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LARGE MAMMALS FROM THE MIDDLE PLEISTOCENE (MIS 11) SITE OF FONTIGNANO 2 (ROME, CENTRAL ITALY), WITH AN OVERVIEW OF “SAN COSIMATO” ASSEMBLAGES.

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ABSTRACT: Here we describe fossil mammal remains recovered from the late Middle Pleistocene (MIS 11) of Fontignano 2 (Rome, central Italy). Two species are recognized: the aurochs *Bos primigenius* and the red deer *Cervus elaphus*. The presence of *B. primigenius* represents one of the earliest diagnostic evidence of the species. Conversely, remains of *C. elaphus* are not fully diagnostic at a subspecies level, despite being long considered among the reference occurrences of *C. e. eostephanoceros* in Italy. This reconsideration, concurrent with the revised chronology of several localities of the area of Rome, questions the validity of the chronosubspecific and evolutionary repartition of the red deer as often envisioned in the literature, i.e., *C. e. acoronatus*, *C. e. eostephanoceros*, *C. e. rianensis*, *C. e. elaphus*. Remains of Fontignano 2 are part of those recovered within the San Cosimato Formation, also including Via di Brava (MIS 13 or MIS 11), with *Palaeoloxodon antiquus*, and San Cosimato (MIS 11), with *Stephanorhinus* sp., *B. primigenius*, *Castor fiber*, and *Emys orbicularis*.

Keywords**:** Fossil vertebrate, Biochronology, Galerian, Quaternary, Italian Peninsula.

1. INTRODUCTION

The area of Ponte Galeria (Rome, Fig. 1), along the Tyrrhenian coast in central Italy, has yielded an exceptional amount of fossil remains recovered from geochronologically calibrated deposits, providing a unique source of knowledge on Middle Pleistocene terrestrial ecosystems of Europe. Indeed, the progressive uplift of the area led to continental depositional conditions since about 0.8 Ma, in coincidence with the start of the activity of the Roman Magmatic Province (Conticelli & Peccerillo, 1992; De Rita et al., 1993; Karner et al., 2001). As a result, volcanic products are intercalated within the fluvial and lacustrine sedimentary successions deposited from this point onwards, providing radiometric age constraints for the correlation of the several fossiliferous localities that are here represented (Ambrosetti, 1965; Ambrosetti & Bonadonna, 1967; Ambrosetti et al., 1972; Caloi & Palombo, 1978, 1979b, 1986; Kotsakis et al., 1992; Di Stefano et al., 1998; Petronio & Sardella, 1999; Milli et al., 2008; Palombo & Milli, 2011; Sardella & Petrucci, 2012; Marra et al., 2014; Sardella et al., 2015). The seminal work of Conato et al. (1980) recognized five informal lithostratigraphic units in the area, extending from the late Early Pleistocene to the late Middle Pleistocene: Monte Mario, Ponte Galeria, S. Cosimato, Aurelia, and Vitinia Formations. Subsequent studies have improved this scheme and further developed its calibration with the Marine Isotopic Scale (MIS), in turn resulting in a refined chronological placement of several fossiliferous localities (Palombo & Milli, 2011; Sardella & Petrucci, 2012; Marra et al., 2014). The name “San Cosimato” has often been employed as a composite Local Fauna, including sporadic fossil findings recovered within the San Cosimato Formation (*sensu* Conato et al., 1980; e.g., Palombo, 2004). However, since deposits of the San Cosimato Formation are now known to represent two distinct sedimentary cycles correlated to Valle Giulia (MIS 13) and San Paolo (MIS 11) Formations (Marra & Rosa, 1995; Funiciello & Giordano, 2008), there are some ambiguities in referring to these assemblages (Fig. 1).

Kotsakis et al. (1992) reported the presence of the two arvicolid rodents *Prolagurus pannonicus* and ?*Predicrostonyx* sp. from the “Blue-grey *Helicella* clays” (Ponte Galeria Formation) at Fontignano. These species are considered indicators of cold climate and are associated with an oligotypic assemblage of molluscs that also support this paleoclimatic inference. The Local Fauna constituted by *Prolagurus pannonicus* and ?*Predicrostonyx* sp. is the oldest in the area of Ponte Galeria and we refer to it as Fontignano 1, to distinguish it from remains recovered from the upper levels (previously considered as San Cosimato Formation) of the same site, which represent Fontignano 2.

Here we provide description and taxonomic attribution of the large mammal fossil remains of Fontignano 2, which, although mentioned in several works (e.g., Di

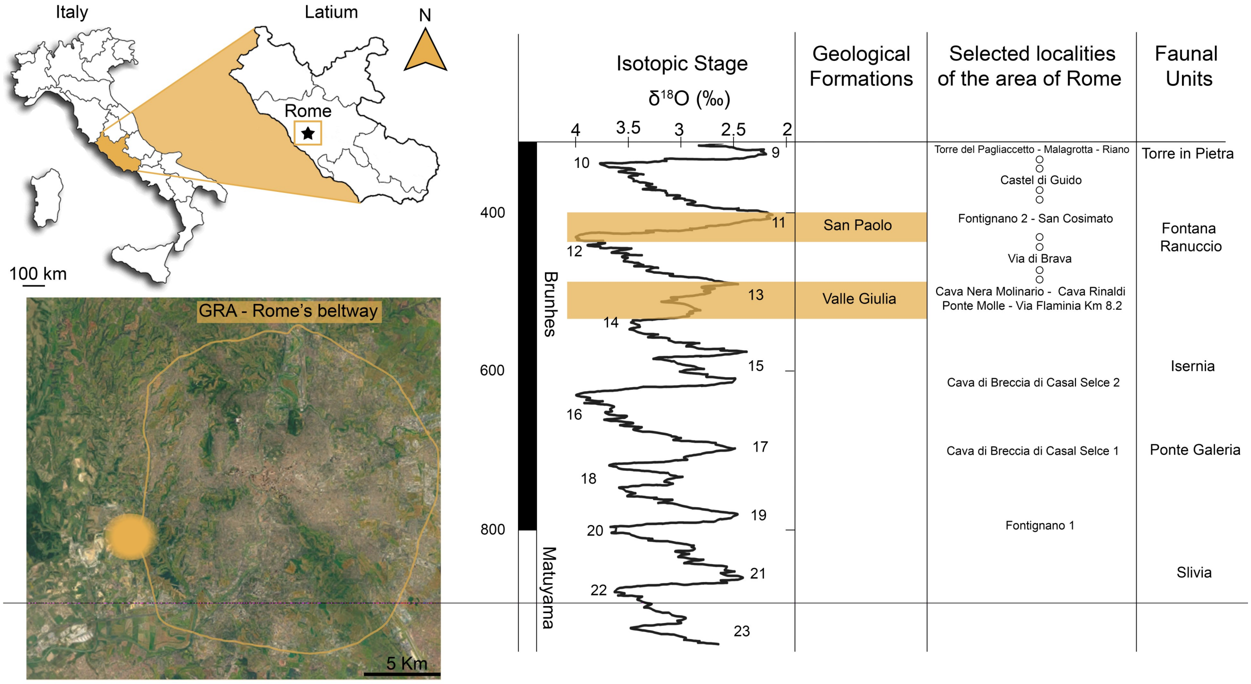

Fig. 1 - Location and geochronological setting of the studied area. The geological Formations formerly included in the San Cosimato Formation are highlighted. Data from: Ambrosetti (1965); Ambrosetti & Bonadonna (1967); Ambrosetti et al. (1972); Caloi & Palombo (1978, 1979b, 1986); Kotsakis et al. (1978, 1992); Conato et al. (1980); Marra & Rosa (1995); Di Stefano et al. (1998); Petronio & Sardella (1999); Palombo (2004); Milli et al. (2008); Palombo & Milli (2011); Sardella & Petrucci (2012); Marra et al. (2014); Sardella et al. (2015); Pereira et al. (2018); Boschian et al. (2019); Mecozzi et al. (2021a).

