Comparison of Craniometric Features between Domestic Pig (*Sus scrofa forma domestica*) and Wild Boar (*Sus scrofa*) from Transylvania Region

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Abstract

Pigs were among the first domesticated animal species after dog, sheep and goats, this important step for mankind dating from late Paleolithic and early Neolithic. Thus current forms of domestic swine are based on wild pigs, the most representative of them are the Asian wild boar and European wild boar. This statement is supported by the fact that the forms of domestic pigs and wild boars can carry interspecific crosses, resulting fruitful hybrids. Based on these arguments take shape the purpose of this scientific papers, to make a comparison between the skull bones of the wild boar and domestic pig, as a result of different environmental conditions in which they formed, they lived and were consolidated during phylogenetic evolution in Transylvania region. For this purpose 52 craniometric measurements were carried to 20 individuals adult males over the age of 4 years, 10 males of wild boar and 10 males of domestic pig specimens belonging to indigenous breeds of pigs. Further processing of data (GraphPad Prism 6) revealed the existence of significant and highly significant differences between craniometric features of wild boar and domestic pigs.

Keywords: *craniometric features, domestic pig, wild boars*

INTRODUCTION

Due to the high adaptive abilities of the representatives of the *Suidae* family, they are widespread all over the world. According to Oliver *et al.* (1993), the species *Sus Scrofa* is the most numerous representative of suborder non-ruminants (Suiformes) and the most widely spread species of the *Suidae* family (Doychev *et al.*, 2012). Pigs were among the first domesticated animal species after dog, sheep and goats, this important step for mankind dating from late Paleolithic and early Neolithic. The earliest evidence of pigs were found in South East of Anatolia, in the Çayönü region, and have been dated from the year 7000 B.C. Studies conducted in recent years in the sequences of mtDNA, showed that pig domestication occurred independently in several geographic areas of Eurasia. Wild ancestor of the domestic pig is the wild boar (*Sus scrofa*), who inhabit in most forest

of Romania, in the Danube Delta and in the bushes of the Carpathians mountains. The morphological structure and craniometric features of skulls in different mammalian species is described in many papers in the literature (Brudnicki, 2005). Data on craniometric features in representatives of *Suidae* can be found in the monograph of the wild boar, reported by Kozlo (1975), while Obrez (1996) analyzed some craniometric features in miniature pigs. Thus current forms of domestic swine are based on wild pigs, the most representative of them are Asian wild boar and European wild boar. This statement is supported by the fact that the forms of domestic pigs and wild boars can carry interspecific crosses, resulting fruitful hybrids.

Based on these arguments take shape the purpose of this scientific papers, to make a comparison between the skull bones of the wild boar and domestic pig, as a result of different

environmental conditions in which they formed, they lived and were consolidated during phylogenetic evolution in Transylvania region.

MATERIALS AND METHODS

The skulls of 20 male, 10 domestic local breeds pig and 10 wild boars hunting trophies from Braşov and Cluj counties, all in completed growth, were used as biological material for the present study. The age of the specimens was determined on the basis of the stage of growth of the third molar tooth (M3). That molar is completely developed at the age of four years (Genov *et al.*, 1992; 1999). After the fourth year, the size of the skull remains largely unchanged (Kozlo, 1975); therefore, only specimens four years and older were included in the analyses.

The animal skulls were macerated by cooking, and then muscles and the cerebrum were mechanically removed and immersed into 5% hydrogen peroxide for bleaching. Craniometric measurements were taken following the methodology of Von den Driesch (1976), a total of 52 skulls craniometric features. Measurements were made using the following tools: electronic

caliper, zootechnical dividers and calibrated ruler (accuracy 0.01 mm and a ruler -1 mm).

The following points were defined in the skulls: Prosthion (P), Rhinion (Rh), Naso-incisive incision (Ini), Infraorbital hole (Inf), Nasion (N), Supraorbital (Sp), Entorbital (Ent), Ectorbital (Ect), Zygion (Zy), Bregma (Br), Akrokranium (Ak), Opisthocranion (Op), Basion (Ba), Hornion (H), Staphylion (St), Postdental (Pd), Premolar (Pm), Molar 3 (M3), Premolar 1 (P1), Premolar 2 (P2), Canine recess (C), Incisive 3 (I3), Nasointermaxillare (Ni), Otion (Ot), Opisthion (O).

