Hipparion houfenense*, *H. tchicoicum*, *Pliocrocuta pyrenaica*, *Lynx issiodornensis*, *Homotherium crenatidens*, *Ursus minimus*, *Parailurus* sp., *Arctomeles* sp., *Ailurus* sp., *Zyglophodon* sp., *Orchonoceros gromovi*, *Capreolus constantini*, *Gazella sinensis*, *Antilospira zdanskyi* a.o. (Sotnikova and Kalmykov, 1991; Vislobokova and Kalmykov, 1994; Erbajeva, 1996, and others). It differs from earlier Early Pliocene Ruscinian faunas by the presence of primates and appearance of rooted voles of *Villaniya* and *Mimomys* genera. Typically, the fauna is distinguished by dominance of leporids and zokors (up to 45% and ~20%, respectively), and also by the presence of *Parapresbytis*, of lesser panda, hamsters of *Kowalskia* and *Gromovia* genera, *Promimomys* voles and scarce remains of *Villanyia* and *Mimomys* voles (up to 5%).

As follows from the analysis of the fauna species composition and studies of individual taxa evolution, the Udunginian fauna is somewhat older than the

subsequent Chikoian complex. The relative age is indicated by the presence of archaic *Gromovia* hamsters, abundant leporids, and remains of some Ruscinian mammals. The diversity and abundance of the forest inhabitants (hares, murids, monkey, bears, small panda, roe deer, elks etc.) are characteristic for the fauna of the early Middle Pliocene. Climate was rather humid at that time (Malaeva, 1989).

The red beds of the Chikoi Suite are known also from the Tologoi key section located on the left bank of the Selenga River, 14 km southwest of Ulan-Ude (Fig. 2A). Tologoi is the key section not only for the western Transbaikalian Region, but also for the whole of Eastern Siberia. The multi-layered section is unique in that it presents a sequence of continental deposits accumulated in the Ivolga depression from the Middle Pliocene through the Late Pleistocene, with only small gaps. The locality was studied using paleomagnetic techniques, and fossil remains have been recovered from both under and above the Brunhes/Matuyama boundary. The earliest evidence of permafrost, dated to the Early Pleistocene, was also found in this section (Vogt et al., 1995).

All researchers agree in recognizing three units in the sequence:

- The lower unit—red sandy clays up to 2.0 m thick abounding in grus, with calcareous concretions at the base. The sediments contain the mid-Pliocene Chikoian fauna referred to as the Tologoi 1.1 (Vangengeim, 1977; Erbajeva and Alexeeva, 2000). Those fossiliferous deposits have a reversed polarity and belong to the Gauss epoch (Gnibidenko et al., 1976). The red beds are overlain with an erosional unconformity capped by a rose-coloured loam with abundant calcareous nodules. The rose loam contains rare remains of *Borsodia laguriformes*, which is typical of Early Pleistocene faunas. This fauna is termed Tologoi 1.2.
- The middle unit is composed of non-sorted compact yellow–gray and brown sandy loam, with occasional grains of coarse sand and small lenses of fine gravel up to 1.5 m thick. In the middle of this unit the Brunhes/Matuyama reversal occurs within a fossil soil horizon (Gnibidenko et al., 1976). As for fossil remains, there are two faunas recovered from sediments below the reversal and attributable to the latest Early Pleistocene (those are Tologoi 2.1 and Tologoi 2.2). Other faunas occur above the reversal and are dated to the early Middle Pleistocene (Tologoi 2.4; Tologoi 2.5 with Tologoi faunistic complex and Tologoi 2.6 with Ivolginian fauna) (above the reversal) (Alexeeva, 1994; Alexeeva et al., 2000).
- The upper unit up to 12 m thick consists of non-sorted yellow–gray and brown sandy loam with admixtures of fine gravel and sand. The sediments are coarser than those of the underlying unit. There are small mammals remains, rather few in number, belonging to faunas of the late Middle Pleistocene (Tologoi 3.1; 3.2; 3.3) and the Late Pleistocene (Tologoi 3.4) (Alexeeva et al., 2000). These faunas will be considered in more detail below (together with other Pleistocene faunas).