Stefano & Petronio, 1993; Marra et al., 2014) have never been described so far. Moreover, we discuss biochronological implications for the species recognized and we summarize the knowledge on San Cosimato fossil assemblages.

2. MATERIALS AND METHODS

The fossil remains described in this work were recovered in the 1990s, during geological surveys carried out in the area of Ponte Galeria (Salami, 1992), and they are housed in the PaleoFactory Laboratory, Department of Earth Sciences, Sapienza University of Rome (PF). The morphological analysis is based on the comparison with other fossil remains as well as recent osteological material stored in the same institution and in the University Museum of Earth Science, Department of Earth Sciences, Sapienza, University of Rome (MUST).

Measurements were taken with sliding calipers nearest to 0.1 mm, mainly following von den Driesch (1976). We also measured the maximum anteroposterior depth of the distal epiphysis of the humerus (DAPd). Uncertain values are preceded by "c." throughout the text. We considered: Greatest length (GL); Greatest length from caput (GLC); Smallest breadth of diaphysis (SD); Anteroposterior distal diameter (DAPd).

Other abbreviations employed in this work are as follows: Faunal Unit (FU); Formation (Fm); Local Fauna (LFA)

3. SYSTEMATIC PALAEONTOLOGY

Order ARTIODACTYLA Owen, 1848
Family BOVIDAE Gray, 1821
Subfamily BOVINAE Gray, 1821
Genus BOS Linnaeus, 1758
Species *Bos primigenius* Bojanus, 1827

Material: right humerus (PF-Font2-1; Fig. 2a1-a2); left horn core (PF-Font2-2; Fig. 2b1-b2).

Description and comparison: The left horn core (PF-Font2-2) also preserves part of the postero-lateral region of the cranium. It is in a better condition than that of the other specimen, although its posterior portion is damaged near the base of the horn. The cornual process is separated from the frontal bone by a marked neck; from this point it extends first laterally, and then anteriorly and upwards. The cross section of the horn is oval in the proximal preserved part, more elongated antero-posteriorly than dorso-ventrally.

The right humerus (PF-Font2-1) is almost complete but severely fractured, and its epiphyses are damaged at the level of the lateral tuberosity (proximally) and of the medial epicondyle (distally). The bone surface is partially encrusted by a grayish patina, with sporadic presence of small pebbles (1 - 5 cm in size). In the proximal epiphysis, the floor of the bicipital groove is swelling in anterior view. Laterally, the lateral tuberosity possesses two shallow grooves. The diaphysis possesses a well-developed midshaft lateral imprint of the deltoid tuberosity in anterior view. In the distal epiphysis the lateral condyle is complete and appears laterally projected. Laterally, the ridge connecting the main shaft with the lateral condyle curves at the level of the junction with the main shaft. The margin of the lateral epicondyle is short and curve, and originates below the lateral epicondylar crest.

There are objective difficulties in the attribution of postcranial remains of Bovidae to *Bison* or *Bos* (e.g., Masini et al., 2013). Nevertheless, PF-Font2-1 is large, measuring c. 460.0 mm in GL, 391.7 mm in GLC, and 78.8 mm in SD; and stout in appearance, especially at the level of the deltoid tuberosity. Morphologically, most of the traits observed in PF-Font2-1 fall in the variability of *B. primigenius*, whereas are different than those of *Bison* (Sala, 1986; Balkwill & Cumbaa, 1992). The morphological features, and the large size and robustness support an attribution to *B. primigenius*. PF-Font2-2 can be confidently assigned to the same species. Indeed, in *Bison* the horns are inserted in the cranium in a more anterior position, and they have a different development, protruding outward and backward; in *Hemibos* the horns are directed posteriorly, with a subtriangular cross section (Petronio & Sardella, 1998; Martínez-Navarro & Palombo, 2004; Masini et al., 2013).

Family CERVIDAE Goldfuss, 1820
Subfamily CERVINAE Goldfuss, 1820
Genus CERVUS Linnaeus, 1758
Species *Cervus elaphus* Linnaeus, 1758

Material: right antler (PF-Font2-3; Fig. 2e); left distal humerus (PF-Font2-4; Fig. 2c1-c4); right distal humerus (PF-Font2-5; Fig. 2d1-d2).

Description and comparison: the right antler PF-Font2-3 preserves only the basal part of the beam, with the insertion of the brown tine and the bez tine, but these two tines are broken. The beam shows pearls and knots typical of the red deer. The beam has an elliptical outline, with the major axis anteroposteriorly oriented. At the level of the insertion, the brow and bez tines have an elliptical outline, flattened mediolaterally. The lack of the tines prevents to estimate the angle that these form with the beam. The bez tine is near to the brow tine, dis-

