Bull. Natn. Sci. Mus., Tokyo, Ser. D, **20**, pp. 1–22, December 22, 1994

Re-examination of the Flatness of the Jomon Tibiae from Tsukumo Shell-Mounds Site, Okayama Prefecture, Western Japan

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Abstract In order to ascertain the measurement method to indicate the flatness of the human tibial shaft formerly studied by KIYONO and his collegues of the University of Kyoto, various methods were applied to measure the transverse diameters at the nutrient foramen and midshaft for the tibiae from Tsukumo shell-mounds site (KIYONO and HIRAI 1928). In the males, flatness indices by VALLOIS' method are the closest to those of the former measurement. In the females, indices by the minimum method is the closest to the former. It is suggested that they measured the transverse diameter as a projected distance from the interosseous border to the medial surface in the direction perpendicular to the maximum sagittal diameter or to the long axis of the cross-section, which is not far from that of the VALLOIS' method. Therefore, comparisons of the indices by the former measurement with those of the VALLOIS' method are actually valid. In addition, the Tsukumo tibiae were revealed to be the flattest among the Japanese tibiae ever studied.

Introduction

Jomon people were ancient hunter-gatherers lived in the Japanese Islands during Jomon age (ca. 11,000–300 B.C.), (AIKENS and HIGUCHI, 1982). Jomon skeletons were usually unearthed from shell-mounds near the coast, as in the case of the present specimens. It is well known that Jomon skeletons exhibit considerable flatness of the tibial shaft compared with those of later ages (MORSE, 1879; KOGANEI, 1893; HASABE, 1939; YAMAGUCHI, 1982; BABA *et al.*, 1989).

KIYONO and his collegues of the Department of Pathology, the University of Kyoto had carried out extensive metrical studies on Jomon and later Japanese skeletons including lower limb bones (e.g., KIYONO and HIRAI, 1928; HIRAI and TABATA, 1928; ISHIZAWA, 1931; IMAMICHI, 1934; JO, 1938). As KONDO (1944) suggested, however, their data on the tibial flatness could not be used for precise comparative studies, because the method they used is not known. In addition, there are some doubts for their data, because the flatness indices of the Tsukumo tibiae are considerably lower (flatter) than those of other Jomon tibiae.

MORIMOTO (1971, 1981) compared MARTIN's (1928), VALLOIS' (1938) and HASEBE's (1939) methods for the transverse diameters of the shaft at the nutrient foramen and midshaft levels in Jomon tibiae. As a result, he suggested to use the VALLOIS' method, because this method could indicate the flatness most properly for all the variation in the shape of the cross-sections. Therefore, the data by the VALLOIS' method have been accumulated for the last decade (e.g., YAMAGUCHI, 1986; MORIMOTO and TAKAHASI, 1986; BABA, 1988; BABA *et al.*, 1989).

The Tsukumo skeletons have been regarded as a standard sample of Jomon human remains, and, consequently, have been referred most often by many authors. If the measurement method of the tibiae used by KIYONO and his collegues is revealed, we can compare their vast data to those of later studies more precisely. So, in order to ascertain the former measurement method, I re-examined the shaft flatness of the tibiae from Tsukumo shell-mounds site (KIYONO and HIRAI 1928).

Materials and Methods

All the human tibiae from Tsukumo shell-mounds site, Okayama Prefecture, Western Japan, now housed in the department of Anthropology, faculty of Science, the Universify of Kyoto, were measured. The specimens contain 87 tibiae in total, that is, 40 male tibiae and 47 female tibiae (Table 1). In other words, tibiae of 22 male individuals (Nos. 2, 3, 9, 10, 13, 19, 24, 27, 30, 32, 33, 35b, 36, 39, 46, 51, 55, 58, 61b, 65, 66, 162) and 25 female individuals (Nos. 1, 4, 6, 7, 11, 12, 14, 17, 20, 23, 34, 35a, 37, 38, 40, 41, 42, 43, 44, 59, 60, 62, 68, 70, 164) were used.

There are some differences in the sexing of the specimens between the present identification and the former identification by KIYONO and HIRAI (1928). That is, No. 13 tibiae formerly designated as those of a female were revealed to be surely those of a male, and No. 59 left tibia designated as thaf of a male is without doubt that of a female from the characteristics in the skull and pelvis. No. 35 skeleton, formerly identified as of a male, consists of two individuals; the No. 35 tibiae formerly measured as of a male are actually of a female (now assigned to No. 35a) and the other tibiae unmeasured are of a male (now assigned to No. 35b). In the former measurement, No. 61 tibiae were assigned to be male, but their values are extraordinally small as a male, must be of a female (now assigned to No. 61a). However, there is no tibia of which values correspond to those of No. 61. Actually the No. 61 tibia preserved is a large right bone unmeasured, must be of a male (now assigned to No. 61b).

The sagittal and the transverse diameters at the levels of the nutrient foramen and mid-shaft were measured by vernier sliding calipers in all the tibiae preserved. The sagittal diameter was measured as the maximum sagittal diameter from the anterior margin to the furthest point (MARTIN, 1928; BRÄUER, 1988; BABA, 1991; Fig. 1).

As for the transverse diameter, following three kinds of methods were taken. The first is by the MARTIN's method, a direct distance from the interosseous border to the medial border (MARTIN, 1928, BRÄUER, 1988; BABA, 1991; Fig. 1). The second is by the VALLOIS' method, a projected distance from the interosseous border to the medial border (or to the medial surface), in which the anterior border is placed in the

Table 1. Shaft flatness of the Jomon tibiae from Tsukumo shell-mounds.

