FIRST FIND OF ELEPHANTID REMAINS
FROM THE PLEISTOCENE OF COPĂCENI (ILFOV COUNTY, ROMANIA)

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Abstract. This paper describes the first fossil proboscidean remains found in the Pleistocene deposits of Copăceni (Ilfov County). A large number of both dental and postcranial fossil remains were recently discovered at this locality. On the basis of their morphometrical parameters the discovered molars are assigned to the species *Mammuthus meridionalis*, whereas two tusk fragments show features indicative of *Elephas antiquus*. The postcranial elements (fragmentary vertebrae, girdle and limb bones) present no taxonomically relevant features, but might belong to *M. meridionalis* because of their co-occurrence with the remains of other mammals that lived during the Early Pleistocene. Some specimens also allowed an estimation of the age at death of the individuals.

Keywords: proboscideans, *Mammuthus meridionalis*, *Elephas antiquus*, Pleistocene, Dacian Basin.

Rezumat. Prima descoperire a unor resturi de elephantide din Pleistocenul de la Copăceni (Judeţul Ilfov, România). Această lucrare descrie primele resturi fosile de proboscidieni descoperite în depozitele pleistocene de la Copăceni (judeţul Ilfov). Un mare număr de resturi fosile, atât dentare cât şi postcraniene, au fost descoperite recent în această localitate. Pe baza parametrilor morfodimensionali, molarii descoperiţi sunt atribuiţi speciei *Mammuthus meridionalis*, în timp ce două fragmente de defensă prezintă caracteristici care indică apartenenţa la *Elephas antiquus*. Elementele postcraniene (fragmente de vertebre, centuri şi oase ale membrelor) nu prezintă caracteristici relevante din punct de vedere taxonomic, dar ar putea aparţine speciei *M. meridionalis* pe baza co-ocurenţei cu resturi ale altor mamifere care au trăit în Pleistocenul timpuriu. Unele specimene au permis şi estimarea vârstei la care au murit indivizii cărora le-au aparţinut.

Cuvinte cheie: proboscidieni, *Mammuthus meridionalis*, *Elephas antiquus*, Pleistocen, Bazinul Dacic.

INTRODUCTION

Freshwater detritic sediments which accumulated during the whole Pleistocene are widespread in the southern part of Romania, where the Dacian Basin was an active sedimentation area during this epoch (for a lithostratigraphical review, see ANDREESCU et al., 2013). Although Pleistocene gravels and sands, locally interbedded with marls and clay lenses, were subsequently covered by loess deposits, they crop out along the multitude of rivers and brooks that cross the Romanian Plain. Sand and gravel used locally in construction have for long been extracted from the river banks. This activity, along with natural erosion of the river banks, has yielded numerous large mammal fossil remains, among which the proboscideans are best represented because of the good degree of preservation of their large and resistant bones and teeth. The elephantid *Mammuthus meridionalis* (NESTI 1825) is the most common fossil proboscidean reported from the area located between the Jiu and Ialomiţa rivers (the central part of the Romanian Plain), which overlaps the Central Dacian Basin (e. g. APOSTOL, 1968).

The proboscidean fossil remains described in this paper were found along the left bank of Argeş River, in the area located just east of the Childrens' Park of Copăceni, Ilfov County (about 200 m both upstream and downstream from the point that has the following coordinates: 44°15′13.5″N; 26°05′35.3″E). The geological succession described from this area comprises Pleistocene deposits assigned to the typical informal lithofacial units known from the Pleistocene of the Dacian Basin: "the Frăteşti beds", "the Marly complex", "the Mostiştea sands" and "the Colentina gravels", covered by loess or terrace deposits (MURGEANU et al., 1966). The deposits that crop out along the river are represented by gray-blue siltstones and gray to light brown fine sands comparable to those described for the "Copăceni beds", a unit with uncertain status (i. e. interpretable as either a separate formation or a member of the Coconi Formation) (ANDREESCU et al., 2013). The preliminary data on the fossil assemblage from Copăceni (Co-P) and Adunaţii-Copăceni (Co) restrict the age of the deposits to the middle to upper part of the Lower Pleistocene (around 1.45-1.35 Ma). The fossils were collected from respectively the left and the right bank of the Argeş River, which acts as boundary between the two localities, so they should in fact be considered parts of the same fossil assemblage. The assemblage reported from this section includes large mammals (proboscideans, rhinocerotids, cervids, bovids), micromammals (rodents, insectivores) (ŞTIUCĂ et al., 2012) and bivalves (*Unio apscheronicus* ALI-ZADE 1936; *Bogatschevia sturi* CEPALYGA 1972) (PETRU ENCIU, verbal communication). These data suggest that the "Copăceni beds" are less related to the geologically younger Coconi Formation, and hint at their separation as a distinct formation that belongs to the Argedavian local stage (ANDREESCU et al., 2013). This information is, however, only preliminary, which leaves the matter of the stratigraphical status of the "Copăceni beds" open to debate.

MATERIAL AND METHODS

Most specimens were found scattered along the river bank, either by villagers who later on donated them to the National Museum of Geology (NMG), or during field campaigns carried out by the NMG or the "Emil Racoviţă"

Institute of Speleology (ISER). Specimens discovered so far are housed at the NMG and the ISER and were assigned provisional working numbers. A single large bone fragment (probably part of a tibia) was found *in situ* by the authors, in a fossiliferous pocket that also contained partially articulated bovid remains (cf. *Leptobos* RÜTIMEYER 1877 - skull fragment, metapodia) and a rhinocerotid maxilla fragment that preserved the anterior most premolars (cf. *Stephanorhinus* KRETZOI 1942). The pocket was overlain by a continuous bivalve layer rich in *Bogatschevia sturi*. The presence of articulated remains that show the same type of preservation suggests the proboscidean bones were part of the same megafaunal assemblage with the rhino and the bovid, with a lesser probability of having been reworked from older deposits, such as the sands of the Frăteşti Formation.