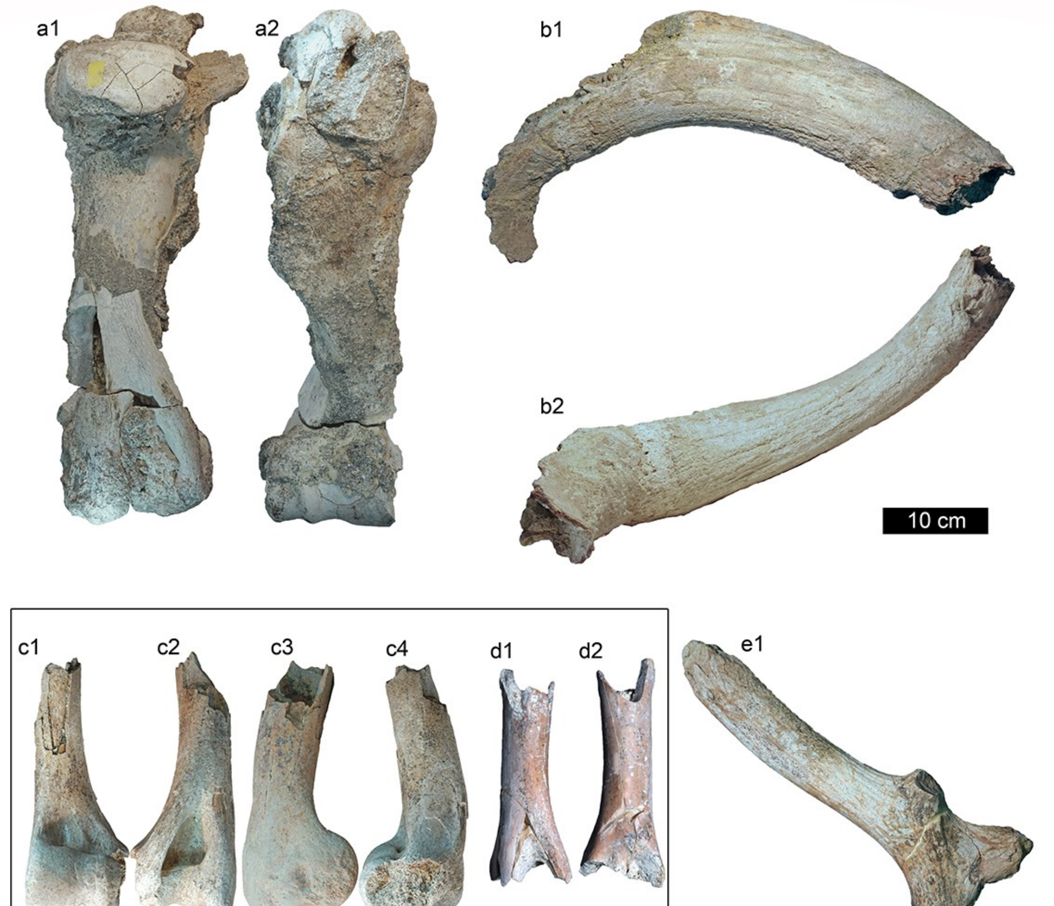

Fig. 2 - Mammal remains from Fontignano 2: *Bos primigenius* right humerus PF-Font2-1 in caudal (a1) and cranial (a2) views, left horn core PF-Font2-2 in dorsal (b1) and frontal (b2) views; *Cervus elaphus* left humerus PF-Font2-4 in cranial (c1), caudal (c2), lateral (c3), and medial (c4) views, right distal humerus PF-Font2-5 in caudal (d1) and cranial (d2) views, right antler PF-Font2-3 in external view (e1).

tanced 42.5 mm from the beam. Above the bez tine, the beam is long 236.9 mm, and there is no trace of the trez tine. Other measurements of the antler are: the antero-posterior breadth of the burr - 64.9 mm; the medio-lateral breadth of the burr - 52.7 mm; the antero-posterior breadth of the beam between the brow and the bez tines - 72.2 mm; the depth of the brow tine at the base - 52.1 mm; the breadth of the brow tine at the base - 30.4 mm; the depth of the bez tine at the base - 34.4 mm; the breadth of the bez tine at the base - 36.5 mm.

The main differences between *C. e. acoronatus* and *C. e. eostephanoceros* is the terminal part of the antler, or crown (Fig. 3). The acoronate red deer lacks a real crown, possessing a terminal fork with only two points (Di Stefano & Petronio, 1992, 1993). On the contrary, the eostephanoceros red deer shows a real crown formed by at least 5 tines (Di Stefano & Petronio, 1992, 1993). The most reliable features in the identification of red deer subspecies are missing in the antler from Fontignano, which suggests caution in the taxonomical attribution.

The left humerus (PF-Font2-4) preserves part of the diaphysis and the distal epiphysis, but the medial condyle is fragmented. In anterior view, the radial pit is slightly larger than the coronoid pit; the epicondylar crest is damaged but appears robust; the capitulum is not preserved; the crest of the lateral condyle is more marked than that of medial condyle. Posteriorly, the medial condyle is more pronounced than the lateral condyle; the olecranon fossa is wide distally, whereas is narrower, but deeper, proximally. PF-Font-5 is a fragmented humerus diaphysis, lacking epiphyses. The morphology and size of the shaft resemble those of PF-Font2-4.

The morphology of the humerus in fallow and red deer is quite similar, especially in the early Middle Pleistocene taxa. Nevertheless, the relative development of the radial and coronoid pit is one of the diagnostic characters to differentiate the modern fallow deer and red deer (Di Stefano, 1995; Lister, 1996). Following this, PF-Font2-4 can be attributed to *C. elaphus*. Considering the biometry, Di Stefano (1995) noticed that the angle described by the orientation of the trochlea is usually more acute in *Dama* (<18°) than in *Cervus* (>20°). In PF-Font2-4 this angle spans 20° and the DAPd measures 53.8 mm, values that support an attribution to *C. elaphus*.

4. DISCUSSION

4.1. Biochronological implications

Bos primigenius

According to Masini et al. (2013) *B. primigenius* is first documented in Isernia FU, even though not from the type locality, but as a component of other LFAs of the Venosa Basin in Basilicata, namely Notarchirico (Cassoli et al., 1999) and Loreto (Caloi & Palombo, 1979a). However, remains from these localities are scanty and mainly limited to postcranial material, elements not fully diagnostic in Bovidae (Moncel et al., 2020). Indeed, Masini et al. (2013, p. 54), discussing the morphological differences between *B. priscus* and *B. primigenius*, remarked that: “Although a number of authors try to tell the difference between the postcranial elements, the objective difficulty of firmly identify either no diagnostic or imperfectly preserved remains of the large bovids, makes it difficult to ascertain the actual extent in time, space and number of findings of the steppe bison fossil record in Italy”. Moreover, the possibility that some remains of the enigmatic *Hemibos galerianus* (Petronio & Sardella, 1998) may have been misidentified cannot be ruled out, since up to now the dental and postcranial morphology of this Middle Pleistocene bovid are still unknown. For instance, Caloi & Palombo (1979a) underlined the slenderness of postcranial remains of *B. primigenius* from Loreto, but for reconciliate this evidence with the species attribution they argued that the sample likely consists mainly of female individuals. It is worth highlighting that the presence of *H. galerianus* in Italy is documented only by two fragmentary horn cores collected from the lower level of Cava di Breccia di Casal Selce (Petronio & Sardella, 1998; Martínez-Navarro & Palombo, 2004) and Ponte Molle (= Ponte Milvio) (Martínez-Navarro & Palombo, 2007). Martínez-Navarro et al. (2010) stressed the importance of the coincidence between the dispersal of *Bos* and the Acheulean culture in Eurasia. However, at Notarchirico remains attributed to *B. primigenius* are only reported from the upper levels of the stratigraphic succession (Cassoli et al., 1999), whereas the occurrence of the species cannot be confirmed in lower levels that document the earliest evidence of an Acheulean settlement in Italy (Moncel et al., 2020; Mecozzi et al. 2021b). A fragment of a frontal bone and a fragmentary proximal femur referred to *B. primigenius* were also found at Monte Oliveto (Berzi, 1972), but a revision of

Taxa	Autorship	Age	Type locality
Cervus acoronatus	Beninde, 1937	600-500 ka	Mosbach
“Cervus” elaphoides	Kahlke, 1960	600-500 ka	Mosbach
“Cervus” reichenaui	Kahlke, 1995	600-500 ka	Mosbach
Cervus priscus	Kaup, 1839	600-500 ka	Mauer
Cervus elaphus eostephanoceros	Di Stefano & Petronio, 1993	500 ka	Cava Nera Molinario
Cervus elaphus rianensis	Leonardi & Petronio, 1974	350-300 ka	Riano
Cervus elaphus angulatus	Beninde, 1937	300 ka	Steinheim am Murr
Cervus elaphus aretinus	Azzaroli, 1961	Middle Pleistocene	Val di Chiana

Tab. 1 - Middle Pleistocene *Cervus* taxa from Europe considered in the text as established by authors.

this material is needed to confirm its classification. *B. primigenius* was also reported by Valdemino (Tozzi, 1969; Nocchi & Sala, 1997), but the material was never described or figured. Finally, a nearly complete hemimandible from Cava Rinaldi was referred to *B. primigenius* by Ambrosetti (1965), but later reassigned to *Bison* sp. (Sala, 1986; Petronio & Sardella, 1998).

