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New perspectives on Late Bronze Age lagoon sites in the South of France revealed by animal exploitation at the La Motte I site (Hérault)

Carole Lespes, Thibault Lachenal, Armelle Gardeisen, Jean Gascó

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- 1 Title
- 2 New perspectives on Late Bronze Age lagoon sites in the South of France revealed by animal
- 3 exploitation at the La Motte I site (Hérault)
- 4 Author
- 5 **Carole LESPES** asm - archéologie des sociétés méditerranéennes, umr 5140, univ paul-valéry, cnrs, f-34000, Montpellier. labex
- 6 archimede programme ia- anr-11-labx-0032-01. carolelespes1@gmail.com
- 7 **Thibault LACHENAL** asm - archéologie des sociétés méditerranéennes, umr 5140, univ paul-valéry, cnrs, f-34000, Montpellier. labex
- 8 archimede programme ia- anr-11-labx-0032-01. thibault.lachenal@cnrs.fr
- 9 **Armelle GARDEISEN** asm - archéologie des sociétés méditerranéennes, umr 5140, univ paul-valéry, cnrs, f-34000, Montpellier. labex
- 10 archimede programme ia- anr-11-labx-0032-01. armelle.gardeisen@cnrs.fr
- 11 **Jean GASCÓ** asm - archéologie des sociétés méditerranéennes, umr 5140, univ paul-valéry, cnrs, f-34000, Montpellier. labex archimede
- 12 programme ia- anr-11-labx-0032-01
- 13 Corresponding author: Carole Lespes
- 14 E-mail: carolelespes1@gmail.com
- 15 Postal address: Université Paul Valéry – Site Saint-Charles
- 16 Archéologie des Sociétés Méditerranéennes - UMR 5140
- 17 Route de Mende
- 18 F-34199 MONTPELLIER Cedex 5
- 19 FRANCE
- 20
- 21 Abstract

22 At the present time, only a few Late Bronze Age sites in the French Mediterranean have yielded
23 faunal data. The newly excavated site of La Motte I (Hérault, France) is exceptionally well preserved
24 owing to its underwater context. The discovery of large quantities of pottery, a wattle and some
25 wooden poles allowed the site to be dated to the Late Bronze Age IIIb (900-775 BC). The
26 zooarchaeological analysis of the mammalian remains has made it possible to identify the nature of
27 butchery operations at the site. Culling profiles show herd management practices during this period
28 and bring to light specific dietary practices. These data reveal meat procurement behaviour in this
29 Bronze Age Mediterranean population, highlighting regular meat acquisition from domestic livestock.

30 Highlights:

- 31 • Zooarchaeological analysis of an exceptionally well-preserved Late Bronze Age lagoon
32 occupation in Mediterranean southern France.
- 33 • Food production is strongly oriented towards land-based resources despite the proximity of
34 the lagoon and the sea.
- 35 • Meat consumption of this Late Bronze Age Mediterranean population was mainly
36 composed of young domestic animals.

37 Keywords: Late Bronze Age; French Mediterranean; culling profile; herd management; lagoons

38

39

40 1. Introduction

41 The Bronze Age and the beginning of the Iron Age in France are the subject of a recent overview
42 (Carozza *et al.*, 2017). This evaluation of French data for the Late Bronze Age indicates a hierarchical
43 organisation, linked to elite status. There is clear evidence for the expansion of fortified settlements,
44 located at strategic locations such as confluence points or on rocky outcrops. While housing data and
45 archaeological evidence (ceramics, metal tools, structures) are available, zooarchaeological analyses

46 are still comparatively rare. Indeed, faunal data in Languedoc at the end of the Bronze Age (Final
 47 Bronze IIIb) are extremely scant. Most of the zooarchaeological studies for Languedoc deal with
 48 earlier periods or different contexts, such as Castelvielh Cave for the Final Bronze IIIa (Gardeisen,
 49 1991) or Les Courtinals settlement for the Final Bronze II and IIIa (Poulain, 2002). For the Final Bronze
 50 IIIb, they mainly consist of simple faunal lists accompanied by basic interpretation (Columeau, 1985;
 51 2002). However, rescue archaeology has sparked new interest in this period among researchers for
 52 the Mediterranean region of France. Moreover, the French Mediterranean context differs slightly
 53 from Late Bronze Age continental sites, both in terms of chronology (Table 1) and culture, as it is
 54 influenced by the proximity of Iberia and Italy, and presents specific local characteristics (Garcia and
 55 Vital, 2006; Gascó, 1998; Lachenal, 2014; Py, 2012).

| Datation B.C | Southern French chronology | French chronology | German chronology | British chronology |
|---------------------|-----------------------------------|--------------------------|--------------------------|---------------------------|
| 650 | Bronze/Iron Transition | Ancient Hallstatt | Hallstatt C | Early Iron Age |
| 700 | | | | |
| 800 | Final Bronze IIIb | Final Bronze IIIb | Hallstatt B2/3 | Later Bronze Age |
| 900 | | | | |
| 1000 | Final Bronze IIIa | Final Bronze IIIa | Hallstatt B1 | |
| 1100 | Final Bronze IIb | Final Bronze IIb | Hallstatt A2 | |
| 1200 | Final Bronze IIa | Final Bronze IIa | Hallstatt A1 | Middle Bronze Age |
| | Final Bronze Ib | | | |
| 1300 | Final Bronze Ia | Final Bronze I | Bronze D | |

| | | | |
|------|--------------------|--------------------|--------------|
| | | | |
| 1400 | Middle Bronze 2 | Middle Bronze 2 | Bronze C2 |

56

57

Tab. 1: Comparative chronology of the Late Bronze Age and beginnings of the Iron Age in Europe.

58

59

The present zooarchaeological analysis provides new perspectives on the way of life of these

60

Mediterranean populations. Geomorphological studies show that the housing site of La Motte I was

61

located on the edge of a former lagoon (Devillers *et al.*, forthcoming), suggesting that it was mainly

62

organized around maritime resources. However, this study shows that terrestrial resources appear to

63

supply important staple foods for these inhabitants. It is clear that such specific types of sites must

64

be compared to previously studied sites (Columeau, 1985) in Languedoc and in the North of France,

65

such as Boulancourt (Seine-et-Marne) and sites in Aisne (Auxiette, 1997; Bălăşescu *et al.*, 2008;

66

Carozza *et al.*, 2017). These sites date from the Late Bronze Age and should reveal whether there are

67

similarities in meat consumption between southern and northern France.

68

Lagoon complexes in the Gulf of Lion (Fig. 1) offered an attractive area for Bronze Age populations.

69

Indeed, lagoons are convenient locations, with a variety of readily available food resources and

70

nearby cultivable land. The first excavations of such sites began in 1940 at the Bages-Sigean lagoon

71

(Guy, 1950). Interest in them was subsequently revived after the discovery of protohistoric

72

settlements in the Lez Delta, such as Port Ariane in Lattes, Hérault (Daveau, 2007). Local

73

archaeologists discovered several sites (Fig. 1) on the edge of the Or Lagoon (Arnal and Prades, 1980;

74

Dedet *et al.*, 1985; Prades, 1974), in the Thau Lagoon (Courtin, 1978; Leroy *et al.*, 2003) and in

75

Vendres (Carozza and Burens, 2000). The Or Lagoon sites were first considered to be transient sites,

76

on herd transhumance routes (Py, 1990). In other words, it was thought that local populations lived

77

near the coast in summer with their herds and moved with them during the wet season to high-

