Sundadonty and Sinodonty in Japan: The Dental Basis for a Dual Origin Hypothesis for the Peopling of the Japanese Islands

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ABSTRACT

Dental trait investigations of recent Japanese and Ainu, prehistoric Jomonese, and comparative external prehistoric populations show that Jomonese were closely related to Sundadont SE Asians, as are the Ainu, while Japanese are closely related to Sinodont NE Asians. The Yayoi ancestors of the Japanese may have originated in a South China-like population. Two separately timed migrations to Japan left descendants. These were the late Pleistocene Jomonese-Ainu, and 2,500 year old Yayoi-Japanese primary lineages. An Amur group, identified by archeological means, reached Hokkaido 15,000 years ago, but apparently failed to survive. Ainu have much Yayoi-Japanese admixture, while Japanese have some Jomon-Ainu admixture. The origins of modern Japan's population are thus best explained by a *dual origin with admixture* hypothesis. Variable Ainu and Japanese admixture provides clues to regional prehistoric events and relations. The rate of dental microevolution supports bioarcheological findings that indicate Yayoi-Japanese migrants branched from mainland Asians about 2,500 years ago.

Introduction

The study of human origins benefits from the huge suite of behavioral capabilities and biological variants found in our species. There are traits, qualities, patterns, and associations available from linguistic, ethnographic, archeological, physical anthropological, and natural historical sources that can assist in answering questions about human origins that antedate written records.

In this paper I will expand on my past dental anthropological studies on the origins and relations of the peoples of Japan based on 29 crown and root traits (Turner et al. 1991). Recent reviews on this subject include those by Suzuki (1981), Yamaguchi (1982), Brace and Nagai (1982), Hanihara (1985a, 1985b, 1986a, 1986b, 1990, and elsewhere), Howells (1986), papers by Dodo, Ossenberg, and others in Akazawa and Aikens (1986), and Anderson (1987), among others. Of the various explanatory models for the variation and characteristics of the populations of the major and southern islands, including those of certain plants and animals, the *dual origin with admixture* hypothesis probably has the most support with the widest range of evidence. Models postulating change and variation due to isolated local evolution, total replacement, secular change, and minor modifications of these themes fail on a number of grounds, most of all because they are either formulated with very restricted databases, usually lacking mainland comparisons, or they ignore or selectively use the physical anthropological literature (Ikawa-Smith 1982a; Turner 1983, 1986a). Moreover, Ikawa-Smith (1982b) has pointed out that older ideas about Japanese population history persist due to deference given to the opinion of elders. I have advocated the dual origin with admixture model since 1975 when I first made comparisons of the dental crown and root morphology in Japanese, Jomonese, Ainu, and prehistoric Chinese series curated in the University of Tokyo Museum; and at Academia Sinica, Taipei (Turner 1976). As we will see, the addition of more Japanese, Jomonese, Ainu, and other Asian dentitions has statistically strengthened this position.

Dental anthropology's diachronic and synchronic contributions to human origins research benefits from several characteristics of the dentition. Teeth evolve slowly, preserve well, and there are many independent traits to work with, including those of the roots as well as the crowns. Dental traits possess a high genetic component for occurrence and expression. Crown trait inheritance has been analyzed by Scott (1973), Hanihara et al. (1975), Harris (1977), Mizoguchi (1985), Nichol (1990), and others.

Enough has been said by way of introduction. Let us now turn to the major points of this paper:

1. Pleistocene East Asians were Sundadonts or Sinodonts.
2. Jomonese are closely related to Sundadont SE Asians.
3. Japanese are closely related to Sinodont NE Asians.
4. Yayoi originated in a South China-like population.
5. Two migrations left descendants--Jomonese-Ainu and Yayoi-Japanese. An Amur group did not survive.
6. Ainu come from Jomonese with much Japanese mixture.
7. Japanese have some admixture with Jomonese-Ainu.
8. Variable Ainu and Japanese admixture provides clues to regional prehistoric events and relations.
9. World dental evolution rate agrees that Yayoi-Japanese branched from mainland Asians about 2,500 years ago.

