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QUATERNARY MAMMALS OF DONGBEI (NORTHEAST CHINA)

Dongbei is situated in Northeast China. Its level topography and fertile soils are formed by the Sungari (Songhuajiang) and Nonni river valleys in the north, the Sungari and Liaohe valleys in the central part, and the lower Liaohe valley in the south. The Great Dongbei, or Manchurian, Plain abounds in Quaternary sediments. To the west and east, mountains and hills prevail: in the east, the Lesser Khingan and Changbaishan ranges extend as far south as the end of the Liaodong Peninsula; in the west the Great Khingan Range towers at an altitude of 800–1000 m above sea level (the highest peak exceeds 1400 m).

According to data from the comprehensive study carried out in the 1950s by Pei Wenzhong, four regions of distribution of Quaternary mammals can be singled out in China (excluding Taiwan, Tibet and Xinjiang): northern, southern, Huai (the Huai River basin), and northeastern (Dongbei). The Huai region represents a transitional zone between the northern and the southern regions, while Dongbei is an offshoot of the northern one.

The study of Quaternary mammals of Dongbei began in 1911, when the Russian researcher Pavlova described fossil remains of a bison found on the banks of the Sungari River. In 1925, the Russian scientist E.E. Anert found remains of woolly rhinoceros and mammoth in Fulaerji (near Qiqikar) and in Zhalainor. In 1931, the Chinese geologist Yin Zanxun and the Russian scientist A.V. Ponosov published a report on their inspection of fossils in the layers of Guxiangtun. From 1932 to 1937, the Russian scientist A.S. Lukashkin studied fossils and stratigraphy. From 1937 to 1943, the Japanese specialists Tokunaga Shigeyasu, Naora Nobuo, Endoo Takatsugu, Ishijima Wataru, and Shikama Tokyo investigated mammalian fauna in Guxiangtun. In 1956, the Russian researchers Gordeev and Zhernakov discovered a complete fossilized

skeleton of a woolly rhinoceros 1.82 m high and 3.67 m long in Fulaerji, in the layer of lacustrine silt deposits at a depth of 9 m from the diurnal surface. This has been the largest finding of this kind discovered in China. Its geological age corresponds to the Late Pleistocene.

In the territory of the Liaoning Province, Quaternary deposits of a different genesis are widespread. Loose sedimentary deposits of continental facies prevail here; deposits of marine facies are limited to the southern seashore. Liaoning has undergone the influence of global climatic oscillations and new tectonic movements. During the Yanshan period, the hills and mountains on the western and eastern margins of Liaoning were in a state of elevation for a long time, as the valley of the lower reaches of the Liaohe River was being formed in the central region. The area between the two rows of low mountains was eroded by rivers and streams, forming wide terraces of various levels on the riverbanks. Karstic processes formed a large number of caves. Such a landscape created excellent conditions for a wide range of mammals.

The remains of these animals serve as a basis for studying the dynamics of their composition and morphology through time, making possible further investigation of climatic changes and their impacts on living conditions.

In the scientific report *A Review of Quaternary Mammals in the Dongbei Region*, Zhou Mingzhen mentioned small bone remains of such animals as aurochs, wild horse, and others, found in Kangping and Faku (Liaoning Province). Until the early 1970s, it was believed that in three provinces of Dongbei, only three fauna complexes – Guxiangtun, Zhalainor, and Yushu – represented Late Pleistocene fauna. Up to the present, about 200 occurrences of Pleistocene mammal remains, including 30 sites containing faunas of varying age,

have been discovered in Dongbei (see Figure). In the Liaoning Province, faunas representative of not only the Late Pleistocene, but also the Middle and Early Pleistocene have been recorded. In Linxi, bones of the vole (*Mimomys chinensis*) have been found; faunal remains have also been recorded in the Early Pleistocene layers in Haimao (Dalian city), and in the Middle Pleistocene layers of limestone caves and fissures in Jinniushan, Miaohoushan, Maoershan (Kazuo Prefecture), and Zanshan (Yinkou city).

Early Pleistocene fauna complexes in Haimao

The remains were collected in a stone quarry located north of the Haimao settlement (Ganjingzi region, Dalian city) at approximately $39^{\circ}9'30''$ N, $121^{\circ}38'42''$ E. The bedrock represents limestone of the Ganjinzi suite of the Xini period; numerous caves and fissures occur in the vicinity. The mammal remains, mainly microfauna, were found in a layer of red clay with a low gravel content. The following animals were identified: hedgehog (*Erinaceus* sp.), mole (*Talpidae* cf. *yanshuella*), Weng white-toothed shrew (*Crocidura wangi*), horseshoe bat (*Rhinolophus pleistocaenicus*), bat (*Myotis* cf. *pequinins*), Nihewan pika (*Ochotona nihewanica*), marmot (*Marmota complicitens*), zokor (*Prosiphneus* sp.), jerboas (*Allactaga* sp.), and vole (*Microtus minoeconomus*).