The systematics and taxonomical nomenclature of mammoths follow LISTER (1996), emended by LISTER & VAN ESSEN (2003) and LISTER et al. (2005), who consider a single monophyletic lineage comprising four species assigned to the genus *Mammuthus* BROOKES 1828: *M. rumanus* (ŞTEFĂNESCU 1924), *M. meridionalis*, *M. trogontherii* (POHLIG 1888), and *M. primigenius* (BLUMENBACH 1799). For an alternative opinion, which envisages a separate genus *Archidiskodon* (POHLIG 1888) that includes the species *A. meridionalis*, see, for example, BAYGUSHEVA & TITOV (2012). MAGLIO (1973) considered *Elephas antiquus* FALCONER & CAUTLEY 1847 to be a junior synonym of *E. namadicus* FALCONER & CAUTLEY 1845. However, some authors consider there are sufficient differences between the European and Asian species, so the former name was generally used to refer to the European species (e. g. MOL et al., 2007). In this paper, the European straight-tusked elephant is referred to as *E. antiquus*.

Molar parameters were measured according to MAGLIO (1973), whereas incisor and postcranial parameters follow ROS MONTOYA (2010); additional measurements, not mentioned by these two authors, are explained in detail in the text. A digital caliper was used for measurements under 15 cm, and a measuring tape for those that surpass this value. All values are given in millimeters.

Molar parameter abbreviations: L = maximum length; H = maximum height; W = maximum width including cover cement. Values in Table 1 are followed, in brackets, by the greatest width excluding the cover cement, and by the number of the plate where the value was measured. Roman numerals indicate that the plate count was made postero-anteriorly, whereas Arabic numbers indicate the count was made antero-posteriorly. Platelets and talonids are not counted as true plates; HI = hypsodonty index; P = total number of plates exclusive of talons (where present, talons are noted as t and platelets as p); F = lamellar frequency; ET = enamel thickness (average calculated for the anterior and posterior enamel crests of all available plates).

Tusk measurements: L = distance from the base to the tip of the fragment, measured along a straight line. Since both specimens are fragmentary, + is always added to account for the missing parts. MLDb = medio-lateral diameter at the base of the fragment; MLDm = medio-lateral diameter at the middle of the fragment; MLDt = medio-lateral diameter at the tip of the fragment; DVDb = dorso-ventral diameter at the base of the fragment; DVDm = dorso-ventral diameter at the middle of the fragment; DVDt = dorso-ventral diameter at the tip of the fragment.

Vertebral parameter abbreviations: Tc = maximum thickness of centrum (measured antero-posteriorly); TDc = transversal diameter of centrum; DVDc = dorso-ventral diameter of centrum.

Long bone parameter abbreviations: L = maximum length; APDp = antero-posterior diameter of proximal epiphysis; APDd = antero-posterior diameter of distal epiphysis; APDm = minimum antero-posterior diameter of diaphysis; MLDp = medio-lateral diameter of proximal epiphysis; MLDd = medio-lateral diameter of distal epiphysis; MLDm = minimum medio-lateral diameter of diaphysis; D = diaphysis lowest medio-lateral diameter.

The elephantid grinding teeth are named according to MAGLIO (1973), who separates three premolars and three molars, contra, for example, LAWS (1966), who names six consecutive molars. Incisors (defenses, tusks) are noted with I, and molars with M. The positions of upper teeth are indicated in superscript (e. g. I^1), whereas the positions of lower teeth are indicated in subscript (e. g. M_3).

RESULTS

Dentognathic remains. Although less abundant in the material discovered so far from Copăceni, dental and jaw remains are the most useful for taxonomical assessment. Parameters measured in molars, compared to previously published data (mainly to MAGLIO, 1973) are the primary criterion of taxonomical determination. Molar and tusk measurements are given in Table 1.

The most complete dentognathic specimen, NMG1, consists in a fragmentary mandible with parts of two molars on each side. The mandible was found *in situ* by Dan Petre Antonescu from Vidra (Ilfov County). Between the time of the discovery and the time its finder donated it to the NMG, the mandible had crumbled into more fragments because of the lack of preparation. On the basis of the existing fragments only the horizontal rami could be restored. The right ramus is the better preserved one. It allows the observation of its gently curving dorsal and ventral outlines (Fig. 1a). Its height, measured on the buccal side, below the middle of the functional tooth (in this case the M_3), reaches 163 mm. The M_2 and M_3 are present, still implanted in the alveoli.

In occlusal view, the M_2s have an oval outline. They preserve four worn plates plus half of the posteriormost plate (Fig. 1b); the other half and the posterior talonid were resorbed, as a result of the pressure exerted by the replacing M_3. The plates are worn laterally, and there are no enamel figures left at the occlusal surface, a condition normal in well-worn mammoth molars. In most plates the enamel crests are parallel to each other and only slightly folded. The

enamel becomes moderately wrinkled in the median part of the posterior most two preserved plates, where it also forms a median loop.

The M_3s are not fully developed and with only seven plates in wear (Fig. 1b) the erupted parts are not extensively worn. None of the worn plates have the enamel crests continuous across the entire width of the molar. The wear figures range from subcircular islets (in the posterior plates) to larger more complicated closed loops, in which the enamel is moderately folded (in the anterior plates). The broken posterior part of the left horizontal branch allows the observation of the plates that had not erupted yet, which raises the total number of observable plates of the molar to 11. The parameters measured for the molars described above are consistent to those mentioned for *M. meridionalis* by MAGLIO (1973). They are wider and lower than the molars of *E. antiquus* and do not show the "dot-dash-dot" antiquoid wear figure.

Figure 1. Proboscidean dentognathic remains from Copăceni. a - b. NMG1, right hemi-mandible bearing the M_2 and M_3, in buccal and occlusal views; c. ISER Co-P01, left M^3, in occlusal view; d - e. NMG2, left I^1, in lateral and dorsal views; f. cross section of NMG2, showing selected measurements of outer Schreger angles; g - h. NMG19, juvenile I^1, in side and dorsal views; i. ventral view of NMG19, showing the fluted outer surface of the dentine layer. Anterior is to the right for a-c and to the left for d-e and g-i. Scale bars: 10 cm.

