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COMPARATIVE CRANIAL NONMETRIC STUDY OF ARCHAEOLOGICAL POPULATIONS FROM INNER ASIA

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ABSTRACT. *Results of the comparative cranial non-metric study of human remains unearthed in the territories of South Siberia, Altai, Buryatia and Inner Mongolia belonging to different historical periods, from Neolithic up to Mongolian (12-13th c AD) periods show general differentiation between populations from eastern Mongolia and Inner Mongolia on the one hand, and populations from Xingjian, Altai, South Siberia, Buryatia and western Mongolia on the other hand. Warring States and Bronze Age populations from Inner Mongolia, and Bronze Age Slab grave population from eastern Mongolia form a separate cluster. Position of Chandman population (with no coffin) from western Mongolia in this cluster might show a probable relationship of that population with the populations from eastern Mongolia or other regions in Inner Mongolia. Cluster analyses showed a picture of very heterogeneous population structure of inhabitants from Southern Siberia, Altai and Western Mongolia during Eoneolithic, Bronze and Early Iron Ages. Close relationship between Neolithic population from central Mongolia and Early Iron Age population from Xingjian; and between Neolithic Baikal, Chandman (with wooden chamber) from western Mongolia, and Afanasev from Altai Mountain indicate about their genetical affinities and biological continuity of those archaeological populations. Cluster analyses of 2nd BC to 8th AD period samples revealed very close characteristics for Xiongnu populations from Altai and Mongolia, and some similarity between Turkic from Altai and Han from Inner Mongolia. Comparative analysis of medieval period and contemporary populations from Baikalia, Buryatia, Mongolia, Inner Mongolia and Northeast Asia show more or less compact picture. Nevertheless, we can observe some tendencies in their biological affinities. Early Mongolians from Buryatia and Qidan from Inner Mongolia are closer to each other and Yuan population from Inner Mongolia and Amur and Korean contemporary populations are* *closer to each other. On the other hand Mongolian period populations from Mongolia and modern Buryats are very close to each other, and to some extent close to Northern Chinese. Modern Chinese are found very different from the other populations studied.*

There are numbers of publications on the craniofacial morphology of archaeological human remains belonging to different historical periods of Central Asia, South Siberia, Altai mountain region, Baikal Lake region, Inner Mongolia and Mongolia: G.F.Debets (1948), M.G.Levin (1958), I.I.Gokhman (1960, 1967), O.Ismagulav (1970), V.V.Ginzburg and T.A.Trofimova (1972), M.V.Kruykov and et al. (1978), D.Tumen (1977, 1978, 1979, 1985, 1987, 1992, 2002, 2003, 2007), N.N.Mamonova (1979), V.P.Alexseev and et al. (1980, 1984), A.N.Popov and et al. (1997), A.N.Baghashev (2000), T.A.Chikisheva (2000a, 2000b, 2003), T.A.Chikisheva and D.V.Pozdnyakov (2000), D.V.Pozdnyakov (2001, 2006), A.I.Buraev (2006), Zhang Quan-chao and et al. (2006), Zhu Hong and Zhang Quan-chao (2007), and D.V.Pozdnyakov and S.A.Komissarov (2007). Based on the results of the craniofacial studies of human remains of Asia, the authors drew significant conclusions on the morphological features of the inhabitants of the region and their history, ethnic origin and cross region migration. However, cranial discrete or nonmetric traits of the prehistoric populations from these regions are not widely studied; there are a few research works on the modern Koreans (Park et al., 2001), and some archaeological populations from China (Zhang Hua, 2005; Wei dong et al., 2006).

Cranial nonmetric, i.e. epigenetic variation, is quite popular in analyzing osteological remains at the population level and has successfully been used to evaluate the evolutionary relations and biological affinities among ancient and contemporary populations from different regions in the world (Finnegan and Marcsik 1979; Hanihara and Ishida 2001a; 2001b; 2001c; 2001d; 2001e; Hanihara et al. 1998; Ishida and Dodo 1992; 1993; 1997; Kozintsev 1972; Ossenberg 1990; Sutter and Mertz 2004; Wenger 1974). The theoretical basis of any such investigation is that 1) the traits are highly genetic in nature; 2) that populations vary in frequencies between even closely related populations; 3) that some consistency is seen without regard to environmental variation; 4) the traits do not vary significantly with age; 5) show little sex difference; 6) show little correlation between the traits used; and 7) are easily defined and have the advantage of being scoreable for highly fragmented skeletal materials. These above assumptions have been tested on many ancient and contemporary populations from Europe, North America and Northeast Asia and were discussed in regard to their ethnic origins and biological relationships.

Cranial nonmetric studies of human remains from different historical periods of Mongolia conducted in previous years (Erdene 2003, 2005a, 2005b, 2006, 2007, 2008) gave us interesting results. However, those studies have not comprised all the historical periods of Mongolia and territorial regions of ancient nomads from Eurasia. In this paper we present the results of comparative cranial non-metric study of human remains from different historical periods (Neolithic, Bronze, Early Iron, and later periods up to

Medieval age) unearthed in Inner Mongolia, China, South Siberia, Buryatia and Baikal Lake region. The present study is the first comprehensive research of its kind comprising the wide range of time and space of ancient nomads from Eurasian steppe.

MATERIALS AND METHODS

Human remains unearthed in the territories of South Siberia, Buryatia and Inner Mongolia belonging to different historical periods are investigated for cranial and mandibular nonmetric traits. The sample consisted of 430 more or less complete skulls of 327 males and 99 females with ages ranging from infantile I to senile. Detailed information on the studied human remains is given in the Table 1 and geographical location of studied anthropological samples is shown on the Fig. 1.