The Chikoian faunal complex, as known from the red beds of the Tologoi 1 section, includes the following species: *Petenyia hungarica*, *Sicista* sp., *Ochotonoides complicidens*, *Ochotona* cf. *intermedia*, *Hypolagus* sp., *Marmota tologoica*, *Orientalomys sibiricus*, *Orientalomys* sp., *Cricetinus* cf. *varians*, *Cricetulus* cf. *barabensis*, *Kowalskia* sp., *Sicista pliocaenica*, *Promimomys gracilis*, *P.* aff. *stehlini*, *Mimomys minor*, *M.* cf. *pseudintermedius*, *Villanyia* cf. *eleonorae*, *Villanyia* sp., *Prosiphneus* aff. *lyratus*, *P.* cf. *praetingi*, *Hipparion tchicoicum*, *Gazella* cf. *gutturosa*, Canidae gen. sp., Felidae sp., *Mustela* sp. There are still some representatives of the Udunginian complex in the fauna, such as *Promimomys*, *Orientalomys*, and *Kowalskia*. The proportion of lagomorphs (10%), and of hares in particular, is considerably reduced in the Tologoi 1 fauna as compared with the Udunginian complex. Some new taxa appear, with the genus *Petenyia* of Insectivora and zokor *Prosiphneus* aff *lyratus*; *Villanyia* and *Mimomys* voles becoming more abundant (up to 22%) and diversified. This data suggests the fauna of the Chikoian complex (recovered from the Tologoi 1 red beds) is essentially different from the Udunginian fauna. The evolutionary level of individual taxa (*Ochotonoides complicidens*, *Villanyia* cf. *eleonorae*, *Prosiphneus* cf. *praetingi*) indicates it to be younger than the Udunginian.

The Chikoian Suite outcrops are found also in the Chikoi River valley at the Beregovaya locality (Fig. 2E). The sediments exposed are reddish-yellow fine sands in the lower part of the section and red–brown clays with rock debris and gravel in the upper part. The total thickness is up to 6 m. It was from those sediments that the Chikoian complex was first determined (Vangengeim et al., 1966).

An erosional unconformity separates these red beds from overlying fine sands and sandy loams with small-sized debris. The overlying deposits yielded fauna dated to the late Middle Pleistocene (*Ochotona daurica*, *Spermophilus undulatus*, *Lagurus transiens*, *Lasiopodomys brandti* a.o.) known as Beregovaya 2 fauna (Bazarov et al., 1976).

The Chikoian complex defined in the Beregovaya 1 locality includes the following species: *Beremendia fissidens*, *Petenyia hungarica*, *Sorex mirabilis*, *Hypolagus multiplicatus*, *H. transbaicalicus*, *Pentalagini* gen., *Ochotonoides complicidens*, *Ochotona gromovi*, *Ochotona intermedia*, *Ochotona sibirica*, *Castor* sp., *Sicista*

pliocaenica, *Orientalomys sibiricus*, *Micromys* cf. *minutus*, *Cricetinus* cf. *varians*, *Cricetulus* cf. *barabensis*, *Mimomys minor*, *M. pseudintermedius*, *M.* cf. *reidi*, *Villanyia eleonorae*, *Prosiphneus praetingi*, *Hipparion tchicoicum*, *H. houfenense*, *Canis* cf. *chihliensis minor*, *Acinonyx* sp., *Lynx shansius*, *Euryboas* cf. *lunensis*, *Nyctereutes* cf. *sinensis*, *Parameles suillus*, *Dicerorhinus* sp., *Gazella* cf. *sinensis*, *Antilospira* sp., *Palaeotragus* sp., a.o. (Vangengeim, 1977; Erbajeva and Alexeeva, 2000). This fauna is characterized by abundance of rooted arvicolids of *Villanyia* genera (up to 70% of small mammals), and by diversity of *Mimomys* voles and pikas (Ochotona) among lagomorphs. The Beregovaya fauna differs considerably from that of Tologoi 1 in species composition and proportion of individual taxa. Distinctions are noticeable also in evolutionary levels of individual small mammals, particularly of voles. Thus two stratigraphic levels are recognized in the Chikoian complex. The older one is represented by the Tologoi 1 locality fauna, whereas the younger is the Beregovaya fauna.

