

## THE VILLAFRANCHIAN MAMMALIAN FAUNAS OF THE ASIATIC PART OF FORMER USSR\*

I.A. Vislobokova<sup>(1)</sup> - M.V. Sotnikova<sup>(2)</sup> - M.A. Erbaeva<sup>(3)</sup>

<sup>(1)</sup>Paleontological Institute, Russian Academy of Sciences, Moscow, Russia

<sup>(2)</sup>Geological Institute, Russian Academy of Sciences, Moscow, Russia

<sup>(3)</sup>Buryat Geological Institute, Siberian Department, Russian Academy of Sciences, Ulan-Ude, Siberia

RIASSUNTO - *Mammiferi villafranchiani della parte asiatica dell'ex URSS* - Il Quaternario *Italian Journal of Quaternary Sciences*, 8(2), 1995, 367-376 - Il lavoro è un compendio, basato sugli studi più recenti effettuati dalla scuola paleontologica russa, delle faune di età villafranchiana — dal tardo Pliocene all'inizio del Pleistocene — che si sono avvicinate nelle regioni asiatiche dell'ex Unione Sovietica, allo scopo di paragonare quelle associazioni faunistiche con quelle dell'Europa occidentale, in particolare con le faune villafranchiane italiane. Vengono citate le località faunistiche tipiche per ciascun intervallo (Villafranchiano inferiore, medio e superiore) elencandone le specie caratteristiche allora presenti. Il confronto con analoghe presenze nell'Europa occidentale e la polarità dei depositi contenenti le associazioni faunistiche permettono considerazioni di carattere cronologico.

ABSTRACT - *The Villafranchian mammalian faunas of the Asiatic part of former USSR* - Il Quaternario *Italian Journal of Quaternary Sciences*, 8(2), 1995, 367-376 - Aim of the paper is to give a comprehensive view of the mammalian faunas of villafranchian age discovered in many localities of the Asiatic part of former USSR in order to correlate them with contemporaneous western Europe — particularly Italian — local faunas. The typical genera for early, middle and upper Villafranchian are reported together with their respective type localities, and chronology is given as based on paleomagnetic data.

Key words: Mammals, Villafranchian, Asiatic provinces, former USSR  
Parole chiave: Mammiferi, Villafranchiano, province asiatiche, ex-URSS

### 1. INTRODUCTION

This paper is based on new data and is intended to give a reasoned review of mammalian faunas of the Asiatic part of former USSR showing the major faunal events occurred in that territory during Late Pliocene - Early Pleistocene times in order to correlate such events with the Villafranchian faunas of Western Europe, and with faunas of Italy, in particular.

Thirty localities in the Asiatic part of former USSR are considered to be analogues of the Villafranchian of Europe; in all of them remains of both large and small mammals have been found. These localities belonged to the European-Siberian, Mediterranean, and Central Asian paleozoogeographical subareas of the Paleo-Arctic, and have been dated on the basis of the first appearance of some genera, of the evolutionary levels of some forms, and of paleomagnetic and paleoclimatic data.

Fundamental studies on these faunas are those carried out by E.A. Vangengeim, V.S. Zazhigin, V.S. Bazhanov, E.L. Dmitrieva, I.A. Dubrovo, M.A. Erbaeva, Sh. Sharapov, A.V. Sher, M.A. Sotnikova, P.A. Tleuberdina, I.A. Vislobokova, V.I. Zhegallo and others.

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### 2. THE BEGINNING OF THE EARLY VILLAFRANCHIAN

We connect the beginning of the Villafranchian with the events occurred at the boundary between early and late Pliocene times, including the first appearance of *Mimomys*, *Acinonyx*, *Megantereon*, *Homotherium*, *Equus*, and other elements which would have survived up to Pleistocene times. The end of the Villafranchian is taken as the moment of the transformation of *Archidiskodon meridionalis meridionalis* into *A. meridionalis tamanensis*.

In the European-Siberian paleozoogeographical subarea, faunas of the beginning of the early Villafranchian (MN 16a, 3.6±2.6 Ma) were discovered in Western Siberia and North Kazakhstan (Fig. 1). Faunas of this subarea were similar in structure to those of Western Europe differing only for the occurrence of the pikas *Ochotonoides* and *Ochotona* and the camel *Paracamelus*. Some European elements (*Dolomys*, *Tapirus*, *Pliotragus*) were absent whereas some Central Asiatic forms were present. These faunas were also characterized by the first appearance of voles of the genus *Mimomys*, a beaver *Trogontherium minus*, co-existing with late hipparions and other Ruscian elements. Unlike West European faunas, voles of the genus *Villanyia* appeared in the European-Siberian subarea during the transition from the Ruscian to the Villafranchian, and horses of the genus *Equus* possibly invaded the area. So far, *Leptobos*, which appeared in Europe at the beginning of the Villafranchian, has not yet been identified there.

