Bull. Natn. Sci. Mus., Tokyo, Ser. D, **24**, pp. 49–59, December 22, 1998

Sex Differences in Tooth Wear in the Japanese

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Abstract Sex differences in tooth wear were examined in the following five Japanese populations: prehistoric hunter-gatherers (Jomon period), prehistoric agriculturalists (Yayoi period), and medieval (Kamakura period), pre-modern (Edo period), and recent (Meiji–Taisho periods) populations. The results suggested that, in the Jomon, Edo, and possibly Yayoi populations, the posterior teeth were worn more in the males than in the female, while there were no noticeable sex differences in wear severity on the anterior teeth. Clear sex differences were not detected in the severity and pattern of wear in the samples from the Kamakura and Recent peoples.
Key words: Attrition, Sexual dimorphism, Japanese.

Individual variation in the severity and/or pattern of human tooth wear occurs mainly from differences in diets, culinary practices, and ways of using teeth as a tool. Therefore, examinations of sex differences in tooth wear patterns may help to infer gender-based differences in dietary habitat and gender-specific behavior in past populations. In another paper (Kaifu, submitted), the author investigated temporal changes in the pattern of tooth wear in Japanese population samples from the prehistoric to recent times and discussed possible causative factors of those changes. This study examines sex differences in tooth wear in these populations.

Materials and Methods

Materials. The samples used in this study and material selection criteria are the same as in another paper (Kaifu, submitted) and described in detail therein. Only basic points are outlined below.

The skull samples used in this study are listed in Table 1. Hereafter, the terms Jomon, Yayoi, Kamakura, Edo, and Recent are used in this paper to represent samples from the Jomon to recent periods. The Jomon people were prehistoric hunter-gatherers. Although materials from various regions and periods were pooled in this study, the major portion of the present Jomon materials is from shell-mounds of the Middle to Final Jomon periods (ca. 3,500 BC–300 BC) along the coast of the Kanto district. The Yayoi sample is composed of prehistoric agricultural populations from the northern Kyushu region and Yamaguchi Prefecture (so called "Yayoi immigrant populations"). The entire Kamakura sample of this study is derived from the Za-

Table 1. Materials used in this study.

Sample name	Period	Estimated age	Regions	Collection[1]
Jomon	Jomon (Prehistoric hunter-gatherers)	4000 BC–350 BC	Hokkaido, Honshu, and Kyushu	TUM, NSM
Yayoi	Yayoi (Prehistoric agriculturalists)	350 BC–AD 300	Northern Kyushu and Yamaguchi	Kyushu Univ.
Kamakura	Kamakura (Medieval)	AD 1333	Kanto District	TUM, NSM
Edo	Edo (Pre-modern)	AD 1600–AD 1868	Tokyo City	NSM
Recent	Meiji–Taisho (Recent)	AD 1868–AD 1926	Unknown	TUM

[1] TUM=Tokyo University Museum, NSM=National Science Museum, Tokyo.

imokuza site in the southern Kanto region. The Edo sample consists of remains from ordinary burials excavated in the city of Edo (present Tokyo). The Recent sample is composed of specimens derived from dissecting rooms.

Ante-third molar dentitions are the focus of this study, so the skulls of adults and adolescents (dental age more than 14) whose sex could be determined by morphological observation were used. Among adult and adolescent specimens with antemortem loss of no more than two teeth, those judged as maintaining original normal wear pattern were selected.

Sex and age determination. Sex was determined by the present author mainly on the basis of pelvic and cranial morphology. Sex of the Recent sample is known from the records. Dental age was judged for subadult specimens with reference to Ubelaker (1989, Figure 71), from 7 to 20.5 years with an interval of 0.5 years.

Quantification of wear severity. In this study, the first and second molars were used as representing wear on the posterior teeth, and the central incisors were used as representing wear on the anterior teeth. These teeth were chosen in view of their relative positions in the dentition and convenience in wear quantification.

