Scientific report

RELATIONSHIPS BETWEEN HUMANS AND SUINES IN PREHISTORICAL AND HISTORICAL TIME, ON THE ROMANIA`S TERRITORY AND CONNECTIONS WITH THE EUROPEAN AND ASIAN SPACES

The objectives of the project entitled *Relationships between humans and suines in prehistorical and historical time, on the Romania`s territory and connections with the european and asian spaces,* conducted in October 2011 – October 2014 are as follows: Trips to museums for faunal material acquisition; Library and internet documentation; Identification of suines remains from prehistoric and historic archaeozoological assemblages; Domestic pig and wild boar separation remains due to biometric data of postcranial and cranial skeleton; Domestic pig and wild boar remains quantification in the samples analyzed; Estimating the role that suines played in the economy of human communities from Neolithic to Middle Ages and variability in space and time tracking of the importance of suines for the studied settlements; Suines exploitation strategies identification; Morphometric characterization of the species (Descriptive statistics; Bivariate and multivariate analysis); Establishing suines filiation by archaeogenetics analysis; Description of human relationship with the Sus genus and the possible local domestication of the species, identifiable through biometric and genetic study; Estimation of the anthropic impact on the paleoenvironment; Establishing and tracking of genetic and morphometric patterns in a geographical and cultural time frame of European Neolithic Revolution; Communication and dissemination of research results. Participation in national and international scientific meetings; Participation in archaeological campaigns in order to collect faunal remains and registration of the primary data necessary for archaeozoological studies and their integration into the general context of settlements; Publication of articles in ERIH volumes and monographs.
All the objectives proposed in the project have been fulfilled.

1. Communication and dissemination of research results. Participation in national and international scientific meetings

Were published 15 scientific articles, 13 of them in international databases indexed volumes and two in ISI-Web of Science volumes (***Quaternary International***; ***Carpathian Journal of Earth and Environmental Sciences***); three of the articles are in indexed ERIH B volumes (*Istros*, 2012; *Istros*, 2013; *Istros*, 2014).

The research results were presented in the form of communications and posters (a total of 81) at various national and international congresses and conferences (Workshop international Economie alimentaire et alimentation à l'Age du Bronze en Europe: aspects pluridisciplinaires "ECOALIM ", Aix en Provence, France; The Third Annual Zoological Congress of "Grigore Antipa" Museum, Bucuresti; International Scientific Session „The human impact on biodiversity in Black Sea area”, Agigea-Constanta, Romania; A XLV sesiune ştiinţifică internaţională “Pontica. Multiculturalitate în spaţiul Danubiano – Pontic”, Constanta; The fourth Annual Zoological Congress of “Grigore Antipa” Museum, Bucharest, Romania; Colocviul international “Impactul antropic asupra mediului natural în neo-eneoliticul sud-est european”, Piatra-Neamț; Second Arheoinvest Congress, Interdisciplinary research in Archaeology, Iasi; 39th International Symposium on Archaeometry: “50 years of ISA”, Katholieke Universiteit Leuven, Belgium; 5th Archaeozoology and Genetics ICAZ Working Group, Basel, Switzerland; 2nd ICAZ Taphonomy Working Group meeting "Taphonomy and archaeozoological research: recent approaches", Santander, Spain; Association for Environmental Archaeology Autumn Conference 2012, Environmental Archaeologies of Neolithisation, Reading, United Kingdom; 7th World Archaeological Congress, Amman, Jordania; Environmental and Archaeological Science Conference AEA & UKAS 2013, Cardiff, United Kingdom; 9th meeting of *Worked Bone Research Group***,** Zhengzhou, Henan province, China; XIXe Colloque du GMPCA, Caen, Université de Caen, France; The fifth international conference of the ICAZ Animal Palaeopathology Working Group, Stockholm, Sweden; Third Arheoinvest Congress, Interdisciplinary research in Archaeology, Iasi, Romania; 19th Annual Meeting of the European Association of Archaeologists, Pilsen, Republica Cehă; AEA (Association for Environmental Archaeology) Autumn Conference, Social space and environment: landscape reconstruction in environmental archaeology, Kiel, Germania; A XLVI Sesiune Internaţională a Muzeului de Istorie Naţională şi Arheologie Constanţa. Pontica; V International Symposium of Ecologists of the Republic of Montenegro, Tivat; The Fifth Annual Zoological Congress of “Grigore Antipa” Museum, Bucuresti; 6th ICAZ – Archaeozoology, Genetics and Morphometrics Working Group Meeting, Lisbon, Portugal; Fifth International Conference on Late Roman Coarse Wares Cooking Wares and Amphorae in the Mediterranean. Archaeology and Archaeometry, Alexandria (Egypt); International Symposium on Biomolecular Archaeology (ISBA), Basel, Switzerland; 10th Meeting of the Worked Bone Research Group of the International Council of Zooarchaeology, Beograd; 20 Annual Meeting of European Association of Archaeologists, Istanbul; 12th International Conference of Archaeozoology, San Rafael, Argentina).

As book chapters or articles in conference proceedings there are 11 publications. Were published four books, three of them at Alexandru Ioan Cuza University Press (”**Arheozoologia Neoliticului din Estul şi Sud-Estul României”; ”Carved bone and antler from northern Dobruja in archaeological and archaeozoological context”; ”Comunitățile cucuteniene din zona Târgului Frumos. Cercetări interdisciplinare în siturile de la Costești și Giurgești”)** and one at a foreign publishers. (”**Niculițel**. **A Roman Rural Settlement in North-East *Moesia Inferior.* Archaeological & Archaeozoological Research”)**. Of the four books, two are published full in English and two in Romanian, but with summaries in English.

2. Participation at archaeological excavations and research stages

In June 2012 two stages have been realised in University of Durham (United Kingdom), each stage of two weeks (Stanc Simina şi Luca Monica) – to analyze swine remains of archaeogenetic point of view and to document in the university library.

In the years 2011-2014, the faunal assemblages have been analysed in different museums, whence they derived. The animal remains were selected either into museums or on the archaeological sites. After that, some assemblages were transported to "Alexandru Ioan Cuza" University of Iaşi, where they have been analysed in the Laboratory of Archaeozoology, Faculty of Biology. Another part of assemblages have been analysed in the Laboratory of Archaeozoology from National Musem of Romanian History, Bucureşti, in the Institute of Eco-Museum Research, Tulcea, in the Museum of Dacian and Roman Civilisation, Deva; in the case of the assemblages discovered in the archaeological sites from Republic of Moldova (Orheiul Vechi/Old Orhei and Soroca), the archaeozoological analyse has been made in Chişinău or Orheiul Vechi/Old Orhei and Soroca respectively (these samples have not been transported to Iaşi).

Travels to Museums of History and Archaeology of Deva, Drobeta Turnu Severin, Baia Mare, Bucuresti, Tulcea, Constanta, Cluj Napoca, Brăila, Slobozia, Călăraşi, Vaslui, Galaţi, Caransebeș, Bacău, and to Institute of Archaeology of Chişinău were realised in order to analyse the faunal assemblages, and to create a metric database. Scientific publications found in the libraries of the same institutions were used to document the research subjects.

In the months of July, August and September of the years 2012, 2013 and 2014, a part of the research team directly participated in archaeological excavations (to collect faunal remains), on the sites of Slava Rusa (Ibida Fortress; Tulcea County; Neolithic and Roman), Jurilovca (Argamum Fortress; Early and Late Roman; Tulcea County), Niculiţel (2-3 centuries; Tulcea County), Tăcuta (Chalcolithic – Cucuteni culture; Vaslui County), Crăsanii de Jos (Piscul Crăsani point; Ialomiţa County; Getic site), Niculiţel (Roman; Tulcea County), Isaccea (Roman, Middle Ages; Tulcea County), Orheiul Vechi/Old Orhei (Middle Ages), Soroca (Middle Ages), Enisala (Neolithic, Iron Age; Tulcea County), Luncaviţa (Neolithic; Tulcea County), Borduşani (Neolithic; Ialomiţa County), Cârlomăneşti (Bronze Age; Buzău County), Oltina (Early Middle Ages; Constanţa County), Murighiol (Roman; Tulcea County), Ardeu (Iron Age; Hunedoara County), Costești (Neolithic; Iași County).

3. Estimation of the swine importance in the economy of the ancient human communities on the territory of Romania

3.1. Quantification of faunal remains found in archaeological sites

In the years 2011-2014, we have analysed faunal assemblages from: Crasnaleuca (Bronze Age), Tăcuta și Costești (Cucuteni culture), Niculiţel (Roman period), Niculiţel (Babadag culture), Babadag (Babadag culture), Orheiul Vechi/Old Orhei (Middle Ages), Soroca (Middle Ages), Târgu Frumos (Precucuteni culture), Răcari (Roman period), Poduri (Chalcolithic, 2 samples), Cotacu (Neolithic), Gălăţui (Neolithic), Isaccea (Neolithic), Sultana

(Neolithic), Bucşani (Neolithic), Chitila (Neolithic), Tăcuta (Neolithic), Isaccea (Roman), Isaccea (Middle Ages), Slava Rusă (Roman and Romano-Bizantin), Piscul Crăsani (Iron Age), Ardeu (Iron Age), Argamum (Roman) (Tables 1-5).

In the studied assemblages, 3367 fragments are of pig (*Sus domesticus*) and 447 of wild boar (*Sus scrofa*). The frequency of pig remains in the analysed assemblages varies from 4% (Gălăţui, Chitila) to 32% at Tăcuta (of the total of specific identified mammals). We have not identified pig remains in the Starcevo Cris settlement of Cotacu; this absence could be considered as an indicator of human mobility to ensure food for the cattle and sheep/goat herds.

Pig is on the third place as frequency in the studied assemblages, after cattle (*Bos taurus*) and sheep/goat (*Ovis aries*/*Capra hircus*); there is an exception – the sample of Bucşani, where pig is on the second position, after cattle. In the sample of Tăcuta, pig has the highest frequency – comparatively with cattle and sheep/goat.

The frequency of wild boar varies from 0.87% at Sultana to 9.36% al Chitila. There are not wild boar remains in the assemblages of Gălăţui. Related to wild mammals, wild boar has the highest frequency in the samples of Răcari, Slava Rusă, Cotacu; in the other samples it is exceeded by red deer (*Cervus elaphus*).

The animal selection for slaughter varied from one settlement to another, as it is indicated by the age profiles according to dentition. Pig was breeding in order to obtain meat, leather and fat. Age classes at death show that, in general, pig was slaughtered as immature, until the age of two years; animals reached the optimal weight at about the age two years, when the slaughter efficiency was maxim. We suppose that pig was primitive with backwardness. Adult individuals were also identified, but with less frequency; they probably were kept as reproductives.

3.2. Variability of swine (*Sus domesticus* and *Sus scrofa*) in the Bronze Age on Romanian territory

In the Bronze-Age osteological material from samples collected from across Romanian territory, the mammalian bone remains predominate, and among these bovines and ovicaprids dominate with values over 70% of the total number of identified remains. The swine remains witness a numerical increase during the Bronze Age in all the studies regions, with most being recorded in settlements from Transylvania (20.45% of the total mammalian remains) and Banat (21.75%) (figure 2).

From among the swine, pig registered the highest shares in all geographical regions (Moldavia, Dobrudja, Transylvania, Wallachia, and Banat), and for all sub-periods of the Bronze Age (Early, Middle and Late). The highest frequency has been registered for the Middle and Late Bronze Age in Wallachia (22.25% of the total) and Transylvania (24.02%). The fewest pig remains have been registered for the transition period from Aeneolithic to the Bronze Age (Banat, Dobrudja, Moldavia) (figure 3).

Table 1. Quantification of mammal remains from the first millennium AD samples.

Species	**Argamum (Incinta Nord) (II-IIIth centuries)**		**Răcari (IVth century)**		**Niculiţel (II-IIIth centuries)**		**Slava Rusă (IV-VIth centuries)**		**Slava Rusa (sector X) (IV-VIth centuries)**		**Slava Rusă (sector T10)**	
	NR	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**
Bos taurus (cattle)	82	36.61	405	30.54	1304	67.71	259	36.43	230	26.31	292	34.27
Ovis aries/Capra hircus (sheep/goat)	70	31.25	472	35.6	308	15.99	165	23.21	337	38.38	218	25.59
Sus domesticus (pig)	55	24.55	393	29.64	182	9.45	116	16.31	193	22	182	21.36
Equus caballus (horse)	3	1.34	7	0.53	15	0.78	41	5.77	36	4.1	31	3.64
Equus asinus (donkey)	-	-	-	-	-	-	35	4.92	3	0.34	7	0.82
Canis familiaris (dog)	2	0.89	4	0.3	17	0.88	71	9.98	42	4.78	57	6.69
Felis domesticus (cat)	-	-	-	-	-	-	1	0.14	-	-	5	0.59
Domestic mammals	**212**	**94.64**	**1281**	**96.6**	**1826**	**94.81**	**688**	**96.76**	**841**	**95.9**	**792**	**92.96**
Cervus elaphus (red deer)	8	3.58	15	1.13	33	1.71	8	1.13	9	1.02	29	3.4
Sus scrofa (wild boar)	2	0.89	21	1.58	30	1.56	12	1.69	11	1.26	9	1.06
Capreolus capreolus (roe deer)	2	0.89	4	0.3	6	0.31	1	0.14	4	0.45	5	0.59
Ursus arctos (bear)	-	-	3	0.23	-	-	-	-	-	-	-	-
Lepus europaeus (hare)	-	-	1	0.08	13	0.68	1	0.14	11	1.26	11	1.29
Meles meles (badger)	-	-	1	0.08	-	-	-	-	-	-	-	-
Vulpes vulpes (fox)	-	-	-	-	-	-	1	0.14	1	0.11	2	0.23
Bos primigenius (aurochs)	-	-	-	-	18	0.93	-	-	1	0.11	-	-
Canis lupus (wolf)	-	-	-	-	-	-	-	-	-	-	4	0.47
Wild mammals	**12**	**5.36**	**45**	**3.4**	**100**	**5.19**	**23**	**3.24**	**36**	**4.1**	**60**	**7.04**
Total identified mammals	**224**	**100**	**1326**	**100**	**1926**	**100**	**711**	**100**	**878**	**100**	**852**	**100**

Table 2. Quantification of mammal remains from the second millennium AD samples.