Discussion

1. *Sundadonts and Sinodonts.* My work on the dental evolution of East Asians is based on some 4,000 individuals from 80 sampling locations as far south as the Malay Peninsula of Southeast Asia to the far northern Chuckchi Peninsula of Siberia, with numerous coastal, island, and interior sampling points in-between these geographic extremes (Turner 1987, 1990). The major finding of my East Asian research is the identification of two geogenetic divisions for Hanihara's (1969) Mongoloid dental complex — a southern division I call Sundadonty, and a northern division called Sinodonty. Sundadonty is characterized by a retained and somewhat simplified earlier dental pattern. Sinodonty has a pattern of trait intensification so far unknown to occur before 15,000 years ago. The eight most distinctive trait frequency differences between Sundadonty and Sinodonty involve incisor shoveling, double-shoveling, molar enamel extensions, upper third molar reduction, deflecting wrinkles, and 3-rooted lower first molars, each of which is less common in Southeast Asia, while four-cusped lower second molars and two rooted upper first premolars are more common in Southeast Asians.

There is no obvious adaptive value to either pattern — both seem to be the result of random genetic changes. However, a few workers, such as Mizoguchi (1985), have proposed that some traits, for instance, incisor shoveling, may have minor adaptive value under some environmental conditions. Because there is no identifiable prehistoric clinal variation across Eurasia, the specialized Sinodont pattern had to have evolved out ot the more generalized Sundadont pattern (Turner 1988).

The geographic area in which I find Sundadonty to occur, is about the same region where Cheboksarov (1966) found facial and head features in living groups to make up his "South-Asiatic subgroup of Pacific Mongoloids." The distribution of Sinodonts matches his "Eastern

Asiatic" subgroup plus his "Continental Mongoloids." My dental correspondences with Cheboksarov are very important, because these two entirely different large databases place the Japanese and Ainu in completely different divisions of the Macro-Asian gene pool.

Elsewhere (Turner 1989) I provide the results of a worldwide clustering analysis based on some 12,000 individuals. Twenty-eight crown and root traits were employed in multivariate comparisons using the Mean Measure of Divergence statistic to assess biological relationships. The dendrogram had two main branches. In the upper main cluster occurred most of the Southeast Asian populations that make up the Sundadont division of the Mongoloid dental complex, including the Jomonese. Given the many sampling locations of this big dendrogram, it is difficult to believe that the Jomonese spread out into Oceania as Brace and Nagai (1982) have proposed. Patently, just the opposite happened. The ancestors of both the Jomonese and Oceanic peoples originated in Southeast Asia. Recent Japanese were positioned in the lower and mainly Sinodont branch, including all Native Americans and Northeast Asians. An examination of the samples from Japan and one comparative sample from China (Anyang) shows that the more than 900 Jomonese and Japanese individuals continue to form distinctly different clusters (Figure 1).

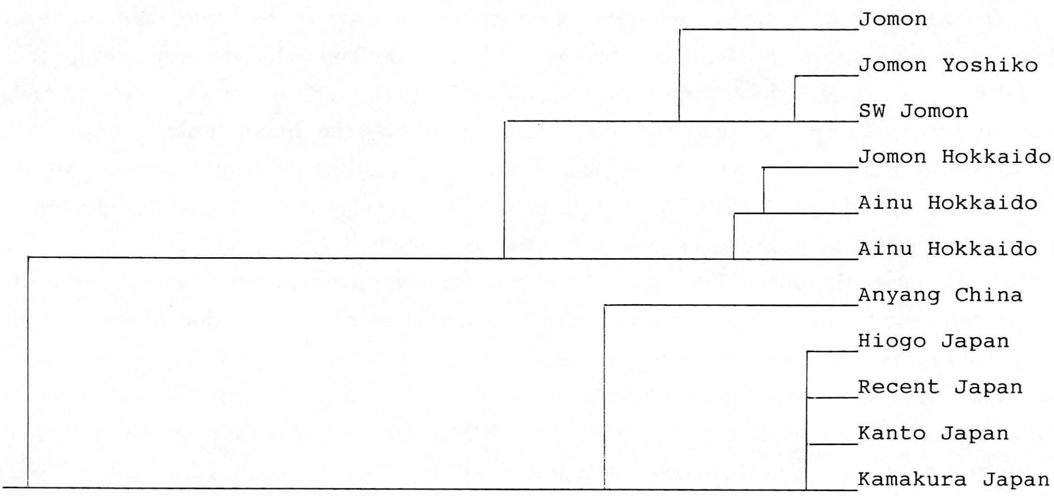

Fig. 1. Dendrogram of Japanese and Chinese odontological relationships, based on 28 traits with Mean Measures of Divergence clustered with Wards method. Computer reference: Japan 1. Trait sample size range: Jomon (16-135) individuals, Anyang China (8-224), Hiogo Japan (13-96), Kamakura Japan (54-144), Recent Japan (43-110), Jomon Hokkaido (23-103), Kanto Japanese (27-56), Ainu Hokkaido 1 (5-21), Ainu Hokkaido 2 (38-96), Jomon Yoshiko (7-81), SW Jomon (2-67).