The scoring method proposed by Scott (1979) was used to quantify wear severity on the molars (*M2* and *M1 wear score*). In this method, the occlusal surface is visually divided into four quadrants and each is graded 1–10. The score for the whole tooth is the sum of these four numbers and ranges from 4–40. For the occlusal wear parameter on the anterior teeth, labiolingual diameter of the dentine exposed on the occlusal surface of the central incisor (*I1 dentine thickness*) was used. *I1 dentine thickness* was measured in the projected plane perpendicular to the long axis of the crown, not in the occlusal plane. The mean of right and left sides were used for the analyses but one side was used when the data of the other side was not available.

Analyses. Principal component analysis (PCA) was performed to evaluate between-sex differences in the distribution of wear score within samples. The matrix used was correlation matrix of each population. Results of the PCA, however, are affected by the degree of differences in age distribution between both sexes. In order to

supplement this, sex differences in the rate of molar wear were examined through male and female comparisons in the molar wear scores of subadult subsamples whose dental age can be evaluated. All the statistical procedures were performed using SYSTAT Macintosh 5.2.1.

Results

Table 2 shows the component loadings of the first principal components (PC Is) derived from the PCA within each population. These explain between 70 and 90% of

Table 2. Component loadings of the PC Is.

Variables	Jomon	Yayoi	Kama.	Edo	Recent
Maxillae					
M^2 wear score	0.97	0.95	0.92	0.94	0.89
M^1 wear score	0.95	0.97	0.92	0.95	0.96
I^1 dentin thickness	0.89	0.84	0.83	0.78	0.69
Total contribution (%)	87.7	85.1	79.5	80.3	73.1
Mandibles					
M_2 wear score	0.96	0.95	0.91	0.95	0.93
M_1 wear score	0.94	0.91	0.94	0.94	0.90
I_1 dentin thickness	0.82	0.86	0.77	0.77	0.66
Total contribution (%)	82.7	82.0	76.7	79.3	70.3

Table 3. Results of the one-tailed Mann–Whitney's *U* test for the component scores.

		Max.	Mand.
Jomon	N (M/F)	42/20	33/18
	U statistic	278.0	146.0
	Prob.	0.03	0.00
Yayoi	N (M/F)	14/14	13/10
	U statistic	43.0	29.5
	Prob.	0.01	0.03
Kamakura	N (M/F)	46/28	23/17
	U statistic	518.0	118.0
	Prob.	0.16	0.03
Edo	N (M/F)	41/22	35/24
	U statistic	229.5	211.0
	Prob.	0.00	0.00
Recent	N (M/F)	26/9	24/9
	U statistic	105.0	96.5
	Prob.	0.65	0.64

