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1 Neanderthal and Carnivore Occupations in Unit II from the Upper Pleistocene Site of 2 Ramandils Cave, (Port-la-Nouvelle, Aude, France).

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8 ABSTRACT

9 The northwestern Mediterranean coast includes varied environment with abundant faunal and lithic resources exploited
10 during the Upper Pleistocene. In this area, the Ramandils Cave (Port-la-Nouvelle, Aude, France) records Middle Palaeolithic
11 levels dating to Marine Isotope Stage (MIS) 5. Evidence of Neanderthal occupations are observed throughout the sequence;
12 with numerous lithic industries, burnt faunal remains, marine shells, and few human bones. In unit II, the richest one, lithic
13 exploitation strategies are linked to the availability of major areas of flint supply implying a defined mobility pattern. Several
14 archaeostratigraphic levels have been individualised, with ungulate remains affected by human and carnivore predation,
15 involving alternated occupations of the cave during different periods. By confronting studies on origin and management of
16 lithic raw material with taphonomical and zooarchaeological data of large mammals, we attempt to gain a better
17 understanding of the site function, occupation duration, and regional mobility pattern in unit II of Ramandils Cave.

18 **Keywords:** Neanderthal occupations, Upper Pleistocene, large mammals, lithic industry, mobility pattern, site function

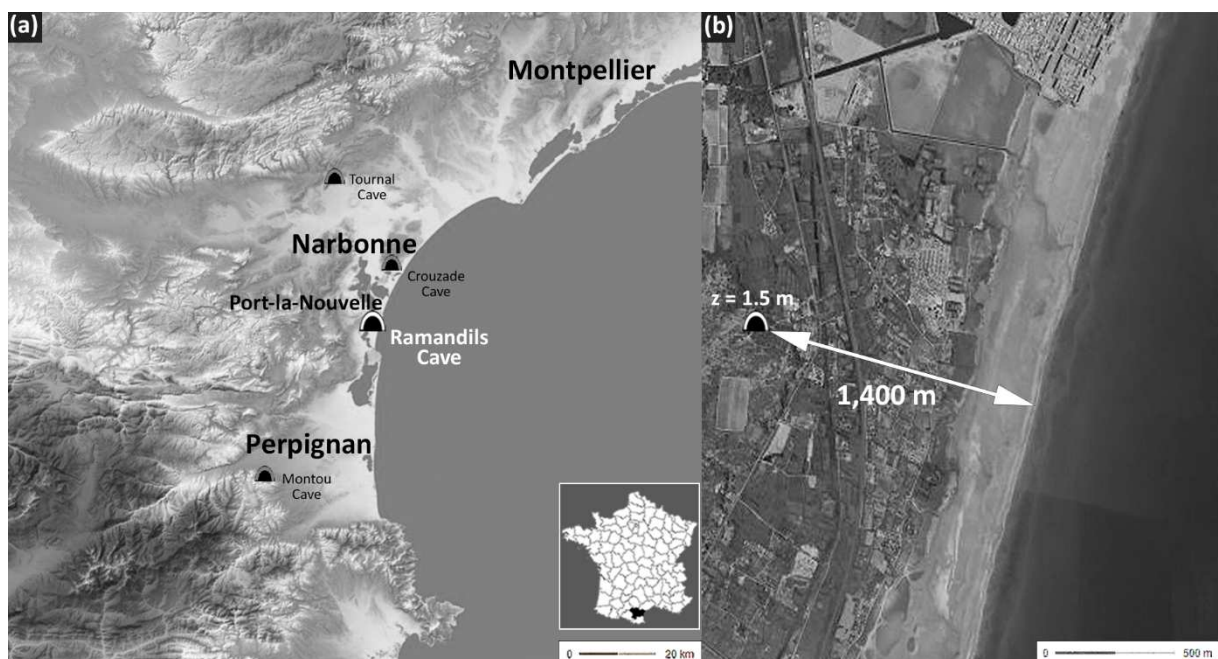
19 1. Introduction

20 The northwestern Mediterranean coast records several Middle Palaeolithic sites, correlated
21 between Marine Isotopic Stage (MIS) 5 to 3, with recurrent Neanderthal occupations, such as
22 Ramandils cave, Crouzade cave, Tournal cave, and the rockshelter of Les Canalettes
23 (Bischoff *et al.*, 1988; Cochard *et al.*, 2012; Daujeard *et al.*, in Djindjian *et al.*, 2018; Magniez,
24 2010; Rusch *et al.*, 2019; Saos, 2003; Saos *et al.*, 2016, 2017; Valladas & Joron, 1993;
25 Yokoyama *et al.*, 1987a). Faunal associations reflect climatic conditions between these
26 transition periods as well as human and carnivore behaviours, frequently recorded in the same
27 assemblages during Upper Pleistocene (Brugal *et al.*, 2017; Costamagno *et al.*, 2005;
28 Daujeard *et al.*, 2016, Discamps *et al.*, 2012; Magniez, 2010; Rendu, 2007; Saladié *et al.*,
29 2018, among many others). This involves representation, with different intensities and
30 frequencies, of zooarchaeological and taphonomic markers on ungulate carcasses, implying
31 various subsistence behaviors of these two types of predators. Occupation and Mobility
32 patterns are accessible through regional studies (Daujeard & Moncel, 2010; Daujeard *et al.*,
33 2016; Grégoire, 2012; Lebègue *et al.*, 2010; Patou-Mathis, 2000; Szmidi, 2003; Valensi &
34 Psathi, 2004; among many others), by taking into consideration raw material resources
35 available in the territory, as well as faunal remains and lithic tools analyses found in sites.
36 Three major occupation modes are discerned in this chronological period, long-term
37 residential camps with predominantly anthropogenic accumulation, short-term regular camps
38 that can be occupied alternately with carnivore occupations, and brief stopover as bivouacs,
39 such as highlighted in South of France around Mediterranean coast and in the Rhône Valley
40 (Daujeard & Moncel, 2010; Daujeard *et al.*, 2016; Magniez, 2010; Saos *et al.*, 2016).

41 The coastal context of Ramandils cave (Port-la-Nouvelle, Aude, France) with the
42 proximity of various ecosystem and major areas of flint supply point out this site as a key
43 sequence for mobility studies during upper Pleistocene. Last excavations (Boutié *et al.*, 1998)
44 have yielded several occupation levels with both Neanderthal and carnivore activities, mainly
45 represented by numerous lithic tools, burnt bones, marine shells, and coprolite deposits.
46 Recent studies on large mammal remains, palynological analyses of coprolites and new
47 radiometric dating were conducted (Rusch *et al.*, 2019), and allow to correlate the sequence to
48 the end MIS 5. The results highlighted temperate climate with forest, open (grasslands), and
49 rocky landscapes. The unit II, the richest one of Ramandils Cave, is chosen here for the study
50 of the successive occupations on this strategic place. Archaeostratigraphic approach in
51 progress permitted to individualise several occupation levels in this unit, with evidence of
52 human and carnivore activities. Thereby, thanks to archaeozoological parameters, using
53 mortality patterns, seasonality by large mammal spectrum, anatomical distribution, and
54 taphonomic traces studies, in addition with lithic raw material supply modalities and lithic
55 production technological processes, we will attempt to interpret subsistence strategies and
56 economical scheme of the lithic production. These feature combinations will allow us to gain
57 a better understanding of mobility patterns and site function.

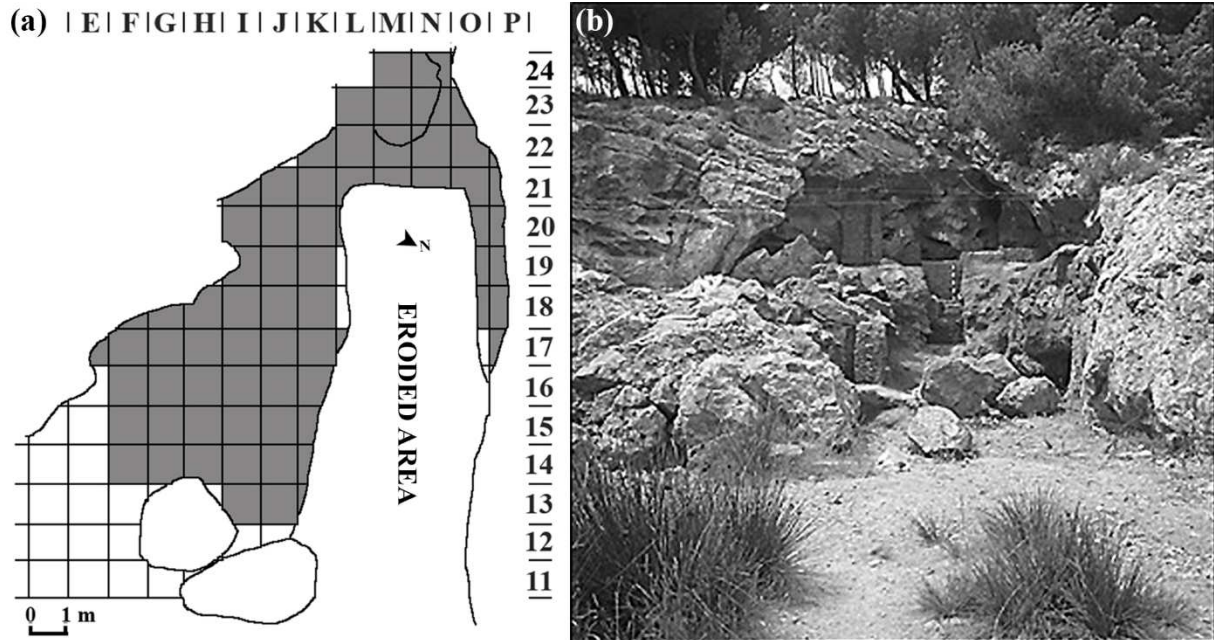
58 2. Site presentation

59 Ramandils Cave (Port-la-Nouvelle, Aude department, southern France), is located 30 km
60 south of Narbonne (fig. 1a), altitude 1.5 m, and separated from the current Mediterranean
61 shoreline by 1,400 m of lagoon deposits (fig. 1b). This east-facing cavity, towards the sea, is
62 formed at the bottom of an Urgo-Aptian limestone hill, called Cap Romarin, east of the first
63 Corbières massif foothill. This cave nowadays has a collapsed ceiling on the most part.



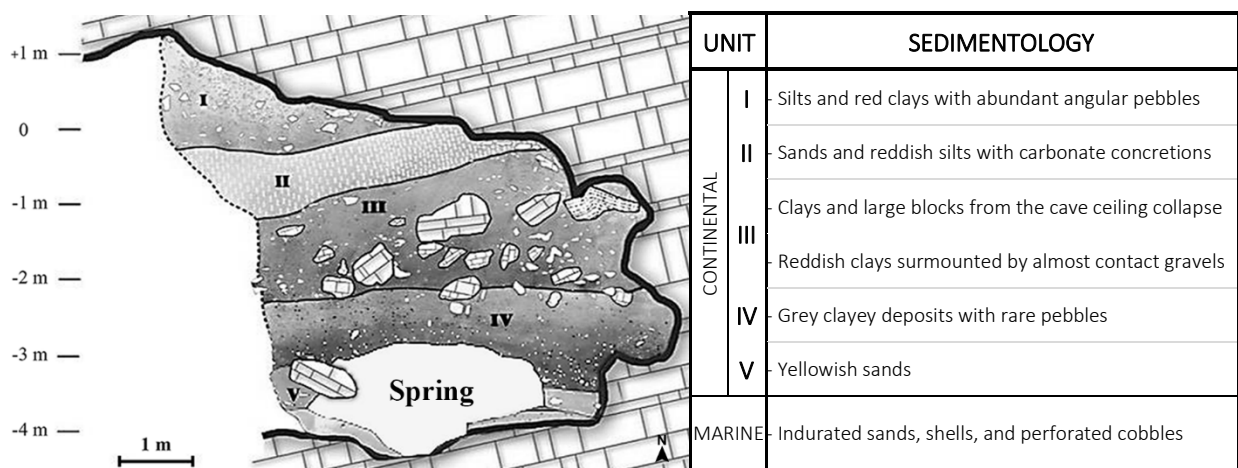
64
65
66 Fig. 1: Ramandils Cave locations : (a) raised-relief map with upper Pleistocene sites and (b) aerial photography (modified according
www.geoportail.gouv.fr)

67 The site was discovered in 1925 by Théophile Hélène (Grégoire, 2011). Planned yearly
 68 excavations were directed by Paul Boutié between 1983 and 1994 (Boutié *et al.*, 1998), on
 69 more than 50 m², according to systematic methods and based on a grid reference to record
 70 Cartesian data (fig. 2).



71
 72 Fig. 2: (a) Grid reference with excavated areas in gray, each one-meter squared area is distinguished by a letter (E to P) correlated with a
 73 number (11 to 24). (b) East view of the cave (modified according to Boutié, 1990 and Rusch *et al.*, in press, photo credit: P. Boutié, Centre
 74 Européen de Recherches Préhistoriques, Tautavel).

75 The cave, more than 5 m high, was completely filled with sediment, partially eroded in the
 76 lower part by an active natural spring (fig. 3). The stratigraphic sequence firstly records, at the
 77 bottom, a marine level with marine shells dated by Electron Spin Resonance (ESR) method to
 78 128 ±15 ky (Yokoyama *et al.*, 1987) to the last Thyrrenian transgression. Secondly,
 79 continental deposits are individualised (Kabiri, 1993) into five stratigraphic units (numbered I
 80 to V), containing among others, equids teeth, dated by ESR/U-Th (Uranium–Thorium)
 81 method between 94 ± 7 ky (unit V) and 77 ± 6 ky (unit I) to the end of Marine Isotope Stage
 82 (MIS) 5 (Rusch *et al.*, 2019).



83 Fig. 3: Stratigraphy of the North section (modified according Kabiri, 1993; Boutié *et al.*, 1994).

84 Mousterian occupations are recorded for all continental levels, mostly represented by lithic
 85 industries (29,994 pieces) corresponding to a Typical Mousterian (Molès, 2008). The
 86 peculiarity of this lithic collection is that all pieces have very small dimensions. The unit II
 87 levels have 15,832 lithic pieces, of which 68.4% are less than 15 mm and thus generally
 88 uncoordinated. This is the richest stratigraphic unit of the site.

