The Dental Morphology and Continuity of Prehistoric and Historic Humans of China

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Summary

Dental morphological traits recorded in two Neolithic and one historic series from northern China, and some fossil teeth which date to the Paleolithic time of China are examined. The observed data are subjected to multivariate statistical analyses through comparisons with other Asian populations to study the temporal and spatial variation of human teeth in China. The major findings are as follows: (1) The frequencies of most dental morphological traits of the Neolithic and historic humans in northern China are quite similar to those of other NE Asians, and are different from SE Asians; (2) In comparison with Japanese, the dental morphological traits of Neolithic and historic Chinese show greater resemblance to Yayoi and recent Japanese, than to Jomon and Ainu. Yayoi people are more like historic northern Chinese than Neolithic Chinese in dental morphology; (3) Cluster analysis and factor analysis once again confirm the two divisions of East Asian populations corresponding to the distributions of Sundadonty and Sinodonty in Turner's terminology. Among the former, both Neolithic and historic Chinese are tied with other NE Asians including Yayoi and recent Japanese. As closer affinity between Yayoi and historic Chinese is also revealed; (4) The temporal changes of certain dental traits are studied by observing selected specimens of fossil teeth found in China. Some dental traits (e.g. which include shovel -shaped incisors, double-shovel incisors, interruption grooves, degeneration of third molars, deflecting wrinkle, three-rooted lower first molars and five-cusped lower second molars) which characterize modern Mongoloids are found in *Homo erectus* and modern hominids of the same general region. No fossil teeth have enamel extensions suggesting that this trait occurs only on the teeth of anatomically modern humans.

Based on the present study, the author believes that the dental characteristics of Mongoloids were formed much earlier than Neolithic period. Some of these dental features can be traced to the *Homo erectus* of China. These findings provide new evidence which strongly support the regional continuity in East Asia. A local origin of modern Chinese and continuity from prehistoric and historic times is the best interpretation for the dental morphological traits examined.

Key words Teeth, Dental anthropology, Dental morphological traits, Mongoloids, Chinese, Modern human origins

Introduction

In the past decades, research on human teeth has played an increasingly important role in assessing population affinities, origins, and the evolution of anatomically modern humans. Using the observations of teeth primarily of Japanese, Ainu and American Indians, Kazuro Hanihara defined the "Mongoloid dental complex" to characterize the dental morphology of East Asians (Hanihara K., 1968, 1969). Based on the observations of dental morphological characters of East Asian and Pacific populations from different time periods and geographical regions, Christy G. Turner II of Arizona State University identified two geogenetic divisions for Hanihara's Mongoloid dental complex—a southern division which he called Sundadonty and a northern division he referred to as Sinodonty (Turner, 1987, 1989, 1990). According to Turner's description, Sundadonty is characterized by a retained and somewhat simplified earlier dental pattern, while Sinodonty has a pattern of trait intensification so far unknown to occur before 15,000 years ago(Turner, 1992). Turner's studies indicate that there is no identifiable prehistoric clinal variation across Eurasia. Therefore, the specialized Sinodont pattern had to evolve out of the more generalized Sundadont pattern (Turner, 1987, 1992). According to Turner, Southeast Asia should be a geogenetic center out of which all modern populations of East Asia and the Pacific originated. This hypothesis has been used to explain the origins of Mongoloids, or East Asian populations, including the origins of the Japanese. Further dental and cranial investigations by other researchers (e.g., Hanihara K., 1991; Hanihara T., 1992a, 1993, 1994, 1996), have supported Turner's views. Others, however (e.g., Wu, 1992a, 1992b) have expressed different opinions to the origins of East Asians (Wu, 1992a, 1992b). One of the key problems is that we lack sufficient studies and comparisons of dental specimens from the Pleistocene to the Holocene in China (Hanihara T., 1994). Turner, himself, also admits that he has not "personally examined any of the Pleistocene or early Holocene teeth from China" (Turner, 1987). So, the purposes of present study are:

(1) to provide a summary description and analysis of 28 dental morphological traits of the Chinese from Neolithic to Historic periods;

(2) to make some comparisons of dental morphology of Neolithic and Historic Chinese with other Asian populations including Japanese;

(3) to study the evolutionary changes of some dental morphological traits from *Homo erectus* to modern human times in China;

(4) using dental morphology of prehistoric hominids from China, speculate on the origins of Mongoloids.

Materials and methods

The dental specimens used in present study include the human teeth of Neolithic and historic periods from three sites in northern China (Table 1)

The dental morphological data of some other Asian populations cited from references were used including some data on Japanese populations. Because missing data occur in some comparative groups, two separate statistical analyses were performed using 17 samples with 28 dental traits, and 22 samples with 8 dental traits, respectively. For the purpose of studying the temporal changes of some dental traits, some fossil teeth found in China were also used (Table 2).

The observations of 28 morphological traits were made using the Arizona State University dental anthropology system (Turner et al. 1991). The individual count method was used to record the dental morphological data (Turner, 1985). The dental traits studied include (1) winging UI1; (2) shoveling UI1; (3) double-shoveling UI1; (4) interruption grooves UI2; (5) tuberculum dentale UI2; (6) mesial ridge UC; (7) distal accessory ridge UC; (8) hypocone UM2; (9) Cusp 5 UM1; (10) Carabelli's cusp UM3; (11) parastyle UM3; (12) enamel extension UM1; (13) 1-rooted UP1; (14) 3-rooted UM2; (15) peg/reduced/congenital absence UM3; (16) lingual cusp number LP2; (17) groove pattern LM2; (18) 6-cusped LM1; (19) 4-cusped LM2; (20) deflecting wrinkle LM1; (21) distal trigonid crest LM1; (22) protostylid LM1; (23) cusp 7 LM1; (24) Tome's root LP1; (25) 2-rooted LC; (26) 3-rooted LM1; (27) 1-rooted LM2; (28) odontome U+LP.

The methods used to analyze these data include the biological distance coefficients of multivariate Mean Measure of Divergence (MMD) statistic developed by Smith (Berry and Berry, 1976; Green and Suchey 1976), cluster analysis and factor analysis. The cluster analysis and factor analysis were performed with the statistic package of SPSS/PC+ version (Marijia J. Norusis/SPSS Inc. 1990). Cluster was done with seven different algorithms available in SPSS/PC+ 4.0 based on the MMD distance coefficients. For this report, the results obtained from Median method and Ward's method were used because these two methods seem to provide the best general fit with known relationship at the population level. For factor analysis, the method of Principal Components Analysis (PCA) was used for factor extraction from the data of the frequencies of dental non-metric traits.

Results

1. Dental morphology of Neolithic and Historic Chinese

The frequency distributions of 28 dental morphological traits in the three Chinese series are given in Table 3. For the purpose of comparison with other Asian populations, dental morphological data of some other Asian populations are also listed.

Table 3 reveals that the frequencies of most of the dental morphological traits of the Neolithic and historic inhabitants of northern China are quite similar to those of other northeast Asians, such as Siberia, Amur, Lake Baikal, north China-Mongolia and Japan, and are different from Southeast Asian populations, Jomon, Hong Kong, and prehistoric Taiwan. This is especially true in traits of shovel incisors, double-shovel incisors, interruption groove of upper incisors, enamel extension of upper molars, deflecting wrinkle of lower molars and three-rooted lower first molars.