Species	**Cetatea medievală Soroca.** Remains descovered in 2012.				**Orheiul Vechi (XV-XVIIth centuries)**	
	Cazemata 5		**Turnul 1**			
	NR	**%**	**NR**	**%**	**NR**	**%**
Bos taurus (cattle)	148	26.48	115	52.27	563	63.33
Ovis aries / Capra hircus (sheep/goat)	175	31.31	52	23.64	152	17.1
Sus domesticus (pig)	214	38.28	52	23.64	58	6.52
Equus caballus (horse)	3	0.54	-	-	10	1.12
Canis familiaris (dog)	5	0.89	-	-	4	0.45
Felis domesticus (cat)	1	0.18	-	-	-	-
Domestic mammlas	**546**	**97.67**	**219**	**99.55**	**878**	**98.76**
Cervus elaphus (red deer)	-	-	-	-	1	0.11
Capreolus capreolus (roe deer)	5	0.89	-	-	3	0.34
Sus scrofa (wild boar)	1	0.18	-	-	5	0.56
Lepus europaeus (hare)	7	1.25	1	0.45	1	0.11
Bos primigenius (aurochs)	-	-	-	-	1	0.11
Wild mammals	**13**	**2.33**	**1**	**0.45**	**11**	**1.24**
Total identified mammals	**559**	**100**	**220**	**100**	**889**	**100**

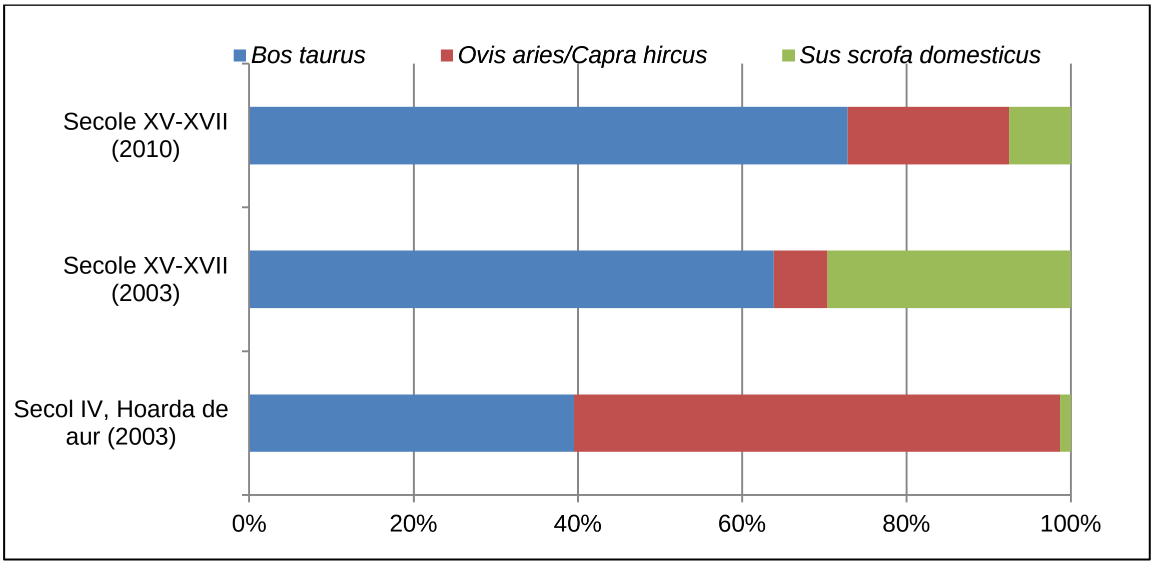

Figure 1. Orheiul Vechi. Comparative analysis for the main domestic mammals in three samples.

Table 3. Quantification of mammal remains from Iron Age and Bronze Age saples.

Species	**Piscul Crăsani (Iron Age)**		**Niculitel (Culture Babadag)**		**Babadag (Culture Babadag) (1)**		**Babadag (Culture Babadag) (2)**		**Crasnaleuca (Bronze Age)**	
	NR	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**
Bos taurus (cattle)	351	44.71	185	46.6	511	38.36	201	41.5	274	50.2
Canis familiaris (dog)	24	3.06	28	7.05	20	1.50	18	3.7	6	1.1
Equus caballus (horse)	61	7.77	42	10.58	179	13.44	53	10.9	30	5.5
Ovis aries/Capra hircus (sheep/goat)	172	21.91	76	19.14	361	27.10	111	22.9	161	29.5
Sus domesticus (pig)	150	19.11	20	5.04	162	12.16	78	16.1	39	7.1
Domestic mammals	**758**	**96.56**	**351**	**88.41**	**1233**	**92.56**	**461**	**95.1**	**510**	**93.4**
Cervus elaphus (red deer)	16	2.04	33	8.31	46	3.45	16	3.3	12	2.2
Capreolus capreolusi (roe deer)	2	0.25	5	1.26	3	0.22	2	0.4	5	0.9
Sus scrofa (wild boar)	9	1.15	8	2.02	41	3.08	3	0.6	18	3.3
Bos primigenius (aurochs)	-	-	-	-	1	0.08	-	-	-	-
Canis lupus (wolf)	-	-	-	-	4	0.30	-	-	-	-
Lepus europaeus (hare)	-	-	-	-	3	0.23	2	0.4	1	0.2
Vulpes vulpes (fox)	-	-	-	-	1	0.08	1	0.2	-	-
Wild mammals	**27**	**3.44**	**46**	**11.59**	**99**	**7.44**	**24**	**4.9**	**36**	**6.6**
Total identified mammals	**785**	**100**	**397**	**100**	**1332**	**100**	**485**	**100**	**546**	**100**

Table 4. Târgu Frumos (Precucuteni Culture) (Faunal sample discovered in 2003-2004 and analyzed in 2013).

Species	**I level**	**II level**	**II-III levels**	**Total**	
	NR	**NR**	**NR**	**NR**	**%**
Bos taurus (cattle)	62	308	10	380	62.4
Sus domesticus (pig)	11	30	3	44	7.22
Ovis aries/Capra hircus (sheep/goat)	4	84	8	96	15.76
Canis familiaris (dog)	1	-	-	1	0.16
Domestic mammals	**78**	**422**	**21**	**521**	**85.55**
Sus scrofa (wild boar)	3	16	-	19	3.12
Bos primigenius (aurochs)	4	7	-	11	1.81
Cervus elaphus (red deer)	4	12	1	17	2.79
Capreolus capreolus (roe deer)	3	27	2	32	5.25
Castor fiber (beaver)	-	3	-	3	0.49
Wild mammals	**14**	**65**	**3**	**82**	**13.46**
Equus caballus (horse)	-	5	1	6	0.99
Total identified mammals	**92**	**492**	**25**	**609**	**100**
Unidentified mammals	57	215	28	300	-
Unio sp.	1	13	-	14	-
Total	**150**	**720**	53	**923**	**-**

Table 5a. Quantification of mammal remains from neolitical samples.

Sample	Cotacu Buzău County, Starcevo Cris Culture)		Gălăţui (Călăraşi County, Bolintineanu Culture)		Isaccea (Tulcea County, Boian Culture)		Poduri (Bacau County, Cucuteni A2 Culture)		Sultana (Călăraşi county, Gumelniţa Culture)		Bucşani (Giurgiu County, Gumelniţa Culture)		Poduri (Bacău County, Cucuteni A2 Culture)		Chitila (Ilfov County, Gumelniţa Culture)		Tăcuta (Vaslui County, Cucuteni Culture)	
Species	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**	**NR**	**%**
Bos taurus (cattle)	45	27.61	282	77.69	167	38.3	592	44.31	134	38.95	275	34.03	554	40.08	217	45.11	372	27.02
Ovis aries/Capra hircus (sheep/goat)	113	69.33	55	15.15	42	9.63	361	27.02	147	42.73	66	8.17	475	34.37	76	15.8	426	30.94
Sus domesticus (pig)	-	-	15	4.13	36	8.26	197	14.75	22	6.4	163	20.17	265	19.37	24	4.99	444	32.24
Canis familiaris (dog)	-	-	1	0.28	80	18.35	5	0.37	11	3.2	15	1.86	26	1.88	8	1.66	24	1.74
Felis domesticus (cat)	-	-	-	-	-	-	-	-	-	-	-	-	1	0.07	-	-	-	-
Domestic mammals	**158**	**96.94**	**353**	**97.25**	**325**	**74.54**	**1155**	**86.45**	**314**	**91.28**	**519**	**64.23**	**1321**	**95.58**	**325**	**67.56**	**1266**	**91.94**
Cervus elaphus (red deer)	-	-	2	0.55	69	15.83	72	5.39	14	4.07	109	13.49	19	1.37	68	14.14	48	3.49
Sus scrofa (wild boar)	4	2.45	-	-	15	3.44	30	2.25	3	0.87	22	2.72	19	1.37	45	9.36	35	2.54
Capreolus capreolus (roe deer)	-	-	-	-	10	2.29	34	2.54	1	0.29	18	2.23	14	1.01	26	5.41	21	1.53
Ursus arctos (bear)	-	-	-	-	-	-	3	0.22	-	-	10	1.24	1	0.07	-	-	-	-
Lepus europaeus (hare)	-	-	-	-	2	0.46	3	0.22	7	2.03	3	0.37	2	0.14	2	0.42	-	-
Meles meles (badger)	-	-	-	-	-	-	2	0.15	-	-	10	1.24	-	-	-	-	-	-
Castor fiber (beaver)	-	-	-	-	4	0.92	2	0.15	-	-	21	2.6	3	0.21	-	-	-	-
Canis lupus (wolf)	1	0,61	-	-	-	-	4	0.3	-	-	-	-	1	0.07	-	-	1	0.07
Equus ferus (wild horse)	-	-	1	0,28	-	-	2	0.15	-	-	33	4.08	-	-	1	0.21	-	-

Vulpes vulpes (fox)	-	-	1	0.28	2	0.46	-	-	4	1.16	5	0.62	-	-	-	-	2	0.14
Bos primigenius (aurochs)	-	-	6	1.65	3	0.69	28	2.1	1	0.29	51	6.31	-	-	8	1.66	1	0.07
Martes martes (pine marten)	-	-	-	-	4	0.92	-	-	-	-	1	0.12	-	-	5	1.04	-	-
Lutra lutra (otter)	-	-	-	-	2	0.46	-	-	-	-	1	0.12	-	-	1	0.21	-	-
Felis silvestris (wildcat)	-	-	-	-	-	-	1	0.07	-	-	3	0.37	-	-	-	-	-	-
Mustela putorius (european polecat)	-	-	-	-	-	-	-	-	-	-	2	0.24	-	-	-	-	-	-
Cricetus cricetus?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.07
Wild mammals	**5**	**3.06**	**10**	**2.75**	**111**	**25.46**	**181**	**13.55**	**30**	**8.72**	**289**	**35.77**	**59**	**4.26**	**156**	**32.44**	**109**	**7.92**
Equus caballus (horse)	-	-	-	-	-	-	-	-	-	-	-	-	2	0.14	-	-	2	0.14
Total identified mammals	**163**	**100**	**363**	**100**	**436**	**100**	**1336**	**100**	**344**	**100**	**808**	**100**	**1382**	**100**	**481**	**100**	**1377**	**100**
Bos taurus/Bos primigenius	1	-	-	-	3	-	14	-	5	-	13	-	-	-	-	-	-	-
Sus sp.	4	-	-	-	29	-	9	-	32	-	17	-	-	-	27	-	-	-
Bos/Cervus	-	-	-	-	107	-	61	-	7	-	36	-	-	-	8	-	-	-
Ovicaprine/Capreolus	-	-	-	-	-	-	7	-	2	-	4	-	-	-	29	-	-	-
Equus sp.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Total mammals	**168**	**-**	**363**	**-**	**575**	**-**	**1427**	**-**	**393**	**-**	**878**	**-**	**1382**	**-**	**545**	**-**	**1377**	**-**

Table 5b. Quantification of mammal remains from Costești samples (Cucuteni and Horodiștea Erbiceni II Cultures).

