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PALAEOECOLOGY AND TAPHONOMY OF THE STRAIGHT-TUSKED ELEPHANT LATE MIDDLE PLEISTOCENE SITE OF POGGETTI VECCHI (SOUTHERN TUSCANY, ITALY)

Chiara Capalbo [1,2], Paul P.A. Mazza[1], Federico Masini [2], Andrea Savorelli [1]

1 Dipartimento di Scienze della Terra, Università di Firenze, Firenze, Italy
2 Dipartimento di Scienze della Terra e del Mare (DISTEM), Università di Palermo, Palermo, Italy
Corresponding author: C. Capalbo <chiaracapalbo@gmail.com>

ABSTRACT: Works for the construction of thermal pools at Poggetti Vecchi, near Grosseto (Tuscany, Italy) exposed an accumulation of fossil bones, largely belonging to the straight-tusked elephant *Palaeoloxodon antiquus*, mixed up with stone and wooden tools. The site is radiometrically dated to the late Middle Pleistocene, and the artefacts were thus created by early Neanderthals. Palaeobiological and taphonomic analyses of the fauna remains are part of a more general, multiproxy study of the site that provides new information on MIS 7-6 transition, as well as on human-animal interactions.

KEYWORDS: Palaeoclimate, palaeoenvironment reconstruction, palaeobiology, taphonomy, elephants

1. INTRODUCTION

Poggetti Vecchi is an open-air archaeo-palaeontological site confined within a narrow valley and located in Southern Tuscany (central Italy), some 5,5 km WNW of Roselle and 7 km NW of Grosseto (42° 49'8.92" N, 11° 4'19.41" E, Fig. 1). The Fig. 2 shows the aerial view of the site, from Bing Map (https://www.bing.com/maps/?cc=it) with details and annotation concerning the location of the cores S1 and S2 and log A and B. The excavation exposed an about 3 m thick sedimentary succession, deposited in a very narrow bay through alternating phases of accumulation and erosion. All in all, seven lithostratigraphical units, of either terrigenous or carbonate nature, have been recognized (U1-U7, Fig. 3). Vertebrate bones, *mixed up with* stone tools and wooden multipurpose digging sticks, were discovered mainly in the lower portion of the succession (Unit 2). The remains are overlain by thermal carbonates, radiometrically dated to 171 ±3 ka (Benvenuti et al., 2017). Based on this dating the human artifacts can be assigned to early Neanderthals; this sparks interest in the site, especially from a geoarchaeological perspective. The utilization of this multidisciplinary approach at Poggetti Vecchi provided valuable new insights into the human and animal life in this period of time and in this part of Italy where palaeontological and prehistoric discoveries had never been reported before.

2. MATERIALS AND METHODS

The vertebrate assemblage includes straight-tusked elephant *Palaeoloxodon antiquus,* aurochs, red deer, roe deer, fallow deer, a very advanced transitional speleoid bear *Ursus deningeri-spelaeus*, *Emys orbicularis*, *Hierophis viridiflavus*, and undetermined birds. There are also many small mammals, including watervole

Fig. 1 - Geographical map of Southern Tuscany showing the

Arvicola amphibius and several other voles [*Microtus* cf. *arvalis*, *Microtus* (*Terricola*) ex gr. *savii* and *Microtus* sp]. Most of the bones (a total of 747) were found in Unit 2. Palaeobiological and taphonomic analyses here presented have been integrated into a geoarchaeological multiproxy study of the site.

The relative abundances of the taxa from the different layers were expressed in number of identified specimens (NISP) and minimum number of individual (MNI) counts. Specimens have been attributed to individuals by side matching, taking into account several characteristics, such as size, relative proportions, the degree of

