

Skeletal Morphology of the Jomon People

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ABSTRACT

The Jomon people were different from modern Japanese with many distinctive skeletal characters, such as the prominent glabella and nasal bones, broad and low face, edge-to-edge bite, long distal limb segments, flat tibial shaft, and so on. Most of these characteristics are shared by the modern Ainu in Hokkaido. The modern Japanese, on the other hand, share their characteristic features, such as the flat frontnasal profile, projecting upper incisors, relatively short distal limb segments, and so on, with the Mongoloid peoples in the Asiatic mainland.

Drastic physical changes occurred to the Japanese inhabitants during the Yayoi and Kofun periods under strong genetic and cultural influences of the immigrants from the mainland who introduced agriculture and other technology to these islands. The influences spread rapidly over Honshu but slowed down as they went to the north, thus allowing the Ainu to retain physical characters of the native Jomon population.

The Jomon-Ainu cluster is quite isolated morphologically among the Neolithic and later populations in East Asia. They share many archaic characters with the Upper Palaeolithic population in Eurasia. Among the fossil sapiens remains from East Asia, the Liujiang skull from South China and Minatogawa skull I from Okinawa are relatively close to the Jomon, while the Zhoukoudian Upper Cave series from Beijing is rather remote.

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Since the Japanese islands were detached from the Asiatic mainland by the postglacial rise of sea-level in early Holocene, around 10000 years B.P., there developed a unique cultural tradition that is called the "Jomon Culture" after the characteristic potteries with *jomon* (cord-mark) ornaments. Although potteries and polished stone implements were quite popular as in the continental Neolithic cultures and some remains of a few cultivated plants are sporadically found, the basic subsistence economy of the Jomon people is generally thought to have largely depended on hunting and foraging as in the Paleolithic or the Old Stone Age. The Jomon period lasted until about 300 B.C., when it was succeeded by the Yayoi period. The transition was marked with the introduction of rice farming and metal tools from the Continent of Asia.

The soil condition in Japan is generally unfavorable for bone preservation under the acidifying influence of extensive fall of volcanic ash. However, people of the later half of the Jomon period left a number of shell mounds (or shell middens) along the bay shore, and interred the remains of the deceased in or around them. Most of the human skeletal remains of the Jomon period, now available for research, have been excavated from these shell mounds that afforded ideal alkaline environment for bone preservation with exceptionally high concentration of calcium ion. Discussions on the skeletal morphology of the Jomon people in this paper are mostly based on those materials of the later half of the Jomon period that had been preserved in those shell mounds.

The Jomon people were different from the modern Japanese people with many distinctive morphological characters (Yamaguchi, 1982). As shown in Figs. 1 and 2, they had larger (longer and broader) braincase, heavier glabella and brow ridges, broader and lower facial skeleton, deep-set frontonasal suture, more prominent nasal bones, lower and wider eye sockets and nasal opening, more nearly vertical subnasal profile, edge-to-edge bite of the front teeth, stronger masticatory muscle markings, relatively heavier tooth attrition, less curved lower border of the mandible, longer, thicker, and less curved clavicles (collar-bones), shorter and more robust humeri (upper arm bones), longer forearm and hand bones, more pilastric femora (thighbones with well-developed vertical ridge on the posterior surface of the shaft), relatively longer and transversely flatter tibiae (shinbones), and larger foot bones than the Japanese of later times. Fig. 2 shows the midshaft cross section of a Jomon femur with the 'pilaster' or the vertical posterior ridge, and the lozenge-shaped cross section of the midshaft of a Jomon tibia with sagittally large and transversely small diameters. Such flatness of the tibial shaft is called 'platycnemia'.

The Jomon people share many of these distinctive skeletal characters with the Ainu in Hokkaido. The large braincase with the prominent glabella, the low and broad face with the high nasal bridge and the oblong orbital margins, the edge-to-edge bite, the long forearm and lower leg in relation to the upper arm and thigh, and the flattened midshaft of the shinbone are the characteristics of the Jomon as well as of the Ainu skeletons.