Species	**Cuc. A3**	**Cuc. AB**	**Cuc. A3+AB**	**Cuc. A3+AB+ Horod.Erb.**	**Cuc. AB+ Horod.Erb.**	**Total**
	NR	**NR**	**NR**	**NR**	**NR**	**NR**
Bos taurus (cattle)	47	66	103	141	315	672
Ovis aries/Capra hircus (sheep/goat)	84	27	113	143	300	667
Sus domesticus (pig)	35	15	49	67	97	263
Canis familiaris (dog)	2	5	3	7	6	23
Domestic mammals	**168**	**113**	**268**	**358**	**718**	**1625**
Bos primigenius (aurochs)	5	3	12	8	12	40
Cervus elaphus (red deer)	25	15	50	72	138	300
Capreolus capreolus (roe deer)	6	1	6	4	14	31
Sus scrofa (wild boar)	15	5	19	11	31	81
Canis lupus (wolf)	-	2	1	-	1	4
Vulpes vulpes (fox)	-	1	-	-	-	1
Lepus europaeus (hare)	3	-	6	2	8	19
Castor fiber (beaver)	2	-	2	-	-	4
Meles meles (badger)	-	-	1	1	-	2
Ursus arctos (bear)	-	-	2	-	5	7
Felis silvestris (wildcat)	-	-	-	2	-	2
Total mamifere sălbatice	**56**	**27**	**99**	**100**	**209**	**491**
Equus ferus ? caballus (wild horse ? domestic horse)	2	12	6	13	44	77
Bos taurus/Bos primigenius	2	-	-	-	-	2
Ovis/Capra/Capreolus	1	-	-	-	-	1
Bos taurus/Cervus elaphus	-	3	-	-	-	3
Total mammals	**229**	**155**	**373**	**471**	**971**	**2199**

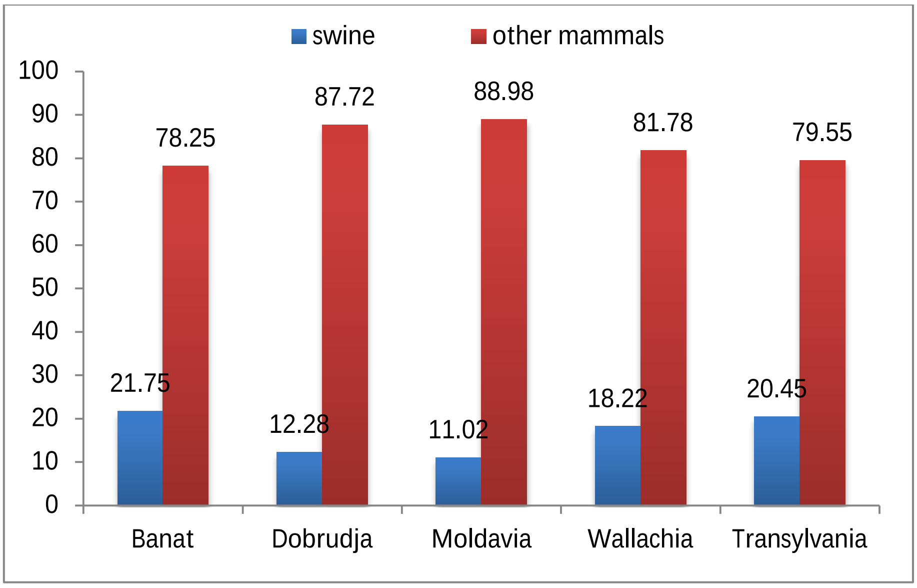

Figure 2. Proportion (% NR) of pigs and other mammals identified in the Bronze Age archaeological sites in Romania.

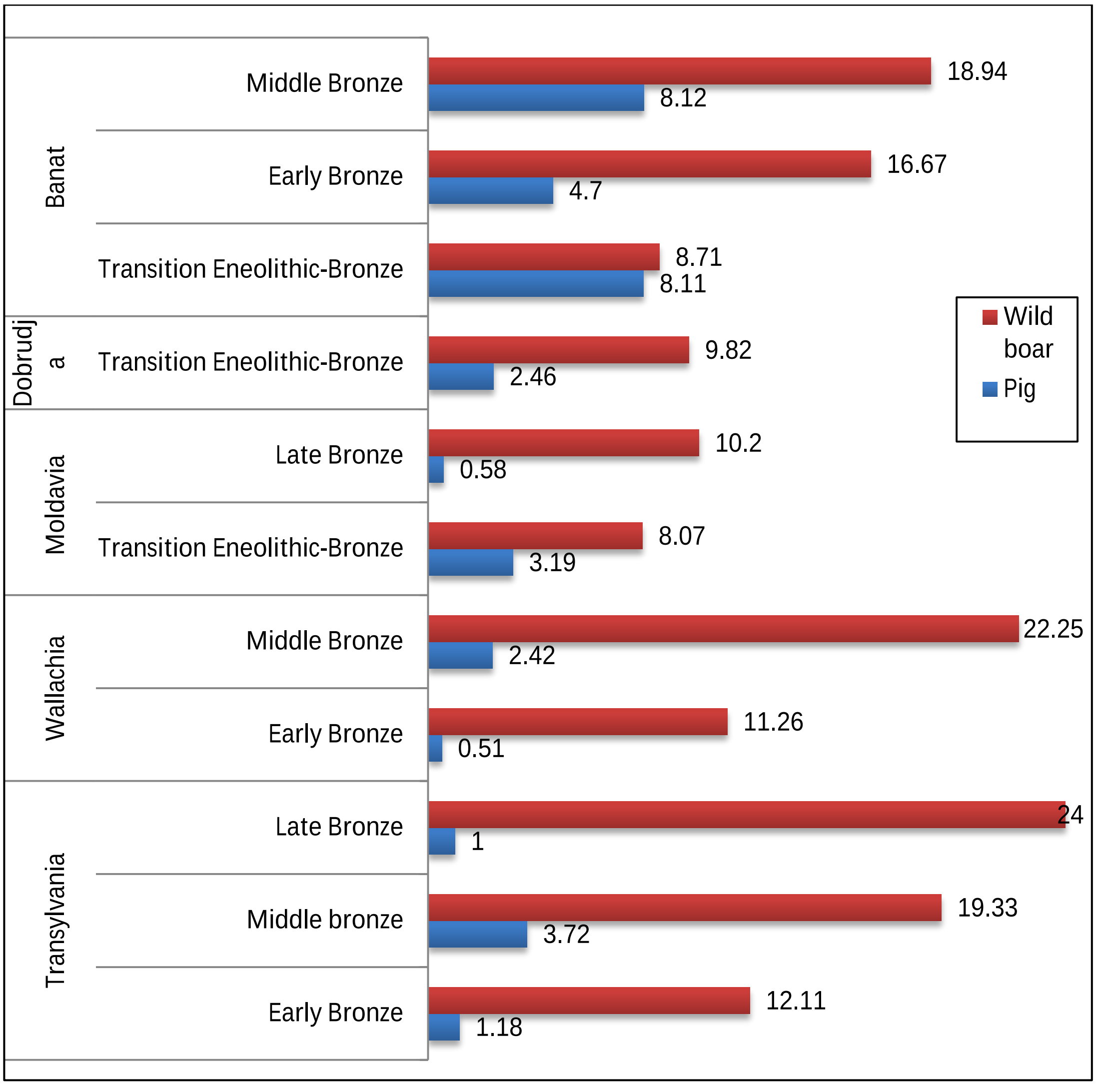

Figure 3. Proportion (% NR) of the domestic pigs and wild boar from the total identified mammals in the studied sites.

3.3. Frequency of pig in samples from the 4th–10th centuries from the eastern and south-eastern Romania

The archaeozoological material belonging to samples from the 4th–10th centuries from the eastern part of Romania includes 16,113 remains from domestic mammals, of which 19.58% belong to domestic pig. The highest frequency of pig is found in the sites from Vărărie (45.45%) and Udești (43.81%). These data could provide an image of the relative importance of pig in human alimentation during the 7th-9th centuries (from settlements located in the Carpathian piedmont), compared with the 3rd-5th centuries, a period for which smaller frequencies of domestic pig have been found: Bârlălești (7.28%), Nicolina (8.57%), Gara Banca and Ghilănești (settlements from the Moldavian Plain) (figure 4)

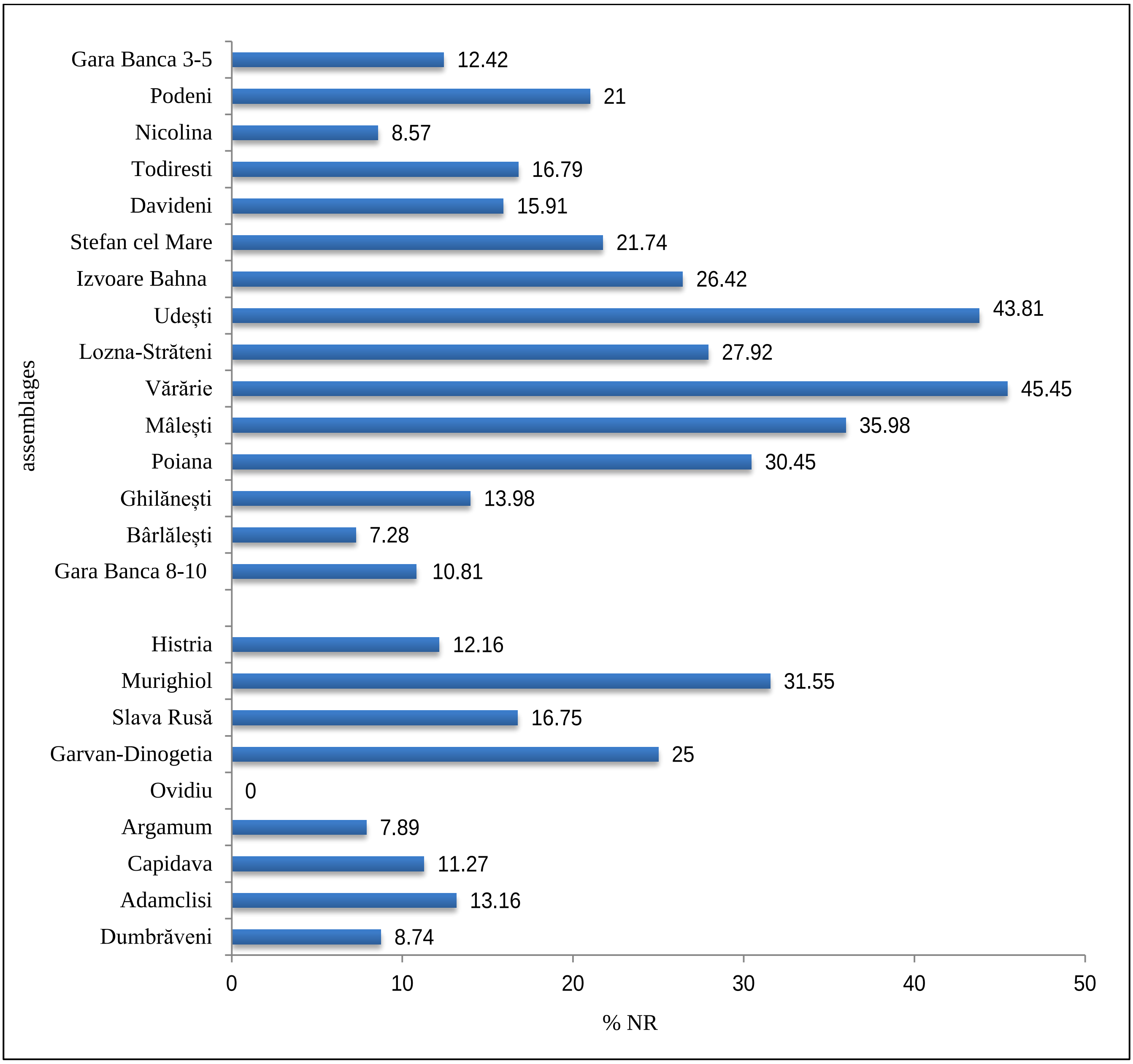

Figure 4. Pig frequencies (from the total identified mammals) in IV-Xth centuries samples.

4. Morphometric characterization of the swine using descriptive statistics and bivariate and multivariate analysis

4.1. Morphometric studies on archaeozoological material from the Neolithic period

The morphometric characterization of the domestic and wild pig populations from the Neolithic of Romania aimed the following:

- to distinguish as clearly as possible the domestic form from the wild one by identifying variables that facilitate this separation;
- to establish the limits of metric variation for the analysed anatomical pieces (in the univariate analysis);
- the manner in which certain anatomical pieces evolve (in the bivariate and multivariate analyses).

The faunal material subjected to analysis originates for the most part from settlements belonging to the following Neolithic cultures: Precucuteni, Cucuteni, Boian, and Gumelnita. Even though traditional measuring was performed on all the anatomical pieces, the statistical analysis was conducted only for those pieces that met the minimum criteria for inclusion in the statistical analysis. These anatomical pieces and their mesured variables are listed in table 6.

Table 6. Variables used for the morphometric study.

Abreviation	**Variables description**
maxilla	
GL P2-P4	length of the premolar row
GL M1-M3	length of the upper molar row
GL M3	length of the third molar
GB M3	breadth of the third molar
mandible	
GL m1-m3	length of the molar row
GLm3	length of the third molar
GB m3	breadth of the third molar
scapula	
GLP	Greatest length of the Processus articularis (glenoid process)
SLC	Smallest length of the Collum scapulae (neck of the scapula)
LG	Length of the glenoid cavity
BG	Breadth of the glenoid cavity
humerus	
BFd	Breadth of the Facies articularis distalis
Bd	(Greatest) breadth of the distal end
Dd	Dd - (Greatest) depth of the distal end
SD	SD - Smallest breadth of diaphysis
radius	
Bp	(Greatest) breadth of the proximal end
BFp	(Greatest) breadth of the Facies articularis proximalis
tibia	
Bd	(Greatest) breadth of the distal end
BFd	Breadth of the Facies articularis distalis
Dd	(Greatest) depth of the distal end
calcaneus	
GL	Greatest length
GB	Greatest breadth
astragalus	
GL	Greatest length
GB	Greatest breadth

Cross breeding render difficult the separation of swine remains; the anatomical pieces that allowed a clear separation between the domestic form and the wild one were:

- **Tibia**: Bd = 25 - 31 mm (pig) and Bd = 38 - 46 mm (wild boar);
- **Humerus**: Bd = 28 - 43.5 mm (pig) and Bd = 50 - 58 mm (wild boar),
  Dd = 34.2 - 48.1 mm (pig) and Dd = 44.8 - 60 mm (wild boar);
- **Radius**: Bp = 24 - 34.5 (pig) and Bp=37.5 - 45 mm (wild boar);
- **The third mandibular molar**: GL= 29.5 - 39.5 mm (pig) and GL = 40.2 – 52 mm (wild boar).

