Relationship of Chinese Tungusic ethnic minorities with Okhotsk cultural people in regard to dental metric traits

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Abstract

We used crown measurements to analyze the anthropological characteristics of three Tungusic tribes, Ewenki, Hezhen, and Oroqen, residing in the Amur River basin of China. Previous findings suggest that Amur River basin populations were involved in the population structure of Tungusic people. We then compared our findings with those of individuals with a north Asian ethnic background to examine the distribution of those characteristics in north Asian Mongoloids (1). The total crown area was classified as Sinodont (2). A deviation diagram showed scant differences among Hezhen, Oroqen, and Okhotsk individuals, indicating the closeness of those populations (3). Q-mode correlation coefficients and 2-dimensional expression suggested that Tungusic individuals were the Central Asia type. Hezhen and Oroqen were plotted closer to Okhotsk cultural people, and closely related. Race mixture occurred among the Baikal, then spread from Lake Baikal and Central Asia from the south in the post-Neolithic Era, and the groups gradually diffused to the lower Amur region. Therefore, it is reasonable to conclude that a different degree of miscegenation occurred between the Baikal and Central Asian regions in the area from Lake Baikal to lower Amur in accordance with the geographical features.

Keywords: Tungusic; Hezhen; Evenki; Oroqen; crown measurements

Introduction

The Chinese population consists of 55 officially recognized ethnic minorities, while the Han Chinese majority accounts for approximately 92% of the population. According to the 6th population census of China (1), the total population in 2010 was approximately 1.37 billion, of which the 55 ethnic minorities account for approximately 113 million and the Han Chinese approximately 1.225 billion. These minority groups are extensively distributed throughout China in 19 provinces and autonomous regions occupying 63.7% of the total area of China and formed by a wide variety of people.

Although there have been many biometric and anthropological studies of Chinese ethnic minorities performed, only a few have reported regarding metric or non-metric crown traits. Here, we analyzed anthropological characteristics of the Tungusic ethnic minority of northern China, which is formed by the Manchu, Xibe, Ewenki, Oroqen, and Hezhen people, by analyzing crown measurements. Samples were obtained from the 3 smallest ethnic populations, the Hezhen, Oroqen, and Ewenki, which had populations of 4640, 8196, and 30,505 reported in 2000. These ethnic groups were originally mainly engaged in hunting in the vast area from the Baikal region in Siberia to the Amur River basin and Xinganling mountains, Figure 1 (2). The Hezhen are traditionally fisher-gatherers living in the Amur River (Heilongjiang), Ussuri River, and Songhua River basin regions and their name indicates the lower reaches of a river, while the Ewenki traditionally hunt reindeer as a nomadic people and their name has the sense of people who live in a large forest (2). Because of the closed nature of the Xinganling Mountains area, they are assumed to have had little chance to be genetically related to other ethnic groups, making them an appropriate group to sample for our research. Several studies of Tungusic minorities have been performed for somatology features (3) and Haptoglobin genotypes (4), while the only research of dental features was in regard to the incidence of shovel-shaped incisors. Other studies regarding cranial morphology and mitochondrial DNA haplotypes suggest that the people of the lower Amur region are related to the origin of the Okhotsk people (5-8).

In the present study, we evaluated the relationship between these three Tungusic minorities and the Okhotsk people in terms of dental features. In addition, we discuss Mongoloid distribution in Northern Asia by using comparisons among the ethnic groups in that area.

Materials and Methods

Based on a previous method of research of the Oroqen (9), we used plaster casts of permanent dentition of Ewenki and Hezhen samples kept by the Head and Neck Anatomy Division of Kyushu Dental College. The casts were made using dental impressions of samples obtained from 79 males of the Ewenki tribe and 79 males of the Hezhen tribe, all of whom were junior high school students aged 12-16 years, and chosen for the low degrees of attrition and abrasion. Measurements of mesiodistal (MD) and buccolingual (BL) crown diameters of the teeth in the right maxillary and mandibular arches, except for the third molars, were made according to Fujita’s system (10) using digital point slide calipers (Mitsutoyo Co. Ltd) with an accuracy of 0.01 mm. Any teeth with obvious dental abnormalities, such as excessive wear, caries, impression flaws, partial eruption, or fillings obstructing the proper placement of the caliper beaks, were excluded. Data from the right side have been customarily used in anthropological studies. For this study, measurements of excluded teeth on the right side were replaced by values of the corresponding teeth on the left.