Table 4 lists the frequency distributions of eight dental morphological traits in 22 Asian populations. Besides the three Chinese samples used in the present study, Table 4 includes Anyang from Shang Dynasty of China (3000 years ago), and Ainu. These eight dental traits were defined as key features to distinguish Sinodonty and Sundadonty by Turner (1990). Table 4 shows the similar pattern as in Table 3. The three Neolithic and Historic Chinese samples are closer to Anyang, Japan and other northeast Asians in the frequencies of the eight dental traits. The dental trait frequencies of Jomon and Ainu are similar to those of Southeast Asians.

In Table 3 and 4, dental morphological data of Jomonese, Ainu and recent Japanese are presented. The frequencies of some dental morphological traits in Yayoi are also available. Inspection of these data indicates that the dental morphology of the three Chinese groups is much closer to Yayoi people and recent Japanese than to Jomon and Ainu people.

The Mean Measure of Divergence (MMD) statistic was applied to 28 dental non-metric traits for the 17 samples in Table 3. The distances presented in Table 5 indicate that some of the smallest distances in this table are among the three

Chinese groups. These latter also have closer distances with other northeast Asian populations including recent Japanese than with Southeast Asian populations. The distances of each of the three groups with recent Japanese fall within the range, 0.1142-0.3767, while these same groups have distances of 0.3635-0.7642 with Jomon people, respectively. It is worthy to note that the distance between Longxian of Historic Chinese and recent Japanese (0.1142) is smaller than the distances between Neolithic Chinese (Xiawanggang and Miaozigou) and recent Japanese (0.2506 and 0.3767).

Based on the MMD distances, a cluster analysis was undertaken. Figure 1 is the dendrogram constructed from the matrix of distances given in Table 5. In this dendrogram, two major clusters can be recognized. The first cluster, in the upper part of the Figure, contains the Jomon, prehistoric Taiwan and Southeast Asian populations; the second cluster includes recent Japan, Hong Kong, south China, north China-Mongolia, Lake Baikal, Siberia, Amur, and the three Neolithic and historic populations examined in the present research. This two divisions correspond well to the results of other researchers who have similarly noted a southern and northern separation for East Asia(Hanihara T., 1992b, 1992c; Li, et al., 1991; Turner, 1987). The three Chinese series, which are the focus of this study are positioned in the Sinodonty branch using Turner's Sundadonty/Sinodonty terminology. It should be noticed that within the second major cluster the three Neolithic and Historic Chinese groups form a separate branch separate from other modern northeast Asian populations. Also, south China and Hong

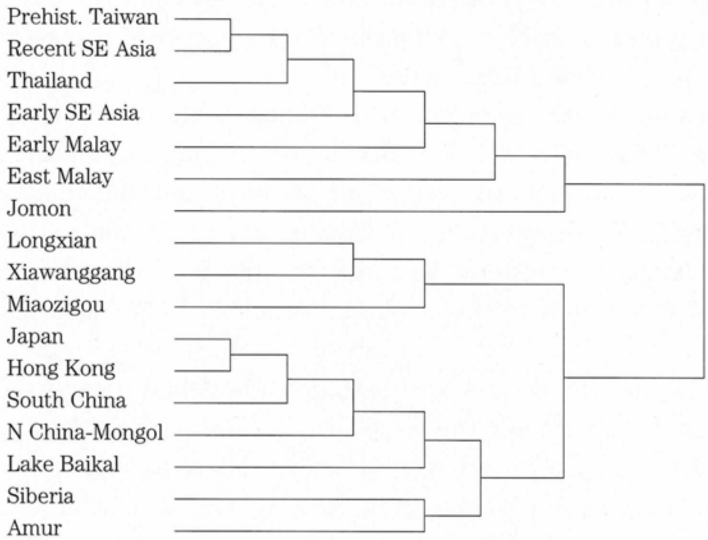

Fig. 1 Dendrogram of 17 Asian population based on MMD distances for 28 dental morphological traits

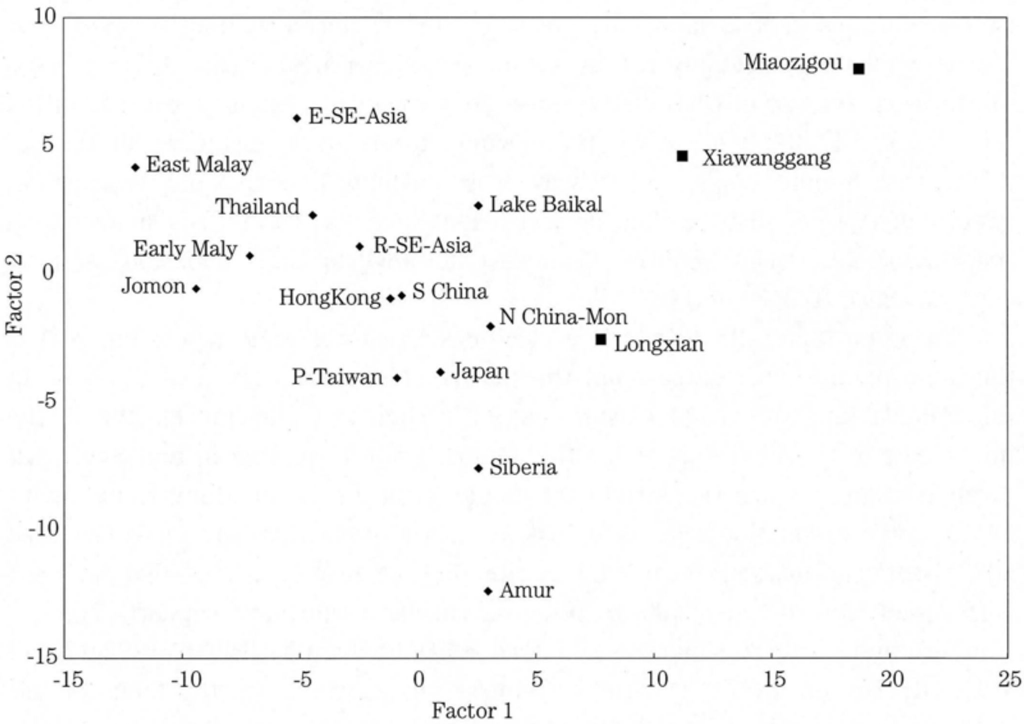

Fig. 2 Two dimensional distributions for 17 Asian populations on the first and second factors based on 28 dental traits.

Kong are clustered with northeast Asians, and not with Southeast Asians.

Figure 2 presents the two dimensional distribution of groups on the first and second factors obtained from factor analysis.

The population relationships shown in Figure 2 are similar to those in the dendrogram in Figure 1. A dichotomous division within East Asia is again revealed. Southeast and Northeast Asians are placed in left and right sides of the figure respectively. The three Chinese samples align with the northern groups. Among these latter, the historic Longxian sample is closer to other modern northeast Asians than it is to the Neolithic samples of Miaozigou and Xiawanggang.

