

The Foot Bones of the Jōmon Remains from the Ebishima (Kaitori) Shell Mound in Hanaizumi, Iwate Prefecture

By

Bin YAMAGUCHI

Department of Anthropology, National Science Museum, Tokyo

Abstract The three major tarsal bones, five metatarsal bones, and two phalanges of the great toe of the prehistoric Jōmon skeletal remains from the Ebishima site in the Tōhoku district were measured and compared with those of two other Jōmon series and two modern Japanese series. The Ebishima foot bones bear a close resemblance to other Jōmon materials with the longer calcaneus, metatarsals, and phalanges and the larger trochlea-neck angle of the talus and posterior talar facet angle of the calcaneus than in the modern Japanese. This implies that the Jōmon foot skeleton was not only longer than but also different in the tarsal structure from the modern Japanese.

The foot bones of 29 adult human skeletons (14 males and 15 females) of the Late to the Latest phases of the Jōmon period, excavated at the Ebishima (alias Kaitori) shell mound, Hanaizumi, Iwate Prefecture, were measured in conformity with the MARTIN's osteometric system and compared with those of other Jōmon and modern Japanese series. The provenance of the material was described elsewhere (YAMAGUCHI, 1983).

Materials

The male skeletal materials consist of the Ebishima 6, 13/14, 24, 26, 29(1), 29(2), 44, 45, 46, 51, 52, 56, 60, and 63, and the female materials are the Ebishima 5(2), 7, 9, 10, 13, 15, 16, 27, 30, 43, 47, 48, 57, 58, and 62. Measurements of the major limb bones and hand bones of these skeletons were already published by the present author (YAMAGUCHI, 1983, 1990).

Measured bones are the talus, the calcaneus, the navicular, the metatarsals, and the phalanges of the great toe. All the measurements were taken after MARTIN's definitions (BRÄUER, 1988) to the nearest 0.5 mm or degree.

Results

The sample sizes (N), means (M), and standard deviations (s) of the measurements are given in Table 1 for the right side, left side, and the average of both sides. When one side was missing, the measurement of the other side was used for the average.

A set of five metatarsals, irrespective of side, was preserved in 6 male and 5 female

Table 1. Measurements of the Ebishima foot bones.

		Male			Female		
		N	M	s	N	M	s
Talus:							
Length (1)	R	9	49.67	2.06	5	46.20	3.70
	L	8	49.50	2.27	8	45.25	1.75
	Avg*	11	49.55	2.07	10	45.65	2.66
Breadth (2)	R	5	40.40	1.52	3	37.00	1.00
	L	5	40.60	1.67	5	37.00	1.58
	Avg	7	40.21	1.47	5	36.90	1.19
Height (3)	R	4	28.75	1.71	4	26.25	1.50
	L	4	29.50	1.29	5	26.80	0.84
	Avg	6	29.00	1.41	8	26.38	1.06
Trochlea-posterior calcaneal facet angle (15)	R	7	45.14	5.34	4	46.75	5.74
	L	8	44.75	3.45	6	47.17	5.88
	Avg	11	45.09	4.75	9	47.06	5.82
Trochlea-neck angle (16)	R	9	26.67	4.56	5	27.60	2.70
	L	7	25.71	4.72	4	28.75	6.99
	Avg	11	26.73	4.04	7	28.00	5.25
Torsion angle (17)	R	6	29.67	4.03	2	29.50	12.02
	L	5	38.40	8.20	5	35.20	4.09
	Avg	8	34.38	8.28	6	32.83	6.85
Calcaneus:							
Maximum length (1)	R	7	76.71	2.81	4	67.75	3.95
	L	10	77.00	2.49	8	67.63	3.58
	Avg	11	76.73	2.46	10	67.90	3.34
Middle breadth (2)	R	7	40.86	2.48	6	36.83	1.83
	L	8	39.88	1.73	9	37.00	2.29
	Avg	12	40.25	2.29	10	36.85	2.12
Height (4)	R	6	40.83	1.83	5	37.40	4.72
	L	8	40.38	1.69	6	36.67	3.38
	Avg	9	40.67	1.71	8	36.94	3.53
Posterior facet angle (14)	R	6	55.67	3.50	7	53.57	5.94
	L	9	53.89	5.35	7	56.57	5.03
	Avg	10	55.00	3.94	11	55.18	5.23
Talo-calcaneus angle (15)	R	4	12.25	3.20	3	4.33	6.81
	L	6	7.83	4.67	3	5.00	4.36
	Avg	7	10.43	3.52	5	5.40	5.18
Navicular:							
Breadth (1)	R	5	38.40	1.67	3	37.33	1.53
	L	8	38.63	1.41	2	34.50	0.71
	Avg	9	38.56	1.36	4	36.38	2.14
Height (2)	R	5	26.80	1.92	1	30	

Table 1. Continued.