As can be seen in Figure 1 the Jomonese and Ainu form one cluster, whereas the Anyang Chinese and Japanese from another. Brace et al. (1989) find the same sort of relationship using craniofacial measurements. Most of Howells' (1989) computer runs on craniometric data position the Ainu very far from the Japanese. More-or-less the same can be said for Omoto's (1983) genetic studies, the dental studies of T. Hanihara (1989a, 1989b), and the nonmetric cranial studies by Dodo and Ishida (1990), among other investigations.

More and better understanding of phenetic relationships can be gained by examining the actual MMD values on which Figure 1 was based (Table 1). I have five samples of recent Japanese called Japan, Japan Kamakura, Recent Japan, Kanto Japan, and Japan Hiogo. The latter series may be unfamiliar to most readers. It was excavated near Kobe in the late 1800s, and is curated in the Museum of Man, Paris, France. There are four samples of Ainu---Ainu Sakhalin, Ainu Hokkaido 1, Ainu Hokkaido 2, and Ainu 1 + 2. There are five Jomonese series---Jomon, Jomon Tsukumo, Jomon Hokkaido, Jomon Yashiko, and SW Jomon. The three comparative series are Anyang, China; Poundbury, England; and Early Malay Archipelago. Provenience and quantitative information for these series is given in Turner (1990). Poundbury is an A.D. 150 to 350 Romono-British Christian cemetery sample from Dorset, being analyzed by T. Molleson.

2. *Jomonese dental samples are much more similar to each other, Ainu, and Southeast Asians than they are like Japanese, Chinese, or British samples.* First, recall that a small MMD value indicates a closer multivariate relationship than does a larger value. In the rank-ordered Jomon divergence comparisons (Table 1), note that the Jomon series are generally more like the Early Malay Archipelago sample than they are like Ainu or Japanese. Anyang Chinese are very divergent from these Jomon samples. Clearly, the Chinese and Jomonese belonged to different genetic networks. Overall, the range of Jomon internal divergence is 0.000 to 0.105 MMD units. This is more than five times greater than the internal divergence of the Japanese samples, suggesting that the Jomonese had a longer period of internal microevolution than have the Japanese, or that the Ainu are much admixed. The Jomon-Ainu, and Jomon-Southeast Asia affinity is consistant in all Jomon samples except SW Jomon where the divergence with Southeast Asia is substantial (MMD=0.250). The SW Jomon sample may be mixed, that is, it may contain some post-Jomon individuals not recognized on archeological grounds. It is evident that the Jomonese people had their origins in late Pleistocene Southeast Asia, whereas the Japanese samples link very closely with the mainland Anyang Chinese (0.027 MMD). The very close craniological link between the Jomonese and the 17,000 year old Minatogawa skeletons from Okinawa, studied by H. Suzuki and K. Hanihara (1982), and their associates, is especially noteworthy.

Table 1. Mean Measures of Divergence (computer file World 12).