89 This collection contains 0.7% of cores, 20.9% of flakes, 5.9% of blades. The production
 90 modes are mainly Levallois and SSDA (39.7% each). Among the Levallois systems, the
 91 Lineal (52.7%) is the most represented followed by the orthogonal recurrent modality (24.6%)
 92 and the recurrent centripetal ones (20.6%). The cores on flakes (kombewa production)
 93 represents 6.9% and testify to a secondary chaîne opératoire on the initial productions already
 94 of small dimensions (tab. 1) as a clear ramified flint exploitation strategy (Bourguignon et al.,
 95 2004). Discoids are rare (3.4%). The remainings 10, 3 % are indeterminate knapping systems.
 96 The reduction sequence on flint is totally represented into the site from the first steps of
 97 preparing cores, through the production of blanks by various methods (Levallois dominant,
 98 followed by SSDA and discoide methods) until the retouching process to produce tools on
 99 flakes or blades and ramification of a part of the Levallois production, resulting in a
 100 microlithisation of the production. The larger flakes were selected to produce flake tools. Tool
 101 percentage is low 4.8%. Flake tools are mainly side-scrapers (48%), followed by denticulates
 102 (20 %) and notches (13 %). A large part of the flake production was not retouched on tools.

	PRINCIPAL RAW MATERIAL	ORIGIN	MATRIX	INPUT MODALITY	SECONDARY RAW MATERIAL	ORIGIN	MATRIX	INPUT MODALITY
RAMANDILS UNIT II	flint	semi-local	blocks, slabs	raw blocks, prepared blocks	quartzite, chert, limestone	semi local	pebble	whole
	REDUCTION SEQUENCE	DEFICIT PRODUCT	PRODUCTION GOAL	SECONDARY METHOD	RAMIFICATION	IMPORTANCE OF TOOLS	DOMINANT TOOL	ASSOCIATED TOOL
	complete for flint partial for other raw material	retouched tools on flakes	flakes (micro)	SSDA	yes	low	scraper	denticulate

103 *Tab. 1: Main techno-economic characteristics of the unit II lithic assemblage (according to data from Moles, 2008).*

104 Faunal remains (14,927 remains) are represented by large mammals, (Gerber, 1973; Banès
 105 1996, 1998; Rusch *et al.*, 2019), birds (Vilette in Boutié, 1993), lagomorphs and
 106 microvertebrates (Percie-du-Sert, 1992) with terrestrial (André in Boutié, 1993) and marine
 107 shells (Cataliotti-Valdina in Boutié, 1990; Celiberti & Moigne in Saos *et al.*, 2016). In unit II,
 108 three fragmented human teeth were discovered (Chevalier & Bécam in Saos *et al.*, 2016),
 109 without specific attribution or burial context.

110 3. Material and methods

111 All of the material studied corresponds to coordinated objects that comes from Boutié's
112 excavations, recorded according to the grid reference and stratigraphic subdivision in unit II.

113 3.1. Archaeostratigraphy

114 The Ramandils Cave has delivered an important archaeological material consisting of,
115 unburnt and burnt bones, lithic tools, stones, shells, coprolites, ... representing about 31,000
116 coordinated objects. The first step is to create a database from the excavation notebooks and
117 to validate the data before adding the faunal and lithic remains. The second step is to realize
118 vertical sections of the objects along the transverse and longitudinal axes of the cave. In
119 Ramandils Cave, the archaeological remains are so numerous that profiles were made every
120 10 cm. It is then possible to begin the individualization of archaeological levels.

121 The profiles will be cross-referenced before highlighting the lower and upper limits of each
122 occupation level. For the study of an excavation zone, of a square meter, it is thus proceeded
123 with a hundred of cross-checks. Once, the limits of occupation levels are defined, each object
124 is assigned a soil name (Pois, 1998, 1999). In unit II 6 levels are defined in unit II: S8, S9,
125 S10, S11 and S12.

126 3.2. Study of lithic Raw Material and their Origin

127 The raw materials of the whole unit II were petrographically determined on a macroscopic
128 basis and classified by category of rocks. Flints were characterized by the description of their
129 microfacies with binoculars and then close to the known petrographical facies of the
130 Languedoc-Roussillon repository of sedimentary siliceous rocks. This repository (Grégoire *et*
131 *al.*, 2010), set up in the framework of a PCR program, available at the European Center for
132 Prehistoric Research at Tautavel was used as a reference for identifying sources. Following
133 this method, categories of rocks were identified in unit II and have been linked to potential
134 sources (Boutié *et al.*, 1998; Grégoire, 2000). From these identifications, a territory can be
135 drawn and hypotheses of supply strategies can be proposed in relation to the settlement
136 systems of territories by these nomadic peoples (Grégoire, 2012).

137 3.3. Zooarchaeology

138 Taxonomic and anatomical identifications were made from the reference collection of the
139 European Center for Prehistoric Research at Tautavel, following the relevant literature
140 (Barone, 1999; Pales & Garcia, 1981; Schmid, 1972; Varela & Rodriguez, 2004, among many
141 others). The Number of Remains (NR), the Number of Identified Specimens (NISP), and the
142 Minimum Number of Individuals (NMI) by combination were calculated (Grayson, 1984;
143 Klein & Cruz-Uribe, 1984; Lyman, 1994, 2008; Moigne, 1983; Poplin, 1981). The assessment
144 of post-depositional modifications (Lyman, 1994) was conducted for diagenetic processes
145 study (tab. 2) analysing steps of concretion, oxidation (manganese or iron impregnations),
146 cortical bone alteration, and cracking.

		Unit II levels							
		S10		S11		S12		Total	
NR Total		896	100%	2233	100%	548	100%	3677	100%
Legible bone total		819	91%	2039	91%	489	89%	3347	91%
Illegible bone total		77	9%	196	9%	61	11%	334	9%
Concretion	Legible bones (C1)	224	25%	612	27%	152	28%	988	27%
	Illegible bones (C2 +C3)	39	4%	101	5%	38	7%	178	5%
	Total	263	29%	713	32%	190	35%	1166	32%
Oxides (Mn, Fe)		474	53%	739	33%	122	22%	1335	36%
Cortical bone alteration	Legible bones (D1 +D2)	620	69%	1355	61%	198	36%	2173	59%
	Illegible bones (D3)	39	4%	100	4%	26	5%	165	4%
	Total	659	73%	1455	65%	224	41%	2338	63%
Cracking (F1 +F2 +F3)		136	15%	263	12%	96	17%	495	13%

Tab. 2: Climatic and edaphic markers on bones remains (NR) from unit II levels.

147

148 Concretions are described with 3 steps. The first one (C1) is slight and isolated spots; the
149 second one (C2) is a fine cover on the complete bone and the third one (C3) corresponds to
150 bone being inside the concretion. Only remains with the first step have apparent cortical bone,
151 accounting for around 27 % of NR. Remains with step 2 and 3, for between 4 and 7% of NR,
152 have not legible surface and are therefore not eligible for study other taphonomic markers.

153 Oxide deposits, mainly manganese, are observed on more than a quarter of remain in S11
154 and S12, and on more than half in S10. This low pigmentation of remains reveals bone
155 surface and other taphonomic markers.

156 Cortical bone alteration due to water circulation is divided-with 3 steps. The first one (D1)
157 with thin dissolution cups and the second one (D2) with slight desquamation areas
158 corresponds to bones with legible surface, noticed for 36% of NR in S12 to 69% of NR in
159 S10. The third step, with desquamation affecting a large part of cortical surface is not eligible
160 for study biological markers, representing about 4% of NR.

161 Cracking is related to the fissuring process, also due to the water circulation. The first step
162 is just a thin hair-like fissure, the second one has pronounced splits but the size of bones is not
163 affected, and the third one has deep or severe cracking. All these steps reveal cortical bones
164 with legible surface for around 13% of total NR

165 Legible bones, accounting for 91% of NR, are sorted according step criteria of concretion
166 and cortical bone alteration, that can be combined on the same bone fragment.

167 Material fragmentation was noticed according to size class, in millimetres, and nature of
168 remains (fig. 4). In unit II, mainly pieces are less than 40 mm length, especially for bones
169 remains, taken into account in the study of human and carnivore impacts. For the long bones
170 of mains species, size class and the circumference of diaphysis fragments were noted as well
171 as the distribution of partial remains, with complete epiphysis, and whole bones (Bunn, 1983;
172 Villa and Mathieu, 1991).

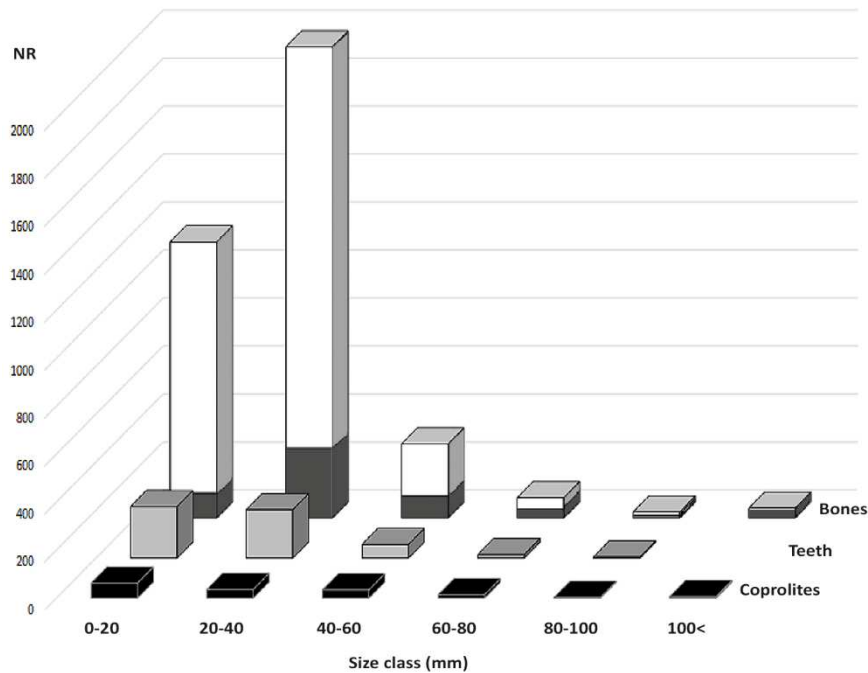


Fig. 4: Material length according class size (mm) and nature of remains from unit II, for determinate (dark grey) and indeterminate (white) bones, teeth (light grey) and coprolites (black).

173
174
175

176 A biostratigraphic alteration study was carried out on damage caused by roots, and rodents
177 (scraping) or carnivores tooth marks (pitting, furrowing, puncturing and scoring), with
178 digestion processes products by carnivores (Binford, 1978, 1981; Blumshine, 1986;
179 Dominguez-Rodrigo & Piqueras, 2003; Fosse 1996; Hayne, 1980; Klein and Cruz-Urbe,
180 1984). A part of coprolites is attributed to cave hyena, following morphological description
181 (Jouy-Avantin *et al.*, 1999, 2003; Vivent, 1989), during palynological and parasitological
182 analyses (Lartigot-Campin & Moné, 2017). Coprolites occurrence in unit II levels was used to
183 identify the zooarcheological sequence and carnivore activities in the site (Diedrich, 2012;
184 Discamps *et al.*, 2012; Pineda, 2017).

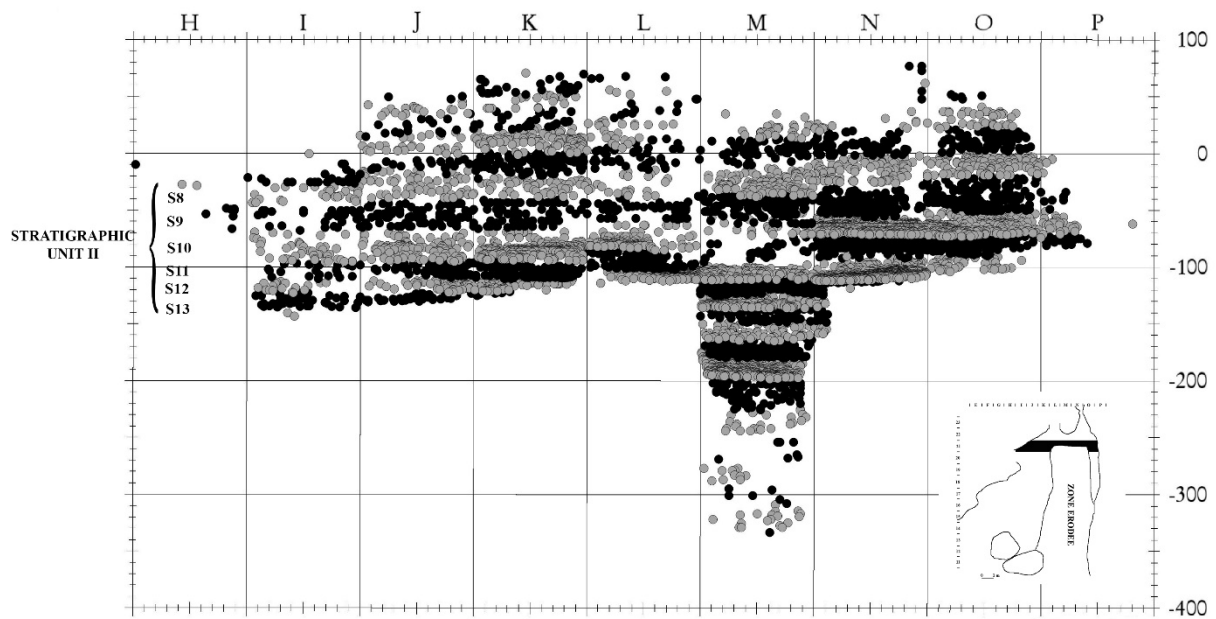
185 Anthropic modifications of bones were studied (green fractures, cut marks, percussion
186 marks, and technological applications of bones—essentially retouchers) according the
187 relevant literature (Binford 1981; Daujeard *et al.*, 2018; Mallye *et al.*, 2012; Noe-Nygaard
188 1989; Potts & Shipman 1981; Shipman & Rose 1983; Villa & Mathieu, 1991) and a
189 microscope was used. Burnt remains were recorded for colour and burning localisation
190 (according Lebon, 2008).

191 Mortality profiles (Stiner, 1990) were based on age-at-death, established on eruption,
192 replacement, and dental wear, or epiphysis fusion. Seasonality was determined from the
193 current dates of ungulates birth (Azorit *et al.*, 2002; Cornevin & Lesbre, 1894; Guadelli, 1998;
194 Hayssen *et al.* 1993; Hillson, 1986; Magnell, 2007; Mariezkurrena, 1983; Pérez Ripoll, 1988).
195 In this regard, we only considered those species in which the age-at-death is estimated in
196 months corresponding to equids, bovids, cervids, and suids.

