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**Bone tools, ornaments and other unusual objects during the Middle to Upper
Palaeolithic transition in Italy**

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32

33 **Bone tools, ornaments and other unusual objects during the Middle to Upper Palaeolithic**
34 **transition in Italy**

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69

70 **Abstract**

71 The arrival of Modern Humans (MHs) in Europe between 50 ka and 39 ka coincides with
72 significant changes in human behaviour, notably regarding the production of tools, the exploitation
73 of resources and the systematic use of ornaments and colouring substances. The emergence of the
74 so-called modern behaviour is usually associated with MHs, although claims of symbolic thinking
75 in non-MH groups have been advanced in past decades. In this paper, we present a synthesis of the
76 Italian evidence concerning bone tool manufacturing and the use of ornaments and pigments in the
77 time span encompassing the replacement of Neandertals by MHs. Current data show that
78 Mousterian bone tools were mostly obtained from bone fragments used "as is". Conversely an
79 organized production of "finely shaped" bone tools is characteristic of the Uluzzian and the
80 Protoaurignacian, and the complexity inherent in the manufacturing processes suggests that bone
81 artefacts are not to be considered expedient. Some traces of symbolic activities are associated with
82 Neandertals in northern Italy. Ornaments (mostly tusk shells) and pigments used for decorative
83 purposes are well recorded during the Uluzzian. Their features and distribution suggest an
84 intriguing cultural homogeneity within this technocomplex. The Protoaurignacian is characterized
85 by a wider range of archaeological evidence, consisting of personal ornaments (mostly pierced
86 gastropods), pigments and engraved items.

87

88 **Keywords**

89 Italy, Mousterian, Uluzzian, Protoaurignacian, bone tool, ornament

90

91 **1.Introduction**

92 The dispersal of Modern Humans (MHs) in Europe between 50 ka and 39 ka BP and the
93 concomitant disappearance of Neandertal populations are central to the emergence/diffusion of the
94 so-called "modern human behaviour" that has usually been associated with "advanced" cognitive
95 and technological skills. Concepts like "behavioural modernity", "symbolic thinking", and others
96 like these are particularly sensitive topics, especially in the context of the Middle-Upper

97 Palaeolithic transition, where different human species with most probably different (though not
98 inherently necessarily inferior or superior) cognitive characteristics and social structures are
99 involved. We agree with other scholars (Eren et al., 2013 and references therein; see also session
100 A21a-Neanderthals on their own terms: new perspectives for the study of Middle Palaeolithic
101 behaviour by Chacón M.G. and Rivals F. of the XVII World UISPP Congress Burgos, 1-7
102 September 2014) in questioning the utility of indistinctly applying these notions, in a comparative
103 way, to extremely varied realities (cognitively, geographically, climatically, environmentally,
104 chronologically). Indeed, since notions like "modernity" and "symbolism" (and their degrees of
105 expression) are relative and abstract concepts, they are risky foundations for objective scientific
106 comparison (Henshilwood and Marean, 2003; Nowell, 2010; Shea, 2011; Ames et al., 2013;
107 Burdukiewicz, 2014; Moro Abadía and Nowell, 2015). This premise is all the more necessary as our
108 paper focuses on some categories of archaeological materials (i.e. bone tools, ornaments, colouring
109 substances and other non-utilitarian artefacts) displaying a suite of attributes that are often
110 considered as indicators of behavioural modernity for their innovative characteristics (Mc Brearty
111 and Brooks, 2000). While an in-depth consideration of what constitutes "modern human behaviour"
112 falls beyond the scope of this paper, we use here common terminology with no direct implications
113 for the link between symbolic thinking/modern behaviour on the one hand and the use of ornaments
114 and non-utilitarian objects in general on the other. In other words, we do not equate the simple
115 presence of ornaments and non-utilitarian objects as markers of symbolic thinking/modern
116 behaviour.

117
118 Among technological innovations, however, bone tool manufacture appears to have been a pivotal
119 element in outlining what is commonly defined "behavioural modernity", as it entails the
120 occurrence of complex technical skills that make possible the creation of a multi-stepped technical
121 system. Complex bone technologies allow the manufacture of functional implements by means of
122 anticipation of tasks expressly tailored to working hard animal tissues, such as scraping, grinding,
123 grooving and polishing (Mellars, 1973; Klein, 1999).

