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Title: Evidence of butchery marks and anthropic modifications on horse remains in a Late Bronze Age site of northern Italy: the case of Bovolone.

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Keywords: Horse exploitation; Cut-marks; Bone artefacts; Taphonomy; Archaeozoology; SEM; Late Bronze Age; Po plain; Northern Italy

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Abstract: The site of Bovolone (Verona, northern Italy) was discovered in 1996 and has been the object of systematic excavations until 2005. The settlement has been dated on the basis of pottery remains and bronze objects to Late Bronze Age. The analysis of the faunal remains shows a predominance of domestic compared to wild fauna. When compared to other contexts of the Bronze Age in northern Italy, horse presence is attested by an high number of remains. The low frequency of horse remains in the living contexts has always been considered a consequence of the value that this animal had during the Bronze Age. The site of Bovolone opens a new perspective, because the remains analyzed have yielded evidence of anthropic traces attributable to various processes of the slaughter chain and the use of certain anatomical elements to manufacture artifacts.

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Opposed Reviewers:

Title: **Evidence of butchery marks and anthropic modifications on horse remains in a Late Bronze Age site of northern Italy: the case of Bovolone**

Key-words: Horse exploitation, Cut-marks, Bone artefacts, Late Bronze Age, Po plain, Northern Italy

Authors Order: Marco Bertolini, Ursula Thun Hohenstein

Dear Editor,

we wish to submit a manuscript devoted to the results of the research carried out the horse remains coming from the site of Bovolone (Verona, northern Italy), dated on the basis of pottery remains and bronze objects to Late Bronze Age. The faunal assemblage shows, when compared to other contexts of the Bronze Age in northern Italy, an high number of horse remains with evidence of butchery.

This the first evidence on the Italian penisula of horse exploitation after its reintroduction during the bronze Age.

We hope that our contribution meets the interests and standards of your prestigious journal. All co-authors agree with submission of the manuscript, the research is our own and has not been previously published or submitted for publication elsewhere.

Author information

The authors declare no competing financial interests and that none of the material has been published and it is an original contribute.

Yours Sincerely,

Ursula Thun Hohenstein

Corresponding author and scientific director of the project

Reviewer #1:

1. The authors present an important methodological part for the systematic study of horses (age, sex, height of withers, etc.) but taphonomic or zooarchaeological methodology haven't been included (MNI, MNE, cutmarks, bone breakage, etc.). It is advisable to include this methodology, even synthetically.

DONE

2. It is necessary to consider the use of *Equus ferus* rather than *Equus caballus* because, at present, both species (wild and domestic) are considered the same species, and wild name should prevail over domestic.

We homogenize the use of *Equus ferus* and *Equus caballus*.

3. It would be interesting if the authors deepening about causes of anatomical bias of horses. Have recovered 189 remains belonging to 6 individuals, there is no skeletal axial and some elements such as carpal and patellas are totally absent. Perhaps the use of quantification indices as %MAU or similar could be useful in this regard.

Done

4. Why the remains of horse, and especially the axial appear so fragmented? This happens with other taxa or is exclusive of horses? I consider it is interesting to delve into this fact because the underrepresentation of the horse in these chronologies. The Bovolone record could provide very interesting information.

Done

5. The authors emphasize the presence of remains belonging to *Equus asinus*, by their scarcity in the fossil record, but then does not comment anymore about them. What anatomical elements are? It might be interesting that information about them be extended.

Done

6. The authors explain that there are fresh bone breakage, but there are singular breakage patterns?

Done

7. The typology of bone fractures of horse are similar to their in other taxa?

Done

8. Three bone artifacts are described, but then the authors refer to only two objects, slide and skate foot. I must think the distal metapodial and proximal metatarsal belong to a single object? Perhaps it is not clear in the text.

They could belong to the same object but they have been discovered in different SSUU

9. Why no pictures of the artifact on radius?

We decide to keep unpublished for a future work.

10. Although it is convincing the interpretation on bone artifacts, it is desirable that the authors discuss the possibility of other uses or purposes for these objects to reinforce the final interpretation.

DONE

11. I consider it is necessary to extend the conclusions. As they seem more future proposals than conclusions themselves.

DONE

12. Minor comments:

Figures:

Figure 7 it is necessary to include some comment about images D and E.

Figure 8 it is necessary to include some comment about images E and F.

DONE

Tables:

Could be interesting if authors include some geographical reference about sites listed in table 4 for aid to reading.

DONE

References:
Bellato and Bellintani (1975) y Bellintani and Cassoli (1974) are poorly sorted, they must be located before Bendrey (2007)

Bertolini: the year of publication is absent (2014?)

DONE

Reviewer #2:
Minor points:

- 95: clarify what these hybrid horses are

DONE

- 97 onwards: the way in which Warmuth et al's work is supposed to have "allowed to identify the origin of domestic horses" is very unclear; this passage requires re-writing

DONE

- 194 (and others): no point in providing %s with one or more decimal points; it gives a false sense of precision

DONE

- 259: the identification of the donkey requires to be better justified; also are there butchery marks on donkey bones too?

DONE

- 320: clarify if 'butchery marks' also include skinning marks. In general a comment concerning to what extent cut marks can be associated with skinning is needed.

DONE

- Final part of the discussion: the occurrence of bone artefacts made of horse bones is commendably put in its European context; it seems to me necessary to do the same for the butchery marks. This is the earliest Italian sites with butchery marks on horse bones, but how does this compare with the wider European evidence?

DONE

Evidence of butchery marks and anthropic modifications on horse remains in a Late Bronze Age site of northern Italy: the case of Bovolone

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Abstract

The site of Bovolone (Verona, northern Italy) was discovered in 1996 and has been the object of systematic excavations until 2005. The settlement has been dated on the basis of pottery remains and bronze objects to Late Bronze Age. The analysis of the faunal remains shows a predominance of domestic compared to wild fauna. When compared to other contexts of the Bronze Age in northern Italy, horse presence is attested by a high number of remains. The low frequency of horse remains in the living contexts has always been considered a consequence of the value that this animal had during the Bronze Age. The site of Bovolone opens a new perspective, because the remains analyzed have yielded evidence of anthropic traces attributable to various processes of the slaughter chain and the use of certain anatomical elements to manufacture artifacts.

Key-words: Horse exploitation, Cut-marks, Bone artefacts, Late Bronze Age, Po plain, Northern Italy

1. Introduction

1.1 *Exploitation of the horse in the Bronze Age*

The archaeozoological data until now available for the Bronze Age settlements show a constant shortage of skeletal remains related to the horse in faunal assemblages if compared with the frequencies of other domestic species (De Grossi Mazzorin, 1995; De Grossi Mazzorin et al., 1998). This aspect has often been interpreted as a consequence of the fact that these animals had to play a certain role in traction or transportation, and not in the alimentary purposes (De Grossi Mazzorin et al., 1998).

With particular regard to the Bronze and Iron Age, the hypothesis that over the years has increasingly been consolidated in the Italian territory is that this animal was a status symbol, that only a few small groups of people could have available (De Grossi Mazzorin et al., 1998).

This hypothesis was essentially supported by three main factors: the reduced amount of remains within the archaeological sites when compared to the other domestic animals; the bones found within the residential contexts are often complete and free from traces of butchering or cooking.

The latter aspect was supported according to the same authors from some archaeological finds, such as for example the case of the village of Frattesina (Rovigo - northern Italy) where a limb of horse was found in anatomical connection with evident traces left by carnivores (De Grossi Mazzorin, 1995; De Grossi Mazzorin et al., 1998).

Finally, the horse seems to have a valency of religious character, reinforced by the presence of clay figurines found within many villages of the Terramare (Bettelli, 1997).

Aim of this work is to expose the recent results of the analyses conducted on the equine remains found within the site of the Late Bronze Age in Bovolone, that bring to light new aspects of the economic exploitation of this animal during the Late Bronze Age in northern Italy.

1.2 Spread of the horse in Italy

When and how the horse was domesticated is a question that for years has been the subject of research and debate in an international context (Anthony, 2007; Levine, 1996, 1999, 2004, 2005, 2006).

The research undertaken in the last twenty years have certainly broadened our knowledge enabling us to recover some important information regarding its dissemination and domestication in Eurasian continent, aspects that according to some authors (Anthony, 2007; Outram et al., 2009) would seem to be related to the dissemination of the Indo-European languages and cultures, of metallurgy and specialized forms of combat. During the Pleistocene the wild horse was fairly common in Europe, hunted by the hunter-gatherers. This animal is generally correlated to open environments of prairie, where there are relatively poor *habitats* with strong seasonal variations (van Asperen, 2010).

On the basis of the archaeological record, with the start of the Holocene there is a reduction of this animal in the European territory (Anthony, 2007; Levine, 2004), so that in some areas seems to have completely disappeared (Arbogast et al., 2002; Bendrey, 2012). The drastic demise is certainly due to the presence of more temperate climate periods with the beginning of the Holocene, in association to the increase of forest cover (Bendrey, 2014; Orlando et al., 2013).

The distribution of the populations of wild horses during the chronological period in which began the domestication is clearly to relate to the Steppes extended across the north of the Eurasian continent (Bendrey, 2014; Sommer et al., 2011; Warmuth et al., 2011).

The genetic analysis carried out on modern populations of horses in the various villages of the northern Eurasian steppe, has allowed providing additional support for an origin of horse domestication in Eurasian steppe, as suggested by archaeologist (Warmuth et al., 2012). Warmuth et al. (2011) investigated the patterns of genetic diversity in modern purebred horses from different European locations, to distinguish the regions where the domestic population might have originated from a local wild population, and where the horses were imported in the past. The results show a high genetic diversity in breeds from Iberian and Caspian Sea regions.

The presence of open environments in the Iberian Peninsula and in south-eastern and eastern Europe (the Balkans, the northern area of the Pontus and the Russian plain), might have consisted of refuge areas for wild horses due to the persistent expansion of forest cover in south-central Europe during the Holocene (Warmuth et al., 2011).

On the basis of archaeological data, the wild horse seems to be disappearing in the Italian peninsula towards the end of the Upper Pleistocene, and then reappears in the domesticated form in full Holocene, during the Bronze Age (Azzaroli, 1985; De Grossi Mazzorin, 1995; De Grossi Mazzorin et al., 1996).

Only the isolated case of Monte Fellone in Puglia would be the sole evidence of wild horses in the Italian territory during the Early Neolithic (Azzaroli, 1985). According to Azzaroli (1985), it would be perhaps one of the last wild populations survived in the Peninsula, but the same author is complaining of serious questions about the datings of deposit.

Therefore, the most ancient evidence seems to be traced to some Eneolithic contexts, including the "bell-beakers" village of Querciola (Firenze) (Corridi and Sarti, 1989-1990) and the burial site of Cerquete-Fianello (Roma) (Curci and Tagliacozzo, 1994) that have returned skeletal remains attributable, according to the authors, to the domestic horse, therefore placing a *post quem* term for the reintroduction of this animal in the Peninsula towards the end of the Copper Age. Previously on these discoveries, there were sporadic reports of this animal in Eneolithic contexts, such as the necropolis of Remedello (Colini, 1898-1902), and the sites of Conelle and Berbentina of Sassoferrato dated between the Late Eneolithic and the first phase of the Early Bronze Age, that according to Peroni (1989), despite the uncertainty concerning the dating of contexts could constitute a tangible proof of the presence of the horse during the Italian Eneolithic.

The archaeological documentation concerning the domestic horse in the Early Bronze Age is still very scarce; in fact, the most ancient finds are concentrated in northern Italy and come from villages of Mori loc. Colombo (Trento) (Marconi, 2005), Sonnenburg (Bolzano) (Riedel, 1984) and Barche of Solferino (Mantova) (Riedel, 1976), and are mainly characterized by a small number of artefacts.

Recently, the analysis of faunal finds from the villages of the Early Bronze Age in Lavagnone (Desenzano, Brescia) (De Grossi Mazzorin and Solinas, 2013) and Povegliano (Verona) (Bertolini et al., 2015) would provide new and important evidence of the presence of this animal in the territory in this prehistorical phase.

The documentation of domestic horse precisely on these sites would favour the hypothesis according to which the import took place from the north, probably through the Alpine passes of Brenner or Dobbiaco and the Adige valley, up to its mouth in the Po Valley (Azzaroli, 1972, 1985; De Grossi Mazzorin, 1995)

In central Italy the situation is more uncertain since the artefacts come from the excavations of old date or chronologically unclear contexts. In addition to the signalling in the necropolis of Cantalupo (Roma) (Colini, 1898-1902), there are equine remains in Conelle of Arcevia (Ancona) and Berbentina of Sassoferrato (Ancona), mentioned above, on which datings Azzaroli (1985) expresses many doubts.

Starting from the Middle Bronze Age, the amount of sites that have returned remains of horse greatly increases, indicating that the equine breeding was already fairly widespread in this chronological phase (De Grossi Mazzorin, 1995).