Among the Haimao microfauna, noteworthy is *Prosiphneus* sp. This animal, up until now undiscovered in Northeast China, is a relic of the Neogene period. Its remains have been also recorded in Early Pleistocene layers and are often found in Nihewan suites of the North China Cenozoic. The Haimao fauna in the vicinity of Dalian marks the first Early Pleistocene section in this region, whose age is ca 1.6 – 1.2 Ma, corresponding to the Hejiashan fauna in the region of Tangshan (Hebei Province).

Middle Pleistocene faunas

Five occurrences of Middle Pleistocene fauna have been found in the territory of Dongbei (mainly in the Liaoning Province): the Jinniushan, Miaohoushan, Maoershan (Kazuo Prefecture), Anping (Liaoyang city) and Zanshan (Yinkou city) faunas. In addition, several loci of bone fragment accumulation have been recorded.

1. **Jinniushan fauna**, a microfauna rich in anthropological remains, was found during excavations of the prehistoric site of Xitiancun, southwest of Dashiqiao (Yinkou Region). The site is located in a cave of Early Xini limestone ($40^{\circ}34'40''$ N, $122^{\circ}26'38''$ E). The total depth of cave deposits is 13.5 m. Stratigraphic layers may be divided into two groups with a border in the fourth layer. The upper group

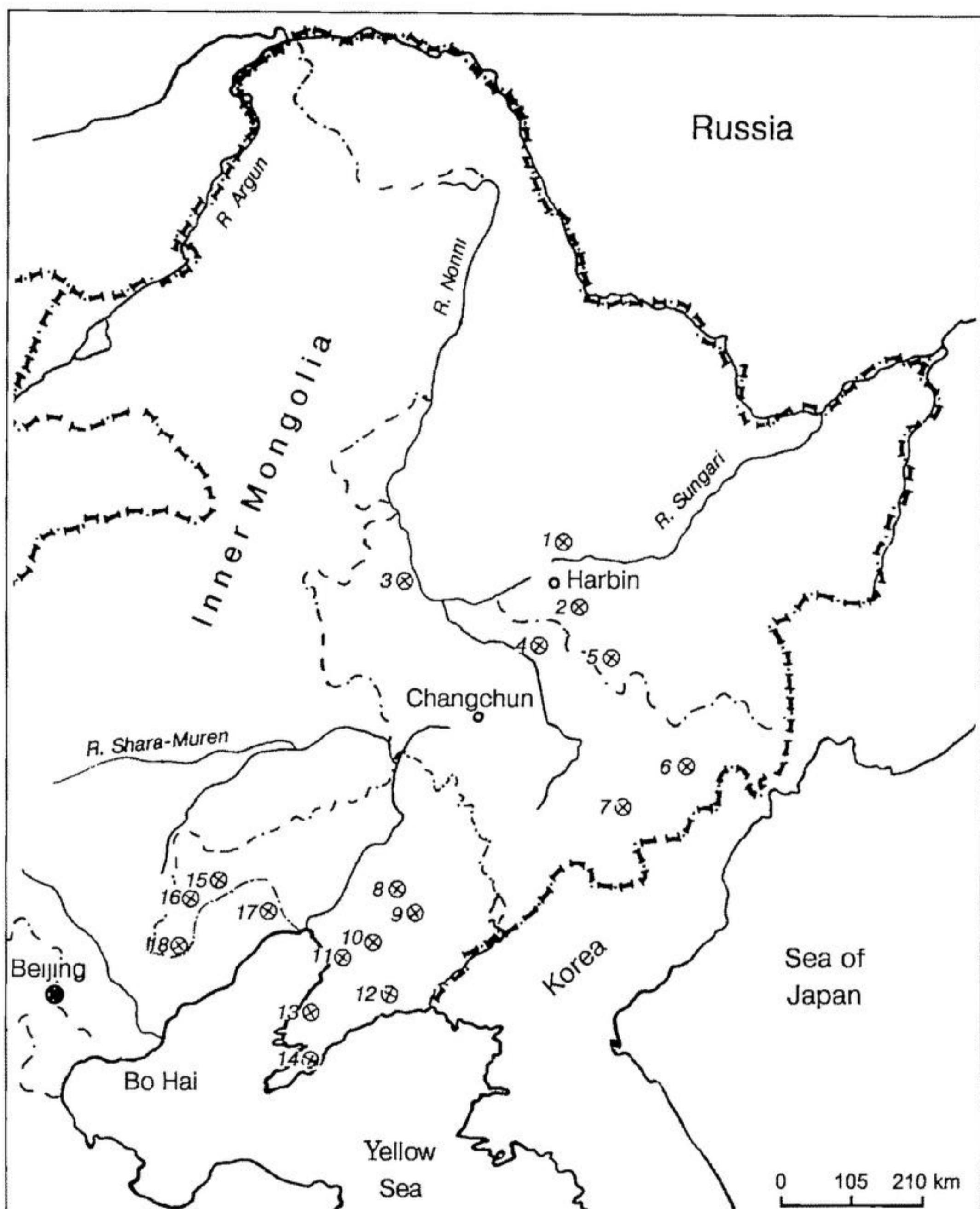
contains the Middle Pleistocene layers of brownish-gray and brown-yellow loamy sand and breccia; according to the uranium dates its age is ca 160 – 200 ka BP. The lower group of sediments was composed of firmly cemented cave breccia and sandy clay of brown-red color; according to uranium dates its age is ca 200 – 310 ka BP. Human bones were found in layer 8 (260 ka BP). All the remains found represent Middle Pleistocene species that have often been encountered in northern regions of China, as well as relict species of the Tertiary period. The most important species are. Han hedgehog (*Erinaceus olgae*), Weng hare (*Lepus wongi*), Brandt vole (*Microtus brandtioides*), beavers (*Trogontherium cuvieri* and *Sinocastor* cf. *zelanskyi*), porcupine (*Hystrix lagrelii*), ape (*Macaca robustus*), dog (*Canis variabilis*), Chinese raccoon (*Nyctereutes sinensis*), sabre-toothed tiger (*Homotherium ultima*), cheetah (*Acinonyx* cf. *jubatus*), Sanmen horse (*Equus sanmeniensis*), Merk rhinoceros (*Dicerorhinus merki*), and giant antler deer (*Megalocervus pachyosteus*).