In figure 5 we illustrate the separation of the pig from the wild boar through the bivariate analysis. The relation between the two variables (Bd and Dd) is strongly positive for both forms (domestic and wild), but according to the Pearson correlation index it is greater for the domestic form ($r = 0.9$; $p < 0.05$).

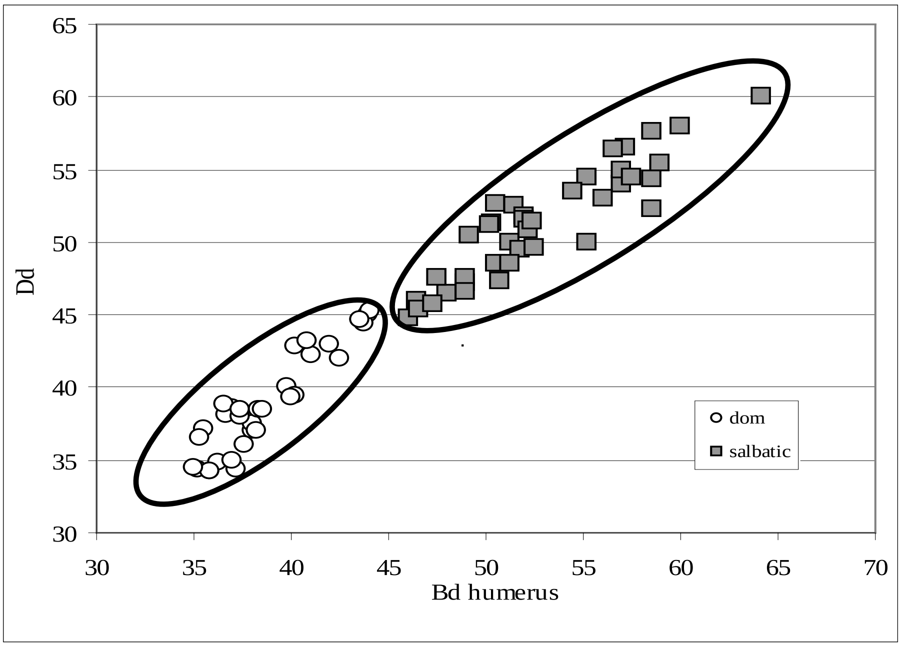

Figure 5. Separation between pig and wild boar by the bivariate analisys for humerus (Bd and Dd) (correlation index: $r = 0.9$, $p < 0.05$ (pig); $r = 0.8$, $p < 0.05$ (wild boar).

Significant differences between the populations of domestic pigs from the four cultures investigated were highlighted in the multivariate analysis of the scapula (figure 6).

The two main axes, representing 93.83% of the total variance, reveals the following:

- the presence of sexual dimorphism — shown by the grouping of the data on the graph on each side of the main axis (particularly for the population from Gumelnița);
- the SLC and GL variables reveal significant differences between the pig populations from the Gumelnița and Precucuteni cultures (secondary axis).

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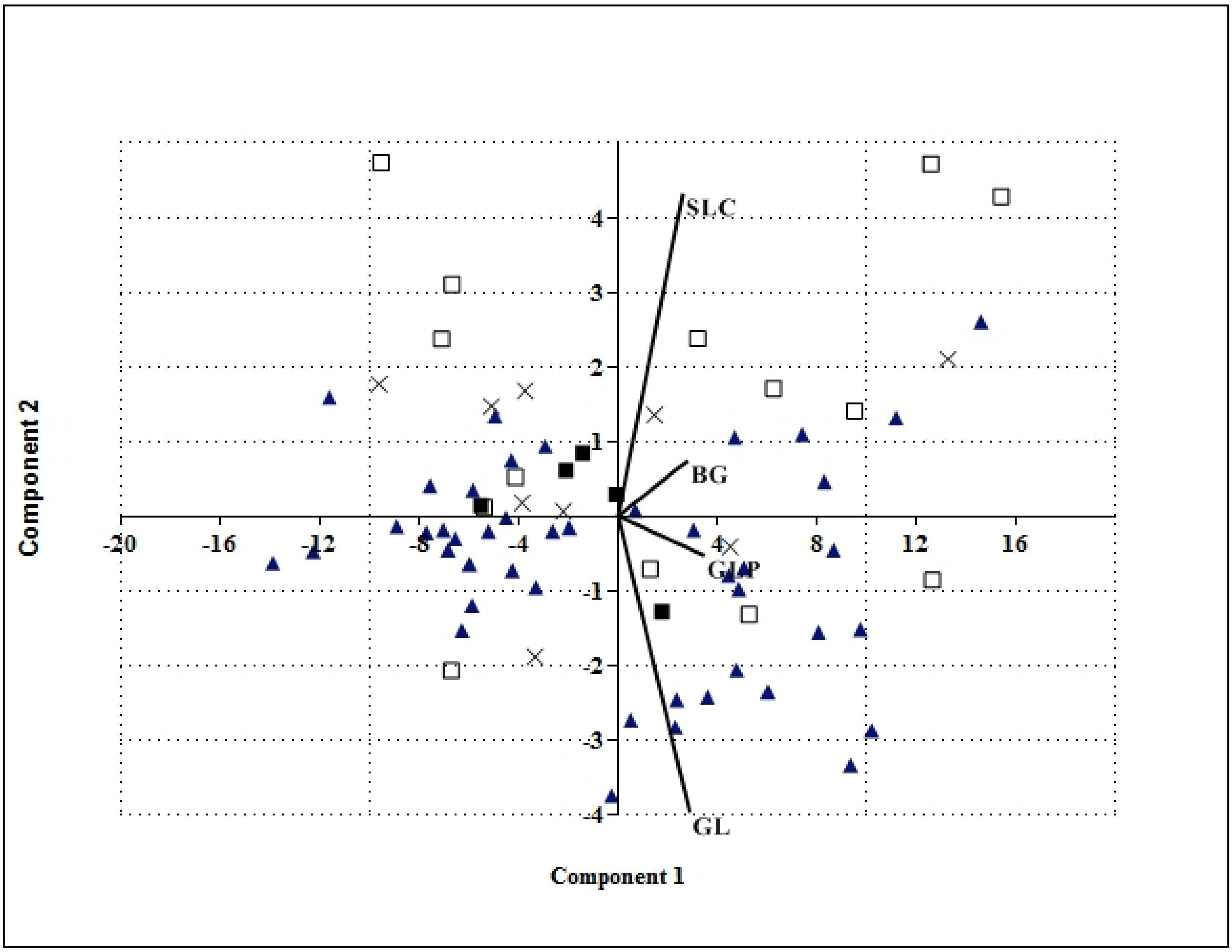


Figure 6. Graphical representation of the analysis of the main components for scapula (abbreviations in the graph are listed in Table 6). Legend: □ Precucuteni Culture; X Cucuteni Culture; ■ Boian Culture; ▲ Gumelnita.

The description from the morphometric point of view (the central tendency and variability) of the pig populations from the Precucuteni and Cucuteni cultures is presented in table 7.

Table 7. Descriptive analysis for pig (Precucuteni and Cucuteni Cultures).

Anatomical element and variable	**Culture**	**Statistical index**							
		n	**M**	**EM**	**Std.Dev.**	**Min**	**Max**	**confidence (95.0%)**	**CV %**
maxilla LM3	Precucuteni	7	31.71	0.57	1.5	30	34	1.38	4.72
	Cucuteni	27	31.29	0.66	3.41	26.5	40.5	1.35	10.91
maxilla BM3	Cucuteni	16	18.96	0.54	2.16	16.3	24	1.15	11.38
maxilla GL M1-M3	Cucuteni	8	66.46	1.31	3.71	63	72	3.1	5.58
mandible GL	Precucuteni	10	85.4	2.41	7.63	72	94	5.46	8.94

symph.	Cucuteni	5	52.64	3.17	7.08	47	65	8.79	13.45
	Precucuteni	22	37.86	1.15	5.4	26	44	2.39	14.26
mandible GL m3	Cucuteni	27	30.18	0.9	4.65	17	36.3	1.84	15.42
pelvis LA	Cucuteni	33	31.65	0.36	2.07	26	36	0.73	6.55
	Precucuteni	12	44.5	1.24	4.3	35	49	2.73	9.65
astragalus GL	Cucuteni	11	41.32	0.74	2.46	37	45	1.65	5.96
humerus Bd	Cucuteni	30	37.78	0.56	3.08	28	43.5	1.15	8.15
	Precucuteni	7	32.86	1.26	3.34	28	38	3.09	10.16
humerus BFd	Cucuteni	26	29.05	0.79	4.03	18	36	1.63	13.86
cubitus BFp	Cucuteni	16	26.53	0.4	1.59	24	30	0.85	6
	Precucuteni	24	33.88	0.74	3.6	27	37	1.52	10.64
radius Bp	Cucuteni	22	29.41	0.57	2.66	24	34.5	1.18	9.03
	Precucuteni	38	35.44	0.52	3.19	26.7	39	1.05	9
tibia Bd	Cucuteni	19	30.99	1.45	6.33	25	31	3.05	18.09
	Precucuteni	11	32	0.56	1.84	30	36	1.24	5.76
tibia BFd	Cucuteni	10	26.29	1.1	3.47	21	31.5	2.49	13.21
phalanx 1 GL	Cucuteni	16	43.47	1.46	5.84	33	52	3.11	13.44
phalanx 1 GB	Cucuteni	16	21.34	0.33	1.31	20	25	0.7	6.15
phalanx 1 Bd	Cucuteni	16	20.36	0.4	1.61	17	22.5	0.86	7.89
phalanx 1SD	Cucuteni	16	16.81	0.23	0.91	15	18.5	0.49	5.42
scapula LG	Cucuteni	12	33.92	0.96	3.33	28	38	2.12	9.82
scapula BG	Cucuteni	12	30.13	1.14	3.95	23	35	2.51	13.11
scapula SLC	Cucuteni	11	26.51	0.99	3.28	20	30	2.21	12.38

The metric variability of the characters and the types of relations established between the variables underlines the presence of regional structures the dimensions of which fall in the "palustris" type typical of the Neolithic period.

The **phenotypic variability** at the level of the molars was described using the geometric-morphometry method. The advantages of this methodology consist in the possibility to the visualise the form of the molars, but also the use of mathematical data thus obtained, in the multivariate analysis.

The material used was the second and third mandibular molar from domestic pigs. The material originates from the Neolithic settlements from Târgu Frumos (Precucuteni), Poduri, Hoisești (Cucuteni culture), Căscioarele (Boian culture), Măriuța, and Luncavița (Gumelnița culture). The study employed these two molars for the following reasons:

- have fewer changes in the crown from the mastication process (particularly m2) (Payne and Bull, 1988);
- have a higher frequency in the archaeozoological materials.

The results revealed the presence of a population of pigs with possible different origins. This hypothesis is advanced on the basis of the results obtained from the analysis of the two molars.

Two main characteristics have been identified:

- The median labial concavity of the second mandibular molar - more pronounced in the populations of the Boian and Gumelnița cultures than in the case of populations of the Precucuteni and Cucuteni cultures (figure 7);
- The lengthening of the talonid of the third mandibular molar in the case of the domestic pig populations of the Gumelnița and Boian cultures, in contrast with the shortening of the same part in the case of Precucutenian and Cucutenian populations; other differences were also observed at the level of the cuspids (figure 8).

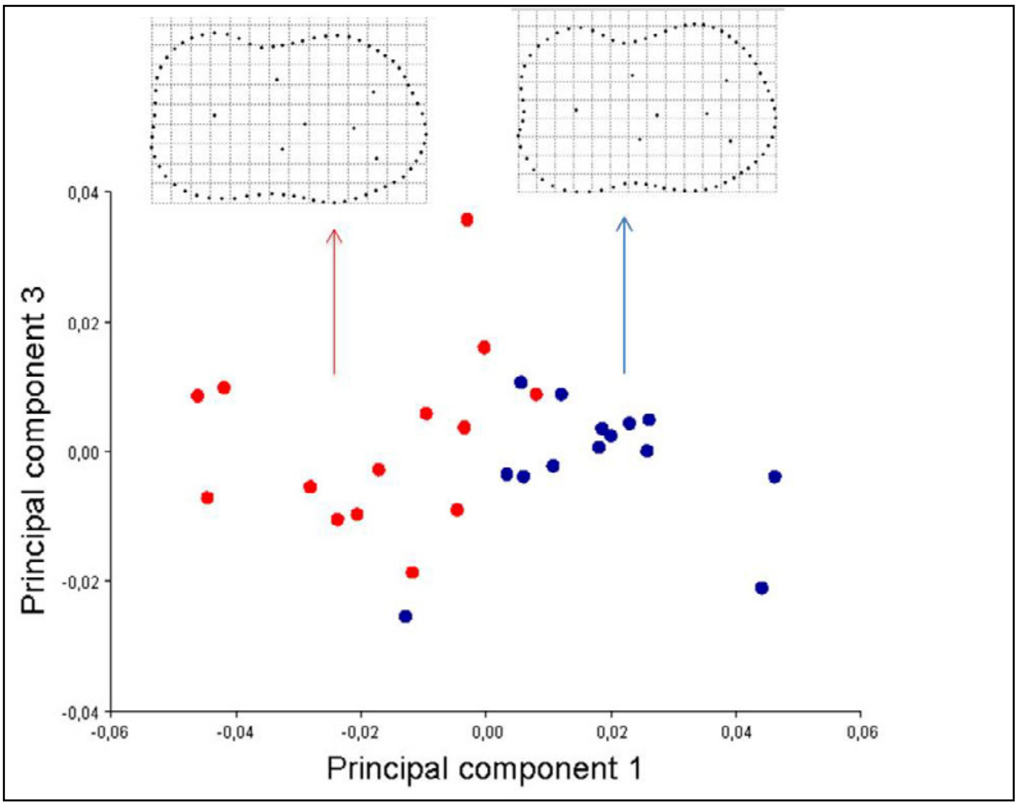


Figure 7. Analysis of the main components for the mandibular molar, highlighting the shape characteristic for different populations (red - Precucuteni and Cucuteni cultures, blue - Boian and Gumelniţa cultures).