JAPAN		JAPAN HIOGO		JAPAN KAMAKURA	
Hiogo	.000	Japan	.000	Hiogo	.000
Kanto	.006	Kamakura	.000	Recent Japan	.000
Kamakura	.017	Recent Japan	.000	Kanto	.000
Recent Japan	.018	Kanto	.000	Ainu Sakhalin	.007
Ainu Sakhalin	.020	Ainu Sakhalin	.017	Japan	.017
Anyang China	.027	Ainu Hokkaido 2	.060	Ainu Hokkaido 2	.035
Ainu Hokkaido 2	.088	Anyang China	.066	Ainu 1+2	.086
Ainu 1+2	.127	Ainu 1+2	.102	Anyang China	.096
Jomon	.186	Jomon Tsukumo	.139	Jomon Tsukumo	.112
Jomon Tsukumo	.205	Jomon	.145	Jomon	.140
SW Jomon	.273	Jomon Hokkaido	.190	Jomon Hokkaido	.185
Jomon Hokkaido	.286	SW Jomon	.255	SW Jomon	.212
Early Malay Arch	.301	Early Malay Arch	.261	Jomon Yoshiko	.246
Jomon Yoshiko	.319	Jomon Yoshiko	.274	Ainu Hokkaido 1	.252
Ainu Hokkaido 1	.348	Ainu Hokkaido 1	.297	Early Malay Arch	.276
Poundbury	.407	Poundbury	.304	Poundbury	.312
RECENT JAPAN		**KANTO JAPAN**		**AINU SAKHALIN**	
Hiogo	.000	Hiogo	.000	Kanto	.001
Kamakura	.000	Kamakura	.000	Kamakura	.007
Kanto	.000	Recent Japan	.000	Ainu Hokkaido 2	.015
Ainu Sakhalin	.016	Ainu Sakhalin	.001	Recent Japan	.016
Japan	.018	Japan	.006	Hiogo	.017
Ainu Hokkaido 2	.041	Ainu Hokkaido 2	.018	Japan	.020
Ainu 1+2	.083	Ainu 1+2	.049	Jomon Tsukumo	.034
Anyang China	.105	Anyang China	.081	Ainu 1+2	.061
Jomon Tsukumo	.134	Jomon Tsukumo	.120	Jomon	.103
Jomon	.147	Jomon	.138	Anyang China	.105
Jomon Hokkaido	.178	Jomon Hokkaido	.141	SW Jomon	.114
SW Jomon	.242	SW Jomon	.200	Jomon Hokkaido	.129
Ainu Hokkaido 1	.253	Jomon Yoshiko	.205	Jomon Yoshiko	.164
Jomon Yoshiko	.253	Ainu Hokkaido 1	.235	Ainu Hokkaido 1	.197
Early Malay Arch	.277	Early Malay Arch	.278	Early Malay Arch	.197
Poundbury	.329	Poundbury	.329	Poundbury	.230
AINU HOKKAIDO 1		**AINU HOKKAIDO 2**		**AINU 1+2**	
Ainu 1+2	.042	Ainu 1+2	.004	Ainu Hokkaido 2	.004
Jomon Hokkaido	.050	Ainu Sakhalin	.015	Ainu Hokkaido 1	.042
Ainu Hokkaido 2	.056	Kanto	.018	Kanto	.049
Poundbury	.080	Kamakura	.035	Ainu Sakhalin	.061
SW Jomon	.082	Recent Japan	.041	Jomon Hokkaido	.073
Jomon Yoshiko	.084	Ainu Hokkaido 1	.056	Recent Japan	.083
Jomon Tsukumo	.128	Jomon Hokkaido	.058	Kamakura	.086
Jomon	.182	Hiogo	.060	Hiogo	.102
Ainu Sakhalin	.197	Jomon Tsukumo	.063	Jomon Tsukumo	.113
Early Malay Arch	.227	Japan	.088	Jomon Yoshiko	.122
Kanto	.235	SW Jomon	.093	Japan	.127
Kamakura	.252	Jomon	.101	Jomon	.132
Recent Japan	.253	Jomon Yoshiko	.113	SW Jomon	.163
Hiogo	.297	Poundbury	.197	Poundbury	.189
Japan	.348	Anyang China	.205	Early Malay Arch	.214
Anyang China	.511	Early Malay Arch	.236	Anyang China	.228

JOMON	
Jomon Tsukumo	.000
Jomon Yoshiko	.061
Early Malay Arch	.067
Jomon Hokkaido	.083
SW Jomon	.097
Ainu Hokkaido 2	.101
Ainu Sakhalin	.103
Ainu 1+2	.132
Kanto	.138
Kamakura	.140
Hiogo	.145
Recent Japan	.147
Ainu Hokkaido 1	.182
Japan	.186
Poundbury	.214
Anyang China	.239

JOMON TSUKUMO	
Jomon	.000
Jomon Hokkaido	.000
Jomon Yoshiko	.000
Early Malay Arch	.018
SW Jomon	.023
Ainu Sakhalin	.034
Ainu Hokkaido 2	.063
Kamakura	.112
Ainu 1+2	.113
Kanto	.120
Ainu Hokkaido 1	.128
Recent Japan	.134
Hiogo	.139
Poundbury	.143
Japan	.205
Anyang China	.314

JOMON HOKKAIDO	
Jomon Tsukumo	.000
Jomon Yoshiko	.041
Ainu Hokkaido 1	.050
Ainu Hokkaido 2	.058
Ainu 1+2	.073
Jomon	.083
SW Jomon	.105
Ainu Sakhalin	.129
Kanto	.141
Early Malay Arch	.153
Poundbury	.155
Recent Japan	.178
Kamakura	.185
Hiogo	.190
Japan	.286
Anyang China	.364