Table 1. Characteristics of the archaeological populations from InnerAsia under cranial nonmetric study

Historical period, culture	Site	Sample size	Curating institution
INNER MONGOLIA (NORTH CHINA)			
Bronze	Jiangjungou	20	Laboratory of Anthropology, Research Center for Chinese Frontier Archaeology of Jilin University, Changchun, China
Early Iron age 500-221 BC	Nileke, Xinjiang	48	
Warring States 475-221 BC	Dashanquian Tuchenzi	54	
Han 207 BC-220 AD	Tuchenzi	9	
Xianbei 3^{rd}-4^{th} c. AD	Ba gou Hulunbuir-Zalanur Liaoning-Beipyo-Lamadong Liaoning-Tsoyang-Zartai yanze Tsayuhuji – Sandovan Tsayuhuji Ulaantsav Ulaantsav-Sandu-dundaji Tsayuzunji-Chilansan	97	
Qidan 10-11^{th} c. BC	Tuchenzi Allucurchin-Yelyu Liaoning-Faku-Imotai Sandu-Chi-an-Haizi Shiliin hot-Dunsan Ulaanhad-Chifeng-Ning-Shanzuizi Wu-nyu-zi	29	
Yuan 12^{th}-14^{th} c. BC	Chengpuzi Zhenzishan	52	
SOUTH SIBERIA and BURYATIA			
Neolithic 4^{th} millennia – 1700-1300 BC	Educhanka Makarovo, Manzurka Marintui Obhoi, Olihon	8	
Bronze, Afanasev, Altai Mountain	Bertek-33 Karakol	14	Sector of Anthropology,

2nd millennia BC	Ust-Kuyum		Institute of Archaeology and Ethnography, Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia
Bronze, Afanasev, Minusin 2nd millennia BC	Krasnyi Yar	3	
Early Iron age Pazyryk, Altai Mountain, 5th-3rd c. BC	Ala-Gail Ala-Gail 2 Balyk-Sook Baratal-2 Bike-3 Bor burgazy-1 Bor burgazy-2 Bor burgazy-3 Borotal-2 Buraty-8 Jolin-2 Kara Tenesh Maltalu Maltalu-80 Ulandryk-1 Ulandryk-2	46	
Early Iron age Karakob, Altai Mountain, 4th-3rd c. BC	Kuraiskaya step Kyzyl Bom Torbedok	6	
Early Iron age Tagar, Minusin 5th-2th c. BC	Kichik kuzur Malye kopyony	17	
Xiongnu-Sarmat period 3rd c BC –2nd c AD	Kara-Bom-11	4	
Turkic period 6th-8th c. AD	Jolin-1 Yustyd-12	3	
Early Mongolian period, Buryatia, 8th-12th c. AD	Enhor Kiya Olihon Onontycha Ulanhad	20	Department of History and Culture of Central Asia, Institute of Mongolian Studies, Buddology and Tibetology, Siberian Branch of Russian Academy of Sciences, Ulan-Ude, Russia
Total		**430**	

Table 2 gives the brief information about the samples used for comparison. Materials for comparison consisted of cranial nonmetric data on prehistoric populations from Mongolia (Erdene, 2003, 2005a, 2005b, 2008), modern population from Korea (Erdene, 2006), modern Buriats, and populations from Amur River and China (Ishida and Dodo, 1992). Samples of Mongolia include nonmetric data of Neolithic, Bronze Age, Early Iron Age, Xiongnu and Mongolian period, and samples of China include nonmetric data of northern and modern Chinese populations.

Fig. 1. *Geographic location of studied cranial samples from South Siberia and Inner Mongolia*

Legend: 1-Bronze age, Inner Mongolia, 2-Early Iron Age, Xingjian, 3-Warring States, Inner Mongolia, 4-Han, Inner Mongolia, 5-Xianbei, Inner Mongolia, 6-Qidan, Inner Mongolia, 7-Yuan, Inner Mongolia, 8-Neolithic, Buryatia, 9-Bronze age (Afanasev), Altai Mountain and Minusin, 10-Early Iron age Pazyryk and Karakob, Altai Mountain, 11-Early Iron age (Tagar), South Siberia, 12-Xiongnu-Sarmat period, Altai Mountain, 13-Turkic period, South Siberia, 14-Mongolian period, Buryatia

Table 2. Ancient and modern populations used for comparison in the present study

Historical period, culture	**Chronology**
Neolit Central Mongolia	2500-3000 BC
Bronze-West Mongolia	2500 up to 4^{th} c. BC
Bronze-East Mongolia, Slab grave culture	2500 up to 3^{rd} c. BC
Early iron-wooden chamber	7th-2nd c BC
Early iron-stone box	7th-2nd c BC
Early iron-no coffin	7th-2nd c BC
Xiongnu	3rd c BC –2nd c AD
Mongolian period	11th-14th c AD
Buryat	Recent Buriats from Northeast Siberia
Amur	Recent indigenous tribes from Amur River basin: Ulchs, Nanaians, Negidals and Orochs
Modern Korean	Modern Koreans
Northern Chinese	Northern part of China, mainly from Liaoning Prefecture
Modern Chinese	Modern Chinese

Fifty nine discrete cranial traits were examined for frequency distributions. We followed Finnegan and Marcsik (1979), Hauser & De Stefano (1989) and Movsesjan et. al. (1975) for criteria and nomenclatures of the variants. References for the scoring of each trait and descriptions of the statistical methods used in the present study are given in previous papers (Erdene 2005, 2006)

RESULTS AND DISCUSSION

Cranial nonmetric variation of prehistoric populations from Inner Mongolia, Xinjiang, South Siberia and Buryatia

Based on the study by Berry & Berry (1967) that stated the lack of sex difference in the distribution of the cranial nonmetric traits, sex-combined frequencies for each trait have been calculated for each population. From the list of 59 discrete traits examined for each skull in the present study, forty traits with high taxonomical value and sufficient sample size are chosen for subsequent statistical calculations. Incidences of 40 cranial nonmetric traits examined in the studied samples of ancient populations of different historical periods from Inner Mongolia, South Siberia and Buryatia are given in the Table 2. Traits are listed in the anatomical localizations: frontal view-lateral view-vertical view-occipital view-basilar view-mandible. Photos of nonmetric trait incidences are given in the Appendix.

The most common traits observed in the cranial samples of ancient nomads from Inner Mongolia, South Siberia and Baikal Lake region are *Parietal foramen present* (0.609-0.938), *Foramen of Vesalius* (0.429-0.969) and *Condylar canal patent* (0.556-0.957). The traits are observed with the relative frequencies of more than 0.5, with the exceptions Xiongnu population from Gornyi Altai for *parietal foramen present* (0.063) and Turkic population from Altai Mountain for *condylar canal patent* (0.125). The other traits observed with the frequencies more than 0.5 for most of the populations are *supraorbital foramen*, *accessory lesser palatine foramina*. We scored only *medial supraorbital foramen* (not taking into consideration a supraorbital notch) and ignored *frontal foramen* (additional foramen usually situated laterally from the supraorbital foramen). All the populations except Han sample from Inner Mongolia show the presence of this trait with relative frequencies more than 0.5. *Accessory lesser palatine foramina* is observed in twelve populations out of sixteen, the relative frequencies are the least in Tagar sample and the most in Xiongnu sample from Altai Mountain.

