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LATE PLEISTOCENE MAMMALS FROM GROTTA CUCIGLIANA (MONTE PISANO, ITALY)

Abstract - The study of the fossil mammals from the «Grotta Cucigliana» collection is here updated. The standard taphonomic parameters NISP, MNE and MNI were established to evaluate the relative frequencies of the taxa. Hypotheses regarding the environmental conditions under which the fauna lived are also proposed on the basis of the results and the ecology of the species identified. Mammals are dominated by *Crocuta crocuta spelaea* and *Cervus elaphus* but the presence of *Stephanorhinus hemitoechus*, *Equus ferus*, *Bos primigenius*, *Rupicapra rupicapra* and *Dama dama* is also significant. The study permits to hypothesize the occurrence of two faunal assemblages (Cucigliana A and B). The biochronological correlations herein proposed indicates that the Cucigliana A assemblage should be referred to the end of the MIS 5a or the beginning of MIS 4, and Cucigliana B to the beginning of the MIS 3.

Key words - Mammals, Monte Pisano, Late Pleistocene, biochronology.

Riassunto - *I mammiferi del Pleistocene Superiore della Grotta di Cucigliana (Monte Pisano, Italia).* Vengono presentati i risultati dello studio della collezione storica della Grotta di Cucigliana, conservata presso il Museo di Storia Naturale e del Territorio e il Dipartimento di Scienze Archeologiche dell'Università di Pisa. Il lavoro ha consentito il recupero e la revisione sistematica dei resti fossili. Il calcolo dei parametri tafonomici standard NISP, MNE e MNI ha permesso una valutazione delle abbondanze relative dei taxa. La fauna è dominata da *Crocuta crocuta spelaea* e *Cervus elaphus*, ma significativa è anche la presenza di *Stephanorhinus hemitoechus*, *Equus ferus*, *Bos primigenius*, *Rupicapra rupicapra* e *Dama dama*. Lo studio ha permesso di ipotizzare la presenza di 2 associazioni faunistiche (Cucigliana A e B) riferibili al Pleistocene Superiore vissute in condizioni climatico-ambientali diverse. Inoltre, vengono tentate delle correlazioni biocronologiche tra queste associazioni e altre faune a mammiferi note rinvenute in numerosi depositi del versante tirrenico dell'Italia centrale e riferite al Pleistocene Superiore.

Si ipotizza che l'associazione Cucigliana A sia riferibile alla fine dello stadio isotopico 5a o all'inizio dello stadio isotopico 4, mentre l'associazione Cucigliana B all'inizio dello stadio isotopico 3.

Parole chiave - Mammiferi, Monte Pisano, Pleistocene Superiore, biochronologia

INTRODUCTION

The Monte Pisano, which is an isolated mountain located between the Arno and Serchio valleys (Fig. 1) (Rau & Tongiorgi, 1974), is paleontologically well known from the second half of 1800 because of the abundant

and wealthy fossil vertebrate paleosites which were there discovered (see Bianucci & Landini, 2005 for an extensive review).

The South-Western side of Monte Pisano is rich in karst caves and quarries abundant in Late Pleistocene mammal fossils (Farina, 2010), such as those discovered at «Buca dei Ladri» (Bianucci, 1980), «Cava la Croce» (Agnano) (Tavani, 1951), «Cava le Conche» (Caprona) (Tavani, 1951) and the most important «Grotta Cucigliana», «Grotta Parignana» (Caterini, 1921; Del Campana, 1925) and «Grotta del Leone» (Cardini, 1947; D'Eugenio, 1990).

Grotta Cucigliana (Acconci, 1880; Del Campana, 1912; 1914) (North Latitude 43°41'13.5" – East Longitude 10°33'12") is located at 28 m a.s.l. in the small centre of Cucigliana, near Vicopisano (Fig. 1). The cave (Fig. 2) was discovered in 1878 (Acconci, 1880) and the first digging was carried out in 1879 directed by Meneghini and Acconci, who collected abundant mammal remains (Acconci, 1880). In later times, other specimens were recovered by Del Campana (1912; 1914). The fauna was examined by Acconci (1880), Del Campana (1912; 1914) and, subsequently, by Mirri (1999). Mammals include abundant *Crocuta crocuta spelaea*, *Cervus elaphus*, *Bos primigenius* and *Equus ferus* and the mammal association is a Late Pleistocene fauna (Mirri, 1999). The material is abundant, but the fossils were unfortunately collected without taking into account their exactly stratigraphical provenance albeit Acconci's efforts (1880). This caused the loss of valuable stratigraphical information.