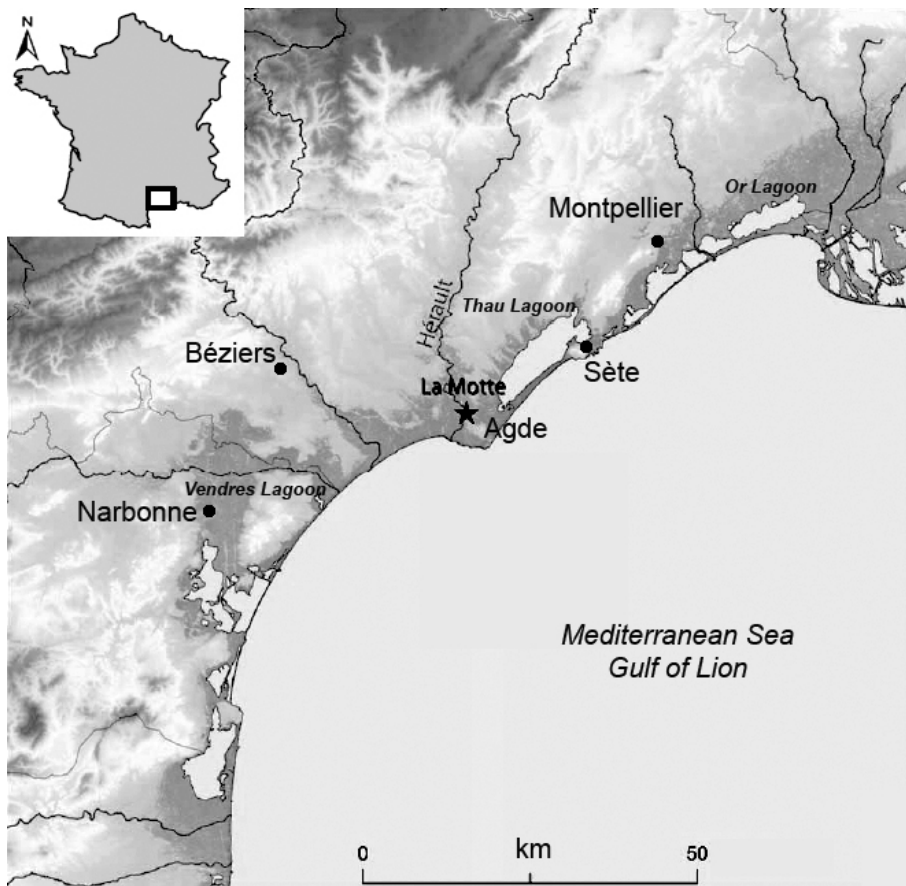
78

altitude sites in mountainous areas. But this hypothesis has since been challenged by recent

79 paleobotanical studies (Bouby, 2014) and the Portal-Vielh excavations (Carozza and Burens, 2000),
80 which show that these lagoon habitats were used year-round.

81

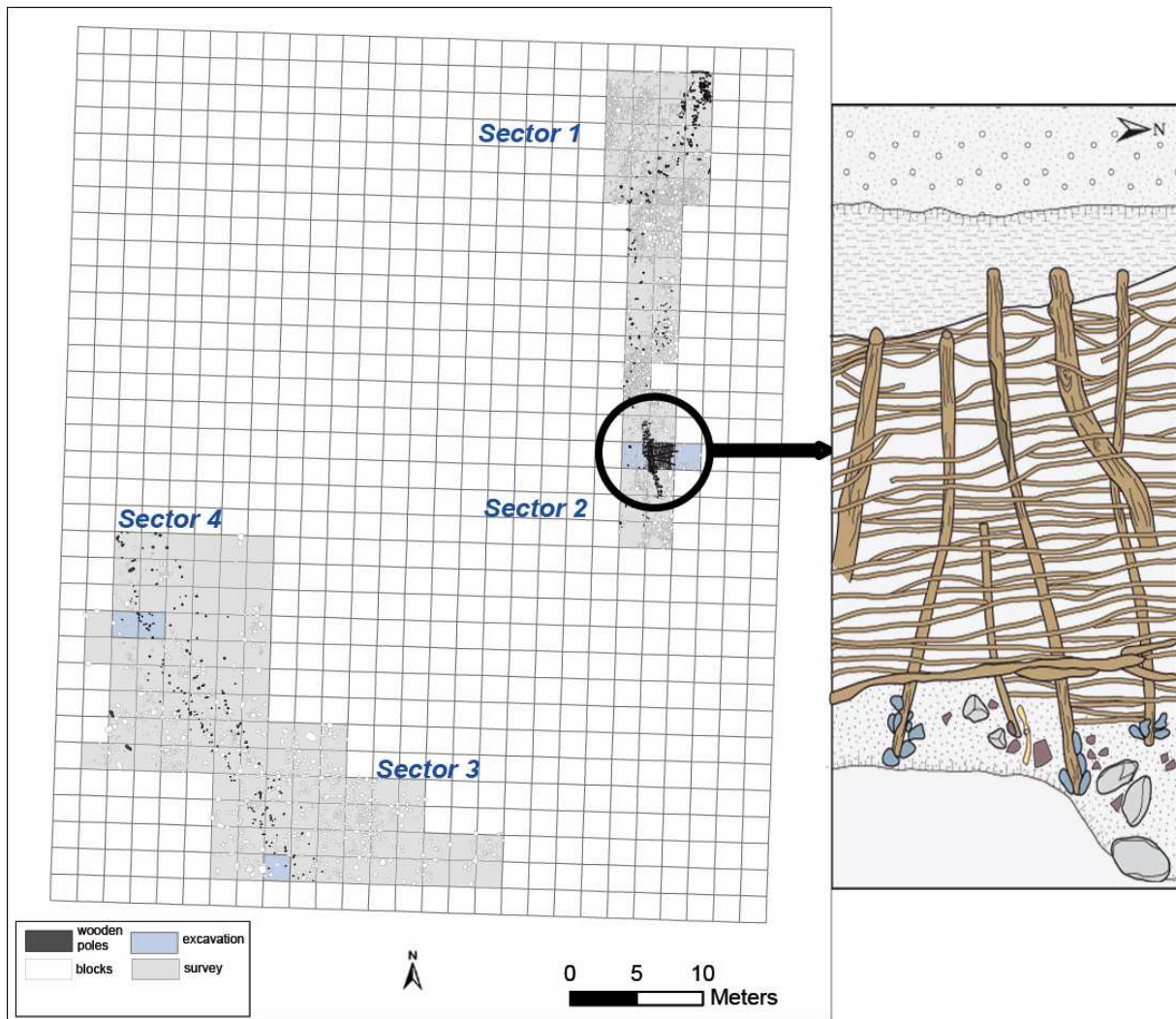
82 2. Site presentation



83

84 **Fig. 1:** Geographical location of the archaeological site of La Motte I (CAD, T.Lachenal), modified.

85 La Motte I is situated in the South of France near the town of Agde (Fig.1). The underwater site is
86 currently submerged in the Hérault River and was discovered by the IBIS diving association in 2002.
87 During the first excavations in 2004, a hoard consisting of an almost complete set of feminine finery
88 was discovered (Moyat *et al.*, 2010; Verger *et al.*, 2007). Surveys were then conducted by J. Gascó
89 and T. Lachenal in 2011 and are still ongoing (Gascó *et al.*, 2015). A planimetric survey and
90 excavations were carried out by divers at two different sites on either side of the river bed and cover
91 3,000 m² (Fig. 2).



92

93 **Fig 2 (in colour):** Map of the excavation of La Motte I in the Hérault River with detailed view of the wattle (CAD, T. Lachenal), modified.

94 This housing site was originally located on the edge of a former lagoon (Devillers *et al.*, forthcoming),

95 which has since been filled with sediments from the Hérault. The remains are immersed under five

96 metres of water and, as a result, are exceptionally well preserved. The large quantity of organic

97 remains in the sediments allows for a precise reconstruction of the evolution of the

98 paleoenvironment and human activities. Ten wooden poles were radiocarbon dated and gave dates

99 ranging from the ninth to eighth centuries B.C. (Gascó *et al.*, 2015). These dates are consistent with

100 the analysis of pottery (Lachenal *et al.*, 2017) corresponding to the Late Bronze Age (ninth to early

101 eighth centuries) and linked to the establishment of the Mailhac I culture in Languedoc (Gailledrat *et*

102 *al.*, 2007; Janin, 2000; Louis *et al.*, 1955). The site also presents riverbank structures, comprising

103 imported basalt rocks and wattle, demonstrating the reinforcement of the banks and the

104 delimitation of an inhabited zone. The hypothesis of a semi-nomadic way of life for these lagoon
105 populations (Py, 1990) has been challenged by recent discoveries. Therefore, the question of
106 permanent settlement at La Motte I remains open. Nevertheless, the excavated levels in which the
107 faunal remains were discovered are primarily waste deposits in the vicinity of the dwelling area and
108 are close to the riverbank structures. In addition, the carpological analysis (Bouby *et al.*, 2016)
109 revealed that the population living at the site was actively involved in agricultural production and
110 practised herd stalling. These factors suggest perennial settlement for the La Motte I site. The
111 analysis of the faunal remains from La Motte I should therefore be expected to confirm these initial
112 results.