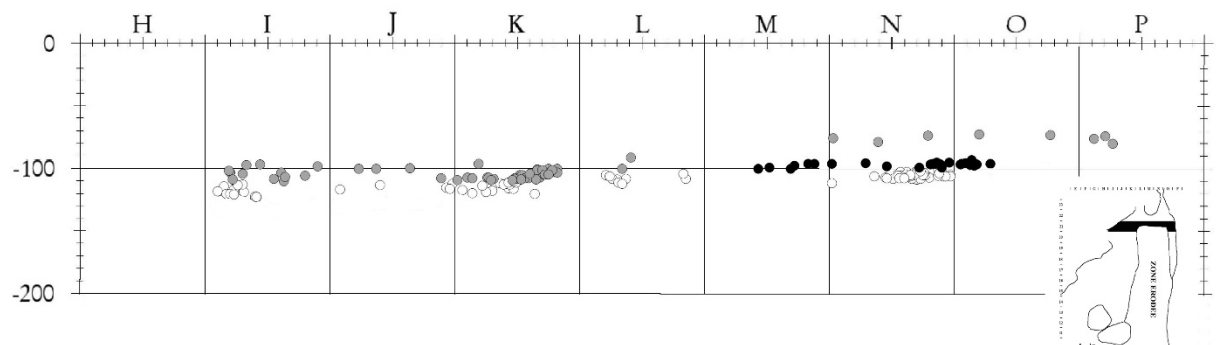
197 **4. Results**

198 4.1. Archaeostratigraphy

199 The study highlighted 26 occupation levels for the entire filling (fig. 5). In this article, we
200 focus on stratigraphic unit II, the richest level which delivered almost 20,000 remains. Six
201 occupation levels were defined in this unit, namely S8, S9, S10, S11, S12 and S13. However,
202 the limits between units I and II and between units II and III still need to be clarified. The
203 archaeological levels we are interested in for this study are mainly levels S10, S11 and S12.



204
205 Fig. 5: Vertical section with all objects of the band 21. The alternance of grey and black is used to differentiate each occupation level

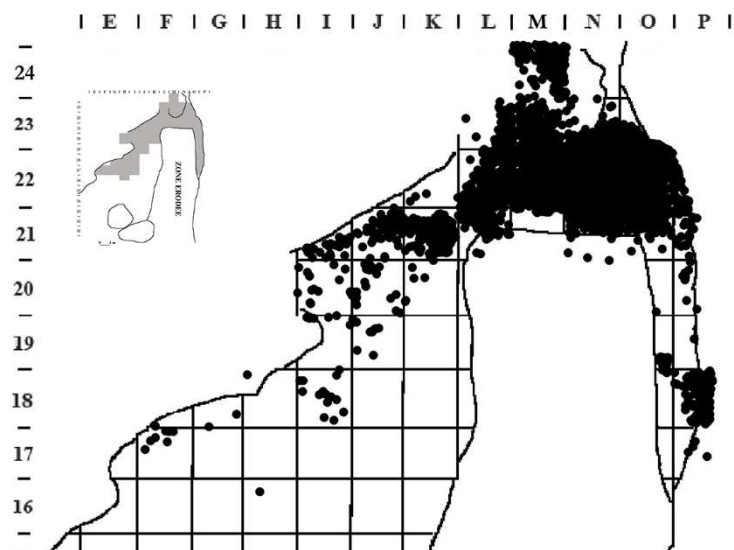


206
207
208 Fig. 6: Vertical section with S11 (grey), S12a (black) and S12 (white) in band 21. S12a corresponds to a coprolites bed. For an easier lecture, only thirty centimeters (between 0 and 30 cm) are represented for occupation levels S11 and S12

209 S10, S11, and S12 are the richest levels, they contain respectively 4,267, 7,893 and 3,696
210 remains (tab. 3). The major part of the archaeological material is distributed into bands 21 to
211 24 (fig. 7). It is also in these three levels that coprolites are concentrated. Coprolites are
212 spatially distributed in specific areas, especially in S12a.

Unit	Occupation level	Fauna	Coprolites	Shells	Lithic tools	Stones	Human bones	Others	Total
II	S8	158	2	10	119	27	0	2	318
	S9	943	5	48	834	158	0	14	2002
	S10	1988	7	55	1977	122	0	23	4172
	S11	3795	39	99	3637	91	2	131	7794
	S12a	6	27	0	0	0	0	0	33
	S12	1772	43	44	1665	50	0	56	3630
	S13a	0	12	0	0	0	0	0	12
	S13	145	3	2	148	15	0	7	320
Total		8807	138	258	8380	463	2	233	18731

213 Tab. 3: Total archaeological material coordinated from stratigraphic unit II-



214 Fig. 7: Spatial distribution of the archaeological material in occupation level S11.
 215 Most of the remains are concentrated in band 21 to band 24.
 216

217 The archaeological approach allows a finer study of the filling than that carried out from
 218 the stratigraphic units (Pois, 2000). At the level of the unit II, it was, indeed, impossible to
 219 perceive these coprolites beds. However, it is interesting to see these coprolite beds at the
 220 limit of human occupations. It should also be noted the presence of coprolites within an
 221 anthropic level that may reflect a short abandonment of the site by humans.

222 4.2. Lithic Assemblages: Raw Material

223 The lithic collection from the unit II were studied by Moles (Molès, 2008) with a techno-
 224 typological approach and by Grégoire (Boutié *et al.*, 1998; Grégoire, 2000) with a
 225 petroarcheological point of view. In this article, we have chosen to use the contribution of the
 226 lithic industries, especially raw materials to feed the multidisciplinary discussion about the
 227 function site and the mobility pattern of human groups. However, unlike fauna, the results
 228 from previous studies were not analysed according to the archaeostratigraphic division
 229 proposed here for unit II. A homogenization work is actually underway but general trends will
 230 therefore be proposed and discussed in relation with the archaeozoological data, offering at
 231 this stage a better study resolution.

232 Ten different raw materials were used in the stratigraphic unit II, the richest one (tab. 4).
233 This is the level with the most lithological diversity. Flint is the most widely used rock with
234 91.5%. Other kinds of rocks are used like quartzite, chert, limestone, quartz, lydian,
235 sandstone, jasper, schist and hornfels.

Unit II	
Flint	91.5 %
Quartzite	4.0 %
Chert	1.9 %
Limestone	1.2 %
Quartz	0.8 %
Hornfels	0.2 %
Jasper	0.1 %
Sandstone	0.1%
Schist	0.1 %
Lydian	0.1 %
Total	100 %

236 *Tab. 4: proportion of lithic raw*
237 *material categories in Ramandils*
238 *Cave unit II.*

239 The flints are generally very altered with a white or beige and total thick patina. Burnt
240 artefacts are abundant (39.6%) and make it difficult to identify flint categories.

241 Essentially represented by flint, siliceous rocks are largely in the majority (94%). Quartzite
242 is the second most used rock after flint, followed by limestone and quartz. Non-siliceous
243 rocks (6%) are represented by various raw materials, collected in the form of pebbles. These
244 pebbles came from alluvial deposits, but also from the marine environment because of the
245 proximity of the Mediterranean shore.

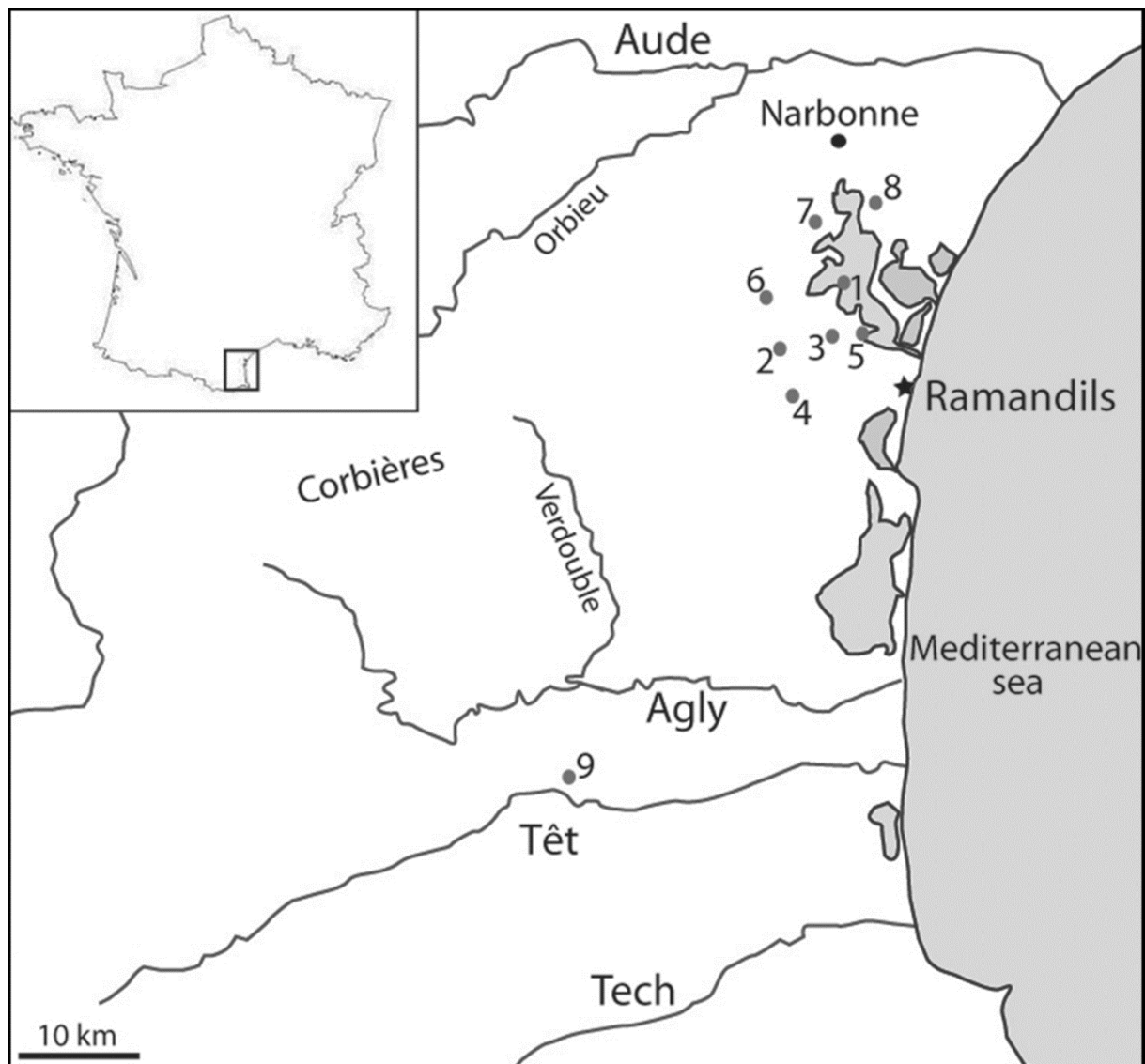
246 Thanks to some flint artefacts little altered or without any thermal impact, several types
247 were recognized. All of them shows the main characteristics of the Miocene and more rarely
248 the Oligocene regional facies, well known (Grégoire, 2010) on the Tertiary Narbonne-Sigean
249 Basin around the site.

250 The study of the microfacies of these flints shows two main groups which correspond to
251 both the stratigraphic upper Oligocene facies and the lower Miocene facies (Aquitainian).

252 The upper Oligocene facies is characterized by a mudstone texture slightly fossiliferous
253 consisting of cryptocrystallin micritic silica with hematites and frequent ferruginous
254 impregnations as well as rare bioturbations. The Miocene flint shows a wackestone /
255 packstone texture with charophytes (boiled stalks, oogones), gastropods and ostracods.

256 The sedimentary texture and the inclusions are reliable discriminating characters to
257 distinguish the two stratigraphic facies and pinpoint their source in the current landscape
258 within the Narbonne-Sigean basin (fig. 8).

259 Concerning the most frequent flint, the poor quality of blanks used for debitage production,
 260 as well as the presence of charophytes remains visible at a macroscopic level, allows to
 261 eliminate the exploitation of high quality oligocene flints provided by the outcrops of
 262 Roquefort des Corbières (fig. 8, flint source n°4), Indeed, Neanderthals have rarely used this
 263 rock which is attested in the site by only a few artefacts. The miocene flints (fig. 8, flint
 264 sources n°1, 2, 3, 5), the most used, probably come from mostly tectonized blocks of the
 265 Presqu'île du Dou, Portel-des-Corbières or Hameau du Lac Miocene sources. Some cherts
 266 coming from the Cretaceous Corbières formation, at the north-west of the site (fig. 8, flint
 267 source n°6), and from the nearest Jurassic formation at the north of the tertiary basin (fig. 8,
 268 flint source n°7), were also used in the unit II.



269
 270 *Fig. 8:* Location of the lithic raw material and faunal sources on the local and semi-local territory around Ramandils Cave. 1 : Presqu'île du
 271 Doul (Miocene flint), 2 : Portel des Corbières (Miocene flint), 3 : Hameau du Lac (Miocene flint), 4 : Roquefort des Corbières (Oligocene
 272 flint), 5 : Sigean (Miocene flint), 6 : Plan du Couloubret (chert); 7 : Hauts de Narbonne (chert), 8 : Aude alluvial deposits (quartz, quartzite,
 273 limestone, hornfels, lydian, sandstone, schist), 9 : Têt alluvial deposits (jasper).

274 4.3. Large Mammals Remains

275 Unit II of Ramandils Cave counts 4,058 NR of large mammals (without considering
 276 coprolites), with 91% distributed in levels S10, S11 and S12. Faunal study will allow to
 277 define the species spectrum and to characterise these three occupation levels.

278 4.3.1. Species Composition

279 The three levels count 3,682 total NR, corresponding to 653 NISP (tab. 5) with S11 as the
 280 richest level (2235 NR, 321 NISP). Faunal spectrum is mainly composed of ungulates (94%
 281 NISP), dominated by red deer, *Cervus elaphus* (33% total NISP), especially in S11 (36%
 282 NISP) and S12 (33% NISP), with horse, *Equus f. germanicus* (28% total NISP), prevalent in
 283 S10 (33% NISP). Moreover, European wild ass, *Equus hydruntinus*, aurochs, *Bos*
 284 *primigenius*, and wild boar, *Sus scrofa*, are well represented in these levels (each by 8% of
 285 total NISP).

286 Carnivores are generally rare (6% NISP), particularly represented by cave hyena, *Crocuta*
 287 *c. spelaea* (2 % NISP), cave lynx, *Lynx spelaeus* (1% NISP), fox, *Vulpes vulpes* (1% NISP),
 288 wolf, *Canis lupus* (0.6% NISP), and cave bear, *Ursus spelaeus* (0.6% NISP). Between S11
 289 and S12, S12 a level is composed of carnivore remains (cave hyena, badger, *Meles meles*, and
 290 unspecified bear) with only one ungulate bone attributed to the horse.

291 At last, a significant number of indeterminate bones are recorded in S10, S11 and S12
 292 mainly classify as small ungulates (2804 NR) according size and thickness criteria, that could
 293 indicate high bone fragmentation.

