NOTE

Measurement of the Skull of Jungle and Domestic Fowls

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In order to clarify the origin of domestic fowl and the relationship between different breeds of domestic fowls, genetical comparison of the external characteristics, body-measurements [6], blood typing [3], and analysis of blood protein types [5] have been carried out. The present study was undertaken to examine the effectiveness of craniometrical method in attaining the objectives mentioned above.

The number and sex composition of the specimens are shown in Table 1. Driesch [2], Sallar [8], and Baumel [1] have earlier reported on the measurements of the skull of the domestic fowl. In the present study, 10 measurements were made.

Tables 2 and 3 show the means and the standard deviations of the measurements of the skull for each breed of jungle and domestic fowls. In most measurements, the means tend to become progressively larger from the red jungle fowl to the Shamo. Some measurements, *e.g.*, the greatest breadth of the Cranium (GB) in the females, the smallest breadth between the orbits (SBO) in the two sexes, the greatest height of the Cranium (GH) in the females, the length of the Incisivum (LI) in the

males, the greatest length of the mandible (GL) in the males, and the length of the Symphysis (LS) in the two sexes, however, do not follow this trend.

As shown in Table 2, the standard deviations of most measurements in the male Tokarajidori are larger than those in males of the other breeds. It is suggested that this breed may have a population with a low degree of uniformity as compared with the other breeds, since the coefficient of variability (S.D./Mean $\times$ 100) of most measurements of this breed is higher than those of the other breeds.

The principal component analysis is often applied to discrimination of the populations [4]. In this study, 65 speci-

Table 1. Number and sex composition of the samples

Breed	Male	Female	Total
Red jungle fowl	5	6	11
Shokoku*	6	5	11
White Leghorn	7	7	14
Tokarajidori*	5	6	11
Satsumadori*	6	6	12
Shamo*	5	5	10
Total	34	35	69

* 4 breeds of native Japanese fowl.

Table 2. Mean and standard deviations of 10 cranial variables for jungle and domestic fowls (Males only)

Item*	Red jungle fowl		Shokoku		White leghorn		Takarajidori		Satsumadori		Shamo	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Cranium												
GL	64.07	2.87	65.95	2.54	75.50	1.96	76.02	6.04	83.95	1.44	88.60	1.28
CBL	59.70	2.97	61.12	2.04	68.94	2.19	69.70	5.34	75.20	1.57	81.76	0.44
GB	28.93	1.50	29.58	1.28	32.41	0.43	32.50	1.91	36.52	0.80	37.54	0.91
SBO	11.80	0.59	13.00	1.35	13.24	1.18	16.28	2.49	17.98	0.63	16.94	0.42
GH	19.70	0.46	20.42	0.60	22.44	0.42	23.14	1.25	24.57	0.66	25.86	0.81
LP	36.23	1.46	36.88	0.98	41.17	1.57	41.54	2.83	45.90	0.57	46.40	1.18
LI	32.35	1.10	34.32	2.07	40.43	1.95	39.22	3.41	46.37	1.39	49.50	0.58
Mandible												
GL	50.10	1.27	53.38	1.67	60.89	1.00	60.58	3.87	67.93	1.16	70.74	2.38
LaF	45.42	1.06	48.08	1.41	55.10	0.61	55.20	3.88	60.75	0.83	63.50	1.63
LS	8.20	0.34	7.82	0.81	9.44	0.33	9.26	1.03	9.20	0.57	10.54	0.26

* GL—Greatest length, CBL—Condylbasal length, GB—Greatest breadth, SBO—Smallest breadth between the orbits, GH—Greatest height, LP—Length from the Protuberantia occipitalis externa to the most aboral point of the Processus frontales of the Incisivum, LI—Length of the Incisivum, LaF—Length from the most aboral point of the Facies articularis on one side to the Apex, LS—Length of the Symphysis.

Table 3. Means and standard deviations of 10 cranial variables for jungle and domestic fowls (Females only)

Item	Red jungle fowl		Shokoku		White leghorn		Takarajidori		Satsumadori		Shamo	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Cranium												
GL	57.18	2.14	61.92	1.65	65.53	2.22	70.65	2.96	72.22	2.13	80.08	2.00
CBL	52.08	2.34	55.56	1.74	59.53	2.68	63.63	3.58	64.35	2.19	74.48	2.08
GB	26.75	0.90	26.36	0.85	28.34	1.03	29.97	1.16	33.33	1.05	33.40	0.97
SBO	11.53	0.97	10.94	0.31	12.53	0.85	13.50	0.86	15.18	0.90	14.98	0.55
GH	19.35	0.67	19.10	0.42	20.34	0.50	21.90	0.57	22.83	0.57	24.86	0.43
LP	34.07	1.50	34.34	0.61	37.94	0.92	39.82	1.28	41.93	1.33	42.32	0.72
LI	28.10	2.12	32.30	0.58	34.73	1.26	35.90	1.85	38.28	1.48	43.48	2.00
Mandible												
GL	45.74	1.06	48.58	0.43	52.66	1.94	57.82	1.30	60.12	1.77	64.32	2.27
LaF	41.40	0.96	44.04	0.76	47.47	1.74	52.46	1.35	53.50	2.03	58.02	2.25
LS	7.20	0.49	7.34	0.42	7.99	0.53	8.42	0.29	7.03	0.53	9.70	0.51

mens, except for two males and one female of the red jungle fowl and one female of the Tokarajidori which lacked some measurements, were used for the principal component analysis.