After being marked the points the following measurements were taken for each skull on the dorsal (Fig. 1), ventral (Fig. 2), lateral (Fig. 3), aboral (Fig. 4) view and also on the mandible bone (Fig. 5).

On dorsal view of the skulls we conducted a total of 16 craniometric measurements as follows:

1. Prosthion- Akrokranium (P-Ak) skull length
2. Prosthion- Opisthocranion (P-Op) profile length
3. Akrokranium- Nasion (Ak-N) neurocranium dorsal length

Fig. 1. Dorsal view of the wild boar skull. 1 -Skull length; 2 -Profile length; 3 -Neurocranium dorsal length; 4 - Viscerocranium length; 5 -Higher neurocranium length; 6 -Face length; 7 -Parietal bone length; 8 -Length of frontal bone; 9 -Maximum length of nasal bone; 10 -Minimum length of the nasal bone; 11 -Ent- Infraorbital hole length; 12 -Infraorbital hole - P length; 13 -The minimum width of parietal bone; 14 -The maximum width of the frontal bone; 15 -Width between supraorbital holes; 16 -The maximum width of the skull.

4. Nasion- Prosthion (N-P) viscerocranium length
5. Akrokranium- Supraorbital (Ak-Sp) higher neurocranium length
6. Supraorbital- Prosthion (Sp-P) face length
7. Akrokranium- Bregma (Ak-Br) parietal bone length
8. Bregma- Nasion (Br-N) length of frontal bone
9. Nasion- Rhinion (N-Rh) maximum length of nasal bone
10. Naso-incisive incision- Nasion (Ini-N) minimum length of nasal bone
11. Entorbital- Naso-incisive incision (Ent-Inf) entorbital- infraorbital hole length
12. Naso-incisive incision- Prosthion (Inf-P) infraorbital hole - prosthion length
13. The minimum width of parietal bone
14. Ectorbital- Ectorbital (Ect-Ect) the maximum width of the frontal bone
15. Width between supraorbital holes
16. Zygion- Zygion (Zy-Zy) the maximum width of the skull

Fig. 2. Ventral view of wild boar skull. 1 -Condyle - basal length; 2 -Basal length; 3 -Occipital Length-Palatine incisive apophyses; 4 -Palatine apophyses of incisive bone length; 5 -Basioccipital length; 6 -Axis basi - facial length; 7 -Condyle - palatine length; 8 -Palate length; 9 -The length of the upper dental arch; 10 -Pd-Canine recess length; 11 -Diastema length; 12 -Premolaro-molar length; 13 -Molar 3 -Premolar2 Length; 14 - Molar length; 15 -Premolar length; 16 -Length of third molar; 17 -Width of third molar; 18 -Maximum width of the hard palate.

On ventral view of the skulls we conducted a total of 18 craniometric measurements as follows:

1. Occipital condyle- Prosthion (Condyl-P) condyle - basal length
2. Basion- Prosthion (Ba-P) basal length
3. Basion- Premolar (Ba-Pm) occipital bone -palatine incisive apophyses length
4. Premolar- Prosthion (Pm-P) palatine apophyses of incisive bone length
5. Basion- Hornion (Ba-H) basioccipital length
6. Hornion- Prosthion (H-P) axis basi - facial length
7. Basion- Staphylion (Ba-St) Condyle - palatine length
8. Staphylion- Prosthion (St-P) palatine length

9. Postdental- Prosthion (Pd-P) the length of the upper dental arch 10. Molar 3- Canine recess (M3-C) molar 3- canine recess length 11. Incisive 3- Premolar 1 (I3-P1) diastema length 12. Premolar 1- Molar 3 (P1-M3) premolaro-molar length	13. Molar 3- Premolar 1 (M3-P2) molar 3 - premolar2 length 14. Molar length 15. Premolar length 16. Length of third molar 17. Width of third molar 18. Maximum width of the hard palate

Fig. 3. Lateral view of wild boar skull. 1 -Maximum length of neurocranium; 2 -Length of the lacrimal bones; 3 -Height of the lacrimal bones; 4 -Lateral length of premaxilla; 5 -Ect-Ent length.