124
125 Artistic evidence, ornaments, and the use of pigments play a major role in defining "modern
126 behaviour" because of the symbolic value they have at least since the Early Upper Palaeolithic
127 (Vanhaeren and d'Errico, 2006; Stiner et al., 2013). From an archaeological perspective, the
128 systematic use of personal ornaments and pigments (possibly also connected to body painting) is a
129 proxy from which a number of behavioural characteristics, involving social relationships within a
130 group (in terms of age, gender, social status etc.) and ethnic identity, can be assumed.

131
132 Bone tool manufacturing first emerges in Africa during the Middle Stone Age (Brooks et al., 1995;
133 Yellen, 1998; McBrearty and Brooks, 2000; Henshilwood et al., 2001; Jacobs et al., 2006 and 2008;
134 d'Errico and Henshilwood, 2007; d'Errico et al., 2012a) where it dates back to between ~90-60 ka.

135
136 There are claims for very early evidence of symbolic thinking reported from Indonesia (geometric
137 engravings ca. 500 ka BP - Joordens et al., 2015), eastern Africa (colouring substances 300- 260 ka
138 BP - Brooks et al., 2018), Morocco, and Israel (possible stone figurines - 500-233 ka BP - Goren-
139 Inbar, 1986; Kuckenburg, 2001). However, a true florescence of symbolic activities (ornaments,
140 pigments, engravings), is first witnessed among MHs in Africa and the Levant between 135 and 70
141 ka BP (Vanhaeren et al., 2006 and 2013; d'Errico et al., 2008 and 2009; Bar-Yosef Mayer et al.,

2009), and they become widespread in the Upper Palaeolithic. In Europe, findings suggesting complex thinking in Neandertal groups have been claimed (e.g. Zilhão et al., 2010; Soressi et al., 2013), however the large-scale expression of these so-called “modern behaviours” is usually associated with the arrival of Modern Humans during the Middle to Upper Palaeolithic transition.

This paper is intended as a the most up-do-date bibliographic review of the evidence for bone tool production, ornament use and the creation of other material evidence of possible symbolic thinking (i.e. colouring substances and engraved items) during the Middle to Upper Palaeolithic transition in Italy namely the period corresponding to the intermediate phases of MIS3 (Table 1 and Fig.1; details on the chronology of sites dating to MIS3 in Italy can be found in Marciani et al., in this special issue). In this review, we also attempt to reconcile and match data from the literature that have offered often quite disparate degrees of information as a result of the age of publications, research traditions, and the content, level (preliminary, exhaustive etc.) and applied methodologies of the studies. Furthermore, our review does not aim to reassess the evidence, but more modestly to provide a complete overview of the published data. For this reason, in our description of the archaeological finds (bone tools, ornaments, etc.), we rely on the nomenclature used in published papers.

Despite these limits, such a comprehensive overview can be of great help in addressing future research on the transitional period in Italy. This is because the Italian peninsula plays a key role in the understanding of the dynamics that drove the shift from Neandertals to MHs, thanks to the presence of a several Late Mousterian, transitional and Early Upper Palaeolithic sites located in markedly different settings (Badino et al. and Romandini et al., in this special issue). Moreover, Southern Italy (Grotta del Cavallo – Benazzi et al., 2011) has arguably yielded the earliest evidence of MHs in Mediterranean Europe, offering an ideal starting point from which to begin investigations into this critical chapter of recent human evolution. While some authors have questioned the integrity of Grotta del Cavallo stratigraphic sequence (Zilhão et al., 2015), its reliability has been recently validated by Moroni and colleagues (2018) and reaffirmed by Zanchetta et al. (2018). This allows us to discuss the Italian evidence in the context of the coeval European record, to highlight those elements which reflect changes or continuities in human behaviour.