113 3. Materials and methods

114 Faunal bones and teeth were collected from all excavation areas in different stratigraphic units and
115 in 2m x 2m squares (Sector 1, 2, 3 and 4; Fig. 2). Three samples were collected for the carpological
116 study in the D26 sounding (SU 4, 15 and 18) and in the wattle zone. These samples were sieved but
117 no faunal remains were found. As the entire sequence of stratigraphic units was dated to the end of
118 the Bronze Age, all the faunal remains were analysed (Table A in the appendices) and recorded by
119 stratigraphic unit and square in the Syslat© database.

120 The complete collection consists of 1,321 mammal, bird, shellfish and fish remains. The shellfish and
121 fish remains are not analysed in this study as they will be studied in detail by other specialists. The
122 taxonomic and anatomical determination was carried out using the reference faunal sampling at the
123 ASM laboratory of the University of Montpellier 3 (CNRS, UMR 5140).

124 The differential diagnosis between *Capra hircus* and *Ovis aries* teeth (Balasse and Ambrose, 2005;
125 Halstead *et al.*, 2002; Helmer, 2000; Payne, 1985) has been contested (Zeder and Pillar, 2010) but a
126 recent study (Gillis *et al.*, 2011) highlighted the reliability of the combination of several criteria. As
127 the bones are well preserved at La Motte I, most mandibular and maxillary bones contain whole
128 dental series, which facilitated differentiation between sheep and goats. With the post-cranial data,

129 a primary distinction was made based on morphological criteria (Boessneck, 1969, Zeder and
130 Lapham, 2010) and confirmed by discriminant analysis (Salvagno and Albarella, 2017). The distinction
131 between rabbits (*Oryctolagus cuniculus*) and hares (*Lepus europaeus*) was made using specific
132 morphological criteria (Callou, 1997).

133 The quantification of faunal remains is expressed by the Number of Identified Specimens (NISP),
134 which includes taxonomically and anatomically identified bones and teeth, and the Minimum
135 Number of Individuals combination (MNIc). The MNIc takes into account species, element frequency,
136 pairing, ageing and sex. The complete dental series on the mandible and maxillary and isolated teeth
137 were used to calculate the MNIc index, taking into account eruption sequence and wear. The age at
138 death (AtD) was defined for large bovids using the most accurate method (Legge, 1992; Gillis *et al.*,
139 2016), in order to be as precise as possible. The use-wear code method was applied to Caprinae
140 (Payne, 1987). To estimate the AtD value of suids, we used a method based on ranking codes (Grant,
141 1982; Lemoine *et al.*, 2014).

142 Culling profiles were calculated in accordance with the recommendations of Brochier, who
143 elaborated a statistically correct method that allows for accurate interpretation (Brochier, 2013).
144 Insofar as possible, age analysis was based on bone epiphyseal fusion (Zeder *et al.*, 2015 for Suidae,
145 Reitz and Wing, 1999).

146 Standard biometrics (Von den Driesch, 1976) were performed on all bones and teeth whenever
147 possible in order to distinguish between *Ovis aries* and *Capra hircus*, *Bos Taurus* and *Bos primigenius*,
148 and to estimate the withers height of the animals. The body size of animals was investigated using
149 reference coefficients for Caprinae (Teichert, 1975), Bovidae (Matolcsi, 1970) and Equidae
150 (Kiesewalter, 1888), to provide a view of the domestic herd present in this region at the end of the
151 Bronze Age.

152 Skeletal representation is divided into four categories: cranial remains include the skull, mandible
153 and jaw, the axial skeleton is composed of vertebrae and ribs, the limbs include the forelimbs

154 (scapula, humerus, radius and ulna) and hindlimbs (coxal, femur, tibia and fibula) and finally the feet
155 include carpals, tarsals, metapodials and phalanxes. The following indices were used in this study in
156 order to determine whether anatomical parts were differentially deposited (Lyman, 2008; Poplin
157 1976):

158 MNE: Minimum Number of Elements (i.e. a humerus) tallied after virtual reassembly taking into
159 account pairing, ageing and the sex of all bone remains for a species.

160 Qsp: This is the number of given elements in a complete skeleton for a species. It can vary according
161 to age (i.e. number of teeth) and species.

162 MAU: Minimum Animal Unit. This is the frequency of skeletal MNE for a given species.

163 $MAU = MNE / Qsp$

164 %MAU: This is the normalized MAU calculated from the highest MAU corresponding to 100%.

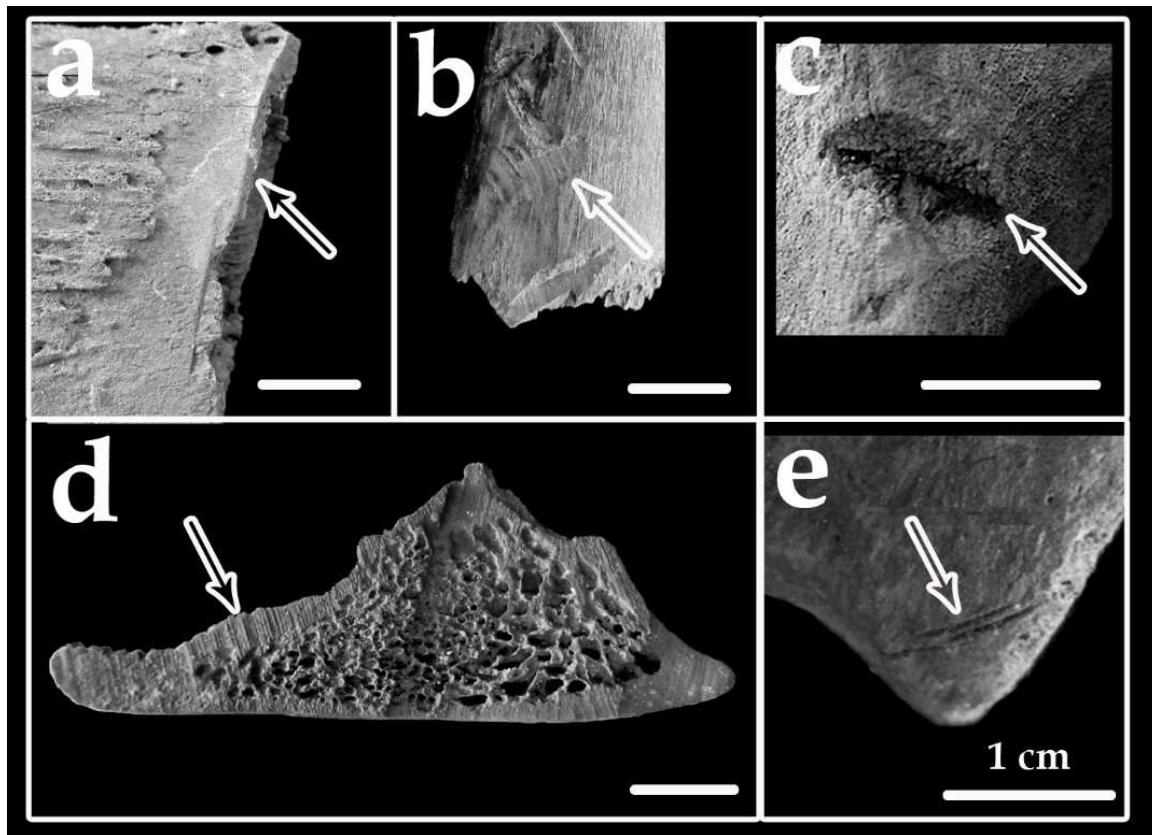
165 $\%MAU = 100 \times MAU / MAU_{max}$

166 PS: The percentage of survivorship is calculated for each element and can be applied to the
167 anatomical region (cranial, axial, limb and foot) and to the entire skeleton using the MAU and MNE.

168 $PS = 100 \times MNE / MNE_{max} \times Qsp$

169 Bone surface modifications were studied in order to identify their causes and to characterize their
170 impact on bone assembly. The cortical surface of all remains was analysed macroscopically and some
171 specimens were inspected microscopically with a Leica stereomicroscope. The orientation and
172 location of marks on the bone were recorded. The marks were then separated into five categories
173 (Fig. 3): notches associated with large tools forming a large triangular depression; slicing, generally
174 made with a cleaver, exposing a sharp section of the bone; scratches, created by knives and forming
175 fine notches on the cortical surface; cortical removal, made either by cleavers or knives and

176 characterized by a longitudinal removal of the cortical surface of the bone; and finally, sawing,
177 recognizable by the irregularity of the section's surface caused by the saw.