Lambdoid ossicle is one of the common discrete traits in the cranial samples of ancient nomads. Although, the frequency does not reach 50% for most of the samples, the trait is observed in all populations. The average relative frequency is 0.4, while the least relative frequency is 0.222 for Qidan sample and the most relative frequency is 0.667 for Han sample from Inner Mongolia.

Table 3. Incidences of cranial nonmetric traits in the sample of ancient populations from Inner Asia

	Cranial nonmetric traits	Neolithic Baikal				Afanasev-Altai mountain			
		Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)
1.	Metopism	7	0	7	0.036	12	1	13	0.077
2.	Supraorbital nerve groove	7	0	7	0.036	7	7	14	0.500
3.	Supraorbital foramen	1	6	7	0.857	3	10	13	0.769
4.	Trochlear spur	7	0	7	0.036	8	3	11	0.273
5.	Zygomatico-facial foramen absent	4	2	6	0.333	8	4	12	0.333
6.	Transverse zygomatic suture vestige	6	0	6	0.042	10	1	11	0.091
7.	Tympanic dehiscence	6	0	6	0.042	10	1	11	0.091
8.	Epipteric bone	4	2	6	0.333	8	1	9	0.111
9.	Wormian bone at squamous suture	4	2	6	0.333	9	0	9	0.028
10.	Parietal foramen present	2	4	6	0.667	3	7	10	0.700
11.	Parietal notch bone	4	2	6	0.333	8	1	9	0.111
12.	Asterionic bone	5	1	6	0.167	9	0	9	0.028
13.	Sagittal ossicle	5	1	6	0.167	12	0	12	0.021
14.	Ossicle at the lambda	5	1	6	0.167	9	1	10	0.100
15.	Lambdoid ossicle	4	2	6	0.333	5	4	9	0.444
16.	Occipito-mastoid wormians	5	0	5	0.050	7	0	7	0.036
17.	Inca bone	6	0	6	0.042	8	0	8	0.031
18.	Biasterionic suture	4	2	6	0.333	8	0	8	0.031
19.	Palatine torus	3	3	6	0.500	9	1	10	0.100
20.	Medial palatine canal	6	0	6	0.042	10	0	10	0.025

21.	Accessory lesser palatine foramina	1	5	6	0.833	2	7	9	0.778
22.	Foramen ovale incomplete	6	0	6	0.042	8	0	8	0.031
23.	Foramen spinosum open	6	0	6	0.042	5	3	8	0.375
24.	Foramen spinosum absent	6	0	6	0.042	7	1	8	0.125
25.	Ovale spinosum confluence	6	0	6	0.042	8	0	8	0.031
26.	Foramen of Vesalius	1	5	6	0.833	0	8	8	1.000
27.	Pterygo-spinous foramen	6	0	6	0.042	7	1	8	0.125
28.	Pterygo-alar foramen	6	0	6	0.042	8	0	8	0.031
29.	Precondylar tubercle	3	3	6	0.500	5	2	7	0.286
30.	Condylar facet doubled	6	0	6	0.042	7	1	8	0.125
31.	Hypoglossal canal bridging	3	3	6	0.500	7	1	8	0.125
32.	Condylar canal patent	2	3	5	0.600	1	6	7	0.857
33.	Sagittal sinus groove flexes left	3	3	6	0.500	7	0	7	0.036
34.	Paracondylar process	4	1	5	0.200	3	3	6	0.500
35.	Jugular foramen bridging	4	1	5	0.200	4	2	6	0.333
36.	Digastric groove doubled	5	1	6	0.167	6	3	9	0.333
37.	Mandibular foramen double	5	1	6	0.167	11	0	11	0.023
38.	Mylohyoid bridging	5	1	6	0.167	11	0	11	0.023
39.	Mandibular torus	5	1	6	0.167	10	0	10	0.025
40.	Accessory mental foramen	6	0	6	0.042	10	0	10	0.025

Table 3. Incidences of cranial nonmetric traits in the sample of ancient populations from Inner Asia (Continued)

	Afanasev-Minusin				**Early Iron age, Pazyryk-Alta Mountaini**				**Early Iron age, Karakob-Altai Mountain**			
	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)
	2	1	3	0.333	45	1	46	0.022	6	0	6	0.042
	2	1	3	0.333	39	7	46	0.152	5	1	6	0.167
	0	3	3	0.917	16	30	46	0.652	0	6	6	0.958
	2	1	3	0.333	43	2	45	0.044	6	0	6	0.042
	2	1	3	0.333	41	3	44	0.068	6	0	6	0.042
	2	1	3	0.333	38	2	40	0.050	4	0	4	0.063
	3	1	4	0.250	38	6	44	0.136	5	1	6	0.167
	4	0	4	0.063	34	1	35	0.029	5	1	6	0.167
	4	0	4	0.063	37	2	39	0.051	5	1	6	0.167
	0	4	4	0.938	9	32	41	0.780	2	4	6	0.667
	4	0	4	0.063	33	10	43	0.233	4	2	6	0.333
	4	0	4	0.063	33	11	44	0.250	5	1	6	0.167
	4	0	4	0.063	44	1	45	0.022	5	0	5	0.050
	4	0	4	0.063	35	10	45	0.222	5	0	5	0.050
	2	2	4	0.500	29	16	45	0.356	4	2	6	0.333
	4	0	4	0.063	39	3	42	0.071	5	1	6	0.167
	4	0	4	0.063	44	1	45	0.022	6	0	6	0.042
	4	0	4	0.063	35	9	44	0.205	5	1	6	0.167
	3	0	3	0.083	23	22	45	0.489	5	1	6	0.167
	3	0	3	0.083	43	1	44	0.023	6	0	6	0.042

	1	2	3	0.667	20	24	44	0.545	3	3	6	0.500
	3	0	3	0.083	38	3	41	0.073	6	0	6	0.042
	3	0	3	0.083	32	9	41	0.220	5	1	6	0.167
	3	0	3	0.083	40	1	41	0.024	6	0	6	0.042
	3	0	3	0.083	40	1	41	0.024	6	0	6	0.042
	0	3	3	0.917	3	38	41	0.927	0	6	6	0.958
	3	0	3	0.083	40	1	41	0.024	6	0	6	0.042
	2	1	3	0.333	41	0	41	0.006	6	0	6	0.042
	3	0	3	0.083	40	1	41	0.024	6	0	6	0.042
	4	0	4	0.063	42	1	43	0.023	6	0	6	0.042
	4	0	4	0.063	33	10	43	0.233	6	0	6	0.042
	1	3	4	0.750	13	28	41	0.683	1	5	6	0.833
	3	1	4	0.250	34	9	43	0.209	4	2	6	0.333
	3	0	3	0.083	27	13	40	0.325	3	3	6	0.500
	3	0	3	0.083	35	2	37	0.054	4	2	6	0.333
	1	3	4	0.750	31	12	43	0.279	2	4	6	0.667
	3	0	3	0.083	39	3	42	0.071	5	0	5	0.050
	3	0	3	0.083	39	3	42	0.071	4	1	5	0.200
	3	0	3	0.083	36	5	41	0.122	5	0	5	0.050
	3	0	3	0.083	35	6	41	0.146	5	0	5	0.050