In Western Siberia the fauna of the time interval

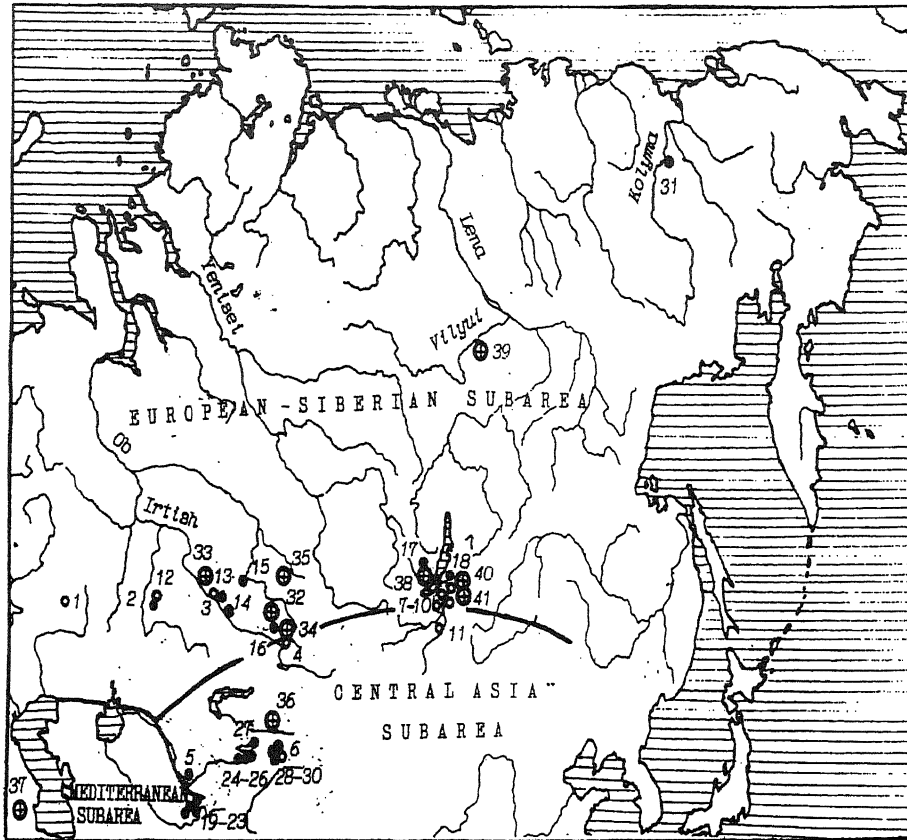


Fig. 1 - Main fossiliferous sites. Open circles = lower Villafranchian sites: 1 - Simbugino; 2 - Beteke 2; 3 - Lebiash'e; 4 - Ostraya Sopka; 5 - Kairakkum; 6 - Esekartkan; 7 - Udunga; 8 - Tologoi; 9 - Ulan-Ude; 10 - Beregovaya; 11 - Shamar. Closed circles = middle Villafranchian sites: 12 - Beteke 3; 13 & 14 - Podpusk-Lebiash'e; 15 - Dumoi Log; 16 - Troitskoe; 17 - Podtok; 18 - Itanza; 19 - Kuruksay; 20 - Obigam; 21 - Karamaidan; 22 - Tutak; 23 - Zil'fi; 24 - Ordokuchar; 25 - Akterek; 26 - Dzhygdyndykoo; 27 - Ichketasma; 28 - Kiikbai; 29 - Andyrkan; 30 - Aktogai (l.h.); 31 - Krestovka. Circles with a cross = Upper Villafranchian: 32 - Kizikha; 33 - Pyatoryzhsk; 34 - Ust'Talovka; 35 - Mokhovsk; 36 - Aktogai (layer 7); 37 - Palan-Tuykan; 38 - Malye Goly I & II; 39 - Vilyuisk; 40 - Zasuchino (the second horizon); 41 - Dodogol.

Principali località fossilifere. Circoletti vuoti = siti del Villafranchiano inferiore; circoletti pieni = siti del Villafranchiano medio; circoletti con una croce = siti del Villafranchiano superiore.

from the Ruscian to the Villafranchian is represented by the Beteke assemblage, the type locality of which being on the Beteke river, a right tributary of the Ishim river (Vangengeim & Zazhigin, 1982). The fauna of the Beteke Series (Beteke 2) includes *Hipparion* cf. *tchicoicum*, *Ochotonoides* sp., *Promimomys gracilis*, *Mimomys* n. sp., and other forms (Zazhigin & Zykin, 1984). The lower part of the Beteke Series is reversely magnetized, whereas the upper part has a normal polarity. This inversion may correspond to the end of the Kaena Subchron (Vangengeim & Pevzner, 1991) or to the Gilbert/Gauss boundary (Zazhigin & Zykin, 1984).

In the Pavlodar Irtysh region, fossils of the Beteke faunal assemblage were found near the village of Lebiash'e. Remains of *Trogontherium minus*, *Equus*, and cervids were distinguished in the lower faunistic horizon (Lebiash'e 1), having a reversed polarity and corresponding to the upper part of the Gilbert Chron (Vislobokova, 1974).

The predominance of *Cytherissa lacustris* among ostracods indicates rather cold conditions (V. Lipagina, pers. comm.). Climate in the south of Western Siberia was more humid than the present one.