Tab. 1: List of Italian sites (corresponding to Fig. 1) that have yielded osseous tools, ornaments, pigments and other non-utilitarian evidence with MIS3 human occupations. Short names of the sites discussed in the paper are in brackets.

Techno-complex	Site	Layers	Osseous tools	Pigments	Ornaments	Other non-utilitarian evidence
	Grotta di Rio Secco (Rio Secco)	8, 7 base/5 5, 5 top	•		•	
	Grotta Maggiore di S.	II	•			

Mousterian (ca. 50-42 ka cal. BP)	Bernardino (S. Bernardino)					
	Riparo Tagliente (Tagliente)	37, 36, 35	•			
	Grotta di Fumane (Fumane)	A9, A5+A6, A6	•	•	•	
	Riparo Bombrini (Bombrini)	MS		•		
	Grotta Reali (Reali)	5	•			
	Grotta di Castelcivita (Castelcivita)	lower rsi	•			
	Riparo l'Oscurusciuto (Oscurusciuto)	4	•			
	Grotta del Cavallo (Cavallo)	FIII-Fa				?
Uluzzian (ca.45-40 ka cal BP)	Riparo Broion (Broion)	1g, 1f	•	•	•	•
	Grotta di Fumane	A3	•			
	Grotta La Fabbrica (La Fabbrica)	2	•			
	Grotta di Castelcivita	upper rsi, rpi, rsa"	•		•	
	Grotta della Cala (Cala)	14	•		•	
	Grotta del Cavallo	EIII, EII-I, DII, DI	•	•	•	
Protourignacian (ca.42-36 ka cal BP)	Grotta di Fumane	A2, A1	•	•	•	•
	Riparo Mochi (Mochi)	G	•	•	•	•
	Riparo Bombrini	A3, A2, A1	•	•	•	•
	Grotta di Castelcivita	rsa', gic, ars	•		•	
	Grotta della Cala	13,12,11,10	•		•	
	Grotta Paglicci (Paglicci)	24	•			

	Grotta di Serra Cicora A (Serra Cicora A)	B	•	•		
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181 2. Bone tools

182 2.1 The Late Mousterian

183 Bone tools are mainly represented by the so-called "retouchers", usually diaphysis fragments used
184 without any modification to retouch stone tools. Although bone fragments defined as retouchers
185 (Giacobini and Pathou-Matis, 2002) occurred previously (i.e., for instance, at Grotta de Nadale -
186 Jéquier et al., 2015- and Grotta Ghiacciaia - Bertola et al., 1999; Thun Hohenstein et al., 2018), they
187 are much more frequent during MIS3 at the end of the Mousterian, especially in northern sites
188 (Table 2). Grotta di Fumane (ex-Grotta Solinas) and Riparo Tagliente (Monti Lessini) have yielded
189 the most abundant evidence. In the very Late Mousterian of Fumane, most of the over 200 bone
190 retouchers were made on ungulate bones (mainly *Megaceros* sp.), and only occasionally on those of
191 bear and ibex (Jéquier et al., 2012 and 2018). Tibiae and femora were the preferred anatomical
192 portions, but metapodials, phalanxes and, exceptionally, canines were also used (Fig. 2).
193 Riparo Tagliente (Monti Lessini) (layers 37, 36, 35) has yielded a total of 75 bone retouchers
194 (Leonardi, 1979; Thun Hohenstein et al., 2018), of which 63 have a certain stratigraphic
195 provenance. Long bone diaphyses of red deer are the most exploited raw material, but aurochs/bison
196 and elk bones are also documented. In the lowermost layers, the exploitation of smaller-sized
197 animals such as roe deer and chamois for retouchers is recorded as well. Metapodials, tibiae,
198 humeri, radi and femora along with a phalanx and a rib were selected for retouchers. At Rio Secco
199 (Pradis Plateau) (layers 8, 7base/5, 5, 5 top), six retouchers on bone fragments from large mammals
200 (one of which probably an elk, and another four bear) were recovered (Peresani et al., 2014a and
201 Romandini et al., 2018). Three bone retouchers have been reported also at Grotta Maggiore di San
202 Bernardino (Colli Berici) (layer II) (Malerba and Giacobini, 1996).