Fossiliferous deposits of the same age (with the Chikoian fauna) are known from the Gryazi locality on the right bank of the Borzya River in Eastern Transbaikalia. They are attributed to the Kholui Suite which is considered an analogue of the Chikoi Suite. In common with the latter, it consists of reddish and dark brown loam with scattered rock debris. There were only small mammal remains found in the Gryazi locality, including *Ochotona* cf. *intermedia*, *Cricetulus* sp., *Villanyia eleonorae*, *Prosiphneus* ex gr. *praetingi*. These taxa are conspecific to those of the Chikoi faunal assemblage known in the Beregovaya locality (Erbajeva et al., 1997).

Both the lithology of the Chikoi Suite deposits and the composition of the Chikoian fauna suggest prevalence of open landscapes (similar to modern savanna in Africa) in southern Transbaikalia, with a mild temperate climate. The red beds exposed in the Beregovaya section bear traces of carbonatization, thus attesting to semiarid climate and irregular precipitation (Ravsky, 1972; Bazarov, 1986; Vangengeim, 1977).

2.3. The Late Pliocene

The Late Pliocene deposits are exposed in the Itantsa R. valley. In the sections of Klochnevo I, Klochnevo II, and Zasukhino, they are reddish-brown or pale yellow with brownish hue loams, overlain by yellow–gray stony loam and thick loess-like sandy loam of Pleistocene age.

There are three horizons of different age recognized in the Klochnevo I section (Figs. 1 and 2F) (Ravsky et al., 1964; Vangengeim et al., 1966; Bazarov, 1968; Erbajeva, 1970):

- The lower horizon—dark red clay with rock debris, and scarce unidentified bones; apparent thickness is 1 m.
- The middle horizon, about 3 m thick on the average, is reddish-brown loam with abundant debris in its lower part. Abundant remains of large and small mammals (Klochnevo I.1) are present.
- The upper horizon—pale yellow loess-like sandy loam, 1.5–2.0 m thick. Some Middle Pleistocene small mammal remains of the Tologoi faunistic complex (Klochnevo I.2) (see below) are present.

The reddish-brown loam of the middle horizon was found to be the product of erosion of the red beds and short-distance transport (Bazarov, 1968). Mammal remains recovered from the deposits were described by Vangengeim as the Itantsinian faunal complex. The latter includes: *Ochotona* cf. *intermedia*, *O.* cf. *nihewanica*, *Marmota* sp., *Spermophilus* (*Spermophilus*) cf. *tologoicus*, *S.* (*Urocitellus*) *itancinicus*, *Castor* sp., *Allactaga* sp., *Cricetinus* cf. *varians*, *Cricetulus* cf. *barabensis*, *Clethrionomys* cf. *kretzoi*, *Clethrionomys* sp., *Villanyia klochnevi*, *Mimomys pseudintermedius*, *M.* cf. *reidi*, *M.* cf. *pusillus*, *Prosiphneus youngi*, *Equus* ex gr. *sanmeniensis*, *Itanzatherium angustirostre*, *Gazella* cf. *sinensis*, Ovibovini gen. The most remarkable feature of the Itantsinian fauna is the first appearance of the genera *Equus*, *Spermophilus*, *Clethrionomys*, and *Allactaga*. Ochotonids were rather abundant in this fauna but are much rarer in comparison to the Chikoian fauna. They are represented by the genus *Ochotona*. The rooted toothed voles *Villanyia* and *Mimomys* are less frequent; these voles and *Prosiphneus* are represented in Itantsinian fauna by more advanced forms than those known from the Beregovaya fauna (Erbajeva, 1998).