Unequivocal fossil remains of *B. primigenius* are only known since Fontana Ranuccio FU, as exemplified by remains from Fontana Ranuccio (Cassoli & Segre Naldini, 1993; Strani et al., 2018), Ponte Molle (Mecozzi et al., 2021a), and the horn core from Fontignano 2 described in this work. In this scenario, an early dispersal of *B. primigenius* (older than Fontana Ranuccio FU) in the Italian Peninsula cannot be confirmed. In younger deposits, *B. primigenius* became soon a common element, as testified for example by the late Middle Pleistocene sites of Malagrotta (Caloi & Palombo, 1979b) and Castel di Guido (Sala & Barbi, 1996).

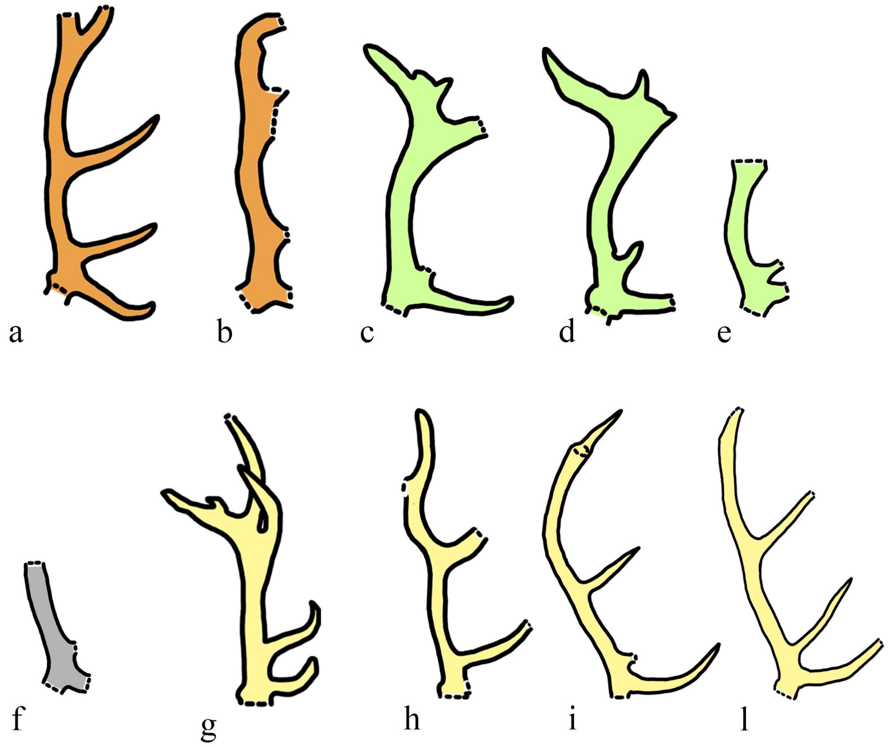

Fig. 3 - Antler morphology of *Cervus elaphus* from localities of the area of Rome: a - Ponte Molle, b - Via Flaminia Km 8.2, c - Cava Nera Molinario, d - Ponte Molle, e - Fontana Ranuccio, f - Fontignano 2, g - Riano, h - Torre del Pagliaccetto, i-l - Castel di Guido; a-b - *C. e. acoronatus*, c-e - *C. e. eostephanoceros*, f - *C. elaphus* ssp., g-l *C. e. elaphus*. Figures not in scale.

Cervus elaphus

The red deer, *C. elaphus* is a typical Middle Pleistocene species but is first documented from a few late Early Pleistocene sites (Atapuerca-TD4-6, van der Made et al., 2017; Bermúdez de Castro et al., 1999; Dorn Dürkheim, Franzen et al., 2000; Happisburgh HSB3, Parfitt et al., 2010).

Many chronological and/or geographical subspecies of *C. elaphus* were named (Tab. 1), with a general agreement in recognizing the simpler antler morphology of earlier forms, but several alternative opinions on the validity and relationships of subsequent taxa (e.g., Heintz, 1970; Di Stefano & Petronio, 2002; van der Made et al., 2014; Croitor, 2018). In Italy, largely relying on remains recovered from the area of Rome, the red deer lineage is often considered to be represented by four different chronosubspecies: *C. e. acoronatus* (Beninde, 1937), *C. e. eostephanoceros* Di Stefano & Petronio, 1993, *C. e. rianensis* Leonardi & Petronio, 1974, *C. e. elaphus* (Leonardi & Petronio, 1974; Di Stefano & Petronio, 1992, 1993, 2002), notwithstanding the occurrence of endemic island forms and of *C. e. aretinus* Azzaroli, 1961 from Tuscany (Azzaroli, 1948, 1961; Di Stefano & Petronio, 2002; Croitor, 2018). The antler of the acoronatus red deer possesses five points, with two basal tines and a third tines in the high position on the beam, all directed anteriorly; while in the upper part there is a bifurcate fork (Fig. 3a-b) (Di Stefano & Petronio, 1992). The term acoronatus was chosen to indicate an antler where the terminal crown lacks, as opposite to the crown that instead characterizes the modern *C. elaphus*. The second taxon is *C. e. eostephanoceros,* recognizable for a first crown-like antler, even if different from that of the modern red deer (Fig. 3c-e) (Di Stefano & Petronio, 1993). As exemplified by the description above, the identification of red deer subspecies rests exclusively on antler morphology, which complicate the reconstruction of the evolutionary history of *C. elaphus*. Indeed, antler remains are not ubiquitously represented in the fossil record, and underestimation of ontogenetically related morphological changes (e.g., presence/absence and number of tines, development of the crown) may led to misidentifications (Heintz, 1970; Lister, 1987). In Italy, antler remains were collected from Fontana Ranuccio (Di Stefano & Petronio, 1993), Cava Nera Molinario (type locality of *C. e. eostephanoceros*) (Di Stefano & Petronio, 1993), Ponte Molle (Mecozzi et al., 2021a), Via Flaminia 8.2 Km (Kotsakis et al., 1978), Riano (Leonardi & Petronio, 1974), Torre del Pagliaccetto (Caloi et al., 1978), and Castel di Guido (Sala & Barbi, 1996). In Europe, *C. e. acoronatus* was identified from the Middle Pleistocene sites of Süssenborn and Mosbach (type locality) (Kahlke, 1960, 1969; Lister, 1990; Di Stefano & Petronio, 1992). Two other putative red deer species were established on the sample of Mosbach: "*Cervus*" *elaphoides* Kahlke, 1960 and