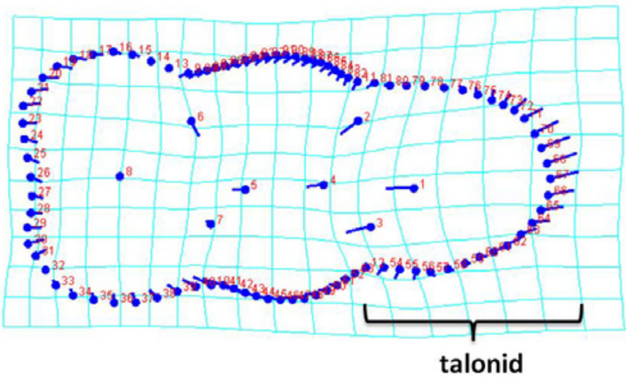


Figure 8. Mandibular third molar shape trend in pig populations for Gumelniţa and Boian cultures.

4.2. Morphometric variability of swine from the Bronze Age on Romanian territory (3000/2500 B.C.-1200/1150 B.C.)

The osseous remains belonging to the postcranial skeleton were much better represented in terms of numbers. Large series of metrical data were obtained from anatomical pieces such as the humerus, radius, tibia, and calcaneus. Significant differences between the size of the pig from different settlements (Mândrișca, Bogdănești and Cernavodă) were shown by the unifactorial ANOVA ($F=6.3$; $p<0.05$). The same significant difference between the pig populations from the three settlements is revealed by the bivariate analysis (GL and GB), as illustrated in figure 9.

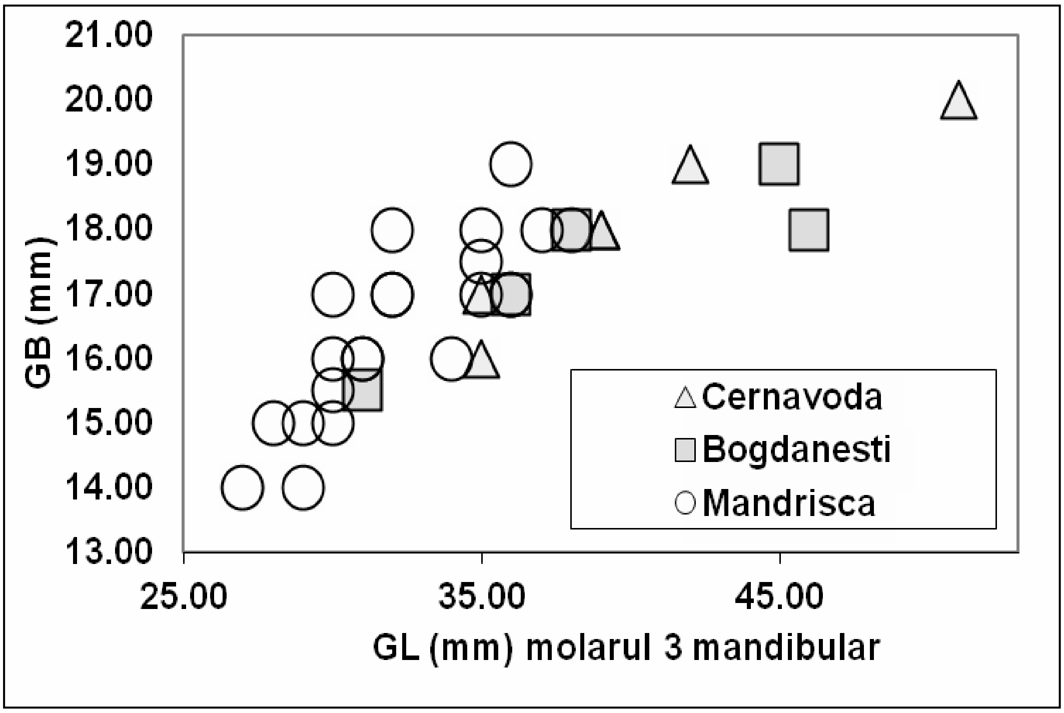


Figure 9. Correlation between length (GL) and width (GB) for the mandibular molar 3, in the samples significantly different.

The results of univariate analysis for the studied anatomical parts of the swines belonging to the Bronze Age samples are presented in table 8.

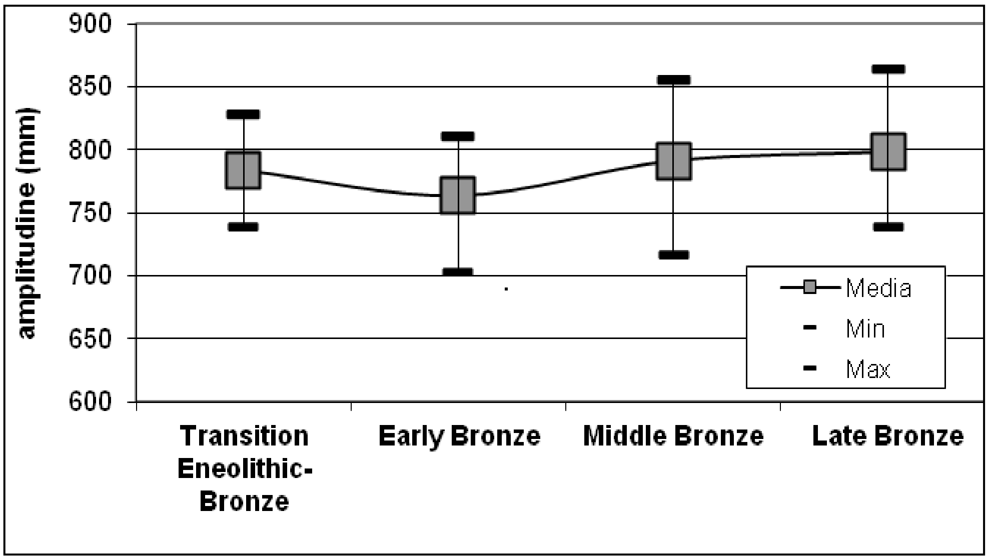
Clear separation limits were obtained for:

- calcaneus: GL = 80-83.5 mm (pig) and GL = 85-108 mm (wild boar);
- humerus: Bd = 26-45 (pig) and GL = 51-58 mm (wild boar).

The withers height was estimated on the basis of the astragalus and the calcaneus. A slight tendency of increase in the withers height for pig towards the end of the Bronze Age is revealed by high values obtained by calculating the Teichert index (Udrescu *et al.*, 1999) (figure 10).

Table 8. Descriptive analysis for suines populations in Bronze Age.

Anatomical element	Form	Variable	n	Average	Median	Standard deviation	Min.	Max.	Confi-dence	CV%
maxilla	domestic	GL P2-P4	5	38.1	35	5.05	34	45	6.28	13.27
		GL M1-M3	27	69.13	70	3.7	61.5	75.5	1.46	5.35
		GL M3	38	33.83	34.5	3.13	27	43	1.03	9.26
	wild	GL M3	9	42.53	43	2.32	40	47	1.78	5.45
mandible	domestic	GL m1-m3	16	71.09	72	4.32	64	77	2.3	6.08
		GLm3	92	35.33	35.75	3.64	22.5	41	0.75	10.31
	wild	GL m3	10	44.26	44.5	2.33	40.6	49	1.67	5.27
scapula	domestic	GLP	22	36.55	36.25	5.09	28	49	2.26	13.92
		SLC	31	24.98	23.5	4.53	20	39	1.66	18.12
		GL	19	31.82	32	5.37	24	42	2.59	16.88
		BG	22	23.94	24	3.4	17	30	1.51	14.21
	wild	GLP	3	45.5	-	-	44.5	46.5	-	-
		SLC	3	54.67	-	-	46.5	62	-	-
		GL	3	45.5	-	-	41.5	49.5	-	-
humerus	domestic	BT	14	32.48	32.6	2.46	28.5	36.2	1.42	7.56
		Bd	40	39.66	41.5	4.24	26	45	1.35	10.68
		Dd	15	35.21	39.5	9.06	18	45	5.01	25.72
		SD	5	18.84	18	5.28	11.8	25	6.55	28.02
	wild	BT	3	45.93	-	-	44.5	47.5	-	-
		Bd	10	54.08	53.75	2.72	51	58	1.94	5.03
radius	domestic	Bp	42	30.44	30	1.86	27	36	0.58	6.12
		Dp	37	21.73	21	2.78	17.5	32	0.93	12.8
tibia		Bd	40	31.05	31.5	2.11	26	35.5	0.68	6.81
		BFd	1	-	-	-	26.4	-	-	-
		Dd	37	27.2	27	4.61	9	38	1.54	16.96
	wild	Bd	11	42.15	42	1.83	39	45	1.23	4.34
calcaneus	domestic	GL	5	63.9	74	31.51	80	83.5	39.13	4
		GB	5	28.6	31	4.22	24	32	5.24	14.75
	wild	GL	6	97.5	99.5	9.97	85	108	10.47	10.23
		GB	6	38.33	39.25	3.25	32	41	3.41	8.48
astragalus	domestic	GL	17	43.09	43	3.02	38	47	1.55	7
		GB	7	25.61	26	1.29	24	27.5	1.2	5.05



Variable	Transition Eneolithic-Bronze	Early Bronze	Middle Bronze	Late Bronze
Average	783.75 mm	764.06 mm	791.3 mm	798.07 mm
Minimum	739 mm	703.2 mm	717.16 mm	739 mm
Maximum	828.5 mm	810.6 mm	855.35 mm	864.3 mm

Figure 10. The withers height variation for pig during Bronze Age.

4.3. Morphologic models in the dentition of domestic pigs identified in the settlement from Stâncești, Botoșani (6th-3rd centuries B.C.)

A sample comprising 131 teeth (the 2nd and 3rd molars from the mandible and maxilla) was subjected to a bivariate analysis. The variables used were the maximal length and the maximal width of the molar.

In what concerns our sample, we can speak about the presence of pig populations characterised by a small variability according to the resulting variation coefficient (CV = 5-11%). The higher values of this index obtained for the length of the 3rd molar both on the mandible as well as the maxillary could reveal different rates of growth of the individuals in relation with their age.

The width of the molars (GB) are much more stable characters from the metrical point of view; this is confirmed by the much lower values of this variable (CV%=5.71).

The bivariate analysis shows an statistically-insignificant correlation between the two variables from the level of the 2nd mandibular molar ($r = 0.25$; $p = 0.18$); accordingly, the length and width of the molar increase independently from each other. Conversely, strong dependency relations ($r>0.8$; $p <0.05$) were found in the case of the other molars analysed (table 9).

The analysis by geometric morphometry of the 2nd mandibular molar highlights significant differences in the shape of the molars for the domestic and wild pig populations from the aforementioned settlement. These differences concern especially the:

- distal part of the molar;

- distal cuspids: hypoconid, pentaconid and entoconid (figure 11).

Table 10 presents the results of the univariate analysis: central tendency and variability. According to the results, the highest variability is found at the level of the 3rd molar both from the mandible and the maxillary (CV% > 9).

Table 9. Bivariate analysis results for the analyzed material.

Molar tooth	Pearson correlation index	Regression equation	Determining factor (R2)	relation significance (p value)
2nd lower molar	0.25	y = 0.1628x + 1.3075	0.065	0.18
2nd upper molar	0.81	y = 0.6034x + 0.5072	0.5859	0.0001
3rd lower molar	0.8	y = 0.2111x + 0.9587	0.6492	0.001
3rd upper molar	0.89	y = 0.4185x + 0.6355	0.7975	0.0001

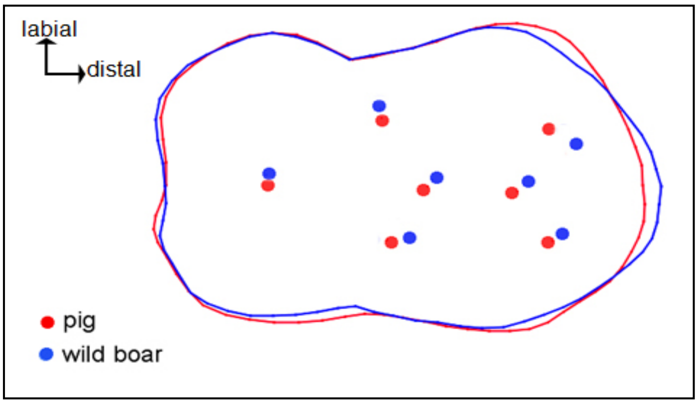


Figure 11. Lower second molar characteristics for pig and wild boar in the settlement of Stancesti (in red - characteristics for pig; blue - characteristics for wild boar).