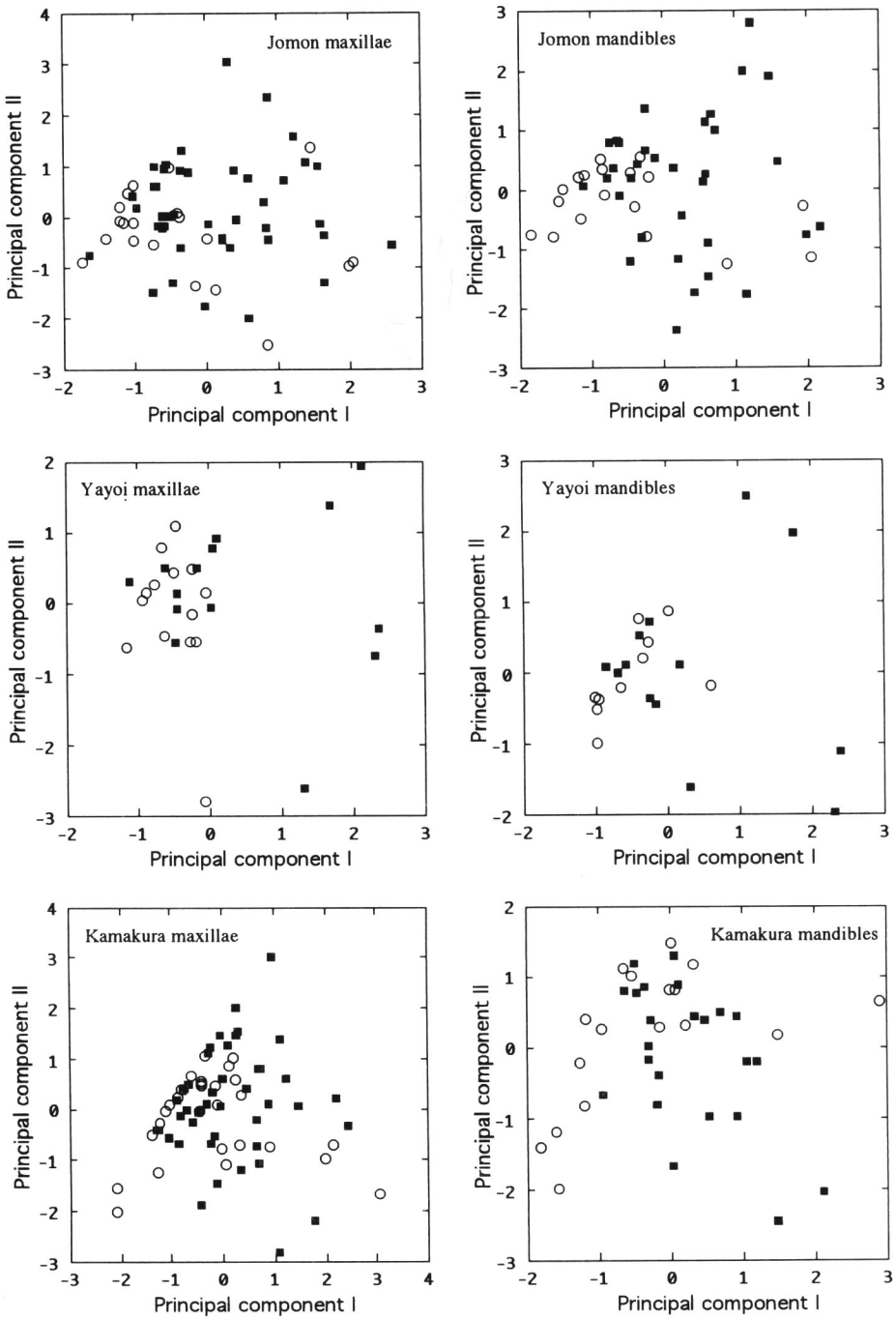

Fig. 1. Scatterplots of the component scores. Solid squares=males. Open circles=females.