On lateral view of the skulls we conducted a total of 5 craniometric measurements as follows:

1. Basion- Nasion (Ba-N) maximum length of neurocranium
2. Length of the lacrimal bones
3. Height of the lacrimal bones
4. Nasointermaxillare- Prosthion (Ni-P) lateral length of premaxilla
5. Ectorbital- Entorbital (Ect-Ent) ectorbital-entorbital length

On aboral view of the skulls we conducted a total of 8 craniometric measurements as follows:

1. Otion- Otion (Ot-Ot) external auditory canals distance
2. Occipital condyle width
3. Width of jugular apophysis
4. Width of occipital hole
5. Opisthion- Basion (O-Ba) height of occipital hole
6. Maximum width of nuchal crests
7. Minimum width of nuchal crests
8. Basion- Akrokranium (Ba-Ak) aboral height of neurocranium

Fig. 4. Aboral view of wild boar skull. 1 -External auditory canals distance; 2 -Occipital condyle width; 3 -Width of jugular apophysis; 4 -Width of occipital hole; 5 -Height of occipital hole; 6 -Maximum width of nuchal crests; 7 -Minimum width of nuchal crests; 8 -Aboral height of neurocranium

Also we conducted 5 craniometric measurements regarding the mandible bone as follows:

1. Length of mandible
2. Height of mandible
3. Width of mandible branches

4. Length of upper canines
5. Length of lower canines

The results of the study was statistically processed using bio-informatic program Graphpad Prism v.6.04.

Fig. 5. Mandible of wild boar. 1 -Length of mandible; 2 -Height of mandible; 3 -Width of mandible branches; 4 -Length of upper canines; 5 -Length of lower canines

RESULTS AND DISCUSSION

The variability of craniometric indices regarding wild boar is between a minimum of 0.68% if the length of the side of the premaxilla and a maximum of 23.81% for occipitalbase length . Domestic pig craniometric indices variability ranges between a minimum of 0.40% in the length of the jaw and a maximum of 35.42% in the parietal bone length.

Regarding the significance of differences for mean values of wild boar and domestic pig from all the 52 indicators considered in this study there were a total of 19 values of the means statistically insignificant. Thus insignificant statistically values was recorded for parietal bone length, the minimum width of parietal bone, width between supraorbital holes, condylo-basal length, basal length, occipital length-palatine incisive apophyses, basioccipital length, condyle-palatine length, palate length, Pd- Canine recess length, diastema length, premolar length, length of third molar, width of third molar, maximum width of the hard palate, maximum length of neurocranium, height of the lacrimal bones, Ect-Ent length and width of occipital hole. Also in the case of 14 craniometric indices were recorded differences statistically highly significant. Of these indices in the case of 10 craniometric measurements (viscerocranium

length, face length, maximum length of nasal bone, Ent-infraorbital hole length, length of the lacrimal bones, lateral length of premaxilla, height of occipital hole, length of mandible, length of upper canines, length of lower canines) the differences are in favor of wild boar, and for the other 4 craniometric indices (the maximum width of the skull, maximum width of nuchal crests, minimum width of nuchal crests, width of mandible branches) the statistical differences are in the favor of domestic pig (*Tab. 1*).

Regarding the differences statistically significant they were recorded in 8 of the 52 indicators included in this study. This craniometric indices are: palatine apophyses of incisive bone length, axis basi-facial length, the length of the upper dental arch, molar 3 –premolar 2 length, molar length, occipital condyle width, width of jugular apophysis and aboral height of neurocranium.

Differences statistical significantly distinct between the means of the wild boars and domestic pig was found only in the case of 3 craniometric measurements (higher neurocranium length, premolaro-molar length and neurocranium dorsal length) and in the favor of wild boar. Regarding the differences statistically very significant they were recorded in 8 of the 52 indicators included in this study. Thus statistically very significant values was

Tab. 1. Mean values, variability and significance of differences (t test) of craniometric features in Suidae from Transylvania region

