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N.N.Kostenko, B.S.Kozhamkulova

ON THE PROBLEM OF THE PLIOCENE-PLEISTOCENE BOUNDARY IN KAZAKHSTAN

The problem of the boundary between the Neogene and Quaternary systems has been argued internationally for a long time. The history of the question is discussed in detail by K.V. Nikiforova (1973, 1976). At an International Colloquium in 1972, USSR, it was suggested to draw the Pliocene-Pleistocene boundary at one of the three stratigraphic levels, i.e. 1) the base of the Bakuan beds and their continental equivalents (0.69-0.7 mln. y.); 2) the base of the Apsheronian (1.6-1.8 mln.y.); 3) the base of the Akchagylian (3.3-3.5 mln.y.), according to the scale adopted in the USSR. The boundary on the USSR geological maps is drawn at the first level, likewise in this report, but the lowering of the boundary is expedient.

The stratigraphic subdivision of the Phanerozoic is based on the marine faunas. Recent publications on deep drilling in oceans may serve the basis for establishing the boundary between the Neogene and Pleistocene on the same principle. In West Europe investigations have shown a possibility of the correlation between marine and continental deposits containing the land mammal fauna. In Kazakhstan the faunal complexes correlable with European (Kostenko, 1974) have been distinguished, hence the continental deposits embedding them might be correlated with marine. The mammal fauna is one of the decisive factors in defining the boundary between the Neogene and Quaternary systems.

The USSR Interdepartmental Stratigraphic Committee (1970) approved the standard horizons for continental deposits in Kazakhstan, comprising the Ilian and Khorgosian horizons corresponding to the Akchagylian and Apsheronian respectively; in different regions the suites correlated by the mammal fauna correspond to them. The distribution of Ili fauna in Kazakhstan has been shown by B.S. Kozhamkulova (1973), the presence of an older Yesekartkan complex at the base of Ilian horizon by P.A. Aubekerova (1974); the fauna has been also found in the Khorgosian horizon (Костенко, 1974).

Very active tectonic movements affected the territory of Kazakhstan and adjacent regions in the middle Pliocene; originally they had been called the Irtysh phase (Костенко, 1963), and later acquired a name Irtysh-Tekes phase implying its regional nature. In the west of Kazakhstan the intermittent transgression of the Akchagylian sea began during this phase following the earth crust uplifting and cutting the deep valleys of pra-Volga, pra-Ural and others as well as the formation of Ustyurt chinks. The transgression extended into the eastern Aral area and northern part of Kyzylkum via Uzboy. The accumulation of the Ilian horizon is confined to this period. The east and southeast of Kazakhstan tended to a general uplifting and resulted in arising a mountain group of Khan Tengri (7000 m), while sinking, locally below the World Ocean level, dominated in the west.

Due to tectonic movements which intensified the erosion coarse clastic material ranging from pebbles in the highest uplifts to sandy away from them deposited at the base of Ilian horizon and the Akchagylian Stage.

In southeastern Tien Shan, Dzungaria and foothill basins the Ili Suite is composed of buff clays, siltstones, sandstones, marls, gravelsatones (up to 800 m thick). The Yesekartkan complex comprising Struthio sp., Emydidae, Lepus sp., Ochotona sp., Castor fiber, Felis (Lynx) sp., Anancus kazachstanensis, Hipparion houfense, Hipparion sp., Dicerorhinus orientalis, Rhinoceros sp., Gigantocamelus liogipes, Gervavitus flerovi, Sinomegaceros sp., Palaeotragus sp., Samotherium sp., Gazella sinensis, Gazella ex gr. dorcadoides, Antilospira sp. is confined to the basal coarse clastic horizon. This fauna contains early Pliocene relics encountered as well in Tulkisay (Turgay region), the Sovkhoz Molodezhny (Karaganda region) and near the town of Pavlodar (Hipparion, Cervavitus, Palaeotragus, Samotherium) and also a number of advanced forms indicating a younger age. The Yesekartkan mastodon Anancus

kazachstanensis is more archaic than A. arvernensis. As a whole, the complex relates to the late Hipparion fauna of Mongolia (Altan Teeli, Khirghis Nur), China (Ertemte, Shathon Gol, Dzin Lo) as well as to the middle Sinapian fauna of Turkey. Despite the fact, that it is dated approximately as the middle Pliocene, like Roussilionian fauna of Europe, this complex differs in absence of primates, tapirs, hippopotamuses, etc. (Аубекерова, 1974).