178
179 **Fig. 3:** Anthropogenic modifications to bone surface. a: slicing (cutting); b: cortical removal b; c: notches; d: sawing; e: scratches.

180 Non-anthropogenic post-depositional marks were also investigated and classified into the following
181 categories: root marks, gnawing by carnivores and rodents, and edaphic marks.

182 All faunal remains were registered in the Syslat© database (Py 1997; Gardeisen 1997).

183

184 4. Results

185 4.1 Taxon diversity

186 5 The faunal assemblage of La Motte I is composed of 1,321 remains (total of identified and
187 unidentified faunal remains), including 685 identified bones and teeth (NISP). They belong to
188 fourteen species: cattle (*Bos taurus*), sheep (*Ovis aries*), goats (*Capra hircus*), pigs or wild boars

189 (*Sus scrofa*), horses (*Equus caballus*), dogs (*Canis lupus familiaris*), deer (*Cervus elaphus*), aurochs
 190 (*Bos primigenius*), rabbits (*Oryctolagus cuniculus*), turtles, birds, shellfish and fish (Table 2;
 191 Annexes Table A).

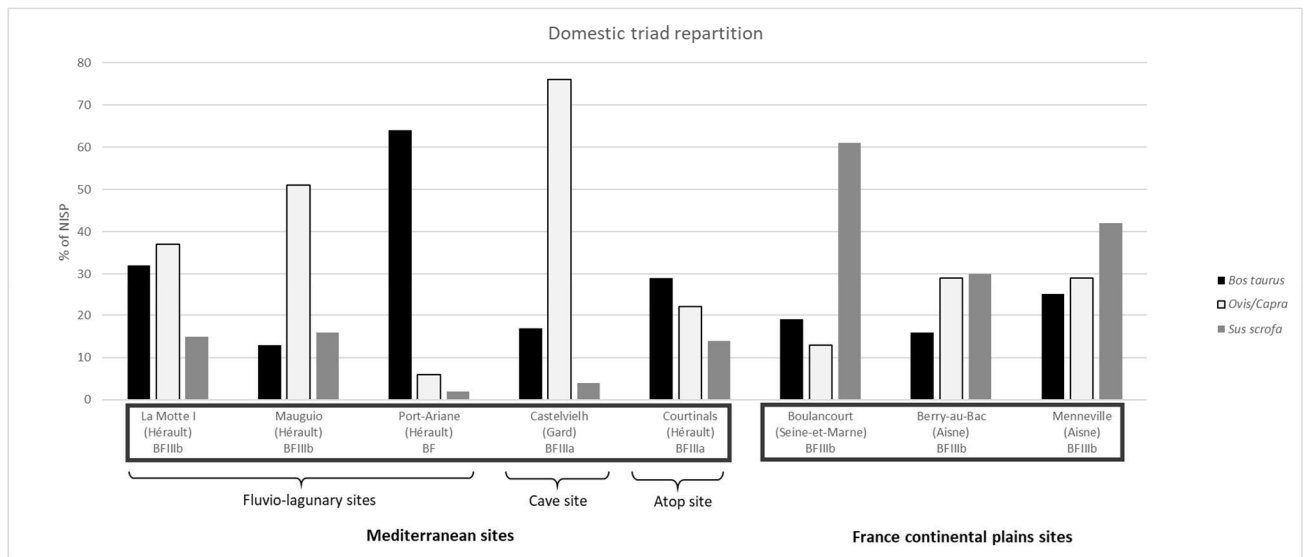
| FAUNAL LIST | | NISP | MNIc |
|---------------|-------------------------------|--------------|------------|
| Cattle | <i>Bos taurus</i> | 215 | 49 |
| Aurochs | <i>Bos primigenius</i> | 3 | 1 |
| Suid | <i>Sus scrofa</i> | 99 | 40 |
| Sheep | <i>Ovis aries</i> | 26 | 20 |
| Goat | <i>Capra hircus</i> | 44 | 31 |
| Sheep/Goat | <i>Ovis/Capra</i> | 183 | 35 |
| Horse | <i>Equus caballus</i> | 10 | 6 |
| Dog | <i>Canis lupus familiaris</i> | 16 | 10 |
| Deer | <i>Cervus elaphus</i> | 55 | 16 |
| Rabbit | <i>Oryctolagus cuniculus</i> | 24 | 8 |
| Pond terrapin | <i>Emys orbicularis</i> | 2 | 2 |
| Cormorant | <i>Phalacrocorax sp.</i> | 3 | 2 |
| | <i>Birds indet.</i> | 3 | 3 |
| | <i>Carnivore indet.</i> | 1 | 1 |
| | <i>Microfauna</i> | 1 | 1 |
| Sea bream | <i>Sparus aurata</i> | * | * |
| | Unidentified | | 636 |
| Total | Total | 1,321 | 225 |

192

193 **Tab 2:** Quantification of the faunal assemblage recovered from the La Motte I site. Number of Identified Specimens (NISP) and Minimum
 194 Number of Individuals combination (MNIc). *Although the ichthyofaunal remains will soon be analysed by a specialist, rare *Sparus aurata*
 195 remains have already been determined.

196 Among the species present at La Motte I, the domestic triad (*Bos taurus*, *Ovis aries*/*Capra hircus*, *Sus*
 197 *scrofa*) prevails. Livestock is mainly composed of goats and sheep, which is common in
 198 Mediterranean areas (Gardeisen, 1991; Columeau, 1985); followed by cattle and pigs. Horses and
 199 dogs are less frequent. Deer is the most hunted wild species, represented by faunal remains mainly
 200 composed of bones (only three fragments of antler have been found), followed by rabbit and aurochs
 201 (*Bos primigenius*). Some sporadic remains of the European pond terrapin (*Emys orbicularis*),
 202 cormorant (*Phalacrocorax sp.*), wild goose (*Anser sp.*), sea bream (*Sparus aurata*) and other
 203 unidentified wild birds have also been recorded.

204



205

206 **Fig. 4:** Comparison of the distribution of the domestic triad in Late Bronze Age sites in France (Columeau, 1985; Forest, 2007; Gardeisen,
207 1991; Poulain, 2002; Auxiette, 1997).

208 It is generally accepted that evidence of pig farming generally increased in France at the end of the
209 Bronze Age (Forest, 2000; Auxiette, 1997), with *Sus scrofa* forming more than 20% of the NISP, which
210 is not the case at La Motte. Pig farming developed considerably (more than 30% of the NISP) in many
211 French continental plains (Fig. 4), but not in Mediterranean sites where husbandry practices seemed
212 to focus more on goats or cattle. For example, in the vicinity of the Mauguio pond (Columeau, 1985),
213 caprines predominate, followed by pigs and cattle. In Port-Ariane (Hérault, France), cattle are clearly
214 predominant, which is counter to the classic Mediterranean pattern (Forest, 2007), usually
215 dominated by caprines (mainly sheep and to a lesser degree, goats), then cattle, pigs (about 20% of
216 the faunal assemblage) and deer (about 10%).

217 The domestic herd of La Motte I is dominated by caprines in terms of NISP and MNIC, and more
218 precisely by goats, with suid livestock coming in third position after cattle. The importance of goats
219 rather than sheep seems to be an original feature of this site. Indeed, at other sites, such as
220 Castelvielh (Gard) or Les Courtinals (Hérault), sheep are the best represented taxon. But this slight
221 difference should be interpreted with caution, as these two sites are dated respectively to the Final
222 Bronze IIIa and Final Bronze II-IIIa and correspond to different types of occupations (cave and hilltop

223 settlement). This first approach shows that the faunal remains represent classic Late Bronze Age
 224 Mediterranean animal husbandry. A group of people settled in a developed settlement with a
 225 communal herd sustaining their needs mainly composed of caprines and bovids, followed by suids,
 226 with some horses and dogs.