Measurement item with modified MARTIN's No.		2 male		3 male		9 male		10 male	
		rt	lt	rt	lt	rt	lt	rt	lt
KIYONO & HIRAI (1928)									
8	Sag. diam. mid.	30	30	35	34	34	32	34	35
9*	Tra. diam. mid.	18	18	21	21	20	19	20	22
9*/8	Midshaft index	60.0	60.0	60.0	61.8	58.8	59.4	58.8	62.9
8a	Sag. diam. n. f.	31	35	39	36	37	35	38	40
9a*	Tra. diam. n. f.	19	19	24	24	22	22	22	22
9a*/8a	Cnemic index	61.3	54.3	61.5	66.7	59.5	62.9	57.9	55.0
BABA (present study)									
8	Sag. diam. mid.	30.3	30.3	34.7	34.1	33.6	31.6	35.3	36.3
9M	T. d. m. (MARTIN)	18.1	19.4	22.5	21.8	21.8	21.0	21.7	22.3
9V	T. d. m. (VALLOIS)	17.9	18.5	22.2	21.2	19.8	19.9	20.5	21.3
9m	T. d. m. (minimum)	17.3	17.5	21.5	20.5	19.4	19.5	19.8	20.8
9M/8	Midshaft index (M)	59.7	64.0	64.8	63.9	64.9	66.5	61.5	61.4
9V/8	Midshaft index (V)	59.1	61.1	64.0	62.2	58.9	63.0	58.1	58.7
9m/8	Midshaft index (m)	57.1	57.8	62.0	60.1	57.7	61.7	56.1	57.3
8a	Sag. diam. n. f.	31.5	34.5	38.4	38.0	36.2	34.0	38.6	40.3
9aM	T. d. n. f. (M)	19.0	20.7	25.6	26.8	23.2	22.7	27.1	26.4
9aV	T. d. n. f. (V)	19.0	19.8	25.2	24.9	21.4	22.0	22.7	23.6
9am	T. d. n. f. (m)	19.0	19.0	23.8	24.4	21.3	21.8	22.3	22.9
9aM/8a	Cnemic index (M)	60.3	60.0	66.7	70.5	64.1	66.8	70.2	65.5
9aV/8a	Cnemic index (V)	60.3	57.4	65.6	65.5	59.1	64.7	58.8	58.6
9am/8a	Cnemic index (m)	60.3	55.1	62.0	64.2	58.8	64.1	57.8	56.8
BABA–KIYONO & HIRAI									
9M/8–9*/8		– 0.3	4.0	4.8	2.1	6.1	7.1	2.7	– 1.5
9V/8–9*/8		– 0.9	1.1	4.0	0.4	0.1	3.6	– 0.7	– 4.2
9m/8–9*/8		– 2.9	– 2.2	2.0	– 1.7	– 1.1	2.3	– 2.7	– 5.6
9aM/8a–9a*/8a		– 1.0	5.7	5.2	3.8	4.6	3.9	12.3	10.5
9aV/8a–9a*/8a		– 1.0	3.1	4.1	– 1.2	– 0.4	1.8	0.9	3.6
9am/8a–9a*/8a		– 1.0	0.8	0.5	– 2.5	– 0.7	1.2	– 0.1	1.8

9* and 9a*, transverse diameters at the midshaft and the nutrient foramen by KIYONO & HIRAI (1928), but their methods are

Table 1. continued

Item in MARTIN'S No.	13 male		19 male		24 male		27 male		30 male	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
KIYONO & HIRAI										
8	28	31	36	35	—	34	34	34	30	30
9*	19	19	22	21	—	20	19	18	21	21
9*/8	67.9	61.3	61.1	60.0	—	58.8	55.9	52.9	70.0	70.0
8a	31	34	38	—	—	35	36	—	34	33
9a*	23	22	24	—	—	22	20	—	23	22
9a*/8a	74.2	64.7	63.2	—	—	62.9	55.6	—	67.6	66.7
BABA										
8	29.8	31.4	35.8	35.1	—	33.7	33.1	33.7	31.0	29.4
9M	20.0	20.1	21.4	21.4	—	20.4	17.9	18.4	21.2	21.5
9V	19.2	19.4	22.1	21.5	—	20.4	18.6	17.8	21.3	21.2
9m	19.0	19.2	21.4	21.4	—	19.6	18.0	17.7	20.8	20.0
9M/8	67.1	64.0	59.8	61.0	—	60.5	54.1	54.6	68.4	73.1
9V/8	64.4	61.8	61.7	61.3	—	60.5	56.2	52.8	68.7	72.1
9m/8	63.8	61.1	59.8	61.0	—	58.2	54.4	52.5	67.1	68.0
8a	35.4	35.2	39.2	38.8	—	34.6	36.6	—	34.0	33.2
9aM	24.7	24.2	26.2	25.7	—	22.7	19.9	—	22.7	23.5
9aV	23.4	22.8	23.9	23.3	—	21.8	20.2	—	22.4	23.0
9am	22.2	21.7	23.3	22.7	—	20.6	19.9	—	22.1	21.9
9aM/8a	69.8	68.8	66.8	66.2	—	65.6	54.4	—	66.7	70.8
9aV/8a	66.1	64.8	61.0	60.1	—	63.0	55.2	—	65.9	69.3
9am/8a	62.7	61.6	59.4	58.5	—	59.5	54.4	—	65.0	66.0
BABA—K & H										
9M/8—9*/8	−0.8	2.7	−1.3	1.0	—	1.7	−1.8	1.7	−1.6	3.1
9V/8—9*/8	−3.5	0.5	0.6	1.3	—	1.7	0.3	−0.1	−1.3	2.1
9m/8—9*/8	−4.1	−0.2	−1.3	1.0	—	−0.6	−1.5	−0.4	−2.9	−2.0
9aM/8a—9a*/8a	−4.4	4.1	3.6	—	—	2.7	−1.2	—	−0.9	4.1
9aV/8a—9a*/8a	−8.1	0.1	−2.2	—	—	0.1	−0.4	—	−1.7	2.6
9am/8a—9a*/8a	−11.5	−3.1	−3.8	—	—	−3.4	−1.2	—	−2.6	−0.7

not known.

Table 1. continued

Item in MARTIN'S No.	32 male		33 male		35b male		36 male		39 male	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	34	33	34	34	—	—	33	33	28	28
9*	19	21	21	21	—	—	23	23	18	18
9*/8	55.9	63.6	61.8	61.8	—	—	69.7	69.7	64.3	64.3
8a	37	36	37	38	—	—	35	36	30	31
9a*	22	23	23	23	—	—	26	26	20	21
9a*/8a	59.5	63.9	62.2	60.5	—	—	74.3	72.2	66.7	67.7
BABA										
8	34.1	32.5	34.2	35.0	—	26.5	31.2	31.5	28.4	28.3
9M	21.9	21.2	21.4	21.0	—	18.7	20.9	22.3	17.8	18.1
9V	19.4	20.0	21.5	20.8	—	18.8	21.7	22.3	17.8	17.9
9m	19.1	19.3	21.0	20.4		17.6	20.8	21.8	17.7	17.6
9M/8	64.2	65.2	62.6	60.0	—	70.6	67.0	70.8	62.7	64.0
9V/8	56.9	61.5	62.9	59.4	—	67.9	69.6	70.8	62.7	63.3
9m/8	56.0	59.4	61.4	58.3		66.4	66.7	69.2	62.3	62.2
8a	36.9	36.5	37.3	37.3	33.5	—	35.0	36.0	30.8	31.2
9aM	23.7	23.9	24.0	23.0	21.7	—	26.5	27.2	20.3	22.5
9aV	23.2	23.4	23.2	22.1	21.0	—	26.2	26.0	20.1	21.7
9am	21.8	21.9	22.7	21.7	20.2	—	26.1	25.4	19.5	20.4
9aM/8a	64.2	65.5	64.3	61.7	64.8	—	75.7	75.6	65.9	72.1
9aV/8a	62.9	64.1	62.2	59.2	62.7	—	74.9	72.2	65.3	69.6
9am/8a	59.1	60.0	60.9	58.2	60.3	—	74.6	70.6	63.3	65.4
BABA—K & H										
9M/8—9*/8	8.3	1.6	0.8	− 1.8	—	—	− 2.7	1.1	− 1.6	− 0.3
9V/8—9*/8	1.0	− 2.1	1.1	− 2.4	—	—	− 0.1	1.1	− 1.6	− 1.0
9m/8—9*/8	0.1	− 4.2	− 0.4	− 3.5	—	—	− 3.0	− 0.5	− 2.0	− 2.1
9M/8a—9a*/8a	4.7	1.6	2.1	1.2	—	—	1.4	3.4	− 0.8	4.4
9aV/8a—9a*/8a	3.4	0.2	0	− 1.3	—	—	0.6	0	− 1.4	1.9
9am/8a—9a*98a	− 0.4	− 3.9	− 1.3	− 2.3	—	—	0.3	− 1.6	− 3.4	− 2.3