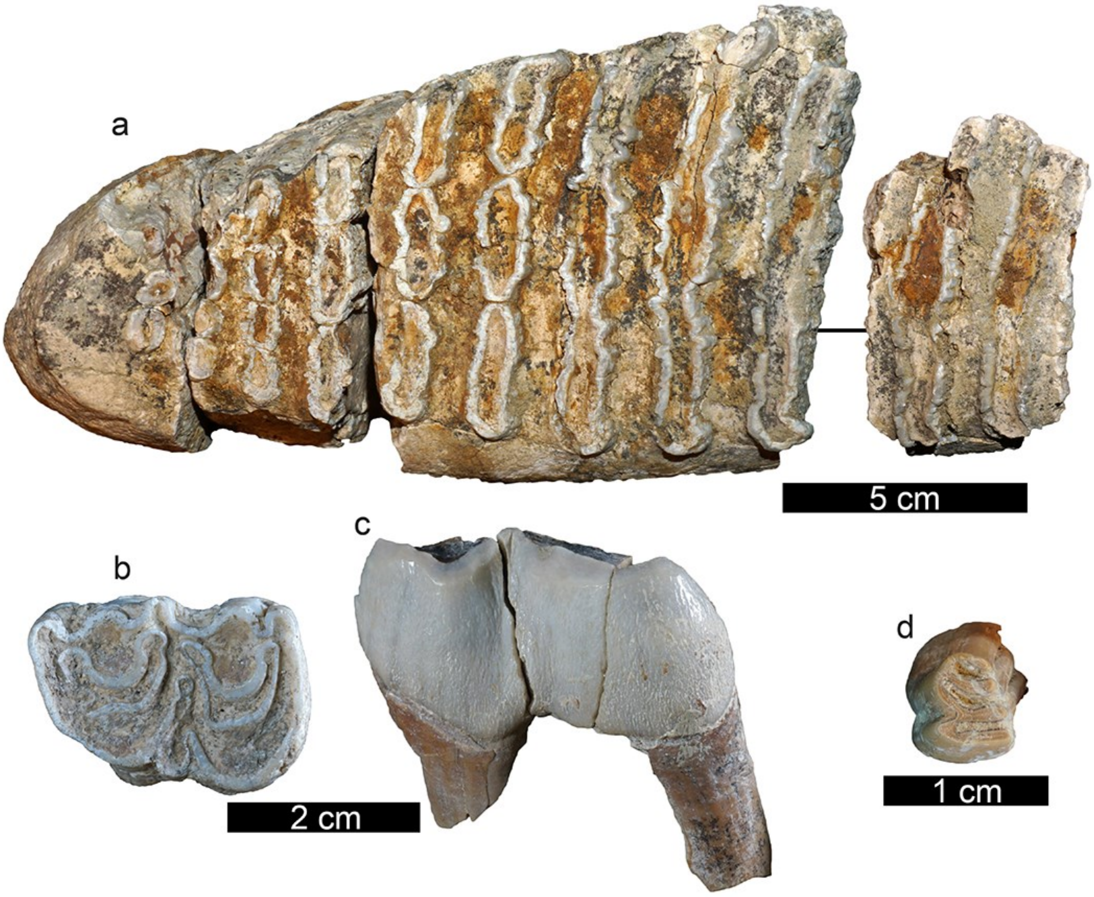

Fig. 4 - Mammal remains from Via di Brava: *Palaeloxodon antiquus* molar PF-Brava-1 in occlusal view (a); and San Cosimato: *Bos primigenius* right upper first molar MPUR sn019/LJ in occlusal view (b), *Stephanorhinus* sp. left lower third or fourth premolar MPUR sn023/LJ in buccal view (c), *Castor fiber* left lower fourth premolar MPUR sn021/LJ in occlusal view (d).

"*Cervus*" *reichenaui* Kahlke, 1995. However, Lister (1990) recognized that specimens of "*C.*" *elaphoides* represented young individuals of *C. e. acoronatus*; and Pfeiffer (1997) reassigned to *Dama* (*Pseudodama*) *reichenaui* the other taxon.

Other evidences of *C. e. acoronatus* were reported by Di Stefano & Petronio (1992), but these were then reconsidered as *Dama* (e.g., Caune de l'Arago, Saint Prest; Lister, 1990) or the lack of antlers limits the attribution at the species level (e.g., Atapuerca, Azanza & Sanchez, 1990). From the Middle Pleistocene locality of Mauer was instead reported the subspecies *C. e. priscus* (Kaup, 1839), a form considered different from *C. e. acoronatus* in having an incipient crown, with six points (instead of the maximum of 5 points in *C. e. acoronatus*). *C. e. eostephanoceros* was only reported from Hundsheim (Di Stefano & Petronio, 1993). Subsequent recovery and description of new material confirm the occurrence of *C. e. acoronatus* at Caune de l'Arago, and also of *C. e. priscus* (or *C. e. eostephanoceros*), providing evidence of a turnover of two forms between MIS 13 and MIS 12 (Magniez et al., 2013). The authors, however, referred the younger form to *C. e. priscus* (or *C. e. eostephanoceros*), reflecting the close morphological affinity and uncertain relationship between these two taxa.

Of considerable interest for red deer evolution is the sample recovered at Steinheim, which was referred to *C. e. angulatus* Beninde, 1937. Eleven complete or nearly complete antlers were illustrated by Beninde (1937), showing a huge morphological variability. Another taxon was proposed, based on the sample from the Middle Pleistocene site of Riano, *C. e. rianensis* (Leonardi & Petronio, 1974). As reported by the authors, the four antlers recovered from this site show a large variability in number of points (five or six) and development of the crown. Although there are slight differences between the antler from Riano and those of the modern red deer, no subspecies separation would seem supported (Fig. 3g-l). In this respect, the antler found in the Via Flaminia Km 8.2 deposit, initially referred to *C. e. rianensis* (Kotsakis et al., 1978) is particularly relevant (Fig. 3b). In fact, the chronostratigraphic revision of this deposit was carried out by Marra et al. (2018), who referred the fossil level to MIS 13. The authors, in addition, noticed that the antler is closer to *C. e. acoronatus* rather than to *C. e. rianensis.* Considering that the type material of *C. e. eostephanoceros* from Cava Nera Molinario is also correlated to MIS 13 but placed in a lower stratigraphic position (Marra et al., 2014, 2018), this suggests a chronological overlap between the two forms.

4.2. San Cosimato assemblages

Apart from *B. primigenius* and *C. elaphus* from Fontignano 2, there are several other remains recovered from the San Cosimato Fm of Conato et al. (1980) (Fig. 4). Palombo (2004) provided a faunal list, even though without further details on the provenance or description of the material: *Stephanorhinus* sp., ?*Dama* sp., *Cervus* cf. *C. e. eostephanoceros*, *B. primigenius*, and *Castor fiber*. However, the fossils reported by Conato et al. (1980) (*Emys orbicularis*, beavers, and rhinoceros) and other associated remains are housed in MUST and catalogued as from "Via della Pisana - San Cosimato", suggesting that they were recovered from the outcrops of the San Cosimato Fm at Via della Pisana, now referred to the MIS 11 sedimentary cycle (San Paolo Fm; Marra et al., 2014). Salami (1992) also mentioned the recovery of a fragmentary molar of *Palaeoloxodon antiquus* from an outcrop of the San Cosimato Fm at Via di Brava (Fig. 4a). This specimen is housed in PF, but it is not accompanied by more precise stratigraphic information that would allow a correlation with updated Fms, and therefore it could be either MIS 13 or MIS 11 in age (Valle Giulia or San Paolo Fms). Finally, Palombo & Ferretti (2005) reported undescribed remains of *Mammuthus trogontherii* from Fontignano (Rome) housed in the Geological Museum "Giovanni Capellini" of Bologna. However, this is a mistake resulting from a case of homonymy. In fact, according to Verri (1886) the material stored in Bologna was recovered from Fontignano in Umbria (near Perugia).

