Quaternary biostratigraphy and biochronology of the West Siberian Plain: trans-regional and trans-zonal correlations

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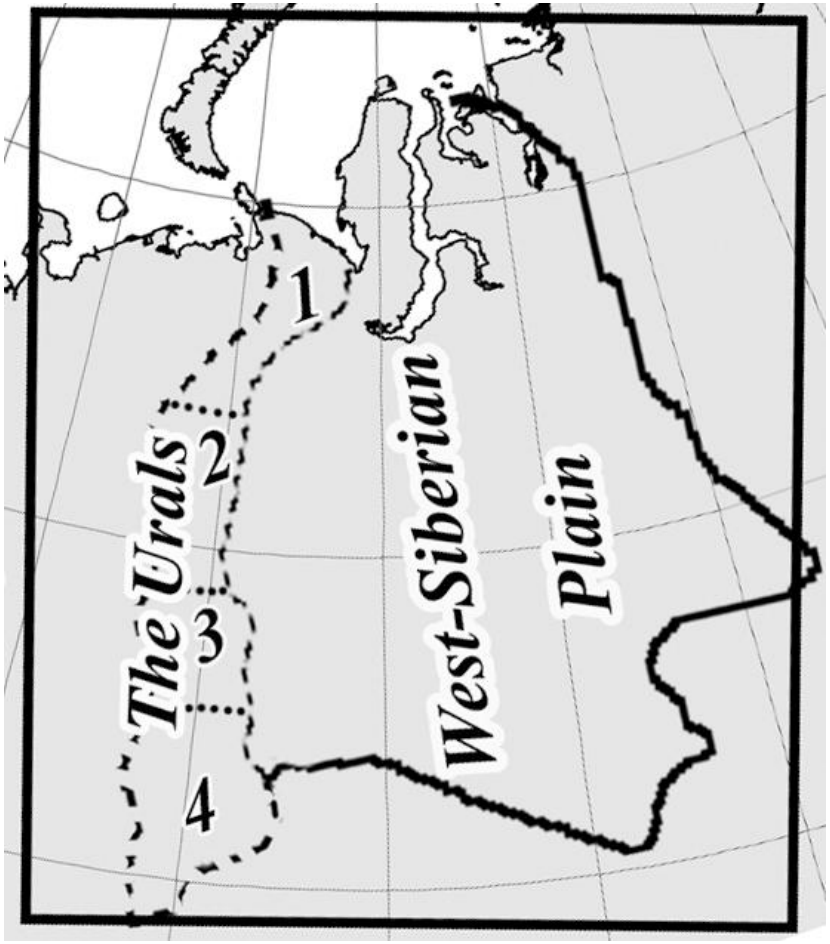
Geographic location of the study area

The West Siberian Plain is one of the largest plains in the World providing opportunity to assess both the climatic gradients and the differences in geological history reflected in sedimentation characteristics.

There are four regional stratigraphic schemes developed for the region:



- The Unified Stratigraphic scheme for the territory of Western Siberia (2000),
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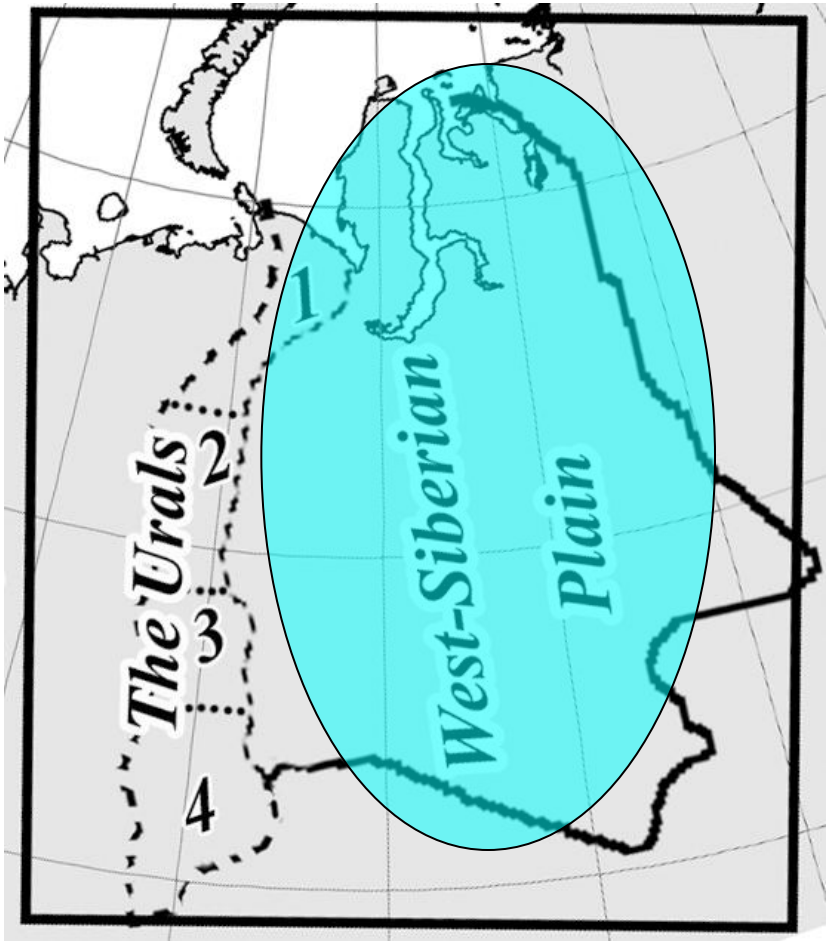

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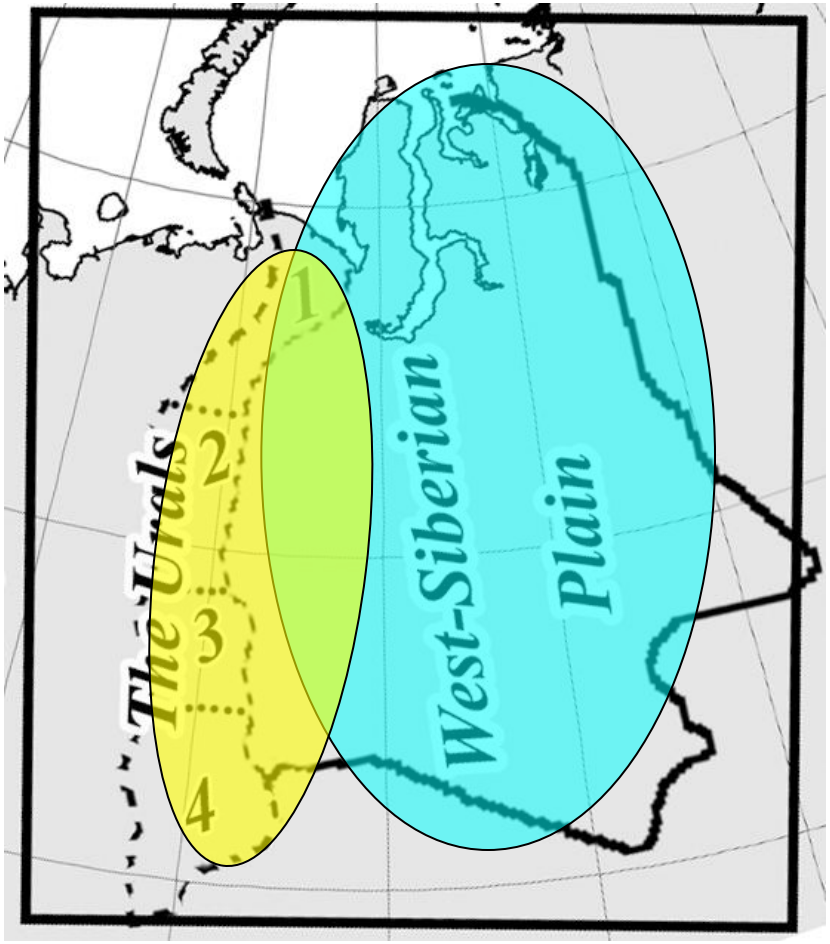