		Male			Female		
		N	M	s	N	M	s
Talar facet length (3)	L	7	26.57	1.90	2	24.75	0.35
	Avg	9	26.50	1.73	3	26.50	3.04
	R	3	28.67	0.58	3	26.33	0.58
	L	4	29.50	0.58	2	26.00	0
	Avg	7	29.14	0.69	4	26.13	0.25
Talar facet height (4)	R	5	22.00	2.00	4	20.75	2.36
	L	7	21.14	1.95	2	19.25	1.06
	Avg	8	21.30	1.87	4	20.81	2.32
Minimum thickness (7)	R	8	8.56	0.94	6	7.92	0.58
	L	10	8.25	1.06	3	8.00	0.50
	Avg	11	8.39	0.82	6	7.88	0.44
Metatarsal I Length	R	8	59.00	2.78	9	56.67	2.74
	L	12	60.33	2.93	6	56.33	3.20
	Avg	13	60.00	2.95	11	56.36	2.93
Middle breadth	R	8	13.19	1.91	9	12.06	0.81
	L	12	13.88	1.05	7	12.14	0.63
	Avg	13	13.48	1.69	11	12.20	0.70
Length-breadth index	R	8	22.35	3.12	9	21.28	1.23
	L	12	23.04	1.95	6	21.62	1.30
	Avg	13	22.47	2.65	11	21.66	1.19
Metatarsal II Length	R	8	74.38	3.29	10	69.20	3.08
	L	10	74.60	3.41	6	69.67	2.80
	Avg	11	74.05	3.01	11	68.95	2.79
Middle breadth	R	8	7.69	0.53	10	7.35	0.71
	L	11	7.82	0.34	7	7.36	0.80
	Avg	12	7.79	0.40	11	7.32	0.72
Length-breadth index	R	8	10.36	0.77	10	10.62	0.89
	L	10	10.47	0.65	6	10.40	0.81
	Avg	11	10.52	0.73	11	10.61	0.82
Metatarsal III Length	R	7	71.43	2.82	9	66.78	3.03
	L	8	70.63	2.07	3	67.67	2.31
	Avg	10	71.05	2.30	10	66.65	2.94
Middle breadth	R	7	7.21	0.27	9	6.56	0.53
	L	8	7.44	1.02	4	7.25	0.65
	Avg	10	7.45	0.79	10	6.63	0.54
Length-breadth index	R	7	10.11	0.70	9	9.80	0.55
	L	8	10.55	1.69	3	10.83	0.80
	Avg	10	10.50	1.36	10	9.93	0.53

Table 1. Continued.