Table 1. Dimensions of proboscidian teeth from Copăceni.

				Molars				
Tooth type	Inventory number	L (mm)	H (mm)	W (mm)	HI (H/W)	P	LF (100P/L)	ET (mm)
M_2 sin	NMG1	+109.5	+30	- (70.22) (PIII)	-	+5.5	5	3.1
M_2dex		+104	+34.8	- (71.8)(PII)	-	+5.5	5.3	3.6
M_3 sin		190+	~127	86.5 (74)(P2)	1.5 (1.7)	11+	5.8	2.8
M_3dex		192.5	+51.4	86.53 (73.95)(P2)	-	11+	5.8	2.6
M^3sin	ISER Co-P01	340	+116.7 (P 2)	- (120.3) (P VI)	-	14, p	4.1	3.44
				Tusks				
Tooth type	Inventory number	L (mm)	MLDb (mm)	MLDm (mm)	MLDt (mm)	DVDb (mm)	DVDm (mm)	DVDt (mm)
I^1 sin	NMG2	+630	135	122.5	106.6	120	105.8	90
I^1	NMG19	+510	75	57.1	45	45	47.2	35

Another jaw fragment, NMG3, is represented by the buccal side of the left horizontal ramus. The inner side of the bone preserves a series of parallel vertical grooves separated by low ridges – imprints left by the molar plates. The imprints of six thick plates can be counted, and allow to estimate the lamellar frequency at 4.5, in most cases a value indicative of a *M. meridionalis* M_3. The height of this preserved horizontal ramus is 119 mm, too low to accommodate the high M_3s of *E. antiquus*.

An almost complete isolated molar, ISER Co-P01 (Fig. 1c), also provides useful information regarding the taxonomical affinities of its former bearer. The molar, reconstructed from several fragments, resembles a rounded rectangle in occlusal view. It has the anteriormost plate extremely worn and partly broken, and is only slightly tapering posteriorly. Only the posteriormost two plates are not in wear. The enamel loop is continuous along the entire width in the nine anterior plates, but is separated in islets in the posterior ones, where only the apical buds are in wear. The enamel crests are subparallel to each other, slightly folded laterally and moderately folded in the median region of the

plates. In lateral view, the occlusal surface is antero-posteriorly convex, and hence indicative of an upper molar. The slight curvature seen in occlusal view shows the molar is a left one. The low plate number, low lamellar frequency, and low hypsodonty index (Table 1) clearly show the specimen belonged to an individual of *M. meridionalis*.

A 630 mm long tusk fragment, NMG2 (Figs. 1d - 1e), shows only a moderate antero-posterior curvature in lateral view. The moderate curvature makes it difficult to assign the fragment to one of the *Mammuthus* species on one hand, and to *Elephas antiquus* on the other. The base of the recovered I^1 is slightly flattened dorso-ventrally, but the cross-section gradually turns to circular. The anteriormost preserved part also exhibits the latero-medial curvature and the twist around the long axis noticeable in elephants, which shows that the fragment comes from the middle to apical part of a left I^1. The specimen broke in two fragments during handling, which offered the opportunity to study the Schreger pattern (e. g. TRAPANI & FISHER, 2003) visible in the freshly broken cross section (Fig. 1f). The angles measured at the level of the outer layers of dentine ranged from 93° to 113°, values that fall outside the range mentioned by PALOMBO & VILLA (2001) for the different species of *Mammuthus*, but are close to the average calculated by the same authors for *E. antiquus*. Although the Schreger outer angles indicate there is a high probability that NMG2 belonged to an *E. antiquus*, this information should be regarded with caution. The values of the Schreger angles show a high variability from the axial to the cortical area, but also from the basal to the apical region of the same tusk. For example, values as high as 125° were reported in tusks of *M. primigenius* (ÁBELOVÁ, 2008).

Another tusk fragment, NMG19 (Figs. 1g - 1h), is only 510 mm long, and has an elliptical cross section, with the medio-lateral diameter greater than the ventro-dorsal one. The tusk is slightly curved ventro-dorsally. The basal part of the fragment, 123 mm long, is narrower, lacks cement and has a cavernous aspect. It probably represents the part that used to be situated within the alveolus. The small diameter of the tusk shows it belonged to a juvenile individual, which also explains the weak curvature. The cement layer is no longer present on large areas of the tusk, which exposes the outer dentine layer. The outermost dentine layer bears a series of narrow longitudinal ridges, separated by wider shallow fossae (Fig. 1i). These flutes give the dentine/cement junction the crenellated aspect considered typical for tusks of *E. antiquus* individuals (POHLIG, 1888).

The postcranial remains are numerous, yet offer no useful taxonomical information. Since most were found isolated along the river bank, no clear association can be made between them and the dental remains of any of the two species mentioned above. Although the occurrence alongside fossil remains of other vertebrates suggests the postcranial remains probably belong to *M. meridionalis* (see the Discussion section), more data are needed in order to confirm this opinion. Until such data are added, the postcranial proboscidean remains described below are assigned to an indeterminate elephantid.

Axial skeleton. The vertebrae are among the most abundant specimens recovered from Copăceni. In all but one vertebra, only the centrum is preserved. The apophyses and neural arches are completely broken off, which makes it difficult to assign the vertebrae to a precise region of the vertebral column. Vertebra measurements are given in Table 2.

A single detached neural arch, which includes the neural spine, has been discovered so far (NMG13). The anterior edge of the neural spine bears an acute ridge. The right branch of the arch preserves its base, including a small part of the centrum. The same right branch bears the posterior articular facet, but this structure is covered by a hardened sediment crust. The outline of the neural arch resembles that of an equilateral triangle. The neural spine is relatively short and the neural canal relatively wide. The size and shape of the neural spine and neural canal, similar to those seen in the 7th cervical described by MASCHENKO et al. (2011) or ATHANASSIOU (2012), hint towards a posterior position within the cervical region (5th-7th vertebra).