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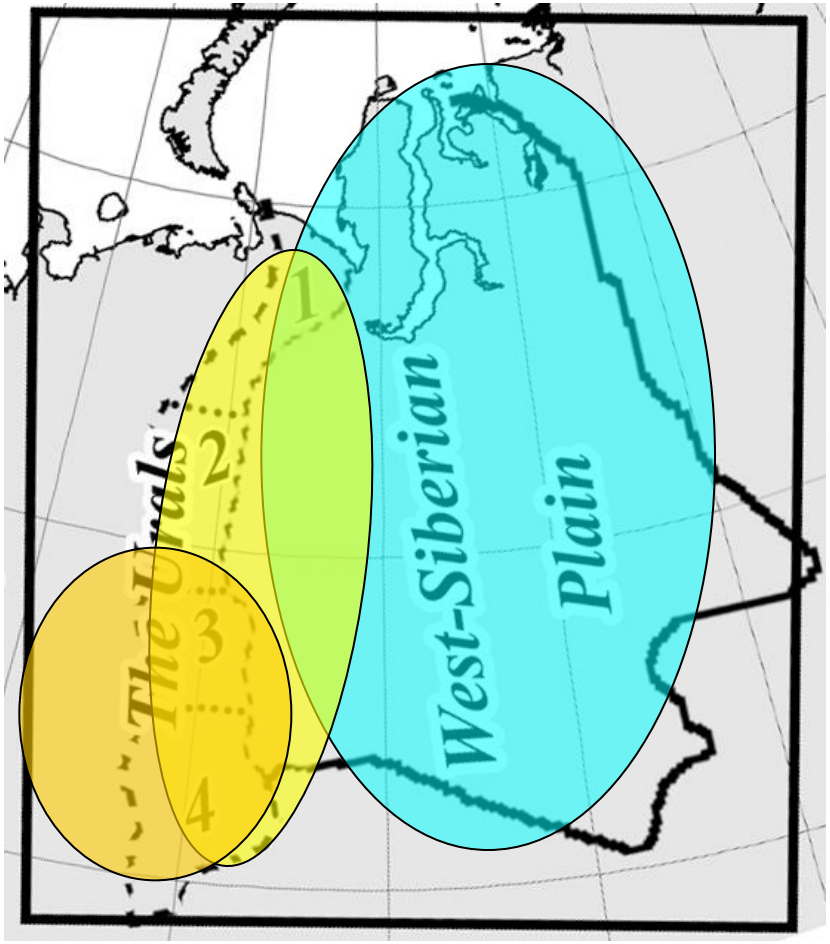

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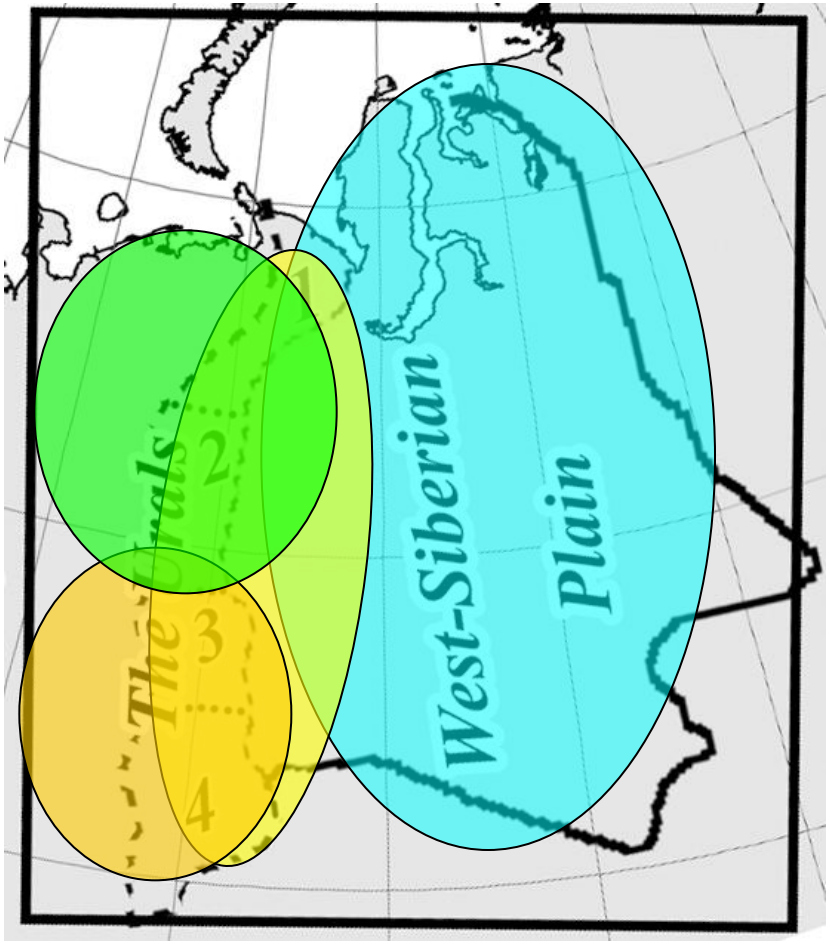

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Correlations at regional level: Why so complicated?

- 1) Administrative subdivision

- 2) Geological history and differences in sedimentation processes

- In the study area, there are several sources of paleontological materials dated back to the Quaternary

Cliffs are the most typical sources of paleontological materials in the West-Siberian Plain

Ob` and Irtysh river banks are more than 60 m high

Fluvial and lacustrine-and-fluvial deposits of Skorodum and Romanovo localities (Eopleistocene – Late Pleistocene)

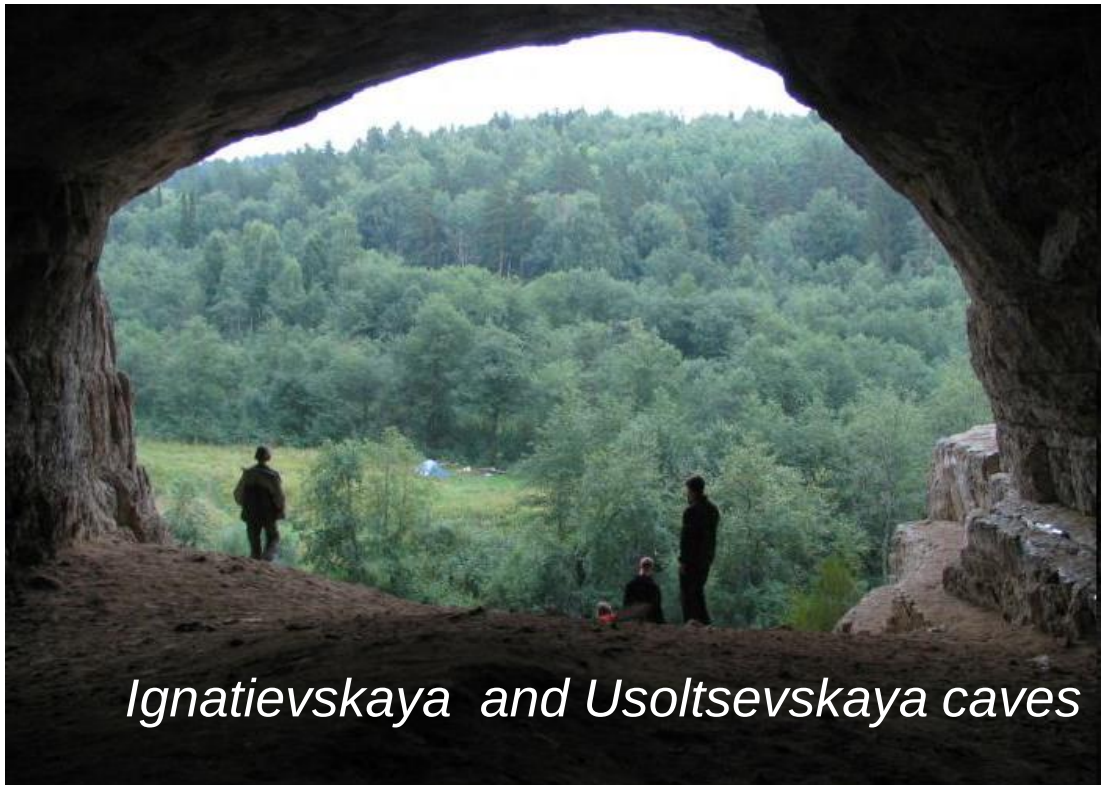
Banks of Trans-Uralian rivers are usually not higher than 20-30 m

Tyulenevo locality (Late Pleistocene)