The aim of the present work, besides the updating of the classification of the Grotta Cucigliana paleontological collection, is comparing the Cucigliana faunal assemblages with the most important Late Aurelian (Gliozzi *et al.*, 1997) mammal associations of Tuscany and Latium. The biochronological correlations herein reported improve the framework of the Late Pleistocene faunas of central Italy.

MATERIALS AND METHODS

The paleontological collection of Grotta Cucigliana, which is now housed mainly at Museo di Storia Naturale e del Territorio dell'Università di Pisa with a small part stored at Dipartimento di Scienze Archeologiche dell'Università di Pisa, consists of 1,013 specimens

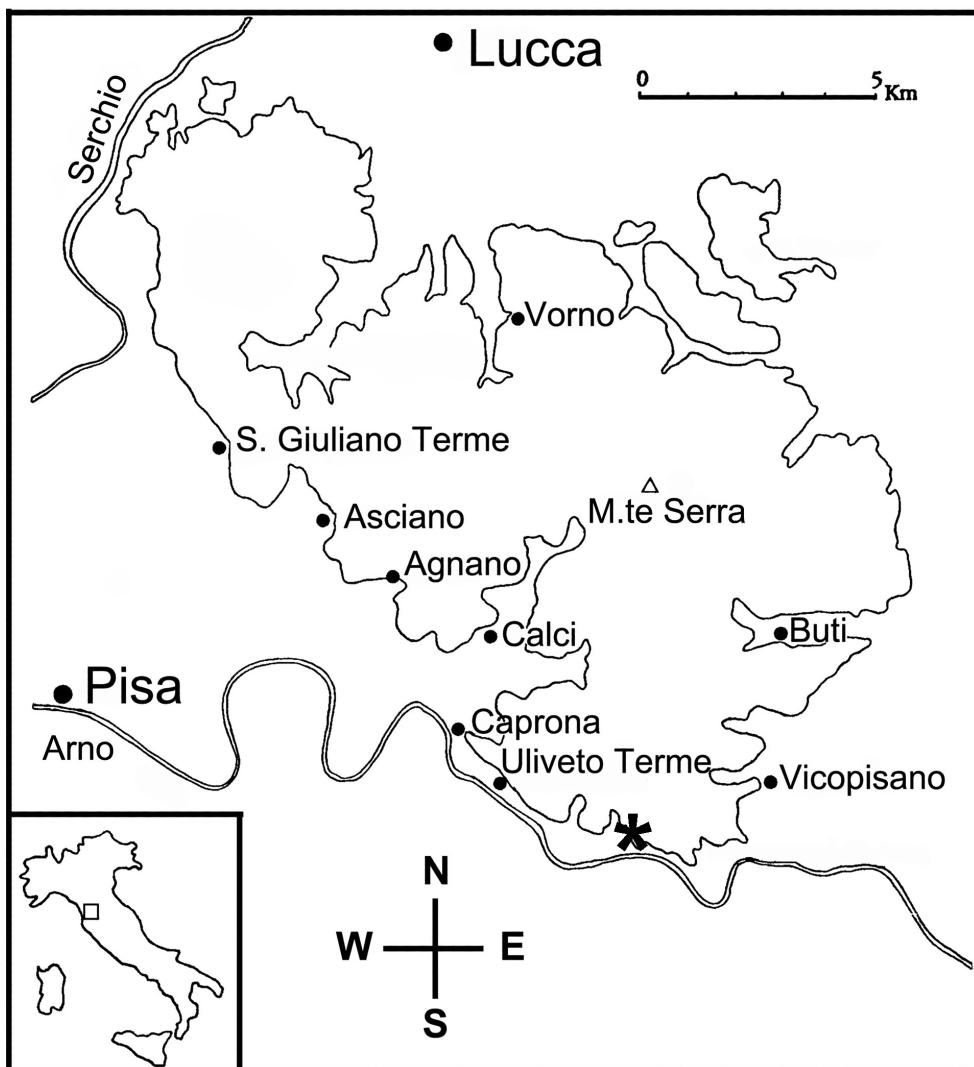


Fig. 1 - Map of the Monte Pisano area. The * represents the geographic position of «Grotta Cucigliana» (Ragaini, 1992; modified).

including also 18 fragments of coal and terra-cotta artefacts. A part of the paleontological collection of Cucigliana is also stored at Museo di Geologia e Paleontologia dell'Università di Firenze and is not included in this study.