227 4.2 Body size

228 Only a few complete bones were available for each taxon for this analysis. Withers height was
 229 estimated for caprines on one radius, one metacarpal and two astragali, for *Bos taurus* (one radius,
 230 two metacarpals and two metatarsals) and for *Equus caballus* (one femur), (Table 3). The results gave
 231 a range of 46.1-56.3 cm for caprines, 103.6-115.6 cm for cattle, and the single whole horse femur
 232 gave a height of 136.7 cm. These results can be compared with those of Boulancourt (Seine-et-
 233 Marne), Port-Ariane (Hérault) and Castelvieu (Gard). For size estimates at Boulancourt, a single
 234 whole metatarsal of *Bos taurus* gave a height estimate of 108.5 cm; a range of 51.8-63.5 cm is given
 235 for goats and no data are available for horses. In Port-Ariane, the measurements of a bovine
 236 metacarpal and an equine metatarsal indicate an estimated size of 117 and 125 cm, respectively.
 237 Caprine bones could not be measured. In Castelvieu, the size of the sheep is between 54 and 60 cm.
 238 Despite the small number of measurements and estimates, a trend towards a smaller size for goats
 239 and cattle is visible while the La Motte I horse seems larger than horses at the other sites (Table 4).
 240 But this comparison is unreliable because the distinction between *Equus asinus* and *Equus caballus*
 241 has not been made at other sites.

242

| Species | Bones | GL | Index | Withers height in cm |
|-------------------|------------|-------|-------|----------------------|
| <i>Ovis/Capra</i> | radius | 139.7 | 4 | 55.9 |
| | metacarpal | 116.3 | 4.84 | 56.3 |
| | astragalus | 24 | 19.24 | 46.1 |
| | | 24.6 | | 47.3 |
| <i>Bos taurus</i> | radius | 237.9 | 4.3 | 102.3 |
| | metacarpal | 173.5 | 6.33 | 109.8 |

| | | | | |
|-----------------------|------------|-------|------|-------|
| | | 173.5 | | 109.8 |
| | | 163.7 | | 103.6 |
| | metatarsal | 205.6 | 5.62 | 115.6 |
| | | 203.3 | | 114.3 |
| <i>Equus caballus</i> | femur | 389.6 | 3.51 | 136.8 |

243

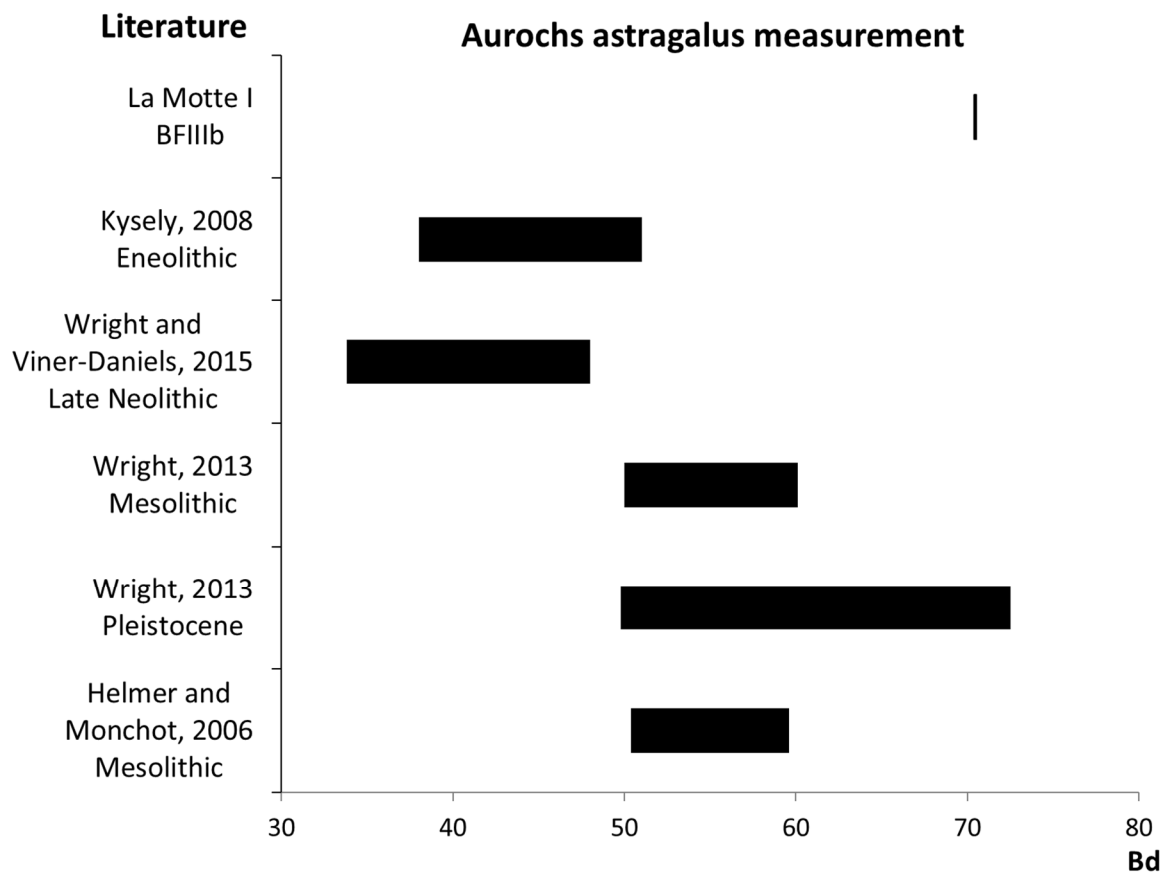
244 **Tab. 3:** Withers height estimation in cm for caprines (*Ovis/Capra*), cattle (*Bos taurus*) and horses (*Equus caballus*) at La Motte I.

| | Castelvielh BFIIIa | Port-Ariane Final Bronze | Boulancourt BFIIIb | La Motte I BFIIIb | Cougourlude Early Iron Age |
|---------------------------------|-----------------------|-----------------------------|-----------------------|----------------------|-------------------------------|
| <i>Ovis aries/ Capra hircus</i> | 57 | x | 58 | 51 | 57 |
| <i>Bos taurus</i> | x | 113 | 109 | 107 | 111 |
| <i>Equus sp.</i> | x | 125 | x | 137 | 107 |

245

246 **Tab. 4:** Comparison of average withers height for caprines, cattle and equids from the archaeological settlements of Port-Ariane (Hérault),
247 La Motte I (Hérault), Cougourlude (Hérault), Castelvielh (Gard) and Boulancourt (Seine-et-Marne).

248 For wild species, three tarsal elements were identified as *Bos primigenius* on account of their large
249 size. All of the aurochs remains are incomplete, but measurements on a fragmented aurochs
250 astragalus (*Bos primigenius*) reveal that the La Motte I specimen is probably a huge male, similar to
251 the largest European Pleistocene specimens (Wright, 2013) and larger than Holocene specimens
252 (Helmer and Monchot, 2006; Kysely, 2008; Wright and Viner-Daniels, 2015; Wright, 2013).
253 Measurements of this aurochs astragalus were compared with other data from Pleistocene and
254 Holocene sites and clearly show the remarkable height of this animal (Fig. 5). This suggests that the
255 environment at that time was conducive to the presence of an aurochs of remarkable size. This is
256 also confirmed by the carpological analysis (Bouby *et al.*, 2016), which shows the presence of a green
257 oak forest and open spaces with heaths and junipers. It also suggests that the size of domestic
258 animals is more related to domestication and selection effects than environmental conditions.



259

260 **Fig. 5:** Comparison of the measurements (Bd) of the aurochs astragalus (*Bos primigenius*) at La Motte I with other European sites (Wright,
261 2013; Wright and Viner-Daniels, 2015; Helmer and Monchot, 2006).

262

263 4.3 Skeletal representation

264 The anatomical profile of the bone assemblage is characterized by the abundance of cranial and limb

265 remains, followed by axial and foot elements (Fig. 6). The same trend is observed for the triad taxa.