The recent Japanese, on the other hand, share their characteristic morphological features, such as the flat frontnasal profile, round eye sockets, more or less projecting upper front teeth, and relatively short distal limb segments, with the Koreans, the Chinese, and other Mongoloid peoples in the Asiatic mainland.

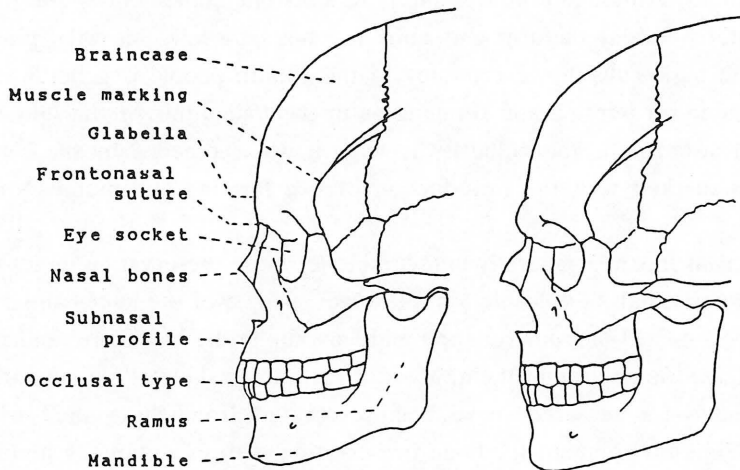


Fig.1 Comparison of the lateral views of a Kofun skull (left) and a Jomon skull (right).

As long as the people of the later half of the Jomon period represented by the remains from shell mounds are concerned, little geographical variation can be discerned in their skeletal morphology. It is true that the cranial height of the Jomon remains slightly increases from west to east and the facial flatness slightly increases from east to west (Yamaguchi, 1980), but, in their craniometric totality, local Jomon samples from shell mounds in different parts of Honshu are as homogeneous as the recent Japanese samples from different districts in Honshu. Fig. 3 is a three-dimensional representation of the Penrose's shape distances between three Jomon and three modern Japanese regional series based on 22 cranial measurements. The Jomon and modern Japanese series form two separate clusters of much the same sizes, and the divergence between those two clusters is much greater than the geographic variations within each cluster.

Our knowledge on the people from the earlier half of the Jomon period is still quite limited because of the relative scarcity of skeletal materials. Most of the earlier Jomon skeletal remains have been excavated from cave sites in the mountains rather than from shell mounds along the shore. Contrary to our expectation, many of the earlier Jomon remains from cave sites are relatively gracile with the low facial skeleton and the thin limb bones. Shown in Fig. 4 is a gracile skull with the very low face from the Earliest phase of the Jomon period that was excavated at the Nakatsugawa Cave site in the island of Shikoku (Dodo, 1976). We do not know whether the difference in the prevalence of skeletal gracility or robustness between the earlier and the later Jomon peoples is due to the environmental differences between the inland and maritime habitats or to some genetic influences from the outside in the middle of the Jomon period. To answer this question, we need to have much more skeletal materials from the earlier Jomon period.

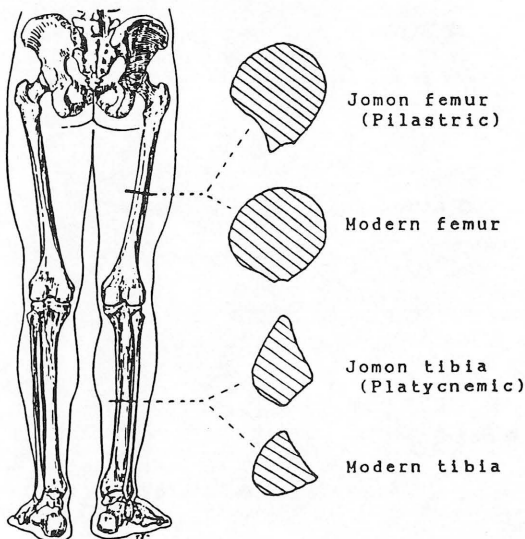


Fig.2 Comparison of the midshaft cross sections of the Jomon and the modern thighbones and shinbones.