	S10		S11		S12a		S12		Total	
Total carnivores (NISP)	11	5.9%	18	5.6%	3	75%	8	5.6%	40	5.9%
<i>U. arctos</i>	1	0.5%	1	0.3%	-	-	-	-	2	0.3%
<i>U. spelaeus</i>	1	0.5%	2	0.6%	-	-	1	0.7%	4	0.6%
<i>M. meles</i>	-	-	1	0.3%	1	25%	-	-	2	0.3%
Lutrinae indet.	1	0.5%	-	-	-	-	1	0.7%	2	0.3%
<i>C. lupus</i>	-	-	1	0.3%	-	-	3	2.1%	4	0.6%
<i>V. vulpes</i>	1	0.5%	4	1.3%	-	-	1	0.7%	6	0.9%
<i>C. c. spelaea</i>	3	1.6%	6	1.9%	2	50%	2	1.4%	13	2.0%
<i>L. spelaeus</i>	4	2.1%	2	0.6%	-	-	-	-	6	0.9%
<i>F. silvestris</i>	-	-	1	0.3%	-	-	-	-	1	0.2%
Unspecified carnivores (NR)	2	-	6	-	1	-	-	-	9	-
Total ungulates (NISP)	176	94.1%	302	94.4%	1	25%	135	94.4%	613	93.9%
<i>P. antiquus</i>	-	-	6	1.9%	-	-	-	-	6	0.9%
<i>S. hemitoechus</i>	4	2.1%	2	0.6%	-	-	1	0.7%	7	1.1%
<i>E. f. germanicus</i>	61	32.6%	86	26.9%	1	25%	38	26.8%	186	28.5%
<i>E. hydruntinus</i>	17	9.1%	24	7.5%	-	-	12	8.5%	53	8.1%
<i>Bison</i> sp.	-	-	1	0.3%	-	-	-	-	1	0.2%
<i>B. primigenius</i>	22	11.8%	20	6.3%	-	-	11	7.7%	53	8.1%
<i>C. caucasica</i>	1	0.5%	8	2.5%	-	-	4	2.8%	13	2.0%
<i>C. elaphus</i>	52	27.8%	116	36.3%	-	-	48	33.8%	216	33.1%
<i>D. dama</i>	3	1.6%	7	2.2%	-	-	1	0.7%	11	1.7%
<i>R. tarandus</i>	-	-	2	0.6%	-	-	1	0.7%	3	0.5%
<i>C. capreolus</i>	4	2.1%	5	1.6%	-	-	2	1.4%	11	1.7%
<i>S. scrofa</i>	12	6.4%	25	7.8%	-	-	16	11.3%	53	8.1%
Unspecified large ungulates (NR)	36	-	58	-	-	-	29	-	123	-
Unspecified small ungulates (NR)	646	-	1808	-	-	-	350	-	2804	-
Indeterminate large mammal (NR)	25	-	41	-	-	-	27	-	93	-
Total NISP	187	100%	320	100%	4	100%	142	100%	653	100%
Total NR	896		2233		5		548		3682	

294 Tab. 5: Large Mammals composition in unit II levels of Ramandils Cave, by NISP (black) and NR (grey).

295

4.3.2. Human and Carnivore impacts

296

Biological markers are noticed in the unit II levels, produced by various agents (tab. 6).

297

Human activities have the highest impact on more half remains, especially with burning processes increasing from the base, 52% NR affected in S12, to the top, 79% NR affected in S10. Butchery activities are stable all along the levels with cut marks, on 13 to 20% of remains, and green fractures related to bone breakage, on 9 to 15% of remains, despite rare percussion marks, on less than 3% of remains. At last few bone retouchers were found mainly on long bone fragment of cervids and unspecified small ungulates. Finally, the red deer remains are the most affected among all species by human impacts, while for the horse, butchery marks are scarcer.





305

Damage caused by carnivore activities are clearly more reduced, with less than 4% of remains affected by tooth marks and rare digested bones. These markers are observed on main species with close values, constant for the horse and with a low increase for the red deer in S11.

309

Other biological impacts are recorded. Rodent impact is insignificant in unit II levels with less than 1% of remains affected by scraping. Root marks increase from the base, with less than 5% NR in S12, to the top, not exceeding 10.4 % NR, inducing plant cover on the cave floor.

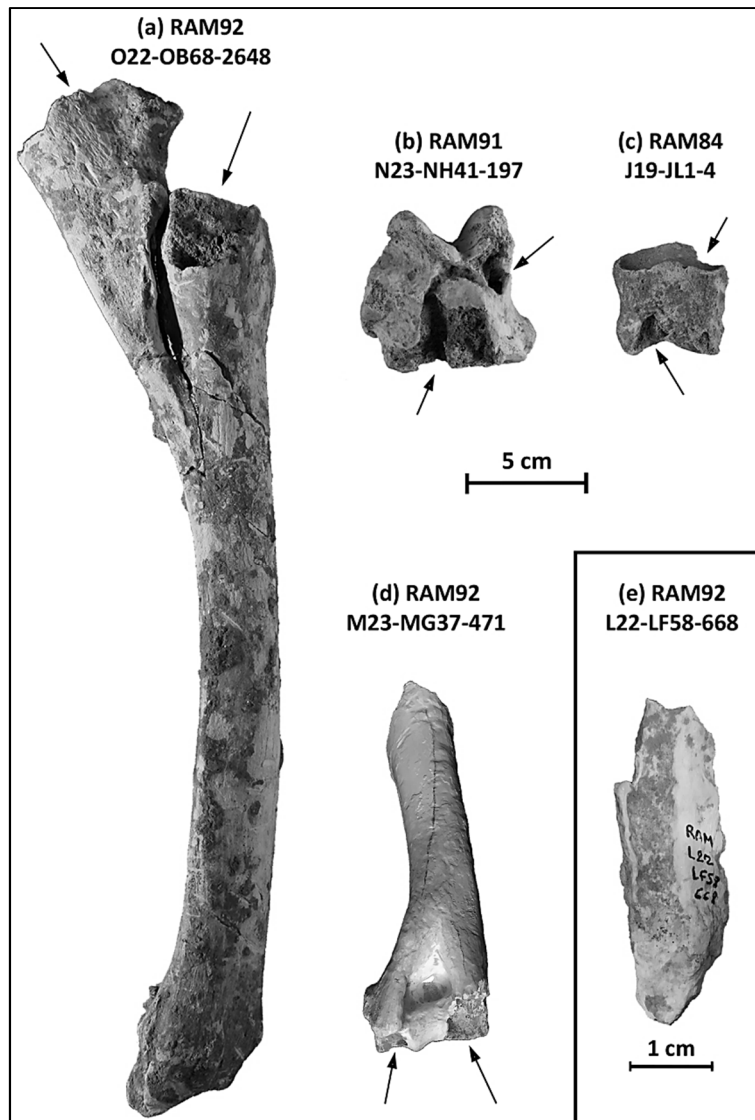
312

		S10				S11				S12				Total			
		Total NR		Main species		Total NR		Main Species		Total NR		Main species		Total NR		Main Species	
																	
NR Total		896	100%	52	61	2235	100%	116	86	550	100%	48	39	3681	100%	216	186
Legible bones		819	91%	49	54	2039	91%	111	59	489	89%	47	31	3347	91%	207	154
Human	Burning	710	79.2%	40	27	1706	76.3%	88	55	283	51.5%	39	18	2699	73.3%	167	100
	Cut marks	173	19.3%	12	2	441	19.7%	36	4	70	12.7%	13	1	684	18.6%	61	7
	Fractures	133	14.8%	21	4	278	12.4%	28	5	50	9.1%	10	4	461	12.5%	59	13
	Percussion	14	1.6%	3	-	34	1.5%	9	-	13	2.4%	5	-	61	1.7%	17	-
	Retouchers	2	0.2%	-	-	3	0.1%	1	-	3	0.5%	1	-	8	0.2%	2	-
Carnivore	Tooth marks	31	3.5%	2	4	80	3.6%	9	4	21	3.8%	2	4	132	3.6%	13	12
	Digestion	9	1.0%	3	2	7	0.3%	1	-	7	1.3%	2	1	23	0.6%	6	3
Rodent	Scraping	3	0.3%	-	-	4	0.2%	-	-	3	0.5%	1	-	10	0.3%	1	-
Plant	Root marks	93	10.4%	12	6	192	8.6%	21	6	27	4.9%	7	1	312	8.5%	40	13

313

Tab. 6: Biologic and anthropic markers on bones remains (NR) from unit II levels with main species representation (NISP)

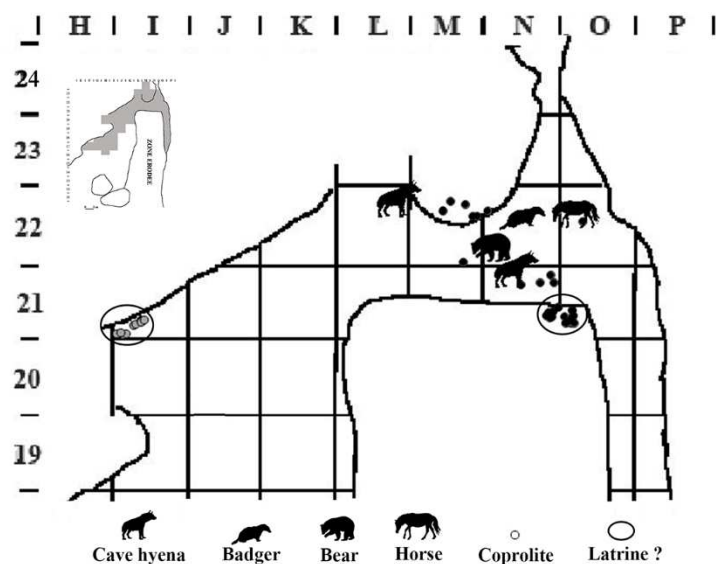
315 Direct evidence of carnivore occupation are noticed in unit II levels by a low percentage of
 316 carnivore remains, 6% NISP (tab. 5), with the cave hyena and the lynx relatively more
 317 represented. Scarce marks on large mammal bones, less than 4% NISP in each level (tab. 6),
 318 can be attributed to carnivore impact. Without considering unspecified ungulate remains
 319 which have the highest values, traces are mainly recorded on main species, red deer and
 320 horse. Most affected remains corresponding to burnt bones with butchery marks, such as
 321 green fractures, indicating carnivore scavenging during human abandonment periods of the
 322 cave. However, unburnt bones are affected (fig. 9), especially horse remains with whole long
 323 bones, which can be transported by large predators such as cave hyena. Further studies such
 324 as on the size of tooth marks will allow us to determine the specific agents affecting large
 325 mammal bones (Dominguez-Rodrigo & Piqueras, 2003).



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 Fig. 9: Carnivore marks on unburnt ungulate remains: (a) epiphysis gnawing on a right radio-ulna of horse, (b) puncturing marks on a left talus of horse, (c) epiphysis gnawing on a second phalanx of horse, (d) epiphysis gnawing on a right humerus of ibex, (e) digested metatarsal of red deer (photos L. Rusch and D. Dainat, Centre Européen de Recherches Préhistoriques, Tautavel).

332 In unit II levels, 116 coprolites are coordinated, with some attributed to cave hyena in S12
 333 (Lartigot-Campin & Moné, 2017). In these levels anthropic impact evidence (lithic industry
 334 and burnt bones) are recorded, that confirm recurrent carnivore occupations during short
 335 abandonment periods of the site by human.

336 Two unit II levels are mainly constituted of coprolite beds, S12a and S13a, between
 337 occupation levels with human activity evidence (fig. 6). Archaeostratigraphical studies permit
 338 to observe coprolite concentrations in S12a, between the bands 21 to 22, especially in areas
 339 M, N and O (fig. 10), with four carnivore remains. Indeed, two deciduous tooth of young cave
 340 hyena, one badger tibia and one sesamoid of unspecified bear are recorded. Likewise, one
 341 ungulate remain was found in S12a corresponding to a whole horse radio-ulna with gnawing
 342 marks (fig. 9a). Spatial distribution shows a coprolite concentration more or less circular in
 343 the squares N21 and O21 that suggests a latrine area (Bearder and Randall, 1978; Kruuk,
 344 1972; Pineda *et al.*, 2017), as well as in S13a, located in the square I21. Further study will
 345 confirm the presence or absence of latrines. However, it is interesting to see these coprolite
 346 beds at the limit of human occupations.











347
 348
 349 Fig. 10: Spatial distribution of levels S12a (black) and S13a (grey). Two areas
 with a coprolites concentration look like latrines.

350

351 - Skeletal Part and Coprolite Distribution

352 Fragments of indeterminate long bone (2,469 of total NR corresponding to 72% total NR
 353 without coprolites) are predominant in the distribution of anatomical elements (tab. 7) with
 354 isolated teeth (385 of total NR as 10% of Total NR without coprolites) attesting to high
 355 taphonomic impact. However, fragile elements are recorded in the sequence as cranium
 356 (76 total NR), vertebrae (46 total NR), and ribs (36 total NR), adding carnivore coprolites
 357 (135 total NR) distributed in the three levels and in S12a.

358 Main species are less than 100 total NISP, except for the red deer in S11 (116 total NISP)
 359 with prevalence of isolated teeth and long bones, such as metapodials, in each level (tab. 7).
 360 Almost all skeletal elements of red deer are recorded in S11 and S12, whereas axial elements
 361 and bones of hind quarter are missing in S10. For the horse, skeletal distribution seems
 362 reversed compared to red deer remains with almost all skeletal elements in S10 and S11,
 363 whereas hind leg bones are lacking in S12. For secondary species partial skeletal distribution
 364 is recorded in each level with mainly teeth and long bones.