5. CONCLUSION

Three distinctive LFAs can be recognized under the name San Cosimato: Fontignano 2 (MIS 11), with *B. primigenius* and *C. elaphus*; Via di Brava (MIS 13 or MIS 11), with *P. antiquus*; and San Cosimato (MIS 11), with *Stephanorhinus* sp., *B. primigenius*, *C. fiber*, and *E. orbicularis*. According to Palombo (2004), to this list can be added ?*Dama* sp.

We argue that the name San Cosimato should be restricted to the LFA. Indeed, for bichronological correlations and paleoecological inferences it would be more desirable to refer to updated Fms (e.g., Funiciello & Giordano, 2008), or to geochronologically constrained localities withing them (Milli et al., 2008; Marra et al., 2014; Sardella et al., 2015).

The study of the fossils collected from Fontignano 2 reveals the presence of *B. primigenius* and *C. elaphus*. An overview of the bovid sample of the Middle Pleistocene sites of the Italian Peninsula suggests a first dispersal of *B. prigeminius* in Fontana Ranuccio FU, with no clear evidence of an earlier diffusion (Isernia FU). The geological revision of many fossiliferous sites of the city of Rome and its surroundings allowed to update their chronology. In this new scenario, the two red deer subspecies, *C. e. acoronatus* and *C. e. eostephanoceros*, seem to overlap in time during MIS 13, as testified by the lower stratigraphic position of the type material of *C. e. eostephanoceros* from Cava Nera Molinario than that of *C. e. acoranatus* from Via Flaminia Km 8.2. The coexistence of two red deer subspecies within a so restricted geographical area is hardly conceivable and may reflects the shortcomings of a dichotomic separation in the absence of a clear understanding of population variability. In this respect it is worth to remark that the replacement between acoronated and coronated forms occurring at Caune de l'Arago during the MIS 13 - MIS 12 transition is not abrupt (Magniez et al., 2013), and the presence of more advanced morphologies within the samples of Mosbach and Mauer was also noted (Lister, 1987; Di Stefano & Petronio, 1993). More in general, complete antler remains of *C. elaphus* from the Pleistocene of Europe are scanty, and other morphological and biometric analyses are needed to complement our knowledge on the evolution of the species (Lister et al., 2010; Magniez et al., 2013; van der Made et al., 2014; Iannucci et al., 2020).

The description of the fossil remains from Fontignano 2 highlights the importance of adding faunal element with a clear chronological context for the reconstruction of the Quaternary terrestrial ecosystem of the Euro-Mediterranean area.

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REFERENCES

Ambrosetti P. (1965) - Segnalazione di una fauna con *Elephas antiquus* nella zona di Ponte Galeria (Roma). Bollettino della Società Geologica Italiana, 84(1), 15-28.

Ambrosetti P., Bonadonna F.P. (1967) - Revisione dei dati sul Plio-Pleistocene di Roma. Atti Accademia Gioenia di Scienze Naturali in Catania, 18, 33-70.

Ambrosetti P., Azzaroli A., Bonadonna F.P., Follieri M. (1972) - A scheme of Pleistocene chronology for the Tyrrhenian side of central Italy. Bollettino della Società Geologica Italiana, 91, 169-184.

Azanza B., Sanchéz B. (1990) - Les Cervidés du Pléistocène Moyen d'Atapuerca (Burgos, Espagne). Quaternaire, 3-4, 197-212.

Azzaroli A. (1948) - I Cervi fossili della Toscana con particolare riguardo alle specie villafranchiane. Paleontographia Italica, 43, 45-81.

Azzaroli A. (1961) - Il nanismo dei cervi insulari. Palaeontographia Italica, 56, 1-32.

Balkwill D., Cumbaa S.L. (1992) - Guide to the Identification of Postcranial Bones of *Bos taurus* and *Bison bison*. Canadian Museum of Nature.

Beninde J. (1937) - Über die Edelhirschformen von Mosbach, Mauer und Steinheim a. d. Murr. Paläontologische Zeitschrift, 19(1), 79-116.

Berzi A. (1972) - An early Middle Pleistocene fauna at Monte Oliveto (S. Giaminiano, Siena, Italy). Palaeontographia Italica, 68, 28-33.

Bermúdez de Castro J.M., Arsuaga J.L., Carbonell E., Rosas A., Martínez I., Mosquera M. (1997) - A hominid from the Lower Pleistocene of Atapuerca, Spain: Possible ancestor to Neandertals and modern humans. Science, 276, 1392-1395.

Boschian G., Caramella D., Saccà D., Barkai R. (2019) - Are there marrow cavities in Pleistocene elephant limb bones, and was marrow available to early humans? New CT scan results from the site of Castel di Guido (Italy). Quaternary Science Reviews, 215, 86-97.

Caloi L., Palombo M.R. (1978) - Anfibi, rettili e mammiferi di Torre del Pagliaccetto (Torre in Pietra, Roma). Quaternaria, 20, 315-428.

Caloi L., Palombo M.R. (1979a) - La fauna quaternaria di Venosa: bovidi. Bollettino del Servizio Geologico Italiano, 100, 101-140.

Caloi L., Palombo M.R. (1979b) - Resti di mammiferi del Pleistocene Medio di Malagrotta (Roma). Bollettino del Servizio Geologico Italiano, 100, 141-188.

Caloi L., Palombo M.R. (1986) - Le Mammalofaune Plio-Pleistocene dell'area Laziale: problemi biostratigrafici ed implicazioni paleoclimatiche. Memorie del Servizio Geologico Italiano, 35, 99-126.

Cassoli F., Di Stefano G., Tagliacozzo A. (1999) - I Vertebrati dei livelli superiori (Alfa ed A) della serie stratigrafica di Notarchirico. In: Notarchirico: Un sito del Pleistocene medio iniziale nel bacino di Venosa (Ed. by Piperno M.). Edizioni Osanna, Venosa, Italia, 361-438.

Cassoli F., Segre Naldini E. (1993) - Le faune. In: Dives Anagnia. Archeologia della valle del Sacco (Ed. by Gatti S.). L'Erma di Bretschneider, 30-38.

Conato V., Esu D., Malatesta A., Zarlenga F. (1980) - New data on the Pleistocene of Rome. Quaternaria, 22, 131-176.

Conticelli S., Peccerillo A. (1992) - Petrology and geochemistry of potassic and ultrapotassic volcanism in central Italy: petrogenesis and inferences on the evolution of the mantle source. Lithos, 28, 221-240.