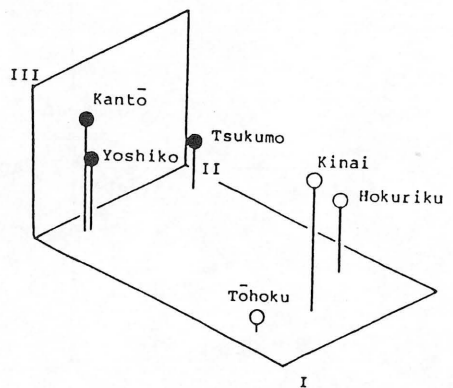


Fig.3 Three-dimensional reduction of the Penrose's shape distances between the Jomon (●) and the modern Japanese (○) regional series based on 22 cranial measurements.

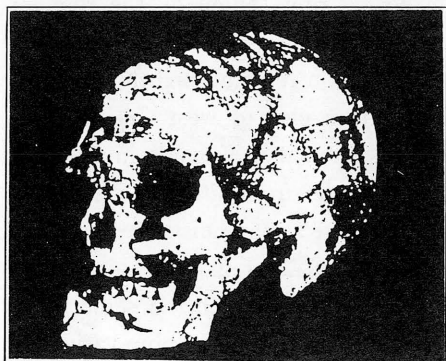


Fig.4 An Earliest Jomon skull from Nakatsugawa Cava in Shikoku.

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Fig. 5 gives the result of distance analyses of the Jomon and recent East Asian and some Oceanian populations by means of the Mahalanobis' generalized distance (See Hanihara, 1981, 1983 for the sources of modern Japanese data, and Yamaguchi, 1982 for the sources of other data) . The following eight measurements of male crania were used so that the general cranio-facial size and shape could be represented: the length (1), breadth (8), and height (17) of the braincase, the length (40), breadth (45), and height (48) of the facial skeleton, the length (5) of the cranial base, and the minimum frontal breadth (9). The numbers in parentheses are those assigned in the craniometric system of Martin (Bräuer, 1988).

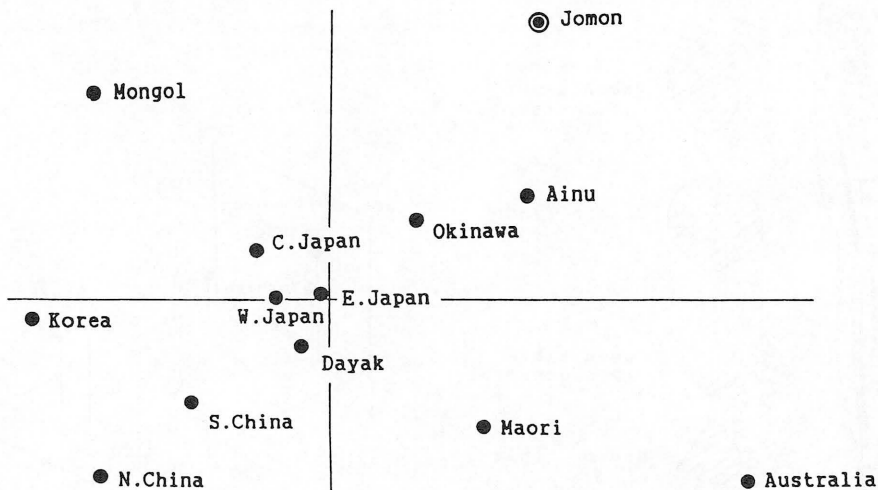


Fig.5 Two-dimensional reduction of the Mahalanobis' distances between the Jomon and the 12 modern population samples from East Asia and Oceania, based on 8 measurements of male crania.