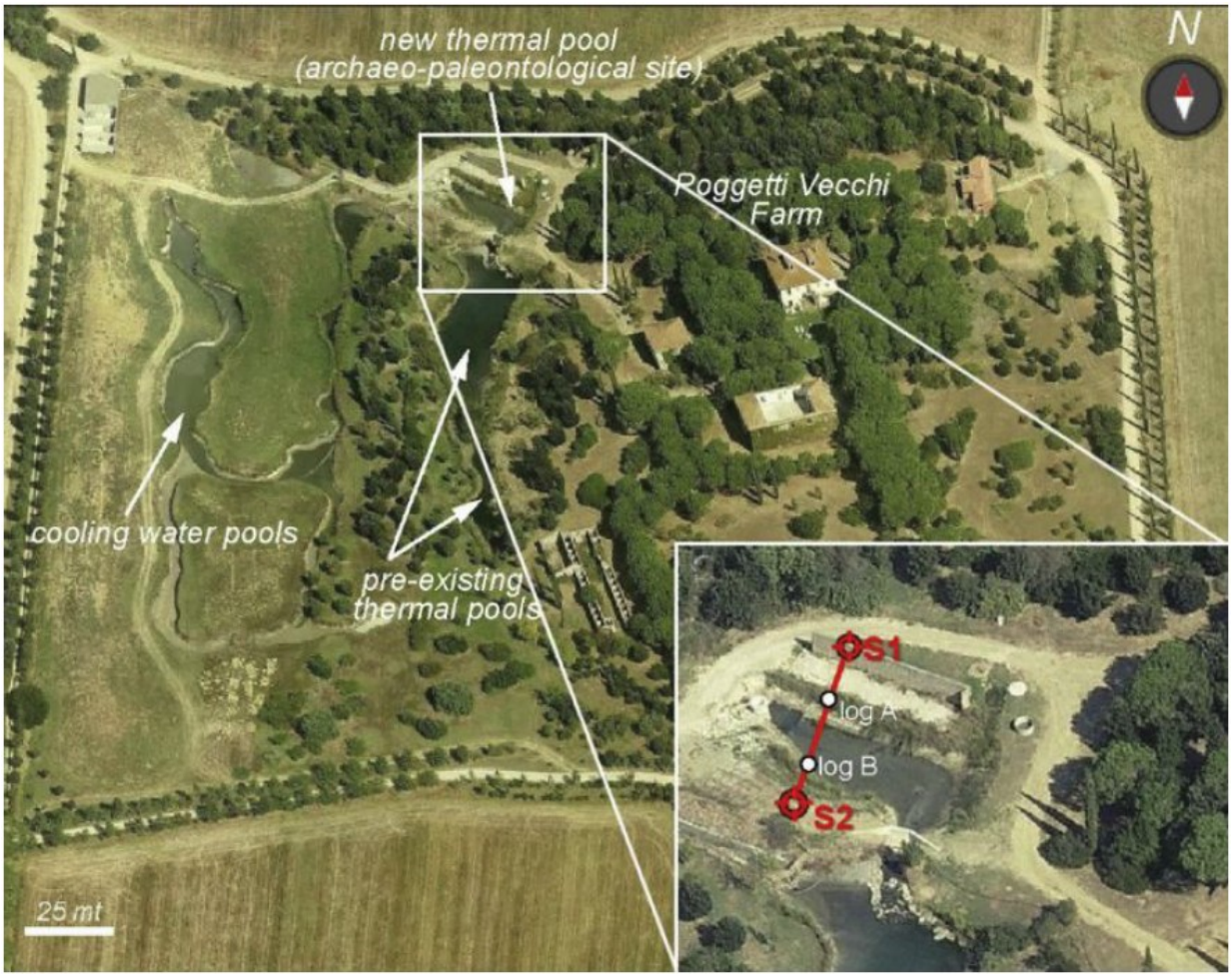

Fig. 2 - Aerial view of the site with the location of cores S1 and S2 and logs A and B as reported in Fig. 3. (The Figure was drawn from Benvenuti et al., 2017).

ossification, age and state of preservation. To avoid biases induced by different fragmentation potential, the NISP was calculated separately for each of three distinct size classes (<10-100 kg; 100-300 kg; >300 kg).