Figure 3 displays the dendrogram based on the dental data given in Table 4 using eight dental traits. Nearly the same two divisions of East Asian populations are revealed. Japan is tied closely with Longxian, Mongolia and south China, the three earlier samples of the Xiawanggang, Anyang, and Miaozigou form a cluster. Both Jomon and Ainu are positioned in the Southeast Asian branch of this diagram.

These results indicate that the dental morphology of the three Chinese sam-

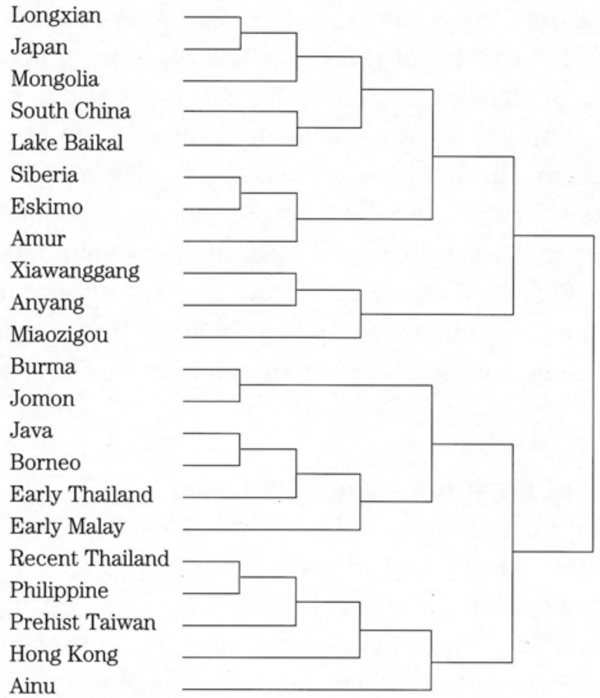

Fig. 3 Dendrogram of MMD distances based on 8 dental morphological traits recorded in 22 Asian samples

ples in present study is more like that of other Northeast Asian (Sinodonts) than Southeast Asian (Sundadonts). Further differences among the three groups according are also evident. The frequencies of most dental morphological traits in Miaozigou and Longxian samples seem to be more like other typical Mongoloids of Northeast Asia with Sinodont characteristics than those of Xiawanggang. In the Xiawanggang sample, some dental morphological traits show similarities to the Southeast Asian dental pattern such as the low frequencies of Peg/Reduced/Congenital absence of UM3 and six-cusped lower first molars, and high frequency of four-cusped lower second molars. Previous research on the cranial characteristics of Xiawanggang remains indicates that the skulls from Xiawanggang have some southern Mongoloid features (Zhang and Chen, 1984). The reason for the southern pattern may be related to its geographic location. The Xiawanggang site is located near Hanshui River, a branch of Yangtze River, and is closer to Southern China than are the Miaozigou and Longxian sites. Even though currently no Neolithic human teeth from South China are available to describe their dental morphology, the present study suggests that there seems to have had marked physical differences between the peoples of southern and northern China at least since the Neolithic. From the frequency distributions presented in Table 3 and 4, temporal changes from the Neolithic to the Historic Periods are further evident. For example, the frequencies of the congenital absence of upper third molar in Neolithic humans of Xiawanggang and Miaozigou are 16.2% and 15.4% respectively, while in the bronze age specimens from Anyang and historic period specimens from Longxian, the frequencies increase to 32.6 and 55.4%, respectively. The present results indicate that the Longxian sample resembles recent Japanese and Yayoi more than Xiawanggang and Miaozigou in dental morphology, and the results shown in Figures 2 and 3 also show a closer affinity between Longxian and recent Japanese. Overall, these findings indicate that the dental morphology of Chinese has experienced some microevolutionary changes within the last 10,000 years.

2. Observations of fossil teeth found in China

Dental morphological traits observed in some hominid fossil teeth from China are now used to examine possible temporal changes in these traits and what they reveal about human origins in East Asia. The most important finding is that some dental traits, which characterize modern Mongoloids, are present in *Homo erectus* specimens from China, suggesting continuity between earlier and later hominids of the region. The main findings are as follows:

(1) The occurrence and expression of shovel-shaped incisors and double-shoveled incisors in the fossil teeth from China are presented in Table 6. This assembled data, in addition to confirming the results of earlier investigators that shovel-shaped incisors exist in nearly all upper incisors of fossil teeth discovered in China, further show that double-shoveled incisors occur in the teeth of *Homo erectus* as early as 650,000 years BP in Yuanmou, Yunnan Province. Temporal changes in the frequencies of double-shoveled incisors are also revealed in Table 6. While expressions of double-shoveling in all *Homo erectus* teeth are very weak, this trait is much more pronounced in the tooth of an early *Homo sapiens*, Dingcun Man. However, Tongzi Man and Liujiang Man in south China do not possess this trait at all.

(2) The upper central incisors of Yuanmou Man and upper lateral incisors of Dingcun Man all exhibit interruption grooves.

(3) Enamel extensions are not present in any fossil teeth, suggesting this trait occurs only in the teeth of anatomically modern humans.

(4) Visual and x-ray examinations have revealed two cases of congenital absence

of third molars in the fossil specimens of China. In Lantian Man from Shaanxi Province (650,000 years BP), both mandibular third molars are congenitally absent, and in Liujiang Man the right upper third molar is congenitally absent. It is well known that in the course of human evolution there is a tendency for the third molars to either reduce in size or to be congenitally absent. Some researchers (e.g. Bailit and Friedlaender, 1966; Brace et al. 1971, 1987) consider expressions of third molar degeneration such as pegged shape, reduced shape, congenital absence and impaction of third molars as forming a complex of related traits. Applying this concept to the data presented here reveals some other evidence regarding third molar degeneration. In Jinniushan Man, both upper third molars are markedly reduced. In the mandible of Upper Cave specimen No 101, both third molars appear to be impacted lingually.

(5) One lower molar occlusal feature, called the "deflecting wrinkle", by Weidenreich (1937) was found to be present in the fossil teeth of *Homo erectus* from Zhoukoudian. This trait is quite common in northeast Asian populations, and it is less common outside of Asia. In the present study, the fossil lower molar teeth from three sites, Zhoukoudian, Xichuan and Dingcun, are available for observation of this trait. In addition to possessing shovel-shaped incisors, all fossil lower molars found in China exhibit deflecting wrinkles.

(6) A three-rooted lower first molar was found on the right side of the mandible of *Homo erectus* excavated at Zhoukoudian in 1959. According to Turner (1971, 1987, 1990, 1995) this trait is predominantly found only in anatomically modern humans.

(7) Earlier studies indicate that four-cusped lower second molars and absence of hypoconulids, which are regarded as dental simplification, have high frequencies in Southeast Asian populations. The high occurrence of five-cusped lower second molars in northeast Asians are thought to represent trait intensification (Turner, 1987, 1990). In the present study, the lower second molars of fossil teeth from Zhoukoudian, Xichuan and Dingcun have five cusps.