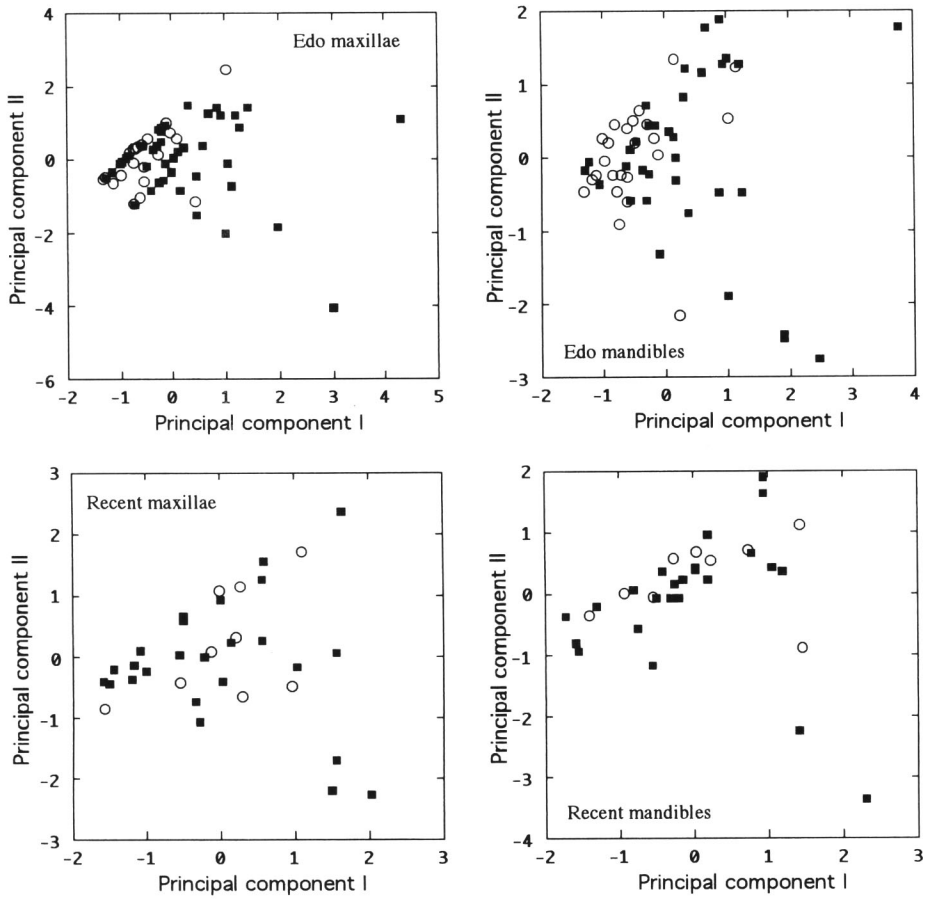

Fig. 1. (continued).

the total variances. In every population, the PC Is give greater scores if wear on the whole dentition is heavy.

The component scores for each individual are shown in Figure 1. Sex differences in the distribution of these scores were tested by the Mann-Whitney *U* test and the results are tabulated in Table 3. These results indicate existence of significant sex differences in the scores in both jaws of Jomon, Yayoi, and Edo, and in the mandible of Kamakura (the male scores tend to be greater than the female scores).

Next, the varimax rotation was applied to the above components and the results were shown in Table 4–5 and Figure 2. In both jaws of every population but Kamakura, the factor Is give greater scores if wear on the first and second molars is heavy, and the factor IIs give greater scores if wear on the central incisors is heavy. These two factors explain about 90% or more of the total variances in every case. The exis-

Table 4. Factor loadings of the rotated factors.

Variables	F I					F II					F III
	Jomon	Yayoi	Kama.	Edo	Recent	Jomon	Yayoi	Kama.	Edo	Recent	Kama.
Maxillae											
M^2 wear score	0.81	0.94	0.86	0.94	0.98	0.44	0.33	0.31	0.29	0.14	0.42
M^1 wear score	0.92	0.89	0.43	0.92	0.78	0.40	0.42	0.32	0.33	0.34	0.85
I^1 dentin thickness	0.40	0.36	0.26	0.30	0.18	0.91	0.93	0.93	0.95	0.98	0.27
Total contribution (%)	55.3	60.0	32.8	60.8	53.5	39.4	38.5	35.1	36.8	36.3	32.1
Mandibles											
M_2 wear score	0.90	0.49	0.89	0.92	0.48	0.37	0.39	0.24	0.31	0.22	0.40
M_1 wear score	0.94	0.88	0.52	0.94	0.89	0.32	0.30	0.31	0.29	0.17	0.80
I_1 dentin thickness	0.34	0.28	0.21	0.30	0.15	0.94	0.92	0.95	0.96	0.97	0.22
Total contribution (%)	60.0	36.2	36.7	60.6	34.7	37.6	36.0	35.2	36.6	34.3	28.1

Table 5. Results of the one-tailed Mann-Whitney's *U* test for the rotated fator scores.