Croitor R. (2018) - Plio-Pleistocene deer of western palearctic: taxonomy, systematics, phylogeny. Institute of Zoology of the Academy of Sciences of Moldova, Chişinău, pp. 140.

De Rita D., Funiciello R., Corda L., Sposato A., Rossi U. (1993) - Volcanic units. In: Sabatini Volcanic Complex (Ed. by Di Filippo M.), Consiglio Nazionale Delle Ricerche, Progetto Finalizzato "Geodinamica" Monografie Finali, 11, 33-79.

Di Stefano G. (1995) - Identification of fallow deer remains on the basis of its skeletal features: taxonomical considerations. Bollettino della Società Paleontologica Italiana, 34(3), 323-331.

Di Stefano G., Petronio C. (1992) - Nuove osservazioni su *Cervus elaphus acoronatus* Beninde del Pleistocene europeo. Bollettino della Società Paleontologica Italiana, 31(3), 295-315.

Di Stefano G., Petronio C. (1993) - A new *Cervus elaphus* subspecies of Middle Pleistocene age. Neues Jahrbuch für Geologie und Paläontologie, 190(1), 1-18.

Di Stefano G., Petronio C. (2002) - Systematics and evolution of the Eurasian Plio-Pleistocene tribe Cervini (Artiodactyla, Mammalia). Geologica Romana, 36, 311-334.

Di Stefano G., Petronio C., Sardella R. (1998) - Biochronology of Pleistocene mammal faunas from Rome urban area. Il Quaternario, 11, 191-199.

Driesch von den A. (1976) - A guide to the measurement of animal bones from archaeological sites. Peabody Museum Bull., 1, 1-136.

Franzen J.L., Gliozzi E., Jellinek T., Scholger R., Weidenfeller M. (2000) - Die spätaltpleistoäne Fossillagerstätte Dorn-Dürkheim 3 und ihre Bedeutung für die Rekonstruktion der Entwicklung des rheinischen Flußsystems. Senckenbergiana lethaea, 80(1), 305-353.

Funiciello R., Giordano G. (2008) - Note illustrative della Carta Geologica d'Italia alla scala 1:50.000, Foglio 374 Roma. APAT, Dipartimento Difesa del Suolo, Servizio Geologico d'Italia, pages 158.

Heintz E. (1970) - Les Cervidés villafranchiens de France et d'Espagne. Mémoires du Muséum National d'Histoire Naturelle. Série C, Sciences de la Terre, 22, 1-303.

Iannucci A., Sardella R., Strani F., Mecozzi B. (2020) - Size shifts in late Middle Pleistocene to Early Holocene *Sus scrofa* (Suidae, Mammalia) from Apulia (southern Italy): ecomorphological adaptations? Hystrix, 31(1), 10-20.

Karner D.B., Marra F., Renne P.R. (2001) - The history of the Monti Sabatini and Alban Hills volcanoes: groundwork for assessing volcani-tectonic hazards for Rome. Journal of Volcanology and Geothermal Research, 107, 185-219.

Kahlke H.-D. (1960) - Die Cervidenreste aus den altpleistozänen Sanden von Mosbach (Biedrich-Wiesbaden). Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, 7, 1-75.

Kahlke H.-D. (1969) - Die Cerviden-Reste aus den Kiesen von Süssenborn bei Weimar. Paläontologische Abhandlungen, A 3(3/4), 547-609.

Kahlke H.-D. (1995) - Der "kleine Hirsch" aus dem unteren Mittelpleistozän von Mosbach (Wiesbaden-Bieberich). Beiträge zur Geologie von Thüringen. Neue Folge, 2, 97-100.

Kaup J.J. (1839) - Eine zweite fossile Art der Hirsch-Gattung aus dem Rheine, *Cervus priscus*. Neues Jahrbuch für Mineralogie, Geognosie. Geologie und Petrefakten-Kunde, 297-300.

Kotsakis T., Palombo M.R., Petronio C. (1978) - *Mammuthus chosaricus* e *Cervus elaphus* del Pleistocene superiore di Via Flaminia (Roma). Geologica Romana, 17, 411-445.

Kotsakis T., Esu D., Girotti O. (1992) - A post-Villafranchian cold event in central Italy testified by continental molluscs and rodents. Bollettino della Società Geologica Italiana, 111, 335-340.

Leonardi G., Petronio C. (1974) - I cervi pleistocenici del bacino diatomitico di Riano (Roma). Memorie dell'Accademia Nazionale dei Lincei, 12, 103-208.

Lister A.M. (1987) - Diversity and evolution of antler form in Quaternary deer. In: Biology and managment of the Cervidae (Ed. by Wemmer C.M.). Washington Smithsonian Institution, Washington, 81-98.

Lister A.M. (1990) - Critical reappraisal of the middle Pleistocene deer species "*Cervus*" *elaphoides* Kahlke. Quaternaire, 3-4, 175-192.

Lister A.M. (1996) - The morphological distinction between bones and teeth of fallow deer (*Dama dama*) and red deer (*Cervus elaphus*). International Journal of Osteoarchaeology, 6, 119-143.

Lister A.M., Parfitt S.A., Owen F.J., Collinge S.E., Breda M. (2010) - Metric analysis of ungulate mammals from the early Middle Pleistocene of Britain, in relation to taxonomy and biostratigraphy. II: Cervidae, Equidae and Suidae. Quaternary International, 228, 157-179.

Magniez P., Moigne A.-M., Testu A., De Lumley H. (2013) - Biochronologie des mammifères quaternaires. Apport des cervidae du site pléistocène moyen de la Caune de l'Arago (Tautavel, Pyrénées-Orientales, France). Quaternaire, 24(4), 477-502.

Marra F., Rosa C. (1995) - Stratigrafia e assetto geologico dell'area romana. Memorie Descrittive della Carta Geologica d'Italia, 50, 49-118.

Marra F., Pandolfi L., Petronio C., Di Stefano G., Gaeta M., Salari. L. (2014) - Reassessing the sedimentary deposits and vertebrate assemblages from Ponte Galeria area (Rome, central Italy): An archive for the Middle Pleistocene faunas of Europe. Earth-Science Reviews, 139, 104-122.

Marra F., Nomade S., Pereira A., Petronio C., Salari L., Sottili G., Bahain J.J., Boschian G., Di Stefano G., Falguerès C., Florindo F., Gaeta M., Giaccio B., Masotta M. (2018) - A review of the geologic sections and the faunal assemblages of Aurelian Mammal Age of Latium (Italy) in the light of a new chronostratigraphic framework. Quaternary Sciences Reviews, 181, 173-199.

Martínez-Navarro B., Palombo M.R. (2004) - Occurrence of the Indian genus *Hemibos* (Bovini, Bovidae, Mammalia) at the Early-Middle Pleistocene transition in Italy. Quaternary Research, 61, 314-317.

Martínez-Navarro B., Palombo M.R. (2007) - The horncore of *Hemibos galerianus* from Ponte Milvio, Rome (Italy). Rivista Italiana di Paleontologia e Stratigrafia, 113, 531-534.