The higher horizons of the Ili Suite yield the fauna of the Ili complex correlative with faunas of Khapry and Villafranchian (Бажанов, Костенко, 1958). The fauna has been collected and identified by V.S. Bazhanov, N.N. Kostenko (1964); B.S. Kozhamkulova (1969); G.F. Lychev, P.F. Savinov (1974). The complex includes Struthio sp., Testudo sp., Ochotonoides comlicidens, Hypolagus brachygnathus, Ellobius primigenius, Miomys (Tianshanomys) antis, M. aff. intermedius, Anancus arvernensis, Anancus sp., Anancus cf. sinensis, Archidiskodon cf. gromovi, Allohippus robustus (Equus stenonis), Cervus sp., Gazella subgutturosa; abundant mollusks and ostracods are present as well.

Tectonic movements definitely activated at the end of the Pliocene (the Khorgos phase) and resulted in accumulation of gravels, boulders-and-pebbles, sands, gravels with subordinate clays (up to 600 m thick). The Khorgos Suite contains Archidiskodon meridionalis, mollusks, and ostracods.

In the west of Kazakhstan the short-term regression of the Akchagylian sea followed later by the intermittent Apsheronian transgression was associated with the Khorgos diastrophic phase. The subsequent Koybyn tectonic phase was also widely manifested. During this phase in mountainous regions of Tien Shan, Dzungaria, Saur Paleogene and Neogene deposits including the Ilian and Khorgosian horizons were folded and overlapped with an angular disconformity by the lower Quaternary deposits.

The regression of the Apsheronian Sea and the Bekuan transgression were associated with the Koybyn phase in the western part of Kazakhstan.

In the southeastern area E.I. Beliayeva has identified Canidae (Vulpes sp.), Mustelidae, Equus sp., Cervus elaphus (?) from the lower Quaternary deposits. The typical Koshkurgan forms such as Elasmotherium sibiricum, Dicerorhinus mercki, Asinus hidruntinus, Archidiskodon cf. wusti were found during excavation works at Kapchagay (Кожамкулова, 1974). The thickness of the deposits distinguished as Koturbulak Suite exceeds locally 300 m.

In the southern margin of central Kazakhstan (Betpakdala) the Kenschagyr Suite (Никифорова, 1960) referred to the Ilian horizon by

mollusks and ostracods was singled out while mapping; the suite consists of clays with sands at the base (100-160 m thick); higher follows with an erosional break the Kokurium Suite (gravels, sands, pebbles, 20-30 m thick) with fragments of egg shells of Struthio sp.; it is unconformably overlain by the lower Quaternary deposits.

In southwestern Tien Shan and Karatau Ridge the Aksakatay Suite attributed to the Ilian horizon rests on the Beldersay Suite characterized by the Hipparion fauna; it consists of buff clays, sandy limestones interbedded with pebbles and gravelstones (300-400 m thick) with remains of Equus stenorhis.

The Mashat Suite of conglomerate (250-270 m thick) belongs to the Khorgosian horizon.

The lower Quaternary Koshkurgan Suite consists of alluvial and proluvial pebble beds, conglomerates, sands, limestones, and clays (up to 60-80 m thick) and contains the fauna of the Koshkurgan complex: Paracamelus gigas, Equus caballus cf. mosbachensis, Asinus hidruntinus, Dicerorhinus mercki, Bison priscus subsp. (Хисарова, 1963). The flint implements of the Chellean-Acheulian epoch (Алишбаев, Костенко, 1968) have been found in conglomerates near the upper reaches of the Arystandy River.