The Poggetti Vecchi fauna comes from a lacustrine marginal deposit; the susceptibility of the specimens to hydraulic transport and fluvial scattering had to be estimated by adopting Vorrhies' approach (Behrensmeyer, 1975; Villa & Mahieu 1991; Voorhies, 1969). Bone surface modifications (pre- and post-depositional) were sought for using conventional analytical approach. The degree of weathering was evaluated following Behrensmeyer's (1978) weathering stages (from stage 0 – non altered to stage 5 – heavily altered). The palaeobiology of the Poggetti Vecchi mammals (age and sex) have been assessed based on different proxies. Ontogenetic ages were calculated from the degree of ossification and epiphyseal fusions (Roth, 1984; Kangwana, 1996; Lister, 1999; Reitz & Wing 2010; Speth, 2000; Herridge, 2010), as well as from tooth eruption and wear (Laws, 1966; Krumrey & Buss 1968; Brown & Chapman 1991; Haynes, 1991; Hillson, 2005; Rasmussen et al., 2005). Some of Poggetti Vecchi's mammal remains have been tentatively sexed, aiming at assessing the relative frequencies of males and females. Palombo & Villa (2003) was followed to sex the remains of *Palaeoloxodon antiquus*.

3. RESULTS

The macromammal assemblage from Unit 2 is dominated by very large herbivores: the straight-tusked elephant *Palaeoloxodon antiquus* and the aurochs *Bos primigenius* (39.9% and 19.4% of the largest species, respectively). Based on the developmental stages of different skeletal remains (skull, mandible, molar, and tusk) from Unit 2, *Palaeoloxodon antiquus* is represented by a total of 7 individuals: three juveniles of 1-8 years, one 14-15-year-old sub-adult, two 20-30-year-old adults, and one individual older than 40 years. The skulls are crushed into splinters; a fairly complete, but poorly preserved, tusk (n.162) belongs to one of the prime adult individuals. Based on the criteria proposed by Palombo & Villa (2003) and Lister (1996), the assem-