In addition to the above mentioned, osteological remains of birds and reptiles have been found. The lower group of Jinniushan layers corresponds mainly to the upper part of the stratigraphic profile at the Zhoukoudian-1 site.

The upper portion of Jinniushan sediments contained fragments of a human skeleton (cranial, vertebral, carpal and ulna bones), lithic implements and much evidence of the use of fire. These are the earliest and the best-preserved fossil human remains in the territory of Dongbei. In the culture-bearing horizon of more than 1 m, over 10 thousand bone fragments (broken for extracting the marrow) were found. Stone implements scattered over the horizon, ash accumulations and numerous human bones form an integrated occupation horizon. This proves that humans inhabited Jinniushan for a long period of time.

2. **Miaohoushan fauna** is synchronous with *Homo erectus*. This fauna is associated with the prehistoric cave site formed in Ordovician limestone on the southern slope of Miaohoushan Mountain, east of Shanchengzi (Benxi Prefecture), at $40^{\circ}14'49''$ N, $124^{\circ}7'50''$ E. At present, it is the northernmost occurrence of Middle Pleistocene faunal remains, as well as the northernmost Lower Paleolithic site found in China. Eight stratigraphic units (numerated downwards) have been identified at the cave. Starting from layer 6 and below, Middle Pleistocene sediments composed of sandy loam of yellowish-brown color with breccia inclusions occur. This portion of the sediments corresponds to the Miaohoushan fauna. Layers 7 and 8, situated above, contain the Shanchengzi fauna.

The Miaohoushan fauna is represented by Sanmen horse, Merk rhinoceros, giant antler deer, buffalo



Map showing the location of the key Pleistocene mammal occurrences in Northeast China

1 – Yanjiagang, 2 – Acheng, 3 – Qian, 4 – Yushu, 5 – Xuetian, 6 – Antu, 7 – Fusong, 8 – Anping, 9 – Miaohoushan, 10 – Xianrendong, 11 – Jinniushan, 12 – Qianyang, 13 – Gulongshan, 14 – Haimao, 15 – Maoershan, 16 – Hezidong, 17 – Juejiadian, 18 – Bajianfang.

(*Babulus* sp.), Lydekker boar (*Sus lydekkeri*), Chinese hyena (*Hyaena sinensis*), dog (*Canis variabilis*), Asiatic cheetah (*Acinonyx* sp.), Young panther (*Panthera youngi*), Weng hare (*Lepus wongi*), marmot (*Marmota complicidens*), macaque, sabre-toothed tiger, and beavers (*Sinocastor anderssoni* and *Sinocastor zdanskyi*). These faunal remains were found in the lowermost part of layer 4. According to paleomagnetic data, the age of the lower layers of the cave is not less

than 730 thousand years, and that of layers 4 – 6 is 330 – 140 thousand years. Judging by the findings, the fauna mainly corresponded to forest-steppe environments. According to spore-pollen analysis data, the environment was characterized by warm and humid climatic conditions, with deciduous, evergreen and coniferous plants coexisting.

3. ***Maoershan fauna*** is represented by remains found in caves situated in Ordovician limestone in

Dongshanzui, near the Zhangjingyingzi settlement (Xingluzhuang Region, Kazuo Prefecture, Chaoyang District, Liaoning Province). The faunal remains are located in the upper reaches of the Dalinghe River ($41^{\circ}6'58''$ N, $119^{\circ}17'49''$ E). The bones were found in a sandy loam layer of brown or red-brown color. They belonged mainly to zokor (*Myospalax* sp.), Weng hare (*Lepus wongi*), wolf (*Canis* sp.), badger (*Meles* sp.), hyena (*Hyaena* sp.), bear (*Ursus* sp.), Sanmen horse, boar, and giant antler deer. Two species well represented in the sample – Sanmen horse and giant antler deer (*Megalocervus*) – are of special importance for the stratigraphic dating of the sediments. Judging by the structure and proportions, the horse teeth of the upper jaw are somewhat larger than in the specimens whose remains were found at Zhoukoudian (loci 1 and 13). This probably points to the fact that by the late period of the Middle Pleistocene a gradual increase in the size of the Sanmen horse was taking place. The giant antler deer also demonstrates the classic type: the thickness of the outgrowth on the lower part of the frontal bone is well expressed, the cross-section of the lower edge of M3 is almost round, and the thickness of projections is larger than that in the specimens from Jinniushan and Miaohoushan. It may be stated that the bones of the frontal part of the deer skull are the most classic specimens among those preserved up to the present time in the Middle Pleistocene layers in the Dongbei Region.

