

## Deciduous Tooth Size in the Prehistoric Jomon and Yayoi Peoples of Japan\*

By

**Hirofumi MATSUMURA**

Department of Anthropology, National Science Museum, Tokyo

**Abstract** Mesiodistal and buccolingual crown diameters were measured on the deciduous teeth of the prehistoric Jomon and Yayoi series of Japan. By the comparisons between them, it was implied that the deciduous tooth size was larger in the immigrants from the Asian Continent in the Yayoi period than in the Jomon natives, as in the permanent ones. On the other hand, the deciduous tooth size of the modern Japanese was smaller than those of the two prehistoric populations. From the distance analyses applied to the deciduous crown diameters, relationships of the modern Japanese with the two prehistoric populations were not so conspicuous as shown in the permanent teeth. In wider aspect, the comparisons with several other populations including non-Mongoloid series demonstrated that in deciduous tooth size the Jomon and Yayoi peoples had the close affinities with other Mongoloid populations, especially with the modern Japanese.

### Introduction

Population history of the modern Japanese has long interested many physical anthropologists. As well known, special attention has been focused on the morphological transition from the prehistoric Jomon (ca. 10,000 B.C.–300 B.C.) to the Yayoi period (300 B.C.–A.D. 300). Nowadays, it is generally accepted that the Yayoi skeletons from the northern Kyushu district and Yamaguchi prefecture in the western part of Japan are not only of hybrids between Jomon natives and immigrants from the Asian Continent (KANASEKI, 1976) but are of the immigrants themselves (HANIHARA, 1984).

Recently, measurements of tooth crowns also have given the clues to the solution of the population history of Japan. From aspect of permanent tooth size, BRACE & NAGAI (1982) suggested that the modern Japanese were predominantly derived from the Yayoi immigrants who carried larger teeth than those of the Jomon natives. MATSUMURA (1990, 1992) also inferred that the immigrants from the Continent during the Yayoi and protohistoric Kofun periods were characterized by the largeness of crown sizes in the permanent teeth.

In the present study, crown sizes of the deciduous teeth were also examined for

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\* Part of this study was preliminarily presented at the 96th Meeting of the Japanese Association of Anatomists, held in Kyoto, (MATSUMURA, 1991).

the Jomon and Yayoi series. At the same time, comparative studies with other different population samples were attempted.

### Materials

The materials used in the present study were the deciduous teeth of prehistoric Jomon and Yayoi series. The Jomon samples were 72 individuals collected from the sites of the Middle to Latest Jomon stages in the various parts of Japan as reported in the previous paper (MATSUMURA, 1989). They are housed in the Department of Anthropology and Prehistory of the University Museum of the University of Tokyo, the Department of Anthropology of the National Science Museum, Tokyo, the Laboratory of Anthropology of Kyoto University and the Department of Anatomy of Sapporo Medical College. The Yayoi materials were 83 individuals from the Doigahama, Nakanohama, and Koura sites in the western part of Honshu, and Kanenokuma site in the northern Kyushu district, which are generally considered to consist mainly of the immigrants from the Asian Continent (KANASEKI *et al.*, 1960; NAITO, 1971, 1984; NAKAHASHI *et al.*, 1985; NAKAHASHI, 1989). These samples are stored in the Department of Anatomy of Kyushu University.

For comparisons with other representative population samples, the data measured by HANIHARA (1976) on the modern Japanese, Australian Aborigines, Pima Indians, American Blacks and Caucasians were cited.

### Methods

Mesiodistal and buccolingual crown diameters were measured on the deciduous teeth for each individual. The measurements were taken on the right side teeth. When the right side tooth was unavailable, left side one was substituted. For statistical analyses, the data from both sexes were combined, since most Jomon and Yayoi samples were non-adults of unknown sex. In the first step of statistical comparisons, differences of crown diameters between the Jomon and Yayoi peoples were examined by the two tailed *t*-tests. In the next step, comparisons with the different populations were made by computing PENROSE's distances (CONSTANDSE-WESTERMANN, 1972) on the bases of mesiodistal crown diameters. For standardizing the measurements, the standard deviations derived from both the Jomon and Yayoi samples combined were used. In order to schematize the population relationships, the multidimensional scaling (MDS) method (TORGERSON, 1958) was applied to each distance matrix. Lastly, in order to elucidate more detailed characteristics in deciduous tooth size of the Jomon and Yayoi peoples, an additional statistical analysis was attempted, which will be explained in the "Results".