In the Central Asian subarea, faunas of similar ages were discovered in Southeastern Kazakhstan and in Transbaikalian regions. Pikas, jerboas, zokors *Prosilphneus* and camels were typical of this subarea, which had an almost continental climate. In this area, faunas of the beginning of early Villafranchian are characterized by the first appearance of voles *Villanyia* and *Mimomys*, carni-

vores *Lynx* ex gr. *issiodorensis* and *Homotherium*, the large deer *Axis* and *Orchonoceros*, the roe *Capreolus*, the elk *Libralces*, co-existing with mastodons, hipparions and other Ruscian forms. Voles, proboscideans, and ungulates were usually represented by peculiar species, and carnivores by peculiar subspecies. A great number of Euro-Siberian forms were present in faunas living in the transitional zone between the European-Siberian and Central Asia paleozoogeographical subareas.

Common features of Central Asia and West Europe faunas are: 1) the first appearance of the large carnivores *Homotherium* and *Pliohyaena* (= *Pachycrocuta*) in the Transbaikalian regions and of *Chasmaporthetes lunensis* in the closest Shamar fauna (Mongolia); 2) the presence of *Parameles* (= *Arctomeles*), *Pannonictis* and *Ursus* ex gr. *ruscinensis-minimus*; 3) the replacing of small Ruscian deer by advanced taxa of larger size. Whereas canids had disappeared at the beginning of the Villafranchian in western Europe, on the contrary this guild still lived in the central Asia subarea. Dispersion of wolf-line canids in Europe — the so-called "wolf" event — took place only at the beginning of the late Villafranchian (Azzaroli et al., 1988). Europe and in Transbaikalian regions were covered by a relatively dense forest, while the south of Kazakhstan was contemporaneously characterized by forest steppes, savannahs, and frank steppe.

In Kazakhstan, the faunas of Ostraya Sopka and Esekartkan are referred to the MN 16a subzone (Fig. 2). At Ostraya Sopka *Proochotona* cf. *eximia*, *Pliomys* ko-

Ma	Paleom. scale	Mammal zones	EUROPEAN-SIBERIAN SUBAREA		CENTRAL ASIAN SUBAREA		MEDITERRANEAN SUBAREA
			WESTERN SIBERIA, NORTHERN KAZAKHSTAN	EASTERN SIBERIA, CISBAIKALIA, NORTHEASTERN SIBERIA	SOUTHERN KAZAKHSTAN, NORTHERN TADZHIKISTAN, KIRGIZIA	TRANS-BAIKALIA	SOUTHERN TADZHIKISTAN
1.67	M A T U Y A M A	19	Pyatoryzhsk	Vilyuisk Malye Golý I -	Aktögäi (1.7) +/-	Zasuchino (h.2)	
1.8		18	Kizikha + , Ust'Talovka +	Malye Goly 2 +		Dodogol	
2.01 2.04 2.12 2.14	R A	17	Beteke 3, Durnoi Log, Troitskoe- Podpusk -, Lebiash'e 2 -	Podtok -, Krestovka -	Akterek, Dzhilgyndykoo, Ordokuchar, Ichketasma, Kiikbai, Andyrghan -	Itanza	Zil'fi + Kuruksay - , Obigarm - , Karamaidan - Tutak,
2.48		16b			Kairakkum +/-	Beregovaya	
2.92 3.01 3.05 3.15	K A U S S	16a	Beteke 2			Tologoi -, Ulan-Ude, Udunga,	
3.4			Lebiash'e 1-		Esekartkan - , Ostrava Sopka -		
3.6	G I L B E R T	15					

Fig 2 - Correlation of main localities.  
Correlazione fra le principali località.

walskii, *Promimomys gracilis*, *P. cf. stehlini*, *Villanyia praeungaricus*, a small *Canis*, and other local elements were discovered in the Irtysh river, upstream of Semipalatinsk (Bazhanov *et al.*, 1968; Kojamkulova, 1969). The presence of *Meriones*, *Prosiphneus*, *Paracamelus praebactrianus* and *Axis ubensis*, adapted to live on rather dry grounds, may serve as evidence of relatively arid conditions during the time of their existence (Vislobokova, 1974).

The Esekartkan savannah type fauna, found in the Tekess depression of Northern Tien Shan, is formed by ostriches *Struthio*, mastodons *Anancus*, *Hipparion houfense*, giraffes *Palæotragus*, and others together with antilopes *Antilospira* and *Gazella sinensis* (Tleuberdina,

1982; 1988). The presence of these latter forms allow us to correlate the Esekartkan fauna with that from the Daodi Formation of the Nihowan Basin in Northern China (Vislobokova *et al.*, 1993).

The fossiliferous deposits of Ostrava Sopka and Esekartkan have reversed polarity and seem to correspond to the end of the Gilbert Chron (Vislobokova, 1974; Tleuberdina, 1988).

Faunas of Transbaikalian regions lived under more humid climatic conditions than those of Kazakhstan, animals of forest biotopes being predominant. The very rich Udunga fauna was discovered in deposits on the left bank of the Temnik River, the left tributary of the

Selenga River. This fauna with *Promimomys* cf. *stehlini*, *P. aff. gracilis*, *Mimomys* cf. *minor*, *Villanyia* cf. *eleonora*, and *Orientalomys sibiricus* seems to belong to the MN 16a subzone.