At the Zasukhino section (Figs. 1 and 2B), situated at the right slope of the Itantsa River valley on the spurs of the Morskoy ridge, the following five layers are exposed (from bottom to top):

1. Dark cherry-coloured or brown clay and loam with weathered rock debris, devoid of fossil remains; apparent thickness up to 2 m.
2. Reddish-brown and light brown loam with interlayers of small debris and gruss; thickness ranges from 2 to 3 m; remains of small mammals (Zasukhino 1).
3. Yellowish-brown loam 1–2 m thick, with an admixture of sand, gravels and rubble lenses; fossils recovered from the layer are attributed to the Dodogolian fauna of the Early Pleistocene (Zasukhino 2).
4. Brownish-gray sandy loam and sands with minor admixtures of rubble and scarce boulders detached from the bedrock. The average thickness is 3.5 m. This layer has been found to contain large lens-like accumulations of fossils of both large and small mammals belonging to the latest Early Pleistocene Zasukhinian fauna (Zasukhino 3) and to that of the Middle Pleistocene (Zasukhino 4, 5); the latter

assemblage is presumably an analogue to the Tologoi faunistic complex.

5. Yellowish-gray loess-like loam and sandy loam, 1–2 m thick, with fossils of the Late Pleistocene small mammals (Alexeeva et al., 2000).

Deposits of similar type and structure are exposed in the Klochnevo II locality.

Layer 2 of the Zasukhino site (Zasukhino 1) closely resembles the middle horizon at the Klochnevo I.1 locality. It includes fauna associated with the Itantsinian complex, with *Villanyia klochnevi*, *Prosiphneus youngi*, *Clethrionomys* sp., and others, dated to the Late Pliocene (Bazarov et al., 1976; Agadjanian and Erbajeva, 1983).

The analysis of the small mammal faunas together with palynological evidence permits the reconstruction of paleo-landscapes of the area. The savanna-like forest-steppes and steppes characteristic for the Middle Pliocene gradually gave way to grassland and dry steppes during the Late Pliocene. The landscapes continued to be of mosaic type, with steppe, meadows and mixed forest in the river valleys and along the foothills (Ravsky et al., 1964; Belova, 1985). The mammalian fauna and pollen flora indicate that the climate of Western Transbaikalia changed towards cooler and drier conditions during the transition to the Itantsinian faunas.

The Chikoi Suite deposits occur much farther south. They are known in Northern Mongolia in the Selenga River basin, in the Orkhon R. valley (Devjatkin, 1981; Zazhigin, 1989, and others).

2.4. Early Pleistocene

At the beginning of the Early Pleistocene, the terrain in Western Transbaikalia still held its appearance inherited from the Late Pliocene. This interval was marked by deposition of red, reddish-brown, orange-brown and grayish-yellow loams, sandy loams and sands; carbonatization is characteristic. Genetically, most of the deposits are deluvium and proluvium (Ravsky, 1972).

The oldest Pleistocene formations are found at the base of an unconsolidated sediment exposure near Dodogol village on the right bank of the Uda River (Fig. 2C) and, probably, in the Tologoi location (Tologoi 1.2). Three members of different age are distinguished in the Dodogol section by Bazarov (1968) as follows (from the bottom upwards):

1. The lower member consists of bright red clay with occasional concretions of carbonates. It is dated to Pliocene on geological evidence. No bone remains were recovered.
2. The middle member is bright red loam with laminae of carbonates. Small mammal remains recovered from the deposits are defined as the Dodogolian fauna dated to the Early Pleistocene (Dodogol 1); it includes *Ochotona bazarovi*, *O.* cf. *nihewanica*, *Borsodia laguriformes*, *Allophaiomys pliocaenicus*, *Prosiphneus youngi*, *Spermophilus* sp. a.o. (Agadjanian and Erbajeva, 1983). According to Zudin (1980) the deposits of this horizon have reversed polarity and correspond to the Matuyama magnetozone.
3. The upper layer consists of pale gray and yellowish sandy loam and sands. The lowermost layer yielded the latest Early Pleistocene fauna (Dodogol 2). Upwards, this assemblage is replaced by the Middle Pleistocene small mammal faunas which are analogous to the Tologoi faunistic complex (Dodogol 3, 4) (Erbajeva, 1970) (see below).