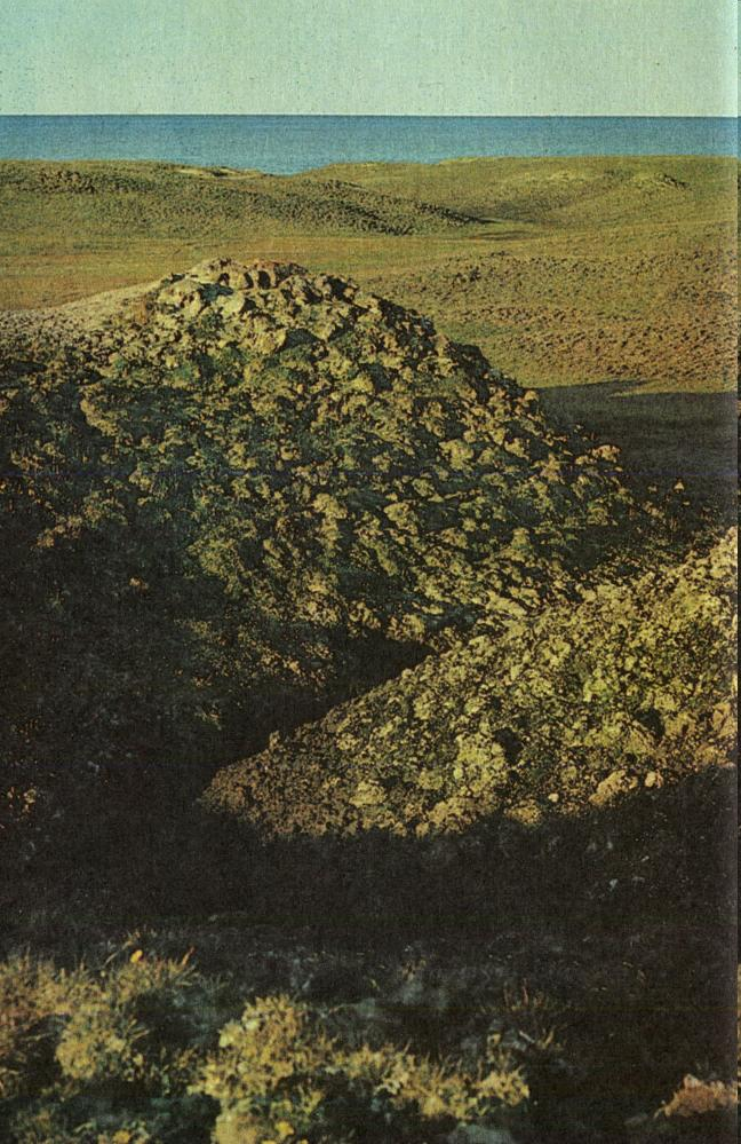
Quarries are another source of materials in both Western Siberia and Trans-Urals

Fluvial and lacustrine and fluvial deposits of Korkino and Baturino localities (Eopleistocene-Late Pleistocene)

Caves and grottos
are typical for Ural Mountains
and Trans-Urals



Ignatievskaya and Usoltsevskaya caves



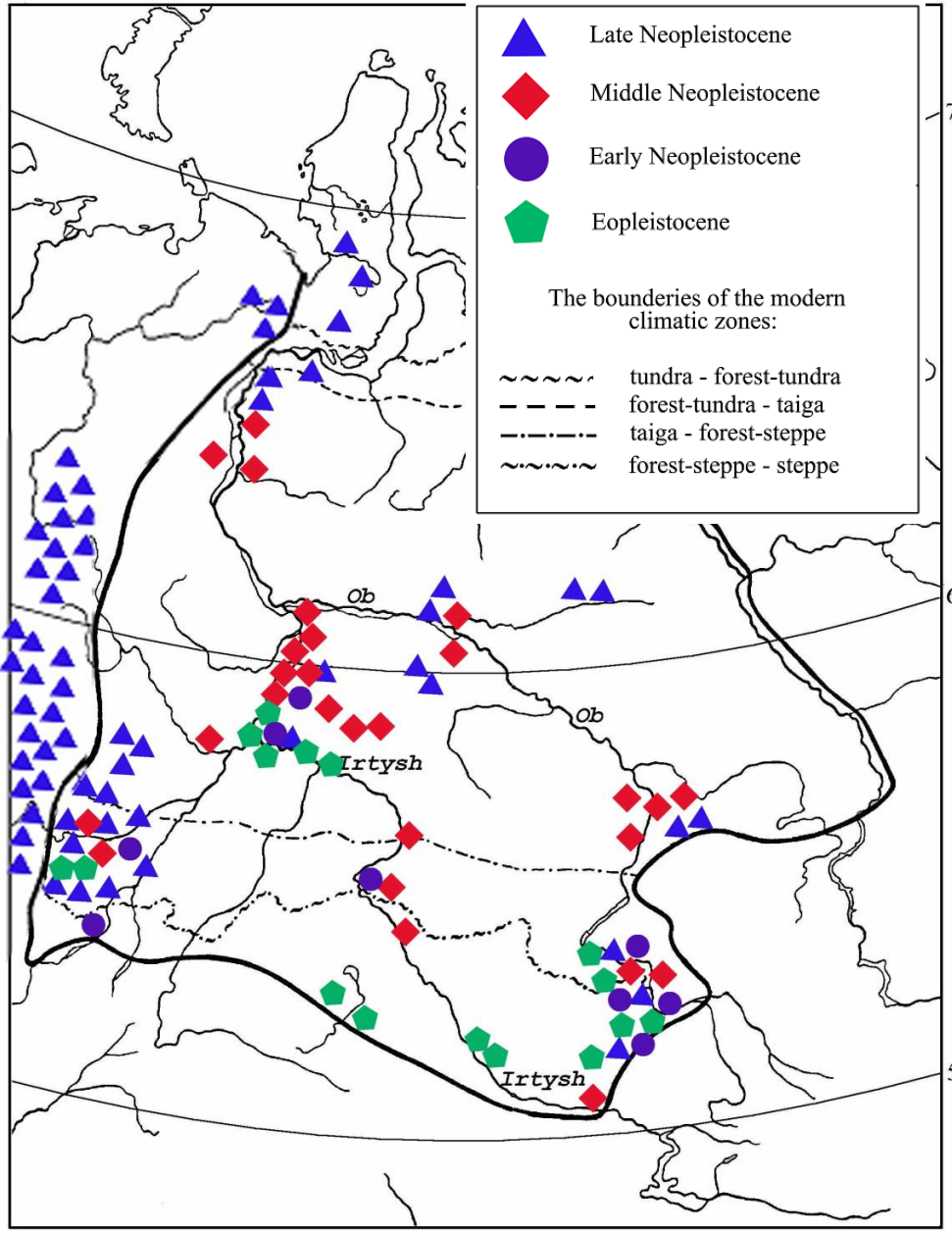
Moreover, there are some additional sources of Holocene materials:

peat bogs and infillings of burrows of carnivorous mammals

Because of the differences in sedimentation processes,

the quaternary fossil records in different parts of the region

are not uniformly documented

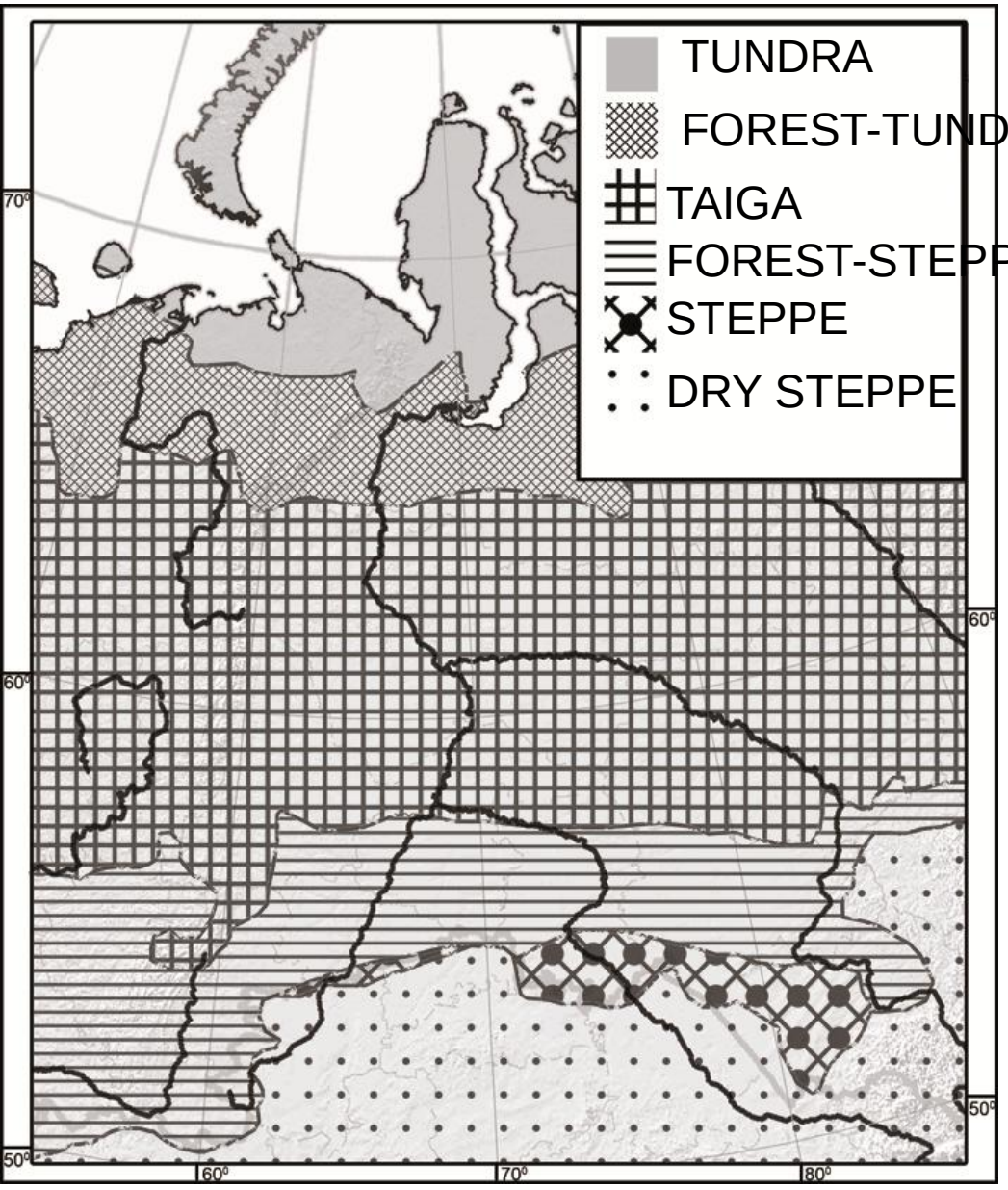


The southern part of the West-Siberian Plain is documented from the Late Pliocene to the end of the Late Pleistocene.