The central Po Valley is the area in which focus more discoveries, especially among Veneto, eastern Lombardy, and Emilia-Romagna.

Despite the number of documentations increases significantly with respect to the Early Bronze Age, the amount of remains found is always very small if compared to other domestic *taxa*, except for certain Terramare sites as Poviglio (Reggio Emilia) (Riedel, 1989) and Gorzano (Modena) (Azzaroli, 1972), where respectively were discovered 65 and 102 bone fragments of horse. In central Italy remains of horse associated with pottery finds dating back to the Early Bronze Age and the beginning of the Middle Bronze Age were discovered in the submerged village of Vicarello in Bracciano lake (Fugazzola Delpino, 1982) which, however, given the nature of the archaeological deposit their datings are not secure. To these are, in addition, the remains found in the swamps of

Celano (L'Aquila) (De Grossi Mazzorin, 1989) and S. Mauro (Salerno), and at the site of Tufariello of Buccino (Salerno) (De Grossi Mazzorin, 1995, 1996).

Between the Middle and the Late Bronze Age, there was a significant increase in documentations of this animal which, however, as in the previous phases, are accompanied by a small number of remains that generally never exceeds 70 units. With respect to the Middle Bronze Age, spreading appears to embrace the entire Peninsula by highlighting how the domestication of the horse was part of the cultural heritage of the community of the Bronze Age present in our territory (De Grossi Mazzorin, 1995).

1.3 The site of Bovolone

The site is located in the countryside to the east of the town of Bovolone located a few km south of Verona. The site was discovered in 1995, during agricultural works to the north of Via Crosare which is located to the east of the town (Fig. 1).

Traces of a complex and very probably stable village appear according to the archaeological evidence already starting the Middle Bronze Age. The site, however, seems to reach its full development from Late Bronze Age (1,350 – 1,170 BC), step better documented from archaeological material found. Archaeological investigations have brought to light part of a very extensive and structured village.

The buildings are characterized by a rectangular plan, and consist of wooden structures identified by the presence of postholes for the housing of the poles (Fig. 1). In total there were recognized at least a dozen housing of dimensions traceable back to modules of about 10x7 m and in some cases small modules of 7.5x7 m.

Fig. 1. Location of the site of Bovolone. The settlement is located in northern Italy, 30 kilometers south of Verona. The excavation area brought to light part of a very extensive and structured village (bottom right image courtesy of Soprintendenza per i Beni Archeologici del Veneto).

The extreme closeness to a paleoriver bed of Menago river, and the dense presence of post-holes would support the hypothesis of a wooden deck raised, however, the presence of some hearths at the ground level seems to suggest the use of structures located on the decking.

A second phase housing can see the replacement of some structures oriented along the north-south axis, with other isoriented along the northwest-southeast axis and limited in a not used area. This

change, according to the archaeological evidence, could be due to a retraction of the village and its rearrangement likely correlate to a flood event that has changed the attitude of the bank of the river Menago.

1.4 Faunal composition

Overall, the osteological material examined is composed of 5,218 remains belonging to mammals, birds, amphibians and reptiles, of which 2,724 were determined at the level of species, genus or family. The unidentified remains amounted to 2,494, and were distributed on the basis of the size of the animal, especially considering the thickness of the diaphysis, including 1207 finds that are totally unidentified (Tab.1).

The fauna is composed mainly of domestic animals. Cattle, pigs and sheep/goat are the most represented domestic *taxa* for both the number of remains and the minimum number of individuals (Tab. 1). The equids are present with 192 remains corresponding to a MNI of 6 and, finally, the dog with 20 remains (MNI 4).

The wild fauna is characterized by abundant presence of deer than other wild species. Important is the presence of anatids among the remains of avifauna, which would indicate a moist environment in the proximity of the site, hypothesis confirmed by the presence of the marsh turtle (Bertolini et al., 2015; Petrucci et al., 2012; Thun Hohenstein et al., 2012).

The breeding was mainly aimed to obtain secondary products as regards cattle and sheep/goat, which are present in the sample with a more abundant number of adult individuals. Opposite consideration should be made for the pig which was mainly slaughtered at a young and sub-adult age to recover a better quality of meat.

The estimated size of animals of Bovolone site is consistent with those of other sites in the basin of Garda Lake during the Middle and Late Bronze Age (Riedel, 1996).

Despite the good preservation of the bone surfaces, were the anthropogenic traces identified on only 6% of the examined sample. There is a clear predominance of chopping marks, with respect to the

cut marks that are mainly in the epiphysis and, in rare cases, the diaphysis. The cut marks have a deep V-shaped cross-section with no secondary striations inside, ascribable to the passage of a probably well-sharpened metal blade on the surface of the bone. Due to the scarce number of remains with anthropogenic traces, it is not possible to obtain a complete picture with regard to the butchery chain of all animals (Bertolini et al., 2015; Petrucci et al., 2012; Thun Hohenstein et al., 2012).

The cattle remains are those who have better preserved traces linked to the activity of butchery. They have been identified in almost all the anatomical elements with the exception of the ribs and the vertebrae, where the evidences found are very scarce. Cut marks and chopping marks are generally located in proximity of the articular portions and are usually related to disarticulation and skinning practice. Sheep/goat and pigs show rare traces referable to disarticulation of anatomical elements. As for the wild animals, the traces documented until now are mostly tied to the exploitation of raw material. For example, the red deer has 24 remains with marks of anthropic activity, of which 17 are located on portions of antler. The roe deer shows only 3 marks, all recorded on fragments of antler (Petrucci et al., 2012; Thun Hohenstein et al., 2012).

2. Materials and methods

The osteological sample relative to the equines amounts to 192 remains. The finds were determined using the collection of reference stored at the Laboratory of Archaeozoology and Taphonomy, University of Ferrara.

The equid bones were quantified using the following criteria: NISp (number of identified specimens), MNE (minimum number of elements; Binford, 1978), MNI (minimum number of individuals; Klein and Uribe, 1984). MNE was calculated taking into account the skeletal element, epiphyseal fusion ageing and the laterality. Estimating the number of elements made it possible for us to calculate the MNI. Due to the large amount of upper and lower isolated teeth, we tried to

237 determine them by associating the criteria proposed by Eisemann et al. (1988), in comparison with
238 some skulls of the collection.
239 Those teeth, for which it was not possible to establish the correct determination, were divided into
240 two categories: P3 - P4, M1 - M2 (Eisemann et al., 1988; Levine, 1982).
241 The ages of individuals were calculated by analyzing the degree of teeth wear, and for this reason
242 were taken the height of the tooth crown (H). For all the premolars and molars, excluding L2P, the
243 height was measured at 1 cm from the base of the roots until the parastylus (Eisemann et al., 1988;
244 Levine, 1982). For the second upper and lower premolar, the measurement has been carried out
245 from the higher margin of the anterior root to the antero-lingual edge of paraconid in the lower one,
246 and of the anterostylid in the upper one (Eisemann et al., 1988; Levine, 1982). The data were then
247 compared with the wear stages proposed by Levine (1982) to estimate the age at death. For the
248 incisors isolated or still in their anatomical location, were followed the parameters provided in the
249 "Official guides for determining the age of the horse" (AAEP, 1996).
250 The osteometrical measures were obtained by following the method proposed by Angela Von Den
251 Driesch (1976).
252 At a later stage, for the height at the withers measurement the indexes of May (1985) were applied.
253 The archaeozoological studies have been carried out by analyzing the entire assemblages and
254 separating the unidentified remains for size classes wherever it was possible. A taphonomic analysis
255 has been carried out on all the specimens in order to distinguish the edaphic and anthropic
256 modifications referring to Beherensmeyer, 1978; Behrensmeyer et al., 1986; Blasco et al., 2008;
257 Domínguez-Rodrigo et al., 2009; Giacobini, 1995, 1996; Lyman, 1994; Malerba and Giacobini,
258 1993; Olsen and Shipman, 1988. Carnivore and rodent marks were recognized following to
259 Binford, 1981; Brain, 1981; Cilli et al., 2000; Giacobini, 1995. Burnt bones were distinguished too
260 (Bennett, 1999; Asmussen, 2008). Intentional fresh bone fracturing for marrow extraction, post-
261 depositional fractures and manufacturing marks were identified (Anconetani and Peretto, 1996;
262 Blasco Sancho, 1992; Lyman, 1994; Myers et al., 1980; Peretto et al., 1996; Sadek-Kooros, 1972;

Shipman et al., 1984; Villa and Mahieu, 1991). The analysis of bone surfaces was carried out using a binocular stereo microscope Leica SD6 with digital imaging capture function (camera EC3). Replicas of the cut marks have been carried out using silicon moulds (Provil Novo ® Fast Light Set, Heraeus Kulzer) and epoxy resin (Araldite ® LY554, Hardener HY956) to be analyzed through Scanning Electron Microscopy (SEM Zeiss EVO 40).

3. Results

3.1 Horses exploitation at site

3.1.2 Horse anatomical representation

The osteological sample belonging to the domestic horse in Bovolone, consists of 189 finds, while only 3 remains can be attributed to donkey, whose presence would be the first documentation in northern Italy in this period.

All the major skeletal areas are documented with the exception of the axial skeleton, which is represented by a single fragment of atlas. The large amount of vertebrae and ribs fragments attributable for size and thickness to ungulates of great size, still allows assuming that certainly some of them were to belong to this taxon. Unfortunately, the fragmentary degree of this category of remains has not allowed a correct taxonomic determination for all the animals in the site.

The ribs, in fact, are often fragmented into elements of reduced or smaller dimensions, while the vertebrae are preserved mostly in the form of incomplete spinal or lateral processes, and therefore, hardly attributable to a species. The scarcity of the vertebral bodies and small bones like carpals and patella is perhaps attributable to either carnivore or anthropic action. Possibly, these elements were discarded and thrown from the top of the pile dwellings and attacked by the carnivores, thus creating a lacuna in the skeletal parts of these animals in the settlement. However, the long bones were possibly not discarded and retained for further use to manufacture hard animal materials. Another hypothesis to explain this lacuna is that this animal was slaughtered and its remains were discarded in another area of the village which has not yet been investigated.

By analyzing the single anatomical elements, *neurocranium*, *splanchnocranium* and isolated teeth together constitute the largest set, while the appendicular skeleton is still very well represented showing a certain balance in the amount of fragments distributed between the fore and hind limbs. The carpal bones and the patella are completely absent. However, the proportions between the left and right limbs are, albeit slightly, less balanced, the latter ones slightly lower for quantity (Tab. 2).

The state of preservation appears very similar each remains of the sample, where manganese oxides and root etching are the main modifications found on the surfaces of the entire sample. Evidences attributable to the action of carnivores are visible on about 19 finds, and are mainly located on the epiphyseal portions. Only two finds show a completely modified surface by the heat with a reddish colour, indicating an indirect exposure to a not particularly high temperature.

On the basis of the single anatomical elements, in particular the metacarpals, were at least 5 individuals calculated, one of which would show a small size compared to other individuals. This is confirmed by other elements such as fragment of distal tibia, radio-ulna and some teeth.

According to the size and robustness of the anatomical elements and the state of fusion of the epiphysis, is conceivable that this is attributable to adult individuals.

The evaluation of MNI was also performed on isolated teeth by associating frequency of the single element with the estimated wear degree. Thus, it has been estimated an MNI of 6 individuals, slightly higher than that outlined by the measurement based on the elements of the post-cranial. The classes of age estimated on the basis of the method proposed by Levine (1982) confirm what was seen for the post-cranial skeleton, in other words that all individuals had to be adults. Being isolated teeth, should be pointed out that it was not possible to obtain a precise age, but we have paused to estimate ranges of age by gathering in group's teeth that showed similar wears. It is important to note that there is certain heterogeneity in our data, because the six specimens show a very different age among themselves (Fig. 2).