		Male			Female		
		N	M	s	N	M	s
Metatarsal IV Length	R	6	68.00	2.76	5	64.20	3.83
	L	8	69.38	3.07	5	65.20	3.11
	Avg	11	68.77	3.00	7	64.57	3.14
Middle breadth	R	6	7.75	0.94	5	7.60	0.89
	L	9	8.11	0.89	5	7.20	0.84
	Avg	11	8.07	0.87	7	7.25	0.78
Length-breadth index	R	6	11.43	1.78	5	11.82	0.76
	L	8	11.76	1.63	5	11.02	1.12
	Avg	11	11.74	1.54	7	11.21	0.94
Metatarsal V Length	R	3	64.67	2.08	7	59.57	3.95
	L	7	62.43	2.44	6	59.83	4.36
	Avg	8	62.94	2.76	9	60.06	3.58
Middle breadth	R	4	10.50	0.41	7	9.29	0.76
	L	7	9.93	0.93	6	9.25	0.76
	Avg	8	10.00	0.90	9	9.31	0.68
Length-breadth index	R	3	16.00	0.36	7	15.59	0.89
	L	7	15.87	1.18	6	15.47	0.77
	Avg	8	15.82	1.08	9	15.50	0.87
Proximal phalanx of digit I Length	R	7	28.57	1.99	4	28.50	1.29
	L	10	29.60	0.84	3	28.50	2.18
	Avg	12	29.00	1.60	6	28.71	1.58
Middle breadth	R	7	13.93	0.73	4	12.63	0.75
	L	10	13.70	0.59	3	12.00	0
	Avg	12	13.73	0.61	6	12.42	0.66
Middle thickness	R	7	9.57	0.53	4	9.13	0.48
	L	10	9.80	0.42	3	9.33	0.58
	Avg	12	9.67	0.42	6	9.29	0.46
Length-breadth index	R	7	48.90	3.69	4	44.35	3.07
	L	10	46.31	2.20	3	42.23	3.09
	Avg	12	47.47	3.47	6	43.35	3.29
Length-thickness index	R	7	68.77	2.65	4	72.45	5.22
	L	10	71.62	3.63	3	77.77	4.79
	Avg	12	70.52	3.71	6	75.03	5.72
Distal phalanx of digit I Length	R	2	22.50	0.71	1	24	
	L	3	24.83	2.75	3	23.33	1.76
	Avg	5	23.90	2.36	3	23.42	1.77

Numbers in parentheses refer to the definition of measurements given by R. MARTIN (BRÄUER, 1988).
 * Average of right and left sides. When one side was not available, the measurement of the other side was used for the average.

Table 2. Individual sets of the metatarsal length I through V.

Skeleton No.		Sex	I	II	III	IV	V
Ebishima	6	M	57 (l)	71 (l)	68 (l)	65 (l)	59 (l)
	24	M	63 (l)	77 (l)	73 (l)	70 (l)	64 (l)
	29(l)	M	61 (r)	78 (r)	74 (r)	72 (r)	63 (r)
	45	M	60 (l)	72 (l)	69 (l)	66 (l)	62 (l)
	51	M	64 (r)	77 (r)	74 (r)	71 (l)	67 (r)
	56	M	60 (r)	74 (r)	72 (r)	70 (r)	66 (l)
(N=6)	Mean	M	60.83	74.83	71.67	69.00	63.50
	(s)		(2.48)	(2.93)	(2.58)	(2.83)	(2.88)
Ebishima	7	F	59 (l)	71 (l)	69 (l)	67 (l)	64 (l)
	13	F	58 (r)	73 (r)	68 (r)	67 (r)	60 (r)
	15	F	54 (r)	68 (r)	65 (r)	64 (r)	59 (r)
	48	F	60 (r)	74 (r)	72 (r)	69 (r)	67 (r)
	62	F	56 (r)	69 (r)	66 (r)	65 (r)	60 (r)
(N=5)	Mean	F	57.40	71.00	68.00	66.40	62.00
	(s)		(2.41)	(2.55)	(2.74)	(1.95)	(3.39)

(r): right bone; (l): left bone.

Ebishima skeletons. Table 2 gives the individual data of the lengths of those full sets of the metatarsals.

Since the sample sizes are small, comparison was made only for the statistics based on the averages of right and left sides or either side available.

Comparison

The means and standard deviations of the average measurements in the Ebishima foot skeletons are compared with those of the right foot skeletons of the Jōmon series from Yoshiko (ISHISAWA, 1931) and Tsukumo (KIYONO and HIRAI, 1928), and of the modern Japanese series from Kinai (HIRAI and TABATA, 1928) and Hokuriku (SUNADA, 1931–1932), in Tables 3 and 4. The values marked with single or double asterisks are significantly different from those in the Ebishima series at the level of 0.05 or 0.01.

As shown in Table 3, all the five series are similar to each other in the length and breadth of the talus. But the three Jōmon series are equally smaller in the talus height and larger in the trochlea-neck angle than the two modern samples, in both sexes. The trochlea-posterior calcaneal facet angle in the Jōmon series from Yoshiko and Tsukumo are definitely smaller than that in the modern Japanese, but the angle in the present series is as large as the latter and significantly different from the above Jōmon series. There may be an inter-observer difference in metric technique behind this incongruity. The torsion angle of the Ebishima talus is similar to those in other Jōmon samples and significantly smaller than in the modern Japanese from Kinai, but, again, the other modern sample from Hokuriku is quite different from the Kinai sample with the torsion angle as small as the Jōmon tali. This may be another example of

Table 3. Comparison of tarsal bone measurements.