These findings indicate that some dental morphological traits which have higher frequencies and pronounced expressions in ccontemporary Northeast Asian populations were present in specimens of Homo erectus from China, and have persisted to the present.

Discussion

It is widely accepted that there are major differences in physical characteristics between the human populations in Southeast and Northeast Asia. However, there are temporal problems and different interpretations for this differentiation (Brace and Tracer, 1992; Brace et al., 1989; Li et al., 1991, Turner, 1987). Based on the research of cranial characters of Neolithic specimens, Chinese scholars have proposed that in the Neolithic period of China the cranial differences between Southern and Northern Chinese were already in place, suggesting they originated before the Neolithic (Zhang, 1989). Brace and colleagues (Brace and Tracer, 1992; Brace et al., 1984) hold different opinion. Their studies divide mainland Asian populations into northern and southern components. They further believe that there is less differentiation between the Neolithic in both regions which they interpret as representing an undifferentiated precursor. At the same time, these authors caution this hypothesis requires further testing when additional specimens and adequate samples from south China become available (Li et al. 1991).

The results of the present study support the twofold concept of Sinodonty and Sundadonty corresponding to northern and southern peoples in East Asia. It is further shown that the populations of Neolithic and historic periods of China have closer ties with other northeast Asian populations. Taken together, these findings support the notion that the physical differences between Southeast and Northeast Asian populations originated at least before Neolithic period.

According to dental studies by Turner (1987, 1989, 1990), northeast Asian populations, which possess the Sinodont pattern, evolved from early Southeast Asians who are characterized as possessing the generalized Sundadont pattern or, Southeast Asians with the Sundadont pattern migrated northward and evolved into the people with Sinodont pattern. The dental morphological traits of the two Neolithic samples from China examined in this paper show that, compared with Miaozigou of Inner Mongolia, the Xiawanggang sample near the Yangtze River exhibits some elements of the southern dental pattern such as low frequencies of congenital absence of upper third molars and six-cusped lower first molars, and high frequency of four-cusped lower second molars. A similar finding was found in cranial studies of Neolithic skulls discovered in Northern China including the Xiawanggang site (Han and Pan, 1984; Zhang, 1989). These latter studies reveal that the cranial characteristics of Neolithic inhabitants in north China, especially along the Yellow River, exhibit certain southern Mongoloid characters. Despite these findings, the present author does not believe that there is sufficient evidence to confirm a major northern expansion of southeast Asian populations with the Sundadont dental characteristics at or before Neolithic period. Likewise, environmental studies (Zhu, 1972) have suggested that the climatic condition of Neolithic time in North China may have been much warmer and more humid than present, somewhat like present day Southeast Asia and this may be responsible for dental features observed. Another possibility is that the people of the Neolithic retained some undifferentiated, or primitive characters. However, the possibility of some influences from the south can not be excluded at this time.

The results of the present study indicate that, compared with Neolithic people of Northern China, the Longxian people of the Zhanguo Period (2000 years BP) are not only more like the typical Mongoloid populations in dental morphology but they also show closer affinities to modern Northern Chinese. This observation has contributed to the belief that in the past 10,000 years the physical traits of Northern Chinese have been evolving in the direction to the modern Northern Chinese. This process reflects the trend of microevolution of the physical characteristics of the northeast Asians.

Regarding the population history of Japan, both dental and cranial studies have indicated the existence of two major populations in Japan. Jomonese, and their Ainu descendants, seem to link Southeast Asians through the possession of a Sundadont pattern while modern Japanese, who possess the Sinodont pattern, are closer to the Yayoi people who came to Japan from the Asian mainland two thousand years ago (Hanihara T., 1991, 1992c, 1993; Turner, 1976; Turner and Hanihara K., 1977). Based on these findings, the "dual structure hypothesis" or "dual origins with admixture hypothesis" was proposed by Kazuro Hanihara and Turner, respectively (Hanihara K., 1991; Turner, 1992). Although there are differing opinions (Brace et al. 1989; Li et al., 1991; Wu, 1992a), this hypothesis is broadly accepted. In present study, some comparative data of Japanese populations are included. As previously mentioned, the frequencies of dental morphological traits of Neolithic and Historic Chinese are closer to those of Yayoi and recent Japanese, and different from Jomonese and Ainu. Compared with Neolithic Chinese, the Yayoi people are much closer to the Historic Longxian sample in certain dental traits. The dendrogram which results from applying a clustering algorithm to MMD distances based on 9 dental traits recorded in two Yayoi samples and the samples listed in Table 3 is shown in Figure 4.

Inspection of Figure 4 shows that the divisions of the East Asian populations are similar to those of Figures 1 and 3. In both, Yayoi and recent Japanese are tied with northeast Asians, and Jomon falls into the southeast Asian branch. Two Neolithic Chinese samples, Miaozigou and Xiawanggang, form an isolated cluster suggesting possible temporal differentiation of these two groups. In the northern branch, two Yayoi populations are tied closely with Longxian, a historic Chinese

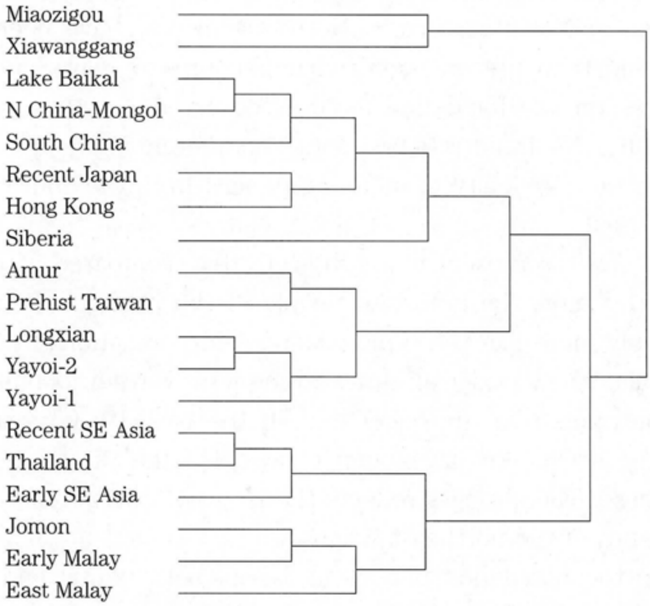

Fig. 4 Dendrogram showing the affinities of Yayoi with other Asian populations using MMD distances based on 9 dental morphological traits

series. The closeness between Yayoi and historic Longxian people seems to confirm the affinity of Yayoi with mainland East Asian populations. The time period of Longxian sample is similar to the Yayoi Period of Japan, and supports the legend of Hsu Fu. Another important element in Figure 4 is the close affinity between recent Japanese and south China. The associations shown in Figure 1, 3, and 2 indicate that Japanese are more similar to peoples of mainland Asia, particularly those of southern China, than they are to the prehistoric Jomonese. These findings support the view that there occurred a major post-Jomon immigration to Japan from Mainland Asia.