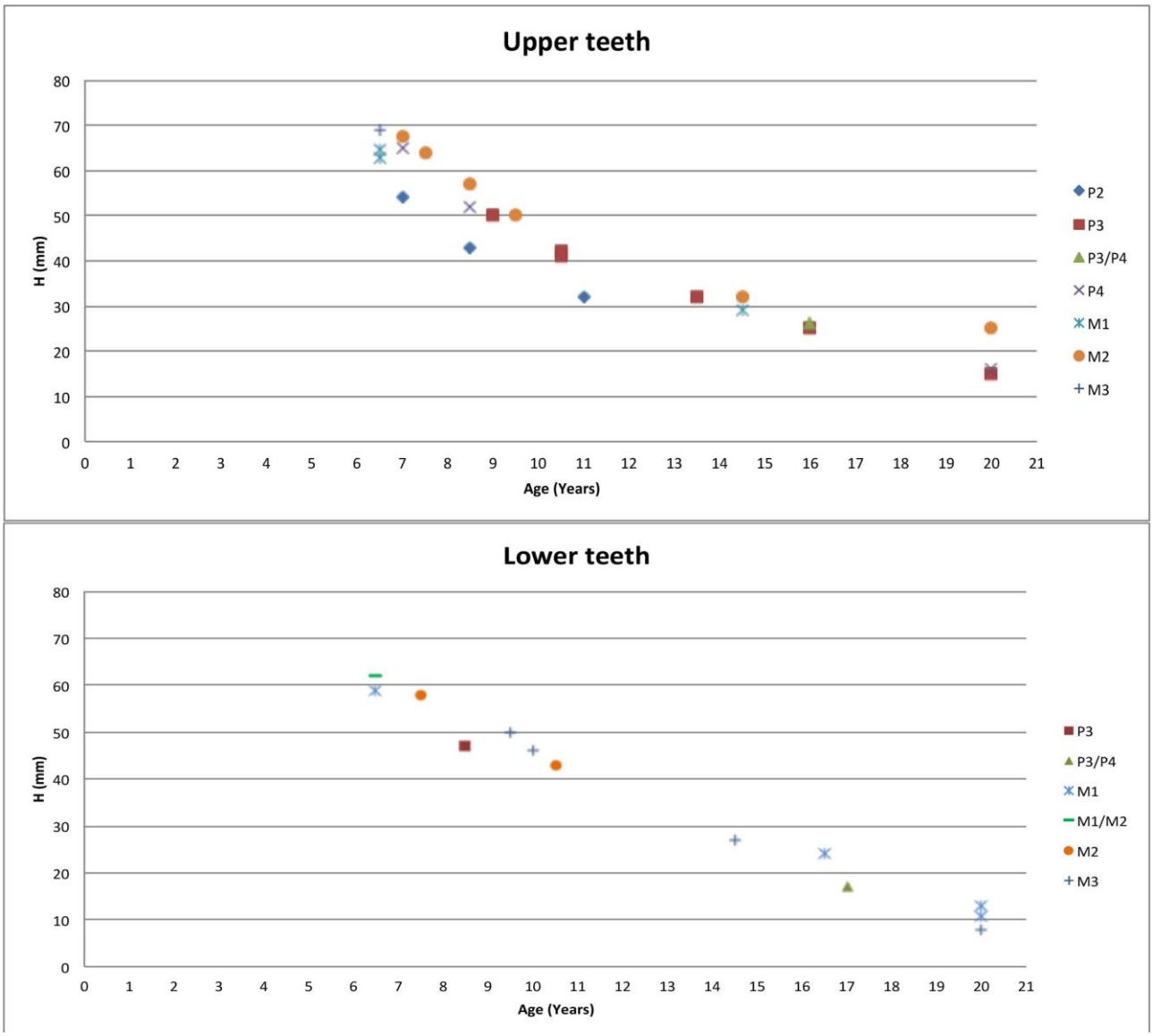


Fig. 2. Bovolone. Age at death of the horse estimated on the basis of the crown height of the upper (A) and lower molars (B).

By analyzing the ratio of minimum number of elements (MNE) and number of remains expected (eNR) it can be seen that the values obtained are quite consistent for the estimated number of individuals, especially for the hind limb (Tab. 2).

The determination of sex was problematic in the absence of diagnostic elements. In fact, only in one case it was possible to establish the sex of the animal. A particularly robust upper canine suggests that it is a male specimen, since in female individuals the presence of the canines is rarer and generally of smaller dimensions.

Thanks to two metacarpals and a metatarsal, it was possible to estimate three heights at the withers (Tab. 3) using the indexes of May (1985); the mean obtained of 134.5cm is consistent with the data on this animal for the Italian territory in this chronological period (Fig. 3, Tab.4). The index of slenderness (SD * 100/GL), calculated on metapods mentioned above, highlights individuals with medium slender diaphysis (Tab.5) in line with the horse data (De Grossi Mazzorin et al., 1998) as regards the Italian Bronze Age.

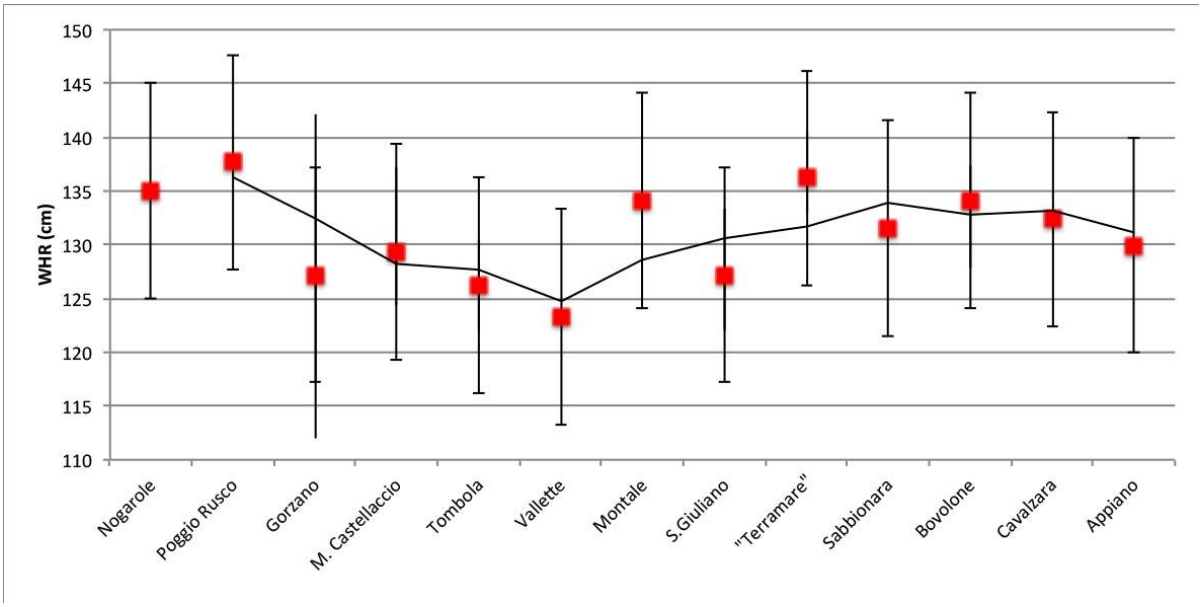


Fig. 3. Height at withers of horses during the Bronze Age in northern Italy.

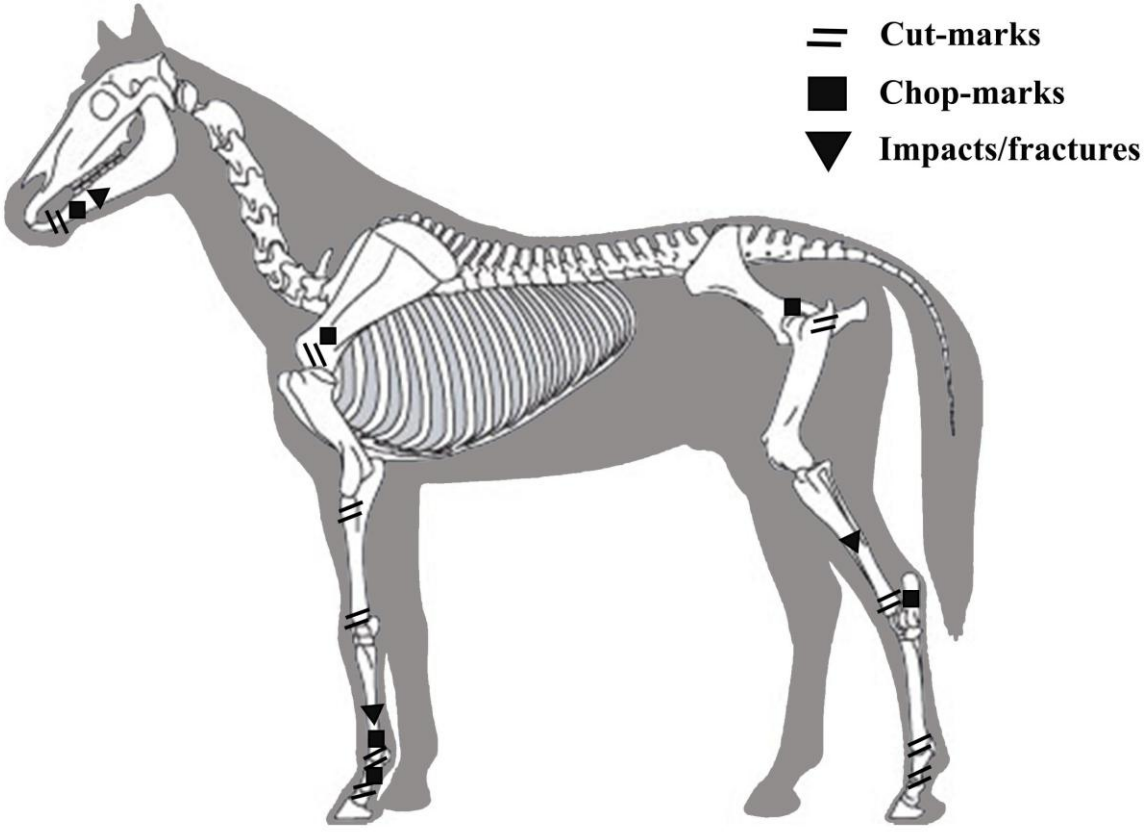
3.1.3 Donkey exploitation on the site

The donkey is represented by a total of three remains: a fragment of radio-ulna, an astragalus and a first phalanx. The morphologies and sizes of the elements are different from those of the horse present in Bovolone. The first phalanx has a large or broad epiphysis, but the dimensions are still lesser than the ones of the horse. Moreover, the central portion of the bone is particularly narrow. The remains are attributable to an adult, perhaps senile since the radius and ulna are completely fused together. The state of preservation of the remains is scarce due to alterations linked to the action of carnivores. All three remains, in fact, present traces of carnivore action on the epiphyseal portions. Traces attributable to human action are absent on the remains of this animal.

344 3.1.4. *Anthropic evidence*

345 The taphonomic analysis of sample has led to the identification of several traces of anthropic origin
346 that allowed shedding light on some aspects of the horse butchery chain. These evidences are
347 distributed on 23.9% (NR 46) of the entire sample. The traces denote different actions that can be
348 attributed to various phases of the butchery line. The main evidences identified are mostly cut-
349 marks, chop-marks and finally fractures on fresh bone (Fig. 4).

350



351

352 Fig. 4. Bovolone. Distribution and position of butchery marks on horse's skeleton.
353

354 Butchery cut-marks were identified on 18 osteological remains, in many cases in association with
355 other types of traces. The morphology of cut-marks certainly allows excluding the use of lithic
356 tools. Effectively, the profile of the traces mainly presents a V-shaped morphology, without
357 secondary characteristic striations on the side walls, typical of the passage of a lithic tool. Traces

are in most cases located on articular or epiphyseal portions indicating the action of disarticulation. Metacarpus and tibia are the anatomical elements which have the greatest number of evidences in this sense, all concentrated in proximity of the distal epiphysis (Fig. 5).

Fig. 5. Butchery marks on horse remains: (A) metapodial with disarticulation cut-marks located in the lateral (b), plantar (c, d) and medial (d) views of the distal epiphysis. Detailed views of the cut-marks at the stereomicroscope (B, C and D; bar scale 1 mm) and at SEM (E, F).

The evidences related to skinning are less frequent in the sample. They have been identified on a total of three fragments.

Skinning traces were identified on a phalanx, with traces longitudinally-oriented and placed on the dorsal surface of the diaphyseal portion of the element (Fig. 6). To these finds are associated two cranial fragments that have elongated cut-marks near the zygomatic process.

The actions or movements related to skinning are typically elongated and parallel to each other. This is an indication of the repeated movement of the blade to slice the skin in the case of the phalanx and for cutting and removing the skin present over the zygomatic of the cranium.

Fig. 6. Butchery marks on horse remains: (A) First phalanx with skinning marks on the volar view; (B) Detailed views of the cut-marks at the stereomicroscope and at SEM (C, D).

Some cut-marks were identified within the mandibular symphysis to indicate probably the removal of muscle tissues of the tongue (Fig. 7).