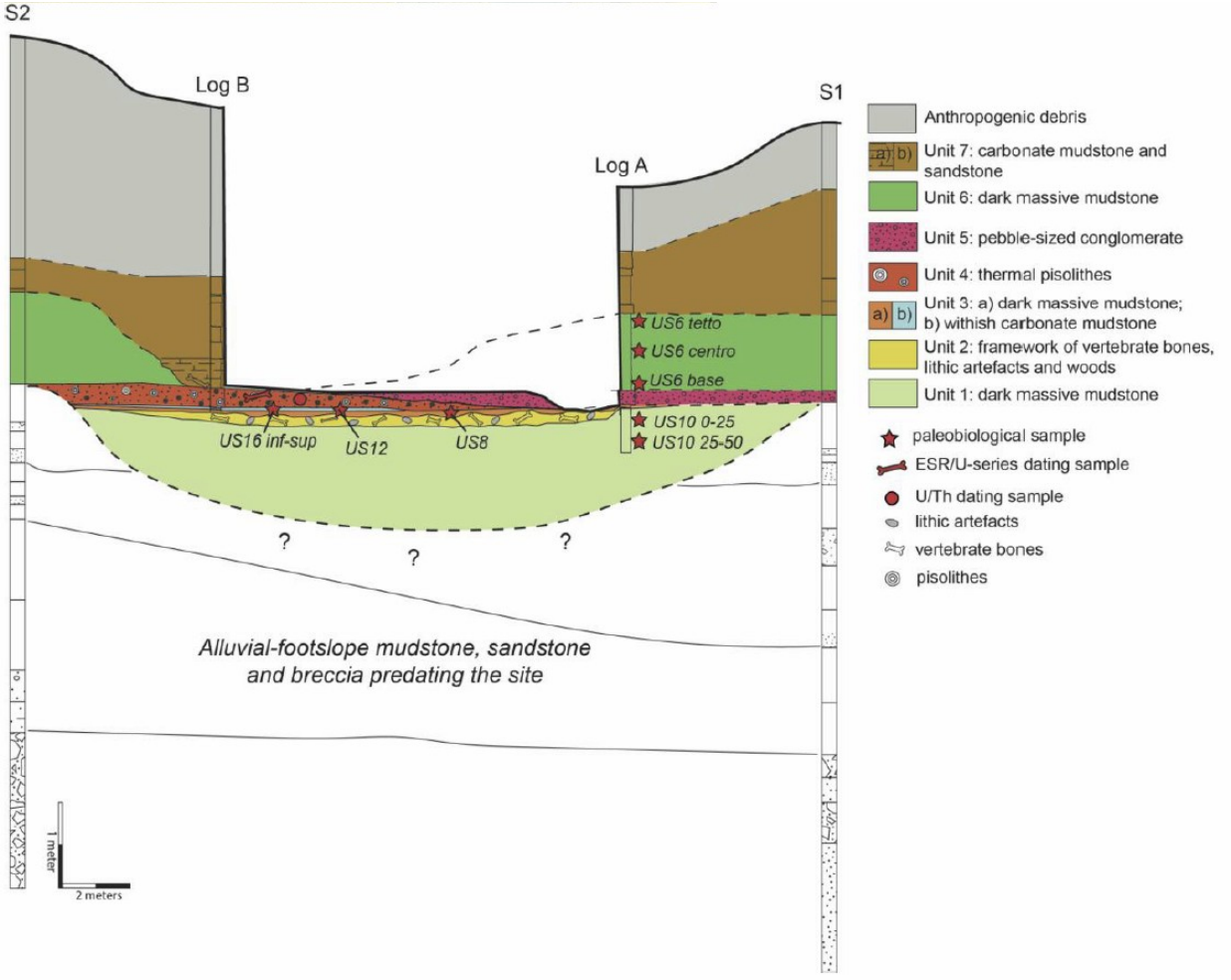

Fig. 3 - Correlation of stratigraphical data along the cross section showed in Fig. 2. (The Figure was drawn from Benvenuti et al., 2017).

blage from Poggetti Vecchi's Unit 2 includes elements of both males (i.e., the right pyramidal 987 has the articular surface for the unciform largely overlapping the hooked process; the right uncinate 295 bears an elongated and straight joint surface for metacarpal V) and females (i.e., the right coxal bone 5245 with the wing of the ileum shaped like that of female individuals of *Mammuthus*).

The bones retrieved from the dark clay sediments of Unit 2 had subhorizontal orientation, and were concentrated in a NE-SW-trending strip. They were found juxtaposed with little or no sediment in between. The general state of preservation of the bones is good; almost all, however, are broken and have severely scratched surfaces (37,2%). The relative skeletal frequencies of the site's best-represented species, i.e., *Palaeoloxodon antiquus* and *Bos primigenius*, gave revealing results. The vertebrae, ribs, basipodial bones, and phalanges of *P. antiquus* are unexpectedly underrepresented whereas the opposite occurs for *B. primigenius* (Fig. 3). Due to their high fragmentation, ribs are generally overestimated in the NISP counts.

The analysis of the collection of remains of *Palaeoloxodon antiquus* reveals that easily winnowed bones of the Voorhies Groups I (i.e., ribs and vertebrae) and I & II (i.e., phalanges) are under-represented; in contrast, the modestly transportable ones, belonging to Voorhies Group II (i.e., humerus, radius, pelvis, femur, tibia, metapodial) and the lag elements of Voorhies Group III (i.e., skull, mandible), are quite more numerous. Moreover, the elephant bones show relatively low incidence of abrasion/polishing (18.63%). Conversely, *Bos primigenius*, *Cervus elaphus* and *Capreolus capreolus* are largely represented by bones that are susceptible to hydraulic transport and most of them are polished and show evidence of abrasion.

Based on NISP counts, virtually all the hardparts are broken (95%). Most (23%) were fractured in dry state and only 6% in fresh state; spiral fractures are rare (3,7%).

Very few bones (2.5%) have undergone modest weathering (1.7% are in weathering stage 1, and 0.7% in weathering stage 1/2-2: Behrensmeyer 1978). Root etching (1.9%) was observed on the bone surfaces and, sometimes, also on the fractures. Humic corrosion evi-