Tooth size measurements obtained for the Ewenki and Hezhen were compared to data obtained from males of the Oroqen (9) and 13 Northeast Asian ethnic groups (Table 1), including Modern Japanese, Hokkaido Ainu (11), Urga Mongolians, Aleutian Islanders (12), Sakhalin Ainu, Nanay, Negidal, Ulch, Buriats, Arctic Siberians (13), Jomon/Hokkaido/Tohoku, Epi-Jomon/Satsumon, and Okhotsk culture (14) people. All comparisons were made using data from males, as female samples were not available in other studies of ethnic groups.

1) Total crown area

The crown area, calculated by multiplication of the mesiodistal and buccolingual diameters, is a quantified outline of the crown from the occlusal view and used as an index to estimate crown size (15). To compare the crown dimensions among the Tungusic groups (Hezhen, Oroqen, Ewenki) and 13 ethnic groups, the gross crown areas were calculated by summing the products of the mesiodistal and buccolingual dimensions of each tooth from the right upper and lower central incisors to second molars.

2) Deviation diagram

A deviation diagram can be obtained standardizing measurement values and is useful to compare relative magnitudes between groups. Measurements of incisor (I), canine (C), premolar (P), and molar (M) (where M is the sum of M1 and M2) teeth in the upper and lower jaws were performed. The average values for individual teeth were calculated from the crown sizes of the three Tungusic groups and 13 Northeast Asian groups, then each measurement unit was standardized. Also, the Tungusic groups and four Far Eastern groups; Modern Japanese, Hokkaido Ainu, Jomon/Hokkaido/Tohoku, and Okhotsk culture people, which are related to the Okhotsk culture, were selected and the results are shown. In order to evaluate the exact deviation of the Tungusic groups and four Far Eastern groups in Northeast Asia, the grand mean of all 16 populations was used, not only the mean of those 7. From those measurements, a standard deviation diagram showing relative size variations among the Far Eastern groups in Northeast Asia was produced.

3) Q-mode correlation coefficient

Shape elements were extracted from multivariate crown measurement values to calculate the degree of similarity using Q-mode correlation coefficient (16). Using the average values of individual teeth, similarity matrixes among the groups were computed, then converted into a matrix of dissimilarity. The groups were then classified by cluster analysis using Ward's method to create a dendrogram. Since many of the groups were distributed in dimensional space, multidimensional scaling (MDS) (17) was performed with the dissimilarity matrix to reduce the dimension, then a scatter plot was created for visualization of similarities among the groups.

Results

Table 2 shows values for sample size, average value, and standard deviation, based on data obtained from the three Tungusic groups and 13 Northeast Asian groups.

1) Total crown area

Figure 2 presents the total crown areas of the Tungusic and surrounding Northeast Asian groups. The northernmost groups showed larger values, while groups with Jomon characteristics, such as Hokkaido Ainu, showed smaller values. The three Tungusic groups were positioned above the Jomon and each followed the Aleutian Islanders in the Northernmost group.

2) Deviation diagram

Figures 3 and 4 show the relative size differences among the three Tungusic and 4 Far Eastern groups. The Tungusic groups showed larger values than the average of Northeast Asians for nearly all measurement units except MD diameter of LM. The MD diameters of the Oroqen were large for upper and lower I and P, and upper M, while smaller for lower M, which was similar the proportions of the Okhotsk culture. BL diameters of the Hezhen and Oroqen were large in upper and lower P, and lower I, which were also similar to the Okhotsk. Thus, the proportions of the three Tungusic groups were similar to those of the Okhotsk culture, though the overall sizes were different.

