

Metric Study of the Crania from Protohistoric Sites in Eastern Japan

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Abstract One hundred crania from Protohistoric burial sites in the Kantō district and the southern part of the Tōhoku district were measured. By comparing with six modern and seven earlier series from East and Northeast Asia, the eastern Japanese Protohistoric cranial series was found to be very close to the prehistoric Yayoi series from western Japan and considerably remote from the Jōmon series from eastern Japan. Among the pre- and proto-historic series from Asiatic mainland, the protohistoric Anyang series was disclosed as the closest to the cluster of the Yayoi and the Protohistoric series of Japan.

Comparative studies on the cranial measurements of the human remains from Protohistoric burial sites of mound type (*kofun*) or of cave type (*ōketsubo*) have already been carried out by Jō (1938) and SUZUKI (1969), after the traditional method of craniometry as defined by MARTIN (1928). The materials measured by Jō were derived from sites in western Japan, while those measured by SUZUKI were from the Kantō district in eastern Japan.

Both authors concluded that the Protohistoric crania were intermediate in metric characters between the prehistoric Jōmon and the modern Japanese crania. The present author also conducted a metric study on a series of Protohistoric crania from various sites in eastern Japan and arrived at a similar conclusion, i.e. craniometrically the Protohistoric series was situated just halfway between the Jōmon and the modern series, though there was a slight difference between the materials from western and eastern Japan, as pointed out previously by MORISAWA (1976), and those from eastern Japan were a little closer to the Jōmon, with broader facial skeleton (YAMAGUCHI, 1985 a).

On the other hand, a comparative analysis on the facial flatness measurements carried out recently by the present author has shown that the Protohistoric crania are far distant from the Jōmon crania, relatively closer to the modern Japanese crania, and closest to the Neolithic crania from North China (YAMAGUCHI, in press). The purposes of this article are first to publish a new craniometric table based on materials including some recent acquisitions, and secondly to carry out a comprehensive distance analysis on the craniometric data including the facial flatness measurements.

Materials and Methods

One hundred (58 male and 42 female) adult crania from Protohistoric burial sites, dating from the 4th to 8th centuries, in the Kantō district and the southern part of the Tōhoku district were measured according to the definitions given by MARTIN (1928) and YAMAGUCHI (1973). All the materials are kept either in the National Science Museum, Tokyo or in the University Museum, the University of Tokyo.

In measuring the facial length (no. 40) and the upper facial height (no. 48), two different prosthions were used in accordance to the following definitions given by MARTIN (1928). "Prosthion=derjenige Punkt am Alveolarrand des Oberkiefers, der in der Mediansagittal-Ebene zwischen den mittleren Schneidezähnen am meisten nach vorn vorragt. Das Prosthion liegt also nicht an dem unteren Ende des zwischen die Schneidezähne vorgeschobenen Knochenteiles, sondern an der am meisten nach vorn vorstehenden Stelle seiner Vorderwand. Nur für die Messung der Obergesichtshöhe (Maß Nr. 48) ist der Meßpunkt an die Spitze des genannten Fortsatzes zu legen."

Definitions of the facial flatness measurements are as follows (WOO & MORANT, 1934; YAMAGUCHI, 1973). Frontal chord=the chord between the frontomalaria orbitalia (*fmo*), i.e. MARTIN's no. 43(1). Frontal subtense=the subtense from the nasion to the frontal chord. Simotic chord=the minimum horizontal breadth of the two nasal bones; i.e. MARTIN's no. 57. Simotic subtense=the minimum subtense from the median ridge of the nasal bones to the simotic chord. Zygomaxillary chord=the chord between the zygomaxillaria anteriora (*zma*), the points where the zygomaxillary sutures cross the upper margins of the attachment areas of the masseter muscles. Zygomaxillary subtense=the subtense from the subspinale (*ss*) to the zygomaxillary chord.

Results of Measurements

The means and the standard deviations of the measurements and indices are given in Table 1.

The vault is mesocranial, ortho-/hypsi-cranial, metriocranial, and metriometopic in average length-breadth, length-height, breadth-height, and transversal frontoparietal indices. The facial skeleton is mesenic, chamaeprosopic, mesokonchic, and platyrrhine in average KOLLMANN's upper facial, VIRCHOW's upper facial, orbital, and nasal indices, and extremely flat in transverse direction.