4. **Zangshan fauna** includes faunal remains found near the Chenjiabao settlement (Baizhaizi Region), 30 km northeast of Dashiqiao city (Yingkou District) at $40^{\circ}30'01''$ N, $122^{\circ}30'35''$ E. The remains were found on a mountain slope at an altitude of 110 m above sea level in a karstic cave, within sediments of the Shengshuisi group (Liaohe suite of the Xini period). The bones were found in a clay layer of brownish-red color inside the cave. Apart from the faunal remains, a small number of lithic artifacts were found. Representatives of the following orders were identified: Lagomorpha (*Ochotoma* sp.), Rodentia (*Lasiopodoys brandti*, *Myospalax aspalax*, *Micromys* cf. *minutus*), Primates (*Macaca robustus*), Carnivora (*Canis variabilis*, *Nyctereutes* sp., *Ursus arctos*, *Mustela sibirica*, *Meles meles*, *Crocuta ultima*), Perissodactyla (*Equus sanmeniensis*, *Dicerorhinus*), and Artiodactyla (*Sus* sp., *Cervus A* and *B*, *Hydropotes* sp., *Capreolus manchuricus*, *Spirocerus* sp.).

The Zangshan fauna includes representatives of classic Middle Pleistocene species, e.g., Sanmen horse, macaque and dog, as well as species that appeared in the Late Pleistocene. The number of completely extinct species is small. The color of the sediments changes from brown-red at the bottom to light yellow at the top. Thus, in the Zangshan cave, layers representing

two sedimentation stages and illustrating the Middle to Late Pleistocene transition were identified. The upper layer contains bone remains of comparatively late species, e.g., the latest striped hyena, brown bear, and spiral-horned antelope. It may be conjectured that the lower portion of stratigraphic profile was formed at the end of the Middle Pleistocene, the upper layer during the Late Pleistocene.

5. **Anping fauna** was recorded on the eastern side of the Tanghe River, near the Anping(zhen) settlement, southeast of Liaoyang city ($41^{\circ}10' N$, $123^{\circ}26' E$). Bone remains occurred in sediments filling fissures on the surface of Cambrian-Ordovician limestone. The lower portion of the sediments (layers 3 – 5), brownish-red clay with breccia inclusions, contained numerous faunal remains representing seven orders and twenty-two species, including Han hedgehog (*Erinaceus olgae*), zokor (*Myospalax fontanieri*), macaque, Young panther (*Panthera youngi*), Chinese raccoon dog (*Nycterenes sinensis*), Merk rhinoceros, sika deer (*Cervus nippon*), deer (*Rusa elegans*), musk deer (*Moschus moschiferus* var. *pekinensis*), and boar.

The Anping fauna is characterized by a relatively complete preservation of the fossils. Bones of rhinoceros (*Rhinoceros merki*) are especially well represented, allowing the reconstruction of several skeletons. There are also two skulls of Young panther with well-preserved upper and lower rows of teeth. In addition, remains of water deer were found; they are seldom encountered in the Dongbei region, since this species is characteristic of warm and humid climatic conditions. The share of extinct species in the Anping fauna sample reaches 62.5%. Comparing the composition of sediments with the results of analysis of the whole assortment of fossil species, it is possible to attribute this locality to the Middle Pleistocene (although it lacks such classic species as *Megaloceros*, *Hyaena hyaena*, and *Equus sanmeniensis*).

Late Pleistocene faunas

Late Pleistocene fauna locations are extremely widespread in Dongbei. According to incomplete data, about 260 faunal specimens have been found in cave and terrigenic sediments, as well as a small number in marine sediments. Among the most important groups of fauna, the following ones are distinguished: Acheng (Heilongjiang Province), Hezidong, Xianrendong, Yushu (Jilin Province), Yanjiagang (Harbin city), Qianyang (Dandong city), Gulongshan (Daliang city), Bajianfang (Lingyuan Prefecture), and Quejiadian (Changtu Prefecture). All of them encompass a period from the early stage of the Late Pleistocene to the end of the Late Pleistocene. The fauna of the Dongbei mammoth complex has been singled out among them.