In the northern part, all the localities of micromammal and insect faunas are not older than Late Pleistocene.

In the Urals, all the localities are not older than the beginning of the Late Pleistocene.

Geographical location of the main sites of small mammal faunas in the Urals and West-Siberian Plain



Nowadays,

pronounced climatic gradient is reflected

in latitudinal zonality


Tundra


Forest-tundra


Forest-steppe


Taiga

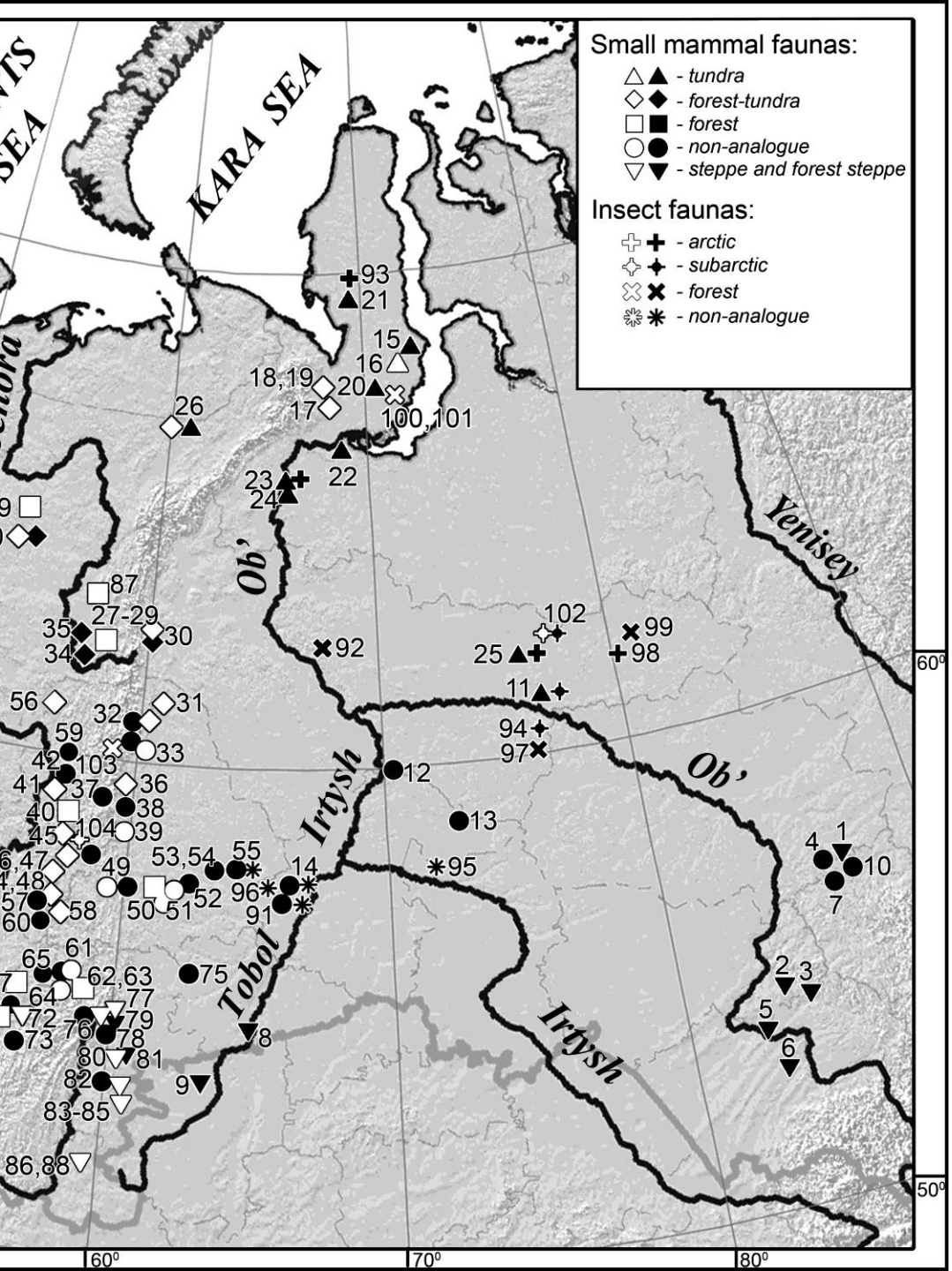

Steppe

The study area experiences pronounced continental climate and extreme seasonality

Materials for biostratigraphical and biochronological purposes include

- Micromammal
- Coleoptera
- Molluscs
- Plant macrofossils
- Spores and pollen

- We focus on the two model groups – arvicoline rodents and insects (coleoptera).
- These groups represent traditional objects of biostratigraphical, biochronological, and paleoecological studies.
- Arvicolines are commonly employed in Quaternary biostratigraphy due to their rapid evolution, abundant fossil record, and wide geographical ranges. Their remains provide paleoenvironmental and paleoclimatic evidences at a number of levels (from the major vegetation types at regional and continental scale to local environments). Beetles are strictly confined to temperature conditions and show high levels of ecological and morphological stability. Beetle species are attributed to particular layers of terrestrial phytocenoses that allows one to use them as indicators of soil, humidity, insolation, and vegetation type.



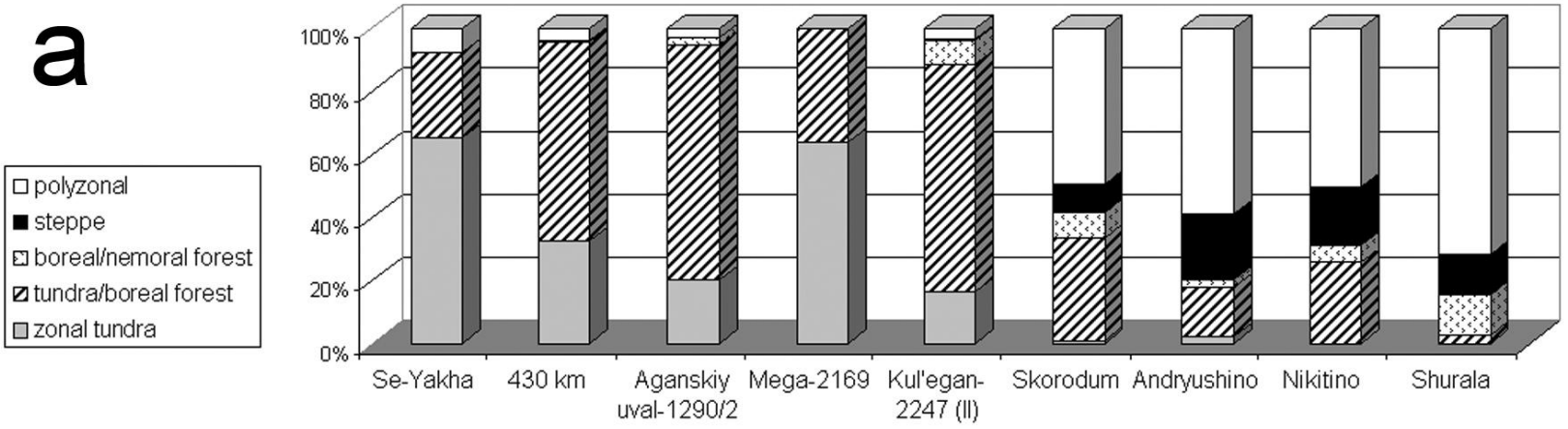
The Late Pleistocene and Holocene fossil record is the best documented in the study area

The Late Pleistocene and Holocene sites of small mammal and beetle faunas in the Ural Mountains and West Siberian Plain. Black signs indicate the sites of the Late Pleistocene age, white signs indicate the Holocene sites