JOMON YOSHIKO	
Jomon Tsukumo	.000
SW Jomon	.031
Jomon Hokkaido	.041
Jomon	.061
Ainu Hokkaido 1	.084
Early Malay Arch	.106
Ainu Hokkaido 2	.113
Ainu 1+2	.122
Ainu Sakhalin	.164
Kanto	.205
Poundbury	.213
Kamakura	.246
Recent Japan	.253
Hiogo	.274
Japan	.319
Anyang China	.439

SW JOMON	
Jomon Tsukumo	.023
Jomon Yoshiko	.031
Ainu Hokkaido 1	.082
Ainu Hokkaido 2	.093
Jomon	.097
Jomon Hokkaido	.105
Ainu Sakhalin	.114
Ainu 1+2	.163
Kanto	.200
Poundbury	.210
Kamakura	.212
Recent Japan	.242
Early Malay Arch	.250
Hiogo	.255
Japan	.273
Anyang China	.411

ANYANG CHINA	
Japan	.027
Hiogo	.066
Kanto	.081
Kamakura	.096
Recent Japan	.105
Ainu Sakhalin	.105
Ainu Hokkaido 2	.205
Ainu 1+2	.228
Jomon	.239
Jomon Tsukumo	.314
Early Malay Arch	.336
Jomon Hokkaido	.364
SW Jomon	.411
Jomon Yoshiko	.439
Ainu Hokkaido 1	.511
Poundbury	.519

POUNDBURY	
Ainu Hokkaido 1	.080
Jomon Tsukumo	.143
Jomon Hokkaido	.155
Ainu 1+2	.189
Ainu Hokkaido 2	.197
SW Jomon	.210
Jomon Yoshiko	.213
Jomon	.214
Early Malay Arch	.219
Ainu Sakhalin	.230
Hiogo	.304
Kamakura	.312
Recent Japan	.329
Kanto	.329
Japan	.407
Anyang China	.519

EARLY MALAY ARCHIPELAGO	
Jomon Tsukumo	.018
Jomon	.067
Jomon Yoshiko	.106
Jomon Hokkaido	.153
Ainu Sakhalin	.197
Ainu 1+2	.214
Poundbury	.219
Ainu Hokkaido 1	.227
Ainu Hokkaido 2	.236
SW Jomon	.250
Hiogo	.261
Kamakura	.276
Recent Japan	.277
Kanto	.278
Japan	.301
Anyang China	.336

Dentally, Minatogawa and Jomon are also very similar (Turner 1987). Jomon origins almost certainly lie to the south. This diachronic evidence rather forcefully suggests that Brace and Nagai (1982) have their Jomon migration going in the wrong direction. Moreover, Oda and Keally's (1979) review of Japanese Paleolithic prehistory indicates stone artifacts occur at least 4,000 years later in northern Japan after initial appearance in southern Japan more than 27,000 years ago. Edge-ground stone tools are found in Japan according to Ikawa-Smith (1979). Bellwood (1985) relates that edge-grinding also occurs in Southeast Asia, Melanesia, and Australia, suggesting an origin in Southeast Asia. Just as Suzuki's craniological study of the Minatogawa series has shown, dental morphology also indicates that the Minatogawa people were members of the population that was ancestral to the later and more northern Jomonese. Thus, there were two East Asian population systems in late Pleistocene times — a coastal group made up of Sundadonts, and a northern continental interior Sinodont group.

3. *All Japanese dental samples are much more similar to each other and China than they are with most Ainu, Jomonese, Southeast Asian, or British samples.* As can be seen in Table 1, the MMD values between the five Japanese samples are very small, ranging from 0.000 to 0.018. These values are significantly less than those between North and South American Indian groups, all of whom are believed to be descended from the paleo-Indian migrants who first colonized the Americas by 12,000 years ago. The Japanese internal divergence is about the same as that which has evolved among Polynesians who spread out from the Fiji Islands less than 2,000 years ago. This matches Omoto's (1983: 48) findings which show that the Japanese are rather homogeneous genetically, because the Japanese gene pool is "largely made up of genes introduced from the continent in relatively recent times." Low internal divergence among the Japanese relative to the Jomonese is a useful estimate of evolutionary antiquity. Japanese have the Sinodont dental pattern, indicating a closer genetic tie with Northeast Asians than with the Sundadonts of Southeast Asia. Matsumoto's (1988) Gm data, and the worldwide genetic study of Cavalli-Sforza et al. (1988) show the same relationship.