The Early Pleistocene sediments of the next biostratigraphical level are exposed at the base of Ust'-Obor section (Fig. 2G) which is situated at the right bank of the Khilok River near Ust'-Obor village (Fig. 1). In this section, two strata of different geological age are recognized. The lowermost part of the section consists of reddish-brown and pale brown loam and sandy loam which include the Early Pleistocene fauna with *Ochotona ustoborica*, *Allophaiomys* cf. *pliocaenicus*, *Lagurodon arankae*, *Prolagurus ternopolitanus*, *Clethrionomys* sp., *Canis* cf. *variabilis*, *Equus sanmeniensis*, *E.* (*Hemionus*) sp., *Spirocerus wongi* and others. This fauna is termed Ust-Oborian. Its principal difference from the preceding Dodogolian fauna consists in the disappearance of *Borsodia laguriformes*, the presence of a more advanced type of *Allophaiomys* cf. *pliocaenicus*, and the appearance of new taxa—*Ochotona ustoborica*, *Lagurodon arankae*, and *Prolagurus ternopolitanus*. The species composition of the Ust-Oborian fauna and evolutionary levels of *Lagurodon* and *Prolagurus* taxa show that this fauna, slightly younger than the Dodogolian one, corresponds to the next younger stage of the Early Pleistocene faunal development.

The upper horizons exposed in the section include scarce remains of Middle and Late Pleistocene mammals. The sediments can be correlated with the sediments of the same ages of other sections.

The Ust-Oborian fauna is followed by the next Early Pleistocene—Kudunian fauna, which is characterized by the constant presence of the genus *Prolagurus* and an advanced type of *Allophaiomys* cf. *pliocaenicus*. Differentiated enamel on its teeth is a distinguishing feature of the latter. Faunas of Tologoi 2.1 and Tologoi 2.2 (below the Brunhes/Matuyama reversal) are similar in evolutionary level to the Kudunian fauna. They include *Crocidura* sp., *Ochotona tologoica*, *Spermophilus* (*Spermophilus*) *tologoicus*, and *Allactaga* sp. The rootless vole *Allophaiomys* cf. *pliocaenicus* persists in Zasukhinian fauna, and it is associated with other taxa of rodents such as *Terricola*, *Lasiopodomys*, *Eolagurus* and

Microtus. The fauna of Dodogol 2 (analogous to the Zasukhinian fauna) includes *Spermophilus* cf. *itancinicus*, *Eolagurus simplicidens sibiricus* of archaic type, and *Myospalax omegodon* a.o. This fauna is the latest in the Early Pleistocene mammalian sequence. Paleomagnetic studies found the Dodogol 2 sediments to be inversely magnetized and overlain with sediments with normal polarity. Presumably, they are located in the upper part of the Matuyama epoch, immediately below the Jaramillo event (Zudin, 1980).

2.5. Middle and Late Pleistocene

The Middle and Late Pleistocene sediments are represented by pale, pale-yellow, pale-greyish loam and sandy-loam, by loess-like loam and sands, referred to the Krivoyarskaya Suite (Ravsky et al., 1964). The deposits include calcareous stains and laminae, as well as grus in various proportions (Figs. 2A–C, Figs. 2E–H). Their thickness ranges from 5 to 15 m. Following are brief discussions of the deposits and attendant fauna.