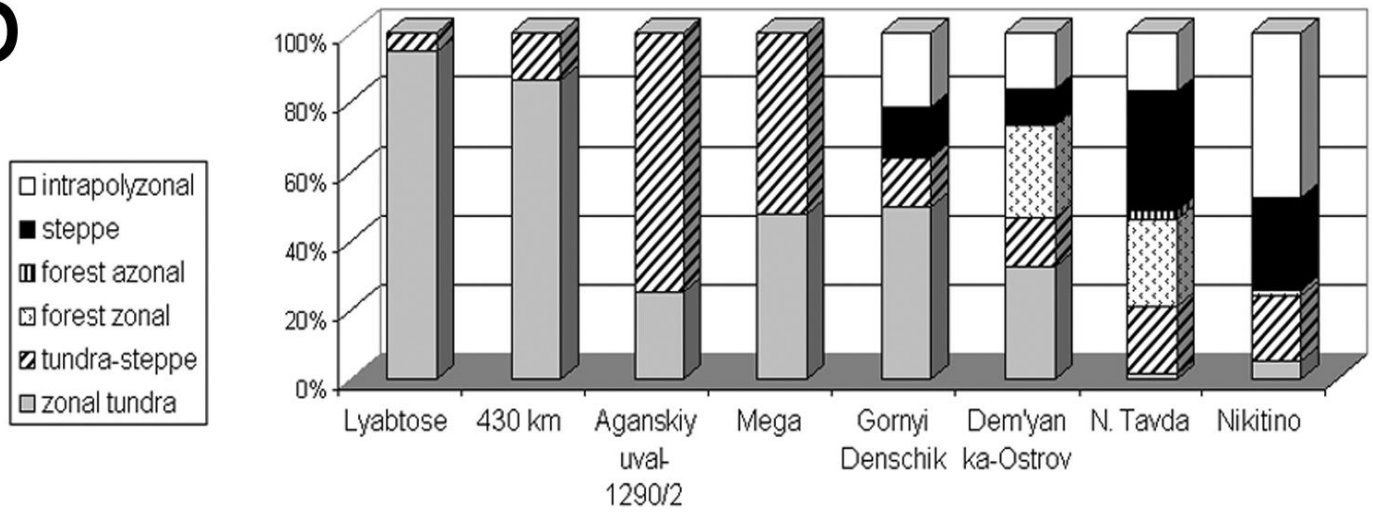
- **The analyzed materials include**
- authors' collections (Бородин, 1988; Бородин, 1992; Бородин, 1995; Бородин, 1997; Бородин, Елькина, 2006; Бородин, Ерохин, Маркова(Самохина), 1997; Бородин, Зыков, Маркова, 2006; Бородин А.В., Ивакина (Погодина), 2000; Бородин, Косинцев, 2001; Бородин, Смирнов, 1984; Бородин и др., 2000a; Бородин и др., 2000b; Бородин и др., 2000c; Бородин, Струкова, Стефановский, 2003; Бородин, Струкова, Трофимова, 2001; Ивакина и др., 1997; Косинцев, Бородин 1990; Смирнов, Большаков, Бородин, 1986; Стефановский, Бородин, 2002; Стефановский, Бородин, Струкова, 2004; Стефановский и др., в печати; Струкова, Бородин, 2002; Струкова и др., 2006; Borodin, 1996; Borodin, Kosintsev 1997; Borodin et all., 1998; Borodin et all., 2001; Borodin, Strukova, Markova, 2006; Borodin, et all., 2006)
- published data (Антропоген Южного Урала, 1965; Вангенгейм, Зажигин, 1982; Галкина, 1975; 1977; 1980; Галкина и др., 1980; Громов, 1957; Гуслицер, Павлов, Панюкова, 1989; Данукалова и др., 2002; Данукалова и др., 2006; Зажигин, 1980; Исайчев, 1977; Карачаровский, 1951; Кочев, 1991; Круковер, 1986; Круковер, 1992; Кузмина, 2003; 2006; Малеева, 1970; 1971; 1976; 1977; 1978; 1982; 1983; Малеева, Воробьева, 1970; Малеева, Елькин, 1986; Малеева, Нордстрем, 1974; Малеева, Стефановский 1988; Маркова и др., 2001; Смирнов, 1992; 1993; 1994; 1996;2001; Смирнов и др., 1990; Смирнов и др., 1992; Смирнов и др., 2007; Смирнов, Кузьмина, Коурова, 1999; Струкова, 1999; Струкова, 2003; Сухов, 1976b; 1978; 1981; Фадеева, 2003a; 2003b; Черных, Малеева, 1971; Яковлев, 1994; 1996; 2003;Яхимович, 1987; Bachura, Kosintsev, 2007; Krukover, 2007; Markova et al., 1995; Markova et al., 2001; Smirnov, 1998 ; Smirnov, Golovachov, 1999; и др.)

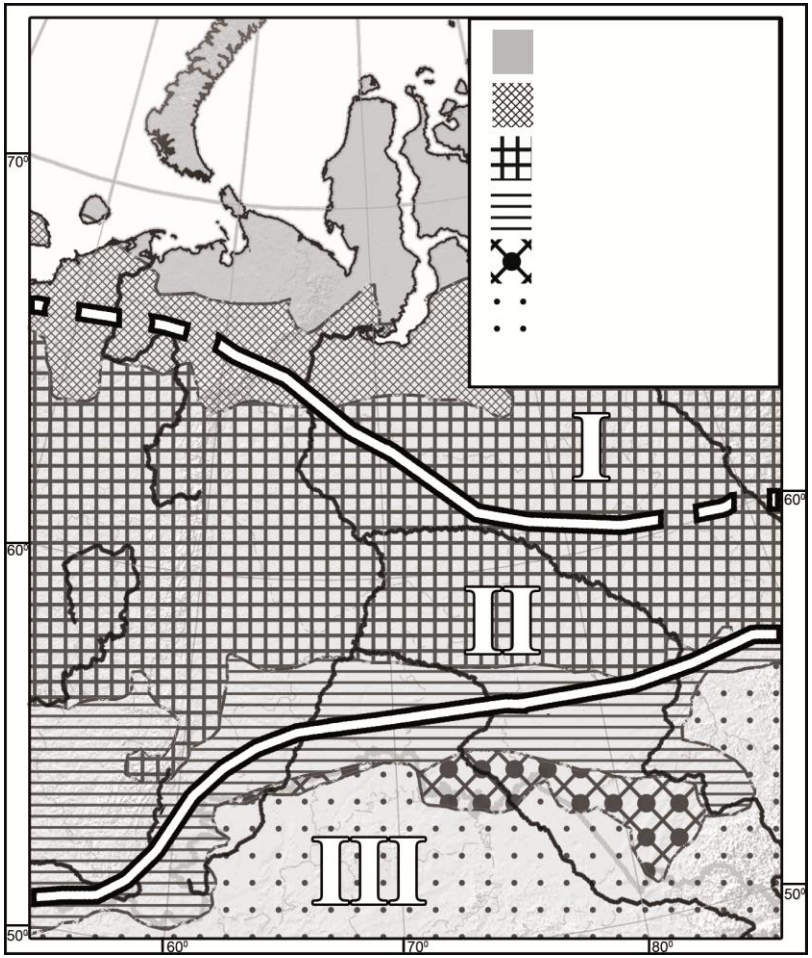
Latitudinal dynamics of insect (a) and arvicoline (b) faunas from the key sites in the Western Siberia dated back to the end of MIS3-beginning of MIS2. Sites are ordered from the north to the south according to the latitude (between 73 and degrees 57 north)