Table 4 indicates that the first principal component (PC1) accounts for 90.7% of all the variation and the second one (PC2) for 4.2%, respectively. In morphometric applications of the principal component

analysis, PC1 was acceptable as a "size" vector and PC2 as a "shape" one. Therefore, most of the variations in the skull of the red jungle fowl and 5 breeds of the domestic fowl can be explained as size differences.

As shown in the upper chart of Figure 1, there is a separation into three ellipsoids: a small-sized group composed of the red jungle fowl and the Shokoku; a middle-

sized group of the white leghorn and the Tokarajidori; and a large-sized group of the Satsumadori and the Shamo, almost entirely based on the discrimination afforded by the size vector (PC1). On the other hand, the female specimens shown in the lower chart of Figure 1 are separated into a small ellipsoid (Shamo) and a large one (other breeds) by the combination of the size vector (PC1) and the shape vector (PC2).

The smallest breadth between the orbits (SBO) strongly contributes to discrimination of the shape of the skull among the jungle fowl and 5 breeds of the domestic fowl, since the eigenvector of this measurement has the largest value in the second component as shown in Table 4. It is also suggested that the proportion of the incisive bone to the whole skull is one of the discriminators of the shape of the skull, since the eigenvector of the length of the Incisivum (LI) is -0.283 , whereas that of the length from the Protuberantia occipitalis externa to the most aboral point of the Processus frontales of the Incisivum (LP) is 0.299 . The length of the Symphysis (LC) has also a large eigenvector in the second component; however, this measurement may not be a good discriminator of the shape of the skull, since the length of the Symphysis is too small to be measured exactly.

The Satsumadori is assumed to originate from the Shokoku and the Shamo [7]. As shown in Figure 1, the Satsumadori resembles the Shamo rather than the Shokoku based on the discrimination by the size vector, whereas it resembles the Shokoku rather than the Shamo based on the discrimination by the shape vector.

Concerning the size of the skull, the male of the white leghorn belongs to the middle-sized group as mentioned above, whereas

Table 4. Eigenvectors of the first and second principal components

Item	Component 1 (90.7%)*	Component 2 (4.2%)*
Cranium		
GL	0.328	-0.073
CBL	0.323	-0.124
GB	0.320	0.105
SBO	0.282	0.748
GH	0.314	-0.174
LP	0.319	0.299
LI	0.318	-0.283
Mandible		
GL	0.328	0.009
LaF	0.328	0.006
LS	0.299	-0.456

* Number in parenthesis represents the percentage of the variation explained by the component

Fig. 1. Principal component chart of the first two transformed variables from 10 cranial variables for male (upper chart) and female (lower chart) jungle fowl and 5 breeds of domestic fowls.

● Junglefowl, ○ Shokoku, ▼ White leghorn, △ Tokarajidori, ■ Satsumadori, □ Shamo.

with regards to the shape of the skull, it resembles the Shamo which belongs to the large-sized group. On the other hand, the female of this breed is distinguished from that of the Shamo not only by the size but also by the shape. This sexual dimorphism is supposed to be one of the characteristics of the white leghorn.

In this study, only 10 cranial measurements were used for the craniometrical analysis, and hence, further studies in more detail will be required to clarify the relationship of the jungle fowl and domestic fowl.

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要 約

野鶏およびニワトリの頭蓋計測（短報）：林 良博・西田隆雄¹⁾・藤岡俊健²⁾・次山 盤¹⁾・望月公子¹⁾・富元幹夫³⁾（東京大学医科学研究所寄生虫研究部，¹⁾東京大学農学部家畜解剖学教室，²⁾名古屋大学農学部家畜解剖学教室，³⁾鹿児島県養鶏試験場）——赤色野鶏，白色レグホン種および日本在来鶏4品種の頭蓋計測をおこない，多変量解析法によって品種間の比較を試み，つぎの成績をえた。（1）サイズによって，小型の赤色野鶏と小国，中型の白色レグホン種とトカラ鶏，大型の薩摩鶏とシャモの3群に区分された。（2）薩摩鶏は，頭蓋の形態においてシャモよりも小国に近似していた。（3）トカラ鶏は，計測値の変異係数が大きく不均一な集団と考えられた。（4）頭蓋の形態差に両眼窩最小幅が大きく関与していた。