Figure 2. Proboscidean vertebra and scapula fragments from Copăceni. a - c. NMG16, cervical vertebra, in anterior, dorsal, and posterior views; d - f. NMG15, cervical vertebra, in anterior, dorso-lateral, and posterior views; g - h. NMG4, right scapula, medial and distal views; i - j. NMG11, scapula fragment, in medial and lateral views. Scale bars: 10 cm.

Two vertebrae (NMG15 and NMG16) are assigned to the cervical region, largely on the basis of the small antero-posterior length of their centrum. In anterior view, the articulation facet is wide and low, with a convex dorsal edge and a horizontal ventral margin (Figs. 2a - 2f). In posterior view, the centrum is more rounded, even if still dorso-ventrally flattened. Only NMG15 preserves the left base of the neural arch.

A rather poorly preserved centrum, NMG14, is antero-posteriorly longer and has a flat ventral side. A difference in size between the larger anterior articulation facet and the smaller posterior one is also visible. On the basis of the above features, this centrum is assigned to the sacral region of the vertebral column.

Another specimen, NMG17, including two fused fragments, shows no relevant features that could help assess its position along the vertebral column.

Table 2. Dimensions of vertebrae from Copăceni.

Assumed vertebral region	Inventory number	TDc (mm)	DVDc (mm)	Tc (mm)
Cervical	NMG15	+127	91.2	81.6
Cervical	NMG16	155	145	61.7
Sacral	NMG14	153	95.1	99.2

Scapular girdle and front limb. Various scapular fragments and front limb partial long bones are the most abundant proboscidean remains found at Copăceni. Among these are the larger parts of a left radius and ulna. A near-complete left pyramidal is the least damaged bone so far discovered at this site. Measurements of the ulna and radius are given in Table 3, whereas those of the pyramidal are given in Table 4.

The largest scapula fragment, NMG11, is 740 mm long and represents the anterior part of the bone (Figs. 2i - 2j). In lateral view, the base of the spine can be seen along the entire length of the fragment. Of the articulation facets or the postero-dorsal shoulder blade nothing is preserved.

The distal part of a right scapula, NMG4, preserves the glenoid cavity almost entirely; only a small part of its anterior tip is broken off (Figs. 2g - 2h). Dorsally, only a small part of the bone is preserved. It includes the distal most part of the spine. The glenoid cavity is 310 mm long and 150 mm wide.

Two other scapula fragments, NMG5 and NMG10, are poorly preserved. They include smaller parts of the distal end, among which parts of the glenoid cavity.

Table 3. Dimensions of long bones from Copăceni.

Type of bone	Inventory number	L (mm)	APDp (mm)	APDd (mm)	APDm (mm)	MLDp (mm)	MLDd (mm)	MLDm (mm)
Ulna	NMG20	850+	300+	-	150	283	-	130
Radius	NMG9	740	109	-	-	122.4	-	-
Tibia	NMG6	850	200	150	119.8	290	205	130.8

One left ulna, NMG20, is almost complete and only misses the olecranon, which was broken off recently. Signs of erosion are visible around the distal epiphysis (Fig. 3e). The bone is robust, and appears antero-posteriorly widened because of the crests that run down from the olecranon (posteriorly) and from the medial and lateral coronoid processes (antero-medially and antero-laterally). The presence of these three crests effectuates the triangular cross section of the proximal part of the ulnar shaft. The distal epiphysis is completely fused to the diaphysis. In proximal view (Fig. 3f), the medial coronoid process is larger than the lateral one, but the difference in size is not as significant as in some specimens of *M. trogontherii* (e. g. TONG, 2012). The two coronoid processes are separated anteriorly by a U-shaped notch, which accommodated the proximal head of the radius. This notch is shallower and more rounded than the one seen in the *M. trogontherii* ulna described by TONG (2012).

Table 4. Dimensions of the pyramidal and distal femur from Copăceni.

Distal femur, NMG7	Pyramidal, NMG12
Maximum antero-posterior diameter of the distal epiphysis: 270 mm	Maximum medio-lateral diameter: 149.4 mm
Medio-lateral diameter of the lateral condyle: 113.4 mm	Maximum antero-posterior diameter: 149.8 mm
Antero-posterior diameter of the lateral condyle: 116.1 mm	Greatest height: 68.6 mm
Medio-lateral diameter of the medial condyle: 103.5 mm	Medio-lateral diameter of the ulnar articulation facet: 146.7 mm
Antero-posterior diameter of the medial condyle: 94 mm	Antero-posterior diameter of the ulnar articulation facet: 112.2 mm
Distance between the trochlear sulcus and the intercondylar fossa: 145.5 mm	Medio-lateral diameter of the unciform articulation facet: 120.2 mm
Maximum medio-lateral diameter of the distal epiphysis: 240 mm	Antero-posterior diameter of the unciform articulation facet: 135.9 mm
	Medio-lateral diameter of the lunar articulation facet: 82.3 mm
	Antero-posterior diameter of the lunar articulation facet: 28.3 mm
	Medio-lateral diameter of the pisiform articulation facet: 81.8 mm
	Antero-posterior diameter of the pisiform articulation facet: 47.3 mm

Much of a left radius, NMG9, including the proximal epiphysis and more than half of the diaphysis (Fig. 3b), was glued together from recently broken fragments. The proximal head has a triangular articulation facet (Fig. 3c), and is continued distally by a thinner diaphysis, which is curved and twists before expanding more distally. The curvature of the shaft runs from the front of the proximal end to the medial side of the distal shaft and end. The proximal epiphysis is completely fused to the diaphysis. More than that, the posterior side of the shaft, just below the proximal end, shows the

area where the radius and ulna were becoming fused to one another (Fig. 3d). The two bones show the same type of fossilization (i. e. in colour and bone texture), are comparable in size, and are partially covered by the same type of crust. These features might suggest that they belonged to the same individual, but there is no direct evidence to support this. If the two bones did indeed belong to the same animal, they were separated prior to burial, since the medial side of the ulna was encrusted, which masks the presumed fusion area.