203

204 In Southern Italy there is little evidence of bone retouchers as such implements were found only at
205 Grotta Reali (Molise) (layer 5) (Thun Hohenstein and Bertolini, 2012) and at Riparo L'Oscurusciuto
206 (Apulia) (layer 4). Two of the three retouchers found at Reali were obtained from long bone
207 diaphyses while the other was made on red deer metapodial. At the Oscurusciuto rockshelter, two
208 retouchers (unpublished) were obtained from large-sized ungulates. As the research stands now, it is
209 unclear why retouchers in southern sites should be so scarce. The frequent presence of concretions
210 on bones in most southern sites may be one potential reason why percussion traces are not easily
211 identifiable.

212

213 Exceptionally, a "hammer" made from a red deer antler was found at Grotta di Castelvita
214 (Campania) (layer lower rsi) (Gambassini, 1997), and a jaw fragment (probably of an auroch) with
215 striations has been recovered at Grotta Breuil (Latium) (layer 7) (Alhaique et al., 2006).

216 Furthermore, a retouched bone shaft was retrieved in the Late Mousterian layers of Grotta Fumane
 217 (dated to 45-44 ka cal BP) (Romandini et al., 2014a).

218
 219 Finally, some so-called "points" from Mousterian layers (Mussi, 1990) were found at Riparo Mochi,
 220 Grotta del Broion, Grotta Bernardini (Apulia) and Grotta di Serra Cicora (Apulia); however, no
 221 analytical data are available for these artefacts, so distinguishing whether anthropic or taphonomic
 222 agents were responsible for their modification remains an open question, and they are therefore
 223 excluded from further consideration here.

224
 225 **Table 2:** Taxonomical attribution of the retouchers recovered in Late Mousterian (<50ka) sites in
 226 Italy (compiled after: Malerba and Giacobini, 1996; Thun Hohenstein and Bertolini, 2012; Peresani
 227 et al., 2014a; Jéquier et al., 2018; Romandini et al., 2018; Thun Hohenstein et al., 2018).

228
 229

	Fumane	Tagliente	Rio Secco	S. Bernardino	Reali	Oscurusciuto	Total
<i>Ursus arctos</i>	1		4				5
<i>Ursus sp.</i>	1						1
<i>Cervus elaphus</i>	106	7			1		114
<i>Alces alces</i>	1	3					4
<i>Megaloceros giganteus</i>	13						13
Cervidae	25						25
<i>Bison priscus</i>	2						2
<i>Bos/Bison</i>	1	3					4
<i>Bos-or Equus.</i>						2	2
<i>Rupicapra rupicapra</i>	4	1					5
<i>Capra ibex</i>	2						2
<i>Capreolus capreolus</i>	3	1					4
Ungulata	1	48					49
Unid. big size			2		2		4
Unid.	87			3			90
Total	247	63	6	3	3	2	324

230
 231
 232

2.2 The Uluzzian

233 Uluzzian bone technology displays substantial changes with respect to the Late Mousterian,
 234 especially due to the emergence of formal tools. The technological process by which bone tools
 235 were produced appears to be part of a tradition shared by all Uluzzian groups in Italy, with the
 236 exception of those from Fumane (Tables 3 and 4). This process entails obtaining awls and
 237 cylindrical or conical elements, from specific anatomical parts, like metapodials of red deer and
 238 fibulae and metapodials of horse.

239 The Uluzzian deposits that have yielded the most bone tools are in Southern Italy. At Grotta del
 240 Cavallo (Apulia) (layers EIII, EII-I and D) eight specimens (Fig. 3, 1-8), mostly awls or
 241 fragmentary awls, were recovered (Palma di Cesnola, 1966; d'Errico et al., 2012b). Grotta di

Castelcivita (Campania) (layers upper rsi, rpi and rsa”) yielded six pieces: four awls (Fig. 3, 10,11, 14), a fragment of a point (Fig. 3, 12) and a double pointed element (Fig.3, 13), interpreted as a straight-hook (d’Errico et al., 2012b). A single awl (Fig. 3, 9) has been found at Grotta della Cala (d’Errico et al., 2012b) (layer 14), while a single specimen (Fig. 3, 15) is known from Central Italy, at Grotta La Fabbrica (Tuscany) (layer 2) (Pitti et al., 1976; Villa et al., 2018), which shows a coating of ochre at its base and other residue traces along its shaft. Villa et al. (2018) draw a parallel between this object and the ochred bone tools of the Still Bay phase from Blombos Cave (Henshilwood et al., 2001; Henshilwood, 2012).