Table 10. Univariate analysis for the molars 2 and 3 of pig.

Molar	**Variable**	**Minimum**	**Maximum**	**Mean**	**Standard deviation**	**Coefficient of variation (%)**
2nd lower molar	length	2.24	3.01	2.62	0.19	7.24
	width	1.49	2	1.73	0.12	7.01
2nd upper molar	length	2.17	2.84	2.45	0.2	8.01
	width	1.69	2.32	1.99	0.15	7.79
3rd lower molar	length	3.48	5.26	4.43	0.41	9.32
	width	1.73	2.07	1.89	0.11	5.71
3rd upper molar	length	3.16	5.32	4.09	0.45	11.01
	width	1.91	3.01	2.35	0.21	8.99

4.4. Morphometric data for domestic pigs from the 4th-9th centuries from eastern and south-eastern Romania

The osteological material used in the statistical analysis is represented by 876 remains. The results show for the studied area the presence of a more primitive form of pigs, with a low sexual dimorphism. The withers height (calculated on the basis of the Teichert index) registers the highest values in the settlements from Poiana (75 cm) and Gara Banca (70 cm), and the lowest for the settlement from Poieni (55 cm). Significant chronological variation for the withers height of pigs during the 4^{th}-10^{th} centuries were not found; likewise, neither in the descriptive analysis of the bone pieces were statistically significant differences observed.

Another approach to ascertaining the size of the pigs from the investigated period consisted of analysing the 3^{rd} mandibular molar. As such, larger pigs were identified in Histria (35 mm) and Gara Banca (9^{th}-10^{th} centuries) (33 mm), and smaller populations in the settlement from Todirești (28 mm) (figure 12).

The values registered for the 3rd mandibular molars from the settlements of Gara Banca (3^{rd}-5^{th} centuries), Podeni, Nicolina, Davideni, and Ghelăiești could indicate populations of domestic pigs of similar size, but since the size of the sample was insignificant, this should be taken with caution.

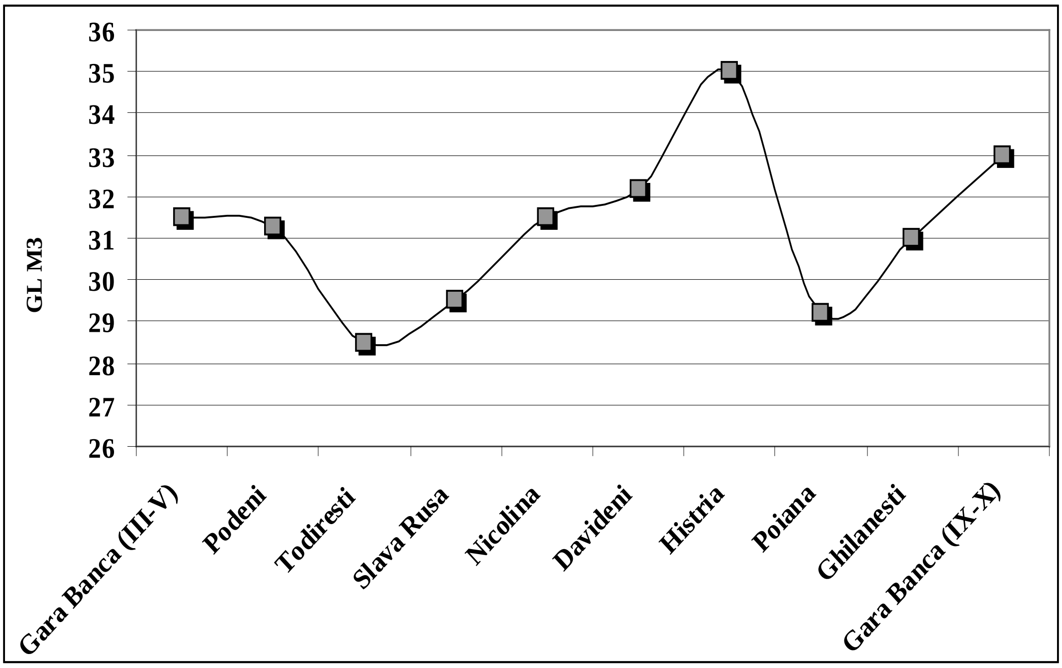


Figure 12. Mandibular third molar variation in the IV-Xth centuries settlements in eastern and south-eastern Romania.

4.5. Metrical data for the osteological material dating from the 2nd millennium from Dobrudja (settlements: Garvăn, Oltina, Piatra Frecăței, Dumbrăveni, Hârșova, Isaccea and Capidava)

11702 remains were identified from these settlements, of which 20% belong to swine. The highest frequency of remains identified as belonging to pig were found for the sites from

Hârșova (27.51%) and Oltina (28.51%), and the lowest for Dumbrăveni (8.04%) and Isaccea (9.20%). The highest shares of wild boar were found in the material from Piatra Frecăței (17%) and Hârșova (3.72%), and the lowest from Dumbrăveni (1.51%) and Oltina (1.81%). Starting from this faunal material, we performed a descriptive analysis in order to characterise the swine populations from the aforementioned area.

The withers height ranged between 64.9 and 82.7 cm for pig, and between 92 and 113.7 cm for wild boar.

The dimensions of the molars are less affected by sex, age and intra-population variations, unlike other anatomical elements (Davis, 2008); accordingly, the molars are the most suited for comparing from a metrical point of view the two swine forms. In our case, the 3rd mandibular molar (with the variables GL and GB) proved to be the most suitable anatomical piece to this purpose, with strong positive links established between the two forms (according to Pearson's parametric correlation coefficient, $r>0.7$; $p<0.05$):

GL = 28-34 mm (pig) and 41-51 mm (wild boar);

GB = 13-16 mm (pig) and 19-21 mm (wild boar).

Another variable considered important for separating the two forms is GLP from the level of the scapula, and Bd from the level of the humerus:

GLP = 29-43 mm (pig) and 45-52 mm (wild boar);

Bd = 30-40.5 mm (pig) and 50-63 mm (wild boar).

A clear separation between the two forms was not achieved at the level of the other anatomical pieces (radius, pelvis, tibia, or astragalus).

4.6. The biometric separation of domestic pig (*Sus domesticus*) and wild boar (*Sus scrofa*) remains identified in sites of the 1st and 2nd millenniums from eastern and south-eastern Romania

From among the measurable cranial remains, the most numerous are the mandibular fragments, for which the length of the 3rd molar was measured most often. For our samples, the variability limits for the length of the 3rd molar are 27 mm and 36 mm for pig, and 41 mm and 51 mm for wild boar, respectively.

In the faunal samples, the postcranial skeleton is much better represented than the cranial one. The riches data series are provided by the humerus, radius, tibia, coxal bone, astragalus, calcaneus, and the metapodials.

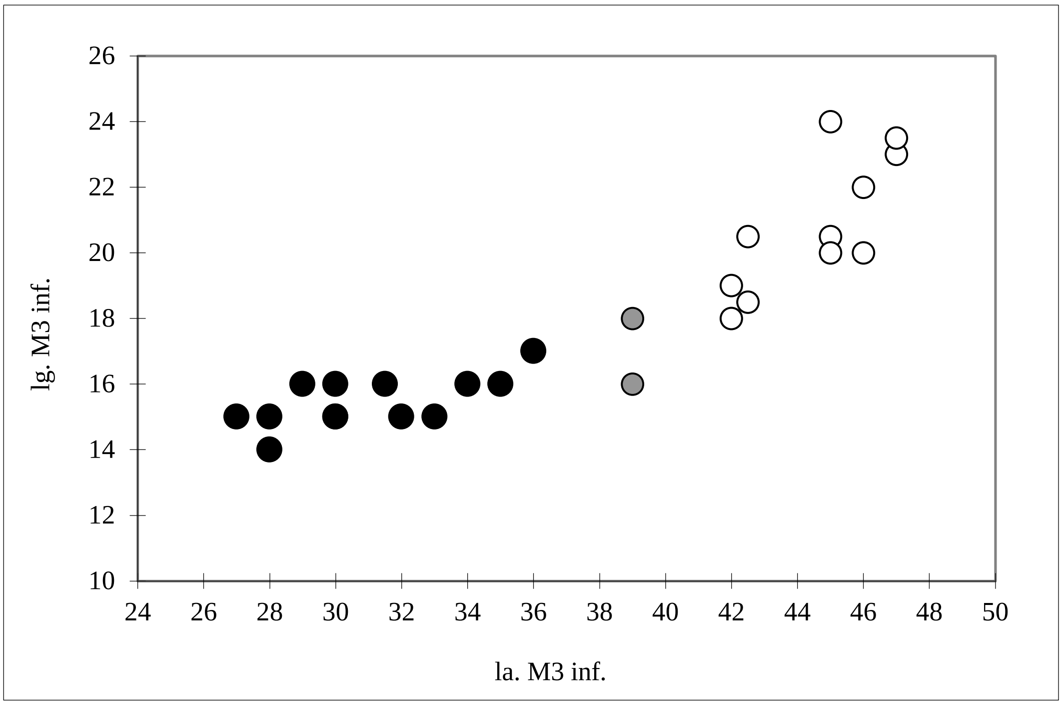


Figure 13. *Sus domesticus* and *Sus scrofa* separation at the level of the lower M3 molar.

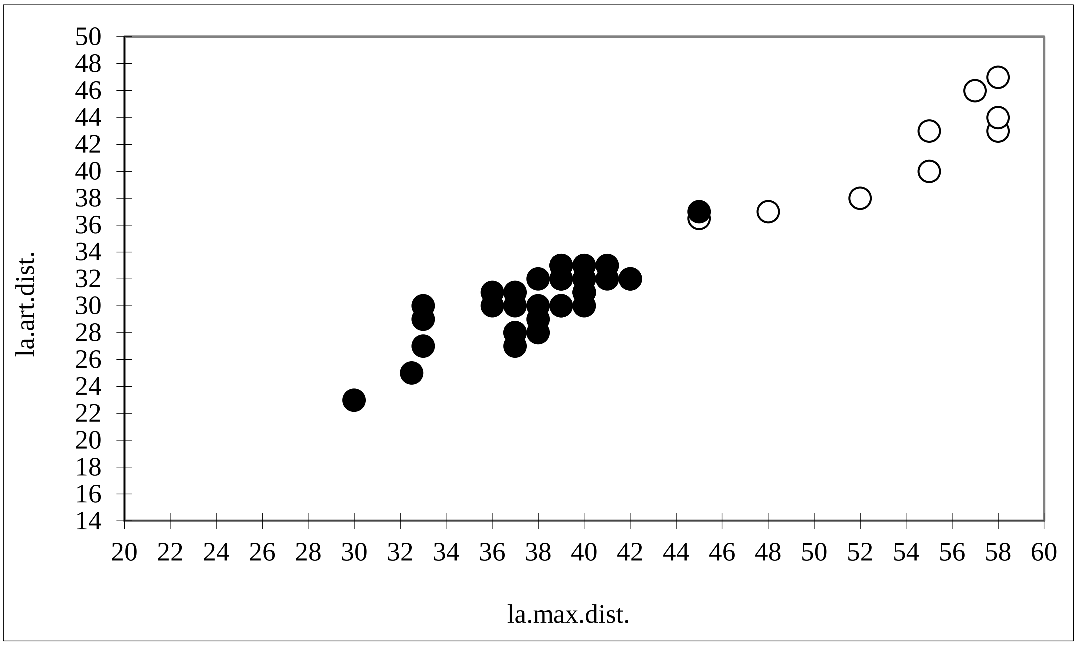


Figure 14. *Sus domesticus* and *Sus scrofa* separation at the level of the distal part of humerus.

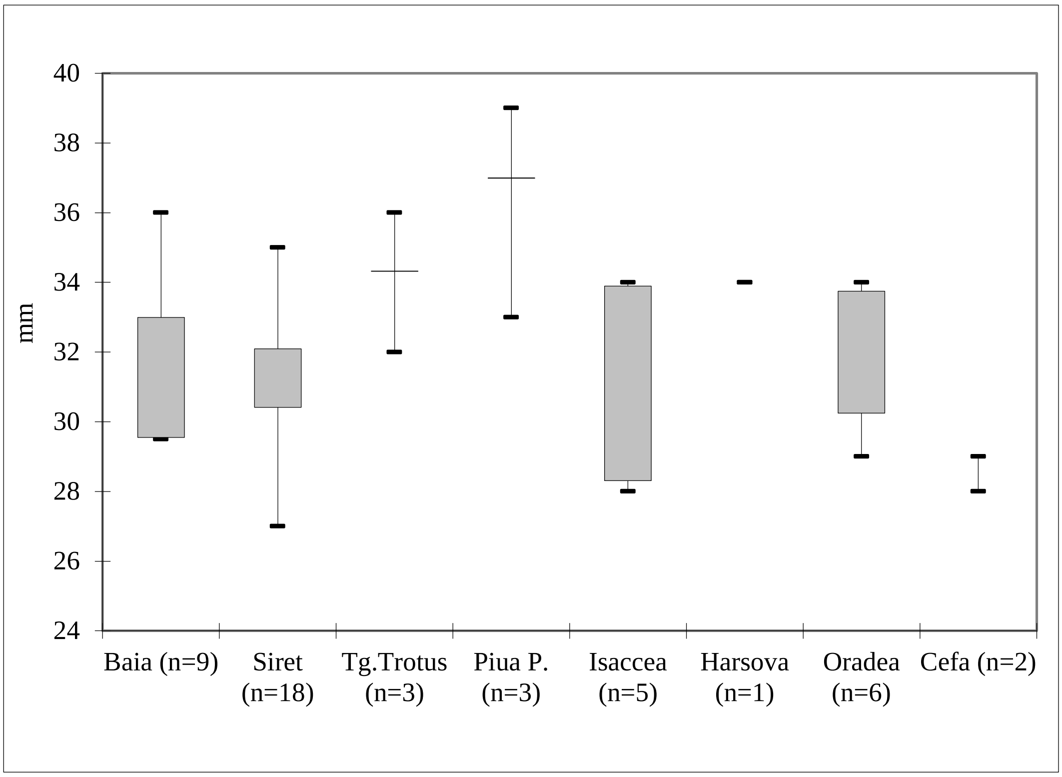


Figure 15. Length variation of the lower third molar (M3) of *Sus domesticus*.