Table 3. Incidences of cranial nonmetric traits in the sample of ancient populations from Inner Asia (Continued)

	Early Iron age, Tagar, Minusin				**Xiongnu-Sarmat, Altai mountain**				**Turkic, Altai Mountain**			
	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)
	15	2	17	0.118	4	0	4	0.063	3	0	3	0.083
	9	8	17	0.471	3	1	4	0.250	3	0	3	0.083
	6	11	17	0.647	2	2	4	0.500	1	2	3	0.667
	15	2	17	0.118	4	0	4	0.063	3	0	3	0.083
	15	2	17	0.118	4	0	4	0.063	2	1	3	0.333
	16	0	16	0.016	3	1	4	0.250	3	0	3	0.083
	16	1	17	0.059	3	1	4	0.250	2	1	3	0.333
	14	3	17	0.176	2	2	4	0.500	2	0	2	0.125
	17	0	17	0.015	4	0	4	0.063	2	0	2	0.125
	4	13	17	0.765	4	0	4	0.063	1	2	3	0.667
	13	4	17	0.235	4	0	4	0.063	1	1	2	0.500
	14	3	17	0.176	3	1	4	0.250	2	0	2	0.125
	15	2	17	0.118	4	0	4	0.063	2	0	2	0.125
	12	5	17	0.294	3	1	4	0.250	2	0	2	0.125
	8	9	17	0.529	3	1	4	0.250	1	1	2	0.500
	15	1	16	0.063	3	1	4	0.250	2	0	2	0.125
	16	1	17	0.059	4	0	4	0.063	2	0	2	0.125
	15	2	17	0.118	3	1	4	0.250	2	0	2	0.125
	10	7	17	0.412	2	2	4	0.500	1	2	3	0.667
	17	0	17	0.015	4	0	4	0.063	3	0	3	0.083

	12	5	17	0.294	0	4	4	0.938	1	1	2	0.500
	16	1	17	0.059	4	0	4	0.063	3	0	3	0.083
	10	7	17	0.412	2	2	4	0.500	2	1	3	0.333
	16	1	17	0.059	3	1	4	0.250	3	0	3	0.083
	16	1	17	0.059	4	0	4	0.063	3	0	3	0.083
	4	12	16	0.750	0	4	4	0.938	0	3	3	0.917
	17	0	17	0.015	4	0	4	0.063	3	0	3	0.083
	16	1	17	0.059	4	0	4	0.063	3	0	3	0.083
	12	4	16	0.250	3	1	4	0.250	2	1	3	0.333
	15	2	17	0.118	4	0	4	0.063	3	0	3	0.083
	9	8	17	0.471	3	1	4	0.250	3	0	3	0.083
	2	15	17	0.882	1	3	4	0.750	2	0	2	0.125
	14	3	17	0.176	3	1	4	0.250	2	1	3	0.333
	8	7	15	0.467	3	1	4	0.250	2	0	2	0.125
	16	0	16	0.016	2	2	4	0.500	2	0	2	0.125
	8	8	16	0.500	4	0	4	0.063	3	0	3	0.083
	11	0	11	0.023	4	0	4	0.063	3	0	3	0.083
	11	0	11	0.023	4	0	4	0.063	3	0	3	0.083
	9	1	10	0.100	3	1	4	0.250	2	1	3	0.083
	9	2	11	0.182	4	0	4	0.063	2	1	3	0.333

Table 3. Incidences of cranial nonmetric traits in the sample of ancient populations from Inner Asia (Continued)

	Early Mongolian period-Buryatia				**Bronze-Inner Mongolia**				**Early iron age, Nileke-Xingjian, China**			
	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)
	19	1	20	0.050	18	1	19	0.053	47	1	48	0.021
	17	3	20	0.150	18	1	19	0.053	32	16	48	0.333
	9	11	20	0.550	9	10	19	0.526	12	36	48	0.750
	16	3	19	0.158	18	1	19	0.053	42	6	48	0.125
	18	1	19	0.053	16	0	16	0.016	36	10	46	0.217
	18	1	19	0.053	13	2	15	0.133	44	2	46	0.043
	13	7	20	0.350	12	7	19	0.368	36	8	44	0.182
	20	0	20	0.013	13	6	19	0.316	41	3	44	0.068
	19	1	20	0.050	18	1	19	0.053	44	1	45	0.022
	3	17	20	0.850	4	13	17	0.765	18	28	46	0.609
	18	2	20	0.100	17	2	19	0.105	41	4	45	0.089
	16	4	20	0.200	13	6	19	0.316	35	10	45	0.222
	19	1	20	0.050	19	0	19	0.013	46	0	46	0.005
	18	2	20	0.100	19	0	19	0.013	41	5	46	0.109
	15	5	20	0.250	10	9	19	0.474	20	27	47	0.574
	18	1	19	0.053	17	2	19	0.105	38	5	43	0.116
	20	0	20	0.013	18	1	19	0.053	46	1	47	0.021
	17	3	20	0.150	13	6	19	0.316	39	7	46	0.152
	6	13	19	0.684	12	5	17	0.294	37	10	47	0.213
	18	0	18	0.014	17	0	17	0.015	47	0	47	0.005