		Maxillae			Mandibles		
		F I	F II	F III	F I	F II	F III
Jomon	N (M/F)	42/20	42/20		33/18	33/18	
	U statistic	243.0	415.5		153.5	279.5	
	Prob.	0.01	0.95		0.00	0.73	
Yayoi	N (M/F)	14/14	14/14		13/10	13/10	
	U statistic	50.0	90.5		32.0	57.0	
	Prob.	0.03	0.73		0.04	0.62	
Kamakura	N (M/F)	46/28	46/28	46/28	23/17	23/17	23/17
	U statistic	591.5	620.5	531.5	174.0	143.0	163.0
	Prob.	0.56	0.79	0.21	0.56	0.15	0.37
Edo	N (M/F)	41/22	41/22		35/24	35/24	
	U statistic	276.5	346.0		238.0	342.5	
	Prob.	0.01	0.13		0.00	0.23	
Recent	N (M/F)	26/9	26/9		24/9	24/9	
	U statistic	108.0	115.5		90.0	89.0	
	Prob.	0.73	0.95		0.47	0.44	

tence of significant sex differences is detected in the score of factor I in both jaws of Jomon, Yayoi, and Edo (the male scores tend to be greater than the female scores), while in no cases sex difference is significant in the score of factor II. The factor I, II, and III of Kamakura are strongly correlated to the *M2 wear score*, *I1 dentine thickness*, and *M1 wear score*, respectively, and no significant sex differences are detected