Table 1. continued

Item in MARTIN'S No.	46 male		51 male		55 male		58 male		61b male	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	29	30	33	—	29	31	34	35	—	—
9*	19	21	18	—	20	20	21	21	—	—
9*/8	65.5	70.0	54.6	—	69.0	64.5	61.8	60.0	—	—
8a	—	34	35	—	34	34	40	38	—	—
9a*	—	20	21	—	23	22	25	25	—	—
9a*/8a	—	58.8	60.0	—	67.6	64.7	62.5	65.8	—	—
BABA										
8	29.0	28.7	34.5	—	30.1	30.0	35.2	36.5	33.7	—
9M	19.4	19.5	21.8	—	21.3	22.1	21.1	22.3	21.4	—
9V	18.5	18.4	18.9	—	19.9	20.4	21.3	22.8	20.4	—
9m	18.1	17.6	18.8	—	19.3	19.5	21.3	22.7	20.3	—
9M/8	66.9	67.9	63.2	—	70.8	73.7	59.9	61.1	63.5	—
9V/8	63.8	64.1	54.8	—	66.1	68.0	60.5	62.5	60.5	—
9m/8	62.4	61.3	54.5	—	64.1	65.0	60.5	62.2	60.2	—
8a	—	34.7	35.4	—	34.9	33.8	40.0	38.5	—	—
9aM	—	24.1	22.8	—	24.5	24.5	25.6	26.3	—	—
9aV	—	20.4	21.3	—	23.4	23.1	24.6	25.0	—	—
9am	—	19.5	20.4	—	22.6	22.3	23.5	24.3	—	—
9aM/8a	—	69.5	64.4	—	70.2	72.5	64.0	68.3	—	—
9aV/8a	—	58.8	60.2	—	67.0	68.3	61.5	64.9	—	—
9am/8a	—	56.2	57.6	—	64.8	66.0	58.8	63.1	—	—
BABA–K & H										
9M/8–9*/8	1.4	– 2.1	8.6	—	1.8	9.2	– 1.9	1.1	—	—
9V/8–9*/8	– 1.7	– 5.9	0.2	—	– 2.9	3.5	– 1.3	2.5	—	—
9m/8–9*/8	– 3.1	– 8.7	– 0.1	—	– 4.9	0.5	– 1.3	2.2	—	—
9aM/8a–9a*/8a	—	10.7	4.4	—	2.6	7.8	1.5	2.5	—	—
9aV/8a–9a*/8a	—	0	0.2	—	– 0.6	3.6	– 1.0	– 0.9	—	—
9am/8a–9a*/8a	—	– 2.6	– 2.4	—	– 2.8	1.3	– 3.7	– 2.7	—	—

Table 1. continued

Item in Martin's No.	65 male		66 male		162 male		1 female		4 female	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	33	34	36	36	—	30	28	26	28	28
9*	20	18	20	20	—	20	18	18	18	18
9*/8	60.6	52.9	55.6	55.6	—	66.7	64.3	69.2	64.3	64.3
8a	37	38	37	37	—	33	29	31	32	32
9a*	21	21	22	21	—	21	18	19	19	20
9a*/8a	56.8	55.3	59.5	56.8	—	63.6	62.1	61.3	59.4	62.5
Baba										
8	32.9	33.9	35.4	35.3	—	29.4	27.9	26.9	28.3	27.8
9M	20.0	19.9	21.0	20.3	—	21.2	18.4	18.3	20.1	19.9
9V	18.7	19.4	20.8	19.4	—	19.7	17.9	17.5	18.3	18.8
9m	18.6	19.2	20.6	19.4	—	19.3	17.6	17.4	17.9	18.4
9M/8	60.8	58.7	59.3	57.5	—	72.1	65.9	68.0	71.0	71.6
9V/8	56.8	57.2	58.8	55.0	—	67.0	64.2	65.1	64.7	67.6
9m/8	56.5	56.6	58.2	55.0	—	65.6	63.1	64.7	63.3	66.2
8a	37.4	37.8	38.2	37.8	—	33.5	29.5	30.0	32.1	—
9aM	22.9	22.1	23.4	22.8	—	22.6	19.3	20.2	23.2	24.2
9aV	21.5	21.1	22.3	21.5	—	21.0	18.9	19.2	21.3	20.9
9am	21.1	20.5	22.0	20.9	—	21.0	18.2	18.5	19.3	20.8
9aM/8a	61.2	58.5	61.3	60.3	—	67.5	65.4	67.3	72.3	—
9aV/8a	57.5	55.8	58.4	56.9	—	62.7	64.1	64.0	66.4	—
9am/8a	56.4	54.2	57.6	55.3	—	62.7	61.7	61.7	60.1	—
Baba – K & H										
9M/8 – 9*/8	0.2	5.8	3.7	1.9	—	5.4	1.6	– 1.2	6.7	7.3
9V/8 – 9*/8	– 3.8	4.3	3.2	– 0.6	—	0.3	– 0.1	– 4.1	0.4	3.3
9m/8 – 9*/8	– 4.1	3.7	2.6	– 0.6	—	– 1.1	– 1.2	– 4.5	– 1.0	1.9
9aM/8a – 9a*/8a	4.4	3.2	1.8	3.5	—	3.9	3.3	6.0	12.9	—
9aV/8a – 9a*/8a	0.7	0.5	– 1.1	0.1	—	– 0.9	2.0	2.7	7.0	—
9am/8a – 9a*/8a	– 0.4	– 1.1	– 1.9	– 1.5	—	– 0.9	– 0.4	0.4	0.7	—