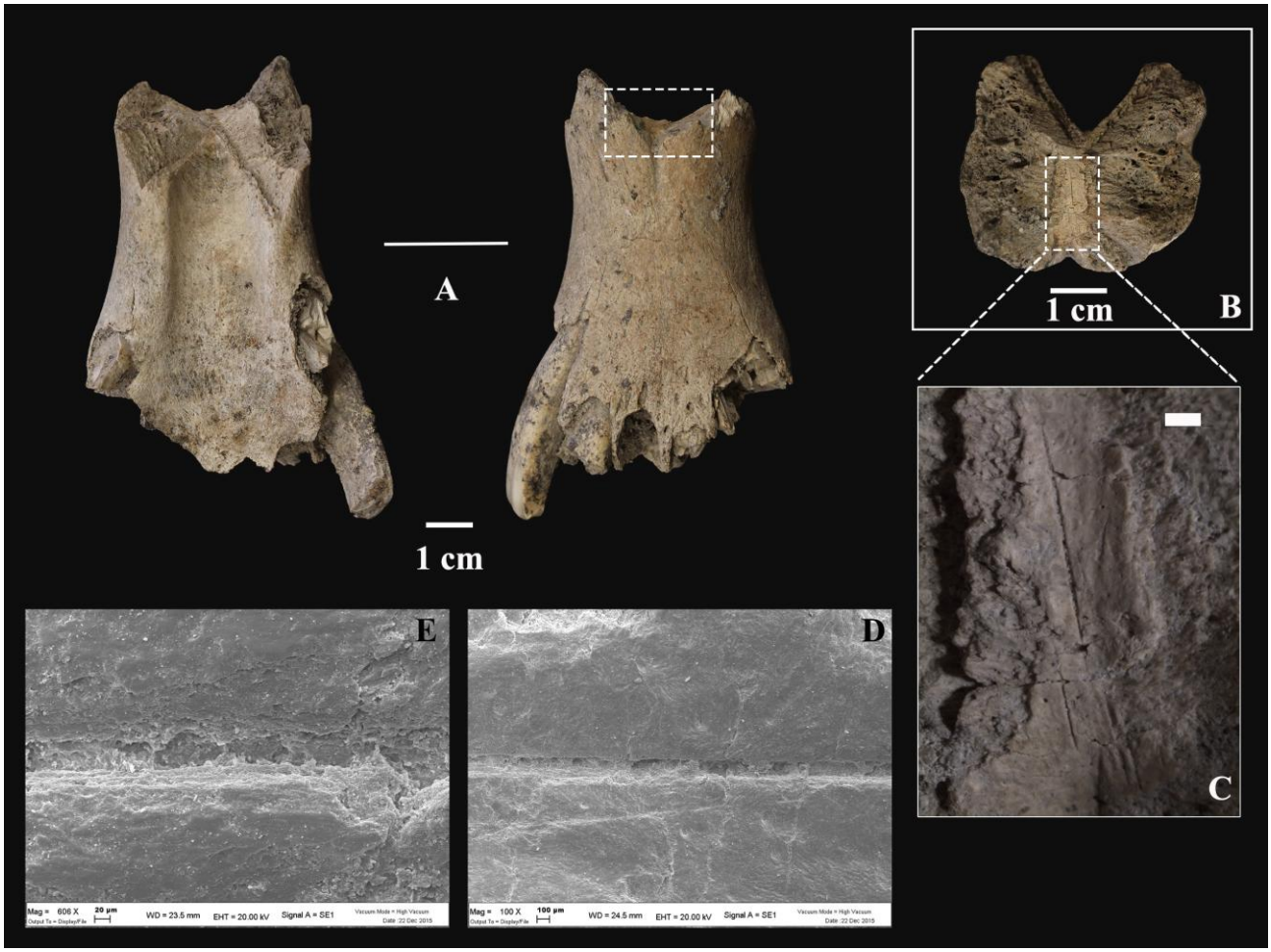


Fig. 7. Butchery marks on horse remains: (A) Fragment of mandible with cut marks on the back of the mandibular symphysis (B). These traces have been produced by the cutting of the geniohyoid and genioglossus muscles in order to remove the tongue (C). Internal morphology of the cut marks at different magnification (C and D; SEM images). The absence of secondary striation it's likely due to a metal tool.

Chop-marks can generally be used for two main functions: divide the carcass into optimal portions to be then cooked or distributed, and obtain fat and bone marrow. The traces identified in the study are mainly located on the muscular insertions areas of scapula and pelvis, or metaphyseal portions of metacarpus and tibia. The frequency of gestures applied on the various anatomical elements is variable; observing scapula and pelvis, more cuts can be seen in various points of muscular insertion, actions precisely attributable to their removal.

As regards the long bones, can be seen that the cuts are always inflicted transversely to the long axis of the anatomical element, in proximity of epiphysis.

In association with the cut-marks, there is a large amount of fresh bone fractures, mainly tibia and metacarpus with oblique and transverse outline and angle. These evidences are quite similar to those one observed on other animals remains. Greatly interesting is an intentional bone breakage inflicted by flexion on the mandibular symphysis, attributable to the recovery of the bone marrow in the two hemimandibules.

3.1.4 *Use of equines remains as raw material for the manufacture of objects*

Within the studied sample were identified two finds that show evident traces of processing and utilization. It is a distal fragment of radius with a partially preserved hole, localized in the center of the metaphyseal surface (caudal view). The hole was very probably a through hole, with beveled edges. The completely smooth internal surface is slightly polished, and is free of traces associated with the realization of the hole that is supposed to be logged in with a drilling action. The diameter of the hole was approximately 5mm; unfortunately, being partially intact, it was only possible estimate the dimension on the basis of other objects in the same site that showed through holes. Both faces of the distal epiphysis show surfaces probably altered from the use, so much so that the surface of the bone was partially removed with consequent exposure of spongy tissue.

The stereo-microscope observation shows a structure of spongy tissue rounded and tending to be slightly shiny. Along the margins of the worn surface, polishing effects are visible.

A second artefact has been made on a fragment of proximal metatarsus. A thru-hole is located on the dorsal surface of the metaphysis. On the lateral and palmar surfaces are present manufacturing marks related to the reduction sequence (Fig 8).

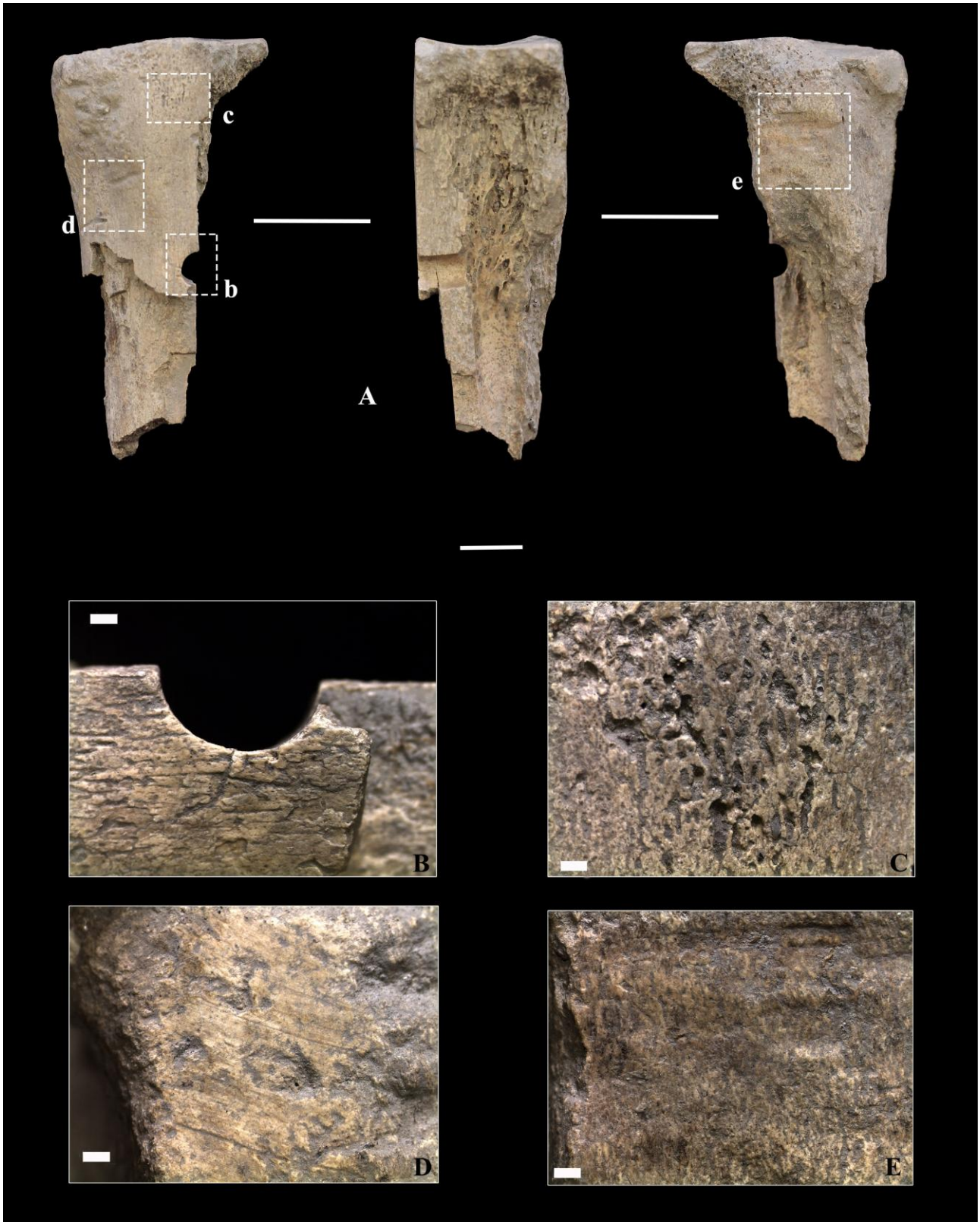


Fig. 8. Bones objects on horse remains: (A) metacarpus used as skate. Thru-hole localized on the proximal epiphysis (B). The dorsal surface is flattened and homogenous (C). On the lateral (D) striations linked to the manufacturing activity are present. (E) Same striations have been found on the plantar view. These kinds of marks are produced for making flattened and homogenous surfaces.

A third artefact has been made on unidentified metapodial, partially preserved and devoid of diagnostic elements to the correct anatomical determination. It is a distal epiphysis that shows three through holes: one at the center of the diaphysis, and two with the entries located laterally, and the exit wound on the palmar surface just above the epiphysis. The bone has fractured just above the holes thus exposing the inner cavity and allowing to analyze in detail their morphology. This has been useful in interpreting the reduction sequence linked to their manufacturing, in particular for the holes placed laterally, effectively made in two distinct moments (Fig. 9). In further detail, it can be observed that those placed on the lateral faces were first performed using a drill. The bottom shows a concave and rounded surface with a diameter smaller than that observed on the lateral surface of the bone. Subsequently, the holes were applied on the palmar surface of the element, which is characterized by an oblique trend that has partly erased the traces of the lateral holes. Also in this case, the bottom of the hole has a circular cross-section slightly narrower at the bottom, denoting that the instrument used to drill had a homogeneous section. The one that should be palmar surface shows a more intense abrasion with exposure of spongy tissue in proximity of the distal epiphysis. While, only on the dorsal face the median relief presents a strong flattening probably attributed to the surface rectification during the tool manufacturing and its subsequent wear.

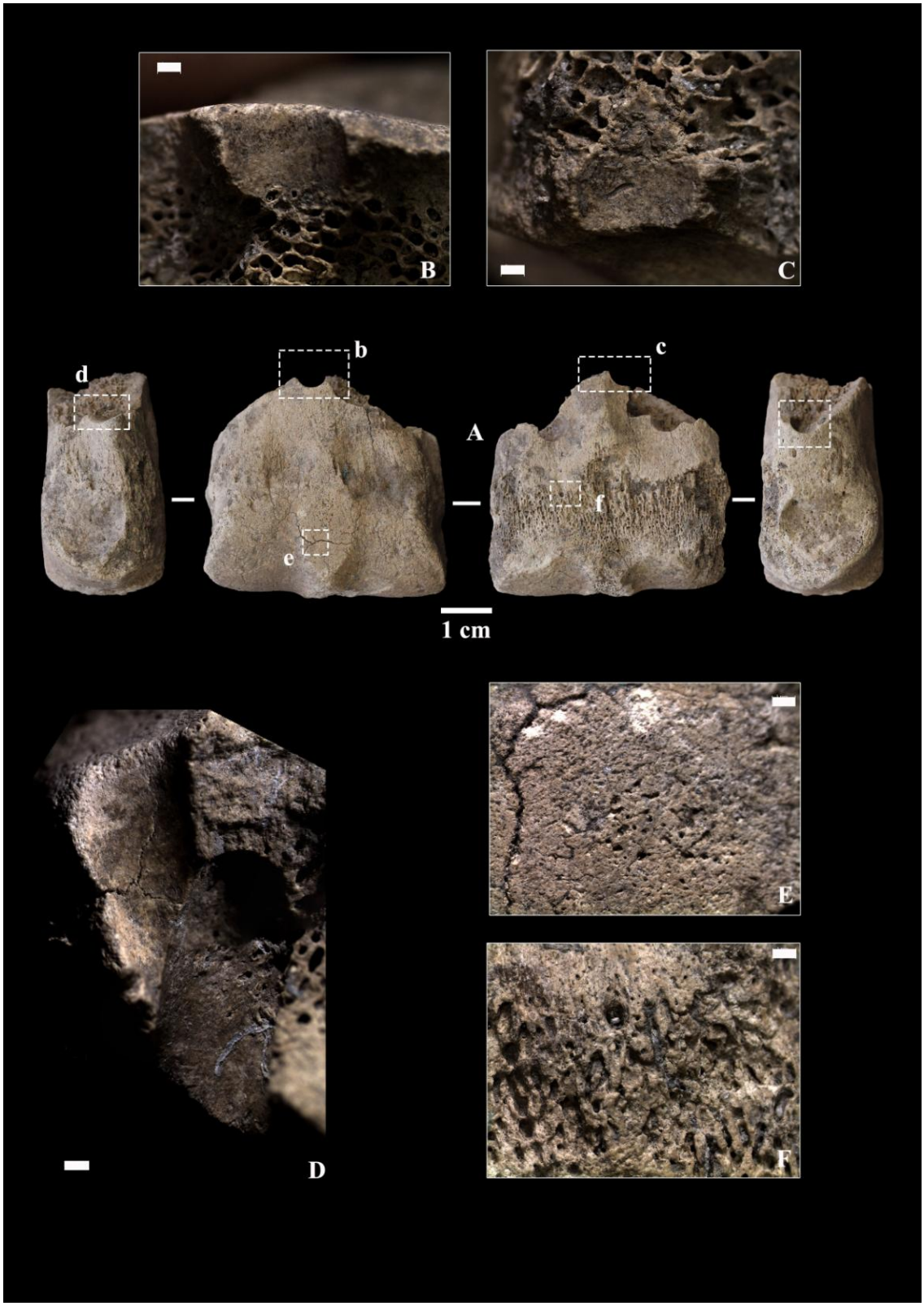


Fig. 9. Bones objects on horse remains: distal epiphysis of a metapodial (A) with several thru-holes on the dorsal (b-B details at the microscope), plantar (c-C details at the microscope), mesial and lateral views (d-D details at the microscope). The side holes have been produced by a double perforation made with a drill (D). The plantar and volar surfaces are strongly flattened by the use-wear.