In 1930-1940's, Weidenreich observed several cranial and dental characteristics in Peking Man specimens which were further evident in modern northern Chinese. From these observations he concluded that there should be a genetic linkage and morphological continuity between *Homo erectus* from Zhoukoudian and modern Mongoloids of Northern China (Weidenreich, 1937, 1939, 1943). His "continuity" hypothesis has been further demonstrated in other parts of the world and developed into the multiregional evolution theory for modern human origins(Thorne and Wolpoff, 1981, 1992; Wolpoff et al., 1984; Frayer et al., 1993). In China, since the discovery of Peking Man, many new human fossils have been found ranging from *Homo erectus* to late *Homo sapiens*. Studies (e.g., Wu, 1990, 1992b, 1995) of these specimens have confirmed Weidenreich's finding and have added additional morphological traits in support of the regional continuity in China. Among the latter, only one dental trait, shovel-shaped incisors, is included. In present study, in addition to shovel-shaped incisors, there are some other dental morphological traits which characterize Northeast Asians and support the view that *Homo erectus* in China evolved into modern Chinese. The seven dental traits which support regional continuity in China are shovel-shaped incisors, double-shovel incisors, interruption grooves of upper incisors, degeneration of third molars, deflecting wrinkle of lower molars, three-rooted lower first molars and five-cusped lower second molars. The frequencies for all 7 traits are higher in northeast Asian populations, traits which have been identified as the key diagnostic features to distinguish the Sinodonty/Sundadonty dental complex (Turner, 1990). The continuity of dental morphological traits in China can be traced back to the *Homo erectus*, and extended via early *Homo sapiens* to modern Chinese covering nearly the entire Pleistocene. This suggests that these dental traits originated locally. A Southeast Asian origin for these dental traits (Turner, 1995) is less possible. The present study supports the regional continuity of human evolution in China and East Asia.

Previous studies of Mongoloid populations have suggested that the so-called Mongoloids actually represent a mixture of human groups with different phylogenetic lineages (Brace et al., 1989; Brace and Tracer, 1992; Li et al., 1991; Omoto, 1995). The results of the present study seem to be in agreement with this idea. The dental characteristics of Neolithic and Historic Chinese closely resembles those of other northeast Asians and greatly differ from Southeast Asians. Importantly, many key dental traits, which characterize typical Mongoloid populations of northeast Asia can be traced back to *Homo erectus* of China. These findings may suggest that the major physical characteristics of modern Chinese can be traced to their local ancestors. Although there may be some gene flow from the south, a big human migration into Northern China from Southeast Asia in late Pleistocene times or the early Holocene is not supported. I agree with the concept of independent origins of the northern and the southern Mongoloids (Omoto, 1995).

Conclusions

In summary, this study has examined some basic dental morphological traits of Neolithic and historic human groups in northern China, and compares these with other East Asian populations. The results indicate that the dental morphology of Neolithic and Historic humans of China is similar to that of other northeast Asian populations. Cluster analysis of MMD distances and factor analysis confirm the south-north division for East Asians which supports Turner's Sundadonty and Sinodonty dental complexes. Further, the present study reveals that several dental features common in modern Mongoloids can be traced back to *Homo erectus* of China. Based on these findings, this study supports regional continuity in East Asia and especially in China. Considering the evidence from previous dental and cranial studies cited, a local origin of modern Chinese is the most likely interpretation. Additional research, using additional dental and cranial specimens, is necessary for further explanation of this topic.

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References

Bailit H.L. and Friedlaender J.S. 1966. Tooth size reduction: a hominid trend. *Amer. Anthropol., 68*: 665-672.

Berry A.C. and Berry R.J. 1967. Epigenetic variation in the human cranium. *J. Anat. 101*:361-379.

Brace C.L. and Tracer D.P. 1992. Craniofacial continuity and change: A comparison of late Pleistocene and recent Europe and Asia. In: Akazawa T., Aoki K. and Kimura T.(eds.). *The Evolution and Dispersal of Modern Humans in Asia*. Tokyo: Hokusen-Sha, pp. 439-471.

Brace C.L. et al. 1971. Post-Pleistocene changes in the human dentition. *A.m. J. Phys. Anthropol*. *32*:191-204.

Brace C.L. et al. 1987. Gradual change in human tooth size in late Pleistocene and post-Pleistocene. *Evolution 41*:705-720.

Brace C.L. et al. 1989. Reflections on the face of Japan: A multivariate craniofacial and odontometric perspective. *Am. J. Phys. Anthrop., 78*:93-113.

Frayer D.W. et al. 1993. Theories of modern human origins: the paleoanthropological test. *Am. Anthrop. 95*:14-50.

Green R. and Suchey J. 1976. The use of inverse sine tranformation in the analysis of non-metrical data. *Am. J. Phys. Anthrop., 45*:61-68.

Han Kangxin and Pan Qifeng, 1984. The study of the racial elements of ancient China. *Acta Archaeologia Sinica, 2*:245-263.

Hanihara K. 1968. Racial characteristics in the dentition. *J. Dent. Rea. 46*: 923-926.

Hanihara K. 1969. Mongoloid dental complex in the permanent dentition. *Proc. VIIIth Internat Congress Anthropol and Ethnol Sciences, 1968*, Tokyo, I. 298-300.

Hanihara K. 1991. Dual structure model for the population history of the Japanese. *Japan Review 2*:1-33.

Hanihara T. 1991. The origin and microevolution of Ainu as viewed from dentition: The basic populations in East Asia, VIII. *J. Anthrop. Soc. Nippon. 99*:345-361.

Hanihara T. 1992a. Dental and cranial affinities among populations of East Asia and the Pacific: The basic populations in East Asia, IV. *Am. J. Phys. Anthrop. 88*:163-182.

Hanihara T. 1992b. Negritos, Australian aborigines, and the "Proto-Sundadont" dental pattern: The basic populations in East Asia, V. *Am. J. Phys. Anthrop. 88*:183-196.

Hanihara T. 1992c. Biological relationships among Southeast Asians, Jomonese, and the Pacific populations as viewed from dental characters: The basic populations in East Asia, X. *J. Anthrop. Soc. Nippon 100*:53-67.

Hanihara T. 1993. Craniofacial features of Southeast Asians and Jomonese. A consideration of their microevolution since the late Pleistocene. *Anthropol. Sci. 101*:25-46.

Hanihara T. 1994. Craniofacial continuity and discontinuity of Far Easterners in the late Pleistocene and Holocene. *J. Hum. Evol., 27*:417-441.

Hanihara T. 1996. Comparison of craniofacial features of major human groups. *Am. J. Phys. Anthrop. 99*:389-412.

Li Y. et al. 1991. Dimensions of face in Asia in the perspective of geography and prehistory. *Am. J. Phys. Anthrop. 85*:269-279.

Norusis M. J. 1990. SPCC Inc. SPSS/PC+ Statistics 4.0 For the IBM PC/XT/AT and PS/2.

Omoto K. 1995. Genetic diversity and the origins of the "Mongoloids". In: *The origin and past of modern humans as viewed from DNA*. Brenner S and Hanihara K.(eds.), World Scientific, London, pp 92-109.

Thorne A. and Wolpoff M. 1981. Regional continuity in Australian Pleistocene hominid evolution. *Am. J. Phys. Anthrop. 55*:337-349.