## Results

### *Comparison between the Jomon and Yayoi peoples*

Means and standard deviations of the mesiodistal and buccolingual crown diameters of the deciduous teeth in the Jomon and Yayoi peoples and the results of the *t*-tests for the differences of the mean values between the two populations are given in Table 1. The significant differences were detected in eight items of measurements out of twenty at the 5% or less probability level. In all of these measurements showing significant differences, the mean values for the Yayoi people are larger than those of the Jomon people. As a whole, the Yayoi people shows larger crown size than for the Jomon people in more than half of the deciduous tooth kinds.

### *Comparison with other populations*

On the bases of distance analyses applied to the mesiodistal crown diameters of the deciduous teeth, both the Jomon and Yayoi peoples were compared with the modern Japanese and other representative populations, such as Pima Indians, Australian Aborigines, American Caucasians and Blacks. Table 2 gives PENROSE's size

Table 1. Means and standard deviations of deciduous crown diameters of the Jomon and Yayoi series and the results of the *t*-tests between them.

		Jomon			Yayoi			<i>t</i> -test
		N	M (mm)	S.D.	N	M (mm)	S.D.	<i>t</i> -values
Mesiodistal diameters								
Upper	di1	20	6.72	0.29	28	6.89	0.34	1.773
	di2	15	5.50	0.20	25	5.64	0.53	1.105
	dc	30	6.52	0.65	34	6.71	0.49	1.275
	dm1	42	7.24	0.32	57	7.51	0.57	3.741***
	dm2	50	9.34	0.56	62	9.54	0.43	2.097*
Lower	di1	14	4.19	0.26	23	4.36	0.23	2.076*
	di2	21	4.87	0.31	32	4.94	0.35	0.709
	dc	27	5.87	0.33	35	6.00	0.30	1.532
	dm1	48	8.63	0.47	54	8.76	0.44	1.488
	dm2	55	10.97	0.47	59	10.87	0.43	1.085
Buccolingual diameters								
Upper	di1	20	4.94	0.20	29	5.12	0.35	1.996
	di2	15	4.80	0.18	26	5.07	0.48	2.521*
	dc	29	5.54	0.42	32	5.76	0.42	2.046*
	dm1	42	8.84	0.34	58	8.95	0.50	1.258
	dm2	50	10.18	0.45	62	10.40	0.44	2.602*
Lower	di1	15	3.75	0.17	23	3.83	0.28	0.957
	di2	20	4.12	0.18	31	4.27	0.25	2.261*
	dc	27	5.27	0.33	33	5.42	0.35	1.570
	dm1	48	7.10	0.41	54	7.53	0.43	5.036***
	dm2	54	9.32	0.37	59	9.44	0.42	1.698

Significance level, \* 5%, \*\*\* 0.1%.

Table 2. PENROSE's size and shape distances based on mesiodistal diameters.  
(upper right: size distances, lower left: shape distances)

	Jomon	Yayoi	Japanese	Aborigine	Pima	Caucasian	Am.Black
Jomon	—	0.129	0.115	0.620	0.007	0.995	0.276
Yayoi	0.067	—	0.490	0.182	0.074	1.845	0.785
Japanese	0.346	0.180	—	1.271	0.183	0.433	0.034
Aborigine	0.460	0.351	0.269	—	0.489	3.189	1.726
Pima	0.601	0.458	0.141	0.215	—	1.179	0.377
Caucasian	0.905	0.709	0.338	0.450	0.212	—	0.222
Am.Black	0.584	0.453	0.164	0.667	0.256	0.387	—