As shown in the figure, the Jomon and the mainland Mongoloid peoples are the most divergent from each other, and the recent Japanese and the Ainu lie between them. Of the two intermediate populations, the Japanese is closer to the Mongoloid in the mainland and Indonesia, whereas the Ainu is much nearer to the Jomon. Local subseries of the Japanese from the east (Kanto and Tohoku districts), from the center (Kinki district), and from the west (Kyushu district) resemble each other closely and form a tight cluster, but the Okinawans (Ryukyu Islanders) are slightly apart from them, drawing toward the Ainu and the Jomon. Similar distance patterns between the mainland Mongoloid, the Japanese, the Ainu, and the Jomon have been observed also in the analyses of non-metric cranial characters by Ossenberg (1986), Dodo & Ishida (1990), and Kozintsev (1990).

After a long debate, it is now widely accepted that the drastic changes which occurred to the skeletal morphology of the inhabitants of the Japanese islands in the post-Jomon periods were caused by strong genetic and cultural influences of the immigrants from the mainland who introduced the Continental civilization based on rice farming to these retarded islands during the Yayoi period (300 B.C. to A.D. 300) and the Kofun period (A.D. 300 to 700). Peoples of novel features, such as the high facial skeleton, round eye-sockets, flat nasal bridge, over-bite of the front teeth and relatively tall stature, emerged first in northern Kyushu and the westernmost part of Honshu during early Yayoi period, and then spread to eastern Honshu by the end of the Kofun period. Their influence extended rapidly over the islands of Kyushu, Shikoku, and Honshu where physical condition was adequate for rice cultivation. However, as it advanced to the north and the south, the spread was slowed down and allowed the Ainu in Hokkaido and the Okinawans in the Southwestern islands to retain the characters of the native Jomon population to a greater extent than the people in Honshu, Shikoku, and Kyushu.

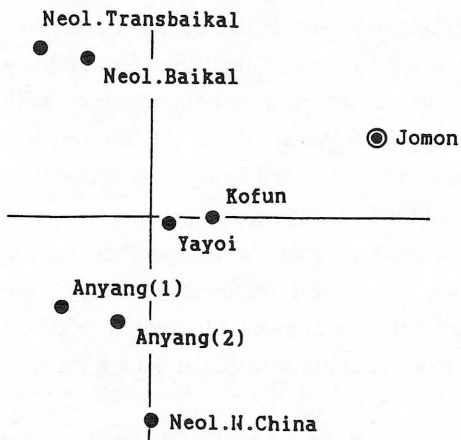


Fig.6 Mahalanobis' distances between the Jomon and other pre- and protohistoric cranial series from East Asia.

The Jomon period spanned several millennia before 300 B.C. Metric data of sizable cranial series of comparable ages are available, in East Asia, for the Neolithic Northern Chinese of the Yangshao and Longshan periods (Han & Pan, 1979, etc.), the Neolithic Pribaikalian and Transbaikalian populations (Debets, 1951; Alekseev & Gochman, 1983), and the Bronze Age Northern Chinese from the Shang sites at Anyang (Institute of History and Institute of Archaeology, Chinese Academy of Social Sciences, 1985). All of them are definitely Mon-

goloid in morphology and show little similarity to the Jomon series. The two-dimensional reduction of the Mahalanobis' distances between the Jomon and other prehistoric and early historic East Asian populations in Fig. 6 demonstrates that none of those continental series of early Holocene is akin to the Jomon. A cluster analysis of Northeast Asian Neolithic cranial series carried out by Trubnikova (1980) also showed that the Japanese Jomon series was quite apart from all others.

Thus the Jomon seems to be isolated in East Asia, either compared with the modern populations or with the early Holocene populations. The only population that is moderately close to the Jomon is the Ainu in Hokkaido. On the other hand, both the Yayoi (Kanaseki, et al., 1960, etc.) and the Kofun (Yamaguchi, 1987) series are away from the Jomon, and much closer to the proto-historic series from Anyang in North China.