Thorne A. and Wolpoff M. 1992. The multiregional evolution of human. *Scientific American 266(4)*: 28-33.

Turner C.G. II. 1971. Three-rooted mandibular first permanent molars and the question of American origins. *Am. J. Phys. Anthrop. 32*:229-242.

Turner C.G. II. 1976. Dental evidence on the origin of the Ainu and Japanese. *Science 193*:911-913.

Turner C.G. II. 1985. Expression count: A method for calculating morphological dental trait frequencies by using adjustable weighting coefficients with standard ranked scales. *Am. J. Phys. Anthrop. 68*:263-267.

Turner C.G. II. 1987. Late Pleistocene and Holocene population history of East Asia based on dental variation. *Am. J. Phys. Anthrop. 73*:305-321.

Turner C.G. II. 1989. Teeth and prehistory in Asia. *Scientific American 206(2)*:88-96.

Turner C.G. II. 1990. Major features of Sundadonty and Sinodonty, including suggestions about East Asian microevolution, population history, and late Pleistocene relationship with Australian Aboriginals. *Am. J. Phys. Anthrop. 82*:295-317.

Turner C.G. II. 1992. Sundadonty and Sinodonty in Japan: The dental basis for a Dual Origin hypothesis for the peopling of the Japanese islands. In: Hanihara K.(eds.) *International Symposium on Japanese as a Member of the Asian and Pacific Populations*. Kyoto: International Research Center for Japanese Studies, 96-112.

Turner C.G. II. 1995. Shifting continuity: modern human origin. In: *The origin and past of modern humans as viewed from DNA*. Brenner S. and Hanihara K. (eds). World Scientific, London, pp 216-243.

Turner C.G. II and Hanihara K. 1977. Additional features of Ainu dentition. V. Peopling of the Pacific. *Am. J. Phys. Anthrop. 46*:13-24.

Turner C.G. II, Nichol CR and Scott G.R.. 1991. Scoring procedures for key morphological traits of the pernament dentition: the Arizona State University dental anthropology system. In: Kelley M. A. and Larsen C.S. (eds.), *Advances in Dental Anthropology*, New York: Wiley-Liss, 13-31.

Weidenreich F. 1937. *The dentition of Sinanthropus Pekinensis: A comparative odontography of the hominids*. Pal Sin, New Series D, No.1, Peking.

Weidenreich F. 1939. *On the early representatives of modern mankind recovered on the soil of East Asia*. Peking Natural History Bulletin, 13:161-174.

Weidenreich F. 1943. *The skull of Sinanthropus Pekinensis: a comparative study on a primitive hominid skull*. Pal Sin, New Series, D, 10:1-484.

Wolpoff M.H. et al. 1984. Modern *Homo sapiens*: a general theory of hominid evolution involving the evidence from east Asia. In: Smith F.H. and Spencer F. (eds.), *The Origin of Modern Humans*. New York: Alan R Liss Inc, 411-483.

Wu Xinzhi, 1990. The evolution of humankind in China. *Acta Anthropologica Sinica 9*:312-323.

Wu Xinzhi. 1992a. Origin and affinities of the stone age inhabitants of Japan. In： Hanihara K. (eds.), *International Symposium on Japanese as a Member of the Asian and Pacific Populations*. Kyoto: International Research Center for Japanese Studies, 1-8.

Wu Xinzhi. 1992b. The origin and dispersal of anatomically modern humans in East and Southeast Asia. In: *The Evolution and dispersal of Modern Humans in Asia*. Akazawa T. et al (eds.), Hokusen-sha, Tokyo, pp373-377.

Wu Xinzhi. 1995. The continuity of human evolution in east Asia. In: *The origin and past of modern humans as viewed from DNA*. Brenner S. and Hanihara K. (eds.), World Scientific, London, pp 267-282.

Zhang Zhenbiao, 1989. Neolithic human skeletons in China. In: *Early Humankind in China*. Wu Rukang, Wu Xinzhi and Zhang Senshui (eds.), Beijing: Science Press, 62-80.

Zhang Zhenbiao and Chen Dezhen, 1984. The Neolithic residents race type at Xiawanggang. *Prehistory 1*:69-76.

Zhu Kezhen, 1972. The preliminary study of climate changes of China in the past five thousand years. *Acta Archaeologia Sinica 1*:15-38.

Table 1 The dental collections used in present study

Site	Number	Provenience
1. Xiawanggang	156	Neolithic (5000 years BP) excavated in Xichuan County, Henan Province
2. Miaozigou	28	Neolithic (5500-5000 years BP) excavated in Inner Mongolia
3. Longxian	140	Zhanguo Period (2000 years BP) excavated in Shaanxi Province

Table 2 The fossil teeth used in present study

Site and Province	Speciments	Age (in thousands of years)
Yuanmou, (Yunnan Province)	two upper incisors	1700, 500-600
Lantian, (Shaanxi Province)	one mandible	650
Zhoukoudian (near Beijing)	one upper incisor, two upper premolars, two lower molars, one mandible	230-500
Yunxian, (Hubei Province)	one upper incisor, one upper premolar, one upper molar, one lower incisor	*Homo erectus*
Xichuan, (Henan Province)	one upper canine, two upper premolars two upper molars, three lower premolars, five lower molars	*Homo erectus*
Jinniushan	a complete skull	210-300
Dingcun (Shanxi Province)	two upper incisors, one upper canine, one upper premolar, one lower molar	160-210
Tongzi, (Guizhou Province)	one upper incisor, one upper premolar	172-192
Liujiang	a complete skull with teeth	670
Upper Cave	a mandible	10.47

Table 3 The frequency distributions of 28 dental morphological traits in some Asian populations