3) Q-mode correlation coefficient

Similarity matrixes for all measured values among the groups were calculated. Using cluster analysis with Ward's method, the groups were classified to form a dendrogram, Figure 5. The dendrogram displayed 2 main clusters, which split further into 3 clusters at a height of approximately 3. Two- (Figure 6) and 3-dimensional MDS plots (Figure 7) were then formed with the dissimilarity matrixes. The 2-dimensional plots showed two large clusters in the cluster analysis, while the Epi-Jomon/Satsumon and Okhotsk culture points were distant from the two clusters. In the 3-dimensional plots with decreased data compression, the Hokkaido Ainu, Sakhalin Ainu, Jomon//Hokkaido/Tohoku, and Okhotsk cultures were distant from the other groups when the linear least-squares method was applied. The contribution ratio of each axis was 47.9%, 23.0%, and 10.5%, respectively.

Discussion

As for the gross crown area, the three Tungusic groups were positioned above Jomon, with each following the Aleutian Islanders in the Northernmost group. In a study of the morphological features of several ethnic groups, Turner divided the characteristics of Mongoloid dentition into 2 groups; Sinodont (Chinese-ype dental profile) and Sundadont (Sunda-type dental profile). Sinodont dentition displays complicated morphological features with large teeth, while the Sundadont pattern has simple features with small teeth (18–21). In the present study, the Tungusic groups were classified as Sinodont based on their crown size. Li Yong-lan, et al., reported that shovel-shaped incisors appeared at a ratio of 85.71% (n=126) in males and 88.57% (n=155) in females of the Ewenki, and 100% (n=40) in males and 98.33% (n=59) in females of the Oroqen (3). The shovel incisor is considered to be a characteristic feature of the Sinodont pattern. Morphological traits including high frequency of shovel incisors also classify Ewenki and Oroqen into the Sinodont group.

The deviation diagram of MD diameters (Figure 3) showed that the Hezhen proportion was small for UI, LI, and LM, the Ewenki proportion was small for UI, UP, UM, LC, LP, and LM, and the Oroqen proportion was small for UC, LC, and LM. Although their overall MD diameters were above the standard average of the Northeast Asian groups, their LM dimension was particularly smaller than the average. The Hezhen and Ewenki proportion with a small UI was opposite that of Oroqen, while the Okhotsk culture and Oroqen groups showed similar results in regard to proportion and size of teeth. Furthermore, the proportions observed in the deviation diagram of BL diameters (Figure 4) were similar to those of the three Tungusic groups. Their BL diameters were generally larger than average, with a proportion of large LI, UP, and LP. Also, the proportions found in the Tungusic groups were similar to those of the Okhotsk culture groups, though there were some gaps in individual tooth size. There were differences for UC dimension, as the Okhotsk culture proportion was small UC. Of the 3 Tungusic groups, Oroqen was similar to Okhotsk culture in regard to the proportion between MD and BL dimensions, indicating a relationship between those groups.