In the area of eastern Aral and in northern Kyzylkum the Shakhshakh Suite of clays interbedded with sands (up to 80 m thick) has been recognized; it bears foraminifera and mollusks peculiar for the Akchagylian. It is followed with an erosional break by the Kokurium Suite of sands and gravels with clay interbeddings in places (10-15 m thick) yielding the fragments of eggs of Struthio sp.

The marine deposits of the Akchagylian, Apsheronian and Bakuan spread over the Caspian area in Kazakhstan and have been widely discussed in literature; the correlation with continental deposits is discussed by N.N. Kostenko (1974).

Within the Turgay hollow and the Ishim area the deposits assigned to the Ilian and Khorgosian horizons by the mammalian fauna are completely continental. The Ilian horizon consists of alluvial and lacustrine-alluvial facies (pebbles, sands, clays, loams and sandy loams, 25-30 m thick). They rest unconformably on different older rocks; formerly they have been described as Kastanay Suite (Сигов, 1954, and other) and Biteke beds or Biteke Suite (Лавров, 1959; Шаңцер, Лаврушин, Микулина, 1967; Зинова, 1974; and other).

The fauna occurrence exposed by the Biteke River, near the former aul Selimjevar have been mentioned by I.A. Orlov (1961)

and other authors. It contains the mammals (except redeposited): Paracamelus praebactrianus, Paracamelus sp., Equus cf. stenonis, Trogotherium cuvieri, T. minus, Castor fiber, Proochotona ex gr. antiqua, Ochotona sp., Mimomys cf. stehlini, Mimomys sp., Lepus sp. The mollusks of the Levantine type have been identified by V.V. Bogachev, I.V. Danilovsky, V.A. Lindgolm, K.A. Liadzhina, U.N. Maderni, V.A. Nikolayev, A.L. Chepalyga and V.S. Zykin. Ostracods and pollen complexes have been described as well.

Apart from the mentioned occurrence, representatives of the Ilian complex have been found in a number of places on the right side of the Ishim River, on the Ubogan-Ishim interfluvium, near the Tobol station, in the basin of the Tasty River. They have been identified by B.S. Kozhamkulova and G.F. Lychev as Anancus arvernensis, paracamelus praebactrianus, Equus stenorhis, Gazella sp., Cervus sp., Trogotherium minus, Dipoides majori.

The Khorgosian horizon is composed of lacustrine and lacustrine-alluvial siltstones and sandy clays with loams at the top and gravelly sand with broken coquina at the base (Zhunshilik Suite); the accumulation of the suite started in the late Pliocene as is evidenced by remains of the southern elephant Archidiskodon meridionalis (Жилкибаев, 1975) and Allohippus sp. from a quarry near the town of Arkalyk. The accumulation continued through the early Quaternary judging by the mammalian remains of the Koshkurgan complex in the upper part of the Zhunshilik Suite. In the Toysay ravine A.A. Boboyedova (1968) collected remains of Dicerorhinus cf. mercki. A tooth of Archidiskodon wusti has been found in a quarry near Rudny (identified by Zhylykibaev); near Kundyzdy village (sovkhos Bakinsky) a cervical vertebra of Elasmotherium sibiricum (identified by Kozhamkulova) has been found at the depth of 5 m.

The Zhunshilik Suite (up to 30-40 m thick) overlaps the Kustanay Suite or rests on older rocks with an erosional break.

In the late Pliocene the Irtysh area of the northern part of Kazakhstan was a zone of accumulation of material washed down by rivers from the Altai mountains and hills of central Kazakhstan; wandering on the plain these flows formed vast overflows and lakes. The alluvial-lacustrine deposits have been insufficiently studied to subdivide them into the Ilian and Khorgosian horizons, although they were described by many authors who distinguished a number of suites characterized more or less by the late Pliocene fauna.