The present study first included the anatomically and taxonomically determination of the specimens, in order to update the previous analysis.

The Number of Identified Specimens (NISP) (Grayson, 1984) and the Minimum Number of Elements (Lyman, 2008) were then established to evaluate the relative frequencies of the taxa.

In order to assess the biomasses represented in the sample, the Minimum Number of Individuals (MNI) (Chaplin, 1971) was also calculated.

MNE and MNI have been assessed both on post-cranial and cranial specimens, taking into account age and size.

The analysis of NISP, MNE, and MNI, together with the ecologic features of determined mammals, allowed to make assumptions on the environmental condition under which the fauna lived.

FAUNA

The fossil material is fairly well preserved, and the determined species are reported in Tab. 1.

The presence of *Dama dama*, *Ursus arctos*, *Felis silvestris*, and *Erinaceus europaeus* has also been reported by Mirri (1999), but not by Acconci (1880).

Even though Acconci (1880) reported *Capra?* and *Felis leo*, the systematic review of the fossil material does not confirm the presence of such taxa in the present collection.

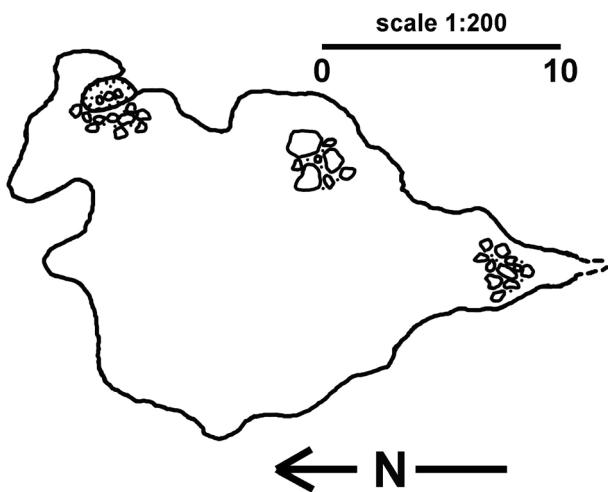


Fig. 2 - Plan of «Grotta Cucigliana» [1].

The specimens determined by Acconci (1880) as *Felis antiqua*, *Mus sylvaticus* and *Elephas antiquus* var. *nana* are herein reported as *Panthera pardus*, *Apodemus ex gr. A. sylvaticus-flaviventer* and *Elephas antiquus*, while the specimens determined as *Lepus variabilis* are reported as *Lepus sp.* because the remains of this taxon lack truly diagnostic elements.

RESULTS

Of the 995 mammal specimens examined here, 14 could be determined only anatomically, and 5 of them are sesamoid bones, while 61 specimens are completely undetermined. The NISP, MNE, and MNI counts are reported in Tab. 1.

Macromammals are dominated by *Crocuta crocuta spelaea* (NISP = 299; MNI = 18) and *Cervus elaphus* (NISP = 191; MNI = 28); *Bos primigenius* (NISP = 87; MNI = 10) and *Equus ferus* (NISP = 84; MNI = 9) are less abundant, while the other faunal components are slightly represented. Noteworthy is also the presence of *Stephanorhinus hemitoechus*, *Rupicapra rupicapra*, *Dama dama* and *Sus scrofa*.

DISCUSSION

The absence of clear stratigraphic information about this fauna impacts on its paleoclimatic and paleoenvironmental significance. In spite of these limits, the paleoecologic indications of the determined species together with the evaluation of NISP, MNE and MNI allow assumptions on the environmental settings of the different faunal associations. Moreover, the comparison of the Cucigliana mammal assemblages with the most important Late Pleistocene faunal associations from Tuscany and Latium, gives a clearer idea of Grotta Cucigliana biochronology.

The faunal association of Grotta Cucigliana includes a mixture of species that lived in different environmental and climatic conditions. Therefore, two faunal assemblages (CUCIGLIANA A and CUCIGLIANA B) have been identified on paleoecological basis (Farina, 2010).