Unfortunately, due to the preservation of the finds, nothing can no longer said about the reduction sequence except make assumptions on trying to classify them typologically. From a morphological point of view, both finds could belong to in the categories of skates or smoothers. According to the arrangement of the holes and the type of traces on the surface, it is very likely that this it is the first type of category. This kind of objects can be divided into sled and foot skates respectively, the difference between the two objects is generally based on the arrangement of the holes, that in the first case are often located centrally according to a dorsal-palmar direction, while in the second one the holes are often located laterally (Choyke and Bartosiewicz, 2005). On this basis, the two analyzed artefacts could be respectively fragment of skate from slide (radius) and a foot skate (metapodial). Unfortunately, due to the poor preservation of both the artefacts, it is not possible to acquire more data to understand both technological and functional aspects.

3.1.2 *Horse use for transportation*

In the Italian territory, the evidence suggesting the use of the horse as a means of transportation starts from the Late Bronze Age, where in some sites were found elements of bites on hard animal tissue. Effectively, both the evidence of Emilian Terramare areas (Provenzano, 1997) and the Final Bronze Age (1,170-900 B.C.) settlement of Frattesina (Rovigo) (Bellato and Bellintani, 1975) have returned the main archaeological documentation in this regard.

In the absence of this type of evidence, we have analyzed the remains of horse on the site of Bovolone to observe potential changes that can be caused by the use of this animal as a means of transportation (Bendrey, 2007, 2012; Brown and Anthony, 1998; Levine et al., 2005).

Possible modifications on the occlusal surface of the diastema caused by the sliding of the bit, have not been observed in the absence of complete mandibular elements (Bendrey, 2007; Brown and Anthony, 1998; Levine, 1999; Levine et al., 2002; Olsen, 2006).

The analysis was then focused on isolated teeth or still in their original position. The sample consists of 3 P2 only, two of which upper and one lower. The study took into account the

methodologies proposed by Brown and Anthony (1998) and Bendrey (2007), trying to observe the wear, particularly the LP2, caused by the bit. In accordance with Levine (2005), the microscopic examination of the occlusal surface proposed by Brown and Anthony (1998) is difficult to apply in the archaeological sample analysis, mainly due to post-depositional alterations affecting the tooth surfaces. From a macroscopic point of view, all three examined teeth, in particular L2P, do not show the wear observed by Brown and Anthony (1998) on the dental occlusal surface, and even that one detected by Bendrey (2007) on the front face of the tooth. However, the absence of these signs does not in any way preclude the use of these animals as a means of transportation, but rather the frequent use of metal or hard animal tissue bits. As has been demonstrated in studies mentioned above, the use of bits in soft material, such as leather or vegetable fibre, do not leave particularly noticeable wear on the occlusal surface of the second premolar, and also if the bit is not regularly applied, the wear generally tends to become uniform (Brown and Anthony, 1998).

4. Discussion

The study on the osteological horse remains at the site of Bovolone allows to look through a new perspective on the role of this animal in the subsistence economy in this village in the Late and Final Bronze Age.

At the moment, the site of Bovolone is an "*unicum*" on the Italian territory for the abundance of remains and for the evidences of horse slaughter that until now had never been encountered in Italian territory during the Bronze Age.

The abundant presence of horse remains, although not found in other sites of the Peninsula, is certainly an indicator of the fact that the breeding of this animal was at that time to be a quite common practice in the area, supporting the assumption already advanced by others authors (De Grossi Mazzorin, 1995; De Grossi Mazzorin et al., 1998, 2004).

The high number of cranial and post cranial remains allowed to estimate the presence of at least 6 individuals within the site. The different age of individuals allows to make several considerations in

this respect. It is likely that the older individuals, two between the age of 15 and 20 years, may have been killed in that they were no longer useful for both the transport and reproduction.

The killing of younger horses is to be probably sought in secondary causes, as all individuals had not exceeded the 15 years of age and were therefore still fully useful for transport and reproduction activities. The hypothesis of a surplus of animals is probably excluded because, as showed by some ethnographic data (Levine, 1998), the animals in excess were generally slaughtered at an age between 1 and 3 years. Perhaps, a more plausible hypothesis is that the four animals, all between the ages of 5 and 11 years, may have experienced problems or injury in life that prevented them from being used in daily activities. Unfortunately, the skeletal elements available have not returned useful elements to support this hypothesis. Despite the numerical sample was not particularly abundant, the analysis of any traces related to the use of bit led to negative outcomes.

The anthropic evidence found on osteological remains allows to assert that the horse would be slaughtered within the site, and that all its products, from the skin to the bone, were exploited by the community of Bovolone.

The anatomical elements which show the greatest number of fractures are mostly metapode and tibia bones, however the absence of diaphyseal fragments of femur, humerus and radius, suggests that their absence is precisely attributable to the fracturing activity. Fractures are more frequent on the anatomical elements containing the highest amount of bone marrow, as observed in other studies (Olsen, 2003; Outram and Rowley-Conwy, 1998).

In addition to the recovery of leather and meat, the horse remains were used in the animal tissue manufacture, as two artefacts made on a metapodial and a radio respectively attest.

Based on morphology and type of wear identified, these objects can be associated with the typological category of foot or sled skate (Choyke and Bartosiewicz, 2005; Küchelmann and Zidarov, 2005). Unfortunately, whilst retaining only the distal portion of both anatomical elements, there is little to say about their reduction sequence. A probable abrasion activity is noticeable on the median bone relief on dorsal articular surface of metapode, likely intended to regularize the surface.

Similar objects were found in some contexts of the Late and Final Bronze Age and Early Iron Age in northern Italy (Bellato and Bellintani, 1975; Bellintani and Cassoli, 1974; Malerba and Giacobini, 1989-90; Petrucci et al., 1998). The raw materials used are mainly of cattle, deer, and in some cases, human bones such as found in Frattesina and Castellari of Vallerana (Padova) (Bellato and Bellintani, 1975; Bellintani and Cassoli, 1974; Malerba and Giacobini, 1989-90).

However, the use of the horse remains for hard animal tissue manufacturing is widely confirmed in East-Central Europe (Choyke and Bartosiewicz, 2005), where the set of objects defined as skates has a cultural tradition starting from Eneolithic, and in some countries it lasts until the beginning of the twentieth century A.D.

The artefacts found in Bovolone, typical of European continental area, could be the result of close contacts between north-eastern Italy and the transalpine regions; assumption that is founded in the numerous archaeological finds in this area of the Italian peninsula.

5. Conclusions

The case of Bovolone has certainly allowed to expand the knowledge relating to the exploitation of the horse in the Italian territory during the Bronze Age.

In the rest of Europe, traces of exploitation of this animal are present mainly in the Eurasian steppe (Levine, 2004; Olsen, 2006). However, while it is difficult to find same kind of evidence in the European Central plains, artifacts obtained from bones of this animal are common here. Similar percentages of horse and appearance of cut marks are present in several Spanish settlements of the Bronze Age (Arribas et al., 1974; Castanos Ugarte, 1992, 1997; Galindo-Pellicena et al., 2015; Lauk, 1976; Legge, 1994; Sanz Breton and Morales Muñíz, 2000; Barrachina, Sanchis Serra, 2008). Recent evidence of El Portalon (Galindo-Pellicena et al., 2015) attests that the practice of horse meat consumption had already spread from the beginning of the Early and Middle Bronze Age in the Iberian territory.

In the case of equids from El Portalon, the size of the metacarpals and their increasing abundance and mortality profile support the idea that they were domestic in the Bronze Age. However, because we could not contrast them with other characteristics, it is not possible to confirm their domestic status (Galindo-Pellicena et al., 2015).

The exceptionality of the case of Bovolone is that the remains of horses identified were definitely domestic as this animal became completely extinct in the territory by the end of the Upper Paleolithic.

At the moment, the data merging from this study find no comparison over the territory, but certainly future research on other faunal assemblage and review of materials already studied could certainly help to determine whether this is an isolated behaviour of this village or a practice diffuse in the territory.

Aknowledgement

We thank the Superintendence of Archaeological Heritage of Veneto for providing the faunal remains analyzed in our study.

Table 1
NISp e MNI of the fauna assemblage from Bovolone.

Taxa	NISp		%NISp		MNI	%MNI	
Canis familiaris	20	0.8	0.8	0.7	4	4.9	4
Equus caballus	189	8.0	7.2	6.9	6	7.2	6
Equus asinus	3	0.1	0.1	0.2	1	1.2	1
Sus domesticus	435	18.4	16.4	15.9	18	21.7	18.3
Bos taurus	1259	53.2	47.7	46.2	29	34.9	29.4
Capra vel *Ovis*	461	19.5	17.5	16.9	25	30.1	25.3
Total domestic animals	**2,367**	**100**	**89.7**	**86.8**	**83**	**100**	**84**
Lepus europaeus	1	0.4	0.05	0.05	1	6.3	1
Martes martes	31	11.4	1.2	1.1	1	6.3	1
Vulpes vulpes	75	27.7	2.8	2.9	2	12.5	2
Sus scrofa	37	13.6	1.4	1.3	3	18.7	3
Cervus elaphus	110	40.6	4.2	4.1	6	37.5	6
Capreolus capreolus	16	5.9	0.6	0.6	3	18.7	3
Elephantidae	1	0.4	0.05	0.05	-		
Total wild animals	**271**	**100**	**10.3**	**10.1**	**16**	**100**	**16**
Total identified mammals	**2,639**	**50.6**	**100**	**96.9**	**99**		**100**
Aves	29	33.3		1			
Amphibia	21	24.1		0.7			
Emys orbicularis	35	40.2		1.3			
Bivalvia	2	2.4		0.1			
Total other taxa	**87**	**100**		**3.1**			
Total identified remains	**2,724**	**52.2**		**100**			
Unid. Large size mammal	800	62		32			
Unid. Large-medium size mammal	197	15		8			
Unid. Medium size mammal	290	23		12			
Total unid. Mammals remains	**1,287**	**100**		**52**			
Unidentified remains	1,207	100		48			
Total unidentified	**2,494**	**47.8**		**100**			
Total faunal assemblage	**5,218**	**100**					

Table 2
Horse body part representation.

Anatomical Elements	NISp	Right	Left	Undet.	NME	MNI	eNR	NME/eNR	NME/NISp
skull	6	2	1	3	1	1	6	0.16	0,16
upper teeth	34	18	12	4	34	6	120	0.28	1,00
jaw	12	2	8	2	2	2	12	0.16	0,16
lower teeth	20	8	9	3	20	3	120	0.16	1,00
atlas	1				1	1	6	0.16	1,00
epistrophaeus							6	0	
scapula	8	4	4		4	3	12	0.33	0,50
humerus	4	2	2		2	1	12	0.16	0,50
radius	8	5	3		4	3	12	0.33	0,50
ulna	5	4	1		3	2	12	0.25	0,60
carpals							84	0	
III metacarpal	11	7	3	1	7	5	12	0.58	0,65
pelvis	12	7	5		7	3	12	0.58	0,58
femur	14	7	7		4	3	12	0.33	0,50
patella							12	0	
tibia	17	7	9	1	7	4	12	0.58	0,41
astragal	4	3	1		3	3	12	0.25	0,75
calcaneus	8	5	3		4	2	12	0.50	0,50
other tarsals	1	1			1		48	0.02	1,00
IV metatarsal	7	4	3		4	3	12	0.33	0,57
metapodials ind.	3			3				-	0,00
rudimental metapodials	2			2	2	2	48	0.04	1,00
phalanx I	6			6	6	2	24	0.25	1,00
phalanx II	5			5	5	2	24	0.20	1,00
phalanx III	1			1	1	1	24	0.04	1,00
Total	**189**	**86**	**71**	**31**	**121**	**6**			

Table 3
Height at withers of Bovolone horses estimated using GL e L1 (May, 1985).