1. *Acheng fauna* was recorded at a site in a karstic cave near the settlement of Jiaojie(zhen), near the city of Achen (Heilongjiang Province). This site, the earliest Paleolithic site so far discovered in Heilongjiang, includes important archaeological objects. The cave sediments contain about 100 stone implements and faunal remains representing twelve species, including Merk rhinoceros (the lower jaw), roe, badger, hare, bear, marmot, and marten. The remains of Merk rhinoceros were the first found in Heilongjiang, although the bones of the lower jaw, discovered in the gully Huangshanchonggou near Harbin city, are recognized only with difficulty. A uranium date of 175 ± 22 ka BP obtained from the rhinoceros teeth places this site within the early stage of the Late Pleistocene.

2. *Shanchenzi fauna* is represented by an assemblage of Late Pleistocene animal remains found in layers 7 and 8 of Miaohoushan cave. Among the main species identified are jerboa, Daurian pika (*Ochotona daurica*), Norway rat (*Rattus norvrgicus*), Chinese raccoon dog, cave bear, fox (*Vulpes cf. vulgaris*), spotted hyena, Przewalski horse (*Equus przewalskii*), deer (*Cervus nippon*, *Cervus elaphus maral*, *Megaloceros ordosianus*), Pleistocene musk deer, Przewalski gazelle (*Gazella przewalskii*), buffalo, and blue sheep (*Pseudois nayana*). Currently existing species prevail, with extinct ones making up only 38.4%. This fauna group is similar to the Sharaosso-gol fauna. Its representatives usually inhabit steppe, arid or desert environments; thus it may be conjectured that during the Late Pleistocene the climate was more arid and cold than at present.

3. *Hezidong fauna* is represented by remains found on the Dalinghe River near the Wafangcun settlement (Shuiquan Region, Kazuo Prefecture, Liaoning Province) at $41^{\circ}15' N$, $124^{\circ}50' E$. The faunal remains were found within sediments of a cave formed in Ordovician limestone. They were discovered together with human remains and numerous lithic artifacts; a layer of ash was also found. Thus the cave represents a classic habitation site of prehistoric man. The extent of the cave sediments is rather large; the culture-bearing layer was composed of grayish-yellow sediments and inclusions of breccia. Bones of twenty-six animal species were found there. They mainly represent Daurian piping hare, great marmot, mole, zokor, Chinese cat, spotted hyena, brown bear, wolf, lynx, wild horse, red deer, Przewalski gazelle, blue sheep (*Pseudois sp. nayana*), and woolly rhinoceros.

The Hezidong fauna is characterized by the presence of representatives of both Pleistocene North Chinese and Dongbei ("woolly rhinoceros – mammoth") faunas. It is similar to the Sharaosso-gol fauna, in which extinct species make up 30.7%. The

most widely represented are remains of the Przewalski gazelle and spotted hyena. Argali, a frost-resistant animal, inhabits regions situated high above sea level. Thus it may be hypothesized that Hezidong man lived during the coldest period of the Pleistocene. Proceeding from stratigraphic characteristics, comparisons with surrounding terraces, the archaic appearance of stone implements, as well as from results of a comprehensive study of the mammal remains, the Hezidong site may be culturally attributed to the Middle Paleolithic, which corresponds to the middle period of the Late Pleistocene, i.e., to ca 70 – 50 thousand years ago.

4. *Xianrendong fauna*. The Xianren (dong) cave (Haicheng Prefecture) is the most important Paleolithic site in the Dongbei territory. Here, not only numerous Late Pleistocene mammal remains, but also fossilized human bones, more than 10 thousand lithic artifacts, bone implements and adornments have been found. The site is situated in the Gushan Manchurian Autonomous County (Haicheng city in southern Liaoning) at $40^{\circ}3' N$, $122^{\circ}58' E$. The bedrock is Early Xini marble of "cloudy whiteness." Layers 2 – 4 inside the cave are composed of breccia-containing fine sandy loam of yellow color. These layers contain archaeological remains. The identifiable faunal remains represent hamster, zokor (*Myospalax fontanieri*), Chinese raccoon dog, corsac, brown bear, cave bear, badger, spotted hyena, Chinese cat, Asian cheetah, mammoth (*Mammuthus primigenius*), boar, giant antler deer, red deer, Przewalski musk deer, and bison. A characteristic feature of this fauna complex is an absolute dominance of Artiodactyla (71.5% of the sample), which is indicative of steppe environment. Remains of otter, buffalo, and Pekinese musk deer, normally living in wetland habitats with a warm climate, were also encountered. This proves that during the Late Pleistocene the climate changed many times. Thermoluminescent dates of 40 – 20 ka BP have been obtained for the site.

5. *Xuetian fauna*. At the Xuetian Paleolithic site (Longfenshan County, Wuchang Prefecture, Heilongjiang Province), lithic artifacts, bone implements and remains of eight animal species were found. Although the species diversity of the fauna is not great, the bones are numerous. They mostly represent mammoth, bison, horse, deer, woolly rhinoceros, and zokor. Two AMS dates ($35,010 \pm 370$ and $37,810 \pm 420$ BP) were obtained for the site.

6. *Yushu fauna*. An accumulation of bones was found near the creamery of Zhoujia (Yushu Prefecture, Jilin Province) at $44^{\circ}43' N$, $125^{\circ}21' E$. The remains were found on the second loess terrace at the convergence of the Sungari and Lalin rivers, in a layer of gray loam with yellow hints. Bones of about thirty mammal species were previously found here.