266 As far as possible, ribs and vertebrae were identified to the taxon, but a determination bias

267 (underestimation) should be taken into account for this category. Indeed, when skeletal

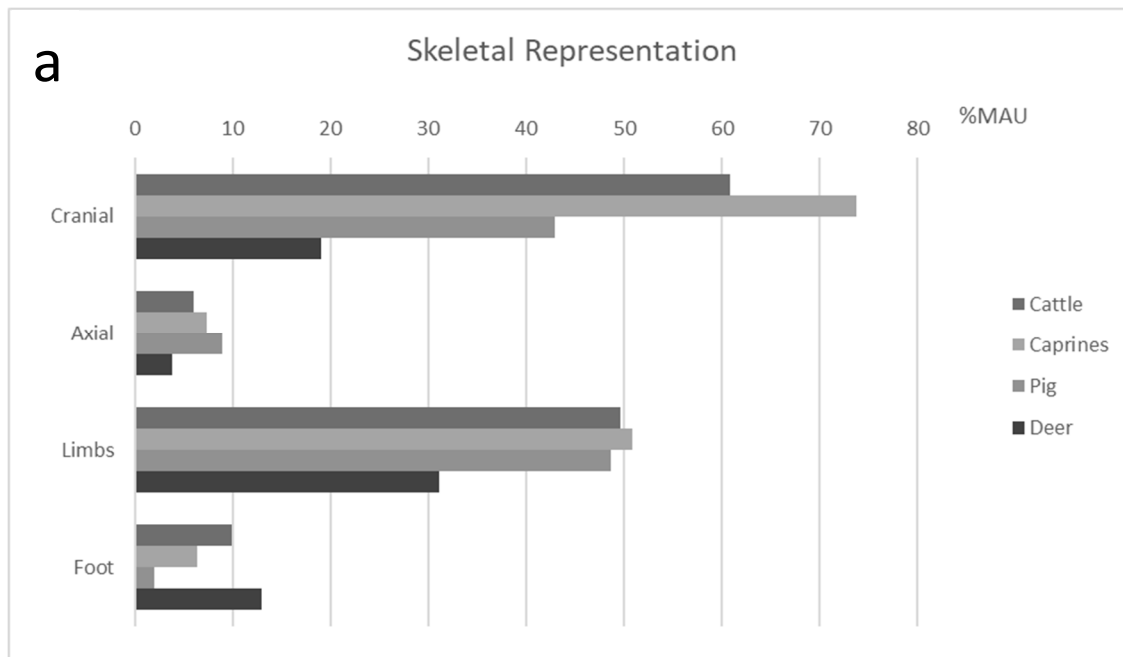
268 representation is viewed as a percentage of the total number of faunal remains (anatomically

269 determined but not taxonomically determined), the foot is still rare but the axial category seems

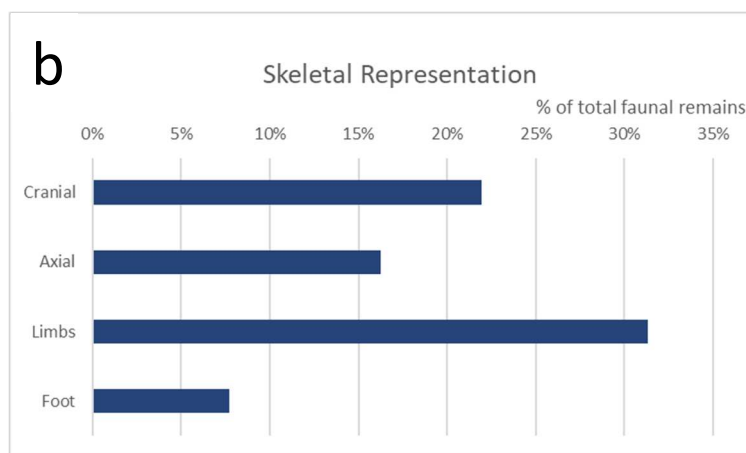
270 better represented. However, this can be explained by the high fragmentation of costal elements. In

271 addition, this under-representation can be explained in part by the high impact of carnivores on

272 bones (20% of the total assemblage shows signs of gnawing).



273



274

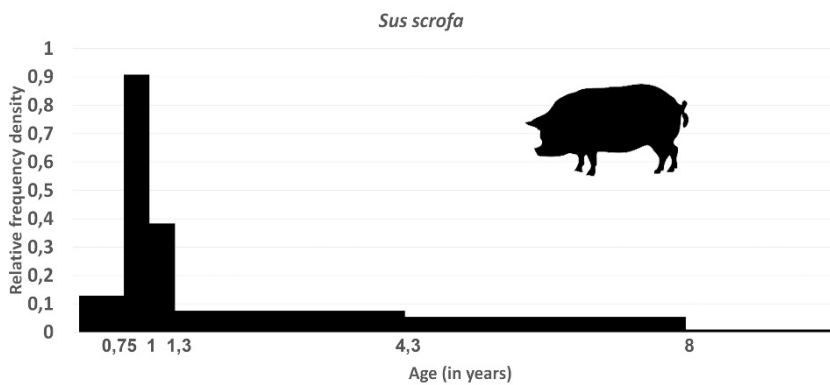
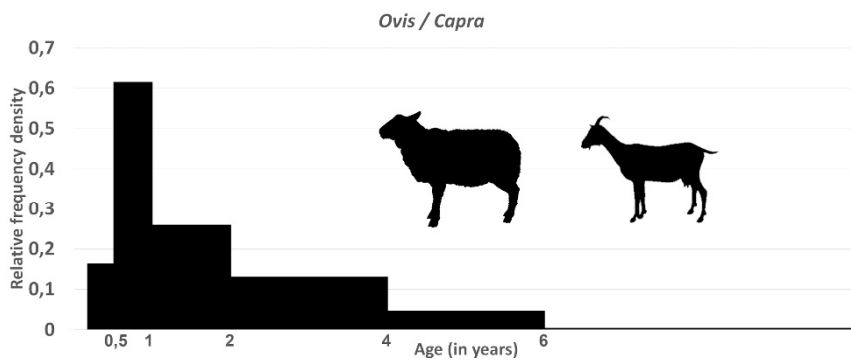
275 **Fig. 6:** a: Skeletal representation per main species in percentage of MAU (Minimal Animal Unit) of the faunal assemblage of La Motte I. b:
 276 Skeletal representation of all species taken together as a percentage of total faunal remains of La Motte I.

277 The analysis of skeletal representation reveals no major differences between domestic and wild
 278 species. The foot category for pigs is rare. The skeletal representation of deer shows that limb bones
 279 outweigh those of the skull and the foot category is well represented in comparison to the axial
 280 category. As deer are wild hunted animals, we can assume that the carcass would have been
 281 processed differently to domestic species. Taponomic bias could play a major role in this particular
 282 skeletal distribution, as small parts may have been moved away by the river current. But this
 283 hypothesis is challenged by the presence of rabbit bones and rare sea bream jawbones. Underwater

284 excavation conditions can also generate biases and although the diving excavators were experienced,
285 it was complicated to take samples for sieving under these conditions. This could impact the
286 representativeness of very small fish remains, but this is not the case for mammalian remains.
287 Therefore, it is more likely that this particular skeletal representation is due to anthropogenic
288 selection, with limbs reflecting culinary waste and cranial remains being rejected after removing
289 edible parts (as evidenced by some anthropogenic marks at the junction of the jaws). The scarcity of
290 axial and appendicular parts of the skeleton could mean that inedible parts of the animal were
291 discarded elsewhere.

292 4.4 Mortality profiles

293 Mortality profiles were only calculated for teeth, taking into account the stage of wear and dental
294 eruption.



295

296 **Fig. 7:** Domestic triad culling profile, based on wear stages and dental eruption. Number of cattle teeth: upper=36, lower=56; caprine
 297 teeth: upper=74, lower=155; suids teeth: upper=19, lower=41.

298 4.4.1 Cattle

299 The combination of lower and upper teeth (N = 92) was used to calculate mortality profiles. AtD
 300 results reflect a strong slaughter peak between 1-2 years (Fig. 7) and subtle peaks at 0-1 months and
 301 2-4 years. This could reflect multiple practices: killing calves for tender meat, slaughtering prime
 302 adults for maximum meat yields and slaughtering retired lactating females and old males for herd

303 management (Gillis *et al.*, 2016). In this case, we cannot confidently identify dairy farming
304 (Greenfield, 2005; Greenfield and Arnold, 2015; Helmer *et al.*, 2007; Payne, 1973).

305 4.4.2 Caprines

306 For sheep and goats, the culling profile peaks between 6 months and 1 year, followed by a slight
307 peak at 1-2 years (N=229, Fig. 7). This depicts an emphasis on tender meat (Helmer and Vigne, 2004;
308 Payne, 1973). However, traces of slaughtering of older adults are also visible in this histogram. Again,
309 this implies that animals were culled post-lactation or for wool farming.

310 4.4.3 Suids

311 Young pigs (N=60) were slaughtered mainly between 10 and 12 months of age (Fig. 7). This may
312 reflect a preference for tender, high-quality meat. Culling older pigs (aged 1 to 4 years) can be
313 interpreted as a quest for maximum meat yields and the killing of pigs over 4 years of age can occur
314 after fattening or at the end of reproductive functions.