Besides listed taxa the following are to be cited: monkeys *Parapresbytis borealis*, mastodons *Zygodon*, hyaenids *Pliohyaena*, machairodontines *Homotherium*, *Hipparion houfenense*, and *H. tchicoicum* (Kalmykov, 1989; Sotnikova & Kalmykov, 1991), large cervids *Orchonoceros gromovi* and *Axis shansius*, roe deer *Capreolus n. sp.* (descending from *Procapreolus wenzensis* from Weze I, Poland — MN 15), small elks (perhaps to be put at the base of the lineage *Libralces gallicus-Alces alces*), *Antilospora* cf. *zdanskyi*, and other taxa (Vislobokova *et al.*, 1995). Variety and abundance of animals of forest biotopes (two genera of hares, murids, monkey, two genera of melines, small wolverines, bears, a small panda, roe deer, and elks) are typical features of this fauna, which lived under relatively humid climatic conditions at the end of the first half of the early Villafranchian (Vislobokova *et al.*, 1993).

Faunas of an age very close to that of the Udunga faunal guild were found in Ulan-Ude and at Tologoi on the left bank of the Selenga River, 13 km upstream of Ulan-Ude (Vangengeim, 1977). The Tologoi fauna contains *Ochotonoides complicidens*, *Ochotona* cf. *intermedia*, *Orientalomys sibiricus*, *Prosiphneus paratingi*, *P. cf. lyratus*, numerous *Mimomys* and *Villanyia*, *Hipparion houfenense*, *H. tchicoicum*, and other animals. The Tologoi fossiliferous deposits have reversed polarity to be ascribed to the Gauss epoch (Vangengeim & Pevzner, 1991).

### 3. THE LATE EARLY VILLAFRANCHIAN

Common features of late early Villafranchian (MN 16b, 2.6+2.48) Asiatic faunas of former USSR and the West European faunas are: 1) the arrival of primitive elephants *Archidiskodon*, and 2) the appearance of felines *Viretailurus* and deer *Eucladoceros* (Azzaroli *et al.*, 1988; Mein, 1990). The most typical elements of forest biotypes (*Ursus minimus*) disappeared because more open landscapes had become widespread. Contrary to the west-European faunas, "the elephant-*Equus*" event is less marked in Asiatic faunas. Horses, which had invaded Siberia at the beginning of the Villafranchian, continued to exist.

The fauna of the late early Villafranchian is represented in Simbugino (Bashkiria), in the European-Siberian paleogeographical subarea. Among other animals, a beaver *Trogotherium minus*, a bog lemming *Synaptomys mimomiformis* and deer *Eucladoceros* lived there (Suchov, 1977).

The large mammals of the late early Villafranchian are known better in the Central Asia subarea, where have been found at Kairakkum (Tadzhikistan) and Beregovaya (Transbaikal). As compared to earlier faunas of the same regions, inhabitants of open landscapes increased: the

Genera	MN 15	MN 16a	MN 16b	MN 17	MQ 18-19
Rodentia					
<i>Promimifinys</i>	_____				
<i>Villanyia</i>		_____			
<i>Mimomys</i>		_____			
<i>Allophaiomys</i>					_____
<i>Clethrionomys</i>				_____	
<i>Prolagurus</i>					_____
<i>Eolagurus</i>					_____
Proboscidea					
<i>Zygodon</i>	_____				
<i>Archidiskodon</i>			_____		
Carnivora					
<i>Canis</i> (small)	_____				
<i>Chasmaporthetes</i>		_____			
<i>Lynx</i>		_____			
<i>Viretailurus</i>			_____		
<i>Acinonyx</i>			-----		
<i>Megantereon</i>			-----		
<i>Homotherium</i>			_____		
Perissodactyla					
<i>Hipparion</i>	_____				
<i>Equus</i>		_____			
<i>Dicerorhinus</i>	_____				
<i>Coelodonta</i>				-----	
<i>Elasmotherium</i>			_____		
Artiodactyla					
<i>Axis</i>		_____			
<i>Elaphurus</i>				_____	
<i>Eucladoceros</i>			_____		
<i>Orchonoceros</i>	_____				
<i>Sinomegaceros</i>				_____	
<i>Capreolus</i>	_____				-----
<i>Libralces</i>	_____				_____
<i>Leptobos</i>					_____

Fig 3 - Distribution of some mammalian genera in the Asiatic part of former USSR.

Distribuzione di alcuni generi di mammiferi nella parte asiatica dell'ex Unione Sovietica.

archaic form of elephants *Archidiskodon*, felines *Viretailurus* and *Acinonyx*, rhinoceros *Elasmotherium*, and deer *Eucladoceros* appeared in the faunal structure (Fig. 3). This peculiarity may be indicative of climatic changes which could have occurred at the end of the Gauss Chron.

The fauna of Beregovaya on the right bank of the Chikoy River differs from that of Udunga by the presence of different species of *Ochotona*, *Prosiphneus*, *Sicista*, and *Micromys*, by the variety of *Mimomys* (*M. minor*, *M. reidi*, and *M. pseudointermedius*), by the predominance of *Villanyia eleonora* and absence of *Promimomys*. Such micromammalian faunal structure and the evolutionary level of *Hipparion* cf. *houfenense* (similar to that of *H. crusafonti* from Roca Neyra) (Eisenmann & Sondaar, 1989), and of *Villanyia eleonora* suggest that the Beregovaya fauna is younger (MN 16b) than the Udunga one (Vislobokova *et al.*, 1993). Variety and abundance of animals of open landscapes in the Beregovaya fauna (pikas, voles *Villanyia*, carnivores *Chasmaporthetes*, *Acinonyx*, *Puma*-like cats, small canids) reflect an apparent landscape-climatic change in Transbaikal regions during that time (Vislobokova *et al.*, 1993).