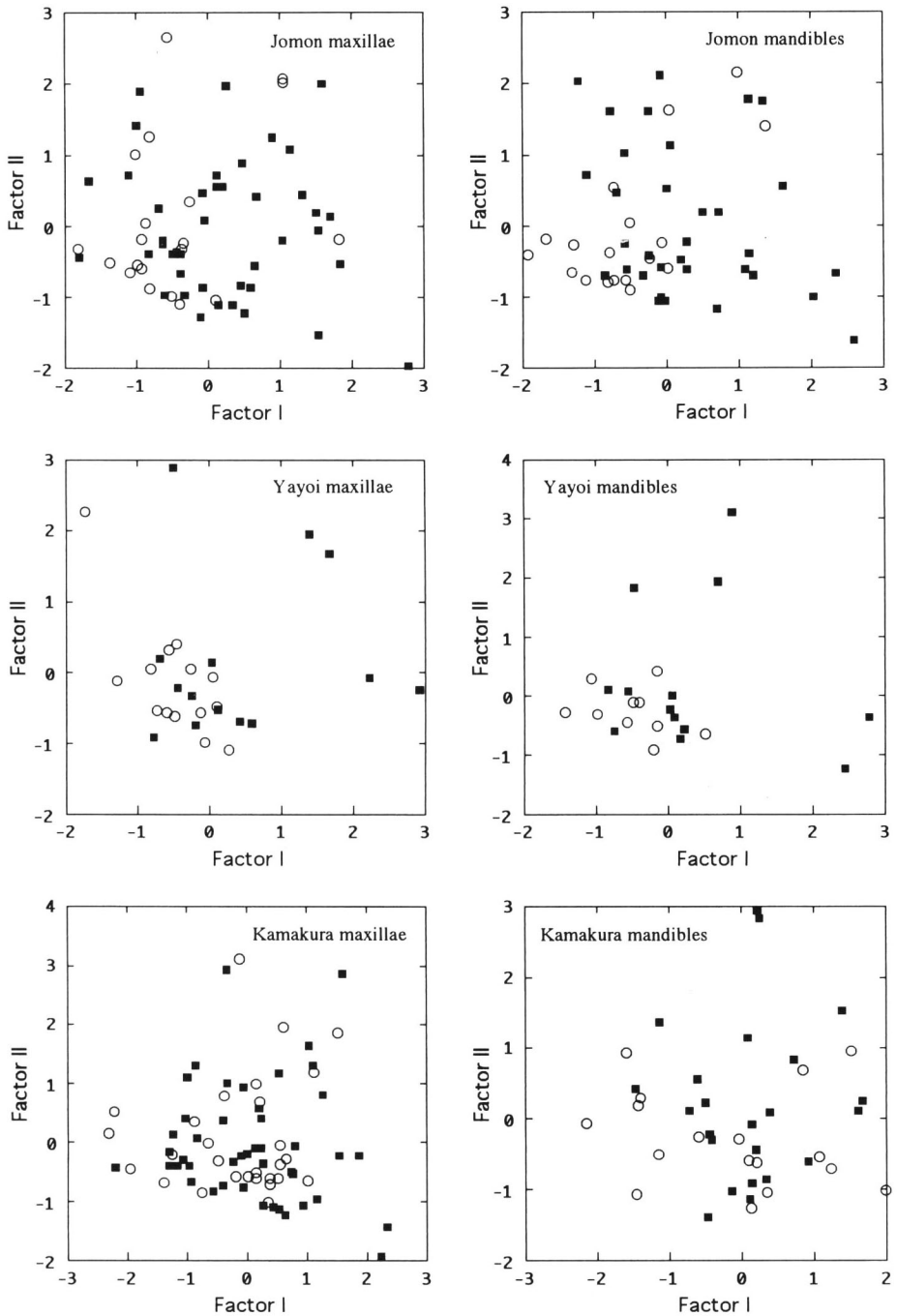

Fig. 2. Scatterplots of the rotated factor scores. Symbols as in Fig. 1.

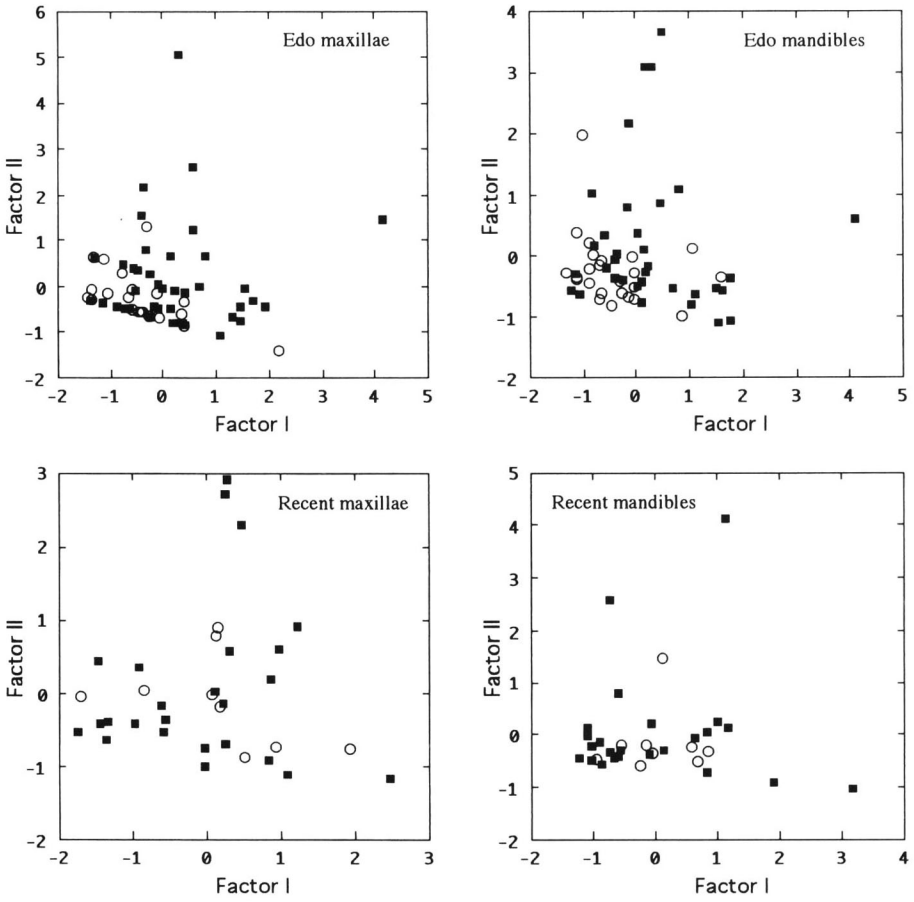

Fig. 2. (continued).

in the distribution of the scores of these factors.