315 The three mortality profiles correspond to a "tender meat" profile. The age limit for older cull
316 animals (9 years for cattle, 6 years for caprines and 8 years for Suidae) may indicate their use for
317 secondary production and herd birth-rate management, in order to always have a large number of
318 young individuals available.

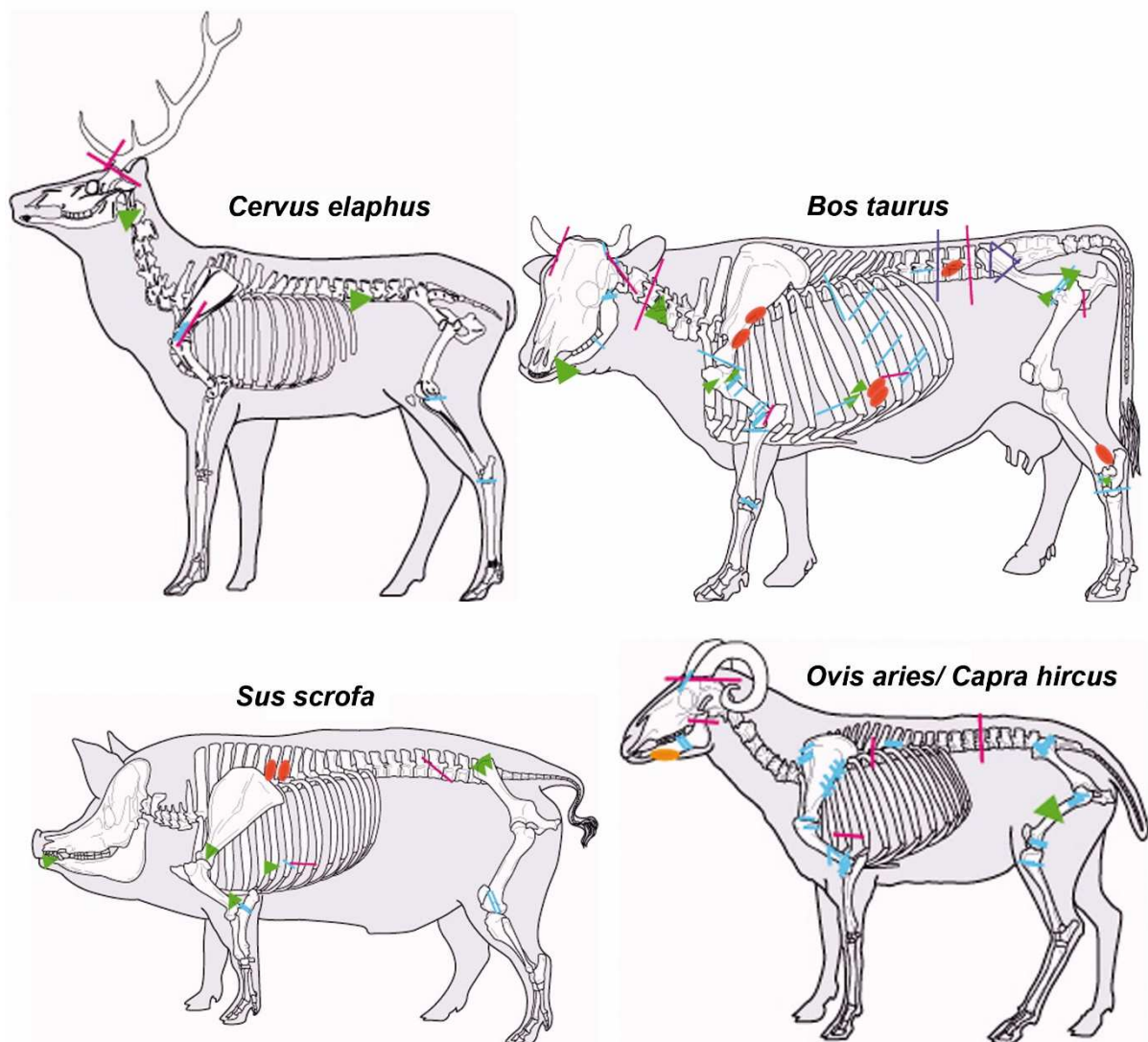
319 4.5 Taphonomic alterations

320 The underwater environment of the site caused specific polishing of the cortical surface of the bones.
321 Almost all the remains are light brown to dark brown. The entire assemblage (1,321 faunal remains)
322 was observed for taphonomic alterations. Most of the bones underwent superficial dissolution due
323 to the fluvial context. Some of them present specific marks made by seaweed and small marine
324 bivalves. Carnivores caused a number of changes in the bone surface as 20% of the total assemblage
325 shows gnawing by carnivores. This indicates that culinary waste was accessible to commensal species
326 and that landfill of the remains was slow. Burnt remains are easily distinguishable from natural

327 staining, as burn marks are black or grey/white while natural staining colours bones soft brown to
328 dark brown. The number of burnt remains is very low.

329 4.6 Anthropogenic marks

330 Cutting marks were identified on 10% of the 1,321 faunal remains and 17% of NISP (Fig.8) on all
331 mammalian species: *Bos taurus*, *Bos primigenius*, *Sus scrofa*, *Ovis aries*, *Capra hircus*, *Canis lupus*
332 *familiaris*, *Oryctolagus cuniculus*, *Equus caballus* and *Cervus elaphus*.



- ▶ Notches
- Sliced
- Scratches
- Cortical removing
- Sawed

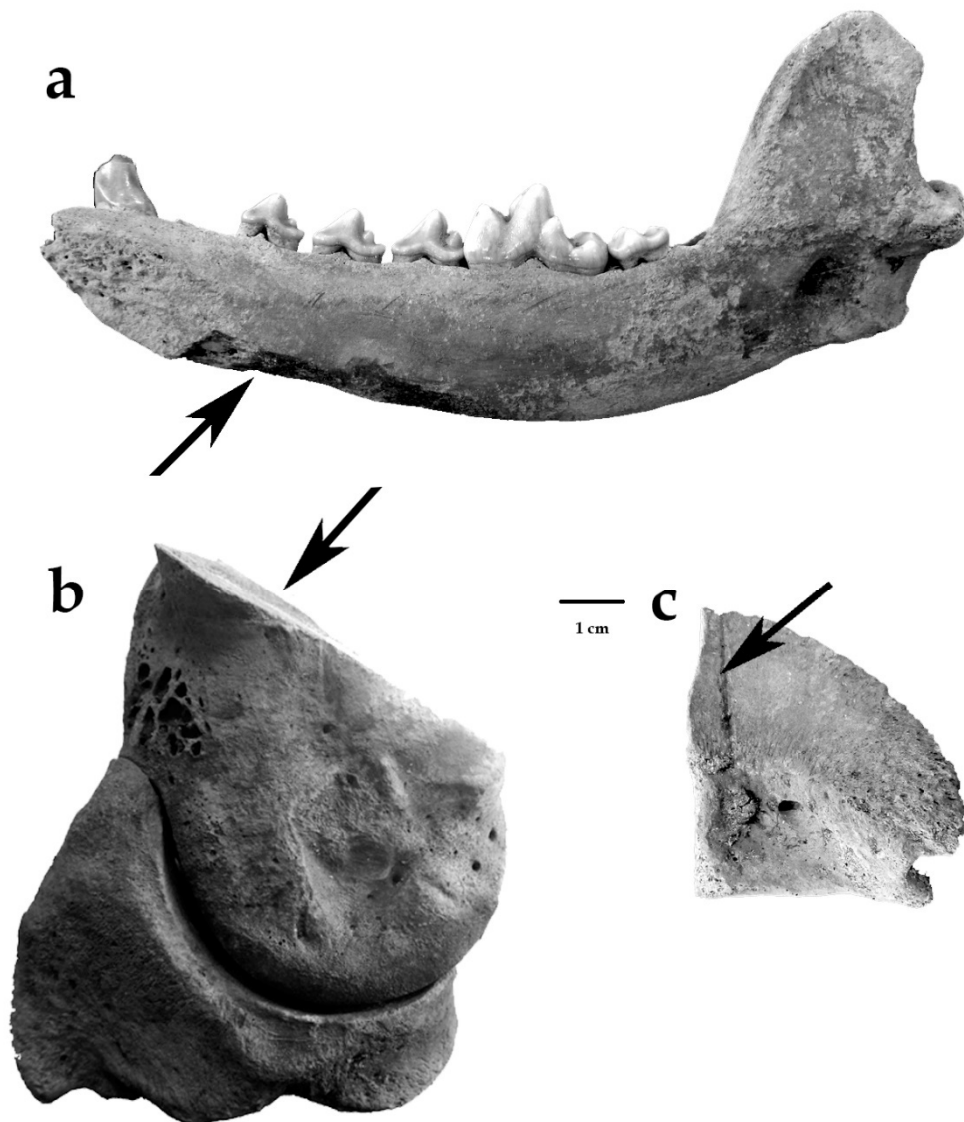
333

334 **Fig 8 (in colour):** Butchery marks on the skeletons of deer, cattle, pigs and caprines.