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From an evolutionary point of view, the Jomon people retained a number of archaic characters that were shared by Eurasian Upper Paleolithic hunter-gatherers, such as the Cro-Magnon people in Europe. The large braincase, prominent glabella and strong brow ridges, low, angular and oblong eye-sockets, relatively long distal limb segments, robust femora with the pilastric ridge, and platycnemic tibiae may be cited as examples of such archaic characters. They were a physically conservative population who maintained, in the isolated insular climate, the basic morphological pattern of the early anatomically modern population until as late as the last millennium B.C. The Jomon affinity should thus be looked for among the Late Pleistocene fossil *Homo sapiens* populations rather than among the Neolithic and later populations of the Holocene epoch.

Japan had been peopled by way of land bridges or narrowed straits during the Late Pleistocene, since 30000 years B.P. at the latest, as demonstrated by many Paleolithic sites yielding abundant stone artifacts. However, fossil human remains are still rare and fragmentary, with the only exception of those from the Minatogawa quarry in Okinawa Island. All the remains from Honshu are so fragmentary that little information can be obtained from them other than that they were considerably smaller in body size than the modern Japanese.

Fossil limb bone fragments from the Honshu island of the Late Pleistocene and their stature reconstructions made by Suzuki (1981) are as follows: a humeral fragment (female) from Ushikawa in Aichi Prefecture, 135cm; a femoral fragment (male) from Mikkabi in Shizuoka Prefecture, 150cm; and a humeral fragment (female) from Hamakita in Shizuoka Prefecture, 143cm.

The fossil remains from Minatogawa in Okinawa Island were found by S. Ohyama, a local fossil collector from 1968 to 1970. They were dated to around 18000 B.P., and described in details by H. Suzuki, K. Hanihara and others (Suzuki & Hanihara (eds.), 1982). Among the four skeletons in varying conditions of preservation, Minatogawa I is the only male skeleton with the nearly complete skull and well-preserved postcranial bones. This young adult fossil man, about 155cm tall, resembles the average Jomon man with the low and broad facial skeleton, the prominent glabella, and many other facial features, but differs from the Jomon with the narrow forehead, short clavicles, non-pilastric femora, relatively short distal limb seg-

ments, and other skeletal features.

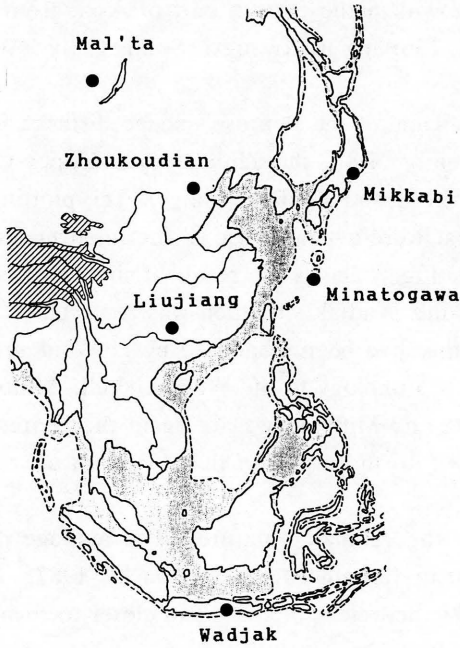


Fig.7 Late Pleistocene *Homo sapiens* remains from East Asia.

Fig.8 Two-dimensional reduction of the Penrose's shape distances between the Jomon and the fossil skulls based on 9 measurements.