Anatomical element	GL	L1	WRH (GL)	WRH (L1)
III Metacarpal	225	219	137.3	140.2
III Metacarpal	225	217	137.3	138.9
IV Metatarsal	244	236	127.8	130.7

Table 4
Height at withers of horses during the Bronze Age in northern Italy.

Site	References	Cronology	NR	Max	Min	Avg.
Nogarole (Verona)	Riedel, 1992	MBA	1			135
Poggio Rusco (Mantova)	Catalani, 1980-81	MBA	1			137.7
Gorzano (Modena)	De Grossi Mazzorin, 1994	MBA	14	142.2	112	127.2
M. Castellaccio (Faenza)	De Grossi Mazzorin, 1996	MBA	9	137.2	124.3	129.3
Tombola (Verona)	Bertolini, 2014	MBA	2	130.4	122	126.2
Vallette (Verona)	Bertolini, 2014	MBA	1			123.7
Montale (Modena)	De Grossi Mazzorin, 1994	MBA-LBA	1			134.1
S.Giuliano (Modena)	De Grossi Mazzorin, 1996	MBA-LBA	7	133.3	122	127.2
"Terramare" (Modena, Parma, Reggio Emilia)	De Grossi Mazzorin, 1994	MBA-LBA	3	140.5	133	136.2
Sabbionara (Verona)	Riedel, 1993	LBA	1			131.5
Bovolone (Verona)	Bertolini, 2014	LBA	3	137.3	127.8	134.1
Cavalzara (Verona)	Riedel, 1979	LBA	1			132.4
Appiano (Bolzano)	Riedel, 1985	LBA	1			129.9

Table 5
Slenderness index calculated on metacarpals.

Anatomical element	index (SD*100/GL)	
III Metacarpal	14	Slender legged
III Metacarpal	15.1	Slightly slender legged

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***Highlights (for review)**

Highlights

- First evidences of horse exploitation have been found dated to Late Bronze Age in Italy.
- Cut-marks, chop-marks and fractures on fresh bone were identified on 6 individuals.
- Some horse metapodials have been used as raw material for the manufacture of objects.

Figure 1

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Figure 2

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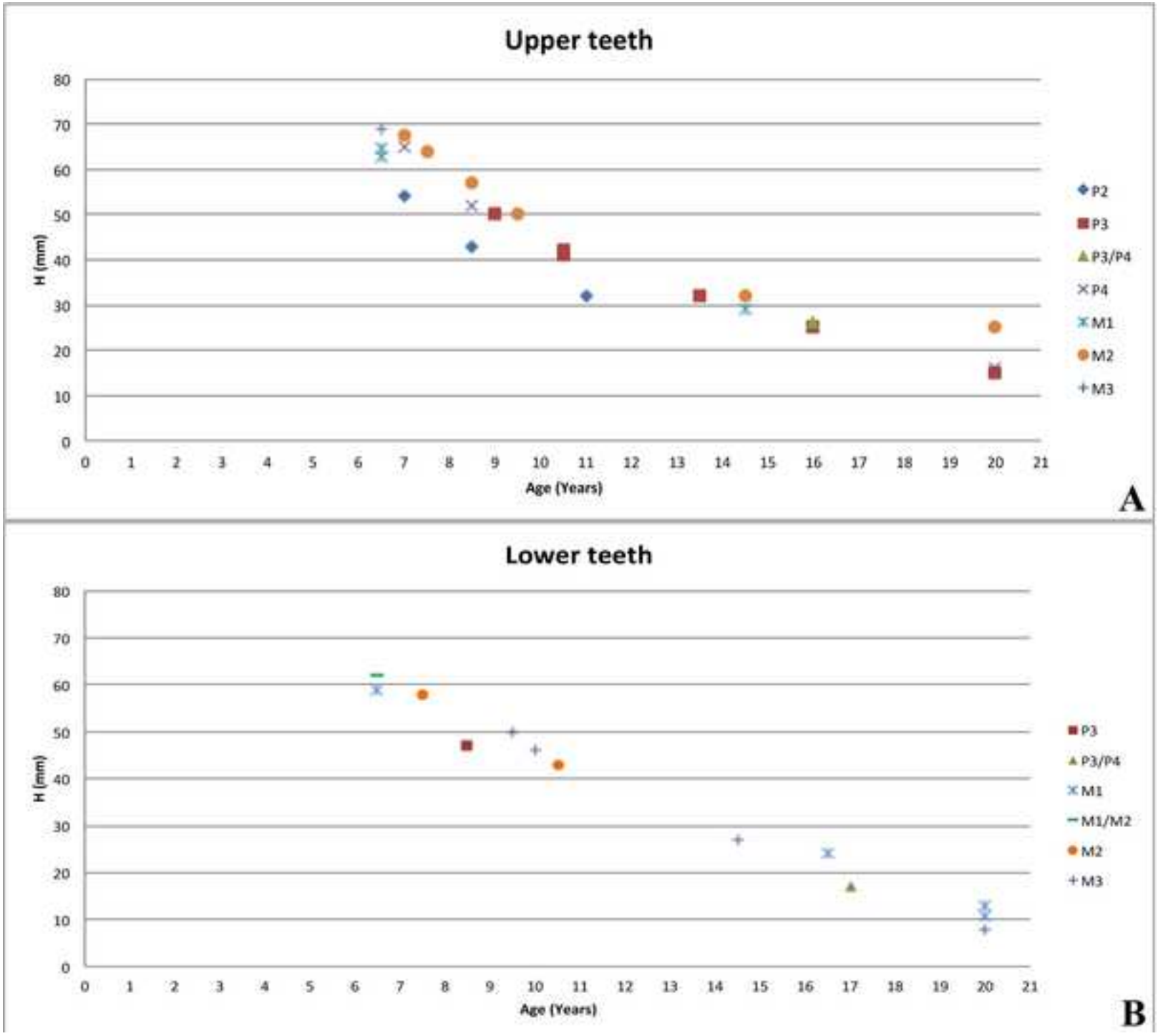

Figure 3

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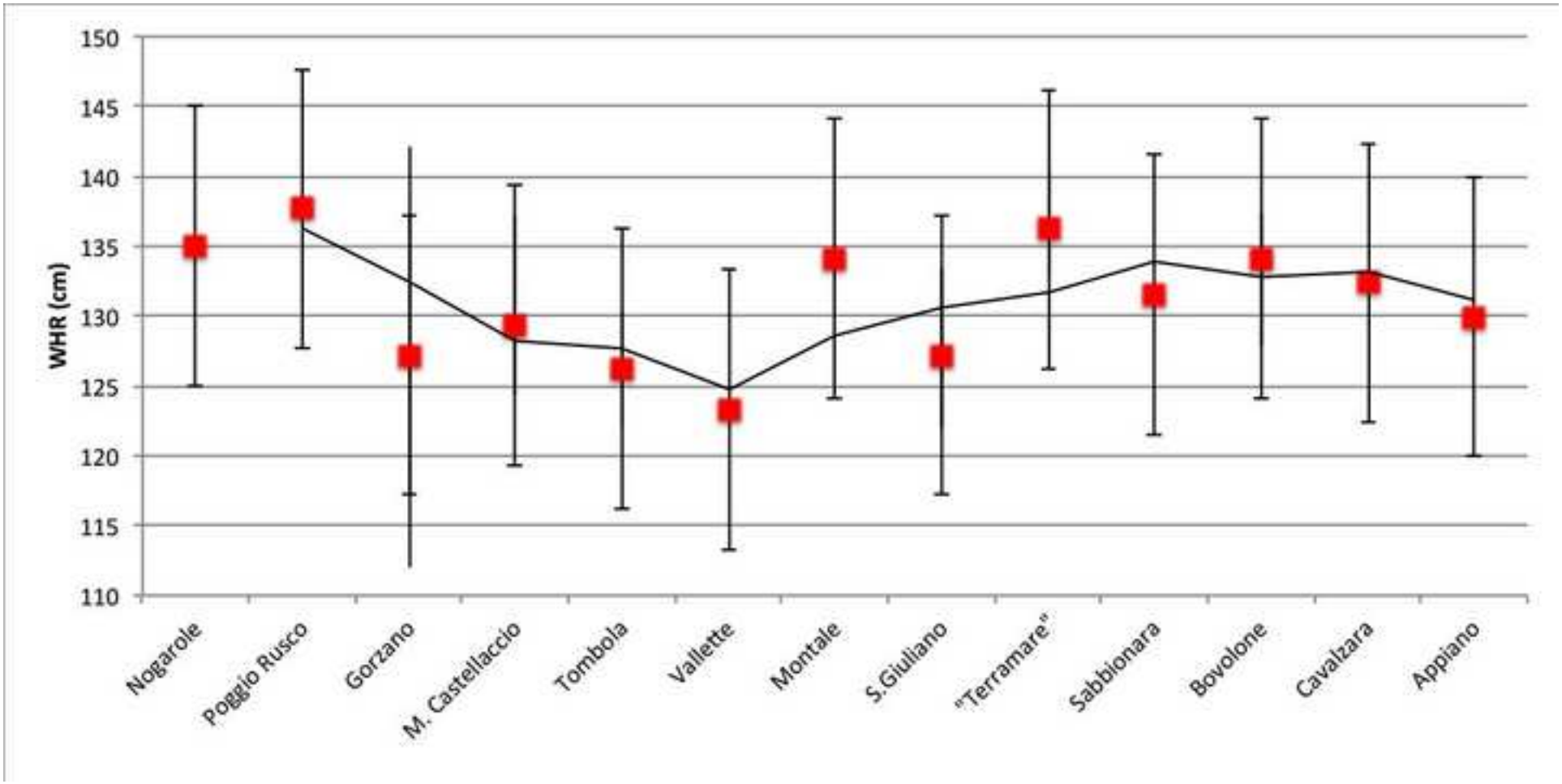

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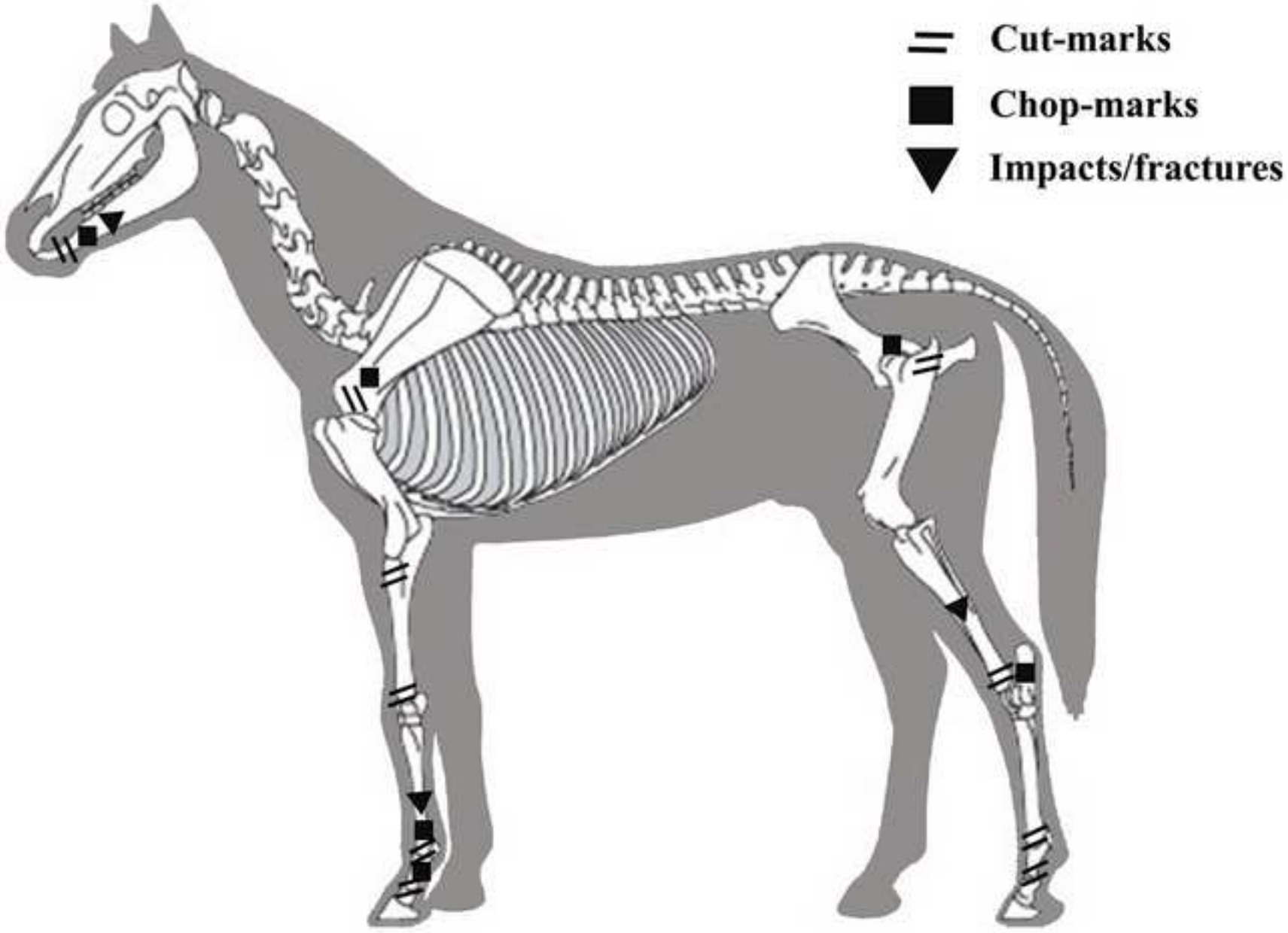