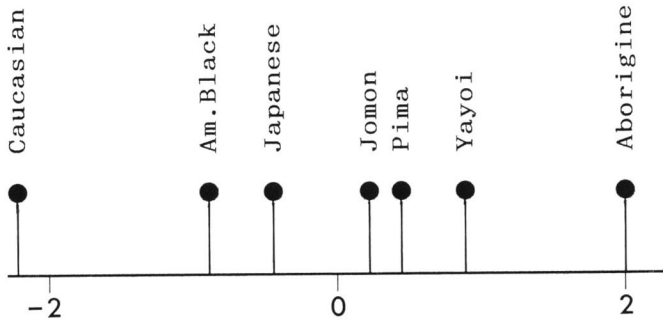


Fig. 1. One dimensional expression of the MDS applied to the PENROSE's size distances.

and shape distance matrices computed. Fig. 1 shows one dimensional expression of the MDS applied to the size distance matrix. The scale on the given axis simply represents the order of overall crown size among the populations compared. Both the Jomon and Yayoi peoples are grouped with the modern Japanese and Pimas as Mongoloids. The overall crown sizes in these four populations are intermediate between the largest in the Aborigines and the smallest in the Caucasians. Fig. 2 is the result of the MDS based on the shape distance matrix. The closest to both the Jomon and Yayoi peoples is the modern Japanese. The Pimas are slightly close to them. Both the Jomon and Yayoi peoples are apparently distant from the rest of the non-Mongoloid populations, i.e. the Aborigines, American Blacks and Caucasians.

#### *Characteristics in deciduous tooth size of the Jomon and Yayoi peoples*

An additional statistical analysis was attempted to elucidate more detailed characteristics in deciduous tooth size of the Jomon and Yayoi peoples. In order to make a systematical comparison of tooth size, the mesiodistal crown diameters were summarized in each tooth group in consideration of correlations between the measurements. For this procedure, the results of the factor analysis conducted by HANIHARA (1974), which were derived from the Japanese samples, were employed. The main factors after rotation given in his paper are as follows; the first factor which concerns with

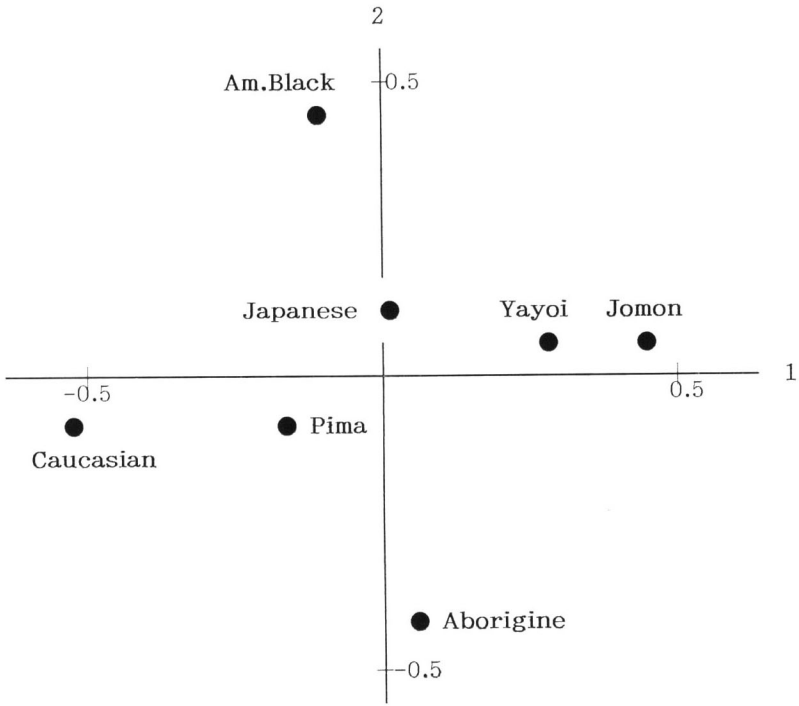


Fig. 2. Two dimensional expression of the MDS applied to the PENROSE's shape distances.