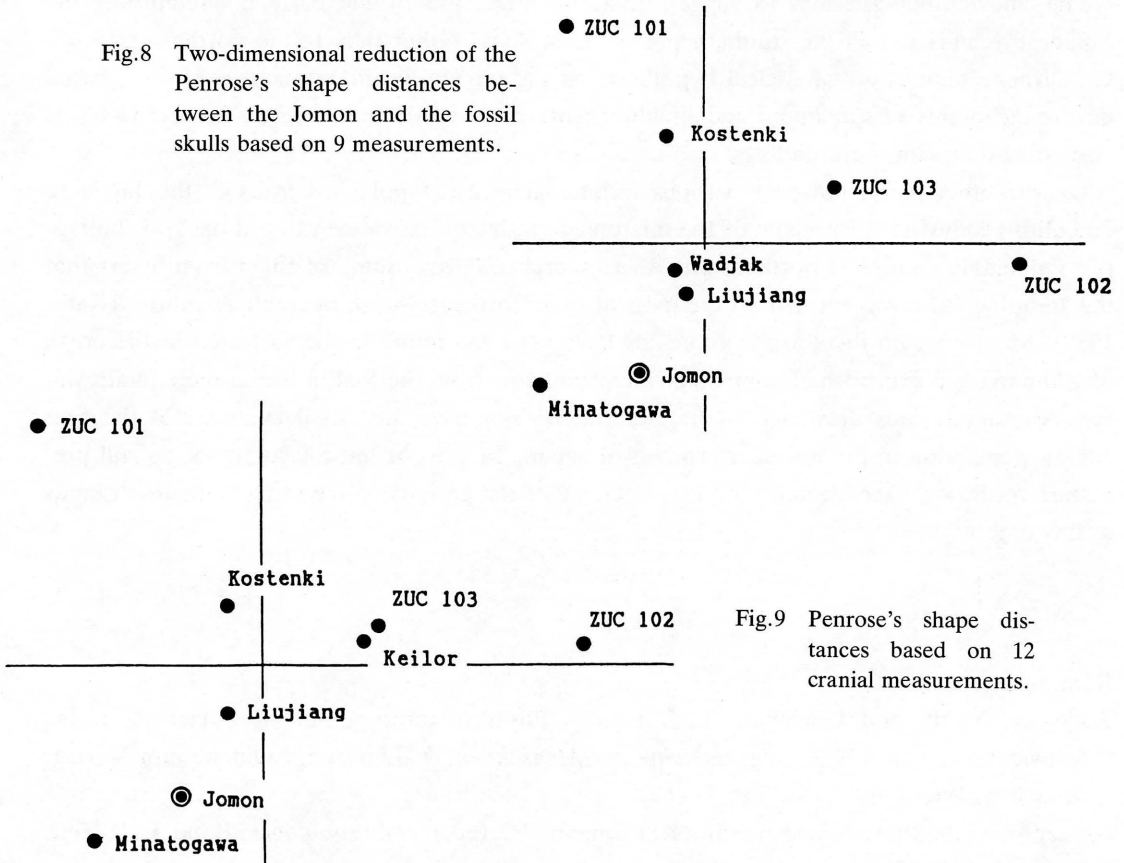


Fig.9 Penrose's shape distances based on 12 cranial measurements.

Fossil sapiens skulls of comparable ages are known, in the eastern part of Asia, from the Zhoukoudian Upper Cave in Beijing (Wu, 1961), Liujiang in Kwangxi, South China (Woo, 1959), and Wadjak in Java (Dubois, 1921) (Fig. 7).

Distance analyses of cranial measurements by means of the Penrose's shape distance indicate that the average Jomon skull is relatively remote from the Zhoukoudian Upper Cave skulls and nearer to those from Liujiang, Minatogawa, and Wadjak (Fig. 8). The plotting in Fig. 8 is based only on the nine measurements that were available for all the fossil materials including the rather incomplete Wadjak specimen. Fig. 9 shows the result of similar distance analysis based on 12 measurements. In this case, the Wadjak specimen was replaced by the better preserved Keilor specimen from Australia that had been diagnosed by F. Weidenreich (1945) as quite similar in both measurements and morphology to the Wadjak skull. Although the Keilor specimen is rather remote, the Liujiang and Minatogawa are again the nearest to the Jomon, and the Upper Cave and Kostenki from northern part of the Continent are more distant from the Jomon.

A similar difference can also be recognized in the estimated statures. The average male Jomon stature is estimated to be around 159-160cm (Hiramoto, 1972; Kouchi, 1987). It is much lower than 174cm of the Upper Cave 101 (Weidenreich, 1938-39) and closer to the 150-155cm of the Liujiang man and 155cm of Minatogawa I.