	S10			S11			S12a		S12			Total		
	Total NR	Main species		Total NR	Main species		Total NR	Total NR	Main species		Total NR	Main species		
														
Antler/horn	13	9	-	11	7	-	-	5	1	-	29	17	0	
Cranium	16	1	2	43	5	2	-	17	1	1	76	7	5	
Maxilla	6	-	-	3	-	-	-	3	-	-	12	0	0	
Mandible	4	-	-	9	1	2	-	7	3	-	20	4	2	
Tooth	124	13	37	170	31	51	2	89	12	24	385	56	112	
Vertebra	11	-	2	19	2	3	-	16	2	1	46	4	6	
Rib	4	-	2	22	3	5	-	10	-	1	36	3	8	
Scapula	1	1	-	2	-	1	-	2	-	-	5	1	1	
Humerus	2	1	-	8	5	-	-	4	1	2	14	7	2	
Radio-ulna	9	7	1	12	7	2	1	3	1	1	25	15	5	
Carpus	-	-	-	2	-	1	-	1	1	-	3	1	1	
Metacarpus	11	7	4	24	13	6	-	6	5	1	41	24	11	
Pelvis	1	-	-	6	1	4	-	4	-	3	11	1	7	
Femur	1	-	-	9	6	-	-	5	2	2	15	8	2	
Tibia	2	-	2	4	3	-	1	6	4	-	13	7	2	
Tarsus	2	-	1	5	1	1	-	3	2	-	10	3	2	
Metatarsus	19	8	5	34	20	5	-	11	10	-	64	38	10	
Metapodial	4	-	1	3	1	-	-	2	1	-	9	3	1	
Sesamoid	2	1	-	8	3	1	1	2	1	-	13	5	1	
Phalanx	17	4	4	21	7	2	-	6	1	2	44	12	8	
Long bone	580	-	-	1596	-	-	-	293	-	-	2469	-	-	
Cancellous bone	62	-	-	208	-	-	-	48	-	-	318	-	-	
Flat bone	5	-	-	14	-	-	-	5	-	-	24	-	-	
Coprolite	7	-	-	39	-	-	27	43	-	-	116	-	-	
Total NR	903			2272			32	591			3798			
Total NR without coprolites	896	52	61	2233	116	86	5	548	48	38	3682	216	186	

365 Tab. 7: Distribution of anatomical elements in unit II levels (NR) with main species representation (NISP)

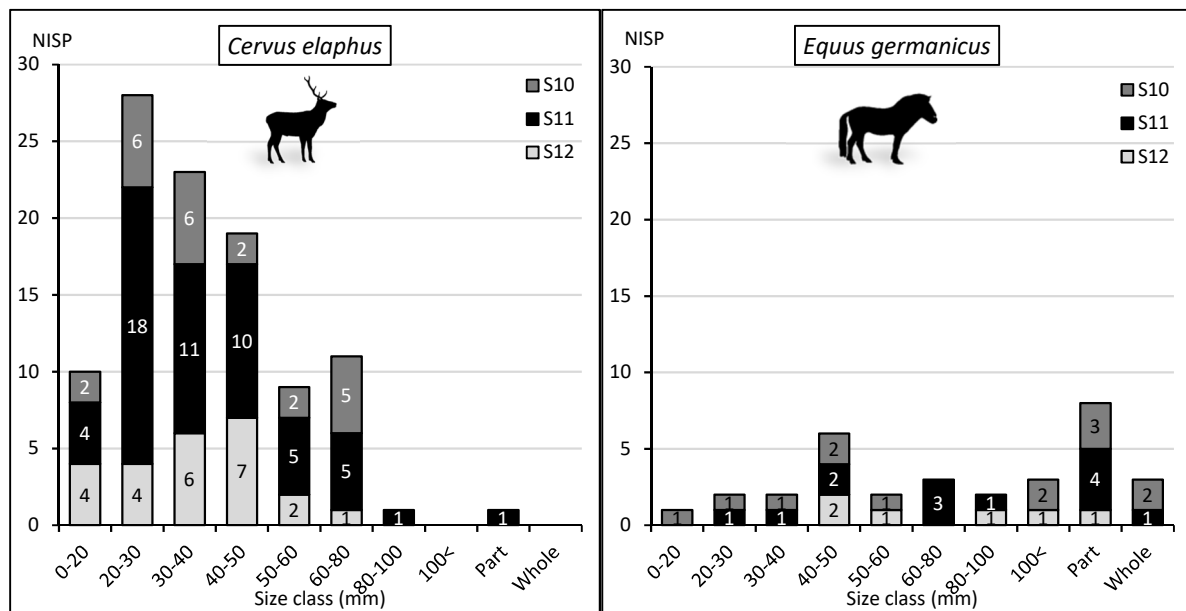
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367 - Fragmentation

368 In unit II levels, 99% of long bones (without considering phalanges) are broken. The
 369 diaphysis lengths are generally less than 50 mm and the diaphysis circumferences are either
 370 less than half of their original dimensions, or complete in rarer cases (as for the few whole
 371 bones).

372 For main species, long bones are not represented with the same size distribution (fig. 11).
 373 Red deer bones are highly fragmented with most remains measuring less than 50 mm in the
 374 three levels (fig. 11), corresponding to less than ¼ diaphysis lengths. One complete epiphysis
 375 was discovered in S11, an unfused proximal extremity of the right tibia, and no whole
 376 elements are recorded in unit II levels. This profile can be explained by the prevalence of
 377 anthropic impacts on red deer remains (tab. 6).

378 Throughout the sequence, the horse is the only large mammal with complete long bones,
 379 excavated in unit II levels and corresponding to metapodials in S10 and S11 (fig. 11) with a
 380 radio-ulna in S12a (fig. 9a). Furthermore, two complete metatarsal epiphyses, with their
 381 diaphysis portion, have been reassembled in S10 and two complete metacarpal epiphyses with
 382 their diaphysis portion have likewise been reassembled in S11. These remains are counted as
 383 partial element in NISP but form two actual whole metapodials in addition to the other
 384 complete long bones. Considering this low fragmentation with unburnt whole bones, human
 385 activities seem less affect horse remains, supporting by carnivore tooth marks on unburnt
 386 elements (fig. 9a, b, c).







387
 388 Fig. 11: Fragmentation indexes of long bones. Comparison of NISP between red deer and horse by Size class (mm), partial elements with a
 389 complete epiphysis (Part), and complete long bones (Whole)

390 - Anthropic Activities

391 Human impact (tab. 6) is mainly attested with various burning processes affecting faunal
 392 remains mostly for red deer (tab. 8). Degree 1 (brown colour), is the most represented bone
 393 modification (47 to 61% of affected NR) decreasing from the base to the top. This first step
 394 applies to heated bones at low temperature less than 300°C (Lebon, 2009). Degree 4 (grey
 395 colour) is well represented (16 to 27% of affected NR), increasing between levels. This
 396 burning step, for temperatures between 400 and 550°C, and partly explain the high
 397 fragmentation of faunal material. In contrast, degree 3 (black colour) and degree 6 (white
 398 colour) with less than 5% of affected NR are the least represented. Double colouration is
 399 observed on 5 to 8% of affected NR.

400

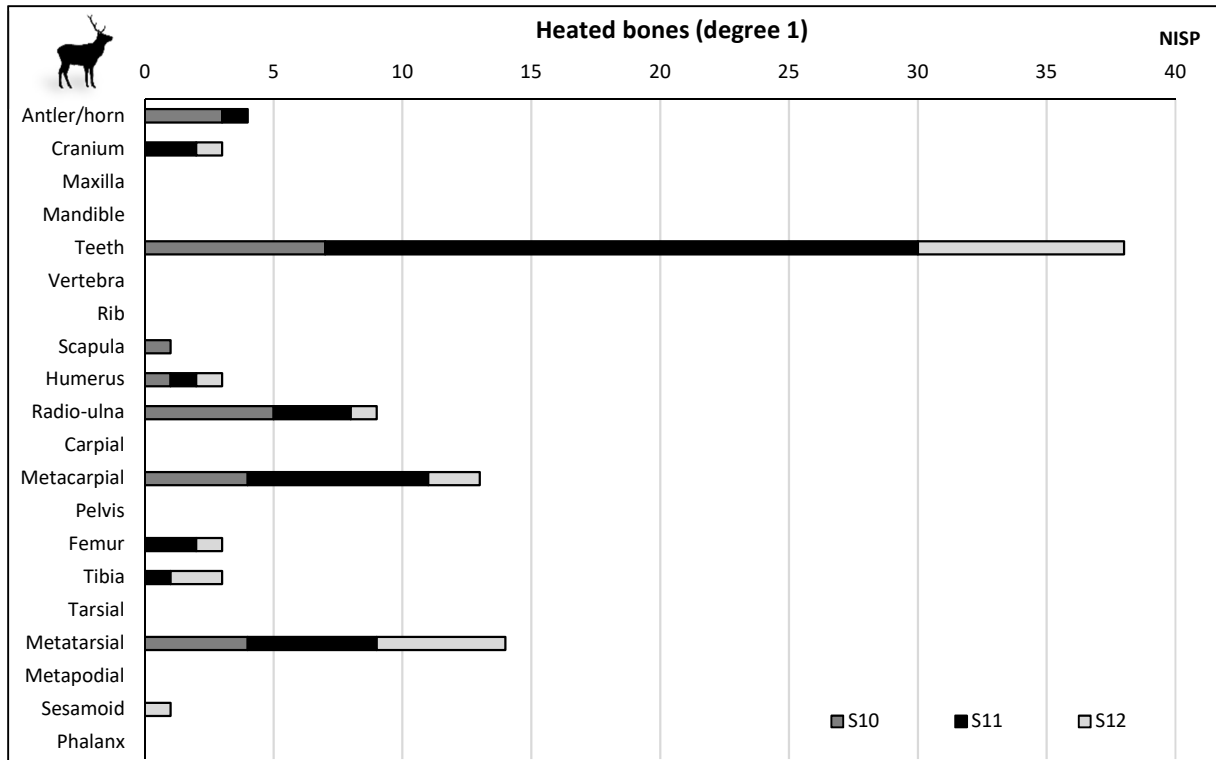
		S10		S11		S12		Total	
		Total NR	Main species	Total NR	Main species	Total NR	Main species	Total NR	Main species
									
1	Brown	336 47.3%	24 19	866 50.8%	45 38	173 61.1%	22 13	1375 50.9%	91 70
2	Brown black	52 7.3%	4	135 7.9%	7 2	12 4.2%	1	199 7.4%	12 2
3	Black	21 3.0%	1 3	67 3.9%	4 3	22 7.8%	1 2	110 4.1%	6 8
4	Dark grey /black	193 27.2	7 4	392 23.0%	19 5	44 15.6%	8 2	629 23.3%	34 11
5	Light grey /white	46 6.5	1	103 6.0%	5 1	13 4.6%	3 1	162 6.0%	9 2
6	White blue	8 1.1%	1	39 2.3%	2	5 1.8%		52 1.9%	3 0
Double coloration		54 7.6%	2 1	104 6.1%	6 6	14 4.9%	4	172 6.4%	12 7
Total		710 100%	40 27	1706 100%	88 55	283 100%	39 18	2699 100%	167 100

401 *Tab. 8: Heating (1) and burning (2 to 6) degrees in unit II levels of Ramandils Cave (NR), with main species representation (NISP).*

402 Heating or burning processes are observed on each skeletal element in unit II levels,
 403 mainly on teeth and indeterminate long bones. For red deer from the three main levels (fig.
 404 12), heating is likewise generally localised on teeth and long bones, especially on metapodials
 405 and radio-ulna, followed by cranium and antler fragments. These distributions support the
 406 hypothesis of bone marrow exploitation with long bone preparation by heating process.

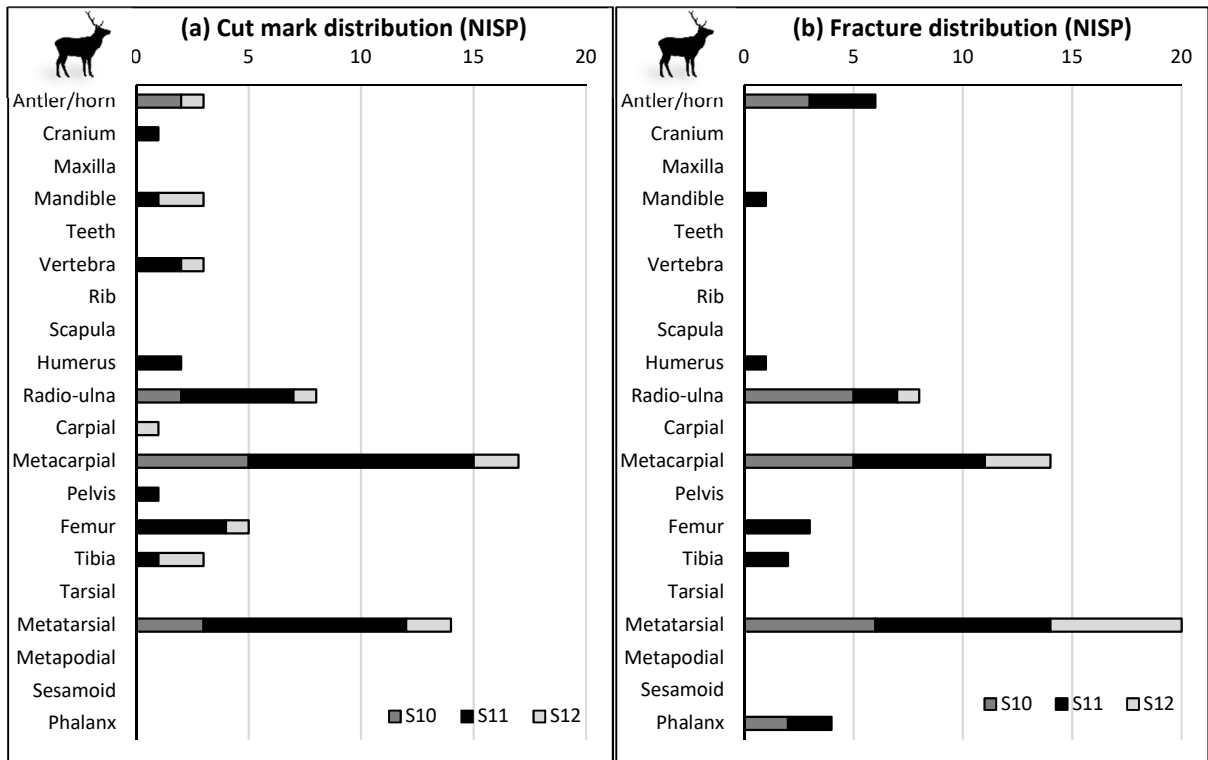
407 Bones bearing cut marks (13 to 19% NR), or green fractures (9 to 15% NR), with higher
 408 percentages in S11 and S10 (tab. 6) are mainly concentrated on unspecified small ungulates
 409 as well as on red deer. These anthropic modifications present similar distribution on red deer
 410 skeletal (fig. 13), mostly located on long bones, especially on metapodials and radio ulna,
 411 likewise for heated processes (fig. 12).

412



413
414

Fig. 12: Skeletal distribution (NISP) of heated bones (degree 1) for red deer.



