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Osteometry of a Skull of Sika Deer in Kuchinoerabu Island, Southwestern Japan

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Abstract We examined osteometrically one female skull of sika deer from Kuchinoerabu Island (Kagoshima prefecture), south part of Japan. This skull took a position in size between that of Kyushu population (*Cervus nippon nippon*) and that of Yakushima population (*Cervus nippon yakushimae*). The skull of Kuchinoerabu had no significant difference from that of Yakushima in any examined measurements.
Key words: Kuchinoerabu Island, osteometry, Sika deer, variation.

Introduction

Only one species of deer, sika deer (*Cervus nippon*), is distributed in Japan. This species has been classified into several subspecies or local populations in this country (Ohtaishi, 1986). But in the sika deer of Kuchinoerabu Island, the morphological record has not been published. So the morphological variation between Kuchinoerabu, Yakushima and Kyushu populations has remained unclear. Therefore the skull obtained from Kuchinoerabu Island was measured in the osteological characters, and then compared with previously reported data of the other populations.

Materials and Methods

A skull specimen (Specimen No.: NSMT-M31240) of sika deer was brought from Kuchinoerabu Island in 1996 and has been stored in the Department of Zoology of the National Science Museum, Tokyo, Japan. The skull was evaluated by 38 measurements according to the ordinary methods (Driesch, 1976; Shiroma & Ohta, 1996). Measurements were carried out with a vernier caliper to 0.1 mm. We compared statistically these data with previously reported female data of Yakushima Island and Nozaki Island populations (Shiroma & Ohta, 1996) in size average and proportion, which is in the ratio of individual values to total length. Nozaki population is regarded as Kyushu population (Ohtaishi, 1986). The sample size of Kyushu population obtained from Kagoshima mainland is small, so we also used the data of Nozaki population.

The age was estimated from the data of attrition and eruption pattern of lower teeth (Ohtaishi, 1980).

Result

The dorsal and ventral aspects of female cranium (NSMT-M31240) are shown in Figs. 1–2. The left lateral view is indicated in Fig. 3. The values of 38 measurements are given in Table 1.

All teeth had replaced and in the examination of molar attrition, wear index of M_1, M_2 and M_3 was individually 3, 3 and 6 (Ohtaishi, 1980). We considered that this specimen is between 3.5 and 4.5 years of age (Fig. 4).

Discussion

Examination on the external morphology in some populations of Japan has indicated that sika deer varies in size and color (Imaizumi 1970; Matsumoto *et al.*, 1984). Kuchinoerabu Island is located at about 10 kilometers to the north-west of Yakushima Island. We assume that deer could swim across these Islands.

The growth curve of many cranium traits and external measurements reaches a plateau by about 3 years in the female of sika deer (Matsumoto *et al.*, 1984), so this specimen is probably an adult. The size of specimen is larger than that of Yakushima and smaller than that of Nozaki, but much closer to Yakushima (Table 1). We cannot confirm the significant difference in proportion data between Kuchinoerabu skull and Yakushima ones. The significant differences are found in 6 measurements between Kuchinoerabu and Nozaki skulls, Greatest neurocranium breadth, Bregma–Nasion, Basion–Akrokranion, Greatest breadth across the nasals, Length of the cheekteeth row, and Length of the molar row. The significant differences between Yakushima and Nozaki skulls are found in 8 measurements in addition to 6 different items between Kuchinoerabu and Nozaki skulls (Table 2). The cranium of Kuchinoerabu shows the following characters: It is identified with Yakushima population in proportion, and this Kuchinoerabu–Yakushima population has larger brain case (neurocranium) than Kyushu population. And a specimen of Kuchinoerabu–Yakushima population has longer teeth row and broader facial bones than that of Nozaki Island. We think that these two features are due to short cheekteeth row and narrow facial bone of Nozaki population.

The present data are not enough to detail the phylogeny and radiation process in this sika deer of Kuchinoerabu. The habitat, food, distribution and density of sika deer are unclear in Kuchinoerabu Island. In the future, after the sample size become larger and the ecological study more advanced, morphological comparison of these isolated insular populations of sika deer will contribute to the evolution of sika deer.

Fig. 1. The dorsal aspect of cranium NSMT-M31040. The right side of brain case is broken.
Fig. 2. The ventral aspect of cranium.