A left pyramidal, NMG12 (Figs. 3i - 3k), is the least damaged and best preserved of all postcranial elements discovered so far. All articulation facets are fused to the bone, evidence it belonged to an adult. In proximal view, the bone has a triangular outline, which includes the concave and flat ulnar articulation facet and the characteristic medio-proximal beak-like process. The distal facet resembles a rounded triangle, and serves for the articulation with the unciform and the 5th metacarpal. The lateral side is subrectangular, with an antero-posterior groove, below which lies the elongated and narrow articulation facet for the magnum. The pisiform articulation facet is placed on the distal part of the lateral side, where it appears as a triangular depression.

Figure 3. Proboscidean limb bones from Copăceni. a. NMG7, right femur, in distal view. b - d. NMG9, left radius, in anterior, proximal, and posterior views. The bulge on the posterior side near the proximal end detailed in d represents the fusion area between the radius and ulna. e - f. NMG20, left ulna, in medial and proximal views; g - h. NMG6, left tibia, in anterior and proximal views; i - k. NMG12, left pyramidal, in proximal, distal, and anterior views. Scale bars: 10 cm.

Hind limb. Only two bones of the posterior member have so far been discovered at Copăceni: a left tibia, almost complete, and a distal right femur, not that well preserved. Measurements of the two specimens are given in Tables 3 and 4 respectively.

Only a distal end of a femur was found: NMG7 (Fig. 3a). The lateral and the medial condyle are both in a decent state of preservation, which allows the measurement of the distal articulation facet parameters (Table 4). The fragment suffered from the transport that occurred after it was unearthed by erosion. The shaft of the femur is broken just above the condyles, with no clues left regarding the degree of fusion between the distal epiphysis and the shaft.

The tibia, NMG6 (Fig. 3g), although found broken in two fragments and showing signs of weathering and transport, is fairly complete. Only a fragment from the proximal part of the anterior side is broken, whereas the distal end is eroded around the edges of the articulation facet. Both epiphyses are completely fused to the shaft, to such a degree that the suture lines cannot be recognized anymore. In proximal view, the medial articulation facet is larger than the lateral one, and is placed at a slightly higher level. The lateral facet is subcircular, whereas the medial one is oval, more developed in antero-posterior direction. The two slightly concave facets are separated by a distinct antero-posterior crest, blunted by recent transport and weathering of the bone.

DISCUSSIONS

So far, only vertebrates that co-existed during the Early Pleistocene have been reported from Copăceni and Adunaţii-Copăceni (ŞTIUCĂ et al., 2012). Their fossil remains were found both *in situ* (especially the microvertebrates, but also several bovid, elephantid, and rhinocerotid bones) and *ex situ* (recently unearthed and transported by the Argeş). The age of the deposits containing the fossil assemblage mentioned by ŞTIUCĂ et al. (2012) is restricted by the biostratigraphical range of the identified taxa to the Lower Pleistocene (1.45-1.35 Ma). The oldest European occurrence of *E. antiquus* is reported from Spain, from around the Early/Middle Pleistocene boundary (0.8 Ma) (MAZO, 1989). This makes it extremely unlikely for the *E. antiquus* remains to come from the same beds as the rest of the Early Pleistocene taxa, and more plausible for the postcranial remains to belong to individuals of *M. meridionalis*, the other elephantid known from Copăceni. Since only the two tusk fragments assigned to *E. antiquus* fall outside the time range indicated by all the other taxa, it seems more probable that they were recently reworked from geologically younger strata located upstream from the site, and transported by the Argeş.

If the postcranial remains found at Copăceni belong to *M. meridionalis*, this will place this collection among the richest of such type described so far from Romania. Only two other sites yielded comparable samples: Dealul Viilor (Oradea, Bihor County) and Leu (Dolj County). Even if the sample from Dealul Viilor is very rich and contains elements that belong to the same individual (JURCSÁK, 1983), the taxonomical assignment to *M. meridionalis* is not supported by any kind of argument. On the other hand, even if the postcranial remains described from Leu only include carpal and tarsal bones (POPESCU, 2008, 2011), the taxonomical assignment is well supported, since these were collected from the same layer that yielded molars positively assigned to *M. meridionalis* (POPESCU, 2004).

Estimates of the ontogenetic development stage of the individuals at the time of death can be based on the wear and replacement stages of the grinding teeth, as well as on the degree of synostosis in long bones.

The wear stage of grinding teeth and their consecutive replacement during the life span of elephantids are useful in estimating the age at death of mammoths, by comparison to the stages seen in extant elephants. LAWS (1966) separated 30 age groups for the African elephant. Given that *Loxodonta africana* (BLUMENBACH 1797) and *M. meridionalis* have similar plate numbers, the use of the age identification system proposed by LAWS (1966) serves as a fairly good approximation for the individual age of mammoths. Differences obviously exist, induced by the different feeding habits of the two species, as well as by the particular development of each individual. The situation seen in the mandible NMG1, where the last plates of M_2 are present, and the M_3 is not completely erupted, is similar to age group XXII described by LAWS (1966). This leads to the estimation of 39±2 African Equivalent Years (AEY) for the mandibular *M. meridionalis* molars from Copăceni. A similar system was developed by ROTH & SHOSHANI (1988), based on data collected from *Elephas maximus* LINNAEUS, 1758. They mentioned a couple of individuals which still had some plates of the M_2 in wear along with plates of the erupting M_3, at the ages of 35-37 years. ATHANASSIOU (2012) argues that using African or Indian elephant equivalent years underestimates the age of the male *M. trogontherii* from Loussiká, since the latter species was larger than extant elephants, and must have had a greater lifespan. Since *M. meridionalis* was similar in size to *M. trogontherii*, the same line of reasoning should also apply to the former. Comparable to the Loussiká mammoth in dental eruption and wear stage, the NMG1 mandible from Copăceni probably belonged to an individual older than 45. The ISER Co-P01 M^3 is completely erupted and almost all plates are in wear, with the anterior most ones almost lost. This wear stage is similar to age group XXV as described by LAWS (1966), and corresponds to 47±2 AEY. Given the large size of the molar, and if one takes into account the issue of the larger size and lifespan of *M. meridionalis*, it is possible that the M^3 belonged to an individual older than 50.