Table 1. continued

Item in MARTIN'S No.	6 female		7 female		11 female		12 female		14 female	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	27	27	—	27	25	27	26	24	30	30
9*	16	17	—	18	19	19	16	16	18	19
9*/8	59.3	63.0	—	66.7	76.0	70.4	61.5	66.7	60.0	63.3
8a	30	31	31	31	31	33	28	28	32	32
9a*	18	19	20	21	21	22	17	18	19	19
9a*/8a	60.0	61.3	64.5	67.7	67.7	66.7	60.7	64.3	59.4	59.4
BABA										
8	26.9	27.4	—	27.6	26.3	26.5	25.3	24.5	29.1	30.6
9M	19.0	18.5	—	18.4	18.7	19.3	18.0	17.3	18.9	19.3
9V	16.9	17.4	—	18.3	19.4	20.0	16.2	16.4	19.0	19.1
9m	16.0	16.4	—	18.1	18.7	19.0	16.0	15.9	18.6	19.1
9M/8	70.6	67.5	—	66.7	71.1	72.8	71.1	70.6	64.9	63.1
9V/8	62.8	63.5	—	66.3	73.8	75.5	64.0	66.9	65.3	62.4
9m/8	59.5	59.9	—	65.6	71.1	71.7	63.2	64.9	63.9	62.4
8a	29.4	30.7	31.4	30.8	31.8	32.0	28.5	28.5	32.0	34.0
9aM	21.0	21.5	21.7	21.0	23.5	24.1	17.8	19.4	19.6	20.8
9aV	18.8	19.3	21.4	20.7	21.9	22.5	17.6	18.4	19.5	20.6
9am	17.8	19.2	21.0	20.3	21.0	21.9	17.5	18.3	19.3	20.0
9aM/8a	71.4	70.0	69.1	68.2	73.9	75.3	62.5	68.1	61.3	61.2
9aV/8a	63.9	62.9	68.2	67.2	68.9	70.3	61.8	64.6	60.9	60.6
9am/8a	60.5	62.5	66.9	65.9	66.0	68.4	61.4	64.2	60.3	58.8
BABA−K & H										
9M/8−9*/8	11.3	4.5	—	0	−4.9	2.4	9.6	3.9	4.9	−0.2
9V/8−9*/8	3.5	0.5	—	0.4	−2.2	5.1	2.5	0.2	5.3	−0.9
9m/8−9*/8	0.2	−3.1	—	−1.1	−4.9	1.3	1.7	−1.8	3.9	−0.9
9aM/8a−9a*/8a	11.4	8.7	4.6	0.5	6.2	8.6	1.8	3.8	1.9	1.8
9aV/8a−9a*/8a	3.9	1.6	3.7	−0.5	1.2	3.6	1.1	0.3	1.5	1.2
9am/8a−9a*/8a	0.5	1.2	2.4	−1.8	−1.7	1.7	0.7	−0.1	0.9	−0.6

Table 1. continued

Item in Martin's No.	17 female		20 female		23 female		34 female		35a female	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	26	25	26	27	—	30	26	25	26	26
9*	19	18	19	17	—	19	17	16	16	18
9*/8	73.1	72.0	73.0	63.0	—	63.3	65.4	64.0	61.5	69.2
8a	30	29	30	32	—	32	29	29	30	29
9a*	20	18	19	18	—	20	18	19	18	19
9a*/8a	66.7	62.1	63.3	56.3	—	62.5	62.1	65.5	60.0	65.5
Baba										
8	25.5	25.1	25.7	26.4	—	29.3	26.0	25.4	27.5	26.0
9M	18.7	18.5	18.8	18.2	—	19.8	19.1	18.0	17.8	18.2
9V	18.8	18.2	18.5	17.2	—	19.0	17.8	17.5	17.2	17.5
9m	18.4	17.7	17.8	16.8	—	18.3	16.8	16.4	16.8	17.2
9M/8	73.3	73.7	73.2	68.9	—	67.6	73.5	70.9	64.7	70.0
9V/8	73.7	72.5	72.0	65.2	—	64.8	68.5	68.9	62.5	67.3
9m/8	72.2	70.5	69.3	63.3	—	62.5	64.6	64.6	61.1	66.2
8a	30.4	29.5	30.0	31.8	—	—	28.9	28.9	29.6	28.5
9aM	20.8	20.0	20.0	20.3	—	—	20.6	21.1	19.6	20.0
9aV	20.0	19.0	19.3	18.6	—	—	19.4	19.7	18.5	19.3
9am	19.7	18.3	18.8	18.2	—	—	17.8	19.0	17.8	18.5
9aM/8a	68.4	67.8	66.7	63.8	—	—	71.3	73.0	66.2	70.2
9aV/8a	65.8	64.4	64.3	58.5	—	—	67.1	68.2	62.5	67.7
9am/8a	64.8	62.0	62.7	57.2	—	—	61.6	65.7	60.1	64.9
Baba – K & H										
9M/8 – 9*/8	0.2	1.7	0.2	5.9	—	4.3	8.1	6.9	3.2	0.8
9V/8 – 9*/8	0.6	0.5	– 1.0	2.2	—	1.5	3.1	4.9	1.0	– 1.9
9m/8 – 9*/8	– 0.9	– 1.5	– 3.7	0.6	—	– 0.8	– 0.8	0.6	– 0.4	– 3.0
9aM/8a – 9a*/8a	1.7	5.7	3.4	7.5	—	—	9.2	7.5	6.2	4.7
9aV/8a – 9a*/8a	– 0.9	2.3	1.0	2.2	—	—	5.0	2.7	2.5	2.2
9am/8a – 9a*/8a	– 1.9	– 0.1	– 0.6	0.9	—	—	– 0.5	0.2	0.1	– 0.6

Table 1. continued

Item in MARTIN'S No.	37 female		38 female		40 female		41 female		42 female	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	26	26	30	29	29	29	25	25	26	26
9*	19	17	16	17	17	18	17	15	19	19
9*/8	73.1	65.4	53.3	58.6	58.6	62.1	68.0	60.0	73.1	73.1
8a	—	31	31	—	32	32	28	27	30	31
9a*	—	19	17	—	20	20	19	18	21	20
9a*/8a	—	61.3	54.8	—	62.5	62.5	67.9	66.7	70.0	64.5
BABA										
8	25.5	26.5	29.6	28.3	28.8	28.7	25.0	25.1	25.9	26.5
9M	19.2	20.0	16.7	17.2	17.8	18.0	16.5	15.8	19.0	19.3
9V	18.3	19.0	16.4	17.2	18.0	17.5	16.0	15.5	19.0	18.8
9m	16.5	17.1	16.3	17.0	17.6	17.4	15.9	15.5	19.0	18.7
9M/8	75.3	75.5	56.4	60.8	61.8	62.7	66.0	62.9	73.4	72.8
9V/8	71.8	71.7	55.4	60.8	62.5	61.0	64.0	61·8	73.4	70.9
9m/8	64.7	64.5	55.1	60.1	61.1	60.6	63.6	61.8	73.4	70.6
8a	—	32.0	30.9	—	31.9	32.4	27.0	27.2	31.0	31.8
9aM	—	24.0	19.3	—	22.3	21.7	20.0	20.0	21.4	21.7
9aV	—	20.7	17.5	—	20.5	21.2	18.6	18.6	21.4	21.6
9am	—	19.7	17.1	—	20.4	20.6	18.3	17.2	21.2	20.4
9aM/8a	—	75.0	62.5	—	69.9	67.0	74.1	73.5	69.0	68.2
9aV/8a	—	64.7	56.6	—	64.3	65.4	68.9	68.4	69.0	67.9
9am/8a	—	61.6	55.3	—	63.9	63.6	67.8	63.2	68.4	64.2
BABA–K & H										
9M/8–9*/8	2.2	10.1	3.1	2.2	3.2	0.6	– 2.0	2.9	0.3	– 0.3
9V/8–9*/8	– 1.3	6.3	2.1	2.2	3.9	– 1.1	– 4.0	1.8	0.3	– 2.2
9m/8–9*/8	– 8.4	– 0.9	1.8	1.5	2.5	– 1.5	– 4.4	1.8	0.3	– 2.5
9aM/8a–9a*/8a	—	13.7	7.7	—	7.4	4.5	6.2	6.8	– 1.0	3.7
9aV/8a–9a*/8a	—	3.4	1.8	—	1.8	2.9	1.0	1.7	– 1.0	3.4
9am/8a–9a*/8a	—	0.3	0.5	—	1.4	1.1	– 0.1	– 3.5	– 1.6	– 0.3