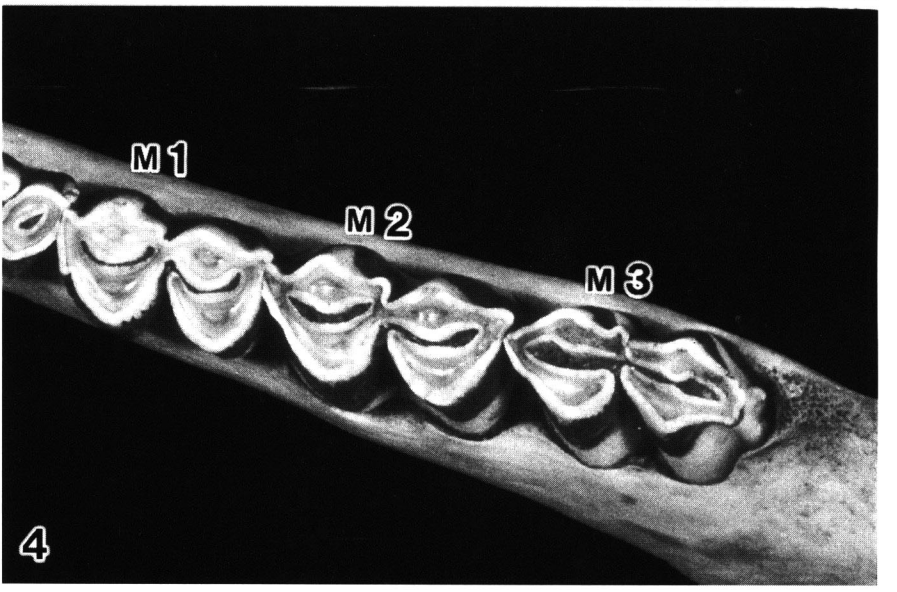

Fig. 3. The left lateral view of cranium.
Fig. 4. The molar row of left mandible.

Table 1. The osteometrical data of four populations.

Measurements	Kuchinoerabu (1)		Yaku (4)*		Nozaki (17)*		Kyushu (2)*	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Total length	219.1	0	214.9	6.21	232.9	7.39	239	9.9
Condylobasal length	207.2	0	202.4	6.21	220.7	6.98	227	7.07
Basal length	192	0	188.6	4.53	206.0	7.05	210.8	5.3
Basicranial axis	48.1	0	46.3	0.51	47.8	2.86	51.3	1.76
Basifacial axis	147	0	144.1	4.9	159.5	5.36	162.7	3.22
Viscerocranium length	107.8	0	99.9	5.1	113.6	4.48	117.2	6.07
Median–frontal length	120	0	120.8	3.01	125.1	3.51	128.8	3.76
Lambda–Nasion	107	0	105.7	2.8	108.8	3.34	112.9	1.39
Lambda–Rhinion	175.8	0	170.7	5.19	178.5	6.54	187.8	3.89
Lambda–Prosthion	206.3	0	202.8	6.6	220.7	6.95	227.3	7.42
Akrokranion-Infraorbitale of one side	157	0	152.1	4.97	162.4	4.94	169.9	6.8
Greatest length of the nasals	70.5	0	65.7	2.39	70.2	3.94	74.3	2.66
Short lateral facial length	116.9	0	111.4	3.85	124.4	5.04	125.0	2.13
Oral palatal length	92.2	0	92.1	1.83	102.4	3.49	104.6	1.85
Lateral length of the premaxilla	56	0	52.0	3.74	62.6	2.82	57.5	1.27
Length of the cheektooth row	69.9	0	66.9	1.53	65.8	3.59	76.7	0.79
Length of the molar row	40.8	0	39.4	1.41	37.2	2.65	45.0	0.04
Length of the premolar row	30	0	29.1	1.32	30.2	1.9	33.6	0.5
Greatest inner length of the orbit	33.3	0	33.3	1.56	34.6	1.19	36.6	1.31
Greatest mastoid breadth	72.7	0	67.2	3.67	73.4	2.53	79.4	5.48
Greatest breadth of the occipital condyles	41.2	0	39.0	2.46	41.8	1.78	46.9	2.66
Greatest breadth at the bases of the paraoccipital process	56.9	0	55.3	2.41	58.3	2.26	66.9	2.46
Greatest inner length of the foramen magnum	20	0	19.2	0.86	20.6	0.92	23.4	2.91

Table 1. Continued.