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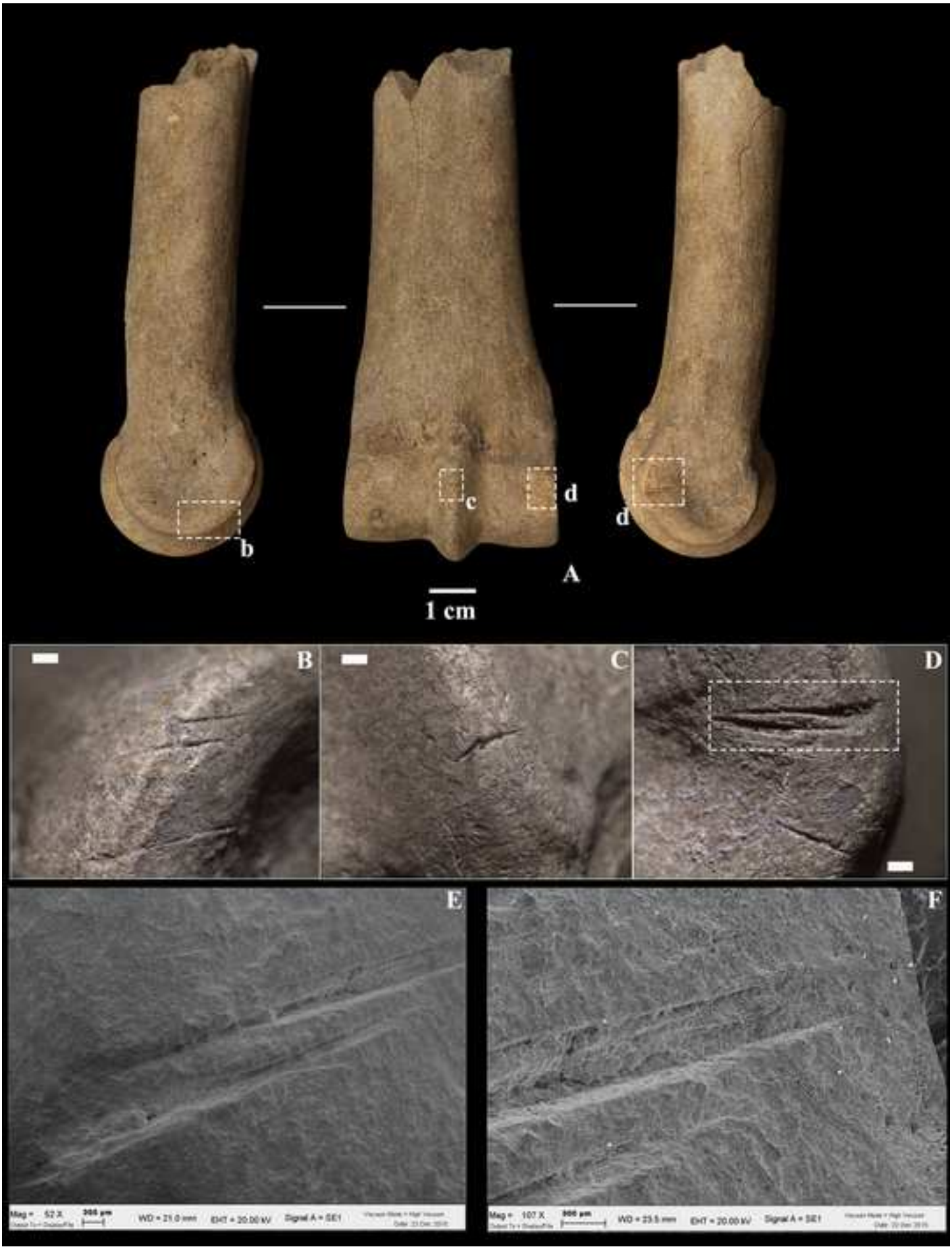

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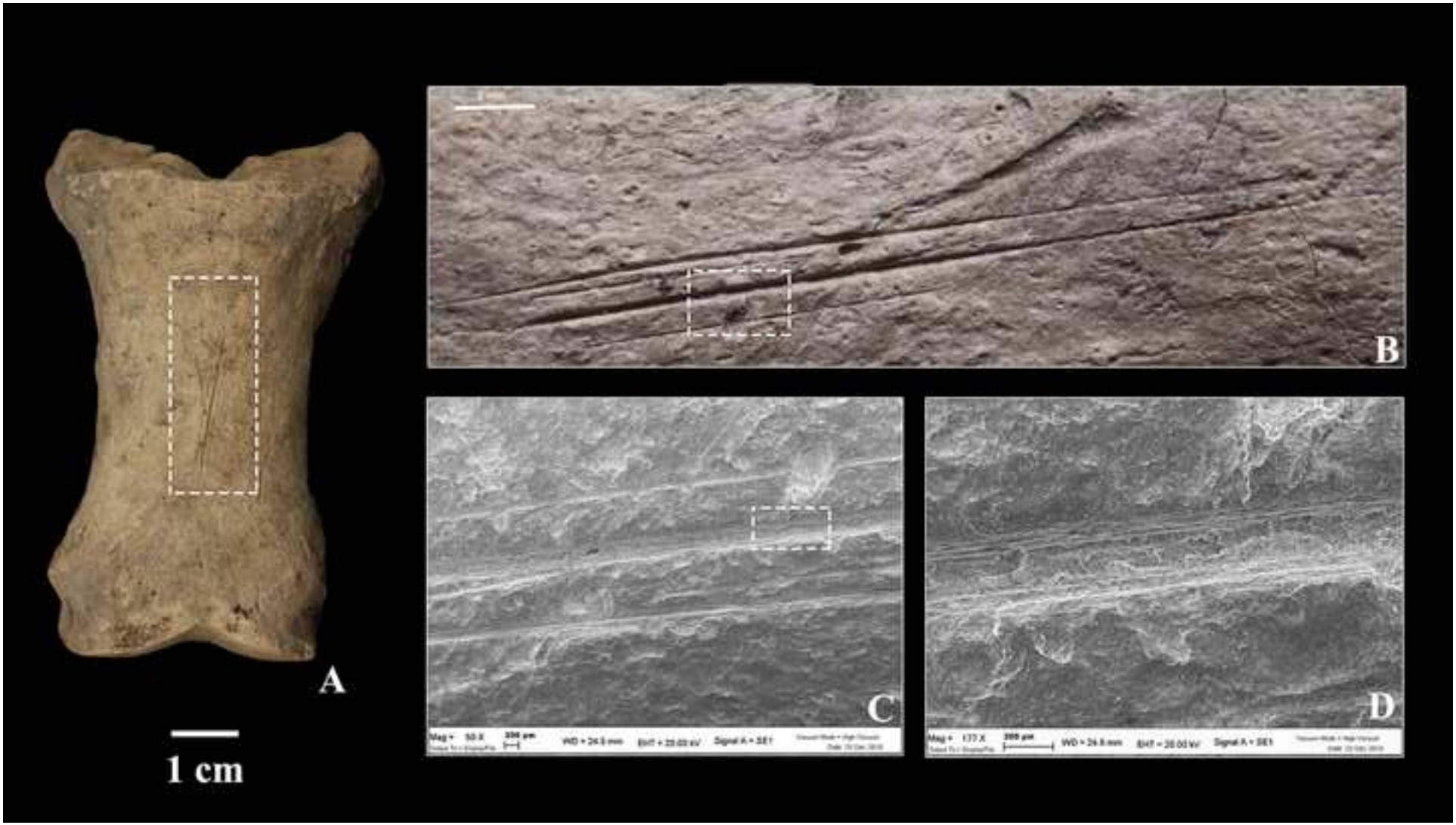

Figure 7

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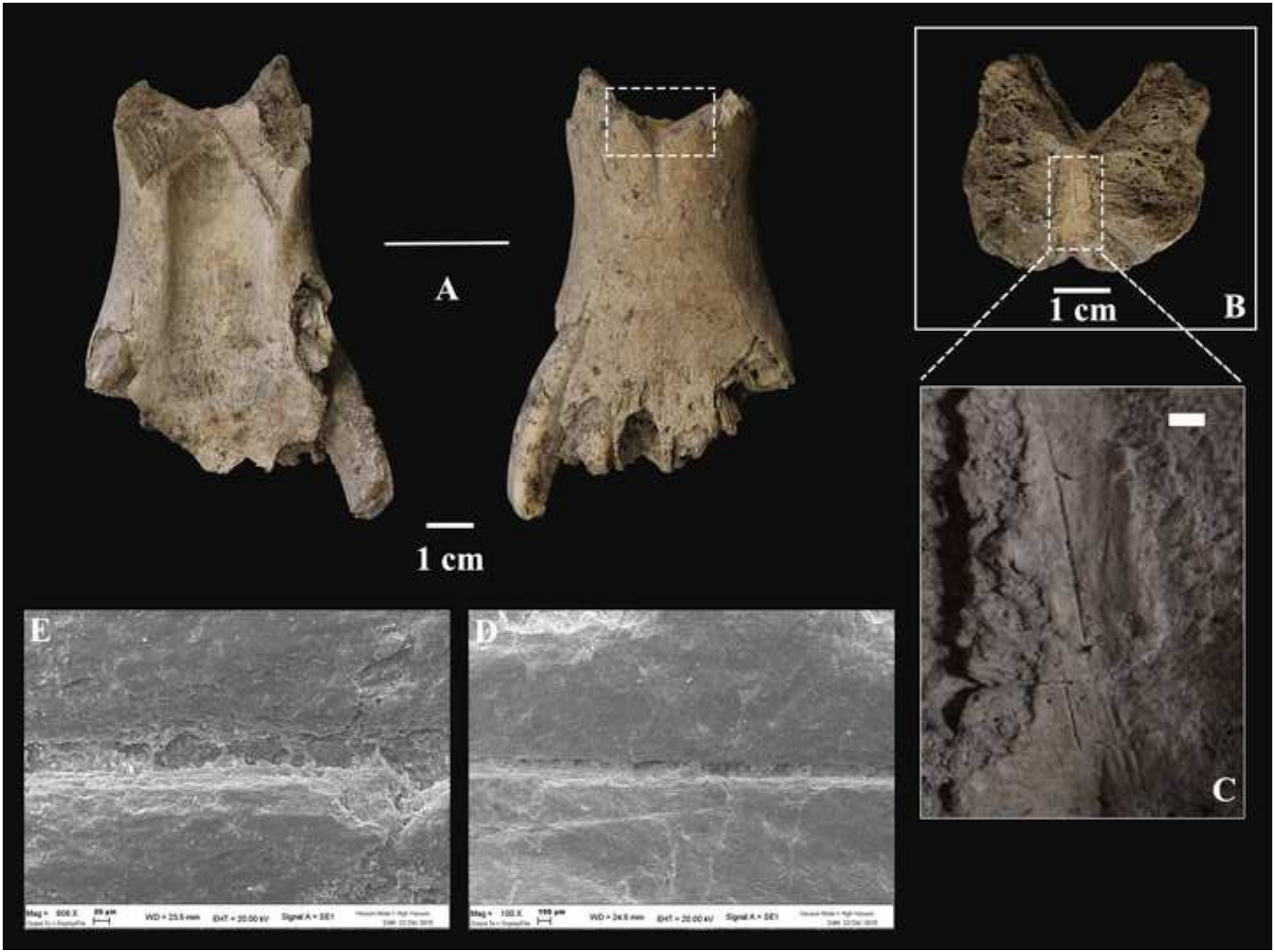