Researcher Zhou Mingzhen considered them as belonging to the Yushu fauna. In the 1970s, the number of findings increased.

The fauna is represented by zokor (*Myospalax fontanieri*), spotted hyena, tiger, true mammoth, Sungarian mammoth (*Mammuthus sungari*), Przewalski horse, woolly rhinoceros, Dongbei roe deer, elk (*Alces alces*), bison (*Bison exiguus*), Przewalski antelope, and auroch. This is the classic "woolly rhinoceros – mammoth" fauna complex of the glacial period. Together with the faunal remains, lithic and bone implements of advanced type, culturally attributed to the Upper Paleolithic, were found. The available radiocarbon dates are 31 – 26 ka.

7. *Antu fauna* was recorded in a limestone cave located on the second terrace of the Buerhatong River in the vicinity of the Mingri(zhen) settlement (Antu Prefecture, Jilin Province). In the cave, fossilized teeth of *Homo sapiens* were discovered. In total, nineteen animal species were identified, among which carnivores prevail, followed by Perissodactyla and Artiodactyla. The majority of animals represent modern species within the framework of the classic "woolly rhinoceros – mammoth" fauna complex. Among them there are such animals as piping hare, wolf, raccoon dog, fox, brown bear, spotted hyena, lynx, tiger, true mammoth, Przewalski horse, woolly rhinoceros, sika deer, red deer (Canadian) (*Cervus canadensis*), elk, and Dongbei bison (*Bison exiguus*).

According to the data of palynological analysis, Chinese spruce and fir grew in the cave environs. At present, they survive only in the Changbaishan Mountains at an altitude of over 1400 – 1800 m above sea level. Thus, Antu man lived under rather cold climatic conditions. Radiocarbon dates range from 35 to 26 ka BP, which chronologically correspond to the Sharaosso-gol fauna.

8. *Yanjiagang fauna* was found at one of the most important recently discovered sites in the Heilongjiang Province, on the second terrace of the Sungari River. In addition to human dwellings constructed of bones of large mammals, numerous bones representing twenty-nine mammal species were found at the site. Extinct species are represented by spotted hyena (*Crocuta ultima*), true mammoth, Sungari mammoth, woolly rhinoceros, Przewalski horse, red deer, giant antler deer, Wang buffalo, and Dongbei bison; they form 24.1% of the fauna sample.

Large mammals, such as horse, giant antler deer, bison, antelope, mammoth, and rhinoceros dominate the fauna collection. People used limb bones of the large animals to construct the walls of their temporary dwellings. Bones of carnivores – wolf, red wolf, fox, stoat, hyena – and of Artiodactyla were also encountered, corresponding to a light forest and steppe

environment. The Yanjiagang stratigraphic profile contains a comparatively thin layer of fossil soil of red-brownish color corresponding to a short episode of warm and humid climatic conditions. A radiocarbon date of $22,370 \pm 300$ BP was obtained for the site.

9. *Gulongshan fauna* was recorded near the Gulongshan stone quarry in the suburbs of Wafangdian city (Dalian District) at $39^{\circ}41'15''$ N, $122^{\circ}01'59''$ E. The faunal remains were discovered in a layer of clay sediments inside a cave formed in Cambrian limestone. The main animals identified are hedgehog, Dongbei piping hare, ground squirrel, migratory hamster (striped), mole, dog, red wolf, brown bear, steppe stoat, spotted hyena, Asian cheetah, horse (*Equus dalianensis*), woolly rhinoceros, true mammoth, giant antler deer, Dongbei sika deer, aurochs, Wang buffalo, spiral-horned antelope (*Spirocerus* sp.), and Przewalski antelope.

The Gulongshan sample represents an immense volume of Late Pleistocene fauna of southeastern China, including fish, reptiles, birds, and mammals. The last include fifty-seven species dominated by rodents, carnivores, and Artiodactyla. Fossilized remains of horse (including the Dalian and Przewalski horses) are numerous. About five thousand horse teeth, representing at least 140 individuals, have been found. A radiocarbon date of $17,610 \pm 240$ BP obtained for the cave corresponds approximately to the fauna of the Upper Grotto (Shandingdong).

10. *Qianyang fauna* was found in a cave formed in Ordovician limestone of the Majiagou suite (Qianyang County, in the region of the Eastern Port of Dandong city). A skull of late *Homo sapiens* and lithic artifacts were found, allowing the attribution of the site to the Upper Paleolithic. The fossils mainly represent Chinese zokor, Aman zokor, macaque, bear, badger, raccoon dog, southern badger, corsac, small boar, wolf, hyena, lynx, horse, red deer, roe deer, and wild boar. The species diversity of this fauna is not great. With only a river separating Qianyang from Korea, it marks an important migration route for North Chinese fauna from the Liaodong Peninsula to the Korean Peninsula. A radiocarbon date of $18,620 \pm 320$ BP was obtained for the layer containing remains of Qianyang man.