		Male			Female		
		N	M	SD	N	M	SD
Talus							
Length (1)	Ebishima	11	49.55	2.07	10	45.65	2.66
	Yoshiko	47	49.6	2.57	51	46.4	2.52
	Tsukumo	17	49.7	2.66	17	45.2	2.07
	Kinai	29	50.5	2.08	20	45.5	1.90
	Hokuriku	25	50.00	2.42	25	45.36	1.94
Breadth(2)	Ebishima	7	40.21	1.47	5	36.90	1.19
	Yoshiko	49	40.3	2.53	53	37.1	2.03
	Tsukumo	18	40.8	2.29	18	37.6	2.34
	Kinai	29	40.2	3.10	20	35.8	2.22
	Hokuriku	35	39.72	1.86	25	35.32	1.90
Height(3)	Ebishima	6	29.00	1.41	8	26.38	1.06
	Yoshiko	48	28.6	1.96	51	26.2	1.56
	Tsukumo	17	28.5	1.97	18	25.6	1.42
	Kinai	29	30.3	1.49	20	27.0	1.50
	Hokuriku	25	30.44*	1.53	25	27.24	1.41
Trochlea-posterior calc. facet angle(15)	Ebishima	11	45.09	4.75	9	47.06	5.82
	Yoshiko	48	38.3**	4.09	51	39.8**	3.22*
	Tsukumo	18	38.8**	4.00	18	38.6**	3.42
	Kinai	29	46.0	4.29	20	45.8	4.30
	Hokuriku	25	46.28	5.28	25	46.28	3.64
Trochlea-neck angle(16)	Ebishima	11	26.73	4.04	7	28.00	5.25
	Yoshiko	48	28.3	4.33	50	29.4	4.09
	Tsukumo	18	24.8	4.16	19	26.2	5.08
	Kinai	29	20.3**	3.19	20	19.0**	3.89
	Hokuriku	25	22.44**	2.32*	25	25.52	2.70*
Torsion angle(17)	Ebishima	8	34.38	8.28	6	32.83	6.85
	Yoshiko	46	37.8	5.72	47	37.1	5.04
	Tsukumo	17	36.2	3.62**	17	35.8	2.96*
	Kinai	29	43.3*	4.12**	20	40.3**	4.69
	Hokuriku	25	33.84	4.00**	25	36.28	5.48
Calcaneus							
Maximum length(1)	Ebishima	11	76.73	2.46	10	67.90	3.34
	Yoshiko	45	77.4	4.09	50	71.6**	3.80
	Tsukumo	16	76.4	3.94	17	69.6	2.95
	Kinai	29	72.4**	3.31	20	66.6	3.75
	Hokuriku	25	74.56	4.11	25	66.36	3.60
Middle breadth(2)	Ebishima	12	40.25	2.29	10	36.85	2.12
	Yoshiko	44	40.5	2.24	49	37.4	1.83
	Tsukumo	15	41.8	2.40	17	37.9	1.89
	Kinai	29	40.7	2.37	20	36.3	2.49
	Hokuriku	25	40.84	1.97	25	36.88	2.02

Table 3. Continued.