The first assemblage (CUCIGLIANA A) is characterized by *Capreolus capreolus* (MNI = 8), *Cervus elaphus* (MNI = 28), *Dama dama* (MNI = 16), *Sus scrofa* (MNI = 4), *Ursus arctos* (MNI = 1), *Canis lupus* (MNI = 4), *Canis aureus* (MNI = 1), *Vulpes vulpes* (MNI = 6), *Stephanorhinus hemitoechus* (MNI = 4) and *Elephas antiquus* (MNI = 1). The assemblage indicates general temperate climatic conditions and a forested and humid environment as suggested by the presence of *Cervus elaphus*, *Capreolus capreolus*, *Sus scrofa*, *Dama dama*, with open areas (grassland) included (*Stephanorhinus hemitoechus* and *Elephas antiquus*).

In the biochronological framework of the Late Pleistocene mammal associations of Tuscany (Fig. 3), the CUCIGLIANA A assemblage is probably younger than the Monte Tignoso mammal association (Del Campana, 1910; Malatesta, 1943), which is referred to the MIS 5e or 5c (Caloi & Palombo, 1994), where abundant pachyderm remains indicating temperate-warm conditions were recognized (elephant, hippopotamus and steppe rhinoceros). The more recent age of CUCIGLIANA A assemblage is suggested by the scanty remains of steppe rhinoceros (NISP = 11; MNE = 10) and elephant (NISP = 2; MNE = 2).

On the other hand, the CUCIGLIANA A assemblage, is probably older than the Grotta Gosto association (Tozzi, 1974), where the climate was probably cooler, as suggested by the presence of chamois (48 specimens; Tozzi, 1974) and by the progressive disappearance of pachyderms (only scanty remains of an indeterminate species of rhinoceros were recognized; Tozzi, 1974). The Grotta Gosto mammal assemblage is referred to the beginning of MIS 3 (Caloi & Palombo, 1994).

In the Latium coast, there are mammal associations (referred to the end of the MIS 5a or to the beginning of MIS 4) similar to CUCIGLIANA A. In fact, the mammals from «Canale Mussolini» or «Canale delle Acque Alte» (Blanc, 1935; Blanc *et al.*, 1957; Farina, 2011) and, in particular, the faunal assemblage from layer C2 (Farina, 2011), is characterized by the occurrence of roe, red, and fallow deer that indicates temperate and forested settings. The association in the layer C2 of this deer assemblage with horse and auroch remains, together with steppe rhinoceros and elephant, indicates the presence of open areas as well. In the layer C2, also the presence of hippopotamus is recognized (Farina, 2011). Other mammal associations of Latium, which are characterized by the presence of steppe rhinoceros associated with a fauna of mixed environment, are those of «Grotta Guattari», «Grotta della Catena», and «Grotta del Fossellone» (Caloi & Palombo, 1994).

In conclusion, the CUCIGLIANA A assemblage could be tentatively correlated biochronologically with the late MIS 5a or early MIS 4 mammal associations of the Latium coast and consequently could be earlier than the MIS 4 climatic deterioration (Fig. 3).

Tab. 1 - NISP, MNE and MNI values of the «Grotta Cucigliana» fauna.

Order	Species	NISP	MNE	MNI
Insectivora	<i>Erinaceus europaeus</i>	4	4	3
Rodentia	<i>Arvicola amphibius</i>	8	8	1
	<i>Apodemus ex gr. A. sylvaticus-flavicollis</i>	1	1	1
Lagomorpha	<i>Lepus</i> sp.	30	29	4
Carnivora	<i>Meles meles</i>	6	6	2
	Mustelidae	1	1	1
	<i>Canis lupus</i>	10	10	4
	<i>Canis aureus</i>	1	1	1
	<i>Vulpes vulpes</i>	16	16	6
	<i>Ursus spelaeus</i>	31	29	4
	<i>Ursus arctos</i>	3	3	1
	<i>Felis sylvestris</i>	3	3	1
	<i>Lynx lynx</i>	2	2	1
	<i>Panthera pardus</i>	37	35	9
	<i>Crocuta crocuta spelaea</i>	299	241	18
Perissodactyla	<i>Stephanorhinus hemitoechus</i>	11	10	4
	<i>Equus ferus</i>	84	82	9
Artiodactyla	<i>Sus scrofa</i>	38	37	4
	<i>Capreolus capreolus</i>	16	16	8
	<i>Cervus elaphus</i>	191	188	28
	<i>Cervus vel Dama</i>	3	3	
	<i>Dama dama</i>	29	28	16
	<i>Rupicapra rupicapra</i>	6	6	2
	<i>Bos primigenius</i>	87	86	10
Proboscidea	<i>Elephas antiquus</i>	2	2	1
Primates	<i>Homo sapiens</i>	1	1	1
	Total values	920	848	140
	Anatomically determined specimens	14	14	
	Total determined specimens	934	862	140