	7	10	17	0.588	10	5	15	0.333	19	27	46	0.587
	18	2	20	0.100	17	1	18	0.056	43	2	45	0.044
	14	6	20	0.300	16	3	19	0.158	39	6	45	0.133
	20	0	20	0.013	18	0	18	0.014	45	0	45	0.006
	18	2	20	0.100	17	1	18	0.056	44	1	45	0.022
	3	17	20	0.850	4	13	17	0.765	11	34	45	0.756
	20	0	20	0.013	18	0	18	0.014	42	3	45	0.067
	20	0	20	0.013	18	0	18	0.014	44	1	45	0.022
	12	5	17	0.294	12	2	14	0.143	40	3	43	0.070
	16	1	17	0.059	17	0	17	0.015	42	2	44	0.045
	14	3	17	0.176	12	5	17	0.294	39	7	46	0.152
	2	16	18	0.889	8	10	18	0.556	13	30	43	0.698
	16	3	19	0.158	16	3	19	0.158	35	10	45	0.222
	9	8	17	0.471	8	4	12	0.333	18	21	39	0.538
	15	1	16	0.063	10	2	12	0.167	38	1	39	0.026
	14	4	18	0.222	7	10	17	0.588	26	21	47	0.447
	16	2	18	0.111	13	3	16	0.016	30	14	44	0.318
	17	1	18	0.056	16	0	16	0.016	41	3	44	0.068
	8	10	18	0.556	16	0	16	0.016	43	1	44	0.023
	15	3	18	0.167	16	0	16	0.016	38	6	44	0.136

Table 3. Incidences of cranial nonmetric traits in the sample of ancient populations from Inner Asia (Continued)

	Warring states, Inner Mongolia				**Han, Inner Mongolia**				**Yuan-Inner Mongolia**			
	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)
	45	2	47	0.043	9	0	9	0.028	48	3	51	0.059
	45	2	47	0.043	8	1	9	0.111	46	5	51	0.098
	15	31	46	0.674	6	3	9	0.333	23	28	51	0.549
	41	1	42	0.024	9	0	9	0.028	41	5	46	0.109
	42	3	45	0.067	8	0	8	0.031	44	3	47	0.064
	29	5	34	0.147	7	1	8	0.125	38	6	44	0.136
	42	10	52	0.192	7	2	9	0.222	40	5	45	0.111
	36	10	46	0.217	5	4	9	0.444	42	6	48	0.125
	45	3	48	0.063	9	0	9	0.028	46	1	47	0.021
	8	32	40	0.800	0	8	8	0.969	7	38	45	0.844
	38	13	51	0.255	6	3	9	0.333	34	14	48	0.292
	44	7	51	0.137	8	1	9	0.111	37	9	46	0.196
	43	3	46	0.065	8	1	9	0.111	49	1	50	0.020
	44	4	48	0.083	9	0	9	0.028	46	3	49	0.061
	31	17	48	0.354	3	6	9	0.667	30	19	49	0.388
	31	13	44	0.295	7	2	9	0.222	39	3	42	0.071
	46	3	49	0.061	8	1	9	0.111	48	1	49	0.020
	37	14	51	0.275	5	4	9	0.444	32	16	48	0.333
	25	19	44	0.432	6	2	8	0.250	29	17	46	0.370
	41	1	42	0.024	7	1	8	0.125	44	2	46	0.043

	19	18	37	0.486	3	5	8	0.625	26	14	40	0.350
	42	4	46	0.087	8	0	8	0.031	46	1	47	0.021
	42	6	48	0.125	7	1	8	0.125	41	6	47	0.128
	46	2	48	0.042	7	1	8	0.125	43	3	46	0.065
	44	3	47	0.064	7	1	8	0.125	46	1	47	0.021
	19	26	45	0.578	3	5	8	0.625	24	22	46	0.478
	46	1	47	0.021	9	0	9	0.028	46	1	47	0.021
	47	0	47	0.005	9	0	9	0.028	44	3	47	0.064
	40	4	44	0.091	7	1	8	0.125	33	4	37	0.108
	46	0	46	0.005	8	0	8	0.031	38	14	52	0.269
	37	9	46	0.196	7	1	8	0.125	33	10	43	0.233
	13	32	45	0.711	1	7	8	0.875	10	30	40	0.750
	43	7	50	0.140	9	0	9	0.028	38	4	42	0.095
	13	25	38	0.658	2	6	8	0.750	20	16	36	0.444
	40	0	40	0.006	6	2	8	0.250	37	4	41	0.098
	17	30	47	0.638	1	8	9	0.889	25	16	41	0.390
	40	5	45	0.111	7	1	8	0.125	38	1	39	0.026
	42	4	46	0.087	8	0	8	0.031	39	0	39	0.006
	46	0	46	0.005	8	0	8	0.031	34	6	40	0.150
	41	5	46	0.109	8	0	8	0.031	39	0	39	0.006

Table 3. (Continued)

	Xianbei				Qidan			
	Absent	Present	Total	Freq (p)	Absent	Present	Total	Freq (p)
	94	2	96	0.021	29	0	29	0.009
	84	8	92	0.087	29	0	29	0.009
	17	75	92	0.815	8	21	29	0.724
	74	5	79	0.063	25	2	27	0.074
	80	2	82	0.024	24	5	29	0.172
	54	12	66	0.182	18	3	21	0.143
	78	16	94	0.170	25	1	26	0.038
	64	8	72	0.111	28	1	29	0.034
	83	1	84	0.012	28	0	28	0.009
	18	59	77	0.766	6	21	27	0.778
	71	11	82	0.134	23	5	28	0.179
	79	5	84	0.060	24	3	27	0.111
	90	2	92	0.022	29	0	29	0.009
	81	4	85	0.047	26	3	29	0.103
	52	33	85	0.388	21	6	27	0.222
	52	10	62	0.161	23	3	26	0.115
	80	3	83	0.036	26	1	27	0.037
	62	13	75	0.173	21	6	27	0.222
	27	45	72	0.625	13	10	23	0.435
	68	5	73	0.068	23	0	23	0.011
	25	43	68	0.632	7	13	20	0.650
	64	3	67	0.045	22	1	23	0.043
	68	7	75	0.093	24	2	26	0.077
	75	0	75	0.003	25	1	26	0.038
	75	1	76	0.013	24	2	26	0.077
	15	39	54	0.722	12	9	21	0.429
	72	0	72	0.003	24	1	25	0.040
	73	0	73	0.003	23	2	25	0.080
	49	3	52	0.058	17	3	20	0.150
	65	1	66	0.015	21	0	21	0.012
	58	11	69	0.159	19	4	23	0.174
	9	51	60	0.850	1	22	23	0.957
	63	11	74	0.149	20	5	25	0.200
	27	19	46	0.413	15	3	18	0.167
	46	5	51	0.098	14	1	15	0.067

	59	20	79	0.253	15	9	24	0.375
	76	6	82	0.073	14	1	15	0.067
	77	5	82	0.061	14	1	15	0.067
	64	22	86	0.256	10	5	15	0.333
	69	16	85	0.188	14	2	16	0.125

Another discrete trait observed in all population samples is *Palatine torus*. In nine samples out of examined sixteen, this trait is found for more than 40% of skulls. Several samples showed *paracondylar process* as common trait for the population. The highest percentage is found for Han (0.750), Warring States (0.658) and Nileke (0.538).