In Kairakkum, the remains of the archaic form of *Archidiskodon*, *Dicerorhinus* sp., and *Elasmotherium* sp. were found. According to paleomagnetic data, the Kairakkum fauna falls in the Gauss-Matuyama inversion (Dodonov & Sotnikova, 1994), thus being similar in age to the Montopoli local fauna which is set into the same inversion period by Lyndsay *et al.* (1980) and is characterized by the arrival of the primitive elephant *Archidiskodon*, the large horse *Equus* cf. *livenzovens* (closely related to *Equus stenonis*), and of the deer *Eucladoceros* (Azzaroli, 1977; Azzaroli *et al.*, 1988).

#### 4. THE MIDDLE VILLAFRANCHIAN

Middle Villafranchian faunas (MN 17, 2.48±2 Ma) are characterized by a wide distribution of open savannah landscapes animals; the southwards displacement of the southern boundary of the European-Siberian subarea, which was connected with the world global cooling, is another conditioning feature. Besides Siberia, Kazakhstan was also included in the European-Siberian subarea.

The first appearance of *Clethrionomys*, a wide distribution of cheetahs *Acinonyx*, elephants *Archidiskodon gromovi*, horses *Equus stenonis*, and deer *Eucladoceros senezensis*, as well as more advanced levels of many taxa (*Villanyia petenyi*, *Mimomys pliocaenicus*, *M. coelodus*, *Cromeromys irtyschensis*, *Ursus etruscus*, *Homotherium crenatidens*, and others) are typical elements (Fig. 4).

In western Siberia, the Podpusk-Lebyazh'e faunal assemblage from the Pavlodar Irtys region (Kazakhstan) follows the Beteke fauna. The typical locality is on the right bank of the Irtys River, from the village of Podpusk to that of Lebyazh'e. This rich complex is formed by *Archidiskodon gromovi*, *Elasmotherium*, *Equus* cf. *stenonis*, *Eucladoceros* sp., *Antilospira* cf. *gracilis*, *Gazella* cf. *sinensis*, etc. Rodents are represented by more evolved forms than those from the Beteke assemblage. *Mimomys pliocaenicus*, *M. coelodus*, *M. reidi*, *Villanyia petenyi*, and *Cromeromys irtyschensis* were identified (Zazhigin, 1980). This assemblage, judging from the presence of *M. pliocaenicus*, may be coeval of the middle Villafranchian fauna of Western Europe, and also of the Khapry fauna of European Russia if the similar stage of evolution of elephants (*Archidiskodon gromovi*) and horses (*Equus* cf. *stenonis*) is taken into account. According to palynological data (R.A. Zinova, pers. comm.) steppes dominated there, and the woodlands were developed along rivers.

Apart from the typical locality, rodents of this (Podpusk-Lebyazh'e) assemblage are known also from Beteke-3 in the Ishim basin, Durnoi Log near Kamen'on-Ob, and from the village of Troitskoe in the Altai region (Zazhigin, 1980).

In Eastern Siberia, a similar micromammalian fauna with dominant voles *Villanyia* and *Mimomys* (Adamenko, 1975), is reported from Podtok (Cisbaikal).

In the Transbaikal region, the Itanza fauna of Klochevo I, II includes: *Ochotona* cf. *intermedia*, *Cricetinus* sp., *Allactaga* sp., *Villanyia* aff. *laguriformes*, *Mimomys* cf. *pusillus*, *M.* cf. *burgondiae*, *Clethrionomys* sp., and *Prosiphneus* cf. *paratingi*. The *Villanyia* aff. *laguriformes* is more advanced than the *V. eleonorae* from Beregovaya and is more archaic than the *V. laguriformes* from Dodogol.

In northeastern Siberia, the association of *Synaptomys-Cromeromys irtyschensis-Mimomys coelodus* was found in the lower members of the Kutuyakh Series by the Krestovka River in the Kolyma Plain (Sher, 1987).

Podpusk, Lebyazh'e-2, and Krestovka faunas are attributed to the earliest Matuyama Chron on the basis of the fossil bearing layers reversed polarity.

During the Matuyama Chron, in the Central Asia subarea, covering the southern Kazakhstan, northern Tadjikistan and Kirgizia faunas *Chasmaporthetes lunensis kani*, primitive forms of *Elaphurus* and *Sinomegaceros* were largely diffused.

In southern Kazakhstan, Kiikbai, Andyrigan and Aktogai (Kopaly) faunas are referred to the middle Villafranchian. At Kiikbai in Alatau remains of *Hypolagus brachygnathus*, *Ochotonoides complicidens*, and *Mimomys pliocaenicus* were found together with other taxa (Lychev & Savinov, 1974; Tyutkova, 1990). The Andyrigan fauna in the Tekess Depression comprises *Cricetulus* sp., *Meriones* cf. *meridianus*, *Villanyia petenyi*, *Mimomys* ex gr. *newtoni-intermedius*, *Equus stenonis*, etc. (Tleuberdina, 1988; Tyutkova & Kaipova, 1993). Limb bones of *Gigantocamelus longipes* were excavated in the southern Andyrigan (Tleuberdina, 1988) in reversely magnetized sediments that may belong to the lower part of the Matuyama. Their age is estimated to be approximately 2.2 Ma (Tleuberdina, 1988).