The second assemblage (CUCIGLIANA B) is characterized by *Rupicapra rupicapra* (MNI = 2), *Bos primigenius* (MNI = 10), *Crocuta crocuta spelaea* (MNI = 18), *Ursus spelaeus* (MNI = 4), *Felis silvestris* (MNI = 1), *Lynx lynx* (MNI = 1), *Panthera pardus* (MNI = 9), *Meles meles* (MNI = 2) *Equus ferus* (MNI = 9) and *Lepus* sp. (MNI = 4).

The assemblage includes temperate and wood cover-indicating species, such as cave bear (NISP = 31) and wild cat (NISP = 3), as well as open areas-indicating species, such as horse (NISP = 84). The disappearance of pachyderms and the occurrence of chamois (NISP = 6), suggest cooler climatic conditions than those hypothesized for CUCIGLIANA A, with the prevalence of open areas and the probable decrease of wood cover on the South-Western side of Monte Pisano. The presence of chamois also suggests that the climate was

not so dry, because of the preference of this species for environments close to the forests.

Considering the other Late Pleistocene mammal associations of Tuscany, the CUCIGLIANA B fauna could be tentatively correlated with the ones from «Grotta Gosto», «Buca della Iena» and «Grotta del Capriolo», which are referred to the beginning of MIS 3 (Fig. 3) and indicate relatively temperate and humid stages and mixed environment (Caloi & Palombo, 1994). In fact, the mammal association of «Grotta del Capriolo» (Pitti & Tozzi, 1971), is characterized by the presence of roe deer, cave bear, wild cat and leopard, associated with horse and scanty remains of auroch, while at «Buca della Iena» (Pitti & Tozzi, 1971) mammals are dominated by horse with a significant occurrence of red deer, roe deer, hyena and cave bear.

On the Latium coast, a faunal association, which is similar to CUCIGLIANA B, is that from the upper layers