According to R.A. Zinova (1974), the Novostanichnaya Suite belongs to the base of the Ilian horizon; it contains along with malacofauna the remains of small mammals, identified by V.S. Za-

zhigin as Baranomys sp., Steneofiber sp., Prosiphneus sp., Desmanidae. R.A. Zinova has found a tooth of Hipparion sp. (identified by Kozhamkulova) and remains of little mammals: Leporinae gen., Hypolagus sp., Procochotona ex gr. eximia-gigas, Ochotona sp., Mimomys (Cseria) gracilis, M. pliocaenicus, M. cf. reidi, M. (Villanyia) cf. petenyii (identified by V.S. Zazhigin) from the Seleta Suite which has been previously recognized by K.V. Niforova who mentioned a tooth of Equus stenonis.

Mimomys ex gr. pliocaenicus, M. minor, Equus ex gr. robustus identified by E.A. Vangengeim and V.S. Zazhigin have been listed by R.A. Zinova from Podpusk-Lebiazhye beds on the right side of the Irtysh River, between villages Podpusk and Lebiazhye. Evidently this is the suite previously known as Moiseyevsk (Бажанов, Кочренко, 1962), but later R.K. Kambariddinov (1969) subdivided it into two subsuites, noting the presence of Archidiskodon gromovi, Antilospira cf. gracilis, Gazella cf. sinensis, besides the Stenon's horse in the lower Moiseyevsk subsuite and Allohippus ex gr. robustus, Elasmotherium sp., Paracamelus cf. gigas in the upper one.

In Pavlodar Irtysh area V.V. Lavrov (1959) recognized the Irtysh Suite and correlated it with the Bitekey Suite.

In the early Pleistocene the sediments accumulated under conditions of frequent changes of lacustrine, fluvial, flood plain facies and of frequent scouring and rescouring, and these conditions account for the lack of key horizons. This circumstance and poor exposures (in the Irtysh valley mainly) led to multiplying the suites distinguished often in coeval strata (Алексева, 1974). It is noteworthy that the typical representatives of the early Pleistocene have been revealed here, such as Elasmotherium sibiricum, Archidiskodon wusti, Equus caballus cf. mosbachensis, Gazella subgutturosa, Dicerorhinus mercki, Bison schoetensacki, etc., identified by V.I. Gromov and later by V.S. Bazhanov, B.S. Kozhamkulova and others.

The lower Quaternary deposits are clearly differentiated along the Irtysh left bank (Аубекепов, 1974) where they form an alluvial part of the IIIrd terrace (up to 7 m), at the base of which Miocene and Oligocene deposits occur. The representatives of the Koshkurgan complex Archidiskodon wusti, Equus caballus cf. mosbachensis, Gazella subgutturosa, Bison sp. (Кожамкулова, 1974) have been recognized here.

In Rudny Altai the sediments of the Vtorushkino Suite differentiated by I.S. Chumakov (1967), deposited in the second half of the Pliocene. Alluvial-proluvial, alluvial and alluvial-lacustrine

clays and loams with gravel pebbles and rare boulders accumulated in intermontane basins, while deluvial and deluvial-proluvial clays with rubble deposited on the slopes. The thickness of the Vtorushkino Suite is 200 m. The suite yields mollusks, ostracods and mammals, typical of the Ilian and Khorgosian horizons. Similar deposits (up to 50-60 m thick) fill deep valleys and troughs in Kalba. The remains of Paracamelus sp., Artiodactyla, Cervidae, collected by B.A. Borisov along the Irtysh River right bank, near the Ostraya hill, are close to the forms of the end of the middle and the late Pliocene (according to E.A. Vangengeim), i.e. to the animals of the Ili complex. The fauna found by V.A. Borisov (1963) on the right slope of the valley of the Kalmakpay River in the southern part of the Zaysan region, evidently belongs to the lower Ilian horizon. L.K. Gabuniya and V.E. Garutt dated the fauna as the middle to upper Pliocene. Later, V.I. Zhegallo (1975) and E.L. Dmitrieva (1975) favored the middle Pliocene age and listed Ictitherium, Martes, Vormela, Machairodus, Chilotherium, Hipparion hippidioides, Sinotherium, Palaeotragus asiaticus, Tragocerus sp., Gazella dorcadoides, Ochotona ex gr. antiqua, Plioscirtopoda sp., Dolomys hungaricus, Pliomys cf. episkopalis, P. kretzoi, Cseria ex gr. gracilis, Mimomys sp., Microtidae gen., Prosiphneus sp.