According to d’Errico and colleagues (2012b), Uluzzian bone tools were produced using at least three different technique steps: regularizing by scraping the end of naturally pointed elements; modifying by scraping thin lengthened shaft fragments; and shaping elongated epidiaphyseal fragments by scraping. The same authors argue that these implements were utilized to perforate a range of materials from relatively hard, like thick leather at Cavallo and La Cala, to soft, like skin, furs and vegetal substances at Castelcivita. Additionally, a single bone splintered piece was also recovered at Grotta del Cavallo (Borgia et al., 2017).

In Northern Italy, Riparo Broion (layer 1g) has yielded four artefacts: two awls, a tip fragment of a pointed tool and a probable needle (Fig. 3, 16-19) The *ad hoc* exploitation of naturally pointed anatomical elements (like the distal end of the ulna, or even the natural pointed end of the vestigial metapodials) and their subsequent shaping by mean of a lithic tool is attested at least for two of these implements. The other tools, obtained from unidentified skeletal portions, were shaped by longitudinal scraping. *Lustre* aspects were identified on three pointed tools, nevertheless a specific functional study was not carried out (Peresani et al., 2019a).

The Uluzzian bone tool assemblage from Fumane (layer A3) includes a basal part of an awl (Fig. 3, 20) and a worked bone piece (Fig. 3, 21). Unlike the rest of the Uluzzian bone tools, the skeletal portions exploited at Fumane are exclusively ribs (Peresani et al., 2016). The awl was obtained by longitudinally incising and splitting a medium-large mammal bone and later shaping its distal active end by scraping. Use-wear analysis suggests this tool was used for perforating ochred leather (Peresani et al., 2016). The second worked object is made from the mid-lateral posterior rib portion of a medium-large mammal, with one side shaped by scraping with the aim to obtain a bevelled edge. At Fumane the use of bone retouchers (eight) is documented also during the Uluzzian (Jéquier et al., 2012).

Table 3: Archaeozoological classification of the Uluzzian bone tools recovered in Italy (compiled after: d’Errico et al., 2012b; Peresani et al., 2016; Villa et al., 2018; Peresani et al., 2019a).

	Broion	Fumane	La Fabbrica	Castelcivita	Cala	Cavallo
<i>E. ferus</i>	Metapodial		1	1		2
	Metatarsal					

	Fibula						1
<i>C. elaphus</i>	Metatarsal					1	2
Medium-large size mammals	Rib		2				
Unid.	Metatarsal						1
	Ulna/Telemetapodial		2				
	Unidentified		2		5		2
Total			4	2	1	6	1
							8

Table 4: Typological classification of the Uluzzian bone tools recovered in Italy (compiled after: d’Errico et al., 2012b; Peresani et al., 2016; Villa et al., 2018; Peresani et al., 2019a).

	Broion	Fumane	La Fabbbrica	Castelcivita	Cala	Cavallo
Awls	3	1	1	2	1	7
Needles						1
Unidentified pointed tools	1	1		4		
Total	4	2	1	6	1	8

2.3 The Protoaurignacian

The Protoaurignacian shows a marked regional difference, with northern Italy having yielded a richer and typologically diverse record of bone artefacts, whilst the record is poor in southern Italy (Table 5).