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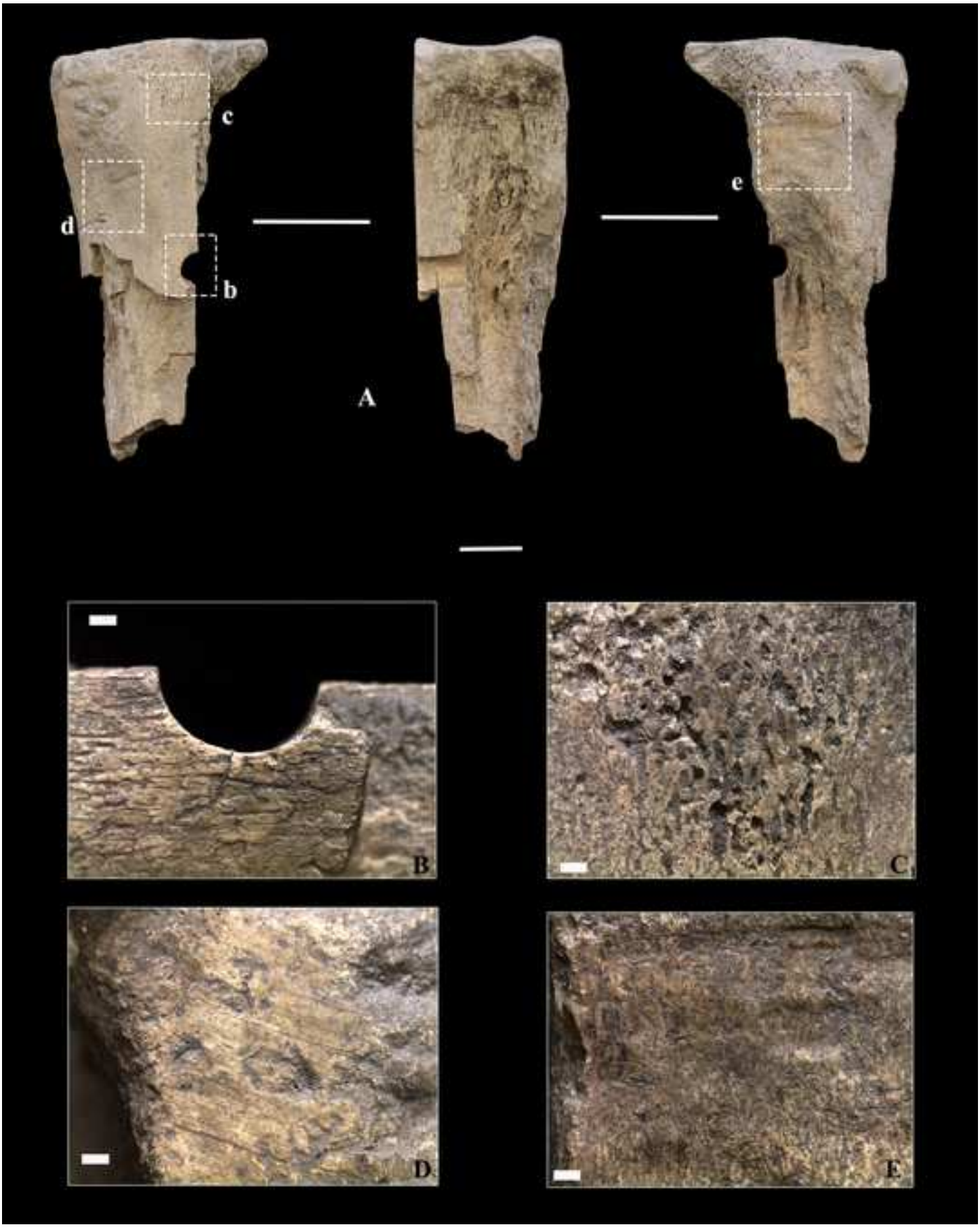

Figure 9

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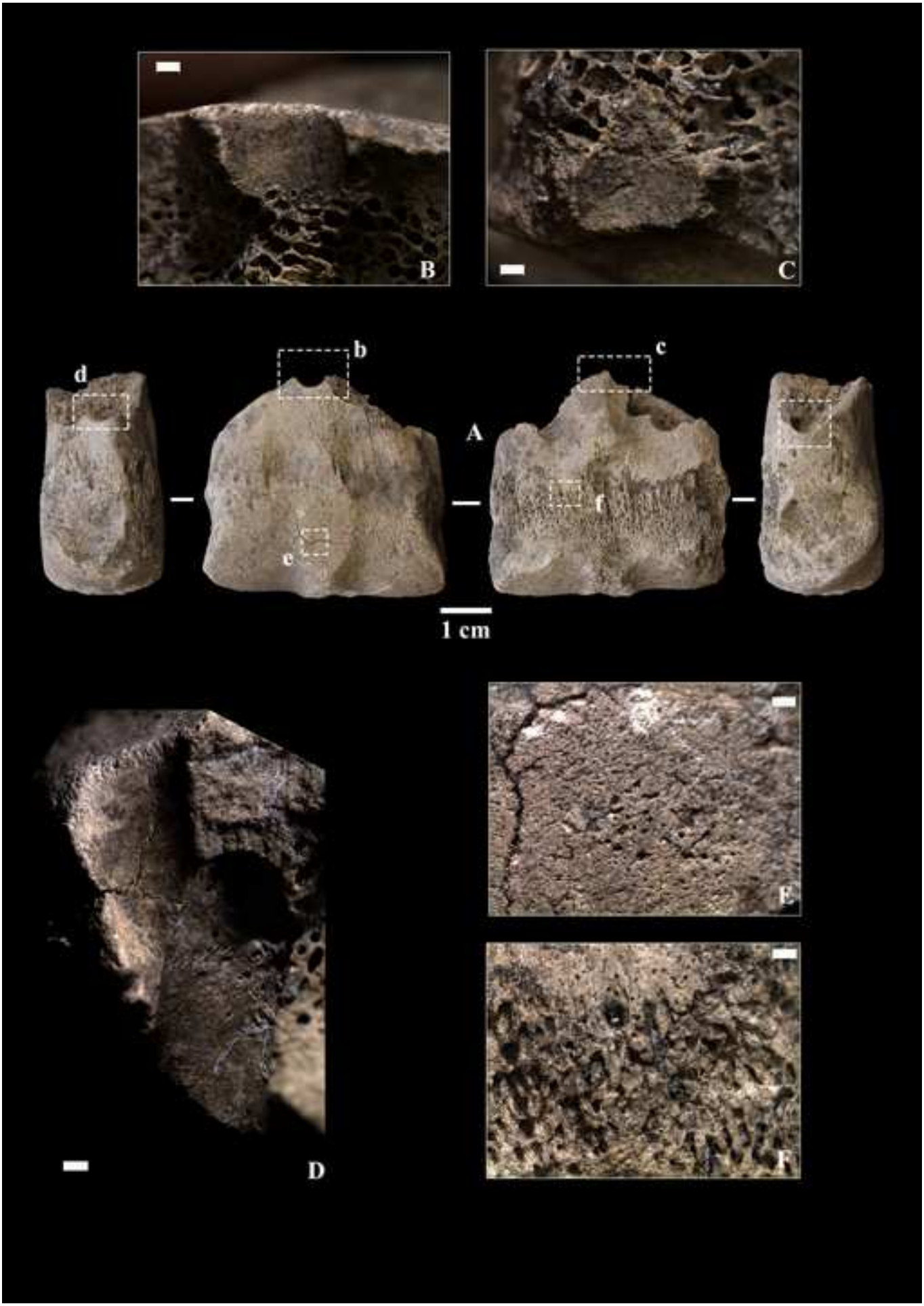

Table 1

Table 1
NISp e MNI of the fauna assemblage from Bovolone.

Taxa	NISp		%NISp		MNI	%MNI	
Canis familiaris	20	0.8	0.8	0.7	4	4.9	4
Equus caballus	189	8.0	7.2	6.9	6	7.2	6
Equus asinus	3	0.1	0.1	0.2	1	1.2	1
Sus domesticus	435	18.4	16.4	15.9	18	21.7	18.3
Bos taurus	1259	53.2	47.7	46.2	29	34.9	29.4
Capra vel *Ovis*	461	19.5	17.5	16.9	25	30.1	25.3
Total domestic animals	**2,367**	**100**	**89.7**	**86.8**	**83**	**100**	**84**
Lepus europaeus	1	0.4	0.05	0.05	1	6.3	1
Martes martes	31	11.4	1.2	1.1	1	6.3	1
Vulpes vulpes	75	27.7	2.8	2.9	2	12.5	2
Sus scrofa	37	13.6	1.4	1.3	3	18.7	3
Cervus elaphus	110	40.6	4.2	4.1	6	37.5	6
Capreolus capreolus	16	5.9	0.6	0.6	3	18.7	3
Elephantidae	1	0.4	0.05	0.05	-		
Total wild animals	**271**	**100**	**10.3**	**10.1**	**16**	**100**	**16**
Total identified mammals	**2,639**	**50.6**	**100**	**96.9**	**99**		**100**
Aves	29	33.3		1			
Amphibia	21	24.1		0.7			
Emys orbicularis	35	40.2		1.3			
Bivalvia	2	2.4		0.1			
Total other taxa	**87**	**100**		**3.1**			
Total identified remains	**2,724**	**52.2**		**100**			
Unid. Large size mammal	800	62		32			
Unid. Large-medium size mammal	197	15		8			
Unid. Medium size mammal	290	23		12			
Total unid. Mammals remains	**1,287**	**100**		**52**			
Unidentified remains	1,207	100		48			
Total unidentified	**2,494**	**47.8**		**100**			
Total faunal assemblage	**5,218**	**100**					

Table2

Table 2
Horse body part representation.

Anatomical Elements	NISp	Right	Left	Undet.	NME	MNI	eNR	NME/eNR	NME/NISp
skull	6	2	1	3	1	1	6	0.16	0,16
upper teeth	34	18	12	4	34	6	120	0.28	1,00
jaw	12	2	8	2	2	2	12	0.16	0,16
lower teeth	20	8	9	3	20	3	120	0.16	1,00
atlas	1				1	1	6	0.16	1,00
epistrophaeus							6	0	
scapula	8	4	4		4	3	12	0.33	0,50
humerus	4	2	2		2	1	12	0.16	0,50
radius	8	5	3		4	3	12	0.33	0,50
ulna	5	4	1		3	2	12	0.25	0,60
carpals							84	0	
III metacarpal	11	7	3	1	7	5	12	0.58	0,65
pelvis	12	7	5		7	3	12	0.58	0,58
femur	14	7	7		4	3	12	0.33	0,50
patella							12	0	
tibia	17	7	9	1	7	4	12	0.58	0,41
astragal	4	3	1		3	3	12	0.25	0,75
calcaneus	8	5	3		4	2	12	0.50	0,50
other tarsals	1	1			1		48	0.02	1,00
IV metatarsal	7	4	3		4	3	12	0.33	0,57
metapodials ind.	3			3				-	0,00
rudimental metapodials	2			2	2	2	48	0.04	1,00
phalanx I	6			6	6	2	24	0.25	1,00
phalanx II	5			5	5	2	24	0.20	1,00
phalanx III	1			1	1	1	24	0.04	1,00
Total	**189**	**86**	**71**	**31**	**121**	**6**			

Table 3

Anatomical element	GL	L1	WRH (GL)	WRH (L1)
III Metacarpal	225	219	137.3	140.2
III Metacarpal	225	217	137.3	138.9
IV Metatarsal	244	236	127.8	130.7

Tab. 3

Table 4

Site	References	Cronology	NR	Max	Min	Avg.
Nogarole	Riedel, 1992	MBA	1			135
Poggio Rusco	Catalani, 1980-81	MBA	1			137.7
Gorzano	De Grossi Mazzorin, 1994	MBA	14	142.2	112	127.2
M. Castellaccio	De Grossi Mazzorin, 1996	MBA	9	137.2	124.3	129.3
Tombola	Bertolini, 2014	MBA	2	130.4	122	126.2
Vallette	Bertolini, 2014	MBA	1			123.7
Montale	De Grossi Mazzorin, 1994	MBA-LBA	1			134.1
S.Giuliano	De Grossi Mazzorin, 1996	MBA-LBA	7	133.3	122	127.2
"Terramare" Varie	De Grossi Mazzorin, 1994	MBA-LBA	3	140.5	133	136.2
Sabbionara	Riedel, 1993	LBA	1			131.5
Bovolone	Bertolini, 2014	LBA	3	137.3	127.8	134.1
Cavalzara	Riedel, 1979	LBA	1			132.4
Appiano	Riedel, 1985	LBA	1			129.9

Tab. 4

Table 5

Anatomical element	index (SD*100/GL)	
III Metacarpal	14	Slender legged
III Metacarpal	15.1	Slightly slender legged

Tab. 5