335 Five categories of anthropogenic cutting marks were observed on cortical bone surfaces. These
336 highlight the stages of carcass processing such as disarticulation, removal of horns and feet, skinning
337 and cutting meat, among others (Gardeisen, 1999). These observations demonstrate some slight
338 differences between the consumed species. Indeed, butchery techniques vary with the size of the
339 animal: for large mammals such as cattle and deer, large tools such as meat cleavers or saws are
340 preferred, while knives are used for medium-sized mammals such as caprines or suids. Cut marks are
341 mainly located on limbs (48%), or on the diaphysis just below the joint surface, suggesting
342 disarticulation and meat removal (Lyman 1987, 1994; Soulier and Costamagno 2017). The only
343 common butchery technique to all four species is observed on lumbar vertebrae (slicing or notching),
344 indicating the separation of the hindquarters. For large mammals (cattle and deer), marks on the
345 cervical vertebrae indicate dissociation of the head. Scratches on carpals and tarsals show
346 disarticulation of the feet and possibly skinning. The deer is the only animal with a longitudinal cut
347 mark on the scapula, probably to remove the meat. Most of the time, cattle and caprines had their
348 horns and antlers cut off, probably for artisanal purposes, although there is no real evidence of this.
349 This can also be interpreted as a phase of skinning. The disarticulation of the femur-tibia connection
350 is observed for all animals except cattle, but the latter are only represented by one entire femur. This
351 reveals that the hind legs were generally separated into two parts for consumption. The heads of
352 cattle show different treatment compared to other species. Analysis of the cut marks plausibly
353 demonstrates the removal of the tongue, jaws and muzzle. Ruminants present similarities such as the
354 removal of the ligament of the scapula and humerus, probably in order to isolate the joints. The
355 cutting of ribs and the removal of meat from ribs and thoracic vertebrae are present on all three
356 taxa. Thin crossed scratches situated along the caudal rim of a caprine scapula seem to indicate on-
357 site consumption.

358 A single scratch was observed on a rabbit coxal, suggesting the consumption of rabbit meat. The
359 astragalus of *Bos primigenius* also shows cut marks and suggests that this animal was hunted. There

360 is no evidence of of horse meat consumption. However, a third phalanx presents some cut marks on
361 the sole, which could indicate the recovery of the hoof, perhaps for artisanal purposes. Scratches
362 were observed on a dog coxal and a dog mandible shows cortical removal at its base (Fig. 9).



363

364 **Fig. 9:** Butchery marks (arrows) visible on bones from La Motte I. a: cortical ablation on canine mandibular base (*Canis lupus familiaris*),
365 labial view. b: medial view of a sliced astragalus of an aurochs in connection with the cubo-navicular (*Bos primigenius*). c: Third phalanx of
366 horse (*Equus caballus*) with medial cut mark (distal view).

367

368 5. Discussion

369 It is generally accepted that at the end of the Bronze Age, the notion of territorial concentration

370 revolves around fortified settlements, which are potentially the seat of a local elite (Brun, 1988; Brun

371 and Pion, 1992; Pautreau, 1992). However, the present zooarchaeological study implies that the
372 lifestyle of the inhabitants on the Languedoc coast seemed quite similar to that of the elites. They ate
373 tender meat and herd management focused on producing young animals, as at the elite site of
374 Boulancourt (Seine-et-Marne, France). Indeed, the mass slaughter of young animals is not a long-
375 term solution for herd management and shows that the inhabitants of La Motte had a comfortable
376 way of life. This is also evidenced by the rich feminine bronze set recovered during the early
377 excavations of the lagoon site, attesting to the presence of a local elite. La Motte I therefore seems
378 to be a much more important site than previously thought, with a high standard of living and families
379 probably belonging to a local elite.

380 Unfortunately, faunal data from Late Bronze Age breeding sites are lacking in France (especially in
381 Languedoc), most often due to the scarcity of remains (less than 100 remains per site in general).
382 This makes it difficult to interpret mortality profiles, for example. The results from La Motte I could
383 be compared with those of lagoon sites around the Or Lagoon (Columeau, 1985) but no in-depth
384 faunal analyses are available for the latter. Age at death categories only include three groups in
385 Columeau's analysis: very young, young and adult individuals. According to his study, caprines and
386 pigs predominate in the young category, and cattle in the adult category as a percentage of MNIs.
387 However, these results should be considered with caution as there is no subadult class and no
388 explanation of the methods used for ageing. For other rural sites in northern France, some compiled
389 analyses (Auxiette, 1997) show an emphasis on pig farming, which is not the case here. But we
390 cannot deduce with certainty whether this is due to cultural, environmental or social differences.

391 The second point is that, despite the presence of the lagoon at the edge of the settlement site, fish
392 remains are rare on the site. This may be due to the lack of systematic sieving for very small fish
393 bones but some medium-sized fish remains were recovered, such as sea bream. Agropastoral
394 activities therefore seem to supply significant subsistence resources. Carpological and entomological
395 analyses (Bouby *et al.*, 2016) of the organic layers of the site backed up this general interpretation.

396 They revealed numerous carbonized seeds and leaf remains, as well as plant residues interpreted as
397 animal litter and two species of insects (*Aglenus brunneus* and *Platytomus tibialis*), linked to livestock
398 stalls and the accumulation of old manure. Meanwhile, fishing is evidenced by a bronze hook
399 adapted to fishing for large predators. This suggests that large fish remains should have been
400 recovered, but they have only been found in small quantities at La Motte I. It can therefore be
401 assumed that the population fished at sea and ate shellfish, but that this was not the main activity of
402 the settlement. La Motte I was not a fishery.

403 As far as large animal hunting practices are concerned, they do not appear to have been vital for
404 subsistence, but were perhaps linked to proving the value and strength of hunters. Although only
405 three aurochs remains have been recovered on the site so far, the height of the hunted animal
406 implies that this was a difficult mission. It can be also assumed that it was killed for security reasons,
407 as the exceptional size of the animal would have represented a danger for the community living
408 there. As regards small game hunting, the scarcity of rabbit remains does not allow us to draw a
409 definite conclusion. Only one coxal shows signs of meat removal. There are also some bird remains,
410 but no anthropogenic marks have been observed on bird bones. In addition, the presence of the
411 cormorant, which is a species living in the aquatic environment, may be coincidental here. All the
412 hunted species could potentially live near the settlement: deer could be present in the nearby
413 riparian forest and rabbits in the surrounding salt marshes. It can therefore be assumed that hunting
414 was opportunistic.

415

416 6. Conclusion

417 The results of this zooarchaeological analysis depict a faunal spectrum dominated by the domestic
418 triad (cattle, pigs and caprines), with significant hunting activity (deer and lagomorphs). Butchery
419 activities are attested by bone remains presenting anthropogenic cut marks. This is supported by the
420 trend in culling profiles highlighting a preference for quality and tender meat consumption. This type

421 of herd management requires a privileged social environment. Minor canine meat consumption is
422 also noteworthy. Thus, although halieutic resources such as sea shells and fish were found on the
423 site, it appears that the livelihood strategies of the Late Bronze Age population of La Motte I included
424 animal husbandry and the consumption of a large amount of meat despite the proximity of the
425 lagoon. The present faunal study shows a preference for the consumption of tender meat, while the
426 presence of the female bronze set suggests that this lagoon settlement enjoyed privileged status.
427 This indicates that - at least in some cases - lagoon sites could be important and influential areas and
428 not merely satellite sites of fortified hilltop settlements.

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432

433 Declaration of interest: none

434

435 Appendices: Table A

436

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