Regarding ecological profiles and cranial features, Debets classified Siberians into 4 groups; Arctic (Aleutian Islanders, Arctic Siberians, Inuit, etc.), Baikal - Old Siberians (Nanays, Negidals, Ulchs, etc.), Central Asian (Buriats, Mongolians, etc.), and Uralic - West Siberians (22). Hokkaido Ainu, Sakhalin Ainu, and Okhotsk cultures were placed in the Unclassified group, because they were not classified by Debets. In our dendrogram created with cluster analysis (Figure 5), Northeast Asians were classified into 2 major clusters, which then split into 3 sub-clusters at the height of approximately 3. Baikal, Arctic, and Unclassified (Hokkaido Ainu, Sakhalin Ainu) were sorted into the first cluster, while Central Asian and Unclassified (Okhotsk culture) were classified into the second. The 3 Tungusic groups were classified in the same sub-cluster as the Central Asian group, suggesting a classification with that group. The sub-cluster in the Tungusic groups split off from the second cluster, and was combined with the sub-cluster of Okhotsk cultures and Epi-Jomon/Satsumon at the height of approximately 5. It then split into a small sub-cluster, which included Hezhen, Oroqen, and Ewenki at a height of approximately 7. Therefore, the 3 Tungusic groups and Okhotsk Culture have a relationship. Among the 3 Tungusic groups, Hezhen and Oroqen showed a strong association, suggesting a related tribal origin between those 2 groups. As showed in the 2-dimensional scatter plot (Figure 6), the groups were classified into 2 major clusters; the Baikal and Arctic groups, and Central Asian groups, while the Epi-Jomon/Satsumon and the Okhotsk culture were placed further away. The three Tungusic groups were plotted in a position closest to Okhotsk culture and Epi-Jomon/Satsumon, as compared to the other Central Asian races. Particularly, both Hezhen and Oroqen were plotted close to them. In the classification by Debets, the Ulch of the Baikal group was plotted in the Central Asian cluster closest to the Baikal cluster. Together, these results led us to concluded that Ulch was a hybrid race of Baikal and Central Asians, as observed in the cluster analysis. In addition, though Hezhen was plotted a position away from Nanai on the first axis, Hezhen and Nanai have the same ethnicity (2), which was speculated to be because of the distributed Nanai residence. At the turn of the century, the Amur River and its tributaries for 100 to 600 kilometers were populated with a large number of Nanai settlements. However, because the Nanai did not share a universal culture or language, their lives were quite isolated and mutual contact was poor (23). It is possible that the difference of mixed race occurring between the Nanai and Hezhen was separated at the border. In the 3-dimensional scatter plot (Figure 7), Hezhen and Oroqen were placed approximately equidistant from the Okhotsk culture and Epi-Jomon/Satsumon groups on the z axis, with a contribution rate of 10.5%.

The 3 Tungusic groups were found to display Sinodonty and assumed to belong to the Central Asian group, which is particularly relevant for both Hezhen and Oroqen, as a relationship between Hezhen and Oroqen was suggested in a study of Y chromosomal STRs by LH Zheng et al. (24). That relationship including Ewenki was pointed out with dermatoglyphics results from a national research project conducted by HG Zhang et al. (25). Through observations of cranial measurements and nonmetric cranial traits, Ishida suggested that Mongoloids who migrated to the lower Amur region were close to the Baikal type, whereas the Central Asian type moved from the south in the post-Neolithic Era (26). In research of all Chinese ethnic groups using mtDNA, QP Kong et al. identified the haplogroup of Oroqen to be N11b, which is peculiar to this tribe and never found in other races in China. N11b belongs to haplogroup N11, which originates in southern China and is close to the Tibetans (27). The diversity of Oroqen's mtDNA haplogroup was reported to be low (28). mtDNA analysis of ancient Tuoba Xianbei remains (4th to 5th A.D.) by Yu Changchun et al. revealed a close relationship to Oroqen and Ewenki, especially Oroqen (29). Based on these previous results, it is reasonable to speculate that the Tungusic groups have maintained their characteristic features from ancient times, which coincides with our conclusion that these three groups had scant influence from other races because of geographical features. Therefore, it is of great importance to consider the three Tungusic groups when evaluating Mongoloid diffusion.

Results of the present study for crown measurements revealed a mixed distribution of Baikal and Central Asian groups in the lower Amur region (Figure 8). Race mixture occurred between the Baikal, who spread from Lake Baikal, and Central Asians from the south in the post-Neolithic Era, then the groups gradually diffused to the lower Amur region. In a study based on Y chromosome DNA, a mixture of Northeast and Central Asians was suggested, which was pointed out to have caused the variety of haplogroups in Northeast Asia (30-33). Therefore, it is possible to consider that in the area from Lake Baikal to the lower Amur, a different degree of miscegenation occurred between Baikal and Central Asians, in accordance with geographical features. We conclude that the Tungusic groups of the Amur River basin are closely related to Okhotsk cultural people, which is supported by the results shown in the deviation diagram. On the other hand, the two- and three-dimensional diagrams plotted Tungusic groups at the upper end of the Central Asian cluster, which lies far from the Okhotsk culture. Nevertheless, since the Okhotsk culture and Tungusic groups share some mtDNA haplogroups, (8, 27, 28, 34, 35), the close relationship between these groups is undeniable.