The above findings seem to suggest that the homeland of the early inhabitants of the Japanese islands was in the southern part of East Asia, rather than in the northern part. C. G. Turner's famous odontological hypothesis on the circum-Pacific population history, based on the dichotomy of sundadont and sinodont patterns of tooth morphology (Turner, 1987), is also consistent with these findings.

On the other hand, however, various technological and typological traits of the Japanese Paleolithic industries, especially of the microblade industry, have been traced back to the Upper Paleolithic culture in northeastern Asia by archeologists. Some of them even assert that the Jomon culture was formed on the basis of that Northeast Asian microblade culture (Kato, 1988). Moreover, no fossil sapiens remains have yet been found in the vast area to the north of Zhoukoudian except the fragmentary infant remains from the Mal'ta site in the Angara valley. Another serious drawback is that we still do not have any fossil evidence of the pre-Jomon population in the northeastern half of Japan. In view of these facts, it seems still premature to draw a conclusion on the major source of the early peopling of the Japanese islands at this time.

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縄文時代人の骨格の形態

山口 敏

縄文時代人は現代日本人に比較して、脳頭蓋が大きく、眉間と眉稜が発達し、顔が幅広く低く、前頭鼻骨縫合部が深くくぼみ、鼻骨が隆起し、眼窩と鼻孔が幅広く、鼻下部は垂直に近く、歯の咬み合わせは鉗子状で、鎖骨は長く、上腕骨が短く頑丈で、大腿骨の後面には付柱状の隆起が発達し、脛骨は扁平で相対的に長い、などの特徴をもっている。これらの形態的特徴のほとんどは北海道のアイヌにも共通して認められる。一方、現代日本人は、眉間から鼻骨にかけて平坦で、眼窩は円く、上顎の切歯が傾斜し、四肢骨の遠位部分が相対的に短いなどの特徴を、朝鮮人、中国人など、アジア大陸のモンゴロイド諸集団と共有している。

東アジアの諸集団の相互類似度を頭蓋計測値によるマハラノビス距離で調べると、縄文人と大陸のモンゴロイドはもっとも遠く離れ、日本人とアイヌがその中間に位置するが、日本人は大陸の集団に近く、アイヌは縄文人の方に近い。縄文時代のあとに日本列島の住民におこった形態上の著しい変化が、弥生時代から古墳時代にかけて大陸から移住してきた人々の遺伝的・文化的影響によるものであることは、広く認められている。その影響は九州・四国・本州には急速にひろがったが、北に行くにしたがって弱まり、その結果としてアイヌのなかに縄文人の形質が比較的濃厚に保存されたと考えられる。

縄文時代と平行する時期の東アジアの頭蓋資料としては、東シベリアと華北地方の新石器時代人と、安陽の青銅器時代人のそれがある。これらはいずれも明らかにモンゴロイドの形態的特徴をもっており、縄文人との類似は全く示さない。縄文人は同時代以後の東アジアの集団と比較するかぎり、全く孤立している。

進化の観点から見ると、縄文人はユーラシアの後期旧石器時代の狩猟採集民と多くの共通点をもっている。発達した眉間、低く幅広い眼窩、付柱型の大腿骨、長く扁平な脛骨などがそれである。かれらは孤立した列島で、初期ホモ・サピエンスの形質を長いあいだ維持してきた保守的な集団であったと言えそうである。縄文人の類縁関係は新石器時代以後の集団にはなく、むしろ更新世の化石サピエンスのなかに求めなければならない。

東アジア地域でこれまでに発見されている更新世のサピエンスについて、ペンローズの形態

距離の方法で頭蓋を比較してみると、縄文人は北京の上洞人からは遠く、中国南部の柳江人と沖縄の港川人に比較的近いことがわかる。このことは日本列島の初期住民の原郷が東アジアの南部にあったことを示唆するように見えるが、日本の旧石器文化のいくつかの要素の系統は北東アジアの旧石器文化にたどられており、その地域の人類化石もまだ明らかになっていないので、いまの段階で日本の初期植民の主な起源地を特定するのは時機尚早と考えられる。