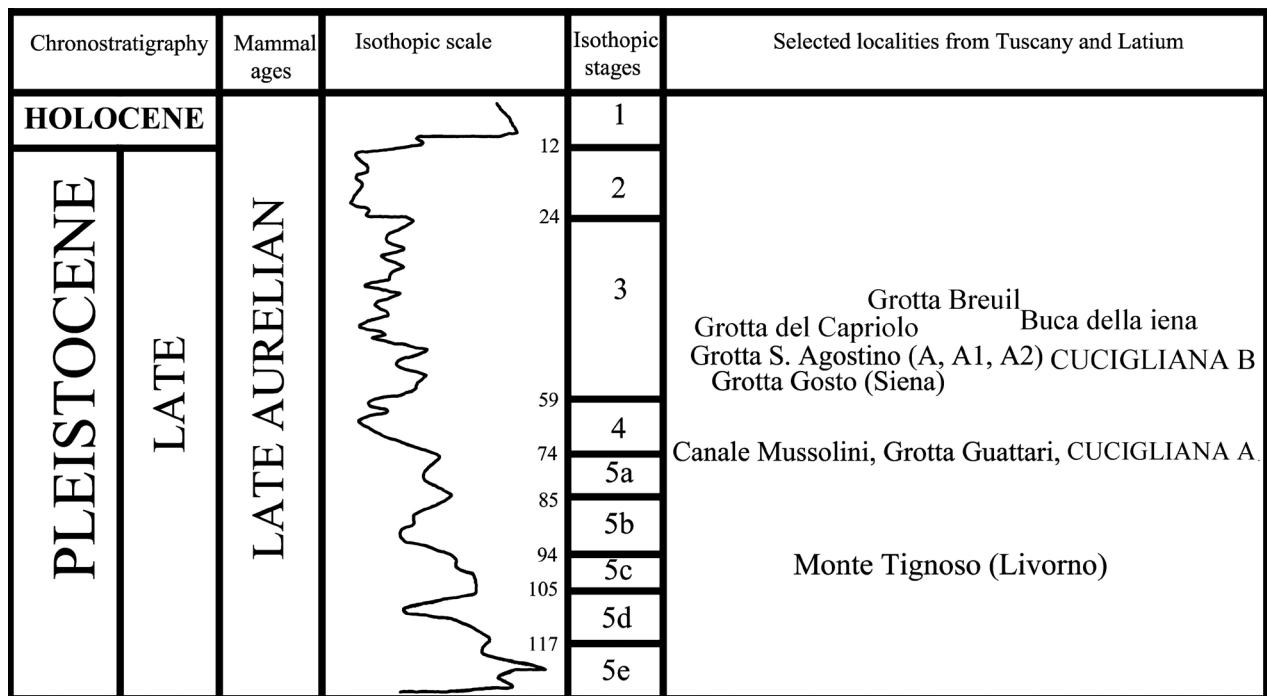


Fig. 3 - Chronological framework of Cucigliana faunal assemblages in comparison with some Late Pleistocene selected localities from Central Italy (Tuscany and Latium).

(A-A1-A2) of «Grotta S. Agostino» (Fig. 3), where a temperate-indicating fauna is well represented (*Cervus elaphus*, *Dama dama* and *Capreolus capreolus*), associated with *Equus*, and with particularly rare «colder» taxa (*Marmota marmota* and *Capra ibex*) (Tozzi, 1970). The «Grotta S. Agostino» faunal association is referred to the beginning of MIS 3 by radiocarbon dates which indicate an interval between 55.000 and 43.000 years ago (Kuhn, 1992 in Caloi & Palombo, 1994).

Another mammal association referred to a temperate-humid oscillation of the beginning of MIS 3 is «Grotta Breuil» (Bietti *et al.*, 1988; Kotsakis, 1992; Caloi & Palombo, 1994), where red, roe and fallow deer are associated with horse and auroch.

In conclusion, the CUCIGLIANA B assemblage could be referred to a temperate-cool oscillation that characterized the beginning of the MIS 3 and could be tentatively correlated biochronologically with the Latium associations of «Grotta S. Agostino» and «Grotta Breuil».

Finally, the paleontological collection of «Grotta Cucigliana» contains also rare remains of rodents (*Arvicola amphibius*, MNI = 1; *Apodemus ex gr. A. sylvaticus-flaviventer*, MNI = 1) and insectivores (*Erinaceus europaeus*; MNI = 3), whose fresh state of conservation and kind of fossilization points to an attribution to a Holocene age. Furthermore, one specimen of *Homo sapiens* probably referred to the Bronze Age or to the Eneolithic (Mirri, 1999) was also recognized.

CONCLUSION

The analysis of the fauna from «Grotta Cucigliana» allowed to improve the knowledge on the Late Aurelian mammal faunas of Tuscany and Latium.

The ecological information provided by the determined species permitted to identify two different faunal assemblages (CUCIGLIANA A and CUCIGLIANA B). The CUCIGLIANA A assemblage can be correlated with the mammal associations of «Canale Mussolini» and «Grotta Guattari» (which straddle the MIS 5a to MIS 4 transition) and can be included in the Melpignano Faunal Unit (Petronio *et al.*, 2007), which precedes the MIS 4 climatic deterioration.

The CUCIGLIANA B assemblage can be correlated with the faunal associations of Tuscany and Latium referred to the beginning of MIS 3 such as «Grotta Gosto», «Buca della Iena», «Grotta del Capriolo», Grotta S. Agostino, and Grotta Breuil» and can be included in the Ingarno Faunal Unit (Petronio *et al.*, 2007).