In the case of the calcaneus, the variability limits range between 66.5 mm and 82 mm for pig, and between 97 mm and 119 mm for wild boar. A clear differentiation of the domestic form from the wild one is also encountered at the level of the IV metacarpus, for which the length varies between 67 mm and 74 mm for pig, and, respectively, between 95 mm and 114 mm for wild boar.

The withers height ranges between 63 cm and 88 cm in the case of pig, and between 92 cm and 114 cm for wild boar.

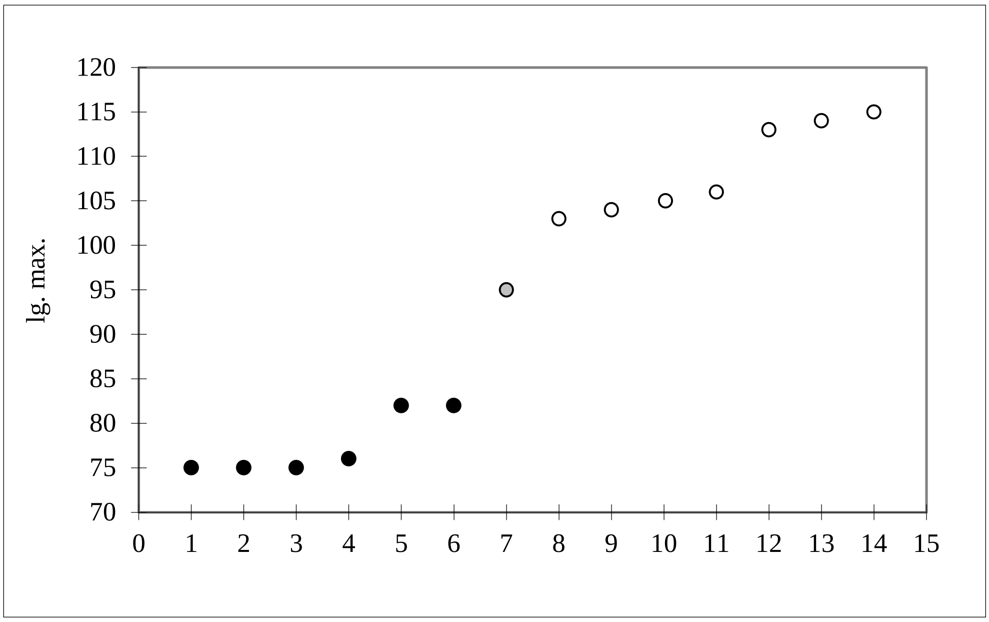


Figure 16. Dimensional separation of calcaneus from pig and wild boar.

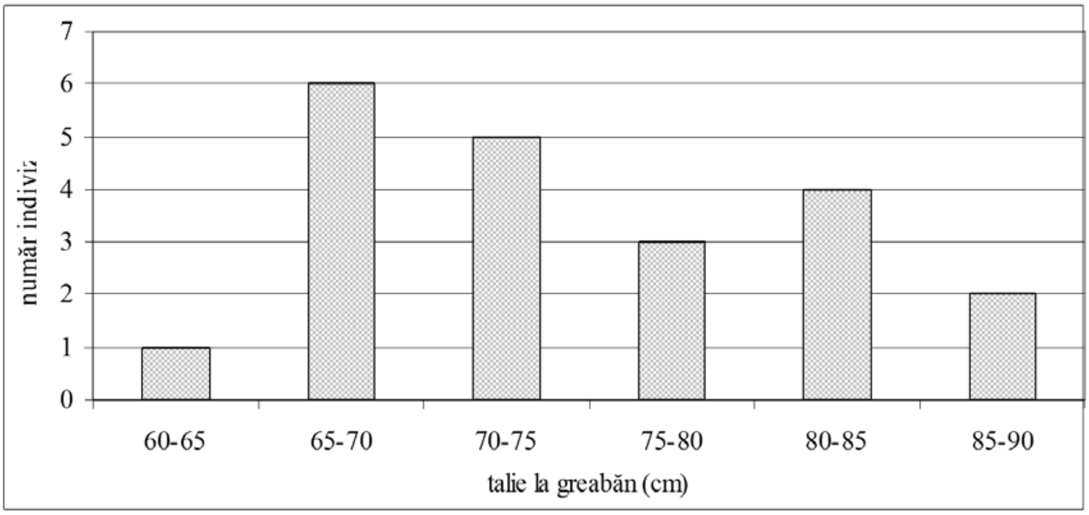


Figure 17. Frequency histogram of the withers height for pig.

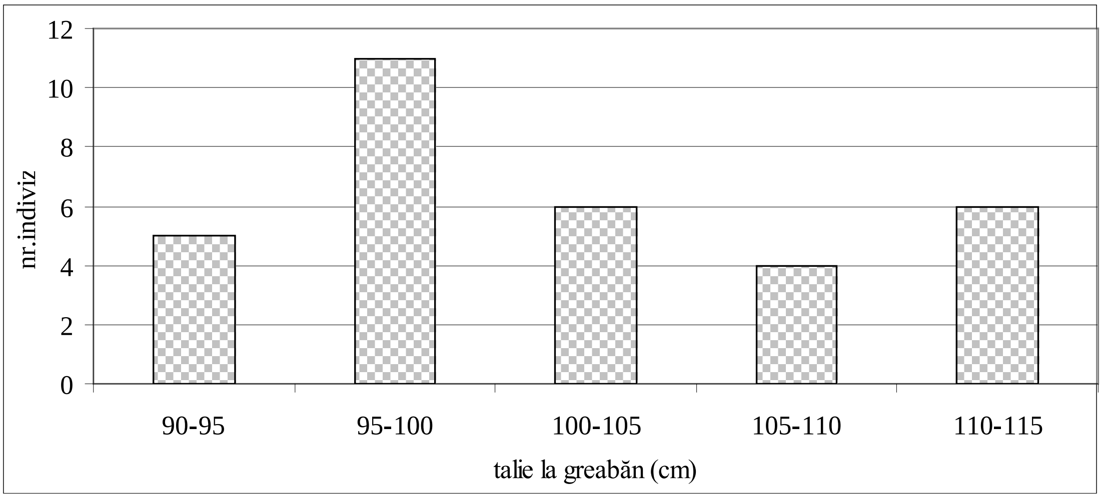


Figure 18. Frequency histogram of the withers height for wild boar.

For some variables there are also values found at the border between domestic and wild pigs, and this fact could suggest a crossbreed between the two forms; in many sites the domestic pigs were raised in semi-foraging conditions around the settlement, which would have favoured mixing between the domestic and wild forms.

Table 11. Metrical data for pig and wild boar.

Anatomical element	**Dimension**	**Sites**	**n**	**Min. (mm)**	**Max. (mm)**	**Mean**
Wild boar						
Astragalus	GL	Piatra Frecăţei	9	50	59	53.4
Astragalus	GL	Slava Rusă	1	54.5	-	-
Calcaneus	GL	Piatra Frecăţei	8	97	119	106
Tibia	Bd	Piatra Frecăţei	14	35	42	38.5

Metacarpus IV	GL	Piatra Frecăţei	5	95	110	99.7
Metatarsus III	GL	Piatra Frecăţei	3	109	120	115.6
Metatarsus IV	GL	Piatra Frecăţei	4	93.5	120	105.1
Molar M3 inf.	GL	Piatra Frecăţei	9	41	51	45.5
Molar M3 inf.	GL	Oltina	1	42	-	-
Pig						
Molar M3 inf.	GL	Baia	9	29.5	36	31.3
Molar M3 inf.	GL	Siret	18	27	35	31.25
Molar M3 inf.	GL	Piua Petrii	2	38	38	-
Molar M3 inf.	GL	Hârşova	2	31	43	-
Molar M3 inf.	GL	Slava Rusă	6	29	32	30.3
Molar M3 inf.	GL	Piatra Frecăţei	4	29	32	30.5
Molar M3 inf.	GL	Oltina	3	31	32.3	31.7
Humerus	Bd	Baia	14	33	45	38.1
Humerus	Bd	Siret	15	33	42	38.6
Humerus	Bd	Piua Petrii	4	37	43	40.2
Humerus	Bd	Hârşova	2	30	37	-
Humerus	Bd	Slava Rusă	2	35	39.5	-
Humerus	Bd	Piatra Frecăţei	7	34.5	40.5	36.5
Humerus	Bd	Oltina	3	34.5	38	36.6
Tibia	Bd	Baia	13	25	32	29.3
Tibia	Bd	Siret	8	28	32	30.3
Tibia	Bd	Piua Petrii	2	30	32	-
Tibia	Bd	Isaccea-med.	2	28	30	-
Tibia	Bd	Slava Rusă	6	24	29.5	27.5
Tibia	Bd	Piatra Frecăţei	1	33	-	-
Tibia	Bd	Oltina	3	26	30	28.3
Astragalus	GL	Baia	3	38	39	38.3
Astragalus	GL	Siret	3	39	44	41
Astragalus	GL	Hârşova	3	35	40	37
Astragalus	GL	Slava Rusă	5	36.8	46	39.8
Astragalus	GL	Piatra Frecăţei	2	47.5	49	-
Astragalus	GL	Oltina	2	40	40.5	-
Astragalus	GL	Adamclisi	1	42.5	-	-
Metacarpus III	GL	Baia	2	75	78	-
Metacarpus III	GL	siret	1	77	-	-
Metacarpus III	GL	Piua Petrii	2	81	83	-
Metacarpus III	GL	Isaccea	1	75.5	-	-
Metacarpus III	GL	Oltina	1	73.4	-	-
Metacarpus III	GL	Adamclisi	1	78.8	-	-
Metatarsus III	GL	Baia	2	81	87	-
Metatarsus III	GL	Piatra Frecăţei	1	72.5	-	-
Metatarsus IV	GL	Baia	2	84	88.5	-
Metatarsus IV	GL	Piatra Frecăţei	2	93.5	94	-
Calcaneus	GL	Siret	4	75	82	77

Calcaneus	GL	Slava Rusă	1	66,5	-	-
Calcaneus	GL	Oltina	1	69	-	-

5. Archaeogenetic analysis

Today, the agriculture, developed during thousands of years, represents a very important field, with a continuous evolution, based on different scientific domains, out of which genetics has a high contribution to the improving and diversifying crops and stocks of domestic animals. If we refer to the animal breeding alone, this was possible only through the domestication process, in which the role of human activity represents a theme still argued by scientists.

For more than one century science tries to answer to different questions like where, how, and when were swine domesticated. The last decades increased the interest for finding out the answers to these questions, as the new genetic techniques facilitated the gathering of more and more data regarding the identification of the wild ancestors and their geographic spread for different domestic animal species, highly important for humans. The transparency of this information depends on the corroboration of different studies, from a wide scope of scientific fields, among which - genetics, archaeology, botanics, zoology, geology. All these fields are necessary for solving an interdisciplinary issue, like animals domestication process.

In order to investigate the emergence of domestic pigs in Europe, hundreds of samples were collected from many archaeological sites on the entire continent, and belonging to different periods of time. By the middle of the XX th century, the archaeological research shed light to the earliest proofs for the existence of the agriculture in the Near East as well as for its subsequent introduction, in the Neolithic period, on the European continent, by the immigrant farmers. The Romanian territory represented an object of interest for these sudies, due to its geographic location, propitious to the spread of domestic animals from Asia and the Near East to Europe, but also due to the cultural context of that specific period, which might have influenced the local domestication process. We are talking about the existence of several Neolithic cultures, like Gumelnita, Cris, Boian-Giulesti, Zau, Precucuteni and Cucuteni, covering a wide period of time, between 6000 BC and 3500 BC.

As an integral part of the animal domestication study, which today represents a world-wide research, the present project aims to investigate the emergence of the first domestic individuals of *Sus scrofa*, on Romanian territory, to explain their spread pattern and the genetic changes appeared in time, as well as to date the process as accurate as possible.

To achieve the established objectives, there were followed three main steps:

1. The identification of the genetic profile for the analysed samples;
2. The corroboration of the morphometric and genetic data;
3. The results analysis and inference according to two main coordinates: space and time.

Material and methods

A first analysis set was carried out for the Neolithic period and comprised 129 samples, consisting in bone remains from different individuals, both of *Sus scrofa* and *Sus domesticus*, from 21 archaeologic sites on Romanian territory (Figure 19).