Crt. nr.	Craniometric features	Wild boar		Domestic pigs		D	t test / test (P)
		X $\pm$ s _y	V%	X $\pm$ s _x	V%		
1	Skull length	409.8 $\pm$ 5.490	3	314.8 $\pm$ 13.09	9.30	6.694 ***	0.0009
2	Profile length	426.3 $\pm$ 2.154	1.13	327.8 $\pm$ 10.85	7.40	8.904 ***	0.0006
3	Neurocranium dorsal length	198.3 $\pm$ 3.929	4.43	142.3 $\pm$ 9.287	14.59	5.554 **	0.0020
4	Viscerocranium length	211.3 $\pm$ 0.8602	0.91	165.3 $\pm$ 1.281	1.73	29.82 ****	<0.0001
5	Higher neurocranium length	155.3 $\pm$ 1.715	2.47	111.8 $\pm$ 9.063	18.13	4.716 **	0.0078
6	Face length	256.3 $\pm$ 2.596	2.26	194.8 $\pm$ 1.068	1.23	21.91 ****	<0.0001
7	Parietal bone length	62.76 $\pm$ 0.5008	1.78	45.10 $\pm$ 7.144	35.42	2.466 ns	0.0686
8	Length of frontal bone	132.5 $\pm$ 3.742	6.32	96.40 $\pm$ 1.897	4.40	8.593 ***	0.0001
9	Maximum length of nasal bone	207.8 $\pm$ 1.497	1.61	162.8 $\pm$ 2.818	3.87	14.10 ****	<0.0001
10	Minimum length of the nasal bone	168.3 $\pm$ 3.929	5.22	127.5 $\pm$ 1.610	2.82	9.615 ***	0.0001
11	Ent- Infraorbital hole length	109.1 $\pm$ 4.297	8.81	67.76 $\pm$ 3.420	11.29	7.528 ****	<0.0001
12	Infraorbital hole - P length	164.3 $\pm$ 1.281	1.74	152.8 $\pm$ 0.663	0.97	7.979 ***	0.0002
13	The minimum width of parietal bone	24.84 $\pm$ 0.8480	7.63	23.92 $\pm$ 0.397	3.71	0.9823 ns	0.3659
14	The maximum width of the frontal bone	119.7 $\pm$ 2.2.322	4.34	136.3 $\pm$ 2.015	3.31	5.411 ***	0.0007
15	Width between supraorbital holes	34.13 $\pm$ 0.4226	2.77	33.20 $\pm$ 1.769	11.92	0.5112 ns	0.6335
16	The maximum width of the skull	161.8 $\pm$ 0.3742	0.52	197.8 $\pm$ 2.375	2.68	14.97 ****	<0.0001
17	Condyle - basal length	357.3 $\pm$ 0.8602	0.54	343.3 $\pm$ 6.160	4.01	2.251 ns	0.0850
18	Basal length	344.3 $\pm$ 1.281	0.83	327.3 $\pm$ 7.053	4.82	2.372 ns	0.0727
19	Occipital Length-Palatine incisive apophyses	239.8 $\pm$ 0.3742	0.35	226.6 $\pm$ 6.383	6.29	2.033 ns	0.113
20	Palatine apophyses of incisive bone length	109.7 $\pm$ 3.464	7.06	97.53 $\pm$ 1.399	3.21	3.265 *	0.0207
21	Basioccipital length	43.76 $\pm$ 4.660	23.8	51.93 $\pm$ 2.134	9.19	1.593 ns	0.1657
22	Axis basi - facial length	301.3 $\pm$ 6.606	4.90	275.8 $\pm$ 3.262	2.64	3.461 *	0.0140
23	Condyle - palatine length	99.26 $\pm$ 2.029	4.57	95.88 $\pm$ 2.059	4.80	1.169 ns	0.2759
24	Palate length	245.8 $\pm$ 4.598	4.18	237.8 $\pm$ 3.707	3.49	1.355 ns	0.2142
25	The length of the upper dental arch	234.8 $\pm$ 3.707	3.53	221.3 $\pm$ 1.715	1.73	3.305 *	0.0179
26	Pd- Canine recess length	141.2 $\pm$ 3.533	5.60	141.6 $\pm$ 1.571	2.48	0.1138 ns	0.9134
27	Diastema length	54.60 $\pm$ 0.9176	3.76	51.69 $\pm$ 1.257	5.44	1.872 ns	0.1015
28	Premolaro-molar length	129.1 $\pm$ 1.987	3.44	116.5 $\pm$ 2.483	4.77	3.963 **	0.0046
29	Molar 3 -Premolar2 Length	118.4 $\pm$ 1.778	3.36	109.3 $\pm$ 2.909	5.95	2.678 *	0.0333