Measurements	Kuchinoerabu (1)		Yaku (4)*		Nozaki (17)*		Kyushu (2)*	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Greatest neurocranium breadth	67	0	64.7	2.39	67.4	1.8	68.7	2.69
Greatest breadth across the orbits	93.4	0	91.6	4.42	94.4	3.78	101.4	0.95
Least breadth between the orbit	65.5	0	64.2	3.17	69.7	2.82	71.8	0.86
Zygomatic breadth	91.8	0	91.7	6.36	95.9	3.56	104.5	0.93
Greatest breadth across the nasals	24.6	0	23.0	2.61	21.3	1.19	24.4	1.58
Greatest breadth across the premaxillae	28.2	0	27.6	1.58	31.5	1.71	34.4	2.72
Greatest palatal breadth	66.9	0	62.5	4.11	68.0	3.08	70.7	2.27
Basion–Akrokranion	46.9	0	43.5	2.01	44.6	1.79	50.2	4.77
Bregma–Nasion	70.2	0	68.1	1.05	67.2	2.92	69.8	1.03
Lambda–Akrokranion	20.9	0	21.4	1.73	24.3	1.23	21.3	2.06
Akrokranion–Eotorbitale of one side	92	0	90.0	2.31	94.4	3.13	100.0	4.77
Nasointermaxillare–Nasointermaxillare	13.8	0	14.4	0.76	14.3	0.82	15.7	1.31
Infraorbitale–Infraorbitale	30	0	28.9	2.71	27.8	2.6	32.3	3.8
Greatest breadth across the zygomatic arch	93.1	0	88.5	3.78	96.2	3.11	100.5	2.76
Lambda–Bregma	47.9	0	47.4	2.55	51.8	4	50.2	2.08

Kyushu population was obtained from mainland of Kagoshima prefecture.

Parenthetic numbers show the sample size.

* Data from Shiroma and Ohta (1996).

Table 2. Comparison of proportion among three female populations.

Measurements	Kuchinoerabu	Yakushima	Nozaki	Kyushu
Total length	219.1	214.9**	232.9	239
Condylobasal length	0.9457	0.9418	0.9475	0.9498
Basal length	0.8763	0.8778	0.8843	0.8818
Basicranial axis	0.2195	0.2156	0.2051	0.2148
Basifacial axis	0.6709	0.6708	0.6848	0.6809
Viscerocranium length	0.4920	0.4647	0.4879	0.4905
Median frontal length	0.5477	0.5624**	0.5370	0.5388
Lambda–Nasion	0.4884	0.4919**	0.4669	0.4726
Lambda–Rhinion	0.8024	0.7942	0.7662	0.7856
Lambda–Prosthion	0.9416	0.9435	0.9472	0.9508
Akrokranion–Infraorbitale of one side	0.7166	0.7080	0.6973	0.7108
Greatest length of the nasals	0.3218	0.3059	0.3014	0.3108
Short lateral facial length	0.5335	0.5183	0.5338	0.5230
Oral palatal length	0.4208	0.4287	0.4395	0.4375
Lateral length of premaxilla	0.2556	0.2425*	0.2687	0.2405
Length of the cheektooth row	0.3190*	0.3112**	0.2823	0.3207
Length of the molar row	0.1862*	0.1835**	0.1598	0.1882
Length of the premolar row	0.1369	0.1355	0.1298	0.1406
Greatest inner length of the orbit	0.1520	0.1550*	0.1483	0.1532
Greatest mastoid breadth	0.3318	0.3127	0.3153	0.3323
Greatest breadth of the occipital condyles	0.1880	0.1816	0.1795	0.1964
Greatest breadth at the bases of the paraoccipital process	0.2597	0.2572	0.2505	0.2798
Greatest inner length of the foramen magnum	0.0913	0.0892	0.0885	0.0980
Greatest neurocranium breadth	0.3058*	0.3009*	0.2892	0.2876
Greatest breadth across the orbits	0.4263	0.4262*	0.4054	0.4242
Least breadth between the orbit	0.2990	0.2988	0.2990	0.3004
Zygomatic breadth	0.4190	0.4268	0.4117	0.4372
Greatest breadth across the nasals	0.1123**	0.1068**	0.0916	0.1021
Greatest breadth across the premaxillae	0.1287	0.1285	0.1350	0.1438
Greatest palatal breadth	0.3053	0.2907	0.2920	0.2959
Basion–Akrokranion	0.2141*	0.2024*	0.1913	0.2100
Bragma–Nasion	0.3204*	0.3167**	0.2885	0.2920
Lambda–Akrokranion	0.0954	0.0997	0.1043	0.0890
Akrokranion–Ectorbitale of one side	0.4199	0.4188	0.4051	0.4183
Nasointermaxillare–Nasointermaxillare	0.0630	0.0669*	0.0613	0.0655
Infraorbitale–Infraorbitale	0.1369	0.1343*	0.1195	0.1350
Greatest breadth across the zygomatic arch	0.4249	0.4117	0.4130	0.4203
Lambda–Bregma	0.2186	0.2205	0.2223	0.2099

All measurements except Total length show the ratio to Total length shows mean size.
Asterisks indicate the measurements having significant difference in comparison with Nozaki skulls.
* $p<0.05$, ** $p<0.01$.

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