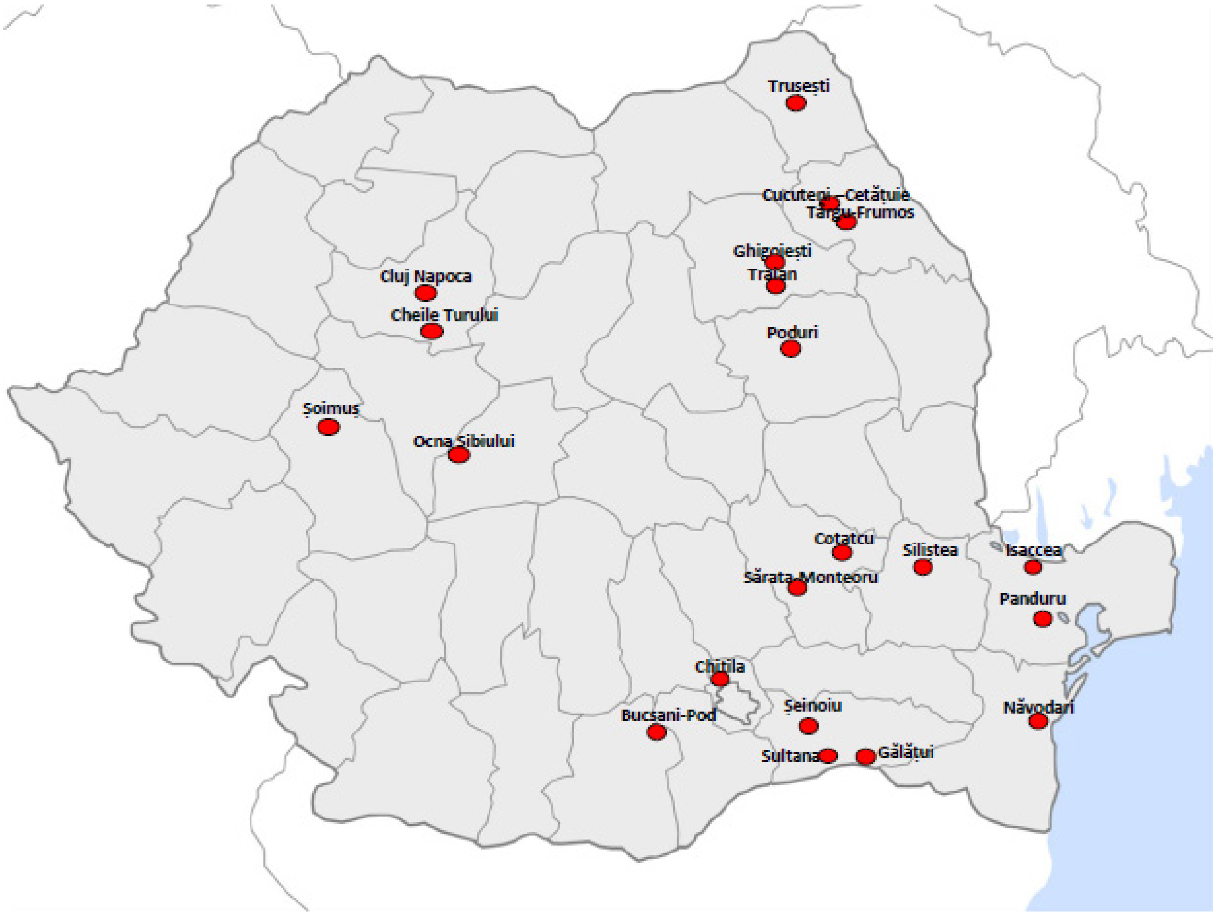


Figure 19. The map for the Neolithic archaeologic sites

To investigate the genetic changes appeared in time, from the Neolithic period until the Middle Ages, a second set, of 79 samples from 23 archaeologic sites on Romanian territory, was also analysed (Figure 20).

The morphometric analysis were based both on size (for the second sample set), and shape, for which were applied the latest techniques of geometric morphometrics (for the samples represented by bone remains with teeth, from the first sample set). All of the morphometric analysis were carried out for the taxonomic determination of *Sus scrofa* individuals included in this study, thus, trying to discriminate as better as possible between the wild and domestic individuals.

As far as genetic analysis are concerned, they comprised more steps, out of which the first ones were carried out in the laboratories dedicated to the ancient DNA analysis.

The first step was the sampling of the bony tissue, for the subsequent DNA extraction. For this, the bony fragments were first grinded in order to eliminate the superficial layer (to decontaminate it), and later transformed into a fine powder. The powder was incubated over night with a lysis buffer, and the next day the extraction protocol continued with the concentration of the extracts by centrifugation with the Amicon Ultra 4 (Millipore). Later, the DNA extracts were purified with the Qiagen kit, which protocol is based on the DNA attachment to the silica membrane.

After the DNA extraction, its final concentration was spectrophotometrically quantified.

Figure 20. The map for the archaeologic sites from the Bronze Age until de Middle Ages

The next step was represented by the DNA amplification. Because of the high damage degree of the ancient DNA, the purpose was to amplify some short fragments. Thus, there were used specific primers, designed to amplify a DNA fragment of 123 bp in length, from the mitochondrial DNA control region (D-Loop). According to the previous studies (Laron et al., 2007), this fragment could discriminate between 7 ancient haplotypes, described for the *Sus scrofa* individuals on the European continent. Likewise, the PCR products quality was improved with certain concentrations of magnesium chloride and bovine serum albumin.

All steps described until now – the grinding of the bone sample and the sampling of the bony tissue for extraction, the extraction protocol, as well as the PCR set-up were carried out in the ancient DNA laboratory.

After the DNA cloning by PCR reaction, the PCR products were visualised through the agarose gel electrophoresis.

The last step in the DNA processing was represented by the DNA sequencing, on both forward and reverse strands, using the Sanger method to identify the nucleotides order in the target DNA. The raw sequences were corrected with the Geneious and Mega5 softwares, in order to obtain the final consensus. The mitochondrial DNA fragments were searched for SNPs (Single Nuclear Polymorphisms), to identify the 7 neolithic haplotypes which existed on the European territory, out of which for three of them was previously assigned a European origin, and or the other four a Near-Eastern origin.

The graphic presentation of the results and the relationships between haplotypes was realised with the help of the Network software. Thus, was built the haplotypes network using the median joining algorithm.

Results and discussion

Previous genetic analysis carried out for the Neolithic domestic pigs from Romanian territory described only the genetic profile originated from the Near East. The wild individuals presented, generally, the European haplotype ANC-Cside, excepting one single *Sus scrofa* individual from the Mesolithic period, for which the ANC-Aside European haplotype was identified.

In the present study, for the Neolithic period, were described four of the seven haplotypes which were previously identified on the European continent: ANC-Y1-6A, ANC-Y2-5A, ANC-Aside and ANC-Cside, and other three new haplotypes.

The results obtained through the present study emphasized a higher number of haplotypes from the Neolithic period on the Romanian territory, compared to the ones identified in the previous studies. Thus, besides the ANC-Y1-6A (originated in the Near East) and the ANC-Cside (European) haplotypes previously identified within the domestic, respectively wild individuals, now can be noticed the emergence of the ANC-Y2-5A (originated in the Near East) and ANC-Aside (European) haplotypes, in the same period of time, both in the domestic and wild individuals, but in different percentages (Figure 21).

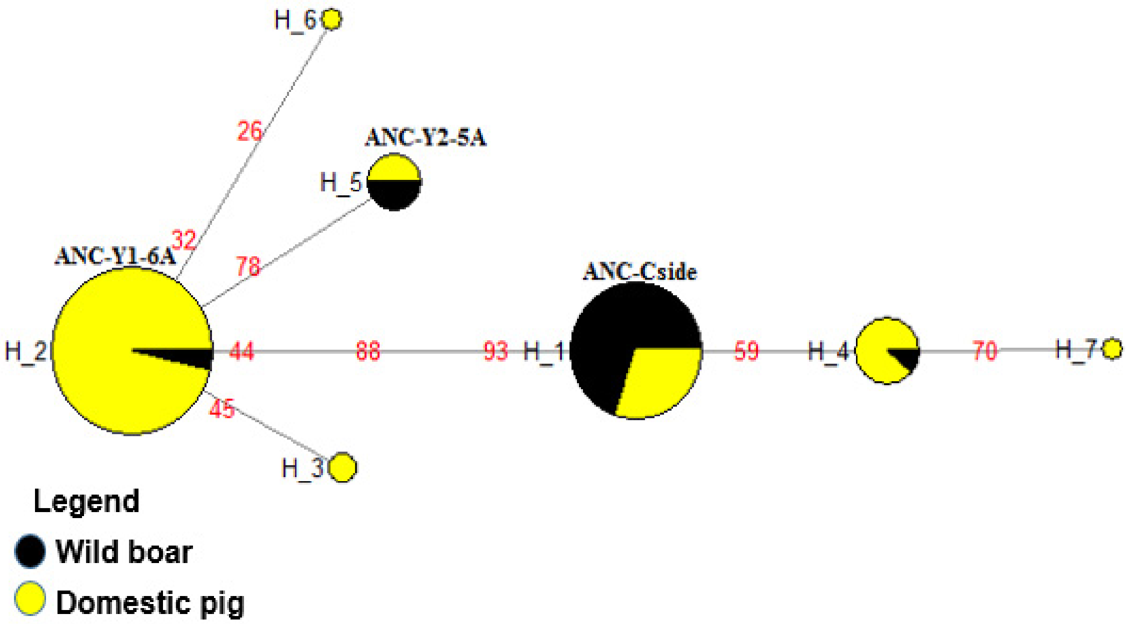


Figure 21. The haplotypes network for the Neolithic samples: the circles size is proportional with the haplotypes frequency and the numbers represent the mutations which separate the haplotypes

Considering the percentage of the wild and domestic individuals with the same haplotype, as well as the prevalence of the haplotype originated in the Near East for the domestic pigs, we can certainly infer the introgression process of the wild pigs from Romanian territory into the stock of domestic pigs which were introduced from the Near East, a process described in the previous studies, as a way of replacing in time the domestic pigs introduced from the Near East with the pigs originated in Europe.

The ANC-Y2-5A haplotype, which origin was previously established also in the Near East, is identified in very few individuals, both domestic and wild. Its presence, alongside the one of the ANC-Aside European haplotype raises new questions about the emergence of these two haplotypes on Romanian territory, in the Neolithic period.

For the second sample set, dating from the Bronze Age until the Middle Ages, there were identified six haplotypes, out of which only three were previously described for the individuals from the European continent: ANC-Aside, ANC-Cside and ANC-Y1-6A (Figure 22).

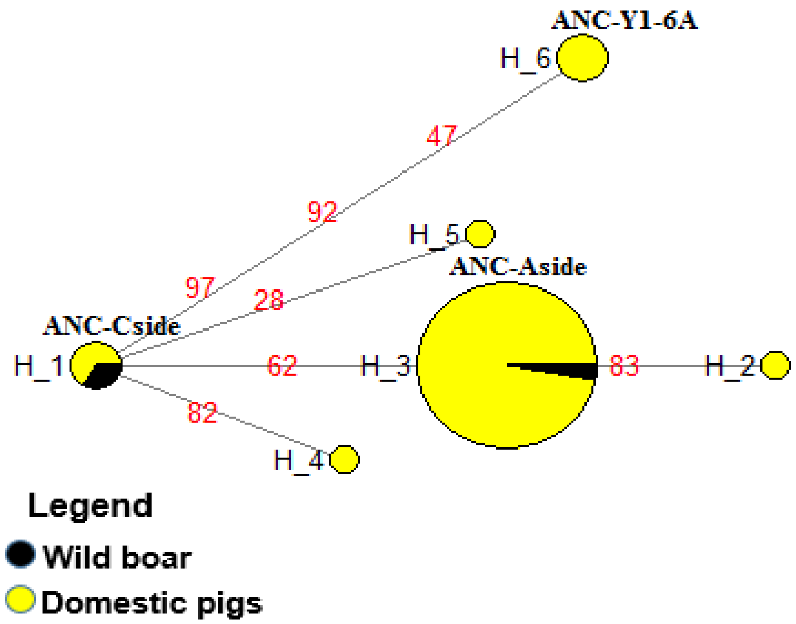


Figure 22. The haplotypes network for the samples dating from the Bronze Age until the Middle Ages; the circles size is proportional to the haplotypes frequency and the numbers on the lines which connect the 6 haplotypes represent the mutations among these.

While during the Neolithic the number of wild *Sus scrofa* individuals was significantly higher, and the majority presented the ANC-Cside European haplotype, starting with the Bronze Age, until the Middle Ages, this haplotype was less identified, and its frequency within domestic individuals also changed.

Major changes also appear in the genetic profile of domestic pigs from the Neolithic, compared to the later periods: the ANC-Y1-6A haplotype, originated in the Near East and prevalent within the domestic individuals is replaced with the European ANC-Aside haplotype.

Conclusion for the archaeogenetic study

The results describe a stage of the European wild boar introgression into the stock of domestic pigs which were introduced from the Near East, during the Neolithic period.

The identification of the ANC-Y2-5A Near Eastern haplotype, during the Neolithic, on Romanian territory, raises new question marks regarding its emergence on the European continent and the dating of this event.

The frequency of the European ANC-Aside haplotype on Romanian territory in Neolithic, contradicts the idea of the wild boar introgression into the stock of domestic pigs, as a main way the domestic pigs with this genetic signature emerged in this specific area and also raises new question marks regarding their origin.

Bibliografie

Davis, S. J.M., 2008. Zooarchaeological evidence for Moslem and Christian improvements of sheep and cattle in Portugal. *Journal of Archaeological Science*, **35**: 991-1010.

Payne, S., Bull, G., 1988. Component of variations in measurements of pig bones and teeth, and the use of measurements to distinguish wild from domestic pigs. Archaeolzoologia 2, 27-66.

Udrescu, M., Bejenaru L., Hrişcu C., 1999. *Introducere în arheozoologie*. Editura Corson, Iaşi.

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