An estimate of the age at death based on the degree of synostosis in limb bones can be made after the relevant information regarding the African elephant as gathered by HAYNES (1993). The larger fragments of long bones (ulna, radius, tibia) all have their epiphyses completely fused to the shaft, showing they all come from adult individuals. The estimates are less precise than the dental development stages, since there are greater differences in body development between males and females of the same age. Males are known to keep on growing until late in life, so their bones fuse at

older ages than in females. The tibia is less useful for age estimates, since both ends fuse to the diaphysis earlier in life than the epiphyses in most of the other limb bones do. In extant African elephants, both epiphyses of the tibia become completely fused with the shaft around the age of 20-24 AEY in females, and around 32 AEY in males. The proximal epiphyses of the radius and ulna fuse to the shaft around 19 AEY in females and earlier than 32 AEY in males. The distal epiphysis of the ulna, however, fuses later than 24 AEY in females and during the late 40s in males. If the radius and ulna from Copăceni belonged to the same individual (as the similar state of preservation suggests), the age of the individual might be even older than the age the distal epiphysis of the ulna becomes fused at. An older age is suggested by the presence on the posterior side of the radius of the area where the fusion with the ulna takes place, which occurs later in life than epiphyseal fusion. The considerable size of the left pyramidal likewise suggests that this bone belonged to an old individual. The specimen is larger than similar bones reported from other sites (POPESCU, 2008; ROS MONTOYA, 2010).

It is a difficult task to taxonomically assess postcranial remains of elephantids because morphology and proportions of these bones are similar in different species. The size ratios drawn from the length of limb bones of partial adult mammoth skeletons proved successful only in separating *M. primigenius* from the larger *M. trogontherii* and *M. meridionalis* (LISTER & STUART, 2010; LISTER et al., 2012). A distinction between the latter two species could not be made, because of their similar size.

An attempt to find some metrical data useful for separating mammoth long bones was made by plotting the measurements taken from the specimens from Copăceni alongside information collected from the literature. The data used in this attempt only include measurements taken from specimens that belong to adult individuals and were compiled from: FELIX (1912); VÖRÖS (1975); AZZAROLI (1977); BAYGUSHEVA & GARUTT (1987); AOUADI (2001); ZIEGLER (2001); MASCHENKO (2002); VASILIEV (2007); LISTER (2009); MASCHENKO et al.(2011); ATHANASSIOU (2012); BAYGUSHEVA et al. (2012); KIRILLOVA et al. (2012); HARINGTON et al. (2012); TONG (2012).

Plotting the transverse diameter against the length of the ulna proved irrelevant because of the superposition of *M. trogontherii* and *M. meridionalis* measurements. The same result was obtained when the length of the glenoid was plotted against its width. A better result was obtained when the length of the tibia was plotted against the medio-lateral diameter of its proximal end (Fig. 4). In the latter case, the values plotted for *M. meridionalis* have the tendency to group towards the right side of the graph, which reflects a wider proximal head of the tibia, whereas the tibia length is similar in *M. meridionalis* and *M. trogontherii*. This result is, however, only preliminary, since it only includes data from a small number of *M. meridionalis* specimens.
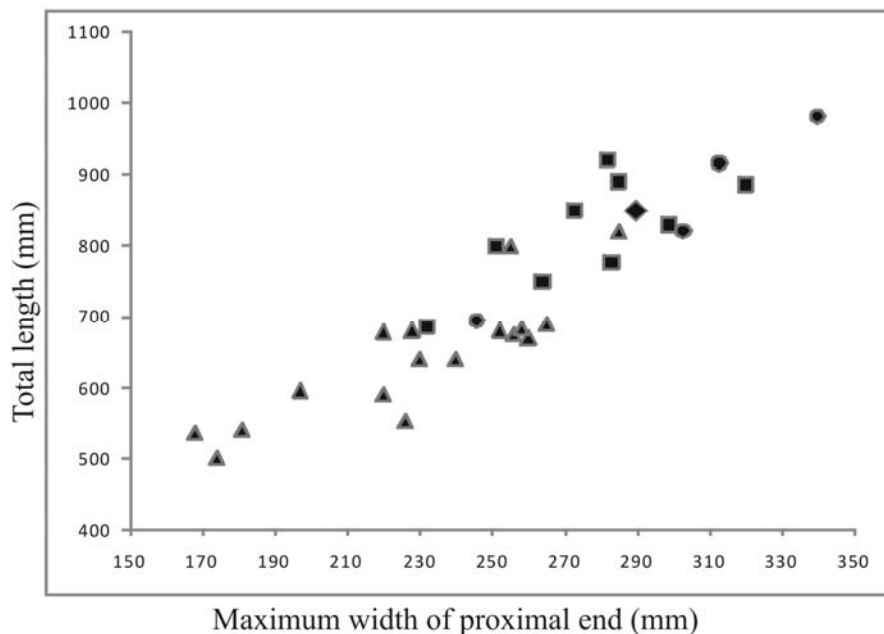

Figure 4. Relationship between the maximum length and the maximum proximal medio-lateral diameter (width) of mammoth tibia. Data for *M. primigenius* are represented by triangles, for *M. trogontherii* by squares, and for *M. meridionalis* by circles. Measurements of the tibia from Copăceni are represented by a rhombus.