The rarest discrete traits found in ancient nomads' samples are *Metopism, Inca bone, medial palatine canal, foramen spinosum absent* and all manibular discrete traits. *Metopic suture* is not observed in Neolithic Baikal, Karakob, Xiongnu and Turkic from Altai Mountain, Han from Inner Mongolia and Qidan population samples. *Inca bone* is not observed in Neolithic Baikal, Afanasev from Altai Mountain, Afanasev from Minusin, Karakob, Xiongnu and Tukic from Altai Mountain, and Early Mongolian period samples from Buryatia. This means that all the populations geographically located in Inner Mongolia and Xingjian reveal this trait. *Medial palatine canal* is also very rare among the studied samples. The trait is noticed in Pazyryk sample from Altai mountain and Han (0.125), Yuan (0.043), and Xianbei (0.068) samples from Inner Mongolia.

Many discrete traits show high variability. These are *supraorbital nerve groove, zygomatico-facial foramen absent, transverse zygomatic suture vestige, tympanic dehiscence, biasterionic suture, foramen spinosum open*.

Results of the study show that wormian bones at different sutures of the skull are distributed with different frequency. The most common wormian bone is at lambdoid suture, as we mentioned above, and asterion. *Sagittal bone, ossicle at lambda, epipteric bone and wormian at squamous suture* are the very rare traits in all the studied samples.

Comparative study of cranial nonmetric traits of archaeological populations from Inner Mongolia, Xinjiang, South Siberia and Buryatia

The comparative analyses were conducted for ***Neolithic, Bronze and Early Iron Age, Xiongnu period*** *and* ***Medieval age and contemporary populations*** separately**.**

<u>Neolithic, Bronze and Early Iron Age.</u>

Frequencies of cranial nonmetric traits of six populations from Mongolia, six populations from South Siberia and Baikal Lake region, one population from Xingjian and two populations from Inner Mongolia are used to calculate the mean measure of divergence (MMD).

Table 4. Matrix of mean measure of divergence (MMD) values for Neolithic, Bronze and Early Iron Age populations from Mongolia, South Siberia, Baikal Lake region and Inner Mongolia

	Neolit-Mongolia	Bronze-West Mongolia	Bronze-East Mongolia	Early iron-Wooden chamber	Early iron-Stone box	Early iron-no coffin	Neolithic Baikal	Afanasev-Altai Mountain	Afanasev-Minusin	Pazyryk-Altai Mountain	Karakob-Altai Mountain	Tagar, Minusin	Bronze-Inner Mongolia	Early iron, Xingjian	Warring states, Inner Mongolia
Neolit-Mongolia		-7.27	-23.38	-4.48	10.02	10.70	-1.87	-7.57	-20.40	-6.81	-14.24	-4.43	-9.59	-0.54	-9.86
Bronze-West Mongolia			-26.22	15.22	16.61	-9.55	-3.06	22.38	-13.45	-3.21	0.41	17.51	16.69	22.70	40.08
Bronze-East Mongolia				-22.01	26.70	21.57	-19.76	-11.97	-28.67	-13.33	-14.76	-11.68	-10.80	-15.81	-13.19
Early iron-Wooden chamber					-3.96	16.84	0.50	3.56	-16.03	24.72	-16.45	25.97	35.65	48.11	113.42
Early iron-stone box						16.08	1.13	-11.23	-20.50	-8.41	-4.61	-1.08	5.47	-6.89	24.94
Early iron-no coffin							-9.11	-7.11	-16.82	-8.57	-9.87	-8.22	-13.84	0.71	1.28
Neolithic Baikal								6.08	-9.67	-0.91	-14.08	5.73	5.43	12.12	11.96
Afanasevo-Altai Mountain									-22.32	20.05	-15.82	3.05	23.92	10.49	51.41
Afanasevo-Minusin										-8.36	-25.04	-10.34	-9.33	-15.12	-3.26
Pazyryk-Altai											-16.17	11.09	17.62	31.03	52.95

Mountain				
Karakob-Altai Mountain	-5.35	-15.69	-13.66	-13.11
Tagar, Minusin		-44.67	-44.09	-46.24
Bronze-Inner Mongolia			30.70	2.28
Early iron, Xingjian				55.12
Warring states, Inner Mongolia				

Multidimensional cluster analyses was applied to the MMD matrix to obtain dendrogram of phylogenetic relationship between populations studied. MMD values for Neolithic, Bronze and Early Iron age populations are given in the Table 5.

Dendrogram of cluster analyses applied to the MMD matrix of cranial nonmetric trait frequencies of ancient nomads is given in the Fig. 3. The multidimensional comparative analyses of cranial nonmetric traits of Neolithic, Bronze and Early Iron age populations from Inner Mongolia, South Siberia and Baikal Lake region reveal three primary clusters.

Within the first cluster there are three subclusters. The first subcluster includes Chandman population with Stone box from Western Mongolia and Tagar population from Kichik kuzur and Malye kopyuny (South Siberia). The next subcluster consists of Chandman population with wooden chamber and Neolithic from Baikal, followed by Afanasev from Altai mountain.

The third subcluster is formed by Neolithic from Mongolia and Nileke population from Xingjian. The first two subclusters form the upper level subcluster and further join to the third subcluster.