a



b

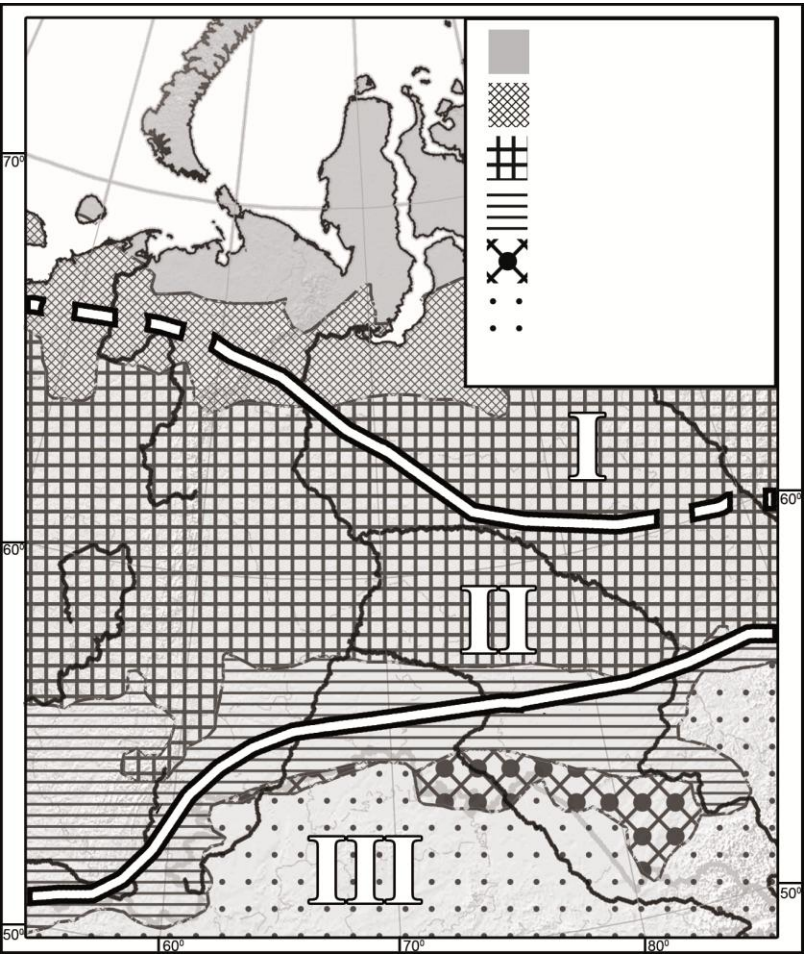




- **The structure of faunas reflect the latitudinal gradient. The three major groups of faunas could be distinguished**:

  - I – tundra-like faunas
  - II - non-analogue
  - III – steppe-like

Modern vs. Pleistocene Zonality



- Thus, when making biostratigraphic and biochronological schemes

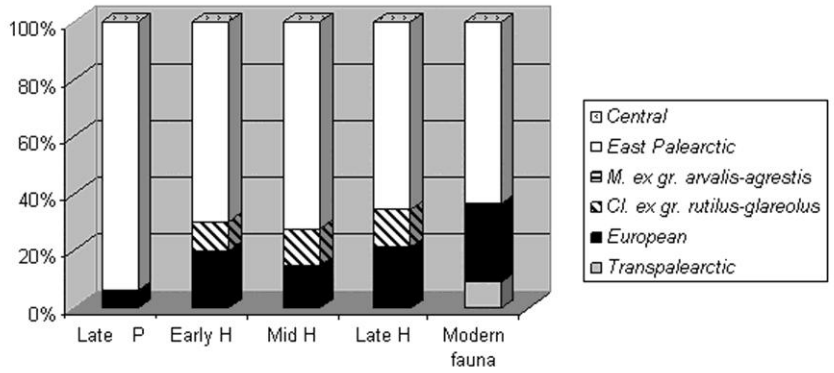
  we should take into account landscape-geographic gradient reflected in the species composition and community structure

- However, we should not only trace the faunal successions within the climatic zones but also to compare faunal assemblages in longitudinal aspect

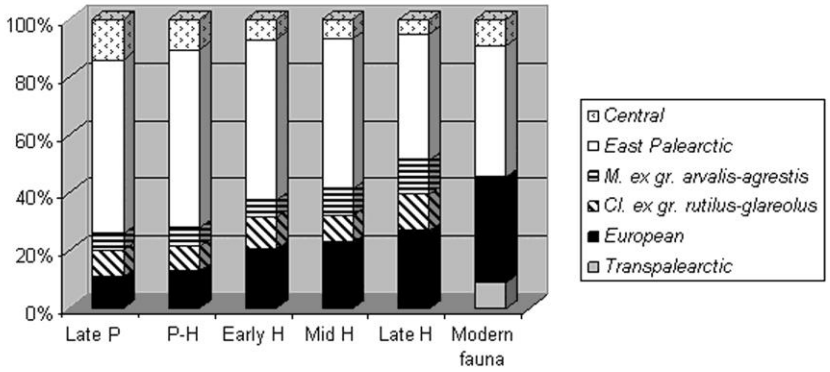
We establish the four biogeographic groups of species as follows:

1) Transcontinental
2) West Palearctic (“European”)
3) East Palearctic and Beringian
4) Central Palearctic group