CONCLUSIONS

The proboscidean remains from Copăceni include molar and tusk fragments assigned to *M. meridionalis* and *E. antiquus*. A large collection of postcranial remains cannot be clearly assigned to one of the two species, but the other vertebrate taxa mentioned from the same site by ŞTIUCĂ et al. (2012) suggest there is a higher possibility these remains belong to *M. meridionalis*. If this interpretation is correct, the collection of *M. meridionalis* postcranial remains from Copăceni is one of the most abundant samples found in Romania assigned to this species.

With the exception of a single tusk fragment the small diameter of which shows it stems from a juvenile, all the other remains from Copăceni belong to individuals that died during adulthood. Some bones, such as the left pyramidal, are very large, which suggests they belonged to older males.

The results of the attempt to separate mammoth species on the basis of limb bone measurements remains are uncertain for most parameters. However, plotting the length of the tibia against the transverse diameter of its proximal epiphysis offers encouraging results, and supports further study of this approach, but based on a more numerous sample.

The specimens described here add to the material already mentioned from Copăceni and Adunaţii-Copăceni (ŞTIUCĂ et al., 2012), and underline the fossiliferous potential of this section, the study of which will also be useful in assessing the status of the "Copăceni beds".

ACKNOWLEDGEMENTS

REFERENCES

ÁBELOVÁ MARTINA. 2008. *Schreger pattern analysis of* Mammuthus primigenius *tusk: analytical approach and utility.* Bulletin of Geosciences. Czech Geological Survey. Prague. **83**(2): 225-232.

APOSTOL L. 1968. *Particularité morphologiques des molaires des proboscidiens fossils quaternaires de Roumanie, conservées dans la collection du Musée d'Histoire Naturelle «Grigore Antipa».* Travaux du Muséum d'Histoire Naturelle «Grigore Antipa». Bucharest. **9**: 581-616.

ANDREESCU I., CODREA V., LUBENESCU VICTORIA, MUNTEANU T., PETCULESCU A., ŞTIUCA E., TERZEA ELENA. 2013. *New developments in the Upper Pliocene–Pleistocene stratigraphic units of the Dacian Basin (Eastern Paratethys), Romania.* Quaternary International. Elsevier and INQUA. Amsterdam. **284**: 15-29.

AOUADI N. 2001. *New data on the diversity of Elephants (Mammalia, Proboscidea) in the Early and Middle Pleistocene of France.* In: Cavarretta et al. (Eds.) Proceedings of the 1st International Congress "The World of Elephants". Instituto Salesiano Pio XI. Rome: 81-84.

ATHANASSIOU A. 2012. A *skeleton of* Mammuthus trogontherii *(Proboscidea, Elephantidae) from NW Peloponnese, Greece.* Quaternary International. Elsevier and INQUA. Amsterdam. **255**: 9-28.

AZZAROLI A. 1977. *Evolutionary patterns of Villafranchian elephants in Central Italy.* Atti della Academia Nazionale dei Lincei. Memorie. Classe di Scienze fisiche, matematiche e naturali, Sezione II. Accademia Nazionale dei Lincei. Rome. **14**(8): 149-168.

BAYGUSHEVA VERA & GARUTT V. E. 1987. *Skelet stepnovo slona* Archidiskodon trogontherii *(Pohlig, 1885) iz severovostochnovo priazoviya.* Proceedings of the Zoological Institute. USSR Academy of Sciences. Leningrad. **168**: 21-36.

BAYGUSHEVA VERA & TITOV V. V. 2012. *The evolution of Eastern European meridionaloid elephants' dental characteristics.* Quaternary International. Elsevier and INQUA. Amsterdam. **255**: 206-216.

BAYGUSHEVA VERA, TITOV V. V., TIMONINA GALINA I. 2012. *Two skeletons of* Mammuthus trogontherii *from the Sea of Azov Region.* Quaternary International. Elsevier and INQUA. Amsterdam. **276-277**: 242-252.

FELIX J. 1912. *Das Mammuth von Borna.* Veröffentlichungen des Städtischen Museums für Völker kunde zu Leipzig. R. Voigtländers Verlag. Leipzig. **4**: 1-52.

HARINGTON C. R., MOL D., VAN DER PLICHT J. 2012. *The Muirkirk Mammoth: A Late Pleistocene woolly mammoth* (Mammuthus primigenius) *skeleton from southern Ontario, Canada.* Quaternary International. Elsevier and INQUA. **255**: 106-113.

HAYNES G.1993. *Mammoths, Mastodons, and Elephants: Biology, Behavior and the Fossil Record.* Cambridge University Press. Cambridge. 427 pp.

JURCSÁK T. 1983. Archidiskodon meridionalis *(Nesti) din Villafranchianul de la Oradea.* Nymphaea. Folia naturae Bihariae. Muzeul Ţării Crişurilor. Oradea. **10**: 87-142.

KIRILLOVA IRINA V., SHIDLOVSKIY F. K., TITOV V. V. 2012. *Kastykhtakh mammoth from Taimyr (Russia).* Quaternary International. Elsevier and INQUA. Amsterdam. **276-277**: 269-277.

LAWS R. M. 1966. *Age criteria for the African elephant,* Loxodonta a. africana. East African Wildlife Journal. **4**: 1-37.

LISTER A. M. 1996. *Evolution and taxonomy of Eurasian mammoths.* In: Shoshani & Tassy (Eds.) The Proboscidea: Evolution and Palaeoecology of Elephants and their Relatives. Oxford University Press. Oxford. 203-213.

LISTER A. M. 2009. *Late-glacial mammoth skeletons (*Mammuthus primigenius*) from Condover (Shropshire, UK): anatomy, pathology, taphonomy and chronological significance.* Geological Journal. John Wiley & Sons, Hoboken. **44**(4): 447-479.

LISTER A. M. & VAN ESSEN H. 2003. Mammuthus rumanus *(Ştefănescu), the earliest mammoth in Europe.* In: Petculescu & Ştiucă (Eds.) Advances in Vertebrate Paleontology "Hen to Panta". Romanian Academy Institute of Speleology "Emil Racoviţă". Bucharest: 47-52.