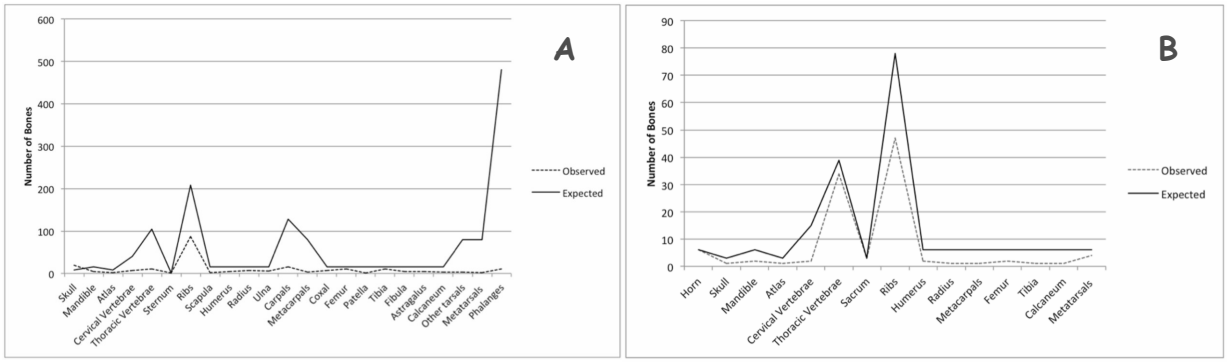

Fig. 4 - Frequencies of skeletal parts (observed versus MNI-based expected amounts of bones). A) *Palaeoloxodon antiquus*; B) *Bos primigenius*. In A) we notice a marked under-representation of axial bones, basipodial bones and phalanges.

dence is very low (1.1%).

A few bones (5%) show evidence of scavenging. The size of the scoring marks, pits and bites are suggestive of a predator or scavenger with blunt pointed teeth. The occurrence of rare hyena coprolites and of an erratic left second lower premolar of the spotted hyena *Crocuta crocuta* attest to the presence of these carnivores at the site. Finally, only three specimens show evidence of human-derived modification: the lateral portion of the diaphysis of a left humerus of *Bos primigenius*, the basal portion of a shed right antler and a fragmental diaphysis of a tibia of *Cervus elaphus*. Both humerus and tibia are very polished.

4. DISCUSSION AND CONCLUSION

The radiometric datings from Unit 4 locates the whole section at a time period between late MIS 7 and late MIS 6. The geological and palaeobiological reconstructions of the site are detailed in Benvenuti et al. (2017). The evidence accumulated by this multi- and interdisciplinary teamwork unraveled the succession of events that occurred during the deposition of the Poggetti Vecchi sedimentary succession (Units 1-6). Four different flooding events were detected, separated by regressions. During the flooding episodes, homogeneous organic muds deposited in this shallow, protected lacustrine setting; in contrast, vertebrate remains and human artifacts accumulated on the erosive surfaces that formed during the regressions.

The fossil records tell us that at the time when the fossiliferous site was formed, the area was dominated by extensive open grassland inhabited by large herbivores, among which *Palaeoloxodon antiquus* and *Bos primigenius*, whereas the red and roe deer probably browsed in sparse groves. This outline is confirmed by the abundant herbaceous plant pollen, especially of Poaceae, which dominates the spectra along all the stratigraphy. The abundant frequency of freshwater fens, together with the high variety of wetland plants and rich mollusk and ostracod assemblages recorded along the whole sedimentary succession, confirm periodic fluctuations of groundwater seeps and freshwater bodies.

In particular, palaeooecological insights indicate that the Unit 2 fauna was well-tuned with the climatic and environmental fluctuations that occurred within the short time period between the onset of MIS 6 (lake lowstand and subaerial erosion at the transition from Unit 1 to Unit 2) and the next interstadial (lake highstand phase and deposition of sedimentary Units 3-4). The palaeobiological inferences from the small and large mammal assemblages are coherent with the succession of palaeoenvironmental signals and sedimentary events and their tuning with the main climatic fluctuations.

Poggetti Vecchi differs from other similar sites in many respects (e.g. stratigraphical age, number of elephants involved, kind of artifacts). The lack of palaeobiological and taphonomic evidence for active hunting suggests that the elephants probably died from some natural, catastrophic event.

The presence of females and males of a wide age spectrum and the bone-to-bone contact (with virtually no sediment in between) of their remains suggest that the elephants were components of a family group, which likely died altogether at the same time. A plausible scenario to account for these simultaneous deaths could be a very intense cold snap, beyond the elephants' thermal tolerance limits and too sudden to flee from.