PENROSE's Shape Distances

Shape components of PENROSE's distances (CONSTANDSE-WESTERMANN, 1972) between 14 cranial series from East and Northeast Asia were calculated on the basis of 16 measurements of male samples (Table 2). Measurements were standardized by respective standard deviations of the modern Japanese series from the Kantō district (MITSUHASHI, 1958; YAMAGUCHI, 1973). Results are shown in Table 3.

The Protohistoric eastern Japanese series is extremely close to the prehistoric

Table 1. Measurements and indices of the crania from Protohistoric sites in eastern Japan.

	Males			Females		
	n	$\bar{x}$	s	n	$\bar{x}$	s
1. Glabello-occipital length (L)	41	182.6	5.76	27	174.9	4.87
5. Basion-nasion length (LB)	25	101.6	4.49	22	97.2	3.96
8. Maximum breadth (B)	28	143.1	5.32	21	138.3	5.09
8: 1	24	78.7	3.39	15	78.8	4.11
9. Minimum frontal breadth (B')	35	94.5	4.10	22	91.5	4.19
9: 8	17	66.1	3.62	13	66.5	2.81
17. Basion-bregma height (H')	30	136.6	5.15	26	131.3	3.50
17: 1	27	75.3	3.31	20	74.9	2.68
17: 8	20	96.1	4.15	15	95.6	5.06
40. Basion-prosthion length	13	100.1	3.09	11	94.9	4.25
40: 5	12	97.5	3.78	11	99.1	3.45
45. Bizygomatic breadth (J)	16	141.6	3.97	9	(131.8)*	5.61
46. Mid-facial breadth (GB)	16	102.4	4.91	8	97.3	4.80
48. Upper facial height (G'H)	22	71.0	3.14	16	66.7	3.68
48: 45	13	50.7	1.83	5	(52.3)*	3.36
48: 46	12	69.2	2.16	7	69.4	3.41
51. Orbital breadth (O ₁)	32	42.9	1.91	24	41.2	1.29
52. Orbital height (O ₂)	33	34.3	1.94	22	33.6	1.47
52: 51	32	80.3	4.62	22	81.7	3.87
54. Nasal breadth (NB)	30	27.1	1.55	18	26.6	1.04
55. Nasal height (NH')	29	51.4	2.58	17	48.3	2.17
54: 55	27	53.2	4.46	16	55.1	3.34
Frontal chord (FC)	20	98.8	3.47	12	93.7	3.86
Frontal subtense (FS)	20	15.2	2.08	12	13.2	1.73
FS: FC	20	15.4	2.07	12	14.1	1.81
Simotic chord (SC)	37	7.4	1.75	27	8.1	1.25
Simotic subtense (SS)	37	2.3	0.89	27	1.8	0.80
SS: SC	37	31.2	9.07	27	22.0	9.18
Zygomaxillary chord (ZMC)	14	100.9	5.47	6	95.0	5.68
Zygomaxillary subtense (ZMS)	14	20.3	3.42	6	19.7	2.38
ZMS:ZMC	14	20.1	3.19	6	20.8	3.28

* Most of the bizygomatic breadth in the females were estimated by doubling half measurement from the midline.

Yayoi series from Doigahama site in Yamaguchi Prefecture. Next closest are the modern Japanese series and the protohistoric Chinese series from Anyang. The distance to the prehistoric Jōmon series is definitely greater than those to the modern Japanese series. The Jōmon series is the most divergent, and the Ainu series is situated between the isolated Jōmon and the cluster of the rest of the series.

Fig. 1 is a two-dimensional approximation of the distance relationship between the six cranial series from Japan. The cluster of the Yayoi and Protohistoric series is closer to the modern Japanese than to the Jōmon and the Ainu.

Table 2. Means of 16 measurements in 14 series of male skulls subjected to PENROSE's distance analyses.