415
416

Fig. 13 (a) Cut mark and (b) green fracture distribution on red deer skeletal (NISP) in unit II levels of Ramandils Cave

417

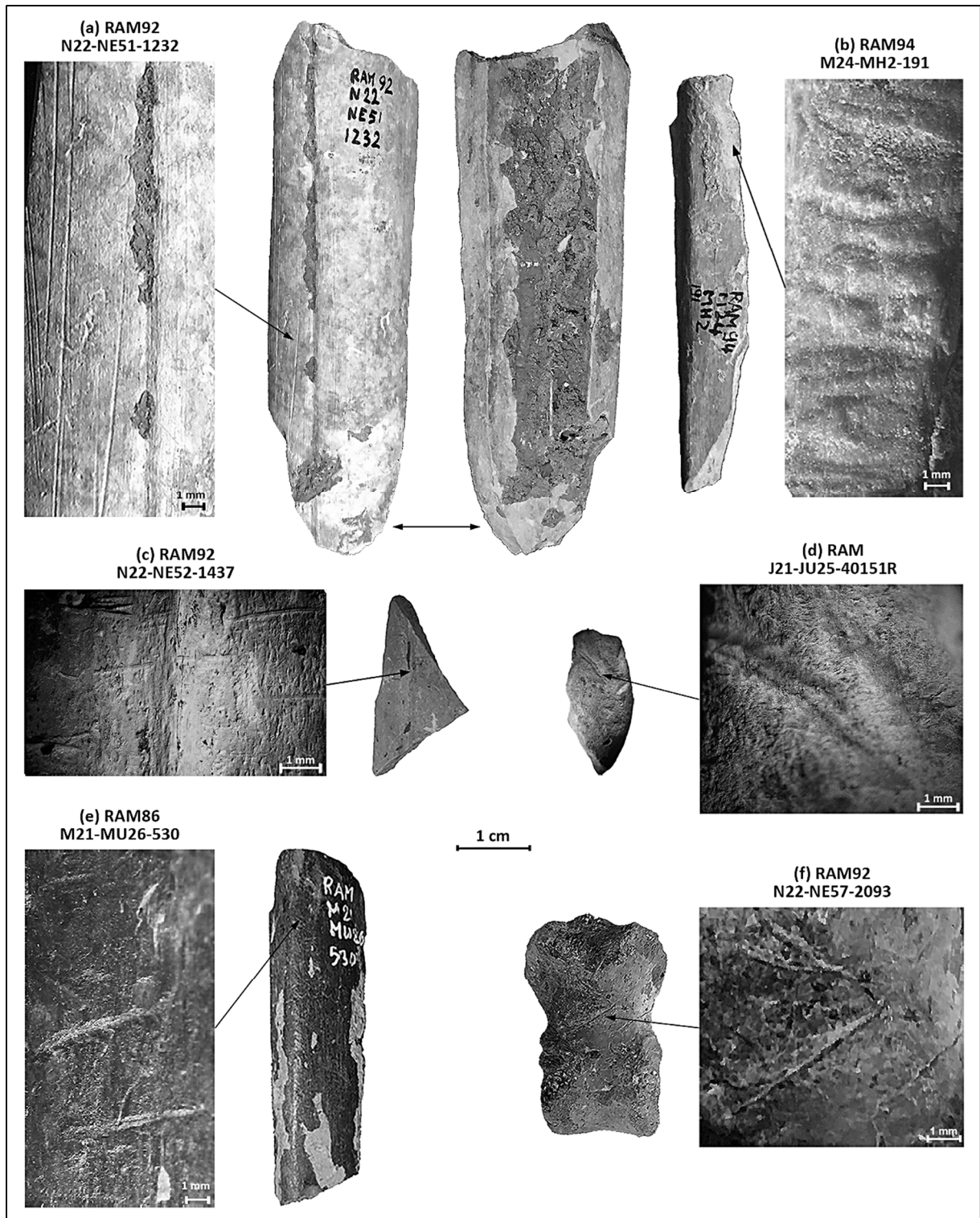
418 Several butchery step were noticed, generally affecting burnt remains, based on
419 morphology, localization and distribution of traces over the bone surface (Binford 1981).

420 Cut marks on burnt cranium of red deer in S11 (fig. 13a) and on one horse phalange in S10
421 could indicate skinning process, as well as for wild boar, with a cranium and phalanges
422 likewise affected in these same levels. However, unlike the wild boar and fallow deer, third
423 phalanges are missing for all ungulates, which may support the hypothesis of an out-site
424 skinning process on main species, or show a differential treatment such as burning process.
425 Incisions on articular parts are observed on carpus and mandible, thoracic vertebrae and long
426 bones extremities (humerus, femur and metapodials) for the red deer in S11 and S12 (fig.
427 13a), interpreted as disassembling step, likewise recorded for aurochs in S11. Traces are
428 recorded in the three levels, on mandibles, ribs, or diaphysis of meat-rich long bones for main
429 species (fig. 13a), showing defleshing processes, likewise for secondary species, essentially
430 aurochs (in S10 and S11) and for wild boar (in the three levels).

431 Scraping marks are noticed on diaphysis of red deer metapodials (fig. 13a). These meat-
432 poor elements are affected by long fine parallel striation to the longitudinal bone axe (fig.
433 14a) or short and close parallel marks perpendicular to the bone shaft (fig. 14c) caused by the
434 removal of periosteum. This cleaning process allows to facilitate bone breakage. Moreover,
435 green fracture on mandible and long bones, mainly on red deer metapodials (fig. 13a, fig.
436 14a), represents the bone marrow removing step, abundant inside these anatomical parts.
437 Some of these remains show percussion marks related to this process.

438 Carnivores are also affected by butchery marks noticed on heated remains. Incisions are
439 noticed on a wolf occipital in S12 (fig. 14d) and a cave bear phalange in S11 (fig. 14f), which
440 can be explained by a disassembling process for the first and a skinning step for the
441 second. Remains of brown bear, *Ursus arctos*, are likewise heated in unit II, with one
442 phalange in S12 and one fibula bearing cut traces could interpreted as skinning marks, in S13
443 (fig. 14e).

444 At last, technological applications of bones are identified in the three levels, corresponding
445 to scarce bone retouchers (tab. 6), mainly on heated long bones of cervids (fig. 14b).



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Fig. 14: Anthropogenic marks on large mammal remains: (a) scraping marks and green fracture on an unburnt metacarpal of red deer, (b) bone retoucher on a brown heated metatarsal of roe deer, (c) scraping marks on blue burnt metacarpal of red deer, (d) cut marks on an heated brown temporal of wolf, (e) cut marks on brown heated fibula of brown bear, (f) cut marks on brown heated phalanx of cave bear (photo by L. Rusch).

451

4.3.3. Mortality profiles and seasonality

453 A low MNI is defined for each species (tab. 9) which not exceeds seven individuals, with
 454 red deer in S11. Closer count is recorded in S11 between main species, red deer (7
 455 individuals) and horse (6 individuals), and secondary species are well represented in this level
 456 by European wild ass (5 individuals), aurochs (5 individuals) and wild boar (4 individuals).
 457 Furthermore, fallow deer, with 5 individuals, counts higher MNI than in other levels. In S10
 458 equids are greater represented, by horse and European wild ass, with 6 individuals for each,

	S10						S11						S12A	S12						Total					
	F	Y	SA	A	O	MNI	F	Y	SA	A	O	MNI	MNI	F	Y	SA	A	O	MNI	F	Y	SA	A	O	MNI
Total carnivores	-	2	-	5	-	7	-	2	-	7	-	9	3	-	-	-	4	1	5	-	6	-	16	1	24
<i>U. arctos</i>	-	1	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	0	-	1	-	1	-	2
<i>U. spelaeus</i>	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	3	-	3
<i>M. meles</i>	-	-	-	-	-	0	-	-	-	1	-	1	1A	-	-	-	-	-	0	-	-	-	2	-	2
Lutrinae indet.	-	-	-	1	-	1	-	-	-	-	-	0	-	-	-	-	1	-	1	-	-	-	2	-	2
<i>C. lupus</i>	-	-	-	-	-	0	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	2	-	2
<i>V. vulpes</i>	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	3	-	3
<i>C. c. spelaea</i>	-	1	-	-	-	1	-	2	-	-	-	2	2Y	-	-	-	-	1	1	-	5	-	-	1	6
<i>L. spelaeus</i>	-	-	-	2	-	2	-	-	-	1	-	1	-	-	-	-	-	-	0	-	-	-	3	-	3
<i>F. silvestris</i>	-	-	-	-	-	0	-	-	-	1	-	1	-	-	-	-	-	-	0	-	-	-	1	-	1
Total herbivores	0	10	3	10	1	24	2	14	4	13	6	39	1	1	8	3	7	0	19	3	32	10	30	7	83
<i>P. antiquus</i>	-	-	-	-	-	0	-	1	-	-	-	1	-	-	-	-	-	-	0	-	1	-	-	-	1
<i>S. hemitoechus</i>	-	1	-	-	-	1	-	1	-	1	-	2	-	-	1	-	-	-	1	-	3	-	1	-	4
<i>E. f. germanicus</i>	-	3	1	2	-	6	-	3	1	2	-	6	1A	-	2	1	1	-	4	-	8	3	6	-	17
<i>E. hydruntinus</i>	-	2	1	3	-	6	1	2	-	2	-	5	-	-	-	-	2	-	2	1	4	1	7	-	13
<i>Bison sp.</i>	-	-	-	-	-	0	-	-	-	-	1	1	-	-	-	-	-	-	0	-	-	-	-	1	1
<i>B. primigenius</i>	-	2	-	1	-	3	-	3	-	1	1	5	-	-	3	-	-	-	3	-	8	-	2	1	11
<i>C. caucasica</i>	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	3	-	3
<i>C. elaphus</i>	-	1	1	1	-	3	-	2	1	2	2	7	-	1	1	1	2	-	5	1	4	3	5	2	15
<i>D. dama</i>	-	-	-	-	1	1	-	1	1	1	2	5	-	-	1	-	-	-	1	-	2	1	1	3	7
<i>R. tarandus</i>	-	-	-	-	-	0	-	-	-	1	-	1	-	-	-	-	-	-	0	-	-	-	1	-	1
<i>C. capreolus</i>	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	1	-	1	-	-	-	3	-	3
<i>S. scrofa</i>	-	1	-	1	-	2	1	1	1	1	-	4	-	-	-	1	-	-	1	1	2	2	2	-	7
Total	-	12	3	15	1	31	2	16	4	20	6	48	4	1	8	3	11	1	26	3	38	10	48	8	107

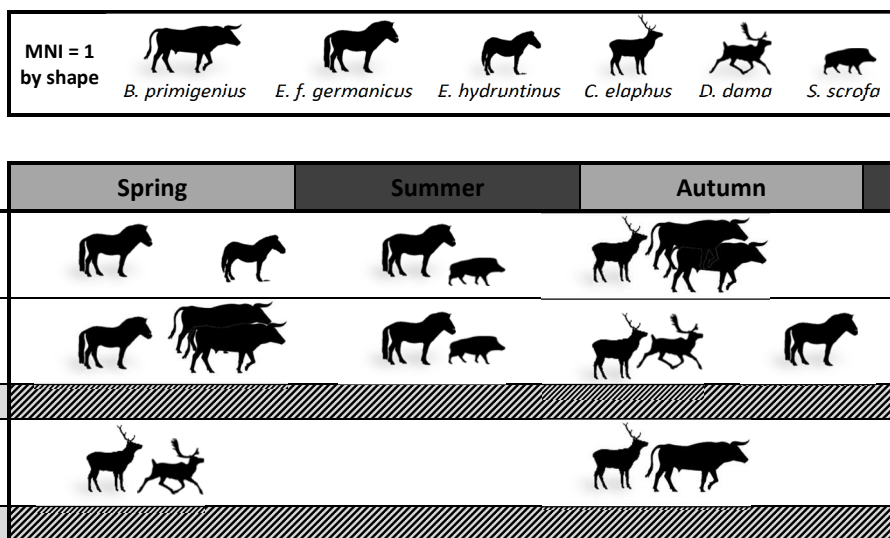
459 compared to red deer (3 individuals) and aurochs (3 individuals).

460 *Tab. 9: Age groups of large mammals (MNI by combination) in unit II levels of Ramandils Cave: (F) foetus, (Y) young, (SA) sub-adult,*
 461 *(A) adult, and (O) old individuals.*

462 Carnivores are scarcer, not exceeding 2 individuals by species, and relatively more
 463 represented by cave hyena, with 6 individuals of total MNI. Young individuals are only
 464 recorded for brown bear in S11 and cave hyena in S11 and S12a (tab. 9), and one senile cave
 465 hyena is noticed in S12.

466 For ungulates, the mortality patterns indicate that all age groups are present in unit II, and
 467 particularly among dominant species. Adults are the most abundant, closely followed by
 468 young individuals (infants or juveniles) and to a lesser extent by sub-adults. This last age
 469 group corresponds to animals which have nearly reached their maximum size, meaning that
 470 hunting a sub-adult prey could have involved the same diet resources as an adult animal. One
 471 senile fallow deer is recorded in S10 while six senile prey are represented in S11
 472 corresponding to one bison, one aurochs, two red deer and two fallow deer. We determined
 473 three foetus teeth in unit II, for wild boar and European wild ass in S11 and for red deer in
 474 S12, meaning that female adult animals were targeted, however no criteria on bones remains
 475 allow us to distinguish them.

476 Ungulates were generally slaughtered several times during the year (fig. 15), with spring,
 477 autumn and winter always recorded in the three levels. Prey selection followed a seasonal
 478 pattern for cervids, systematically occurring during autumn, in the three levels and during
 479 spring in S12. In the same way, in S11 and S10, horse was generally hunted between spring
 480 and summer, European wild ass rather during winter, and wild boar during summer, while in
 481 S12, seasonal recording is not represented for these species. Moreover, aurochs were
 482 slaughtered during various periods, hunted during spring in S11 whereas this bovid is
 483 represented during autumn in S10 and S12, as well as during winter in S12.



484 Fig. 15: Large mammals seasonality in unit II levels of Ramandils Cave

485 **5. Discussion**

486 The results obtained in this study contribute relevant details to knowledge of Neanderthal
487 and carnivore occupations in unit II of Ramandils Cave (tab. 10), and therefore on
488 Mediterranean coast during the Upper Pleistocene. The three more abundant unit II levels
489 record several occupation periods occurred, the densest of which is undoubtedly observed in
490 level S11.

491 5.1. Occupations in Unit II Levels

492 For the material accounted, S8, S9, S13 and S14 are the lower levels of unit II, except for
493 coprolites levels S12a and S13a. Further studies will refine these four occupation levels for
494 allow us to characterise unit III and unit I limits with unit II levels.

495 - S13a

496 S13a level constitute a coprolite deposit in a concentrated area more or less circular. This
497 distribution could be interpreted as a latrine deposit, usually attributed to cave hyena layer
498 (Bearder and Randall, 1978; Crezzini *et al.*, 2015; Fernandez Rodriguez *et al.*, 1995; Fosse,
499 1997; Fourvel, 2012; Kruuk, 1972; Pineda *et al.*, 2017), indicating at least one carnivore
500 occupation during long periods of human abandonment. However, further studies will allow
501 us to characterise this level.

502 - S12

503 Anthropic impact is well attested in S12 level, especially with lithic industry and burnt
504 faunal bones. Red deer and horse remains are prevalent for large mammals, in NISP and MNI.
505 Secondary species are recorded mainly corresponding to aurochs, European wild ass, and wild
506 boar, with lower values of NISP and MNI. Several carnivore species were identified, for less
507 than 6% NISP, relatively represented by wolf and cave hyena, with a low MNI.