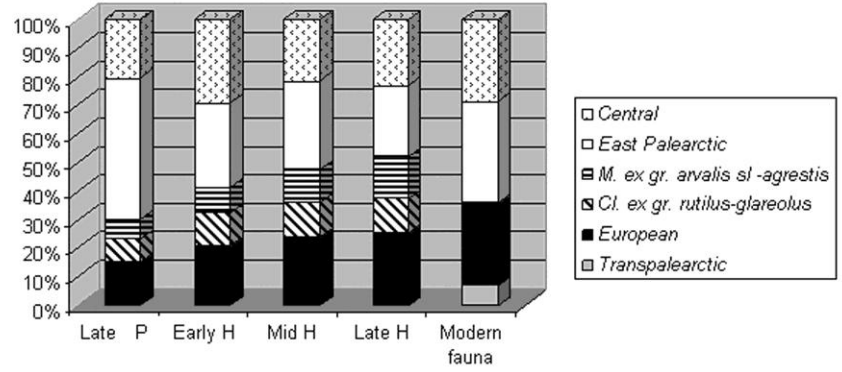
Latitudes above 61 degrees North



Between 56 and 60 degrees North

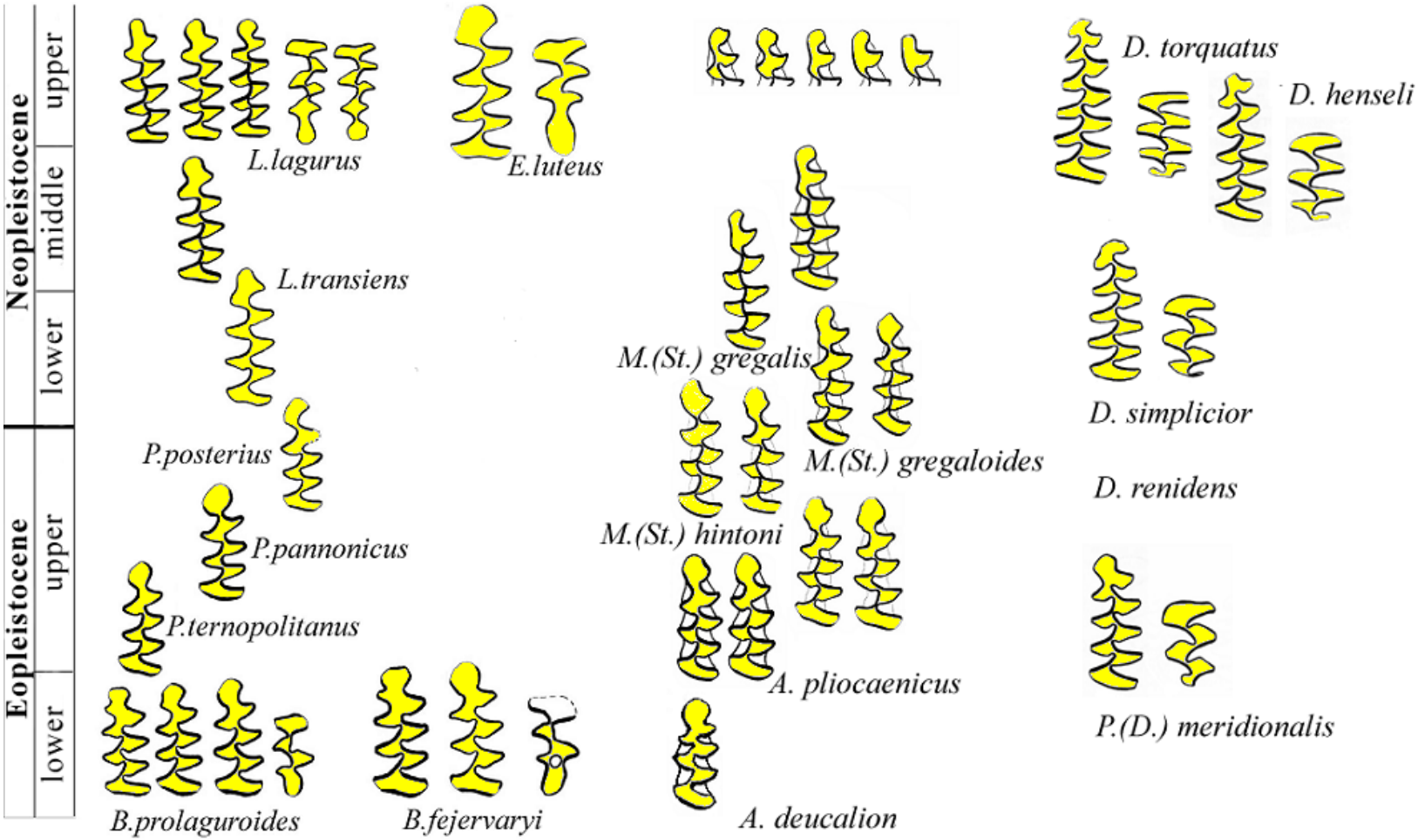


Latitudes below 56 degrees North

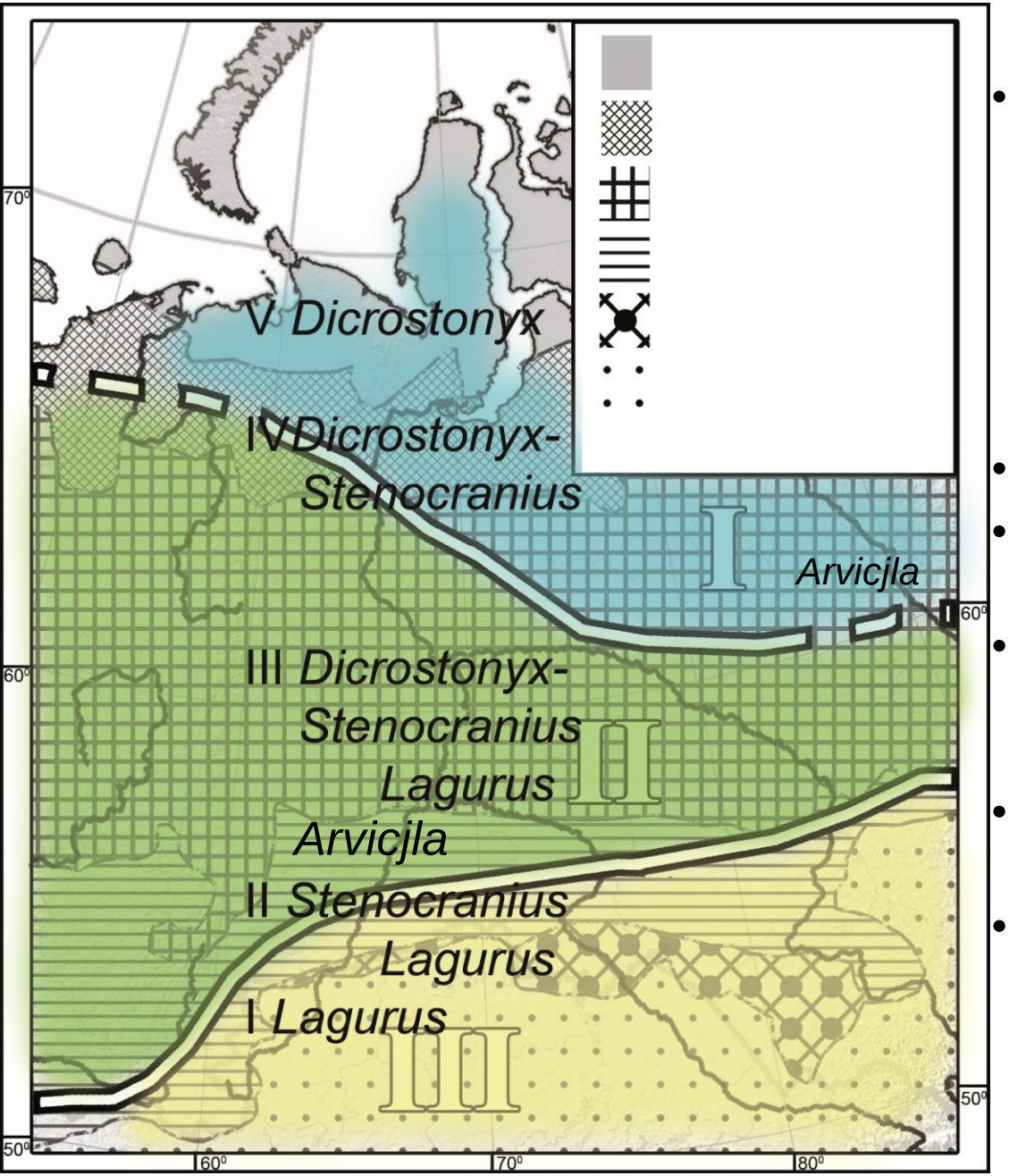


- Occurrence of European, East, Palearctic and Central Palearctic groups of arvicolines shows temporal variability.
- In particular, we can see changes from the Late Pleistocene (P) to Holocene (H) and modern time
- The West Siberia could be regarded as transit territory providing faunal interchange between European, East Plaearctic/Beringian and Central Palearctic faunal groups

Importance of the study area for faunal correlations throughout the continent is determined by presence of the key arvicoline taxa traditionally used for correlation

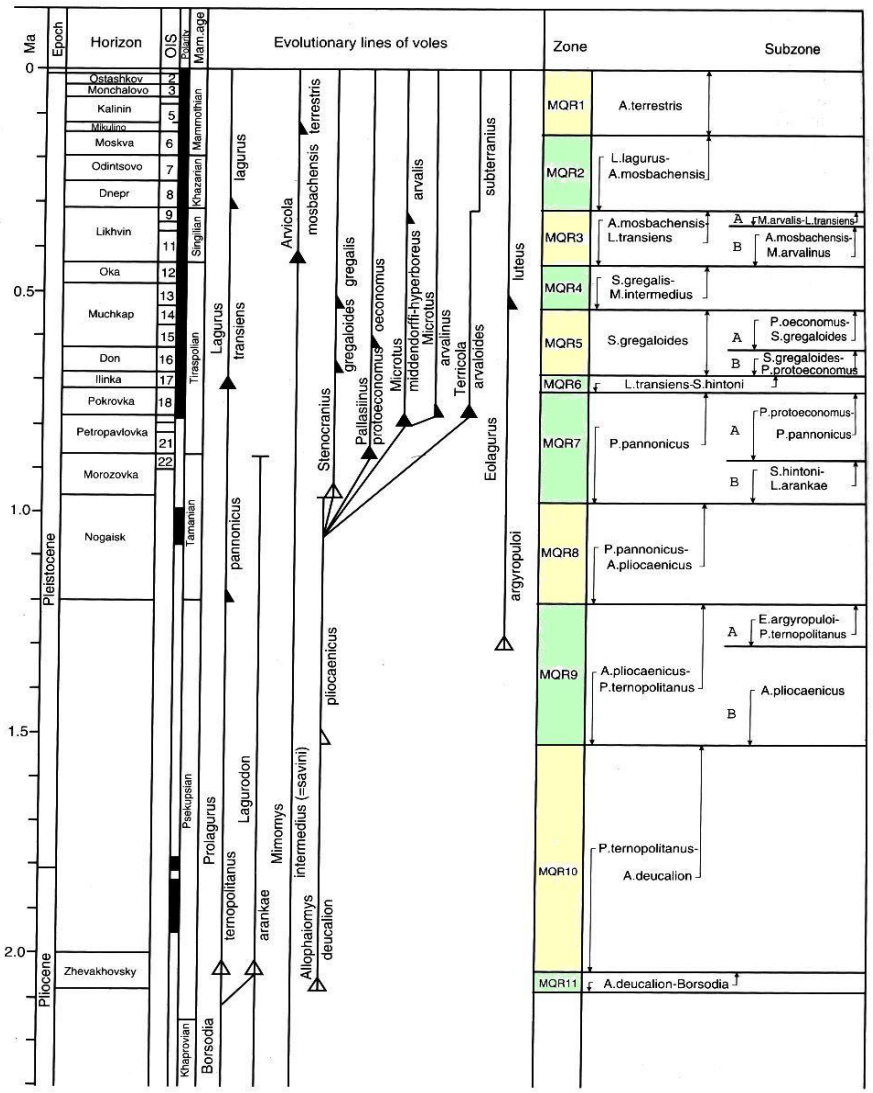


[Бородин, 1996, 2009]



- Based on the key taxa lineages, their latitudinal spread and evolutionary level we can establish **the five latitudinal zones** for trans-regional and trans-zonal correlations:
- I Lagurini lieages zone;
- II *Lagurus – Stenocranius – Arvicjla* lineages zone;
- III *Lagurus – Stenocranius – Arvicola – Dicrostonyx* lineages zone;
- IV *Stenocranius - Dicrostonyx* lineages zone,
- V –*Dicrostonyx* lineage zone.