As can be seen in Table 1, Japanese microevolution is even less than that for recent Ainu. It is very doubtful, given what is now known about the rather uniform rate of Holocene dental microevolution around the world (Turner 1986b), that Ainu would evolve internally so much faster than the Japanese, had both been commonly derived from the Jomonese. After all, it is the Ainu who retain more of the Jomon lifeway than did the agriculturally-based, ranked society of the Yayoi-Japanese population (Ikawa-Smith 1980).

4. *The Yayoi ancestors of modern Japanese originated in a south China-like population.* My small series of Yayoi teeth suggests that the origin of the Japanese could have been in South China (Figure 2). The linguist P. K. Benedict (personal communication) has recently proposed that the Japanese language is not a member of the Altaic family, instead, it belongs with Austro-Tai languages present in South China. A China rather than Korean origin is also what the legend of Hsu Fu suggests (Turner 1976). Although I have as of yet no Korean dental data, it is noteworthy that Bowles (1977) found Koreans to be biologically more like the people of inner and northern Asia than like the majority of Japanese. Hudson (1989) emphasizes that the similarities between Japanese and Korean jar burials, dolmens, and bronze tools are not necessarily proof of ethnic or political unity. Solheim (1989) has recently presented

evidence for an extensive Southeast Asian maritime network in the South China Sea that began to develop as early as 7,000 years ago. He proposes that it was this maritime network which ultimately introduced wet-rice agriculture to Japan. Akazawa (1983, 1990) feels that the most probable place of origin for the Yayoi rice cultivation complex was in southern China. Taken altogether, there is strong dental evidence for an early migration from Southeast Asia to Jomon Japan via Minatogawa, some dental evidence for a Yayoi migration from South China, and other lines of evidence pointing to a South China origin for the Yayoi-Japanese. But, the Jomon and Yayoi migrations were not the only ones to reach Japan. On the basis of archeological findings, a third migration can be proposed, one that reached Hokkaido from the Amur River basin.

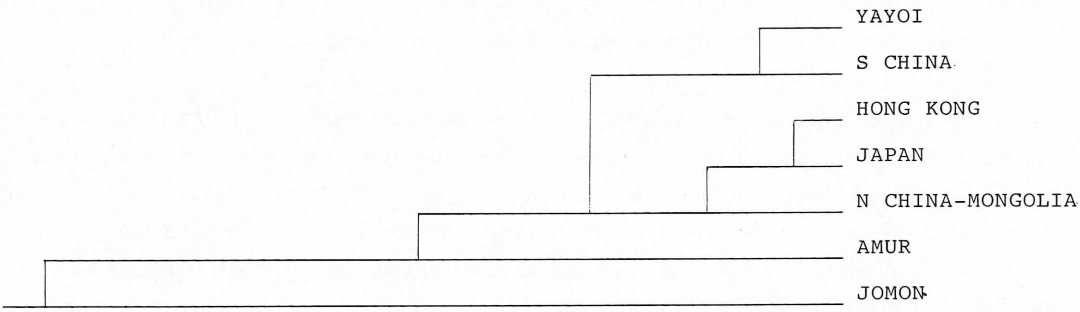

Fig. 2. Dendrogram of Japanese and other East Asian odontological relationships, based on 26 traits with Mean Measures of Divergence clustered with Wards method. Computer reference: Yayoi origin. Trait sample size range: Yayoi (3-9 individuals), South China (33-124), Hong Kong (92-319), Japan (200-522), North China-Mongolia (89-514), Amur (15-103), Jomon (117-338).

5. *Two migrations left descendants in Japan* — Jomonese-Ainu and Yayoi-Japanese. An Amur group did not survive. M. Yoshizaki has excavated many stone artifacts at the Towalubetsu site on Hokkaido. They are about 15,000 years old. These artifacts correspond strikingly with assemblages of unifacial blade tools and burins found in the Amur basin and Sakhalin by Derevyanko (1989), Vasilevskii (1989), and their Soviet colleagues. Identical unifacial tools have also been recovered in large numbers at the 8,000 year old Anangula site in the eastern Aleutians, well known through the extensive work of W. S. Laughlin (1980 and elsewhere) and associates. Recent excavations by D. Yesner and R. Mack (Morrison 1990) add support to established Aleutian prehistory which suggests that the Anangula people were early Aleuts practicing a coastal maritime lifeway. The Anangula ancestors of the Sinodont Aleuts and Eskimos reached the eastern Aleutians by following the southern coast of the Bering Land Bridge from Siberia to Alaska. Because of the tool similarities between Hokkaido and Anangula, it is not unreasonable to hypothesize that the Towalubetsu people were proto-Aleut Sinodonts who did not survive their relatively brief colonization of Hokkaido, whereas related Amur bands expanded into and did survive along the coasts of Alaska. Amur and other Northeast Siberian migrants may have repeatedly reached Hokkaido, without establishing long-lasting colonies. For example, the people possessing the Okhotsk culture endured for only a few centuries after arriving about A.D. 700 (Anderson 1987). There is also solid archeological evidence of reciprocal Jomon influence in the Amur basin (Vasilievskii 1989).