Scatterplot of dental age and the combined score of *M1 wear score* and *M2 wear score* are shown in Figure 3. Although the sample sizes are not sufficient to draw clear-cut conclusion, the tendencies observed are generally not contradictory to the results of the above PCA, suggesting existence of noticeable sex differences in the rate of molar wear in the Jomon and Edo, and no such differences in the Kamakura. Yayoi and Recent are omitted from this analysis because of small sample sizes. Sex differences in the wear rate on the central incisors can not be examined in this manner because the changes in the *I1 dentine thickness* during adolescence are too small compared to the degree of measurement error.

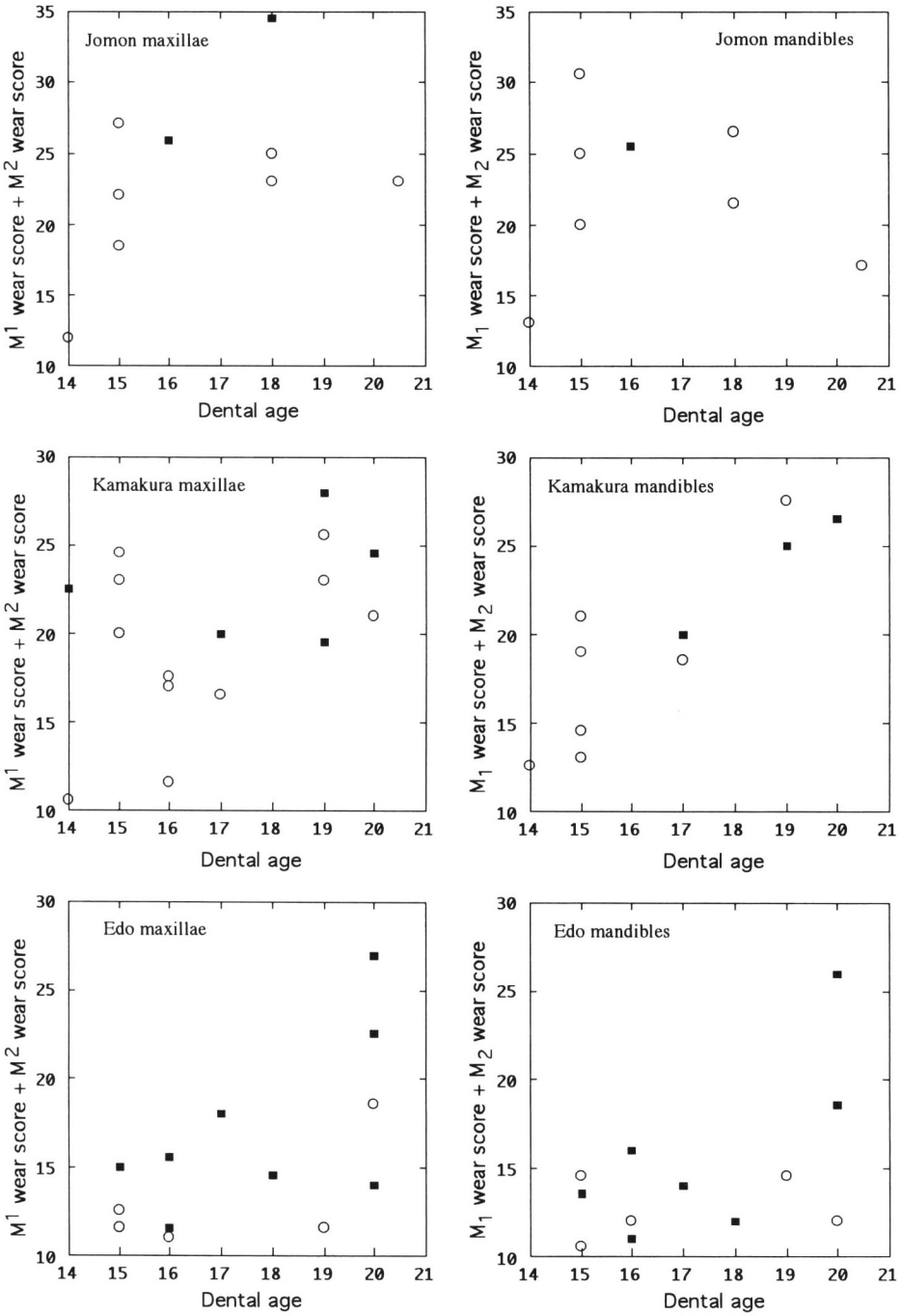

Fig. 3. Scatterplots of wear scores against dental age for subadult subsamples. Symbols as in Fig. 1.

Discussion and Conclusions

The results of the PCA seem to indicate, in general, that there were noticeable sex differences in severity and pattern of tooth wear in the Jomon, Yayoi, and Edo populations. In these populations, the male posterior teeth seem to have been more worn than the female posterior teeth while there were no significant sex differences in the wear severity on the anterior teeth. On the other hand, there seem to have been no such sex differences in tooth wear in the Kamakura and Recent populations.

The actual ages for the most specimens of the Recent sample are known from the records. The Mann–Whitney U test between both sexes did not indicate significant sex difference in age distribution in this sample ($p=0.79$). Therefore, the above interpretation is considered to be correct for the Recent sample. As for the other samples, however, the above interpretation is complicated by the fact that sex differences in age distribution within samples can not be evaluated sufficiently with the available sample sizes. Nevertheless, the comparisons of the molar wear scores in the subadult subsamples showed not contradictory results with the above interpretation, and the results of the PCA seem to reflect real sex differences that existed at least in the Kamakura and Edo populations, and possibly in the Jomon population.