Zones MQR (Vangengeim et al., 1998; Pevzner et al., 2001)

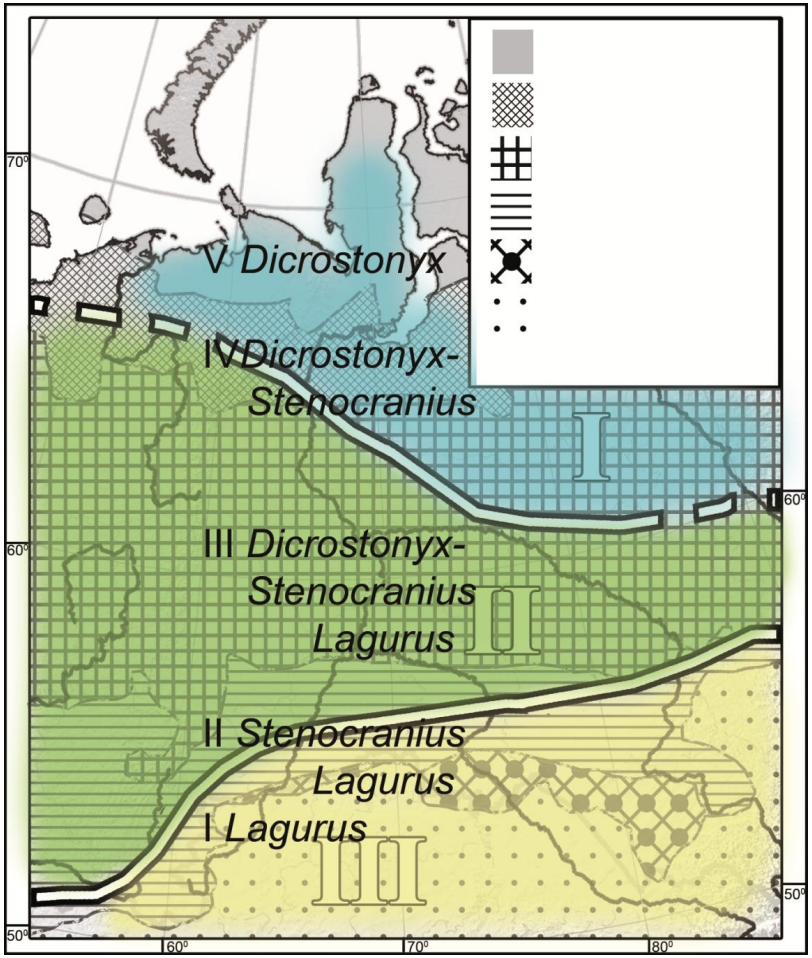


Stratigraphic zones based on the evolutionary appearance of new forms in the key lineages

MQR1	***Arvicola terrestris***
MQR2	***Lagurus lagurus – Arvicola mosbachensis***
MQR3	***Arvicola mosbachensis – Lagurus transiens***
MQR4	***Stenocranius gregalis – Mimomys intermedius***
MQR5	***Stenocranius gregaloides***
MQR6	***Lagurus transiens – Stenocranius hintoni***
MQR7	***Stenocranius hintoni – Prolagurus pannonicus***
MQR8	***Prolagurus pannonicus – Allophaiomys pliocaenicus***
MQR9	***Allophaiomys pliocaenicus – Prolagurus ternopolitanus***
MQR10	***Prolagurus ternopolitanus – Allophaiomys deucalion***
MQR11	***Allophaiomys deucalion – Borsodia***

Correlation of faunal complexes: Europe, Ural Mountains and Western Siberia

Scale				General Till Sequence in West Siberia (Arkhipov, 1989)	Glaciations	Magnetostratigraphy	Age, Ka	East European stratigrraphic scale (Vangengejm et al., 2001)	Mammalian faunal complexes (f.c.)				Siberian stratigraphical scale (Arkhipov, 1987, 1989)	Zones	Subzones	
Global		Russian														
System	Series	Subseries	Link		Siberian, Alpine			Horizons	Eastern Europe	South of West Siberia (The uniform stratigraphic scheme, 2000)	Northern and central parts of West Siberia	Trans-Urals	Horizons			
Quaternary	Pleistocene Upper	Pleistocene Q	Upper Q_3	Sartan	Zyrjanka W?rm	Brunhes \N	10	Ostashkovo	Mammuthus faunal complex Upper part	Mammuthus faunal complex		Mammuthus faunal complex	Sartan	MQR1	*A.terrestris*	
								Monchalovo					Karginian			
				Hashoort				Kalininian					Ermakovian			
				Kormydzi-hantka			100									
					Riss-W?rm			Mikulinian					Kazantsevo			
	Middle		Middle Q_2	Tazovian	Bachta Riss			Moskovian	Lower part	Tazovian			Tazovian	MQR2	*L.lagurus* *A.mosbachensis*	
										Kalmankian			Shirta			
				Upper Samarovo			200	Odintsovian					Samarovo			
									Khazarian		Yarsino f.c.					
				Lower Samarovo			300	Dneprovian								
					Mindel-Riss			Likhvinian	Singilian		Chembakchino f.c.		Tobolian	MQR3	*A.mosbachensis* *L.transiens*	*M.arvalis-L.transiens*
							400									*A.mosbachensis-M.arvalinus*
			Lower Q_1	Nizjami Upper Shaitan	Shaitan Mindel			Okian	Tiraspolian	Viatkian			Nizjamian	MQR4	*S. gregalis - M.intermedius*	
							500	Muchkapian			Koshelevo f.c.		Tiltimian	MQR5	*S. gregaloides*	*P. oeconomus - S.gregaloides*
							600									
				Azovy Lower Shaitan				Don					Azovian			*S.gregaloides-P.protoeconomus*
								Ilyinian					Talagaika	MQR6	*Lagurus transiens- S.hintoni*	
								Pokrovskian				Baturino f.c.		MQR7	*S.hintoni* *P.pannonicus*	*P.protoeconomus* *P.pannonicus*
				Mansi	Mansi		750?	Petropavlian					Mansi			
													Gornofilino			
	Lower	Eopleistocene-EP	Upper			Ja	860?	Morosovian	Tamanian	Razdolian	Scoro-dumian	Sarykulian	Upper part of Kochkovka formation			*S.hintoni - Lagurodon arankae*
								Nogaiskian						MQR8	*P.pannonicus* *A.pliocaenicus*	
			Lower				1200		Pse-kupian	Kizikhian			Lower part of Kochkovka formation	MQR9	*A.pliocaenicus* *P.ternopolitanus*	*E.argyropuloi - P.ternopolitanus*
																A.pliocaenicus
						O	1800					Chumlakian II		MQR10	*P.ternopolitanus* *A.deucalion*	
Neogene	Pliocene	Upper	Upper			Matuyama /R/		Zhevakhovian				Chumlakian I		MQR11	*A.deucalion-Borsodia*	
		Akchagylian					2150?		Khaprovian	Podpusk-Lebiazhian						



- We suggest that the five latitudinal zones established in the study area could be used to correlate regional schemes in Northern Eurasia and Beringia.
- Key taxa in latitudinal zones I-III are the same with European schemes; for latitudinal zones I-III we can apply stratigraphic zones MQR developed by Vangengeim et al. (1998).
- In latitudinal zones IV-V, key taxa are the same with the more eastern territories, namely with Western Beringia

The five latitudinal zones could be used to solve the problem of Pan-Eurasian correlations by linking European and Beringian sectors of Palearctic

- Т.е. по сути дела корреляция с Тесаковской схемой проведена по зоне I-II (т.к. в ней нет линии Dicrostonyx)
- Судя по фаунам, З и В Европ, для центральной и северной их частей, следует ввести еще в MQR и линию Dicrostonyx, которая в Европе известна с уровня Praedicrostonyx (Chaline) по крайней мере
- Корреляция с Забайкальем – по зонам I-III (и в Европе и в Забайкалье – Lagurodon arankae, которого нет у нас (?Более южная веточка лагурин?)
- При межрегиональных сравнениях датировка по наиболее эволюционно высоким уровням таксонов, чтобы избежать эффекта «hudsonius» (это если один отстает по темпам, а если наоборот? Бывает ли такое, что один таксон в регионе резко выскакивает вперед? Или это к вопросу о тафономической неоднородности?)
- Для межрегиональных сравнений – в индекс к MQR добавить индекс широтности LI-V попробовать сравнить с аляскинскими и французскими фаунами. Т.е региональные особенности никто не отрицает, там всякие терриколи и синаптомисы, но наша схема для создания «линьков» (link)
- Видовой состав самой фауны, помимо руководящих форм MQR отражает региональную специфику и детализацию региональной биохронологии и биостратиграфии, понимания процессов минрайий отдельных таксонов и формирования и трансформаций биомов

Conclusions

- Latitudinal landscape zonality has been strongly pronounced in the West Siberian Plain during the Quaternary
- The West Siberia could be regarded as transit territory providing faunal interchange between European, East Plaearctic/Beringian and Central Palearctic faunal groups
- Presence of key taxa allows one to correlate the regional stratigraphic schemes with each other and with stratigraphic schemes of geographically distant regions
- The 5 zones based on latitudinal distribution of the key taxa and their evolutionary level provide a way to correlate biostratigraphic schemes between the regions and to link different parts of the Northern Eurasia together (from a biostratigraphic point of view)

- Thank you for attention!