Yasuda (1990) has suggested that various cultural changes in Japan are associated with long-range fluctuations in monsoon weather patterns, which in my view should have had more disruptive effects on hunters and gatherers in northern than in southern Japan. These climatic fluctuations, with associated faunal changes, perhaps contributed to the failed early colonizations of Hokkaido.

6. *Ainu originate from the Jomon population, but today have much Japanese admixture.* The MMD values in Table 1 suggest that the archeologically-derived Hokkaido 2 series has more Japanese admixture than Hokkaido 1. The Hokkaido 2 series is generally more like the Japanese than like the Jomonese. The close relation between Hokkaido 1 and Poundbury is striking and suggestive, but more reasonably viewed as a random genetic convergence or sampling error than due to an ancient relationship because none of the Jomon or other Ainu dental series is similar to the Poundbury Europeans. The Sakhalin Ainu series seems to be the most admixed of the four Ainu samples, perhaps due to the Sakhalin Ainu having inter-bred with Amur Sinodonts on or near Sakhalin such as the Orok, Ulchi, or Nivkhi. Indeed, Ishida (1990) found the Sakhalin Ainu to have frequencies of nonmetric cranial traits more like those of the Nivkhi than like any other of his six Amur samples. Because the Hokkaido 1 Ainu series seems to show the least amount of Sinodont admixture, it is an important diachronic baseline for assessing the rate of gene flow as Yayoi-Japanese colonists or traders expanded northward into Hokkaido.

7. *Japanese have some admixture with Jomonese-Ainu.* It is evident from the inspection of Table 1 that the Japanese gene pool takes its primary origin from mainland Sinodonts. However, there is enough divergence, especially in the Kamakura and Recent Japan series to conclude that Jomon-Ainu genes were introduced into the gene pool of the Yayoi-Japanese wet-rice agriculturalists. These MMD values support the revised thinking of Hanihara (1985b, and this symposium) who now leans toward the view that the modern Japanese had a complex but basically dual origin, one that is rooted heavily in the mainland Sinodont population, and with a secondary and lower genetic contribution from the Sundadont Jomonese-Ainu aboriginals. Such an interpretation can also be made from the extensive dental crown measurement study of Matsumura (1989), a similar investigation by Mizoguchi (1988), and other workers already referred to.

8. *Variable Ainu and Japanese admixture provides clues to regional prehistoric events and relations.* Ethnoarcheologists and prehistoric archeologists often rely on trade goods and exotic materials to assess culture contact events, trade networks, and processes of cultural dynamics. Usually, little if any attention is given to human skeletal and dental remains as adjunctive resources or independent data sets to test culturally-based hypotheses. Because of the odontological differences between Sinodonts and Sundadonts, archeologically-derived human skeletal remains in Japan offer a major resource for evaluating how the contact between the migrant Yayoi-Japanese and aboriginal Jomonese-Ainu progressed. In some districts there may have been cooperative interaction, leading to extensive inter-marriage. In other districts the relationships may have been antagonistic, culminating in warfare and less inter-breeding. Sahara (1989) points out that warfare in Japan began in Yayoi times. It would be worthwhile to com-

pare the cultural and skeletal-dental evidence for correspondences where issues of interaction, cooperation, warfare, and other events can be proposed from the material culture remains dating between early Yayoi to late Kofun times.