508 Almost all skeletal parts are recorded for the red deer, explained by a whole carcasses
509 transport, but hind limb bones were not found for the horse, which could be explained by
510 partial carcass transport likewise for secondary species. However, the lack of third phalanges
511 for all species may indicate a previous skinning step out-site or differentiated impacts for this
512 anatomical elements such as with burning processes. Several butchery steps are noticed,
513 mainly on long bones of red deer. Firstly, disassembling and defleshing marks indicate a meat
514 exploitation, likewise noticed for one wolf remain for the first process. Secondly, scraping
515 marks, resulting of bone cleaning processes, mainly on metapodials, with green fractures, and
516 some percussion marks induce a bone marrow consumption, supported by the high material
517 fragmentation.

518 Then, high values of heated to burnt bones are highlighted in this level, without any hearths
519 recorded in the sequence. These structures may be located in non-excavated area or might not
520 be preserved, especially in the eroded area on the front of the cave, caused by the active
521 natural spring. Heating and burning in the set may suggest various processes and could partly
522 explain the high material fragmentation. Scarce double colouration on same bone surface
523 indicates differential heat exposure and could suggest possible roasting of the meat, prior to

524 defleshing (Rosell *et al.*, 2012). However, the high bone fragmentation can affect evidence of
525 this meat preparation process, especially for diaphysis fragments. Low calcination can
526 indicate a bone preparation to facilitate their fractures (Cáceres *et al.*, 2002) or preparing bone
527 marrow for removal (Oliver, 1993; Speth *et al.*, 2012), while high calcination could show
528 possible cleaning activities. The low representation of cancellous bones (articular portions,
529 limb extremities or axial skeleton) and the small number of percussion fragments does not
530 exclude the hypothesis of bone grease exploitation or the use of bones as fuel (Daujeard,
531 2008; Lebon, 2008; Morin, 2007, 2010). Further studies would allow us to explain these
532 proportions.

533 Young and adult ungulates, with close MNI, seem to be slaughtered without any age
534 selection. Despite low MNI of large mammals, studies show occupations occurred during
535 almost each seasonal period of the year. This faunal studies could indicate specialised
536 seasonal hunting, especially focus on cervids (red deer and fallow deer) during spring and on
537 aurochs during winter, with a mixed period for red deer and aurochs during autumn, other
538 species such as horse not estimating in months.

539 Moreover, low carnivore occurrence is noticed within S12 level. Few carnivore remains
540 are identified, especially wolf and cave hyena. Scarce tooth and digestion marks, mainly
541 affecting heated and fractured ungulate bones, and coprolites induce scavenging during short
542 human abandonment of the cave.

543 - S12a

544 Another coprolite layer, noted S12a, was described during this study, implying recurrent
545 carnivore occupation of Ramandils cave in unit II. In addition to a richer coprolite bed with a
546 concentrated area more or less circular, S12a records few carnivore remains, especially two
547 young cave hyena (2 MNI), as well as one gnawed long bone of horse, the only one ungulate
548 remains. These results could be interpreted as a latrine deposit and explained by the use of the
549 cave as a den by the cave hyena, usually generating this type of distribution (Kruuk, 1972;
550 Bearder & Randall, 1978; Pineda *et al.*, 2017). However, further studies will allow us to
551 characterise this layer.

552 - S11

553 S11 is the richest unit II level with anthropic activities such as lithic industry and butchery
554 processes. The same main species are recorded than in S12 with the prevalence of red deer
555 and similar distribution is noticed for secondary species. Carnivores are more varied for less
556 than 6% NISP, relatively represented by hyena and canids with a low MNI.

557 Almost all skeletal parts are recorded for the main species, explained by a whole carcasses
558 transport, whereas, as in S12, a partial transport is interpreted for secondary species.
559 However, the lack of third phalanges for ungulates, except for wild boar and fallow deer, may
560 still indicate a previous skinning step out-site or differentiated impacts for this anatomical
561 elements such as with burning processes. The same butchery steps are noticed, mainly on long
562 bones of red deer, with the addition of skinning marks for red deer and wild boar, likewise on
563 a cave bear phalange. High values of heating and burning processes have the same
564 interpretation as for S12.

565 Young and adult ungulates, with close MNI, seem to be slaughtered without any age
566 selection. Despite low MNI of large mammals, seasonality studies could indicate longer or
567 more frequent occupations than in S12. Specialised seasonal hunting seems focus on cervids
568 during autumn and on bovids during spring, with a regular slaughtering of suids and equids
569 (horse and European wild ass) for almost each seasonal periods of the year. European wild ass
570 seems rather hunted during winter, as well as suids, likewise killed during summer.

571 Moreover, low carnivore occurrence is still noticed within S11 level with the same
572 scavenging marks during short human abandonment of the cave. However, considering the
573 preservations of few whole long bones and tooth marks on unburnt remains, not affected by
574 human activities, carnivore may have transported some of their own prey into the cave ().

575 - S10

576 No coprolites level is noticed between S11 and S10 levels as opposed between S13 and
577 S12 with S13a level and between S12 and S11 with S12a level. In S10, recording human
578 occupation evidence, horse is prevalent compared to red deer with the same faunal spectrum
579 and close values for secondary species as in S12 and S11. Carnivores are fewer diversified,
580 represented in lesser extend by cave hyena and lynx.

581 Almost all skeletal parts are recorded for the horse, explained by a whole carcasses
582 transport, but axial elements and bones of hind quarter were not found for the red deer, which
583 could be explained by partial carcass transport likewise for secondary species. However, the
584 lack of third phalanges for ungulates, except for wild boar and fallow deer, may indicate a
585 previous skinning step out-site or differentiated impacts for this anatomical elements such as
586 with burning processes. Several butchery marks are noticed, mainly on long bones of red deer.
587 Skinning step is highlighted for horse and wild boar. Disassembling is not recorded in S10 but
588 other butchery steps are the same as in S11 and S12, likewise for heating and burning
589 processes with the same interpretations as for other levels.

590 Young and adult ungulates, with close MNI, seem to be slaughtered without any age
 591 selection as seen in other levels. Seasonality studies show occupations occurred each seasonal
 592 period of the year. Despite low MNI of large mammals, this faunal studies could indicate
 593 specialised seasonal hunting, similar to the previous levels, for Cervids and bovids which
 594 seem rather killed during autumn, as seen in S12, whereas equids were slaughtered during
 595 almost each season, with a focus on European wild ass during winter, as notice in S11.
 596 Therefore, Suids seem killed during summer likewise in S11 level.

597 Carnivore occurrence is still noticed within S10 level with the same scavenging marks
 598 during short human abandonment of the cave. However, considering the preservations of few
 599 whole long bones and tooth marks on scarce unburnt remains, not affected by human
 600 activities, carnivore may have transported some of their own prey into the cave.

	Human activities							Carnivores activities			
	Hunted prey	Transport	Butchery steps	Fire	Exploitation	Saisonality	Bone industry	Main species	Activities	Coprolites	Occupation
S10	Main: - Horse - Red deer Secondary: - Aurochs - European wild ass - wild board	Whole	- Skinning - Defleshing - Breakage	Heating + Burning	Meat + Bone marrow	Seasonal selective slaughters	Rare retouchers	Cave hyena (young) + Lynx (adult)	Scavenging + Few gnawing remains no affected by human	yes	occasional
S11	Main: - Red deer - Horse Secondary: - Wild board - European wild ass - Aurochs	Whole	- Disassembling - Defleshing - Breakage	Heating + Burning	Meat + Bone marrow	Seasonal selective slaughters	Rare retouchers	Cave hyena (young) + Fox (adult)	Scarce: Scavenging + Few gnawing remains no affected by human	yes	occasional
S12a								Cave hyena (Young)	Gnawing on one whole radio-ulna of horse	Latrine level ?	Den?
S12	Main: - Red deer - Horse Secondary: - Wild board - European wild ass - Aurochs	Whole	- Disassembling - Defleshing - Breakage	Heating + Burning	Meat + Bone marrow	Seasonal selective slaughters	Rare retouchers	Cave hyena (young / old) + Wolf (adult)	Scavenging	Yes	occasional
S13a								None		Latrine level?	occasional

601 *Tab. 10: Synthesis of human and carnivore activities in unit II levels of Ramandils cave*

602 In S10 S11, S12 levels, the material accumulation is mainly due to human input
 603 representing various activities during several occupations periods recorded within unit II but
 604 also in the whole sedimentary filling of the cave.

605 Even if the archeological interpretation from paleoenvironments to settlement pattern
 606 depends on the temporal resolution of the data (Carbonell *et al*, 2012), this first and
 607 preliminary multidisciplinary approach allow us to propose and discuss various hypotheses on
 608 the general human mobility pattern, the site function and its status in the territory.

609 5.2. Mobility pattern

610 - Economic and territorial pattern

611 Even if, at that stage of the study, lithics and faunal remains are not analysed at the same
612 stratigraphic resolution level, we could however begin the first discussion about the economic
613 general pattern of the unit II occupations.

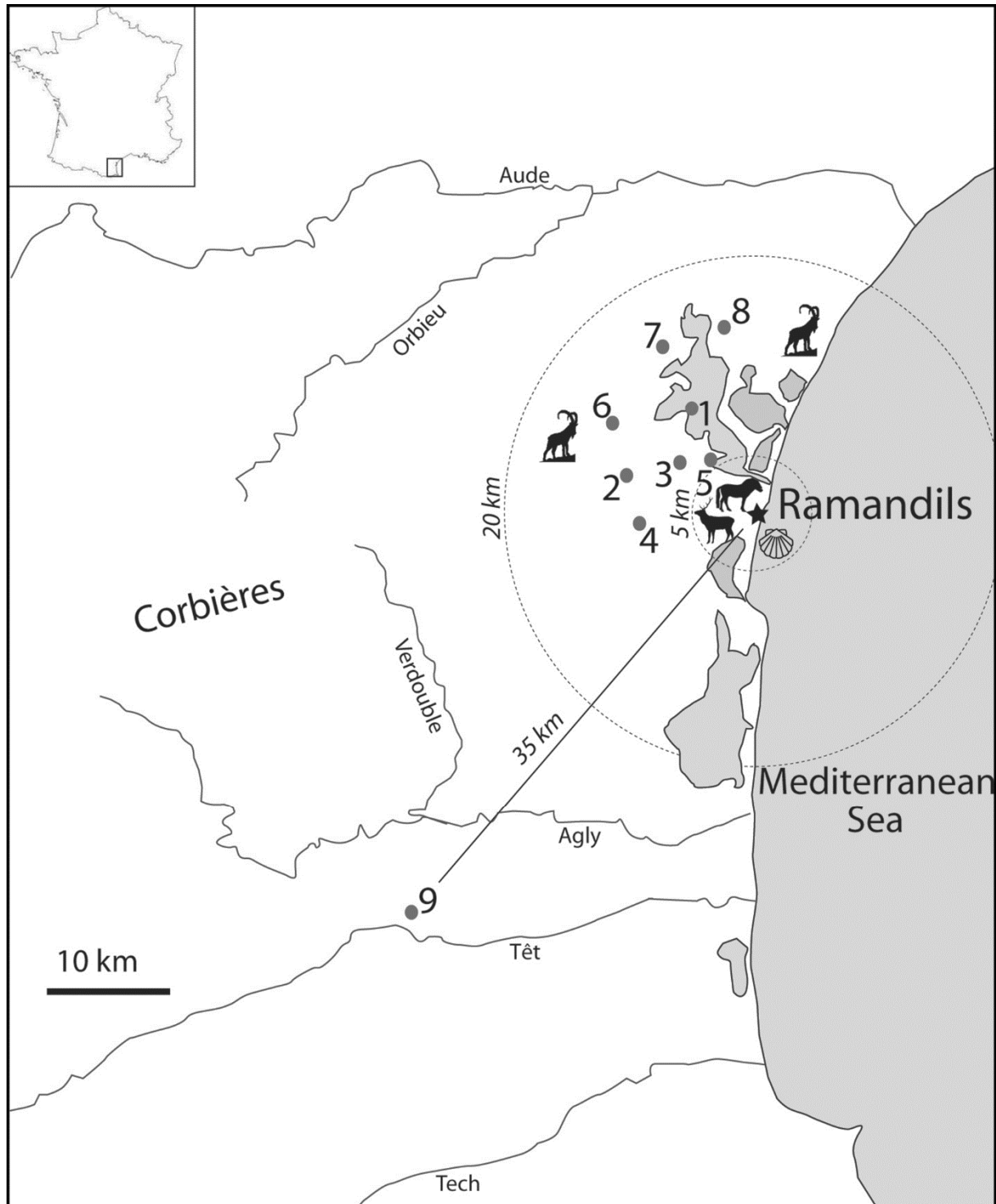
614 Generally, Ramandils settlements seems to be linked to the exploitation of the tertiary flint
615 sources of the Narbonne-Sigean Basin (fig. 16). Raw material origins are mainly from the
616 semi-local area (between 5 and 20 km) around the site. Excepted the jasper, the unique raw
617 material imported from the remote area (35 km), every raw material came from the
618 surrounding of the site between 7 km and 17 km. Flint were principally extracted from the
619 tertiary outcrops of Sigean, Presqu'île du Doul, Portel des Corbières, Hameau du lac. More
620 rarely some cherts were exploited a little further from the cretaceous and jurassic outcrops and
621 the others kind of raw material were collected in the Aude alluvial deposits (quartz, quartzite
622 and sandstone...) at the north of the site or sometimes on the beach deposits, just near the
623 cave.

624 Despite this semi-local procurement pattern, which would rather indicate a strong and well
625 organized exploitation in this area, the punctual arrival of jasper from the Roussillon plain, at
626 35 km south of the site, seems to indicate that groups had an important mobility on the
627 territory and they import punctually materials of interest from these more remote areas that
628 they browse probably for others activities.

629 Moreover, the faunal acquisition is more oriented towards all the available environments
630 around the sites (Rusch *et al.*, 2019). Main species, dominated by red deer and horse,
631 highlight grassland with forests, which could be situated less than 5 km around the cave.
632 Marine shells recorded throughout the sequence involve a transport into the site of less than
633 1,4 m, compared to the current coast. Further studies will allow us to understand the use or
634 consummation strategies of these remains. Furthermore, ibex remains found in this unit
635 involve a rocky environment, located at least in the semi local area between 5 and 20 km (fig.
636 8), because we could hypothesize that ibex were situated on the nearest reliefs of the
637 Corbières massif.

638 The local area seems to be exploited for its subsistence resources while semi local area
639 provided more than 99 % of the lithic raw material used and occasionally this area is
640 exploited for the acquisition of ibex (fig. 16).

641 This pattern is different from the regional Mousterian sites like Crouzade Cave on the
642 cretaceous Clape massif near Narbonne (Saos *et al.*, in press) and Hortus site on the
643 Montpellier region (Lebègue *et al.*, 2010) which are characterised by a mainly local and semi-
644 local flint and animal resources supply but completed with an additional allochthonous lithic
645 raw material generally coming from more than 80 km away. These occupation sites are
646 interpreted as short terms hunting camp or seasonal camps (Grégoire, 2012).