	Series	Male			Female		
		N	M	SD	N	M	SD
Height(4)	Ebishima	9	40.67	1.71	8	36.94	3.53
	Yoshiko	45	38.6*	2.18	48	35.6	2.33
	Tsukumo	18	40.0	2.87	19	36.3	1.86*
	Kinai	29	39.5	2.90	20	35.0	2.06
	Hokuriku	25	38.80	2.62	25	33.52**	2.26
Posterior facet angle(14)	Ebishima	10	55.00	3.94	11	55.18	5.23
	Yoshiko	43	52.2	5.42	50	51.5	6.02
	Tsukumo	17	55.7	3.20	18	49.3**	5.05
	Kinai	29	40.7**	6.88	20	39.2**	6.80
	Hokuriku	25	46.10**	6.05	25	44.20**	4.85
Talo-calcaneus angle(15)	Ebishima	7	10.43	3.52	5	5.40	5.18
	Yoshiko	32	15.2	6.43	39	10.7*	4.54
	Tsukumo	16	17.6**	5.24	16	10.1	4.91
	Kinai	29	-5.2**	7.35	20	-6.8**	4.96
	Hokuriku	25	0.12**	8.04*	25	2.08	6.54
Navicular							
Breadth(1)	Ebishima	9	38.56	1.36	4	36.38	2.14
	Yoshiko	33	38.0	2.50	39	34.9	2.30
	Tsukumo	11	39.3	2.34	12	35.9	1.38
	Kinai	28	38.5	1.55	20	34.1	2.62
	Hokuriku	25	39.20	1.82	25	35.36	2.52
Height(2)	Ebishima	9	26.50	1.73	3	26.50	3.04
	Yoshiko	37	26.5	1.84	40	24.7	1.94
	Tsukumo	14	27.6	3.18	14	25.0	1.36
	Kinai	28	28.4*	2.11	20	25.9	2.61
	Hokuriku	25	28.84**	2.01	25	25.36	1.68
Talar facet length(3)	Ebishima	7	29.14	0.69	4	26.13	0.25
	Yoshiko	34	28.0*	2.44**	40	25.5*	1.32*
	Tsukumo	12	27.3**	1.84*	14	24.9*	1.38*
	Kinai	28	27.7		20	24.6	
	Hokuriku	25	27.56**	1.80*	25	25.04**	1.21*
Talar facet height(4)	Ebishima	8	21.30	1.87	4	20.81	2.32
	Yoshiko	35	20.0	1.65	39	19.0	1.70
	Tsukumo	14	20.5	1.30	15	18.1**	1.36
	Kinai	28	21.4		20	19.5	
	Hokuriku	25	21.32	1.53	25	19.00*	1.46
Minimum thickness(7)	Ebishima	11	8.39	0.82	6	7.88	0.44
	Yoshiko	37	8.0	0.97	42	7.0*	0.99
	Tsukumo	13	8.6	1.27	15	7.7	0.70
	Kinai	28	8.1	1.52*	20	7.7	1.11*
	Hokuriku	25	8.00	1.13	25	7.32	1.35*

*,**: significantly different from the Ebishima at the level of 0.05 or 0.01.

Table 4. Comparison of metatarsal and phalangeal lengths.

	Series	Male			Female		
		N	M	SD	N	M	SD
Metatarsal I	Ebishima	13	60.00	2.95	11	56.36	2.93
	Yoshiko	43	58.5	2.23	48	55.1	2.43
	Tsukumo	17	58.3	3.85	17	54.1*	2.13
	Kinai	29	54.72**	2.68	20	51.70**	2.64
	Hokuriku	25	55.28**	3.00	25	50.80**	3.39
Metatarsal II	Ebishima	11	74.05	3.01	11	68.95	2.79
	Yoshiko	35	70.9**	2.68	34	67.4	2.86
	Tsukumo	13	70.1**	2.87	14	65.3**	2.25
	Kinai	29	65.59**	3.24	20	61.85**	3.51
	Hokuriku	25	66.32**	4.20	25	61.12**	4.35
Metatarsal III	Ebishima	10	71.05	2.30	10	66.65	2.94
	Yoshiko	33	67.9**	2.71	34	65.2	2.78
	Tsukumo	12	67.3**	2.17	9	62.4**	2.27
	Kinai	29	63.41**	3.38	20	59.75**	3.60
	Hokuriku	25	63.60**	4.65*	25	59.24**	3.72
Metatarsal IV	Ebishima	11	68.77	3.00	7	64.57	3.14
	Yoshiko	37	66.6*	2.83	32	63.8	2.80
	Tsukumo	13	65.5**	2.41	11	61.0**	1.95
	Kinai	29	62.14**	3.65	20	58.65**	3.72
	Hokuriku	24	62.50**	3.95	25	57.76**	3.80
Metatarsal V	Ebishima	8	62.94	2.76	9	60.06	3.58
	Yoshiko	28	61.7	2.70	32	58.7	2.56
	Tsukumo	13	61.3	2.13	12	57.5	2.47
	Kinai	29	59.03**	3.23	20	55.65**	3.31
	Hokuriku	25	58.56**	4.00	25	54.44**	3.56
Proximal phalanx of digit I	Ebishima	12	29.00	1.60	6	28.71	1.58
	Yoshiko	28	30.4*	1.88	38	28.5	1.71
	Tsukumo	13	29.4	2.43	16	28.7	2.08
	Kinai	29	26.07**	2.09	20	23.05**	2.65
	Hokuriku	25	27.56*	2.10	25	24.92**	2.00
Distal phalanx of digit I	Eibishima	5	23.90	2.36	3	23.42	1.77
	Yoshiko	12	22.7	1.56	11	22.2	1.54
	Tsukumo	11	22.5	1.21	3	21.7	0.58
	Kinai	29	21.59*	1.78	20	20.10**	1.74
	Hokuriku		21.9			19.5	

*, **: significantly different from the Ebishima at the level of 0.05 or 0.01.

inter-observer error.