Based on these insights, it can be speculated that the narrow valley of Poggetti Vecchi, with its geothermal hot springs, offered a shelter to the elephant clan during a particularly cold season during the transitional MIS 7-6 time span. It can be speculated that by being forced to stay near the only heat source, they consumed all the vegetation in the surrounding area and finally died of starvation.

The accumulated evidence indicates that the carcasses lied largely unexposed and inaccessible to predators, presumably at least partially immersed in water. Decomposition then progressed in the conservative environment until complete skeletonization. After this, the skeletons were disarticulated, and the bones scattered nearby, presumably by occasional (seasonal) streams of water.

Palaeobiological and taphonomical data suggest the death of elephants cannot be associated with active hunting, although elephants were butchered soon after their death. The high amount of stone and wooden implements that were found closely interspersed among the bones, all over the area, is an indisputable sign of animal - human interaction. Hence it likely suggests that

humans managed to access the great amount of flesh that the lucky circumstances made available. The wear patterns on the edges of stone tools indicate butchering actions on soft animal tissues, but also the scraping or shaving of wood, which suggests that the wooden rods were probably at least partially manufactured directly at the site. It is also likely that humans removed only small amounts of flesh, without reaching the bones with the tools they used for processing the carcasses.

The scattering of the bones in a fairly small area, the total lack of anatomical articulation and the virtual absence of specific kinds of bones, such as vertebrae, basipodial and metapodial bones, and phalanges underscore an apparent skeletal selection. Whether this occurred before or after the skeletonization and dismembering of the carcasses is yet unclear. The behavior of extant African hunters (Crader, 1983; Fisher, 1992) may provide insights into the possible patterns of processing and preferential selection of the elephant carcass parts at Poggetti Vecchi. In general, the proximal parts of the limb bones (humeri and femora) and the extremities (carpals, tarsals and phalanges) are removed from the carcasses and transported to the villages, where the flesh can be stripped off more accurately and the marrow extracted if necessary. A similar behavior could explain the underrepresentation of basipodial and metapodial bones and phalanges in the Poggetti Vecchi elephant samples. Nonetheless, the Voorhies (1969) categories of bones represented at the site indicate that the winnowing action of streaming water could also well explain the very low frequencies of easily transportable elements. At the same time, streaming water may account for the occurrence of the remains of other taxa (*Bos*, *Cervus*, *Capreolus*): these bones, which are quite susceptible to hydraulic transport, are largely abraded or polished. They were therefore likely reworked from uphill areas and are allochthonous for the site.

The extensive scratching of the bone and tusk surfaces, as well as by the dominance of dry bone breakage is highly suggestive that the skeletons were trampled over, perhaps repeatedly, by bypassing animals, elephants included. Hence, trampling and kicking can account for their disarticulation and scattering, at a time when the bones were already in dry state. Finally, the root etching and humic corrosion on many bones are probably associated with plant colonization.

Poggetti Vecchi offers the chance to obtain an unprecedented amount of information on how local early Neanderthals interacted with the animals of the time, as well as on how skillfully flexible they were in response to contingencies under the challenging environmental and climatic conditions at the MIS 7-6 transition.

Based on the collected evidence, local human hunters benefited from the large accessibility to concentrated resources unexpectedly made available by the fortunate interplay of palaeobiological, geological and climatic factors. The site thus offers critical information on the behavior of early Neanderthals, which is still very imperfectly known. Contrary to previous belief, early Neanderthals appear to have been particularly skilled to deal opportunistically with environmental and climatic adversities, and able to modify over time the scheduling of their exploiting strategies.

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REFERENCES

Behrensmeyer A.K. (1975) - The taphonomy and paleoecology of Plio-Pleistocene vertebrate assemblages east of Lake Rudolf, Kenya. Bulletin of the Museum of Comparative Zoology, 146, 473-578.

Behrensmeyer A.K. (1978) - Taphonomic and ecological information from bone weathering. Paleobiology, 4, 150-162.