11. *Qingtoushan fauna*. Remains of late *Homo sapiens* and representatives of fauna dominated by small mammals were found on the terrace of the northern side of the Chaganpao River (Qianguo Prefecture, Jilin Province). By the species composition, the fauna corresponds to the Late Pleistocene – Early Holocene transition. Steppe rodents constitute the basic component of this fauna sample, e.g., five-toed jerboa, Dongbei zokor, Brandt vole, marmot (*Marmota bobac*), and Daurian ground squirrel. In addition, remains of woolly rhinoceros, Przewalski horse, wild boar, deer –

Correlation of data on the Quaternary mammal fauna in Dongbei and in the regions of North China

Geological periods	Absolute dates	Archaeological periods	Classical stratigraphic scale	North China	Liaoning Province	Jilin and Heilongjiang Provinces
Late Pleistocene Q ₃	10 ka	Upper Paleolithic	Malan loess	Shandingdong, Beijing city; Zhlyu (Shiyu), Shanxi Province	Bajianfang, Lingyuan Prefecture, Shenjatai, Jinxian Prefecture, Gulongshan, Dallan city (17,610 ± 240), Qianyang, Dandong city (18,620 ± 320); Xianrendong, Halcheng Prefecture (40 – 20 ka)	Zhalainor, Qingtoushan, Jilin Province (10,940 ± 170), Fusong, Jilin Province; Yanjiagang, Heilongjian Province (22,310 ± 300); Yushu, Jilin Province (31 – 26 ka); Xuetian (Experimental Field) in Wuchang, Heilongjian Province (42 – 34 ka)
	50 ka	Middle Paleolithic		Xujiao, Hebei Province, Dingcun, Shanxi Province; Dali, Shaanxi Province	Hezidong, Kazuo Prefecture (70 – 50 ka)	Acheng, Heilongjian Province (17.6 ka)
Middle Pleistocene Q ₂	200 ka	Lower Paleolithic	Lishi loess	Zhoukoudian-1, Beijing city; Chenjiawozhi, Shaanxi Province, Gongwangling, Shaanxi Province	Anping, Liaoyang city; Zangshan, Yingkou city, Jinniushan, Yingkou city (310 – 200 ka), Maoershan, Kazuo Prefecture, Miaohoushan, Benxi city (400 – 140 ka)	
Early Pleistocene Q ₁	1 Ma		Wucheng loess	Nihewan, Hebei Province	Haimao, Dalian city (1.6 – 1.2 Ma)	
	3 Ma					

thirteen species, in total – were found, most of which represented modern species. Some elements of the "woolly rhinoceros – mammoth" fauna complex were also recorded. The climatic conditions corresponding to this complex were characterized by the Dali glacial maximum at the end of the Pleistocene, synchronous

to Würm in Europe and Wisconsin in North America. This fauna collection may serve as a base for a deeper investigation of changes of the "woolly rhinoceros – mammoth" complex of the Late Pleistocene. A radiocarbon date of 10,940 years BP places this fauna at the final stage of the Late Pleistocene.

Conclusions

Apart from the specificity of the dated fauna complexes mentioned above, we can single out some general characteristics of the mammal fauna discovered in Dongbei to the present.

1. The Quaternary mammal fauna of Dongbei is extremely rich. To date, classic fauna complexes representing the Early, Middle and Late Pleistocene have been recorded, which is conducive to the construction of reference profiles for each stage of Quaternary stratigraphy of Northeast China.

2. A comparatively large amount of materials representing the Middle Pleistocene fauna of this region has been found. The main species are the same as those in the Zhoukoudian fauna of North China, e.g., macaque, sabre-toothed tiger, Chinese striped hyena, raccoon dog, Sanmen horse, Merk rhinoceros, Lydekker wild boar, giant antler deer, *Trogontherium* Juya beaver, and Zdansky beaver. Evidently, migration of Middle Pleistocene fauna from North to Northeast China had taken place. Presence of contacts between regions was reflected in archaeological cultures, too. In addition, the stratigraphy of Dongbei sites of the period under consideration is similar to the sequence of sediments of the upper part of Zhoukoudian. For example, the coexistence of the remains of red deer with those of giant antler deer, and Chinese striped hyena with spotted hyena proves that the above-mentioned sites correspond to the late period of the Middle Pleistocene.

Among the Quaternary faunal remains discovered during many years of study in the territory of Jilin and Heilongjiang provinces – the Yushu, Guxiangtun and Zhalainor – a section of Late Pleistocene stratigraphy with the Dongbei "woolly rhinoceros – mammoth" fauna is represented. Among the latest findings, fossils of Middle Pleistocene animals found in the Liaoning Province should be mentioned. However, in the Jilin and Heilongjiang provinces no clear evidence of fauna of this epoch has been found. Remains of Merk rhinoceros discovered in Acheng (Heilongjiang Province) in the 1990s prove that the warmth-loving animal spread north of the 45th parallel (at present, this is the northernmost location of Merk rhinoceros) and existed in Northeast China as early as the initial period of the Late Pleistocene, i.e., 17,500 years ago.