The calcaneus in the Ebishima series closely resembles those of other Jōmon series with the slightly larger length and the definitely larger posterior talar facet angle and talo-calcaneus angle than in the modern samples. In spite of some possibility of

Table 5. Comparison of metatarsal length proportion (III=100).

		N	I	II	III	IV	V
Male	Ebishima	(6)	84.9	104.4	100	96.3	88.6
	Recent Kinai	(29)	86.3	103.4	100	98.0	93.1
Female	Ebishima	(5)	84.4	104.4	100	97.6	91.2
	Recent Kinai	(20)	86.5	103.5	100	98.2	93.1

Table 6. Comparison of the I metatarso-femoral index (length of metatarsal I / maximum length of femur).

	Male			Female		
	N	M	s	N	M	s
Jōmon, Ebishima	6	14.4	0.73	4	14.1	0.82
Jōmon, Yoshiko & Tsukumo	37	14.0	0.56	32	14.2	0.52
Modern, Kinai	29	13.3**	0.46	20	13.5	0.32**

** Significantly different from the Ebishima at the level of 0.01.

Table 7. Comparison of the reduced major axes for the length of the metatarsal I (y) and the maximum length of the femur (x).

	Male equation		σ_a	Female equation		σ_a
Jōmon, Yoshiko & Tsukumo	$y=0.1746x-14.4084$	0.0216		$y=0.1147x+10.5377$	0.0157	
Modern, Kinai	$y=0.1201x+5.2599$	0.0140		$y=0.1279x+2.8111$	0.0128	
	$z^*=20.43$ ($P<0.01$)			$z=66.96$ ($P<0.01$)		

*
$$z = \frac{\bar{x}_1(a_1 - a_2) + (b_1 - b_2)}{\sigma_{a_2}(\bar{x}_1 - \bar{x}_2)}$$
 (S. IMBRIE, 1956.)

inter-observer errors in the angle measurements, at least it may be concluded that the trochlea-neck angle and talo-calcaneus angle in the Jōmon tarsals are significantly larger than in the modern Japanese tarsals.

Little difference can be seen in the navicular measurements between the Jōmon and the modern series. However, the Ebishima navicular is discriminated from all others with the significantly longer talar facet.

Table 4 shows that the metatarsals and the phalanges in the Jōmon series are definitely longer than in the modern series, and that the Ebishima metatarsals are the longest among the Jōmon samples. The mean lengths of the metatarsals in the male Ainu skeletons given by SIOTA (1937), i.e. 55.6, 69.6, 66.1, 65.1, and 62.1 for the right first through fifth metatarsals, are intermediate between those in the Jōmon and modern Japanese skeletal series.

Table 5 gives the mean proportional lengths of the metatarsals for the 6 male sets and 5 female sets listed in Table 2, compared with those for the modern materials from

Kinai. The base length of 100 is metatarsal III. In both sexes, the metatarsal lengths in the Ebishima sample are less uniform, with the relatively longer second metatarsal and the relatively shorter first, fourth and fifth metatarsals than in the modern sample.

Discussion and Conclusion

The Jōmon foot skeleton from Ebishima in northern Honshu falls in line with those from Yoshiko and Tsukumo in central and western Honshu in that the talus is lower, the trochlea-neck angle of the talus is larger, the calcaneus is longer, the posterior talar facet angle of the calcaneus and the talo-calcaneus angle are larger, and the metatarsals and phalanges are longer than in the modern Japanese. These characteristics common to the Jōmon materials from different parts of Honshu imply that the Jōmon people had a long foot with a structure slightly different from that of the modern Japanese. The structural difference in the tarsus is also reflected in the transverse inclination of the trochlea tali. It is well known that in the majority of the Jōmon tali the lateral edge of the superior surface of the trochlea is higher than the medial edge, whereas in most modern tali it is level with or lower than the medial edge. The Ebishima sample corroborates this with six out of eight intact right tali having the lateral trochlear edge higher than the medial.