Conclusion

The three Tungusic groups were found to display Sinodonty and concluded to belong to the Central Asian group, which is particularly relevant for both Hezhen and Oroqen. We also consider that the Tungusic groups of the Amur River basin are closely related to Okhotsk cultural people and a close relationship between them can not be denied. Findings from our anthropological evaluation of crown measurements generally coincide with results from previous cranial studies and genetic research, thus the simple non-invasive method employed is considered to be useful and effective, and also shows promise for future research of Mongoloid diffusion. It will be essential to gather additional samples from the lower Amur groups and not only Chinese to more closely examine the spread of Mongoloids in East Asia.

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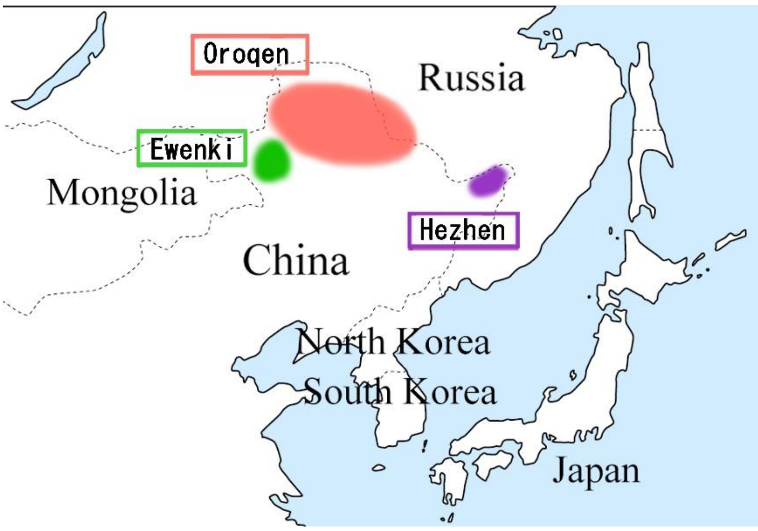

Figure 1 Geographical representation of the three Tungusic ethnic minorities in China.

Population	Period	Provenance	N	Literature
Hezhen	Modern	Heilongjiang, China	79	Present study
Ewenki	Modern	Inner Mongolia Autonomous Region, China	79	Present study
Oroqen	Modern	Inner Mongolia Autonomous Region, China	86	Kataoka(2014)
Modern Japanese	Modern	Kanto, Japan	69	Matsumura(1994)
Modern Hokkaido Ainu	Modern	Hokkaido, Japan	61	Matsumura(1994)
Urga Mongolians	Early Modern	Ulan Bator, Mongol	132	Matsumura(1995)
Aleutians landers	Early Modern	Aleutians lands, Alaska, U.S.A.	146	Matsumura(1995)
Sakhalin Ainu	N.S.	Sakhalin Island	36	Matsumura(2009)
Nanay	N.S.	Lower Amur River basin, Russia	23	Matsumura(2009)
Negidal	N.S.	Lower Amur River basin, Russia	29	Matsumura(2009)
Ulch	N.S.	Lower Amur River basin, Russia	20	Matsumura(2009)
Buriats	N.S.	Troiskosavsk, Russia	29	Matsumura(2009)
Arctic Siberians	N.S. N.S.	Asian Eskimo: Chukchi Peninsula, Russia Chukchi: Chukchi Peninsula, Russia	122 (88+34)	Matsumura(2009)
Jomon//Hokkaido/Tohoku	N.S.	Hokkaido and Tohoku region, Japan	37	Kaburagi(2009)
Epi-Jomon/Satsumon	2300-1300 BP /1300-700 BP	Hokkaido, Japan	17	Kaburagi(2009)
Okhotsk culture	5-12 century AD	Rebun island, Hokkaido, Japan and Sakhalin Island	26	Kaburagi(2009)

N.S.=Data not shown

Table 1 List of population samples from North Asia.