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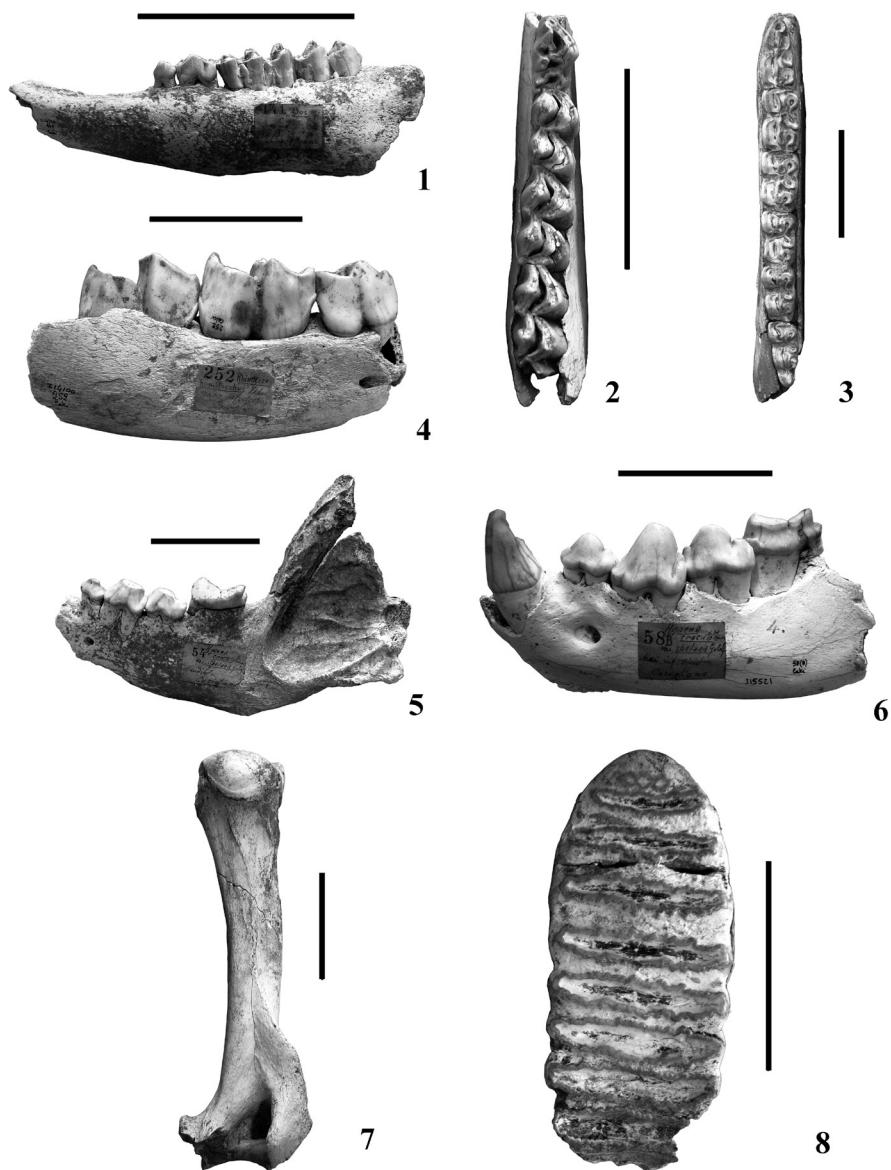
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(ms. pres. il 13 maggio 2011; ult. bozze il 30 luglio 2012)



EXPLANATION OF PLATE I

Bos primigenius BojanusFig. 1 - I14336 left mandible (dP₂, dP₃, dP₄, M₁), lateral view. The scale is 10cm.*Cervus elaphus* L.Fig. 2 - I14028 right mandible (P₄, M₁, M₂, M₃), occlusal view. The scale is 5 cm.*Equus ferus* BoddaertFig. 3 - I14122 left mandible (P₂, P₃, P₄, M₁, M₂, M₃), occlusal view. the scale is 5 cm.*Stephanorhinus hemitoechus* (Falconer)Fig. 4 - I14100 right mandible (P₄, M₁, M₂), lateral view. The scale is 5 cm.*Crocuta crocuta spelaea* GoldfussFig. 5 - I14252 left mandible (P₂, P₃, P₄, M₁), lateral view. The scale is 5 cm.Fig. 6 - I15521 left mandible (C, P₂, P₃, P₄, M₁), lateral view. The scale is 5 cm.*Ursus spelaeus* Rosenmüller & Heinroth

Fig 7 - I14275 right humerus, posterior view. The scale is 10 cm.

Elephas antiquus Falconer & CautleyFig 8 - I15574 left dP⁴, occlusal view. The scale is 5 cm.