At least four successive substages may be distinguished in the development of fauna during the Middle Pleistocene. The faunas of these substages differ from each other by the appearance of some new taxa and by their quantitative ratios. The oldest fauna is represented by the Tologoi faunistic complex known from different localities (Figs. 2A–C, Fig. 2F). The fauna of the Tologoi complex known from type locality Tologoi 2.5 (above Brunhes/Matuyama reverse) includes: *Sorex* sp., *Ochotona gureevi*, *Marmota sibirica nekipelovi*, archaic type *gromovi*, *Cricetulus* cf. *barabensis*, *Allactaga sibirica transbaikalica*, *Ellobius tancrei*, *Meriones unguiculatus*, *Eolagurus simplicidens*, *Lasiopodomys brandti*, *Microtus gregalis*, *Myospalax wongi*, *Pachycrocuta brevirostris sinensis*, *Canis variabilis*, *Vulpes vulpes*, *Martes* sp., *Archidiscodon* sp., *Equus sanmeniensis*, *Coelodonta tologojensis*, *Spirocerus* cf. *peii*, and *Gazella* sp. The most characteristic feature of this fauna is the absence of archaic voles of the genera *Allophaiomys*, *Prolagurus* and *Terricola* and the appearance of the genera *Ellobius* and *Meriones*. The Tologoian fauna is followed by the Ivolginian one which includes *Sorex* sp., *Ochotona* cf. *daurica*, *Ochotona* sp., *Marmota sibirica*, *Spermophilus* cf. *undulatus*, *Allactaga* sp., *Eolagurus* cf. *luteus*, *Lagurus* sp., *Clethrionomys rutilus*, *Lasiopodomys brandti*, *Microtus fortis*, *M.* cf. *gregalis*, and *M.* cf. *mongolicus*. It differs from the preceding (as well from the other stratigraphically younger faunas—Ustkiranian and Tazovian) mainly in the species composition and in their quantitative ratios. As for the Middle Pleistocene faunas, characteristic features are the diversity of genera *Microtus*, as well as an abundance of ochotonids and small cricetids.

The Late Pleistocene sediments are represented by a series of deposits such as loess-like sandy loam and various types of sand. Usually, they bear evidence of cold and arid conditions. The Transbaikalian mammal faunas of that time are characteristically dominated by assemblages of arid cold steppes (the Upper Paleolithic complex). They include *Ochotona daurica*, *Marmota sibirica*, *Spermophilus undulatus*, *Lagurus lagurus*, *Panthera spelea*, *Coelodonta antiquitatis*, *Mammuthus primigenius*, *Equus caballus*, *Bison priscus*, *Bos primigenius*, *Spirocerus kiakhtensis*, and *Rangifer tarandus* a.o. (Khenzykhenova and Alexeeva, 1999). Within the Late Pleistocene fauna (especially that of small mammals, mostly consisting of recent species), it is possible to distinguish three successive substages, which differ mainly in quantitative ratios of taxa. Moreover, some of the species were distributed over a greater area than at present.

3. Conclusion

Geological and paleontological investigations performed in the Transbaikalian Region permit identification of three principal complexes of the Late Cenozoic sediments: the Chikoi Suite of the Middle and Late Pliocene; the Krivoyarskaya Suite of the Middle and Late Pleistocene; and the Early Pleistocene deposits. For the whole sequence, there are abundant faunal data as well as some palynological characteristics. A few sections have been studied by paleomagnetic methods. All the data available enable us to correlate sequences studied in eight key sections of Transbaikalia. Red clays of the Chikoi Suite dated to the Middle Pliocene are exposed in Udunga, Tologoi I, Beregovaya I, and Gryazi. The Late Pliocene deposits of the same suite are known from the Itantsinian key section (composed of a number of partial sections—Klochnevo I, Klochnevo II, Zasukhino). The Early Pleistocene deposits (loams, sandy loams and sands of red, reddish-brown, orange–brown and grayish-yellow colour, with carbonate inclusions) are exposed in the Dododol 1, Tologoi 1.2, Ust'-Obor, Kudun and Zasukhino 2 localities. They contain several faunas of small mammals following each other in time. The Middle and Late Pleistocene deposits are represented by the Krivoyarskaya Suite which includes faunas of the Tologoi complex, the Ivolginian fauna, and others.

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