Table 1. continued

Item in MARTIN'S No.	43 female		44 female		59 female		60 female		61a female	
	rt	lt	rt	lt	rt	lt	rt	lt	rt	lt
K & H										
8	30	29	29	30	—	26	25	25	27	26
9*	18	18	18	17	—	16	16	15	17	17
9*/8	60.0	62.1	62.1	56.7	—	61.5	64.0	60.0	63.0	65.4
8a	32	—	35	34	—	31	29	29	32	30
9a*	19	—	19	19	—	17	17	17	19	18
9a*/8a	59.4	—	54.3	55.9	—	54.8	58.6	58.6	59.4	60.0
BABA										
8	29.4	29.0	28.6	29.7	—	26.7	25.5	25.3	—	—
9M	18.0	18.2	19.4	20.0	—	16.9	18.4	18.3	—	—
9V	17.4	18.0	17.9	18.3	—	16.4	16.9	16.8	—	—
9m	17.3	17.5	17.3	17.0	—	16.0	15.9	15.2	—	—
9M/8	61.2	62.8	67.8	67.3	—	63.3	72.2	72.3	—	—
9V/8	59.2	62.1	62.6	61.6	—	61.4	66.3	66.4	—	—
9m/8	58.8	60.3	60.5	57.2	—	59.9	62.4	60.1	—	—
8a	31.8	—	33.8	33.3	—	30.7	28.8	29.1	—	—
9aM	19.9	—	22.5	22.2	—	19.0	20.0	19.3	—	—
9aV	19.2	—	20.3	18.8	—	17.1	18.0	17.7	—	—
9am	18.9	—	19.9	18.5	—	17.0	16.5	17.1	—	—
9aM/8a	62.6	—	66.6	66.7	—	61.9	69.4	66.3	—	—
9aV/8a	60.4	—	60.1	56.5	—	55.7	62.5	60.8	—	—
9am/8a	59.4	—	58.9	55.6	—	55.4	57.3	58.8	—	—
BABA—K & H										
9M/8—9*/8	1.2	0.7	5.7	10.6	—	1.8	8.2	12.3	—	—
9V/8—9*/8	— 0.8	0	0.5	4.9	—	— 0.1	2.3	6.4	—	—
9m/8—9*/8	— 1.2	— 1.8	— 1.6	0.5	—	— 1.6	— 1.6	0.1	—	—
9aM/8a—9a*/8a	3.2	—	12.3	10.8	—	7.1	10.8	7.7	—	—
9aV/8a—9a*/8a	1.0	—	5.8	0.6	—	0.9	3.9	2.2	—	—
9am/8a—9a*/8a	0	—	4.6	— 0.3	—	0.6	— 1.3	0.2	—	—

Table 1. continued

Item in MARTIN'S No.	62 female		68 female		70 female		164 female	
	rt	lt	rt	lt	rt	lt	rt	lt
K & H								
8	25	25	24	—	28	27	26	26
9*	15	15	17	—	19	19	20	19
9*/8	60.0	60.0	70.8	—	67.9	70.4	76.9	73.1
8a	27	26	27	—	—	29	30	—
9a*	17	17	18	—	—	19	21	—
9a*/8a	63.0	65.4	66.7	—	—	65.5	70.0	—
BABA								
8	25.0	24.4	24.8	—	26.9	26.5	25.7	25.4
9M	16.9	16.7	16.5	—	20.3	20.0	19.6	19.1
9V	16.0	16.2	16.6	—	19.4	19.3	19.4	18.7
9m	15.4	15.7	16.5	—	18.6	17.9	18.6	17.6
9M/8	67.6	68.4	66.5	—	75.5	75.5	76.3	75.2
9V/8	64.0	66.4	66.9	—	72.1	72.8	75.5	73.6
9m/8	61.6	64.3	66.5	—	69.1	67.5	72.4	69.3
8a	27.4	26.9	29.3	—	—	28.9	29.2	—
9aM	18.3	17.7	18.5	—	—	19.3	22.1	—
9aV	18.0	17.3	18.6	—	—	19.0	21.4	—
9am	17.3	17.3	18.4	—	—	18.4	19.7	—
9aM/8a	66.8	65.8	63.1	—	—	66.8	75.7	—
9aV/8a	65.7	64.3	63.5	—	—	65.7	73.3	—
9am/8a	63.1	64.3	62.8	—	—	63.7	67.5	—
BABA—K & H								
9M/8—9*/8	7.6	8.4	− 4.3	—	7.6	5.1	− 0.6	2.1
9V/8—9*/8	4.0	6.4	− 3.9	—	4.2	2.4	− 1.4	0.5
9m/8—9*/8	1.6	4.3	− 4.3	—	1.2	− 2.9	− 4.5	− 3.8
9aM/8a—9a*/8a	3.8	0.4	− 3.6	—	—	1.3	5.7	—
9aV/8a—9a*/8a	2.7	− 1.1	− 3.2	—	—	0.2	3.3	—
9am/8a—9a*/8a	0.1	− 1.1	− 3.9	—	—	− 1.8	− 2.5	—