	E. Japan ¹⁾	Yayoi, Doi, gahama ²⁾	Protohist., E. Japan ³⁾	Modern, Kantō ⁴⁾	Modern ⁵⁾ Kyushū	Modern ⁶⁾ Ainu	Neolith., N. China ⁷⁾	Shang, Anyang ⁸⁾	Modern, ⁹⁾ N. China	Neolith., Baikal ¹⁰⁾	Medieval, Trans-Baikal ¹¹⁾	Mokhe, Troiiskoe ¹²⁾	Modern ¹³⁾ Mongol	Modern ¹⁴⁾ Thai	S.D. ⁴⁾
1. L	183.0	182.8	182.6	181.7	181.4	185.9	180.5	181.6	180.8	189.7	179.7	181.6	182.5	173.3	5.28
5. LB	103.8	101.7	101.6	103.1	102.3	105.4	104.4	101.6	101.3	104.1	97.8	101.9	100.6	99.4	4.18
8. B	143.0	142.6	143.1	142.0	139.3	141.3	143.6	141.6	139.7	144.5	148.9	144.5	149.1	144.3	5.59
9. B'	96.9	96.0	94.5	95.4	93.8	96.2	92.9	91.8	90.8	94.4	92.8	90.5	94.4	92.4	4.73
17. H'	140.9	134.7	136.6	139.1	139.3	138.1	143.3	138.8	139.2	132.4	127.5	134.5	132.3	136.6	4.58
40. (GL')	99.9	99.9	100.1	100.4	97.8	105.0	100.7	98.0	95.8	104.0	96.4	95.1	97.4	96.7	6.22
45. J	143.1	139.4	141.6	136.2	134.5	137.3	139.0	136.2	134.3	141.3	140.2	139.7	142.1	133.6	5.07
48. G'H	66.1	72.4	71.0	72.5	71.8	69.7	74.7	72.4	76.2	74.9	75.7	73.7	77.2	69.9	4.18
51. O ₁	43.5	42.7	42.9	42.2	43.0	43.6	43.5	41.3	42.6	42.2	43.1	43.3	43.6	42.5	1.90
52. O ₂	33.4	34.2	34.3	34.5	34.4	34.3	34.4	33.0	35.6	33.9	35.4	34.2	35.8	33.7	2.03
54. NB	27.8	27.1	27.1	25.9	26.0	25.7	27.4	27.0	25.7	25.9	26.3	27.0	27.4	26.6	1.91
55. NH'	50.0	53.1	51.4	52.3	52.2	50.5	54.2	52.8	55.1	55.0	55.2	54.9	56.3	52.5	3.10
43-1. FC	99.6	100.9	98.8	97.8	96.2	99.5	99.4	96.9	95.6	99.8	99.3	98.9	99.2	97.2	4.29
FS	16.4	15.6	15.2	16.3	14.7	16.9	15.0*	14.4	14.5	15.4*	13.6	11.8	14.9	16.2	2.08
57. SC	10.2	8.4	7.4	7.2	7.2	8.7	7.7	7.7	7.6	8.0	6.8	6.7	7.1	8.3	1.91
SS	4.6	2.3	2.3	2.7	2.5	3.7	2.3	2.2	2.7	3.3	2.8	2.1	3.0	3.0	0.97

* Calculated from the mean angle.

1) DODO, 1986; YAMAGUCHI, 1980. 2) KANASEKI, *et al.*, 1960; DOI & TANAKA, 1987. 3) Present study. 4) MITSUHASHI, 1958; YAMAGUCHI, 1973. 5) HARADA, 1954; DOI & TANAKA, 1987. 6) KOGANEI, 1983; YAMAGUCHI, 1973. 7) YEN, 1972; YEN, 1973; YEN, *et al.*, 1960. 8) Inst. of History, and Inst. of Archaeol., CASS, 1985. 9) SHIMA, 1955/56; ONISHI, 1941; CHEBOKSAROV, 1982. 10) DEBETS, 1951. 11) MAMONOVA, 1961. 12) ALEKSEEV, 1980. 13) SHIMA, 1955/56. 14) SHIMA, 1942.

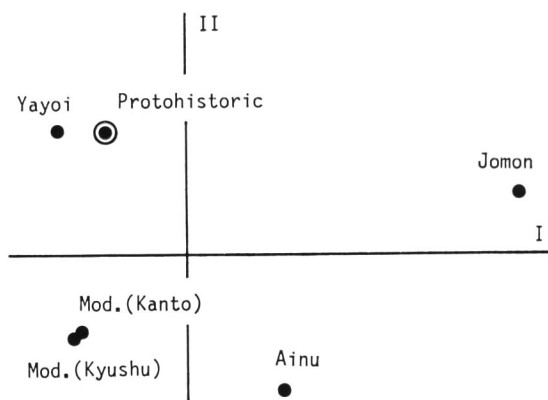


Fig. 1. Two-dimensional representation of the shape distances between six cranial series from Japan by means of a principal coordinates analysis.