The Aktogai lower horizon on the right bank of the Charyn River, tributary of the Ili River, contains *Hypolagus* cf. *brachygnathus*, few *Villanyia*, and numerous *Mimomys* (Tyutkova, 1990).

The middle Villafranchian faunas of southern Tadjikistan are attributed to the East-Mediterranean province of the Mediterranean subarea (Vangengeim *et al.*, 1988), the combination of Mediterranean and Central Asia forms being characteristic of that province. In southern Tadjikistan, a rich faunas assemblage was discovered at Kuruksay including: *Acinonyx* cf. *pardinensis*, *Megantereon megantereon*, *Homotherium crenatidens*, *Archidiskodon* cf. *gromovi*, *Dicerorhinus* sp., *Equus stenonis bactrianus*, *Paracamelus praebactrianus*, *Elaphurus eleonorae*, and *Sinomegaceros tadjikistanis* (Sotnikova, 1989; Vangengeim *et al.*, 1988). Deer are represented by more primitive species than those from the Nihowan fauna (main horizon) (Vislobokova, 1990). This latter is correlated with the MN 18 zone. The most typical members of the Kuruksay fauna are animals of dry open landscapes (*Ellobius*, *Pliohyaena*, *Chasmaporthetes*, *Paracamelus*, *Equus*). Besides them, forest animals [a bear *Ursus* cf. *etruscus*, *Lynx* ex gr. *issiodorensis*, a

MN 15	MN 16a	MN 16b	MN 17	MQ 18-19
	<i>Ochotonoides complicitens</i>			<i>O. cf. complicitens</i>
			<i>Ochotona nihewanica</i>	
	<i>Trogotherium minus</i>			
	<i>Promimomys gracilis</i>			
	<i>P. stehlini</i>		<i>P. ex gr. stehlini</i>	
	<i>Mimomys minor</i>			
		<i>M. reidi</i>		
			<i>M. pusillus</i>	
			<i>M. coelodus</i>	
			<i>M. pliocaenicus</i>	
	<i>Villanyia eleomorae</i>			
			<i>V. petenyi</i>	
			<i>V. laguriformes</i>	
				<i>Allopaiomys deucalion</i>
		<i>Clethrionomys sp.</i>	<i>C. aff. kretzoi</i>	
			<i>Prolagus pannonicus</i>	
			<i>Eolagurus agriopuloi</i>	
	<i>Prosiphneus paratingi</i>		<i>P. cf. paratingi</i>	
				<i>P. youngi</i>
	<i>Canis sp. (small form)</i>			
			<i>C. kuruksaensis</i>	
				<i>C. ex gr. etruscus</i>
	<i>Ursus ex gr. rusciniensis-minimus</i>		<i>U. etruscus</i>	
	<i>Pliohyaena pyrenaica</i>		<i>P. perrieri</i>	
				<i>P. brevisrostris</i>
		<i>Chasmaporthetes lunensis</i>		
		<i>Lynx ex gr. issiodorensis</i>		
			<i>Acinonyx pardinensis</i>	
			<i>Megantereon megantereon</i>	
		<i>Homotherium sp.</i>	<i>H. crenatidens</i>	<i>Homotherium sp.</i>
			<i>Archodiskodon gramovi</i>	<i>A. meridionalis</i>
	<i>Hipparion houfenense (e.f.)</i>	<i>H. houfenense (l.f.)</i>		
	<i>Dicerorhinus megarhinus</i>			
			<i>D. etruscus</i>	
				<i>Coelodonta sp.</i>
	<i>Equus sp.</i>		<i>E. stenonis</i>	<i>E. cf. stenonis</i>
				<i>E. ex gr. sanmeniensis</i>
		<i>Paracamelus praebactrianus</i>		
	<i>Axis ubensis</i>			
			<i>A. flerovi</i>	
			<i>Elaphurus eleonirae</i>	
			<i>Eucladoceros sp.</i>	
	<i>Orchonoceros gromovi</i>			
			<i>Sinomegaceros tadjikistanis</i>	
	<i>Capreolus constantini</i>		<i>Capreolus sp.</i>	
	<i>Libralces sp.</i>		<i>L. cf. gallicus</i>	
	<i>Gazella sinensis</i>			
	<i>Antilospira cf. zdanskyi</i>			
			<i>Antilospira cf. gracilis</i>	
			<i>Gazellospira sp.</i>	
				<i>Leptobos cf. etruscus</i>

- Solid line = actually present  
 - Dashed line = possibly present

Fig. 4 - Stratigraphical range of some species from the Asiatic part of former USSR.

*Intervallo stratigrafico di presenza di alcune specie della parte asiatica dell'ex Unione Sovietica.*

monkey *Papio suschkini* (= *Paradolichopithecus suschkini*), deer *Axis flerovi* and *Libralces cf. gallicus*] as well as savannah inhabitants (*Sivatherium*, *Protoryx*, *Damalops*, and *Gazellospira*) formed the Kuruksay fauna. Such a mixed composition

might be connected with the mosaic landscapes and vertical zonality typical of mountain regions.