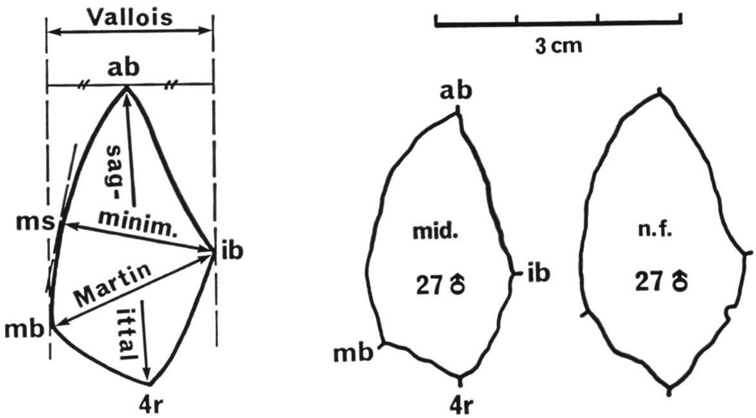

Fig. 1. Measurement methods of tibial shaft cross-sections. Sagittal diameter, a direct distance from the anterior border (ab) to the furthest point; MARTIN's transverse diameter, a direct distance from the interosseous border (ib) to the medial border (mb); minimum transverse diameter, a projected minimum distance from the interosseous border to the medial surface (ms); VALLOIS' transverse diameter, a projected medio-lateral diameter in which the anterior border sits in the middle. Outlines of the cross-sections at the midshaft (mid.) and the nutrient foramen (n.f.) of No. 27 right tibia are shown on the right. In the Tsukumo tibiae, the shape of the cross-section is usually rhomboid having so-called fourth ridge (4r).

middle of the transverse diameter (VALLOIS, 1938; OLIVIER, 1960; Fig. 1). The third is the minimum (projected) distance from the interosseous border to the medial surface (or to the medial border), (Fig. 1).

MORIMOTO (1971, 1981) interpreted the HASEBE's transverse diameter as the minimum distance between the interosseous border and the medial surface, but I regard the HASEBE's transverse diameter as a projected distance between the interosseous border and the medial surface measured in the direction approximately perpendicular to the maximum sagittal diameter, as he described (1939). This method is actually equivalent to that of VALLOIS (1938), because most of the Tsukumo tibiae have rhomboid cross-sections, in which the direction of the maximum sagittal diameter is almost perpendicular to the transverse diameter in the VALLOIS' method. So, I did not use the original HASEBE's method and used the minimum method, which is the same as the HASEBE's method in MORIMOTO (1971, 1981).

For the point of measurement, midshaft and nutrient foramen levels were used. The midshaft was set at the mid-point of the maximum length of the tibia. In case that the maximum length is not avairable due to damage of the bone, the mid-point was estimated by naked eye comparison with other tibiae. The nutrient foramen level has not been defined clearly in most textbook of osteometry (WILDER, 1920; MARTIN, 1928; MARTIN and SALLER, 1955; BASS, 1987; BRÄUER, 1988). OLIVIER only defined the level at the distal end of the nutrient foramen (1960). In the present study, however, the nutrient foramen level was set, according to my speculation on the former method, at the level in which the transverse diameter of the foramen becomes maximum, about 2–3 mm higher than the distal end (lower margin) of the nutrient foramen. Actually the differences in the values between the two levels are negligibly small.

Usually, the flatness index of the tibial shaft has been defined in two kinds (MARTIN, 1928; BRÄUER, 1988; BABA, 1991). That is, the cnemic index in a strict sense is indicated by a percentage of the transverse diameter to the sagittal diameter at the nutrient foramen. The midshaft index is shown by a percentage of the transverse diameter to the sagittal diameter at the mid-point. KIYONO and HIRAI (1928) should have followed these definitions, so did I.

Flatness of the Tsukumo Tibiae

Present and former values of the measurements and indices are listed according to the identification by myself in Table 1. The means and standard deviations of the values are calculated in two ways. That is, those calculated from each of the present and former specimens and those from the specimens common to the former and present identifications (Table 2).

In the minimum method, all the means of the indices belong to platycnemic (below 63.0), while in the MARTIN's method all the means belong to mesocnemic (63.0–69.9), (Table 2). In the VALLOIS' method some (mostly males) belong to platycnemic and others (mostly females) to mesocnemic. In other words, the indices by the MARTIN's method are 3–6 higher than those of the minimum method, and those of the VALLOIS' are intermediate between the two.

MORIMOTO (1981) reported that the cnemic index (at the nutrient foramen) of Jomon tibiae by the MARTIN's, VALLOIS' and HASEBE's (minimum) methods were, regardless of sex, 69, 67 and 65, respectively. The present results of the Tsukumo tibiae show much lower indices, that is, 65–67, 62–65 and 60–61 in the MARTIN's, VALLOIS' and minimum (HASEBE's in MORIMOTO) methods, respectively.

As for the difference in the indices between the three methods, MORIMOTO (1971) reported that indices by the MARTIN's method is about 3–4 higher at the nutrient foramen and about 3 higher at the midshaft than those of the HASEBE's (minimum) method, and that those of the VALLOIS' method are inbetween. The present results show the same tendency as MORIMOTO reported (1971). The differences in the present mean values of the indices are, however, larger than in the case of MORIMOTO (1971), e.g., 5–6 at the nutrient foramen and 3–5 at the midshaft. In addition, indices of the males are considerably (1.5–4) lower than those of the females.

Usually, the transverse diameter is larger in the order of the MARTIN's, VALLOIS' and minimum methods. In the Tsukumo specimens, however, values by the MARTIN's method are sometimes smaller than those of the VALLOIS' and minimum methods. This is because of that most of the cross-sections in the Tsukumo tibiae are not triangular but rhomboid, and that the posterior part of the medial surface is sometimes

Table 2. Means of shaft flatness of the Jomon tibiae from Tsukumo (male).