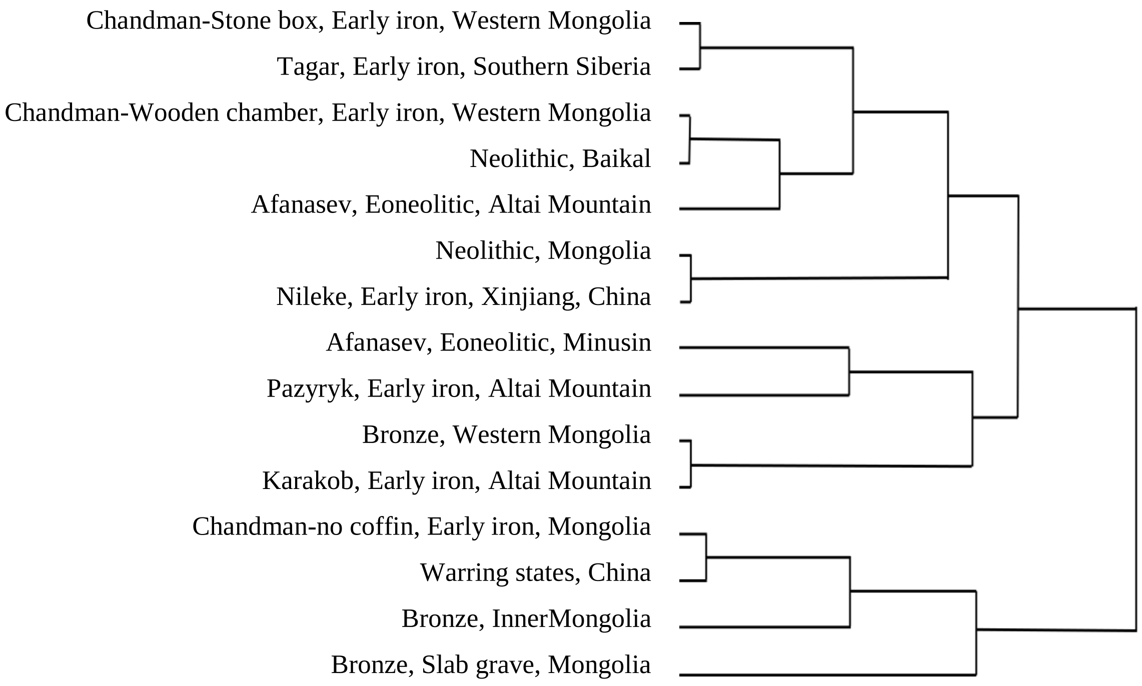

Fig. 2. *Dendrogram of relationship of Neolithic, Bronze and Early Iron Age populations from inner Mongolia, South Siberia, Buryatia, Baikal Lake region and Mongolia*

The second cluster is separated into two subclusters. The first subcluster is formed by Afanasev population from Minusin basin and Pazyryk from Altai Mountain. The other subcluster includes Bronze Age samples from Western Mongolia and Karakob culture from Altai mountain. Cluster analyses reveal a subcluster in the third cluster. Chandman population with no coffin from western Mongolia shows some affinities to the Warring

States population from Inner Mongolia. This subcluster further joins Bronze Age population from Inner Mongolia. Slab grave culture population from Eastern Mongolia from Bronze Age then joins to this subcluster.

Xiongnu period.

MMD values of five populations from Xiongnu and Turkic period of Mongolia, Inner Mongolia and South Siberia are given in the Table applied to cluster analyses.

Table 4. Matrix of mean measure of divergence (MMD) values for Xiongnu, Han, Xianbei and ancient Turkic populations from Mongolia, South Siberia and Inner Mongolia (China)

	Xiongnu, Mongolia	Xiongnu-Altai mountain	Turkic-Altai mountain	Han, Inner Mongolia	Xianbei, Inner Mongolia
Xiongnu, Mongolia		10.02	5.76	7.32	11.77
Xiongnu, Altai mountain			4.13	3.59	4.21
Turkic,Altai Mountain				2.70	-1.15
Han, Inner Mongolia					4.08
Xianbei, Inner Mongolia					

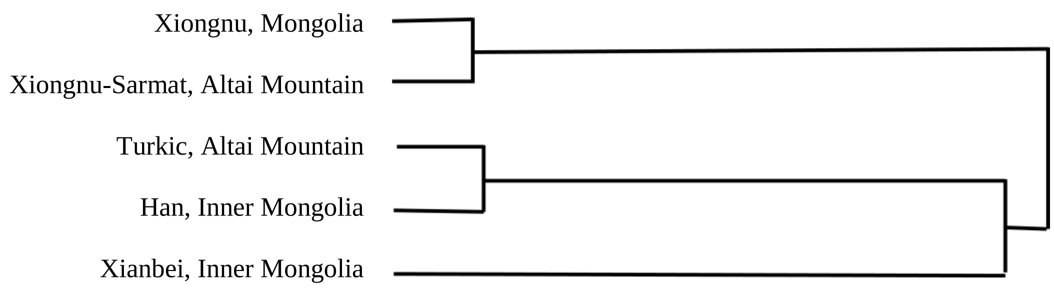

Fig. 3. *Dendrogram of relationship of Xiongnu period populations from Inner Mongolia, South Siberia, Baikal Lake region and Mongolia*

The dendrogram of cluster analyses show two subclusters. The first subcluster consists of Xiongnu from Mongolia and Xiongnu from Altai. These two populations are separated from the rest of the populations and formed an independent subcluster. The other subcluster consists of Turkic population from Altai and Han population from Inner Mongolia. The Xianbei population from Inner Mongolia is joined to this subcluster and forms the upper level subcluster. Multidimensional analyses show somewhat similar biological features of the Xiongnu from Mongolia and Xiongnu-Sarmats from Altai from one hand and Turcik people from Altai and Han people from Inner Mongolia from the other hand. Meanwhile the Xianbei was found quite different among the populations compared.

Medieval age and contemporary populations.

Results of the multidimensional cluster analyses show two separate clusters. The first cluster is further divided into two subclusters. The first subcluster consists of Yuan sample from Inner Mongolia, modern Amur population and modern Koreans. The second subcluster is formed by Early Mongolian population from Buryatia and Qidan population from Inner Mongolia. These two subclusters form a separate subcluster.

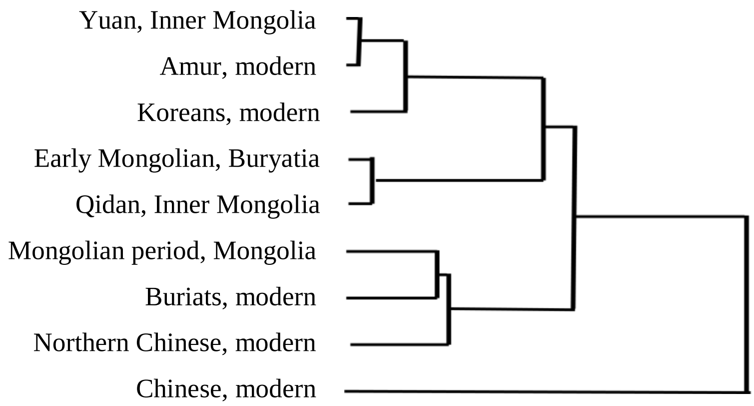

Fig. 4. *Dendrogram of relationship of medieval age and contemporary populations from Inner Mongolia, South Siberia, Buryatia and Mongolia*

The second cluster consists of a subcluster formed by Mongolian period population from Mongolia and modern Buryats, and Northern Chinese joined to this subcluster. Modern Chinese sample is found the most remoted in regard of biological affinities among the studied populations of the medieval and modern period.