The accelerated tooth wear suffered by females in hunting and gathering societies were reported in several populations (Campbell, 1939; Molnar, 1971; Molnar *et al.*, 1983; Richards, 1984). Campbell (1939) attributed this difference to possible dietary differences between both sexes in Australian Aboriginals. He reported that in Australian Abriginal populations, compared to the males, the females tended to consume a greater proportion of natural vegetable foods to which considerable amount of sand and grit is attached. In addition, the males tended to select the most tender meat and the females were left with the remaining tougher portions. Molnar *et al.* (1983) discussed other factors which may have caused this pattern of sex differences in the population they studied.

Several studies indicated that adult female anterior teeth are more worn than adult male anterior teeth in several ancient or native populations (see Larsen, 1997). These differences may reflect some kind of gender-specific behaviors in these populations Larsen (1997).

The pattern of sex differences may vary in other populations. Among the four Australian Aboriginal populations examined by Molnar *et al.* (1989), significant sexual dimorphism was detected only in one population in which the females showed less degree of wear than the males. Little sex differences were also found in another population of Australian Aboriginal (Richards, 1984).

The present study adds another instance showing that the patterns of sex differences in tooth wear vary among populations. The above results suggest that the wear on the molars was severer in males than in females in the Holocene prehistoric hunter-gatherers (Jomon) and prehistoric agriculturalists (Yayoi) of Japan, as well as

in the inhabitants in the capital of the pre-modern Edo period, although the explanation for this pattern of sexual dimorphism is lacking at this stage. On the other hand, marked sex differences probably did not exist in a medieval population in the Kanto district and a population in the recent times.

Acknowledgements

I express my gratitude to Dr. Gen Suwa and Dr. Yoshiyuki Tanaka for their permission to investigate the materials in their care. Thanks are also due to Dr. Bin Yamaguchi and Dr. Yuji Mizoguchi for helpful comments. This study was supported by Grant-in-Aid for Scientific Research, Ministry of Education, Science, Sports and Culture (No. 09740651).

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