	UI1 Winging		UI1 Shovel		UI1 Double-shovel		UI2 Interrup groove		UI2 Tuberculum dentale		UC Mesial ridge		UC Dist accessary ridge		UM2 Hypocone		UM1 Cusp 5		UM1 Carabelli's cusp	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Longxian	30.0	10	86.7	15	47.4	19	54.8	31	22.5	31	4.5	22	80.0	15	97.8	45	3.6	55	5.6	54
Xiawanggang	33.3	6	90.1	71	52.7	74	46.2	78	35.9	78	5.9	101	45.3	53	98.3	120	4.0	125	0.0	128
Miaozigou			100.0	17	57.9	19	75.0	20	45.0	20	0.0	24	46.2	13	88.2	18	16.7	18	11.8	17
Siberia	28.0	75	61.4	44	58.3	24	53.7	67	32.8	61	0.0	90	54.5	22	76.1	138	3.2	63	18.4	109
Amur	47.2	36	64.7	17	78.9	19	29.6	27	11.1	27	11.1	27	53.9	13	82.7	52	21.4	42	26.6	60
Lake Baikal	35.3	17	92.4	13	70.0	10	35.7	14	25.0	16	6.3	16	33.3	3	100.0	24	66.7	3	30.0	10
N China-Mon	29.4	261	84.0	200	30.0	213	46.7	210	19.1	246	2.4	255	66.4	125	90.4	406	28.1	295	30.5	374
Japan	21.9	265	66.0	276	43.8	267	44.5	301	15.5	304	3.0	365	57.9	240	86.5	482	19.7	390	31.2	458
Jomon	19.9	166	25.7	117	1.4	138	64.6	189	23.9	201	2.2	136	69.3	49	82.0	206	31.5	146	8.3	181
Yayoi 1			90.4	42											84.3	51			14.5	62
Yayoi 2			92.5	40											95.8	23			12.2	41
Hong Kong	23.1	295	63.8	307	28.5	299	42.8	283	19.1	298	3.0	305	54.6	249	90.3	299	21.7	276	37.6	301
South China	34.3	35	74.4	35	24.2	33	27.3	44	11.4	44	3.6	55	80.7	26	86.0	93	16.1	62	25.3	99
Pre Taiwan	20.0	15	59.1	22	38.1	21	53.3	15	14.3	14	0.0	10	42.9	7	85.2	27	22.2	9	33.3	15
E SE Asia	29.2	96	32.3	99	10.0	100	43.8	105	27.4	113	2.5	120	56.8	44	93.1	189	37.1	132	37.1	140
R SE Asia	37.5	16	46.2	13	28.5	14	31.3	16	23.5	17	2.6	39	41.2	17	87.3	102	13.5	74	41.9	93
Thailand	28.9	128	37.0	27	9.0	111	30.5	128	19.5	128	7.7	143	47.4	80	89.8	196	28.7	143	40.2	179
Early Malay	13.0	23	29.6	71	28.4	67	32.1	84	32.1	84	9.7	103	50.8	63	89.1	156	24.4	90	23.0	100
East Malay	0.0	11	8.3	12	0.0	3	30.8	13	23.1	13	6.3	16	88.9	9	86.2	29	45.5	22	50.0	28

Table 3 The frequency distributions of 28 dental morphological traits in some Asian populations (continued)

	UM3 Parastyle		UM1 Enamel extension		UP1 1-root		UM2 3-roots		UM3 P/R/CA		LP2 >1 lingual cusp		LM2 Y-groove pattern		LM1 6-cusps		LM2 4-cusps	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Longxian	0.0	27	55.9	59	71.0	69	71.4	56	55.4	56	75.0	48	5.7	53	46.2	65	18.5	54
Xiawanggang	3.2	93	51.7	120	68.5	149	77.4	115	16.2	111	77.8	135	5.8	155	14.8	162	27.6	156
Miaozigou	5.6	18	81.3	16	60.7	28	88.9	18	15.4	13	87.0	23	12.5	16	31.3	16	18.8	16
Siberia	1.0	104	48.5	239	91.3	264	57.7	170	21.9	256	40.9	66	20.2	89	50.0	46	3.5	86
Amur	0.0	27	52.8	89	97.3	111	36.5	85	41.7	103	71.8	39	16.1	56	50.0	44	11.5	52
Lake Baikal	13.3	15	18.7	32	80.0	30	35.7	28	15.6	32	72.7	11	4.8	21	33.3	9	22.2	18
N China-Mon	9.2	131	51.4	514	77.1	419	60.5	390	52.9	380	81.1	276	6.5	338	37.4	211	17.1	258
Japan	1.7	234	54.6	522	75.1	506	68.9	495	42.1	504	66.0	341	13.1	352	42.7	314	13.6	345
Jomon	5.3	207	9.7	278	75.5	241	46.9	254	13.0	338	63.6	294	32.1	290	46.7	214	28.7	244
Yayoi 1															41.5	53	12.5	56
Yayoi 2															47.6	42	18.5	27
Hong Kong	3.4	145	55.6	97	61.9	113	70.7	92	37.4	238	66.4	319	7.5	228	33.7	267	24.3	296
South China	4.4	68	59.8	107	67.3	113	76.1	109	25.0	124	77.7	72	12.5	80	40.0	60	19.5	77
Pre Taiwan	0.0	18	50.0	28	81.8	22	66.7	15	14.3	28	79.2	24	10.5	19	46.7	15	19.9	21
E SE Asia	4.9	122	25.6	203	54.5	154	81.3	112	14.4	160	76.5	157	17.1	187	36.8	136	38.7	163
R SE Asia	4.1	74	40.5	116	66.4	119	78.1	114	12.8	125	61.5	52	15.7	83	27.9	61	31.6	79
Thailand	7.0	128	38.5	166	66.1	168	80.6	144	18.4	206	63.9	147	19.3	176	28.3	120	25.8	163
Early Malay	6.5	93	18.4	87	67.7	62	62.2	74	0.0	104	85.7	105	19.4	139	45.5	99	24.6	130
East Malay	0.0	23	35.5	31	53.3	30	79.3	29	25.0	32	71.4	21	20.0	25	38.9	18	45.8	24

Table 3 The frequency distributions of 28 dental morphological traits in some Asian populations (continued)

	LM1 Deflect wrinkle		LM1 Dist trigo crest		LM1 Protostylid		LM1 Cusp 7		LP1 Tome's root		LC 2-roots		LM1 3-roots		LM2 1-root		P Odontome	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Longxian	61.9	13	25.0	20	14.3	63	1.7	60	47.4	57	1.3	76	26.3	76	34.3	70	1.1	268
Xiawanggang	60.3	73	37.0	92	23.2	181	2.6	155	70.1	137	0.7	152	36.4	187	31.0	184	0.6	831
Miaozigou	100.0	13	50.0	14	53.3	15	11.8	17	76.0	25	3.7	27	47.6	21	27.8	18	1.6	192
Siberia	74.4	43	7.2	83	22.2	87	5.2	96	8.1	62	0.0	130	23.2	164	21.7	143	0.0	54
Amur	71.1	38	20.4	49	7.5	53	7.3	55	13.5	37	0.0	76	20.3	74	61.0	77	5.0	40
Lake Baikal	0.0	2	0.0	5	30.8	13	19.0	21	16.7	12	3.7	27	23.3	30	48.0	25	0.0	6
N China-Mon	29.2	89	5.7	158	30.1	332	9.4	341	5.3	94	0.0	219	34.0	406	42.2	358	4.0	231
Japan	14.9	262	18.0	334	21.2	353	6.5	382	10.0	200	1.2	335	24.2	429	32.9	407	5.0	462
Jomon	4.9	162	6.8	292	13.3	233	5.3	285	3.2	282	1.0	203	3.4	377	9.8	336	0.4	260
Yayoi 1	41.3	46	14.0	50	9.4	64	4.2	72										
Yayoi 2	48.6	35	21.6	37	8.7	46	4.3	47										
Hong Kong	9.8	215	5.3	227	21.9	274	8.8	295	14.0	107	0.0	116	18.4	98	36.7	98	7.6	314
South China	17.9	39	7.9	63	24.7	85	10.6	85	31.9	47	0.0	66	15.0	100	33.7	92	0.0	94
Pre Taiwan	44.4	9	25.0	16	6.9	29	6.1	33	7.7	13	0.0	14	4.0	25	38.1	21	0.0	17
E SE Asia	31.6	76	6.3	96	27.5	171	9.7	217	23.8	84	0.9	112	9.7	237	17.0	165	1.2	83
R SE Asia	19.4	36	10.8	65	18.9	74	7.1	84	25.0	28	0.0	89	17.0	94	29.5	95	3.2	63
Thailand	18.8	80	10.2	128	28.3	166	6.2	178	18.7	91	1.3	157	10.8	186	31.1	180	4.2	189
Early Malay	10.6	66	6.0	116	12.9	124	4.6	131	18.4	76	0.0	80	6.3	142	33.3	105	4.2	120
East Malay	0.0	17	10.0	20	8.7	23	4.0	25	36.9	19	0.0	27	14.3	28	29.6	27	0.0	25

Note: Xiawanggang, Miaozigou and Longxian are my data. Datas of Japan, Jomon, Yayoi 1 and Yayoi 2 are cited from Hanihara T. (1992b). The remaining datas are from Turner (1987, 1990).