On the basis of paleomagnetic data, the Kuruksay fossiliferous horizon is located in the reversely magnetized interval of the lower part of the Matuyama below the Olduvai Subchron. Its accepted age is approximately 2 Ma (Dodonov & Sotnikova, 1994).

In Tadzhikistan, other local faunas attributed to this assemblage were found in Obigarm, Karamaidan, Tutak, and Zil'fi. In Obigarm, *Ursus cf. etruscus*, *Acinonyx ex gr. pardinensis* and *Paracamelus sp.* were found (Dodonov et al., 1991). A more rich fauna is that of Karamaidan where the following forms were found: *Ursus cf. etruscus*, *Equus ex gr. stenonis*, *Dicerorhinus sp.*, *Paracamelus sp.*, *Cervus sp.*, *Protoryx cf. laticeps*, *Gazella sinensis* (Guidebook of Excursion, 1977; Sharapov, 1986).

*Promimomys sp.*, *Canis sp.*, *Dicerorhinus sp.*, *Equus stenonis cf. pamirensis*, *Paracamelus sp.*, *Elaphurus sp.*, and *Sinomegaceros sp.* form the Zil'fi faunal guild (Dodonov et al., 1991).

The bone bearing horizons of Obigarm and Karamaidan have a reversed polarity and are correlated with the lower part of the Matuyama. The normal magnetized fossiliferous layers of Zil'fi correspond to the Matuyama normal part or to the Reunion Subchron.

In Kirgyzia, in the Issyk-kul Depression the faunas of Akterek and Dzhilgyndykoo contain elements of similar age with *Dicerorhinus sp.* and *Gazellospira sp.* in Akterek; and with *Ochotonoides cf. complicitens* and *Promimomys ex gr. stehlini* in Dzhilgyndykoo (Dodonov & Sotnikova, 1994). Remains of *Archidiskodon meridionalis* were found in Ordokuchar, whereas remains of *Equus stenonis* are reported from Ichketasma (Dmitrieva & Nesmeyanov, 1982).

The Asia arid climate during the middle Villafranchian was a consequence of global climatic events, and also of the uplifting of mountain massifs, which led to glaciation. The oldest loess deposits of Central Asia connected with a glaciation, date to about 2.5 Ma at the boundary between early and middle Villafranchian. That is an important level in the area. In China this level is accepted as the Pleistocene lower boundary.

## 5. THE LATE VILLAFRANCHIAN

Late Villafranchian faunas (MQ 18, 19) are known mainly as small mammals. Because remains of large mammals are rare it is impossible to determine a succession of stages equivalent either to the late Villafranchian mammalian stages of Italy or to the European mammalian zones.

The voles *Allopaiomys*, lagurids *Prolagus* and *Eolagurus*, a typical form of *Archidiskodon meridionalis*, *Canis ex gr. etruscus*, *Pachycrocuta brevisrostris* and *Leptobos cf. etruscus* appeared in the late Villafranchian. Contemporaneously, similar faunal changes occurred in

western Europe, where the following events are typical: 1) the massive expansion of *Canis etruscus*, *Pachycrocuta brevirostris*, and of *Leptobos etruscus*; and 2) the appearance of *Archidiskodon meridionalis meridionalis* (Azzaroli *et al.*, 1988). In Europe, the massive expansion of *Pachycrocuta brevirostris* and *Leptobos etruscus* is connected with the "wolf" event of Azzaroli *et al.* (1988), marking the beginning of the Olivola faunal unit. One of the major character of that unit is the replacement of the primitive form of *Archidiskodon* by *A. meridionalis meridionalis*.

In the south of western Siberia, the Kizikha assemblage is correlated with late Villafranchian faunas. The typical locality is the Kizikha village in the Alei basin. Among rodents, rootless voles *Allophaiomys*, *Prolagurus* and *Eolagurus* first appeared. The *Mimomys* fauna, numerically predominant among voles, is more advanced than the forms from Podpusk and Lebyazh'e. The number of elements of *Spermophilus*, *Clethrionomys*, and *Prosiphneus* sharply increased. Such feature may suggest more humid climatic conditions in the south of western Siberia than those of the middle Villafranchian (Zazhigin, 1980).

Large mammals were found at Ust'-Talovka and Pyatoryzhsk, which include *Archidiskodon* cf. *meridionalis* and *Equus* (*Allohippus*) sp. in Ust'Talovka (Vislobokova, 1974) and *A. meridionalis* in Pyatoryzhsk (Kojamkulova, 1969).

The deposits of Kizikha are set in an episode of normal polarity, which may be associated with the Olduvai Subchron of the Matuyama Chron. The fossiliferous layer of Ust'Talovka has a normal polarity and underlies reversely magnetized deposits. This inversion seems to coincide with the polarity inversion occurred at the end of the Olduvai Chron.

In the Kuznetsk basin, *Allophaiomys pliocaenicus*, *Prolagurus* ex gr. *pannonicus-posterius*, *Eolagurus agriropuloi*, *Archidiskodon* cf. *meridionalis*, and other species were found in the Mokhovsk Series (Foronova, 1990).