LISTER A. M. & STUART A. J. 2010. *The West Runton mammoth* (Mammuthus trogontherii) *and its evolutionary significance*. Quaternary International. Elsevier and INQUA.Amsterdam. **228**: 180-209.

LISTER A. M., DIMITRIJEVIĆ VESNA, MARKOVIĆ Z., KNEŽEVIĆ S., MOL D. 2012. *A skeleton of 'steppe' mammoth (*Mammuthus trogontherii (Pohlig)) from Drmno, near Kostolac, Serbia. Quaternary International. Elsevier and INQUA. Amsterdam. **276-277**: 129-144.

LISTER A. M., SHER A. V., VAN ESSEN H., WEI G. 2005. *The pattern and process of mammoth evolution in Eurasia.* Quaternary International. Elsevier and INQUA. Amsterdam. **126-128**: 49-64.

MAGLIO V. J. 1973. *Origin and Evolution of the Elephantidae*. Transactions of the American Philosophical Society. New Series. The American Philosophical Society. Philadelphia. **63**(3): 1-149.

MASCHENKO E. N. 2002. *Individual development, biology and evolution of the woolly mammoth.* Cranium. **19**(1): 4-120.

MASCHENKO E. N., SCHVYREVA ANNA K., KALMYKOV N. P. 2011. *The second complete skeleton of* Archidiskodon meridionalis *(Elephantidae, Proboscidea) from the Stavropol Region, Russia.* Quaternary Science Reviews. Elsevier. Amsterdam. **30**: 2273-2288.

MAZO ANA V. 1989. *Nuevos restos de Proboscidea (Mammalia) en la Cuenca de Guadix-Baza.* In: Alberdi & Bonadonna (Eds.) Geología y Paleontología de la Cuenca de Guadix-Baza. Trabajos sobre el Neógeno-Cuaternario. Museo Nacional de Ciencias Naturales. CSIC. Madrid. **11**: 225-236.

MOL D., DE VOS J., VAN DER PLICHT J. 2007. *The presence and extinction of* Elephas antiquus *Falconer and Cautley, 1847, in Europe*. Quaternary International. Elsevier and INQUA. Amsterdam. **169-170**: 149-153.

MURGEANU G., LITEANU E., BANDRABUR T. 1966. *Harta geologică scara 1:200 000, L-35-XXXIII + K-35-III, 44.Bucureşti*. Comitetul Geologic. Institutul Geologic. Bucharest.

PALOMBO MARIA RITA & VILLA PAOLA. 2001. *Schreger lines as support in the Elephantinae identification*. In: Cavarretta et al. (Eds.) Proceedings of the 1st International Congress "The World of Elephants". Instituto Salesiano Pio XI. Rome: 656-660.

POPESCU A. 2004. *Les pieces dentaires de* Mammuthus (Archidiskodon) meridionalis *(Nesti) de Leu (le Departement de Dolj)*. Drobeta. Seria Ştiinţele Naturii. Muzeul Regiunii Porţile de Fier, Drobeta Turnu Severin. **14**: 118-122.

POPESCU A. 2008. *Carpal bones of* Mammuthus meridionalis *(Nesti, 1825) in Leu (Dolj District).* Oltenia. Studii şi comunicări. Ştiinţele Naturii. Muzeul Olteniei Craiova. **24**: 255-261.

POPESCU A. 2011. *The tarsals of* Mammuthus meridionalis *(Nesti, 1825) from Leu (Dolj County, Romania).* Geo-Eco-Marina. Edit. Vergiliu. Bucharest. **17**: 211-217.

POHLIG H. 1888. *Dentition und Kraniologie des* Elephas antiquus *Falc.*, *mit Beiträgen über* Elephas primigenius *Blum. und* Elephas meridionalis *Nesti*. Nova Acta der Kaiserlichen Leopoldinisch-Carolischen. Deutchen Akademie der Naturforscher. Halle. **53**(1): 1-279.

ROS MONTOYA S. 2010. *Los proboscídeos del Plio-Pleistoceno de las cuencas de Guadix-Baza y Granada*. Ph. D. Thesis. University of Granada. 403 pp.

ROTH LOUISE V. & SHOSHANI J. 1988. *Dental identification and age determination in* Elephas maximus. Journal of Zoology. Wiley-Blackwell. Hoboken. **214**: 567-588.

ŞTIUCĂ E., PETCULESCU A., VASILE Ş., TIŢĂ RODICA.2012. *Macro- and micromammal faunas associated with* Mammuthus (Archidiskodon) meridionalis *in the Lower-Middle Pleistocene from Copăceni (Ilfov County, Romania)*. In: Murariu et al. (Eds.) Annual Zoological Congress of "Grigore Antipa" Museum, Book of Abstracts. Edit. Medialux. Bucharest: 76-77.

TONG H.-W. 2012. *New remains of* Mammuthus trogontherii *from the Early Pleistocene Nihewan beds at Shanshenmiaozui, Hebei*. Quaternary International. Elsevier and INQUA. Amsterdam. **255**: 217-230.

TRAPANI J. & FISHER D. C. 2003. *Discriminating proboscidean taxa using features of the Schreger pattern in tusk dentin*. Journal of Archaeological Science. Elsevier. Amsterdam. **30**: 429-438.

VASILIEV S. K. 2007. *A skeleton of the trogontherian mammoth (*Mammuthus *cf.* trogontherii *Pohlig, 1885) from Southwest Siberia*. In: Boeskorov G. (Ed.) IV International mammoth conference, Yakutsk 18-22 June, 2007. Abstracts: 117-118.

VÖRÖS I. 1975. *A mátraderecskei mammutesontváz*. Folia Historico-Naturalia Musei Matraensis. Gyöngyös. **3**: 151-157.

ZIEGLER R. 2001. *An extraordinary small mammoth* (Mammuthus primigenius) *from Germany*. Stuttgarter Beiträge zur Naturkunde, Serie B (Geologie und Paläontologie). Staatliches Museum für Naturkunde. Stuttgart. **300**: 1-41.

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