Item in modified MARTIN'S No.	All the specimens measured						Specimens common to K & H and BABA					
	right			left			right			left		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
K & H												
8	18	32.44	2.68	19	32.58	2.27	18	32.44	2.68	19	32.58	2.27
9*	18	19.94	1.39	19	20.11	1.45	18	19.94	1.39	19	20.11	1.45
9*/8	18	61.75	5.00	19	61.91	5.06	18	61.74	5.00	19	61.91	5.06
8a	17	35.65	2.87	17	35.47	2.27	17	35.65	2.87	17	35.47	2.27
9a*	17	22.35	1.84	17	22.12	1.73	17	22.35	1.84	17	22.12	1.73
9a*/8a	17	62.94	5.48	17	62.51	5.04	17	62.94	5.48	17	62.51	5.03
BABA												
8	19	32.75	2.38	20	32.16	2.88	18	32.70	2.43	19	32.47	2.61
9M	19	20.66	1.42	20	20.65	1.32	18	20.62	1.45	19	20.75	1.27
9V	19	20.03	1.42	20	20.02	1.45	18	20.01	1.46	19	20.12	1.41
9m	19	19.62	1.34	20	19.53	1.47	18	19.58	1.37	19	19.63	1.44
9M/8	19	63.22	3.92	20	64.53	5.43	18	63.21	4.03	19	64.21	5.38
9V/8	19	61.29	4.16	20	62.51	4.90	18	61.33	4.27	19	62.23	4.86
9m/8	19	60.04	3.84	20	60.95	4.33	18	60.03	3.95	19	60.66	4.25
8a	18	36.07	2.53	18	35.87	2.39	17	36.22	2.52	17	35.70	2.35
9aM	18	23.54	2.29	18	23.98	1.83	17	23.65	2.31	17	23.88	1.84
9aV	18	22.50	1.87	18	22.58	1.64	17	22.59	1.89	17	22.54	1.68
9am	18	21.88	1.74	18	21.83	1.68	17	21.98	1.74	17	21.78	1.72
9aM/8a	18	65.28	4.64	18	66.98	4.66	17	65.31	4.78	17	67.03	4.80
9aV/8a	18	62.48	4.54	18	63.11	4.81	17	62.46	4.68	17	63.28	4.90
9am/8a	18	60.77	4.46	18	60.97	4.61	17	60.79	4.60	17	61.12	4.70
BABA−K & H												
9M/8−9*/8		1.48			2.62			1.47			2.30	
9V/8−9*/8		−0.45			0.60			−0.41			0.32	
9m/8−9*/8		−1.70			−0.96			−1.71			−1.25	
9aM/8a−9a*/8a		2.34			4.47			2.37			4.52	
9aV/8a−9a*/8a		−0.46			0.60			−0.48			0.77	
9am/8a−9a*/8a		−2.17			−1.54			−2.15			−1.39	

K & H, KIYONO and HIRAI (1928); BABA, present study

Table 2. continued (female)

Item in modified MARTIN's No.	All the specimens measured						Specimens common to K & H and BABA					
	right			left			right			left		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
K & H												
8	23	26.87	1.79	25	26.84	1.77	22	26.86	1.83	24	26.88	1.80
9*	23	17.57	1.34	25	17.40	1.32	22	17.59	1.37	24	17.42	1.35
9*/8	23	65.61	6.36	25	64.94	4.61	22	65.74	6.48	24	64.92	4.70
8a	22	30.23	1.90	22	30.41	1.97	21	30.14	1.90	20	30.35	2.03
9a*	22	18.82	1.30	22	18.91	1.27	21	18.81	1.33	20	18.90	1.29
9a*/8a	22	62.39	4.39	22	62.29	3.66	21	62.53	4.45	20	62.39	3.80
BABA												
8	22	26.78	1.59	24	26.90	1.69	22	26.78	1.59	24	26.90	1.69
9M	22	18.45	1.09	24	18.47	1.14	22	18.45	1.09	24	18.47	1.14
9V	22	17.79	1.14	24	17.86	1.12	22	17.79	1.14	24	17.86	1.12
9m	22	17.25	1.10	24	17.22	1.09	22	17.31	1.10	24	17.22	1.09
9M/8	22	69.06	5.22	24	68.79	4.48	22	69.06	5.22	24	68.91	4.63
9V/8	22	66.60	5.32	24	66.52	4.41	22	66.60	5.32	24	66.52	4.41
9m/8	22	64.57	4.86	24	64.11	3.87	22	64.57	4.86	24	64.13	3.87
8a	21	30.22	1.71	19	30.37	1.99	21	30.22	1.71	19	30.37	1.99
9aM	21	20.54	1.59	20	20.88	1.76	21	20.54	1.59	19	20.70	1.62
9aV	21	19.53	1.37	20	19.51	1.45	21	19.53	1.37	19	19.44	1.46
9am	21	18.85	1.36	20	18.96	1.37	21	18.85	1.36	19	18.86	1.34
9aM/8a	21	68.01	4.21	19	68.22	3.94	21	68.01	4.21	19	68.22	3.94
9aV/8a	21	64.68	3.82	19	64.09	4.08	21	64.68	3.82	19	64.09	4.08
9am/8a	21	62.40	3.55	19	62.19	3.56	21	62.40	3.55	19	62.19	3.56
BABA−K & H												
9M/8−9*/8		3.48			3.97			3.32			3.99	
9V/8−9*/8		0.99			1.58			0.86			1.60	
9m/8−9*/8		−1.04			−0.83			−1.17			−0.79	
9aM/8a−9a*/8a		5.62			5.93			5.48			5.83	
9aV/8a−9a*/8a		2.29			1.80			2.15			1.70	
9am/8a−9a/8*		0.01			−0.10			−0.13			−0.20	

bulged more medially to the medial border (Fig. 1).

Assessment of the Method in the Former Study

In order to assess the former method used by Kiyono and Hirai (1928), differences in each value between the former and present measurements were compared. There are some differences in the sagittal diameter, in which the former and the present methods were supposed to be the same (Table 1). That is, while most of the differences are less than 1 mm, considered as the technical error of the measurement, some of the differences exceed 1 mm in Nos. 3, 10, 13, 14, 36, 51, 68 by unknown reasons. However, the differences in the means of the specimens common to the former and present studies are small (0.02–0.23 mm) in the males and females, in the right and left sides, and at the nutrient foramen and midshaft levels, except in the male right bones (0.36 and 0.57 mm).

As for the transverse diameters, most values of the former measurements are close to those of the Vallois' or minimum methods and far from those of the Martin's method. In the mean values also, those of the Vallois' are the closest to the former and those of the minimum method are the second closest in the males, and those of the minimum are the closest and those of Vallois' are the second closest in the females (Table 2, Fig. 1). Values of the Martin's method are the furthest from the former in the males and females.

Accordingly, there is no possibility that Kiyono and Hirai (1928) measured the transverse diameter by the Martin's method, which agrees with the assessment by Morimoto (1981). The Vallois' method (1938) had not been published at that time (1928). It is most likely that they had measured the projected distance from the interosseous border to the medial surface or to the medial border in the direction perpendicular to the sagittal diameter as Hasebe defined later in 1939. It is also likely that Hasebe defined the method like that, because he had understood their method. There is one more possibility that they measured the transverse diameter perpendicular to the long axis of the cross-section of the shaft, which is almost equivalent to the Vallois' method.

For the cnemic index, the former values are closest to those of the Vallois' method and next to it to those of the minimum method in the males, and are closest to those of the minimum method and next to it to the Vallois' in the females.

Application of the Former Data

The present specimens differ from the former specimens in the content, mainly due to the former mis-identification of sex. That is, compared with the former specimens, one female tibia was re-assigned to a male tibia, three male tibiae were re-assigned to female tibiae, two male (actually female) bibiae were lost, and two new male tibiae were added to the present specimens. The former specimens are, however,

Table 3. Comparison of shaft flatness of the Jomon tibiae from Tsukumo.