Measuring part			Hezhen			Ewenki	
		N	Mean	S.D.	N	Mean	S.D.
Mesiodistal diameters(MD)							
Upper	I 1	76	8.65	0.53	76	8.50	0.56
	I 2	68	7.04	0.63	73	6.96	0.58
	C	36	8.07	0.39	76	7.96	0.45
	P 1	50	7.45	0.41	78	7.25	0.41
	P 2	43	6.82	0.44	76	6.69	0.47
	M 1	74	10.40	0.52	74	10.36	0.57
	M 2	19	9.98	0.66	71	9.70	0.56
Lower	I 1	74	5.39	0.35	67	5.41	0.37
	I 2	75	6.09	0.33	70	6.10	0.38
	C	46	7.14	0.40	75	7.00	0.42
	P 1	56	7.32	0.38	78	7.16	0.40
	P 2	52	7.19	0.43	77	7.01	0.50
	M 1	73	11.20	0.51	67	11.22	0.56
	M 2	25	10.56	0.60	70	10.53	0.78
Buccolingual diameters(BL)							
Upper	I 1	63	7.18	0.52	71	7.29	0.53
	I 2	57	6.45	0.57	76	6.49	0.58
	C	29	8.42	0.69	78	8.35	0.58
	P 1	50	9.84	0.65	78	9.68	0.52
	P 2	40	9.79	0.70	78	9.56	0.58
	M 1	77	11.56	0.57	77	11.59	0.54
	M 2	21	11.68	0.88	73	11.55	0.58
Lower	I 1	69	5.83	0.44	67	6.21	0.44
	I 2	68	6.18	0.49	68	6.66	0.47
	C	38	7.54	0.59	73	7.65	0.57
	P 1	53	8.31	0.47	78	8.26	0.50
	P 2	46	8.71	0.56	77	8.66	0.47
	M 1	75	10.99	0.49	72	10.99	0.47
	M 2	29	10.73	0.71	74	10.60	0.53

Table 2 Mesiodistal and buccolingual diameters in Hezhen and Ewenki.

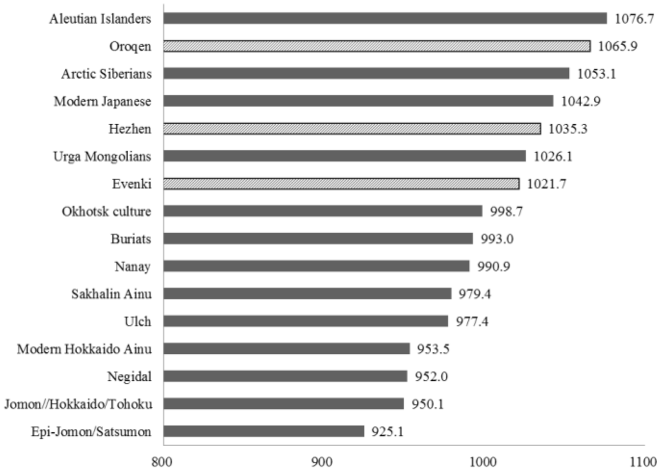

Figure 2 Horizontal bar graph showing total crown areas (MD×BL) of male samples from 16 Northeast Asian groups.