size of the deciduous incisors, the second factor which correlates with size of the deciduous molars and third factor which represents size of the deciduous canines. On the bases of these rotated factor loadings, factor scores were calculated for each population and compared. The results are represented in Fig. 3 with the standardized scores. The scores for the first factor show that the Yayoi people has larger deciduous incisors than those of the other populations compared except for the Aborigines. The scores for the second factor demonstrate that both the Jomon and Yayoi peoples carry comparatively larger deciduous molars. Especially, the Yayoi people seems to have quite large deciduous molars which are comparable with those of the Aborigines. The scores for the third factor indicate that both the Jomon and Yayoi peoples carry relatively smaller deciduous canines as well as the modern Japanese and Caucasians. As a whole, deciduous teeth of the Jomon and Yayoi peoples are characterized by the smallness of deciduous canines and largeness of deciduous molars, not only in absolute size but also in proportion.

### Discussion

Firstly, the present examination revealed that the deciduous teeth of the Yayoi

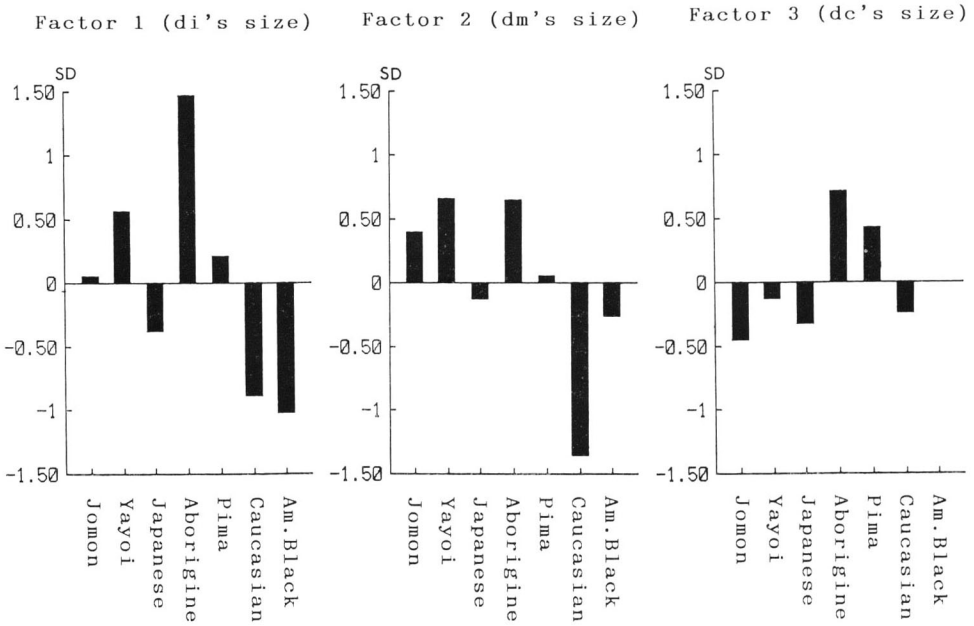


Fig. 3. Standardized factor scores for first three factors in the seven populations.

people were larger than those of the Jomon people. As shown in Fig. 4, overall crown size of the deciduous teeth changed in parallel with that of permanent teeth in transition from the Jomon to the Yayoi people. This fact implies that even in the deciduous teeth the immigrants in the Yayoi period had large crown size, as is the case of permanent ones.