Item in MARTIN's No.		Male						Femal					
		right			left			right			left		
		N	M	SD	N	M	SD	N	M	SD	N	M	SD
K & H by K & H													
8		19	32.1	3.00	21	31.7	3.28	22	26.8	1.68	23	27.1	1.96
9*		19	19.6	1.69	21	19.7	1.75	22	17.7	1.32	23	17.5	1.39
9*/8	(A)	19	61.5	4.45	21	62.4	4.88	22	65.4	6.11	23	64.7	4.69
8a		18	35.4	2.93	19	34.7	2.90	21	30.2	1.87	21	30.5	2.10
9a*		18	21.9	2.10	19	21.5	2.21	21	19.0	1.45	20	19.2	1.36
9a*/8a	(B)	18	62.2	4.47	19	62.0	5.25	20	62.8	5.07	21	63.0	3.71
K & H by BABA													
8		18	32.44	2.68	19	32.58	2.27	23	26.87	1.79	25	26.84	1.77
9*		18	19.44	1.39	19	20.11	1.45	23	17.57	1.34	25	17.40	1.32
9*/8	(C)	18	61.74	5.00	19	61.91	5.06	23	65.58	6.36	25	64.94	4.61
8a		17	35.65	2.87	17	35.47	2.27	22	30.23	1.90	22	30.41	1.97
9a*		17	22.35	1.84	17	22.12	1.73	22	18.82	1.30	22	18.91	1.27
9a*/8a	(D)	17	62.94	5.48	17	62.51	5.04	22	62.39	4.39	22	62.29	3.66
BABA by BABA													
8		19	32.75	2.38	20	32.16	2.88	22	26.78	1.59	24	26.90	1.69
9V		19	20.03	1.42	20	20.02	1.45	22	17.79	1.14	24	17.86	1.12
9V/8	(E)	19	61.29	4.16	20	62.51	4.90	22	66.60	5.32	24	66.52	4.41
8a		18	36.07	2.53	18	35.87	2.39	21	30.22	1.71	20	30.27	1.99
9aV		18	22.50	1.87	18	22.58	1.64	21	19.53	1.37	20	19.51	1.45
9aV/8a	(F)	18	62.48	4.54	18	63.11	4.81	21	64.68	3.82	19	64.09	4.08
Difference													
(C)—(A)			0.24			−0.49			0.18			0.24	
(D)—(B)			0.74			0.51			−0.41			−0.71	
(E)—(C)			−0.45			0.60			1.02			1.58	
(F)—(D)			−0.46			0.60			2.29			1.80	

K & H, KIYONO & HIRAI (1928); BABA, present study; K & H by K & H, KIYONO & HIARAI's data calculated from the identification by KIYONO & HIRAI; K & H by BABA, KIYONO & HIRAI's data calculated from the identification by BABA; BABA by BABA, BABA's data calculated from the identification by BABA.

Table 4. Comparison of shaft flatness of Japanese tibiae.

Specimen	Male					Female		
	9*/8	9V/8	9a*/8a	9aV/8a	9*/8	9V/8	9a*/8a	9aV/8a
Mesolithic Jomon								
Tsukumo (Kiyono & Hirai, 1928)	62.0		62.1		65.1		62.9	
Tsukumo (Baba, present study)		61.9		62.8		66.6		64.4
Yosiko (Ishizawa, 1931)	67.6		67.8		67.1		67.8	
Ota (Imamichi, 1934)	65.4		67.2		65.1		64.1	
Ebisima (Yamaguchi, 1983)		66.4				71.7		
Sanganji (Baba, 1988)		67.6		67.3		71.7		70.0
East Japan (Morimoto, 1989)				67				67
Bronze Yayoi								
Otomo (Matsusita, 1981)		69.1		67.7		72.1		70.4
Doigahama (Zaitsu, 1956)		70.9		69.5		70.8		72.3
Kanenokuma (Nakahashi et al. 1985)		72.9		71.2		78.2		73.5
Protohistoric Kohun								
West Japan (Jo, 1938)	73.0		70.1		72.6		72.1	
Recent								
Kinai (Hirai & Tabata, 1928)	74.0		72.5		77.5		75.7	

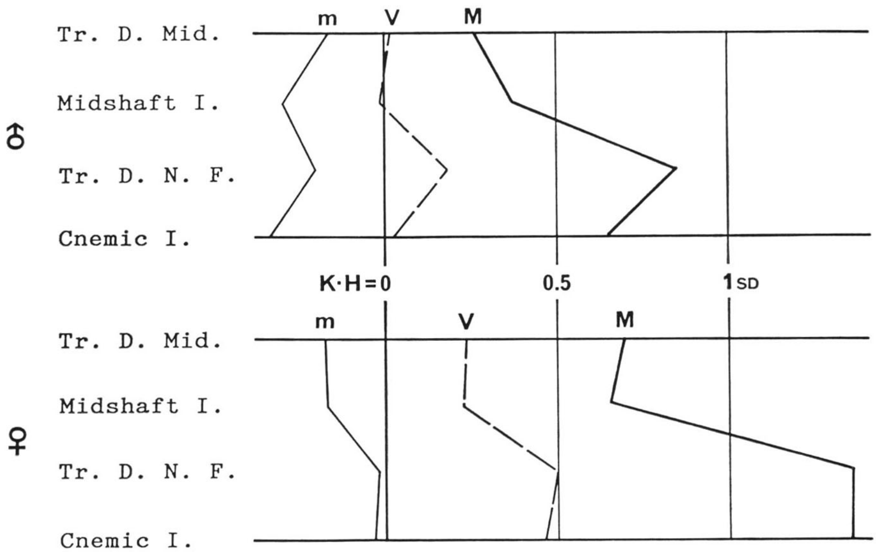

Fig. 2. Deviation graphs of the present values on tibial flatness by MARTIN's (M), VALLOIS' (V) and minimum (m) methods from the former values by KIYONO & HIRAI (K · H).

almost equal to the present specimens in the mean values of the sagittal and transverse diameters and indices, i.e., the difference between the former and present specimens in the means are mostly less than one fifth of the standard deviation (Table 3, Fig. 2). This implies that some minor errors in the identifications and/or calculation procedures did not affect significantly to the mean values.

As far as the present study suggests, we may well compare the former KIYONO and HIRAI's values of the cnemic index and midshaft index with those of the VALLOIS' method with much accuracy. That is, in the males the former values are equivalent to the later values by the VALLOIS' method, and in the females the former values are 1–2 smaller than those of the VALLOIS' method.

Comparison of the Flatness with Other Tibiae

It is well known that Jomon tibiae exhibit a flatter shaft than those of the later ages (Fig. 1, Table 4). Moreover, compared with other Jomon tibiae, the Tsukumo tibiae show marked flatness for all the difference in methods. Therefore, it can be said that the Tsukumo tibiae are the flattest of all the Japanese tibiae ever studied.

Acknowledgements

I thank Dr. K. KATAYAMA of the Department of Anthropology, the University of Kyoto for the use of the Tsukumo specimens.

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