O.D. Moskina (1973) presented in more detail the stratigraphic subdivision of the deposits of the discussed region on the grounds of little mammals. She reasonably referred the lower part of Vtorushkino Suite to the Ilian horizon, because it contains the Nikolaevsk Lagomorpha-Mimomys complex distinguished by her and including Ochotona ex gr. antiqua, Plioscirtopoda sp., Dolomys hungaricus, Pliomys cf. episkopalis, P. kretzoi, Kseria ex gr. gracilis, Mimomys reidi, Mimomys sp., Prosiphneus sp., as well as Paracamelus praebactrianus and Antilospira cf. gracilis.

The sands, gravels, and pebbles with siltstones and humified clays yielding the Shulba Lagurodon-Mimomys-Allofaiomys complex represented by Mimomys reidi, M. intermedius, Villanyia petenyii, V. lagurodontoides, Lagurodon arankae, Prolagurus cf. pannonicus, P. posterius, Eolagurus simplicidens, Allofaiomys pliocaenicus, Pitymys ex gr. hintoni-gregaloides, P. arvaloides, Prosiphneus ex gr. praetingi, Ochotona sp., should be assigned to the Khorgosian horizon.

The Solonovsk Mimomys-Lagurus complex represented by Mimomys reidi, M. ex gr. pusillus-newtoni, M. intermedius, Lagurodon arankae, Lagurus transiens, Eolagurus simplicidens, Allofaiomys pliocaenicus, Arvicola sp., Pitymys ex gr. hintoni-gregaloides,

P. arvaloides, Microtus arvalinus, M. rattiocepoides and distinguished by O.D. Moskina, has been referred by her to the Koshkurgan complex.

The fossil mammalian fauna in question and its occurrence in Kazakhstan are given in Table I. It is evident that the fauna in Kazakhstan may be correlated with faunas of East Europe and partly of the Caucasus which are correlable with the West European faunas (Александрова, 1971; Вангенгейм, Зажигин, 1972; Табуния, 1972; Никифорова, 1973, 1976; and oth.).

The Yesekartkan fauna assigned to the middle Pliocene corresponds to the early Moldavian and Kosyakino in age. The Ili complex is synchronous with the Khapry but it contains also the forms corresponding to the late Moldavian ones.

The Khorgos fauna correlable with the Taman complex seems to correspond to that of the late Villafranchian. Finally, the Koshkurgan fauna corresponds to the Tiraspol complex, thus giving grounds for regarding its host rocks as a continental equivalent of the Bakuan.

Judging by the geologo-tectonical situation and paleontological data the three above said stratigraphic levels can be distinguished quite definitely over the territory of Kazakhstan. In areas of high mountains the upper boundary is the most distinct in such places where the deposits of the Ilian and Khorgosian horizons were folded and the lower Quaternary deposits overlay them with a sharp unconformity. However, the middle stratigraphic level of the appearance of coarse clastic material in the Pliocene sections can be also rather clearly recognized in the highlands. Finally, taking into account stages of historical evolution of the mammalian fauna, the most expedient is to adopt the lower stratigraphic level as the boundary between the Neogene and Quaternary (Anthropogene) systems according to V.I. Gromov's recommendations. This boundary is clearly pronounced by the manifestation of the Irtysh-Tekes tectonic phase which determined the beginning of a new erosional-aggradational cycle.