The comparisons with the modern Japanese show (again Fig. 4) that the overall crown size is smaller than that of the Yayoi people both in the deciduous and permanent teeth. Between the modern Japanese and the Jomon people, the permanent teeth of the former population have larger overall crown size than that of the later. On the contrary, the deciduous teeth of the modern Japanese show smaller overall crown size than that of the Jomon people. In regard to this contrast between the permanent and deciduous tooth sizes, KITAGAWA *et al.* (1989) also gave same view based on the comparison of the Jomon people with the early modern Edo people. As to the proportion in deciduous tooth size, PENROSE's shape distances (Table 2) show that the modern Japanese is closer to the Yayoi people than to the Jomon people. Both the prehistoric populations are closer to each other than to the modern Japanese. On the other hand, the shape distances derived from the permanent teeth (MATSUMURA, 1992) suggested that the Yayoi people was apparently distant from the Jomon people and much close to the modern Japanese. These discrepancies between the deciduous and permanent teeth seem to reflect the difference in the reduction process of tooth

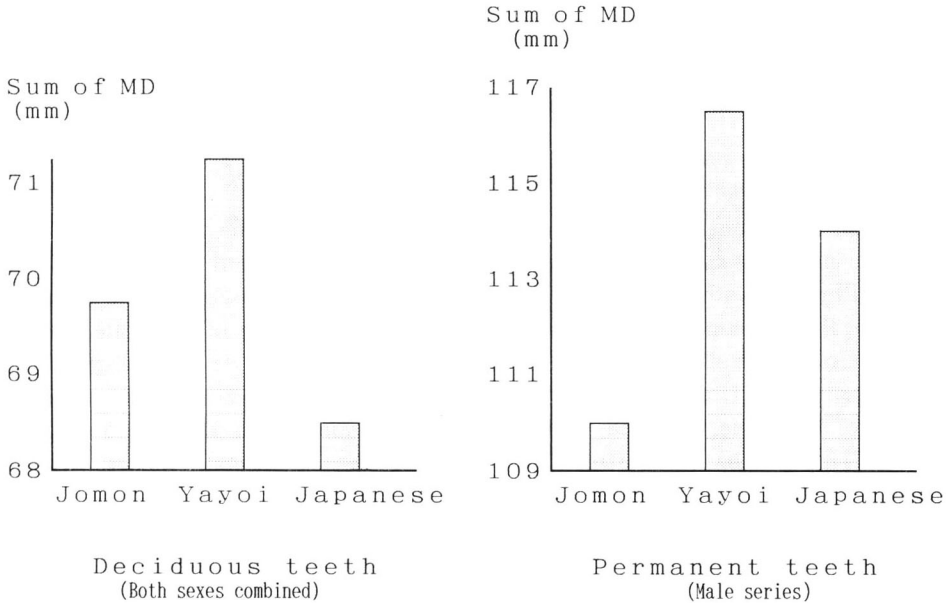


Fig. 4. Estimation of the sum of mesiodistal crown diameters in the deciduous and permanent teeth of the prehistoric and modern series in Japan. (Data on the permanent teeth are cited from MATSUMURA, 1992.)

size from the prehistoric to the modern times.

Secondly, the comparisons with certain other populations including the non-Mongoloid series elucidated the characteristics in deciduous tooth size of the Jomon and Yayoi peoples in wider aspects. That is, the overall crown sizes of both populations were medium, as in other Mongoloid populations. In proportion, the deciduous canines were relatively smaller and the deciduous molars were larger. According to HANIHARA (1974), the deciduous teeth of the modern Japanese and Aborigines belong to 'molar-type' of groups in which the back teeth are comparatively larger. In this sense, the deciduous teeth of the Jomon and Yayoi peoples are also grouped in 'molar-type'. In particular, it should be noted that even in absolute size the deciduous molars of the Yayoi peoples were comparable with those of the Aborigines. In addition to the largeness of deciduous molars in proportion, the smallness of deciduous canines also represents the close affinity of the Jomon and Yayoi peoples with the modern Japanese.

From the present study, it is concluded that in the characteristics of the deciduous tooth size the Jomon and Yayoi peoples have, as a whole, close resemblances with other Mongoloid populations, especially with the modern Japanese. In respect to more detailed phylogenetic relationships between them, however, it is not evident whether investigations of deciduous tooth size will be useful for discussion on the

population history of the modern Japanese. For more advanced arguments, secular change of deciduous tooth size in Japan should be examined with additional data on protohistoric and medieval series. At the same time, comparisons with other Asian Mongoloid series will be expected.

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