According to the male mean values of foot bone measurements reported by SIOTA (1937), the Ainu seems to be fairly close to the Jōmon people with the longer calcaneus and metatarsals and the larger trochlea-neck angle of the talus (25°) and posterior talar facet angle of the calcaneus (50.1°) than the Japanese.

In order to compare the relative length of the metatarsal, a first metatarso-femoral index (length of metatarsal I / maximum length of femur) was calculated. As shown in Table 6, the Ebishima and Yoshiko-Tsukumo pooled Jōmon are very similar to each other and significantly larger than the modern Japanese from Kinai in the first metatarso-femoral index. The reduced major axes that fit the bivariate distributions of the length of metatarsal I (y) and the maximum length of the femur (x) in the pooled Jōmon (Yoshiko and Tsukumo) and modern (Kinai) samples are also significantly different in positions at the level of 0.01, in both sexes (s. Table 7.). These comparisons show that metatarsal I of the Jōmon people was longer than that of the modern Japanese, absolutely as well as proportionally.

It can thus be concluded that the foot bones from Ebishima in northern Honshu are largely in accord with the Jōmon pattern as revealed by the most representative samples from Yoshiko in central Honshu and Tsukumo in western Honshu, and that the Jōmon foot skeleton is generally distinguished from the modern Japanese one with its greater length and somewhat different tarsal structure.

References

- BRÄUER, G., 1988. Osteometrie. In: KNUSSMANN, R. (Hrsg.), *Anthropologie*. Stuttgart · New York, Gustav Fischer, Band I, 160–232.
- HIRAI, T., & T. TABATA, 1928. Anthropologische Untersuchungen über das Skelett der rezenten Japaner, IV. *Jinruigaku Zasshi (Journal of the Anthropological Society of Tokyo)*, **43**: suppl. 1–176. (In Japanese, with German tables.)
- IMBRIE, J., 1956. Biometrical methods in the study of invertebrate fossils. *Bulletin of the American Museum of Natural History*, **108**: 211–252.
- ISHISAWA, M., 1931. Anthropologische Untersuchungen über das Skelett der Yoshiko-Steinzeitmenschen, III. *Jinruigaku Zasshi (Journal of the Anthropological Society of Tokyo)*, **46** (suppl. 1): 1–192; **46** (suppl. 2): 1–189. (In Japanese, with German tables.)
- KIYONO, K., & T. HIRAI, 1928. Anthropologische Untersuchungen über das Skelett der Tsukumo-Steinzeitmenschen, IV. *Jinruigaku Zasshi (Journal of the Anthropological Society of Tokyo)*, **43**: suppl. 303–494. (In Japanese, with German tables.)
- SIOTA, I., 1937. Ainu-jin no sokukotsu nitsuite (On the foot bones of the Ainu) (Abstract). *Kai-bōgaku Zasshi (Japanese Journal of Anatomy)*, **10** (3): 79–80. (In Japanese.)
- SUNADA, S., 1931–1932. Anthropologische Untersuchung am unteren Extremitätsskelette des Hoku-riku-Japaners. *Kanazawa Ikwadaigaku Kaibogaku Kyoshitsu Gyoseki (Arbeiten aus dem anatomischen Institut zu Kanazawa)*, **2**: 48–57; **3**: 46–107; **4**: 11–45, 70–129; **6**: 1–28; **7**: 13–39, 99–118; **8**: 103–121; **9**: 23–65; **10**: 82–112. (In Japanese.)
- YAMAGUCHI, B., 1983. Postcranial bones of the human skeletal remains of the Jomon period from the Ebishima (Kaitori) shell mound in Hanaizumi, Iwate Prefecture. *Memoirs of the National Science Museum, Tokyo*, **16**: 201–223. (In Japanese, with English summary.)
- YAMAGUCHI, B., 1990. The hand bones of the Jōmon remains from the Ebishima (Kaitori) shell mound in Hanaizumi, Iwate Prefecture. *Bulletin of the National Science Museum, Tokyo, Series D*, **16**: 31–38.