In northern Italy, Grotta Fumane stands out for its conspicuous assemblage (Bertola et al., 2013) recovered in the oldest Protoaurignacian complex (layers A2 and A1), composed of points (mainly awls), often showing fractured ends due to use (Fig. 4. 9-10). These pieces were mainly obtained from cervid diaphyses (but in some cases also ribs). Manufacture involved only the shaping of the active part, according to a process called *poinçon d’économie* (Camps-Fabrer, 1990). Use-wear analysis suggests their use for piercing. Some specimens, displaying a very thin (diameter less than 5 mm) and elongated tip, were probably used as needles. A split-based point (Fig. 4.8) has been retrieved at the interface between layers A1 (Protoaurignacian) and D3 (Aurignacian *sensu lato*) (Bertola et al., 2013). Furthermore, several bone retouchers (34) and some *lissoirs* (2) were found (Jéquier, 2014; Jéquier et al., 2018).

Bone tools from Riparo Bombrini (layers A3-A1) (Liguria) comprise eight mostly fragmentary artefacts (Bertola et al., 2013; Holt et al., 2018). These include pointed pieces, needle tips and awls (Fig. 4. 1-7). A bevelled tool obtained from cervid antler previously ascribed to the Protoaurignacian and coming from a disturbed area, has been dated to the Epigravettian (Holt et al., 2018). The points were made on blanks obtained by indirect percussion, then shaped by scraping.

307 The presence of specific traces (rounding, flattening and transversal striations on mesial and
308 proximal parts) on the base of a large pointed piece suggests that this tool was hafted.

309 Diaphyseal fragments obtained by direct percussion from long bones of large size ungulate were
310 used as blanks for the awls, which were later regularized on the distal part only, like the ones from
311 Fumane. The needles were obtained from elongated splinters that were carefully shaped by scraping
312 all over the surface. Use–wear analysis indicates their use on hide (Holt et al., 2018).

313 Riparo Mochi (layer G) (Liguria) yielded seven pointed artefacts, including probable awls and
314 needles (Kuhn and Stiner, 1992 and 1998). The presence of production by-products testifies to a
315 local manufacturing of these tools. Another two antler split-based points originally ascribed to the
316 Protoaurignacian (Kuhn and Stiner, 1992 and 1998), were recently reattributed to the Aurignacian
317 (layer F) rather than the Protoaurignacian following a recent reassessment of their stratigraphic
318 provenance (Tejero and Grimaldi, 2015).

319

320 Contrary to the north, bone implements are rare and scarcely diversified in Southern Italy, where
321 the Uluzzian rather than the Protoaurignacian returned the majority of these artefacts (Riel-
322 Salvatore and Negrino, 2009). Few Protoaurignacian specimens (Table 4) are documented at Grotta
323 di Castelcivita (an awl from a metapodial of roe deer) (layer gic) (Gambassini, 1997), Grotta della
324 Cala (four fragmentary bone points of which one is from a rib) (layers 13 and 12) (Benini et al.,
325 1997; Fig. 4.13-16) and Grotta Paglicci (an awl made on a shaft fragment of a medium-large
326 mammal) (layer 24) (Borgia et al., 2016; Fig. 4.12). A fragmented awl has been also recorded in the
327 so-called "Uluzzo-Aurignaziano" of Serra Cicora A (layer B) (Spennato, 1981; Palma di Cesnola,
328 1993).

329

330 **Table 5:** Protoaurignacian bone tool kits (compiled after: Spennato, 1981; Benini et al., 1997;
331 Gambassini, 1997; Kuhn and Stiner, 1998; Bertola et al., 2013; Jéquier, 2014; Tejero and Grimaldi,
332 2015; Borgia et al., 2016; Holt et al., 2018).

333

	Fumane	Mochi	Bombrini	Castelcivita	Cala	Paglicci	Serra Cicora A
Awls	23		4	1		1	1
Needles			2				
Unidentified pointed tools	19	7	1		3		
<i>Lissoirs</i>	2						
Bone retouchers	34						
Unidentified			1				
Total	74	7	8	1	3	1	1