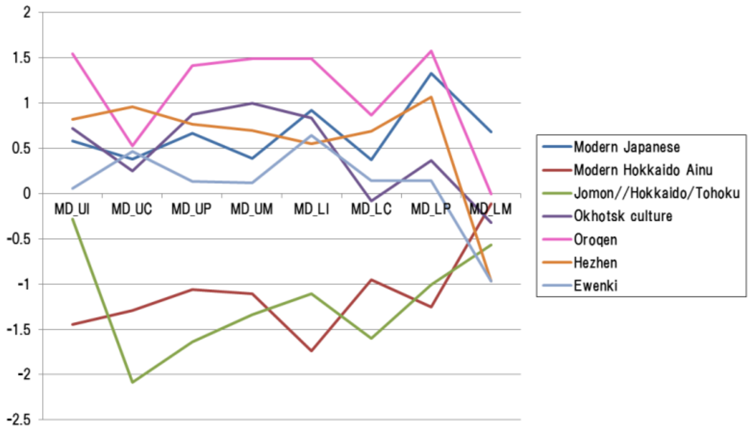

Figure 3 Deviation diagram showing mesiodistal diameters of male samples from 7 Northeast Asian groups. Horizontal line with value of 0 represents the grand mean of the 16 Northeast Asian groups.

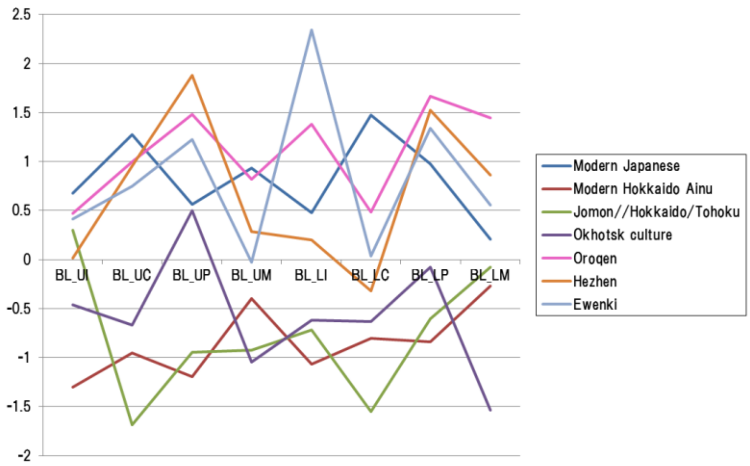

Figure 4 Deviation diagram showing buccolingual diameters of male samples from 7 Northeast Asian groups. Horizontal line with value of 0 represents the grand mean of the 16 Northeast Asian groups.

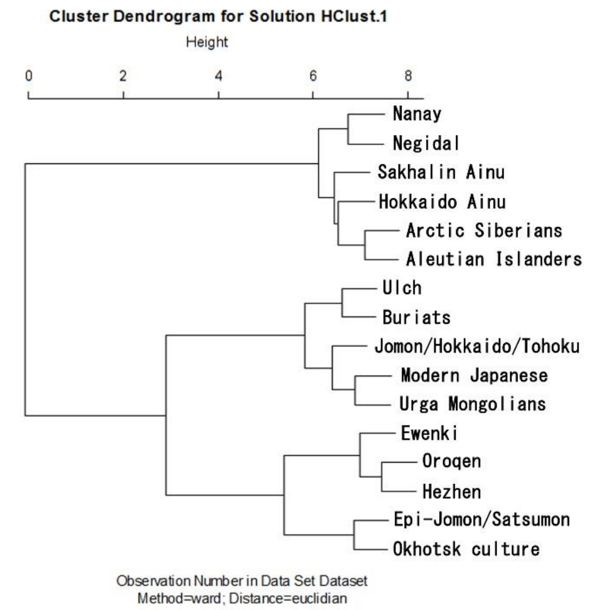

Figure 5 Dendrogram with cluster analysis applied to dissimilarity matrix of Q-mode correlation coefficient in the 16 Northeast Asian groups, based on dental crown measurements of male samples. Ward's method was used for the cluster analysis.