Martínez-Navarro B., Rook L., Papini M., Lisbekal Y. (2010) - A new species of bull from the Early Pleistocene paleoanthropological site of Buia (Eritrea): Parallelism on the dispersal of the genus *Bos* and the Acheulian culture. Quaternary International, 212, 169-175.

Masini F., Palombo M.R., Rozzi R. (2013) - A reappraisal of the Early to Middle Pleistocene Italian Bovidae. Quaternary International, 288, 45-62.

Mecozzi B., Iurino D.A., Profico A., Rosa C., Sardella R. (2020) - The wolf from the Middle Pleistocene site of Ostiense (Rome): the last occurrence of *Canis mosbachensis* (Canidae, Mammalia) in Italy, Historical Biology, pp. 1-12.
Doi: 10.1080/08912963.2020.1769090

Mecozzi B., Iannucci A., Mancini M., Sardella R. (2021a) - Redefining Ponte Molle (Rome, central Italy): an important locality for Middle Pleistocene mammal assemblages of Europe. Alpine and Mediterranean Quaternary, 34(1), 131-154

Mecozzi B., Iannucci A., Sardella R., Curci A., Daujeard C., Moncel M-H. (2021b) - *Macaca* ulna from new excavations at the Notarchirico Acheulean site (Middle Pleistocene, Venosa, southern Italy). Journal of Human Evolution, 153, 102946.

Milli S., Moscatelli M., Palombo M.R., Parlagreco L., Paciucci M. (2008) - Incised-valleys, their filling and mammal fossil record: a case study from Middle-Upper Pleistocene deposits of the Roman Basin (Latium, Italy). GeoActa, Special Publication, 1, 67-88.

Moncel M.H., Santagata C., Pereira A., Nomade S., Voinchet P., Bahain J.J., Daujeard C., Curci A., Lemorini C., Hardy B., Eramo G., Berto C., Raynal J.P., Arzarello M., Mecozzi B., Iannucci A., Sardella R., Allegretta I., Delluniversità E., Terzano R., Dugas P., Jouanic G., Queffelec A., d'Andrea A., Valentini R., Minucci E., Carpentiero L., Piperno M. (2020) - The origin of early Acheulean expansion in Europe 700 ka ago: new findings at Notarchirico (Italy). Scientific reports, 10(1), 1-16.

Nocchi G., Sala B. (1997) - The fossil rabbit from Valdemino cave (Borgio Verezzi, Savona) in the context of western Europe Oryctolagini of Quaternary. Palaeovertebrata, 26(1), 167-187.

Palombo M.R. (2004) - Le mammalofaune della campagna romana: biocronologia, paleoambienti. II Congresso GeoSed, Escursione precongresso, Roma, 1-29.

Palombo M.R., Ferretti M.P. (2005) - Elephant fossil record from Italy: knowledge, problems, and perspectives. Quaternary International, 126, 07-136.

Palombo M.R., Milli S. (2011) - Mammalian fossil record, depositional setting, and sequence stratigraphy in the Middle-Upper Pleistocene of Roman Basin. Il Quaternario, 23(2), 243-248.

Parfitt S., Ashton N., Lewis S., Abel R., Coope G.R., Field M., Gale R., Hoare P., Larkin N., Lewis M., Karloukovski V., Maher B., Peglar S., Preece R., Whittaker J., Stringer C. (2010) - Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. Nature, 466, 229-233.

Pereira A., Nomade S., Moncel M., Voinchet P., Bahain J., Biddittu I., Falguères C., Giaccio B., Manzi G., Parenti F., Scardia G., Scao V., Sottili G., Vietti A. (2018) - Integrated geochronology of Acheulian sites from the southern Latium (central Italy): Insights on human-environment interaction and the technological innovations during the MIS 11-MIS 10 period. Quaternary Science Reviews, 187, 112-129.

Petronio C., Sardella R. (1998) - *Bos galerianus* n. sp. (Bovidae, Mammalia) from the Ponte Galeria Formation (Rome, Italy). Neues Jahrbuch für Geologie und Paläontologie-Monatshefte, 269-284.

Petronio C., Sardella R. (1999) - Biochronology of the Pleistocene mammal fauna from Ponte Galeria (Rome) and remarks on the Middle Galerian faunas. Rivista Italiana di Paleontologia e Stratigrafia, 105(1), 155-164.

Pfeiffer T. (1997) - *Dama* (*Pseudodama*) *reichenaui* (Kahlke 1996) (Artiodactyla: Cervidae, Cervini) aus den Mosbach-Sanden (Wiesbaden-Biebich). - Mainzer Naturwissenschaftliches Archiv, 35, 31-59.

Sala B. (1986) - *Bison schoetensacki* Freud. from Isernia la Pineta (early Mid-Pleistocene, Italy) and revision of the European species of bison. Palaeontographia Italica, 74, 113-170.

Sala B., Barbi G. (1996) - Descrizione della fauna. In: Gli scavi a Castel di Guido, il più antico giacimento di cacciatori del Paleolitico inferiore nell'Agro Romano (Ed. by Radmilli A.M., Boschian G.). Istituto Italiano di Preistoria e Protostoria, Firenze, 55-90.

Salami G.I. (1992) - Rilevamento geologico-strutturale del settore Magliana-Ponte Galeria. Master Thesis, Università degli Studi di Roma "La Sapienza", Roma, pp. 97.

Sardella R., Petrucci M. (2012) - The earliest Middle Pleistocene *Crocuta crocuta* (Erxleben, 1777) at Casal Selce (Rome, Italy). Quaternary International, 267, 103-110.

Sardella R., Bedetti C., Iurino D.A., Pavia M., Bellucci L. (2015) - Comment on "Reassessing the sedimentary deposits and vertebrate assemblages from Ponte Galeria area (Rome, central Italy): An archive for the Middle Pleistocene faunas of Europe" by F. Marra, L. Pandolfi, C. Petronio, G. Di Stefano, M. Gaeta, L. Salari [Earth-Science Reviews 139 (2014), 104-122]. Earth-Science Reviews, 147, 201-203.

Strani F., DeMiguel D., Bona F., Sardella R., Biddittu I., Bruni L., De Castro A., Guadagnoli F., Bellucci L. (2018) - Ungulate dietary adaptations and palaeoecology of the Middle Pleistocene site of Fontana Ranuccio (Anagni, Central Italy). Palaeogeography, Palaeoclimatology, Palaeoecology, 496, 238-247.

Tozzi C. (1969) - Segnalazione di una grotta con fauna fossile a Borgio (Savona). Atti della Società Toscana di Scienze Naturali, Memorie A, 76(1), 195-208.

van der Made J., Stefaniak K., Marciszak A. (2014) - The Polish fossil record of the wolf *Canis* and the deer *Alces, Capreolus, Megaloceros*, *Dama* and *Cervus* in an evolutionary perspective. Quaternary international, 326, 406-430.

van der Made J., Rosell J., Blasco R. (2017) - Faunas from Atapuerca at the Early-Middle Pleistocene limit: The ungulates from level TD8 in the context of climatic change. Quaternary International, 433, 296-346.

Verri A. (1886) - Azione delle forze nell'assetto delle valli con appendice sulla distribuzione dei fossili nella Valdichiana e nell'Umbria interna settentrionale. Bollettino della Società Geologica Italiana, 5, 416-451.

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