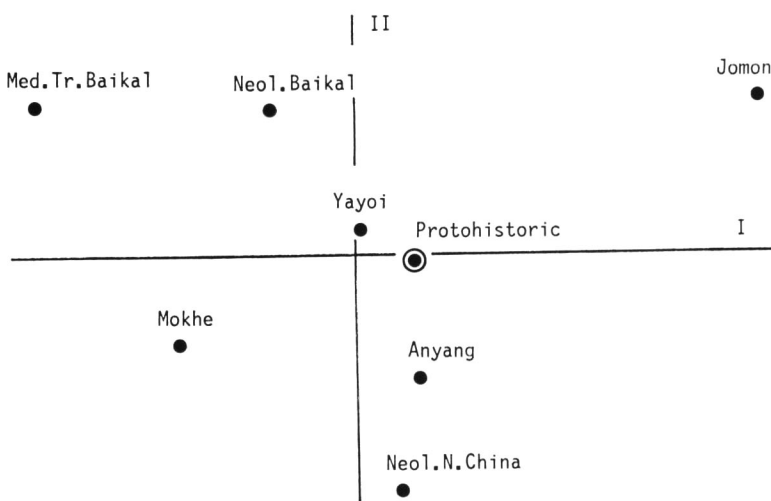


Fig. 2. Two-dimensional representation of the shape distances between eight pre- and proto-historic cranial series from East and Northeast Asia by means of a principal coordinates analysis

Fig. 2 shows the approximate distance relationship between the eight pre- and proto-historic series from East and Northeast Asia. The closest to the cluster of the Yayoi and Protohistoric series of Japan is the protohistoric series from Anyang in North China. Although close resemblances were disclosed between the Yayoi or Protohistoric series of Japan and various modern and prehistoric series from North or Northeast Asia by HANIHARA (1985) and MIZOGUCHI (in press) through their analyses of Q-mode correlation coefficients or MAHALANOBIS' distances based on rather limited number of cranial measurements, only a moderately close distance has been found,

in this study, between the cluster of the Yayoi-Protohistoric series of Japan and the Neolithic/Aeneolithic series from the Baikal districts, and no resemblance in particular has been recognized between the Japanese Protohistoric series and nearly contemporaneous series from Transbaikalia and the Amur basin (Troitskoe).

Discussion

The closeness revealed between the Protohistoric series from eastern Japan and the Yayoi series from Doigahama in cranial measurements corroborates the similar results obtained for measurements of the lower limb long bones (YAMAGUCHI, 1986) and for incidence pattern of some non-metric cranial traits (DODO, 1987). It is thus highly probable that a population which is considerably different morphologically from the indigenous Jōmon people, as represented by the Doigahama series in the early Yayoi period, has spread into the eastern part of Honshu by around the 8th century.

If the Yayoi series from several sites in western Japan, including Doigahama site, were largely composed of Mongoloid immigrants from the Asiatic mainland (probably the Korean Peninsula) and their descendants, as advocated first by KANASEKI (1976) and supported later by BRACE & NAGAI (1982), HANIHARA (1985), NAKAHASHI, DOI, & NAGAI (1985), DODO (1987), and others, the result of the present study as well as those of YAMAGUCHI (1986) and DODO (1987) vigorously confirm the tentative conclusion, drawn from the analysis of nonmetric cranial variants, that the post-Jōmon process of mongoloidization of the Japanese population had been well advanced during the Kofun period even in eastern Japan (YAMAGUCHI, 1985 b).

In this connection, it should still be kept in mind that the skeletal remains excavated from burial mounds and cave-type tombs may not be an unbiased sample of the entire population in Protohistoric Japan. In order to evaluate the extent of representativeness of the present materials, it may be necessary to appeal to some archaeological way or other.

Recently a stimulative attempt to estimate the scale of the immigration during the Yayoi and Kofun periods from mainland has been published. Based on the estimates of the population size of Japan in pre- and proto-historic times given by KOYAMA (1979), viz. approx. 77,000 in the final Jōmon phase and approx. 5,400,000 in the end of the Kofun period, and also assuming the average annual population growth rate to have been 0.2 percent during the 1000 years from the beginning of the Yayoi period to the end of the Kofun period, HANIHARA (1987) has reached a tentative conclusion that the number of the immigrants was about one and a half millions in total, or about 1,500 per year.

The average growth rate, however, could have been somewhat higher than 0.2 percent, since the agricultural settlers could push the frontier from Kyūshū to the east, exploiting the land much more intensively than the native hunter-fisher-gatherers. If the growth rate had been, for example, 0.5 percent, as known for colonizing peoples

during the age of Colonialism (POLGAR, 1972), only 181 immigrants per year would have been sufficient to account for the population increase through the Yayoi and the Kofun periods. The crucial problem that remains to be solved in reconstructing the population history of Japan during the said periods seems to be how to attain valid estimation of the differential growth rates of the native and the immigrant populations.

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