Table 4 The distributions of 8 dental morphological trait frequencies in some Asian populations

	UI1 Shovel		UI1 Double-shovel		UP1 1-root		UM1 Enamel extension		UM3 P/R/CA		LM1 Deflect wrinkle		LM1 3-roots		LM2 4-cusps	
	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
Longxian	86.7	15	47.7	19	71.0	69	55.9	59	55.4	56	61.9	13	26.3	76	18.5	54
Xiawanggang	90.1	71	52.7	74	68.5	149	51.7	120	16.2	111	60.3	73	36.4	187	27.6	156
Miaozigou	100.0	17	57.9	19	60.7	28	81.3	16	15.4	13	100.0	13	47.6	21	18.8	16
Anyang	89.9	118	32.4	142	69.9	143	57.6	224	32.6	215	87.5	8	38.4	172	12.6	103
South China	77.0	26	79.2	24	66.7	66	62.1	66	24.4	78	29.6	27	14.3	70	16.7	54
Hong Kong	53.3	92	42.7	89	61.3	111	57.5	94	31.3	96	23.4	47	18.9	95	27.4	84
Lake Baikal	92.4	13	70.0	10	80.0	30	18.7	32	15.6	32	0.0	2	23.3	30	22.2	18
Mongol	82.1	56	34.0	53	78.9	114	42.9	147	45.7	138	36.0	36	38.9	90	14.3	63
Japan	80.0	20	52.2	23	72.5	138	56.2	130	43.7	126	48.5	64	26.9	119	10.9	92
Amur	64.7	17	78.9	19	97.3	111	52.8	89	41.7	103	71.1	38	20.3	74	11.5	52
Siberia	61.4	44	58.3	24	91.3	264	48.5	239	21.9	256	74.4	43	23.2	164	3.5	86
Eskimo	68.2	132	54.7	117	95.7	767	46.3	703	17.9	786	51.7	176	26.9	598	3.5	372
Early Thailand	31.2	109	19.6	112	51.6	159	26.0	204	16.2	148	45.1	82	9.3	237	37.7	175
Recent Thailand	31.1	74	25.4	59	67.3	107	35.8	109	18.8	128	23.4	47	11.3	133	19.0	100
Burma	13.3	15	23.1	13	65.9	138	36.5	126	17.6	142	0.0	14	13.5	37	21.4	28
Early Malay	23.8	21	5.9	17	50.0	30	5.4	37	0.0	38	30.8	13	6.0	50	50.0	30
Malay-Java	20.0	40	13.6	22	55.1	205	36.8	198	22.0	186	36.2	58	13.1	130	36.8	117
Borneo	27.2	22	11.1	18	53.2	141	34.1	94	27.2	114	25.0	36	13.8	94	25.9	58
Philippine	48.1	27	18.8	16	67.7	155	43.1	123	19.8	126	31.0	58	17.4	121	28.3	92
Prehist Taiwan	59.1	22	38.1	21	81.8	22	50.0	28	14.3	28	44.4	9	4.0	25	19.9	21
Jomon	36.1	36	22.2	59	68.5	73	13.1	76	14.1	135	11.1	72	5.0	100	31.8	66
Ainu	28.4	53	5.9	51	90.2	61	44.5	36	50.9	53	42.9	56	6.4	47	52.6	78

Note: Except Longxian, Xiawanggang and Miaozigou, all data are cited from Turner (1990)

Table 5 Mean Measure of Divergence (MMD) for 17 groups based on 28 traits

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 Longxian	0.0000																
2 Xiawanggang	0.0452	0.0000															
3 Miaozigou	0.1410	0.0805	0.0000														
4 Siberia	0.1199	0.2250	0.2814	0.0000													
5 Amur	0.1152	0.2477	0.2998	0.0920	0.0000												
6 Lake Baikal	0.1877	0.2172	0.3431	0.2102	0.1193	0.0000											
7 North China-Mongol	0.1019	0.2380	0.3128	0.1478	0.1323	0.0479	0.0000										
8 Recent Japan	0.1142	0.2506	0.3767	0.1119	0.1291	0.0603	0.0311	0.0000									
9 Jomon	0.3635	0.4902	0.7624	0.2959	0.4096	0.2532	0.2475	0.2012	0.0000								
10 Hong Kong	0.1315	0.2406	0.3786	0.1711	0.1801	0.0561	0.0379	0.0112	0.1878	0.0000							
11 South China	0.0733	0.1707	0.2666	0.1577	0.1629	0.0913	0.0519	0.0384	0.2088	0.0279	0.0000						
12 Prehistoric Taiwan	0.0667	0.1615	0.2511	0.0455	0.0350	0.0488	0.0437	0.0188	0.1437	0.0202	0.0236	0.0000					
13 Early SE Asia	0.2121	0.2770	0.3903	0.2230	0.2886	0.1338	0.1451	0.1179	0.1141	0.0783	0.0805	0.0446	0.0000				
14 Recent SE Asia	0.1410	0.1781	0.3096	0.1289	0.1628	0.0675	0.0948	0.0443	0.1640	0.0159	0.0269	-0.0085	0.0207	0.0000			
15 Thailand	0.2083	0.2742	0.4013	0.2048	0.2361	0.1116	0.1149	0.0782	0.1314	0.0415	0.0550	0.0297	0.0154	-0.0044	0.0000		
16 Early Malay	0.2763	0.3093	0.5094	0.2378	0.2639	0.1044	0.1992	0.1376	0.1143	0.1144	0.1196	0.0461	0.0620	0.0465	0.0628	0.0000	
17 East Malay	0.3120	0.4441	0.6285	0.3844	0.4009	0.2477	0.2257	0.1564	0.1225	0.1041	0.1181	0.1297	0.0545	0.0864	0.0562	0.0835	0.0000

Table 6 The occurrence of shovel and double-shovel upper incisors in fossil teeth of some early humans from China

Fossil teeth and Provenience	shovel	double-shovel
two central incisors Yuanmou County, Yunnan Province	present	trace
one central incisor from Zhoukoudian near Beijing	present	trace
one central incisor Yunxian County, Hubei Province	present	trace
one central incisor from Shanxi Province	present	marked
one central incisor from Guizhou Province	present	absent
Liujiang Man skull from south China	?	absent