Comparative study of cranial nonmetric traits of ancient and modern populations from Inner Mongolia, Xingjian, South Siberia, Baikal Lake region, Buryatia, Mongolia and Northeast Asia reveal some distinct features of these populations. Results of the study show general differentiation between populations from eastern Mongolia and Inner Mongolia on the one hand, and populations from Xingjian, Altai, South Siberia, Buryatia and western Mongolia on the other hand.

A separate cluster consisting of "Eastern" populations from Bronze and Early Iron Ages, at the same time, include the Chandman population (with no coffin) from western Mongolia. This might show us a probable genetical link of that Chandman population with the nomads from eastern Mongolia or other regions in Inner Mongolia. It is interesting to note, that inspite of the position in the same cluster, the slab grave population from Eastern Mongolia was found rather distinct from the other populations in the cluster: Bronze Age and Warring States populations from Inner Mongolia.

Table 5. Matrix of mean measure of divergence (MMD) values for medieval age and modern populations from Mongolia, Buryatia, Inner Mongolia and China

	Mongolian period, Mongolia	Early Mongolia, Buryatia	Qidan, Inner Mongolia	Yuan, Inner Mongolia	Buryats, modern	Amur, modern	Koreans, modern	Northern Chinese modern	Chinese, modern
Mongolian period, Mongolia		-2.771	-1.555	-2.362	-1.854	-2.018	-2.356	-1.939	-2.350
Early Mongolia, Buryatia			-0.367	-1.334	-0.990	-0.828	-1.937	-0.782	-1.802
Qidan, Inner Mongolia				4.864	6.760	-0.540	9.237	8.213	22.041
Yuan, Inner Mongolia					5.556	-0.086	1.837	5.537	8.633
Buryats, modern						-1.810	6.314	-1.996	4.550
Amur, modern							0.181	-1.708	1.655
Koreans, modern								7.941	11.126
Northern Chinese, modern									6.657
Chinese, modern									

Cluster analyses show us a picture of very heterogeneous population structure of inhabitants from Southern Siberia, Altai and Western Mongolia during Eoneolithic, Bronze and Early Iron Ages. Afanasev population from Altai is found to a certain extent different from Afanasev from South Siberia; and Pazyryks – very different from Karakobs, and even more different from Tagars. At the same time we can see very close biological affinities: between Chandman (with stone box, Early Iron Age, western Mongolia) and Tagar (Early Iron Age, Southern Siberia); between Chandman (with wooden chamber, Early Iron Age, western Mongolia) and Neolithic Baikal; between Bronze Age populations from western Mongolia and Karakobs from Altai; and, between Neolithic population from central Mongolia and Nileke (Early Iron Age, Xingjian). Close relationship between Neolithic population from central Mongolia and Early Iron Age population from Xingjian; and between Neolithic Baikal, Chandman (with wooden chamber) from western Mongolia, and Afanasev from Altai Mountain may show us their genetical affinities and lead to conclude about biological continuity of those archaeological populations. In other words, results of the study show that Neolithic population from Baikal and central Mongolia played a noticable role in the genetic structure of Chandman (wooden chamber) from western Mongolia and Nileke from Xingjian populations respectively.

Cluster analyses of 2nd BC to 8th AD period samples revealed very close characteristics for Xiongnu populations from Altai and Mongolia, and some similarity between Turkic from Altai and Han from Inner Mongolia. Biological relationship of ancient Turkics from Altai to eastern populations was also observed in the craniofacial morphology study by D.V.Pozdnyakov (2001), where he found some cranial morphology similarities in Turkic from Altai and Xiongnu population from Trans-Baikalia.

Comparative analysis of medieval period and contemporary populations from Baikalia, Buryatia, Mongolia, Inner Mongolia and Northeast Asia show more or less compact picture. Nevertheless, we can observe some tendencies in their biological affinities. Early Mongolians from Buryatia and Qidan from Inner Mongolia are closer to each other and Yuan population from Inner Mongolia and Amur and Korean contemporary populations are closer to each other. On the other hand Mongolian period populations from Mongolia and modern Buryats are very close to each other, and to some extent close to Northern Chinese. Modern Chinese are found very different from the other populations studied.

Based on the results of the comparative cranial nonmerric study of ancient and contemporary populations from Inner Asia, it can be concluded that since the Neolithic time population migration to west had being taken place in the territory of Mongolia, which continued during Bronze and Early Iron Ages and lasted up to medieval period. Unfortunately, the present material does not let us to discuss about the relationship of Mongolian period populations from South Siberia, Altai, Xingjian and western Mongolia, and it requires further investigation including broader both in time and space materials.

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ХУРААНГУЙ

М.Эрдэнэ

ДОТООД АЗИЙН ЭРТНИЙ ХҮН АМЫН ГАВЛЫН ХЭМЖИЛТИЙН БУС ШИНЖҮҮДИЙН ХАРЬЦУУЛСАН СУДАЛГАА

Уг өгүүлэлд Өвөр Монгол, Шинжаан, Өмнөд Сибирь, Алтай, Байгал нуур болон Буриадын нутгаас олдсон неолит, хүрэл, төмөр, хүннү, түрэг, кидан, монголын үеийн эртний хүний гавлын ясны хэмжилтийн бус шинжүүдийн харьцуулсан судалгааны үр дүнг толилуулж байна. Олон хэмжээст статистикийн судалгаагаар Хятадын Байлдаант улс, Өвөр Монголын хүрлийн үе, Дорнод Монголын дөрвөлжин булшийн соёлт хүн ам болон Баруун Монголын Чандманий авсгүй оршуулгын олдворууд нэг кластер болж байгаа ба харин Шинжаан, Алтай, Өмнөд Сибирь, баруун Монголын эртний хүний олдворууд маш их хувьсахуйтай, хэд хэдэн кластер үүсгэж байв. Судалгааны дүнгээс харахад одоогийн Монгол, баруун Монголын нутаг дэвсгэр дээр неолитийн үеэс эхлэн баруун зүг чиглэсэн миграц эхэлсэн бөгөөд энэ шилжилт хөдөлгөөн хүрэл, төмрийн түрүү үед улам олон овог аймгийг хамран явагдаж дундад зууныг хүртэл үргэлжилсэн байна.