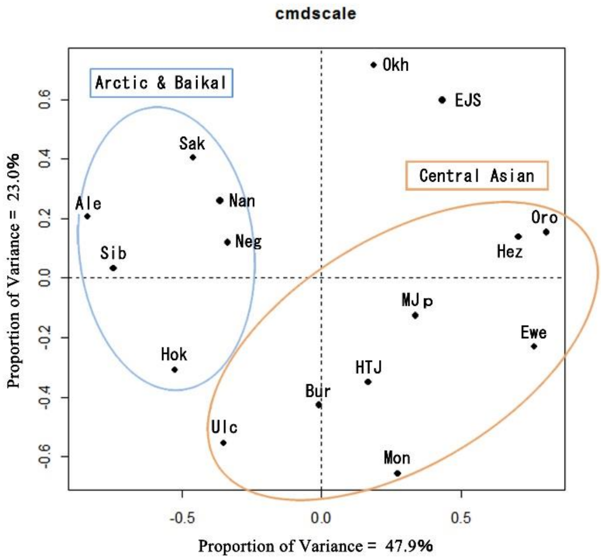

Figure 6 Two-dimensional MDS diagram applied to dissimilarity matrix of Q-mode correlation coefficient in the 16 of Northeast Asian groups, based on dental crown measurements of male samples. Ewe, Ewenki; Hez, Hezhen; Oro, Oroqen; MJp, Modern Japanese; Hok, Hokkaido Ainu; Mon, Urga Mongolians; Ale, Aleutian Islanders; Sak, Sakhalin Ainu; Nan, Nanay; Neg, Negidal; Ulc, Ulch; Bur, Buriats; Sib, Arctic Siberians; HTJ, Jomon/Hokkaido/Tohoku; EJS, Epi-Jomon/Satsumon; Okh, Okhotsk culture.

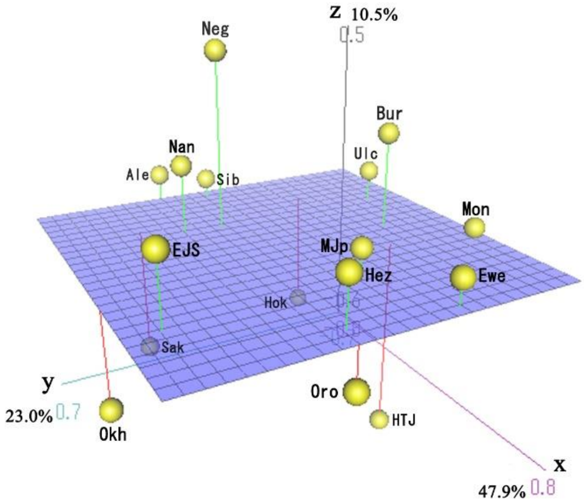

Figure 7 Three-dimensional MDS diagram applied to dissimilarity matrix of Q-mode correlation coefficient in 14 of the Northeast Asian groups, based on dental crown measurements of male samples.

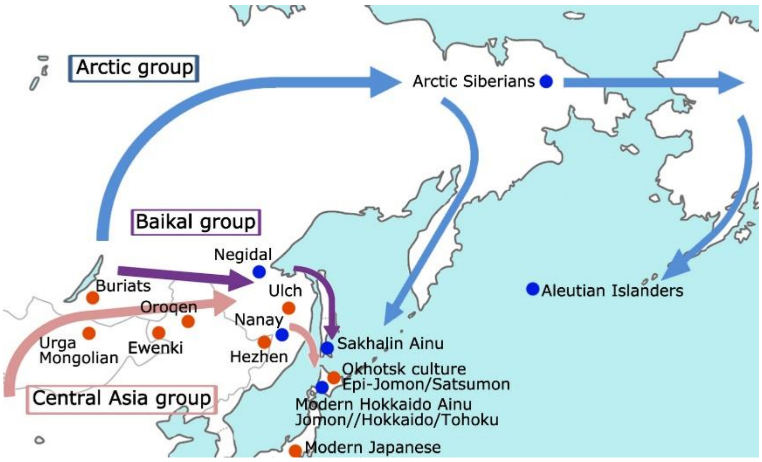

Figure 8. Distribution map of Arctic, Baikal and Central Asian groups based on dental metric traits.