648
649
650

Fig. 16: Economic exploitation territory divided in: local-0 to 5km, semi-local-5 to 20km, and remote area-more than 20 km, including lithic sources and potential location of the main species exploited as food resources.

651 We must go to the Ardèche region, more than 250 km north of Ramandils Cave, at Saint
652 Marcel Cave, to find a Middle Palaeolithic site where the economic mobility pattern is similar
653 (Moncel *et al.*, 2004, Daujeard & Moncel, 2010), with a semi-local supply, oriented on flint
654 procurement, that not exceed 10 km. The different occupations phases of this site, more or
655 less contemporaneous than the Ramandils settlements, are qualified by the authors as “long
656 term residential camp” thanks to the exploitation and consumption strategies, the lithic
657 remains density and the topographic situation for example.

658 In the case of Ramandils cave, arrival of allochthonous raw material testify probably of a
659 logistic mobility (Binford, 1980) from areas exploited for their own resources, to a base-camp
660 (Ramandils?) where natural shelter, water source, faunal abundance from various ecosystems
661 (grassland, forest, mountain, and sea with marine shells), proximity of flint sources and of the
662 shore, makes this place attractive and justify the frequency and the persistence of the
663 settlement. This mobility pattern indicates a territorial economic organization where
664 Ramandils site would take a central place and could work like an aggregation site (Kuhn,
665 1995) within an economic territory of a 35 km radius.

666 The large quantity of lithic material and the complete reduction sequence on flint testify to
667 an intense production activity on the site during the unit II settlement. The abundance of small
668 artefacts resulting from (i) a first massive production of small flakes, recycled in many cases
669 as matrix for (ii) a second phase of flake production, tend to indicate that Ramandils cave
670 seems to be a production site dependent on nearby flint sources which could be interpreted as
671 a long term settlement because of the production strategies.

672 Indeed, from the techno-economic point of view, a general overview of the unit II allows to
673 say that the groups strongly occupied the local and semi-local territory (fig. 16) and, at the
674 same time, carried out intensive lithic production activities on the cave. This intensive activity
675 is also noticeable thanks to the “ramification” process (Bourguignon *et al.*, 2004) in the flake
676 production. These facts, added to the previous one, are also in favour of the long term
677 residential camp.

678 On the other hand, the incomplete reduction sequence for almost nine raw materials other
679 than flint, but less represented, as well as the very punctual contribution of jasper by artefacts
680 at the end of the reduction sequence, seems to demonstrate, that lithic pieces were circulating
681 easily on the territory, and that the production, with these secondary raw materials, was very
682 fragmented in space and time (Bourguignon *et al.*, 2006) which is to say that people circulate
683 a lot between different points of the territory. These facts could be in favour of a logistic
684 mobility from the residential camp, to more specialised camps and support the assumption
685 that Ramandils cave could be used as a long term residential camp connected with others
686 specialized sites, one of which could be in the jasper supply area.

687 5.3. Site function in unit II

688 By taking account of this first results, on faunal and lithic exploitation, intrinsic to the
689 Mediterranean coastal context (climate, topography, ecosystems, raw material available,
690 human groups, etc.), it is possible to propose two hypotheses of occupation site modes (tab.
691 11). Indeed, several criteria tend to support long-term camps, nevertheless, some data seem to
692 favour in short-term repeat occupation, compared to Upper Pleistocene sequences from
693 southern France such as those in northwestern Mediterranean coast and in Rhone Valley
694 (Daujeard & Moncel, 2010; Daujeard *et al.*, 2011, 2012, 2016; Magniez, 2010; Saos *et al.*,
695 2016).

696 In unit II levels, humans are the principal agents of the input and exploitation of ungulate
697 carcasses, likewise in long-term occupations, such as in Saint-Marcel, Baume des Peyrards
698 and Abri du Maras. However, large mammal spectrum highlights two main species, attributed
699 to red deer and horse, with less than 50% NISP, and various secondary ungulates with
700 European wild ass, aurochs, and wild boar. Moreover, carnivore activities are recorded within
701 (S10, S11, S12) and between (S12a, S13a) these levels, with young individuals, coprolites
702 deposits, butchery and carnivore tooth-marks found on the same species (red deer and horse),
703 which could support the hypothesis of short-term occupations.

704 Faunal studies indicate hominin occupations during each seasonal period of the year, with
705 varied acquisition strategies according to the taxa and more frequent slaughtering during
706 autumn and spring. In all levels, cervids were systematically hunted during autumn, whereas
707 equids were killed during almost each season (in S11 and S10), with a focus on European
708 wild ass during winter. Seasonal acquisition strategies are recorded in several Pleistocene sites
709 such in the Rhone Valley (Daujeard & Moncel, 2010; Daujeard *et al.*, 2016), at Baume des
710 Peyrards, where ibex and most of the secondary species were hunted during the cold season
711 and summer, whereas horse was the only one killed during spring, or at Saint-Marcel, where
712 the fallow deer from level u seems frequently hunted during spring and autumn. Periodic
713 recurrence, according to taxa in Ramandils sequence, could imply a planned seasonal
714 exploitation of the territory, mainly concentrated on local and semi local area, also observed
715 by the studies on raw material procurement.

716 In unit II levels, adult and young ungulates are the highest classes, followed by sub-adult
717 group, while older individuals have lower rates. Slaughtering is therefore generally aimed at
718 the most profitable prey that could suggest the capture of females (adult individuals) and their
719 young and can be interpreted as a human characteristic of primary and immediate access to
720 the animals (Gaudzinski & Roebroeks, 2000; Klein & Cruz-Urbe, 1984; Stiner, 1994).
721 Nevertheless, it is important to note that only young and young adults were considered for
722 estimating seasonality. There is a chance that adults could have been hunted during different
723 events and therefore, different seasons. However, age at death was mainly estimated through
724 dental eruption pattern and almost only on isolates teeth.

725 As at Payre, at Baume Flandin and Le Figuier, (Daujeard & Moncel, 2010; Daujeard *et al.*,
726 2016), several transport strategies and butchery processes have been observed for the various
727 ungulates. A differential degree in carcass treatment according to the species is observed in
728 unit II levels of Ramandils Cave. Red deer, reveal most of the hominins action, rarest for
729 secondary ungulates. Main species were almost systematically brought back whole,
730 dismembered, filleted, and broken for an intensive bone marrow recovery, whereas secondary
731 species are mainly represented by skull and limb end. Skinning process is generally scarce
732 and the lack of third phalanges (except for wild boar and fallow deer) could indicate a first
733 butchery step on the kill site. Furthermore, the scarcity of retouchers in these levels show a
734 low technological applications of bones, usually higher for long term residential camps
735 (Daujeard *et al.*, 2018).

736 Combustion structures are not recorded while numerous burnt flint and bones, with high
737 degrees, show fire was intensely used as well as for long-term occupation sites. Hearths could
738 be located in not excavated area or might not be preserved, especially in the eroded area on
739 the front of the cave, caused by an active natural spring (fig. 2). Heated and burnt remains
740 could therefore result of secondary deposits from hearth cleaning activities. The hypothesis of
741 bone grease exploitation or the use of bones as fuel is not exclude, further studies would allow
742 us to explain the low proportion of cancellous bone and percussion marks.

743 Lithics evidence are rather in favour of the hypothesis of the long term pattern with the
744 high quantity of lithic remains, the intensive flake production in situ with a complete flint
745 reduction process, added to the mainly semi-local supply that requires travel between 7 and 17
746 km for supplies and replenishment (tab. 11). However, the short term pattern cannot be totally
747 dismissed supporting by some criteria which indicate a great mobility in the territory like the
748 incomplete reduction sequence for 9 secondary raw materials and the punctual arrival of
749 jasper from 35 km away (fig. 8). In order to go further, it would be necessary to refine lithic
750 studies with the same stratigraphic resolution level as for faunal remains.

751 All these criteria (tab. 11) led us to discuss the status of the site in terms of duration of
752 occupation according to the episodes identified in unit II by archeostratigraphy. All the
753 criteria carrying an information about seasonality, about intensive presence on the site or on
754 the contrary about displacement on the territory were used to evaluate arguments in favour of
755 the two hypotheses tested on this work: the long term residential camp and the short term
756 regular hunting camp. These two categories were chosen to be compared with other studies
757 conducted in South of France, in the same region (Lebègue *et al.*, 2010; Magniez, 2010;
758 Grégoire, 2012; Saos *et al.*, in press) or in the near Rhône valley (Daujeard & Moncel., 2010;
759 Daujeard *et al.*, in Djindjian *et al.*, 2018).

760 However, the site function can also be thought of in terms of activities. Through the lithic
761 toolkit of unit II it is difficult to identify any specialised activities because of the low
762 percentage of flake tools stayed on the site and the absence of traceology study. On the other
763 hand, the large quantity of non-retouched small debitage products and the identification of
764 several and ramified reduction sequences, testify to an intense activity of flint blanks
765 production of which a large part could be exported in the form of retouched tools. The non-
766 immediate proximity of the tertiary flint sources could testify that the site was selected for its
767 position in relation to these lithic resources to develop easily a flake production activity but
768 also for the immediate proximity of various subsistence resources for the group supplying,
769 during the flint exploitation and production activity. Indeed, despite the relative prevalence of
770 red deer and horse, faunal studies do not show specialised hunting in unit II levels according
771 to taxa or age class. Carcasses were intensely exploited for meat and especially for bone
772 marrow with the high use of fire for various burning degree. These data tend to indicate a
773 consumption of available faunal resources around the cave, supporting by leporid (Morin *et*
774 *al.*, 2019) and marine shell exploitation (Cataliotti-Valdina in Boutié, 1990; Celiberti &
775 Moigne in Saos *et al.*, 2016).

776

Hypothesis of sites function	Long-term Residential camps	Short-term regular hunting camps
Agents of bone accumulations	Accumulation of herbivores is mainly due to hominin activity and carnivore tooth-marks are always less than 4% of the total remains.	Butchery and carnivore tooth-marks are found on the same species: mainly red deer and horse. Coprolite levels in S13a and S12a
Animal spectrum	-	Main species < 50% NISP, with various secondary species
Seasonality	All year round (especially in S11 and S10), with most slaughters occurring during the autumn and spring.	Varied acquisition strategies according to the taxa.
Acquisition strategies for animal resources	Slaughtering is mainly made up of young animals and adults, may be Killed in herds and corresponding to females and their young (most profitable prey)	-
Carcass transport strategies	-	Transport strategies and access to carcasses vary according to the taxa. - Main ungulates: whole - Secondary ungulates: partial with poorest pieces (essentially skull and limb ends)
Butchery	Intensive and generalised butchery sequence for consumption (meat and bone marrow)	More complete butchery sequence for big and medium size ungulates and scarce human occurrences for poorest pieces of some others (carnivores share ?)
Fire	Numerous heated (low degree) and burnt bones (high degrees) with burnt lithic artefacts.	-
Bone industry	-	Scarce retouchers
Origin of the lithic raw material	Mainly semi-local, between 7 and 17 km	Punctual arrival of jasper from 35 km away
Chaîne opératoire according to raw material	-Complete for flint, partial for other raw material -Ramification process on flint	partial reduction sequence for secondary raw material
% of tools	Low	-
Lithic remains density	high	-
Specialization degree of lithic production	Low	-
Instance for Middle Palaeolithic sites	Moula (XV, XIV), Abri du Maras, Saint-Marcel, Baume Néron, Baume Vallée, Mandrin (Daujeard & Moncel, 2010, Daujeard <i>et al.</i> , in Djindjian <i>et al.</i> , 2018)	Ornac 3, Saint-Anne, Payre, Baume Flandin, Baume de Gigny, Figuier, Baume Moula VIII, IV (Daujeard <i>et al.</i> , in Djindjian <i>et al.</i> , 2018) Tournal (Magniez, 2010) Hortus (Lebègue <i>et al.</i> , 2010), Crouzade (Saos <i>et al.</i> , in press)

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Tab. 11: Zooarchaeological and lithic criteria to define types of occupation in unit II from Ramandils with instance of Middle Palaeolithic site in Mediterranean coast and the Rhône Valley (Daujeard & Moncel, 2010; Daujeard *et al.*, in Djindjian *et al.*, 2018; Lebègue *et al.*, 2010; Magniez, 2010; Saos *et al.*, 2016, in press).

780 6. Conclusions

781 Our attempt with this paper was to present the first results of zooarchaeological studies in
782 unit II, subdivided by an archaeostratigraphical approach, into several levels. These spatial
783 analyses allowed us, for the first time, to individualize coprolite beds, produced by carnivores,
784 between human occupation levels, permitting to indicate recurrent periods when Neanderthals
785 did not occupy the site and then allow us to better identify periods of anthropic settlements.

786 A rich archaeological material is highlighted in three archaeostratigraphic levels with
787 numerous lithic industries and high proportion of burnt bones. Periods of continuing human
788 presence have therefore influenced the taxonomic profile, reflecting planned exploitation of
789 seasonally available resources, as well as more opportunistic behaviours represented by the
790 procurement of mainly semi local raw materials within a 20 km radius territory. This apparent
791 opportunism could be explained by the fact that the tertiary flint, despite an ordinary quality,
792 had to perfectly correspond to the needs of the hominins.

793 The intensive human activities on these anthropic levels (tab. 11), could indicate long term
794 occupations all year round long with slaughtering of most profitable prey, various butchery
795 steps and numerous lithic artefacts, burnt flint and bones with high burning degree.
796 Nevertheless, several features tend to represent recurrent short-term occupations (tab. 11) with
797 various prey slaughtered, seasonal hunting according to taxa, a differential degree in carcass
798 treatment according to the species, the partial reduction sequences for 9 lithic raw materials.
799 Despite the rare occurrence of carnivore marks, less than 4% of total NR, tooth marks affect
800 the same species which are exploited by humans, inducing prompt scavenging during human
801 abandonment of the cave. Moreover, coprolite deposits within and between unit II levels, on
802 well-defined areas, highlighted by archaeostratigraphical studies, might likewise indicate
803 periods when human groups were not occupying the cave.

804 This multidisciplinary approach permits to highlight the difficulty, for the unit II level of
805 Ramandils cave, of deciding between two hypotheses of function site, related to the duration
806 of occupation and the activities carried out. Indeed, arguments in favour of the two patterns
807 were identified and others seems to be necessary to conclude.

808 To go further, raw material and lithic artefacts studies, performed first on the whole unit II,
809 without fine subdivisions, need to be refined according to the archaeostratigraphical levels,
810 with the aim to define, for each anthropic occupation, the exploited territory and the
811 functional or technical objectives of the settlement. However, a mobility pattern is highlighted
812 by this study indicating an economic organization within a 35 km radius territory of littoral
813 plain, where Ramandils site take probably a central place on Mediterranean coast according to
814 the high human presence recorded on the site and the economic and subsistence modalities
815 observed.

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