In southeastern Kazakhstan, late Villafranchian mammals were discovered at Aktogai (Kochenov & Kojamkulova, 1988; Kojamkulova *et al.*, 1987) in the bone bearing lens of layer 7 of the Iliiskaya Series where the following forms have been determined: *Clethrionomys* aff. *kretzoi*, *Canis* cf. *chihliensis*, *Pachycrocuta* cf. *brevirostris*, *Homotherium* sp., *Archidiskodon gromovi* (= *A. meridionalis*), *Equus* cf. *stenonis*, *Dicerorhinus* sp., *Leptobos* cf. *etruscus*, *Gazellospira* sp., and others (Tyutkova, 1988; Kojamkulova *et al.*, 1987). The layer 7 deposits fall in the polarity inversion which may correspond to the end of the Olduvai episode. The upper layers of the Series include remains of *Clethrionomys kretzoi*, *Eolagurus agriropuloi*, and *Allophaiomys pliocaenicus* (Kojamkulova *et al.*, 1987).

The contemporaneous Palan-Tyukan fauna (Azerbaidzhan) contains a rich late Villafranchian carnivore assemblage including elements common of the late Villafranchian faunas such as *Canis etruscus* and *Panthera* ex gr. *gombazoegensis* (Sotnikova & Sablin, 1994). The presence of this form together with *Nyctereutes*

*reutes megamastoides* suggests an age for the assemblage of approximately 1.8 Ma. In Europe, *Nyctereutes megamastoides* is not found later than Chilhac and the earliest findings of *Panthera* ex gr. *gombazoegensis* are the Olivola ones.

In eastern Siberia, a micromammalian fauna of similar age is known at Malye Goly I and II (Adamenko, 1975). A tooth of *Archidiskodon meridionalis meridionalis* was found in the Vilyuisk district, Yakutia (Dubrovo, 1990). This find confirms the spreading of *A. meridionalis meridionalis* over North America through the Bering land bridge. The invasion of these elephants took place not earlier than 2±1.7 Ma (Dubrovo, 1990).

In the Central Asia subarea, faunas of the late Villafranchian were found in Transbaikalian regions. The chronological equivalent of late Villafranchian fauna in such regions is the Dodogol fauna, discovered in the southern part of Dodogol and in Zasuchino (second horizon). The Dodogol fauna contains remains of *Villanyia laguriformes*, *Allophaiomys* cf. *deucalion* (= cf. *pliocaenicus*), *Prosiphneus youngi*, *Coelodonta*, *Equus* ex gr. *sanmeniensis*, and others (Erbaeva, 1986). In China, *Coelodonta* and *Equus sanmeniensis* appeared at the beginning of the Pleistocene according to the scale accepted in that country (Wu *et al.*, 1991). In Zasuchino, among small mammals *Marmota* sp., *Spermophilus* sp., *Hypolagus* sp., *Ochotonoides* cf. *complicidens*, *Ochotona* aff. *nihewanica*, *Villanyia laguriformes*, *Mimomys pusillus*, *Allophaiomys deucalion*, *Prosiphneus* sp. and other forms were present.

## 6. CONCLUSION

Three major events occurred in the development of the mammalian fauna of the Asiatic part of former USSR: – the first one happened at the beginning of the late Pliocene and was represented by the Beteke assemblages in western Siberia, the Esekartkan fauna in the south of Kazakhstan and the Udunga fauna in Transbaikalia. An adaptive radiation of root-toothed voles of the *Mimomys* and *Villanyia*, a wide distribution of the genus *Paracamelus* and the first invasion of *Equus* in Siberia are characteristic of that time. The same faunistic event occurred at the beginning of the early Villafranchian in Europe.

The second important faunistic event was connected with the appearance of the archaic form of *Archidiskodon*, felines *Viretaiulurus* and *Acinonyx*, rhinoceroses *Elasmotherium* and deer *Eucladoceros*. This event is traced to the south of the Ural, in the Kairakkum fauna of Tadzhikistan, and in the Beregovaya fauna of Transbaikalia, corresponding to the late early Villafranchian of Europe.

The third event was marked by the first appearance of *Clethrionomys* and *Ursus etruscus* and by a wide distribution of the archaic form of *Archidiskodon* (*A. gromovi*), *Equus stenonis* and *Eucladoceros*. The primitive forms of deer *Elaphurus* and *Sinomegaceros* occurred in Central

Asia. The Podpusk-Lebyazh'e fauna in western Siberia, the Kuruksay fauna in Tadzhikistan and the Krestovka fauna in northeastern Siberia belong to this stage. This stage is correlated to the middle Villafranchian fauna of Europe.

The last important event occurred in the Kizikha assemblage of western Siberia, the Aktogai fauna of southeastern Kazakhstan and the Dodogol fauna of Transbaikal at the beginning of the late Villafranchian. At that time rootless voles *Allophaiomys*, *Prolagurus*, and *Eolagurus* appeared among rodents, and *Archidiskodon meridionalis*, *Canis ex. gr. etruscus*, *Pachyrcuta brevirostris* and *Leptobos cf. etruscus* among large mammals. *Coelodonta* and *Equus ex gr. sanmeniensis* were present in Transbaikal. This stage is referred to the late Villafranchian.

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