3. All the faunal remains of various periods studied to present have been found in cave sediments, the majority accompanied by remains of ancient man and lithic artifacts. Evidently, large accumulations of animal bones occur only at dwelling places of Paleolithic man. There was an unbreakable bond between man and fauna. In terrigenic and lacustrine-fluvial sediments, only fragments of fossilized faunal

remains have been found. Much zooarchaeological data have been gathered, which should prove useful for the study of research problems associated with Paleolithic sites, such as the manufacture of stone implements and man-made traces on the surface of bones, and pathology of animal bones and teeth.

Some patterns in the distribution of Quaternary mammal fossils in Dongbei have been observed. The bone accumulations are most frequently encountered in the southern part of the region and less often in the north; they are more often found at the junction of plains and piedmonts, and less often in high mountainous regions; they normally occur on the first and second terraces of rivers, and less frequently on high terraces.

4. Within a time span between ca 33 and 11 thousand years ago, in Dongbei there appeared mammals adapted to the conditions of a comparatively cold climate. For example, in the Hezidong, Gulongshan, Yushu and Yanjiagang faunas, classic representatives of the "woolly rhinoceros – mammoth" fauna complex have been recorded, specifically those animals characteristic of the circumglacial climate, such as spotted hyena, horse, aurochs, and bison.

According to the available archaeological data, woolly rhinoceros did not pass over the Bering Strait into North America. In China, the southernmost limit of its habitat reached 31° N, which is beyond the southern limit of the zone of mammoth habitation (39° N). From this it follows that the adaptation characteristics of the woolly rhinoceros differed from those of other animals of the glacial period. It does not belong to classic species which are widely represented in the natural conditions of circumglacial zone, and for this reason, in the opinion of some researchers (Zhou Mingren, 1991), it is more correct to speak of "mammoth fauna", not "woolly rhinoceros – mammoth fauna."

Andersson ostrich (*Struthio anderssoni*) represents a species that lived under dry climatic conditions in semideserts or deserts. The fauna of the Liaoning and Jilin provinces, where fossilized ostrich eggs were found, and that of North China within the framework of the Malan loess period of the Late Pleistocene, may be considered as similar.

Mammoth that existed during the Late Pleistocene belongs to a group of frequently occurring species characteristic of cold climatic conditions. In China, the northern boundary of its habitat exceeded 52° N, while the southern limit ran along the southern extremity of the Liaodong Peninsula. Remains of mammoth have recently been discovered in the Huanghe River basin, the Hebei and Shanxi provinces, and the autonomous region of Inner Mongolia. Migrating humans followed mammoth, an important object of hunting and source

of food, to various regions of Siberia, North America and East Asia. An analysis of archaeological data demonstrates that the latest layers with buried remains of mammoth correspond to the end of Late Pleistocene (ca 10 ka BP). So far they have not been found in the Holocene layers. Specialists believe that global climatic warming in the Holocene was a cause of extinction of mammoths. Therefore the mammoth remains are important for the analysis of the climatic situation in the Late Pleistocene.

5. The Liaoning Province, situated in the southern part of Dongbei, is characterized by a complicated topography. In the species composition of fauna, the specificities of transition from the North Chinese (Huabei) fauna to the classic "woolly rhinoceros – mammoth" fauna complex are manifested. That is why it is difficult to define the attribution of some species to the northern or to the northeastern fauna. For example, the Middle Pleistocene fauna of Zhoukoudian contains a large number of classic species, such as Sanmen horse, Merk rhinoceros, Chinese striped hyena, macaque, giant antler deer, Andersson beaver, Young panther, and water deer. They are also often found in the Middle Pleistocene layers of Liaoning. Classic species of the Dongbei Late Pleistocene "woolly rhinoceros – mammoth" fauna complex (giant antler deer, spotted hyena) were widespread in the territory of North China and Northwest China up to the Yangzi basin. Representatives of southern fauna, such as Wang buffalo, otter, water deer, and Pekinese musk deer have been found in both Liaoning and Jilin. This proves that during the onset of interglacial period, many representatives of the southern fauna migrated to the north in search of an appropriate natural environment, although they did not cross the border, corresponding to 44° N, between the modern Jilin and Heilongjiang provinces.

6. Migration of Late Pleistocene mammals was caused by climatic conditions, since mammals are as responsive to climate changes as plants are. Evidence of this can be found in the remains of some animal species in Dongbei and other regions of China. At the end of the Late Pleistocene (ca 50 – 10 ka BP), under the influence of the Dali glaciation in China, Würm in Europe, and Wisconsin in North America, some animal species migrated either to the north or to the south. That is why the Quaternary mammal remains found in Dongbei have great importance for studying the spread of Quaternary fauna and the paleoclimatic changes in the territory of China and other regions of East Asia, Siberia and North America.

7. In the region under study, fossil remains of the Late Pleistocene fauna are well represented; they may be arranged in chronological sequence (Table). However, the faunal remains of the Early Pleistocene

and the initial stage of the Middle Pleistocene are very scarce; that is why the further search for such materials is an urgent research task.

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