30	Molar length	76.03 $\pm$ 1.003	2.95	69.01 $\pm$ 2.357	7.64	2.739 *	0.0377
31	Premolar length	52.23 $\pm$ 0.6409	2.74	48.92 $\pm$ 2.020	9.23	1.564 ns	0.1810
32	Length of third molar	36.28 $\pm$ 0.7130	4.39	36.19 $\pm$ 0.892	5.52	0.0787 ns	0.9392
33	Width of third molar	28.88 $\pm$ 0.5314	5.43	22.08 $\pm$ 0.722	7.32	0.2185 ns	0.8330
34	Maximum width of the hard palate	82.35 $\pm$ 1.242	3.37	82.61 $\pm$ 1.085	2.94	0.1577 ns	0.8787
35	Maximum length of neurocranium	251.3 $\pm$ 7.053	6.28	241.8 $\pm$ 5.490	5.08	1.063 ns	0.3206
36	Length of the lacrimal bones	58.05 $\pm$ 0.95	4.22	32.15 $\pm$ 0.669	4.65	20.18 ****	<0.0001
37	Height of the lacrimal bones	31.94 $\pm$ 0.4885	3.42	30.04 $\pm$ 1.414	10.53	1.267 ns	0.2615
38	Lateral length of premaxilla	161.3 $\pm$ 0.4899	0.68	140.7 $\pm$ 1.114	1.77	16.97 ****	<0.0001
39	Ect - Ent length	42.72 $\pm$ 0.7189	3.76	43.16 $\pm$ 0.364	1.89	0.5510 ns	0.6018
40	External auditory canals distance	130.6 $\pm$ 0.4179	0.72	153.3 $\pm$ 1.715	2.50	12.87 ***	0.0001
41	Occipital condyle width	60.75 $\pm$ 0.4454	1.64	72.34 $\pm$ 3.200	9.89	3.589 *	0.0216
42	Width of jugular apophysis	82.61 $\pm$ 1.176	3.18	88.24 $\pm$ 1.309	3.32	3.200 *	0.0128
43	Width of occipital hole	22.70 $\pm$ 0.4648	4.58	22.03 $\pm$ 1.169	11.87	0.5292 ns	0.6183
44	Height of occipital hole	35.97 $\pm$ 0.5103	3.17	22.92 $\pm$ 0.667	6.51	15.53 ****	<0.0001
45	Maximum width of nuchal crests	79.47 $\pm$ 0.6298	1.77	102.6 $\pm$ 0.369	0.81	31.68 ****	<0.0001
46	Minimum width of nuchal crests	70.57 $\pm$ 0.4401	1.39	95.08 $\pm$ 0.551	1.30	34.74 ****	<0.0001
47	Aboral height of neurocranium	135.2 $\pm$ 0.4661	0.77	142.7 $\pm$ 1.745	2.73	4.146 *	0.0108
48	Length of mandible	327.8 $\pm$ 1.497	1.02	277.3 $\pm$ 0.489	0.40	32.07 ****	<0.0001
49	Height of mandible	132.8 $\pm$ 2.375	4.00	152.3 $\pm$ 0.489	0.72	8.042 ***	0.0009
50	Width of mandible branches	146.5 $\pm$ 0.8138	1.24	162.3 $\pm$ 0.489	0.67	16.59 ****	<0.0001
51	Length of upper canines	79.30 $\pm$ 0.6633	1.87	24.80 $\pm$ 0.374	3.37	71.56 ****	<0.0001
52	Length of lower canines	81.30 $\pm$ 0.6633	1.82	27.80 $\pm$ 0.378	3.01	70.25 ****	<0.0001

Note: ns-insignificant; *-significantly; **-significantly distinct; ***-very significantly; ****-highly significant

recorded for skull length, profile length, length of frontal bone, minimum length of the nasal bone, infraorbital hole-P length, the maximum width of the frontal bone, external auditory canals distance and height of mandible.

CONCLUSION

In the present research work, we conclude based on craniometrical measurements corroborated with statistical data processing the common ancestral origin of the two species, the differences being assigned due to general and special environmental conditions, resulting from the process of domestication.

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