Benvenuti M., Bahain J. J., Capalbo C., Capretti C., Ciani F., D'Amico C., Esu D., Giachi G., Giuliani C., Gliozzi E., Lazzeri S., Macchioni N., Mariotti Lippi M., Masini F., Mazza P.P.A., Pallecchi P., Revedin A., Savorelli A., Spadi M., Sozzi L., Vietti A., Voltaggio M., Aranguren B. (2017) - Paleoenvironmental context of the early Neanderthals of Poggetti Vecchi for the late Middle Pleistocene of Central Italy. Quaternary Research, 88(2), 327-344.

Brown W.A.B., Chapman N.G. (1990) - The dentition of red deer (*Cervus elaphus*): a scoring scheme to assess age from wear of the permanent molariform teeth. Journal of Zoology, 224, 519-36.

Crader D.C. (1983) - Recent single-carcass bone scatters and the problem of "butchery" sites in the archaeological record. In: Clutton-Brock J., Grigson C. (Eds.) - Animals and Archaeology, Hunters and Their Prey. BAR International Series 163, vol. 1, Oxford.

Fisher Jr. J.W. (1992) -Observations on the late Pleistocene bone assemblage from the Lamb Spring site, Colorado. In: Stanford D.J., Day J.S. (Eds.) - Ice Age Hunters of the Rockies. Denver Museum of Natural History and University Press of Colorado, Niwot (CO), 51-81.

Haynes G. (1991) - Mammoths, Mastodonts, and Elephants: Biology, Behavior, and the Fossil Record. Cambridge University Press, Cambridge, pp. 413.

Herridge V.L. (2010) - Dwarf elephants on Mediterranean islands: a natural experiment in parallel 531 evolution. PhD thesis, University College London. http://discovery.ucl.ac.uk/133456/.

Hillson S. (2005) - Teeth. Cambridge University Press.

Kangwana K. (1996) - Studying Elephants. In: AWF Technical Handbook Series, vol. 7. African Wildlife Foundation, Nairobi, Kenya, pp. 178.

Krumrey W.A., Buss I.O. (1968) - Age estimation, growth, and relationships between body dimensions of the female African elephant. Journal of mammalogy, 49(1), 22-31.

Laws R.M. (1966) - Age criteria for the African elephant, *Loxodonta a. africana*. East African Wildlife Journal

4, 1-37.
Lister A.M. (1996) - Sexual dimorphism in the mammoth pelvis: an aid to gender determination. In: Shoshani J. & Tassy P. (eds.) The Proboscidea. Oxford University Press, Oxford, 254-259.
Lister A.M. (1999) - Epiphyseal fusion and postcranial age determination in the woolly mammoth, *Mammuthus primigenius* (Blum.). Deinsea 6, 79-88. (25). Deinsea, Annual of the Natural History Museum Rotterdam, 6, 79 - 88.
Palombo M.R., Villa P. (2003) - Sexually dimorphic characters of *Elephas (Palaeoloxodon) antiquus* from Grotte Santo Stefano (Viterbo, Central Italy). In Reumer J.W.F., DeVos J., Mol D. (Eds.), Advances in Mammoth Research. Proceedings of the Second International Mammoths Conference, Rotterdam, May 16-20, 1999. Deinsea 9, 293 - 315.
Rasmussen H. B., Wittemyer G., Douglas-Hamilton I. (2005) - Estimating age of immobilized elephants from teeth impressions using dental silicon. African Journal of Ecology, 43(3), 215-219.
Reitz E., Wing E. (2010) - Zooarchaeology (Third edition), Cambridge, Cambridge University Press.
Roth V. L. (1984) - How elephants grow: heterochrony and the calibration of developmental stages in some living and fossil species. Journal of Vertebrate Paleontology, 4, 1, 126-145.
Speth J.D. (2000) - Boiling vs baking and roasting: a taphonomic approach to the recognition of cooking techniques in small mammals. In: Rowley-Conwy, P. (Ed.), Animal Bones, Human Societies. Oxbow Books, Oxford, 89-105.
Villa P., Mahieu E. (1991) - Breakage patterns of human long bones. Journal of Human Evolution 21, 27-48.
Voorhies M. (1969) - Taphonomy and population dynamics of an Early Pliocene vertebrate fauna, Knox Country, Nebraska. University of Wyoming Contributions to Geology Special Paper No. 1, Larmie.

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