9. *The rate of worldwide dental evolution agrees that the Yayoi-Japanese branched from mainland Asians about 2,500 years ago.* Elsewhere (Turner 1986b) I have presented a concept of temporally-related dental morphological microevolution called "dentochronology." The magnitude of inter-group Mean Measure of Divergence reflects the amount of dental microevoltion. Where genetic isolation can be independently demonstrated between two commonly-derived populations, then the amount of divergence appears to be approximately proportional to the amount of separation time. On the basis of the peopling of the Americas, where paleoenvironmental evidence indicates Siberia and the Americas were separated by the final flooding of the Bering land bridge at 12,000 years ago (Hopkins, 1979), the rate of dental microevolution is 0.01125 MMD per 1,000 years. This was obtained as follows:

$$\frac{\textit{American Indian-NE Asia MMD 0.135}}{\text{12,000 years BP/12}} = 0.01125$$

By dividing the Japanese-Chinese MMD values with the independently-derived dental divergence rate of 0.01125, the time of separation or colonization can be estimated. The Hiogo Japan-China MMD of 0.0282 produces a dentochronological separation estimate of 2,507 years ago. Japan-China (0.0178) gives 1,582 years ago; Recent Japan-China (0.0428), 3,804 years; Kanto Japan-China (0.0364), 3,235 years; Kamakura Japan-China (0.0390), 3,467 years. The mean of these estimates is 2,919 years. These dental estimates of separation time are reasonably like the archeological estimates for the beginning of the Yayoi period, which varies between 2,250 to 2,500 years ago, with a mean of 2,375 years ago.

The mean dentochronological separation estimate between the Jomon samples and the Early Malay Archipelago is 10,600 years, reasonably close to the expected separation date of about 10,000 to 12,000 years based on changes in terminal Pleistocene sea level. The dental dating for the separation of the Ainu and Jomonese ranges between 7,600 to 9,700 years. This range is far from an expected range of about 500 to 2,000 years. These unexpected Ainu-Jomon separation estimates most likely represent the vastly accelerated dental evolution of the Ainu caused by admixture with Japanese-Yayoi and Amur Sinodonts.

In sum, dental crown and root morphology indicates that the living Japanese and Ainu have different primary origins. The Ainu are primarily descended from the Jomonese, but have experienced considerable gene flow from the Yayoi-Japanese. The Yayoi people seemed to have reached Japan in great numbers from the mainland, according to Aoki and Omoto's (1980) gene flow estimates, Hanihara's (1987) independent estimates, Sahara's (1975) interpretation of the Yayoi archeological record, and the Hsu Fu legend. For the moment, language, teeth, and some archeological evidence suggest the South China coastal region as the source of the Yayoi migrants. Gene flow from the Jomonese-Ainu into the Yayoi-Japanese population was less. The social dynamics underlying this differential seem analogous to gene flow directionality in the Americas following the massive migrations of Europeans to the New World. Native Americans received far more European genes than Euroamericans received Indian genes.

Japan and the Americas share a large number of historical and microevolutionary parallels.

The Jomonese had their roots in the late Pleistocene population of Southeast Asia. That population possessed the Sundadont dental pattern. Sundadonts expanded northward along the East Asian continental shelf to Japan before the end of the Pleistocene when Japan was markedly isolated from the mainland by the post-glacial worldwide 100 meter rise in sea level. The relatively small divergence between Jomonese and Southeast Asia matches archeological evidence that shows marked cultural isolation between Japan and the mainland until the arrival of the Yayoi-Japanese beginning about 2,500 years ago. The dental evidence indicates a dual primary origin for the present-day peoples of Japan. A similar dual origin is found in the dental variation of contemporary Australia and the Americas, where boat-based European colonization followed thousands of years after the initial founding populations migrated, respectively, through Sundaland and Beringia.

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日本におけるスンダ型歯列と中国型歯列：歯の形態に基づく日本列島住民の二重起源説

C. G. Turner II

現代の本土日本人、アイヌ、縄文人および近隣の先史時代人の歯の特徴を比較すると、縄文人とアイヌは東南アジア人のスンダ型歯列に近いが、本土日本人は東北アジア人の中国型歯列に近い。弥生人は中国の河南人に近い集団の系統と思われる。したがって時期を異にして日本に渡来した別々の集団が、それぞれの子孫を残したことになる。これらは洪積世末期に渡来し

た縄文人ーアイヌ系統と、2,500年前に渡来した弥生人ー本土日本人系統である。考古学的に、15,000年前にアムール流域の集団が北海道に移動したことが分かっているが、この集団は消滅して子孫を残していないことが明らかである。アイヌはその後、弥生人ー本土日本人系統と混血した。以上の点から、現代の日本人集団は二重起源・混血仮説（dual origin with admixture hypothesis）によってもっともよく説明される。アイヌと本土日本人との混血は、先史時代のさまざまな現象をとく鍵になるだろう。弥生人ー本土日本人の系統が約2,500年前にアジア大陸の集団から分岐したという人類学的・考古学的推測は、歯の小進化の進行速度からみても支持される。

（Translated by K. Hanihara）