334

335

336 3 Ornaments and other unusual objects

337 3.1 The Late Mousterian

338 The earliest evidence connected to symbolic behaviour can be found in the Late Mousterian. The
339 exploitation of animal resources for ornamental purposes has been reported in the North, where
340 eagle claws and raptor bones with cut-marks (Fig. 5), indicating the intentional removals of the
341 claws themselves and of the flight (remex) feathers, were found at the caves of Rio Secco
342 (Romandini et al., 2014b) and Fumane (layers A9, A5 and A6) (Peresani et al., 2011). Both the
343 claws and the feathers have been interpreted by the authors as ornamental items. Layer A9 of
344 Fumane, dated to 47.6 cal ka BP (minimum age), also yielded the only Italian Mousterian shell
345 (Fig.5) interpreted as an exotic object, coloured with red ochre and suspended by a “thread” for
346 visual display as a pendant (Peresani et al., 2013). This is a fossil *Aspa marginata* marine shell,
347 probably collected in Miocene or Pliocene fossil outcrops located, at least, about one hundred
348 kilometres south of the site.

350 To this, we can add a number of engraved bones and stones bearing linear signs. This is the case of
351 several objects retrieved at Riparo Tagliente, Grotta S. Bernardino, Grotta di Fumane in Veneto
352 which were described in old publications (Leonardi, 1975, 1980, 1981, 1983, 1988). Despite their
353 unquestionably anthropogenic origin, there is no evidence that these engravings had any symbolic
354 function (Peresani et al., 2014b). At Grotta Costantini (Liguria), a horse rib showing three groups of
355 linear marks (Bachechi, 2001) has been reported as coming from the top of the Mousterian but it
356 more likely is an intrusive Upper Palaeolithic artefact. In Central Italy, osseous objects with linear
357 incisions are present in the Middle Palaeolithic contexts of Grotta di Gosto (Tuscany) (Tozzi, 1974
358 but see Moroni et al., 2019 for doubts on the chronology of this site) and Valle Radice (Latium)
359 (Biddittu et al., 1967). In Southern Italy, Grotta del Cavallo (Martini et al., 2004) and Grotta
360 dell'Alto (Borzatti von Löwestern and Magaldi, 1967) yielded four and two stones bearing incisions
361 respectively, though again, a symbolic function for these remains has to be demonstrated.

363 Furthermore, several small ochre fragments have been recovered at Bombrini (MS levels), but
364 given their association with concentration of faunal remains, we cannot rule some kind of functional
365 as opposed to ritual/symbolic use for pigments (Riel-Salvatore et al., 2013).

367 3.2 The Uluzzian

369 In the Uluzzian the use of ornaments becomes systematic, thus revealing the emergence of a well-
370 established decorative tradition. The use of shell beads, usually from tusk species (*Antalis* sp.), for
371 ornamental purposes is common in Uluzzian sites (Table 6). Grotta del Cavallo yielded the largest
372 ornamental assemblage (a few hundred), composed mainly of tusk shells, from the whole Uluzzian
373 sequence (Fig. 6, 19-30) (layers EIII, EII-I, DII and DI). Gastropods are fewer in number and
374 overall occur in the final phase (Palma di Cesnola, 1993) (Fig. 6, 17-18). Some fragmentary
375 bivalves are also recorded. 78 marine shells along with a coral branch were found in the Uluzzian
376 layer of Grotta della Cala (layer 14) (Ronchitelli et al., 2009), 24 of which were scaphopods and
377 eight were perforated (six gastropods and two *Glycymeris nummaria* - syn. *G. insubrica*) (Fiocchi,
378 1998; Ronchitelli et al., 2009) (Fig. 6, 7-16). Several marine shells (gastropods and bivalves) are
379 also documented in the Uluzzian of Castelcivita (layer rsa”), but none of them show any kind of

perforation (Gambassini, 1997). In the north, Riparo Broion (layers 1g and 1f) yielded five worn tusk beads and a pierced freshwater gastropod (*Theodoxus danubialis*) (Peresani et al., 2019a) (Fig. 6,1-6). Furthermore, this site has yielded a splintered flake with linear engravings on the cortical back (Peresani et al., 2019a), but the symbolic value of this evidence remains to be clarified. Engraved cortexes are documented since the Lower Palaeolithic, but their occurrence can be the result of varied utilitarian and/or non-utilitarian activities (Majkić et al., 2018a).

Colouring materials (lumps of ochre and limonite) were recovered at Grotta del Cavallo, Grotta Mario Bernardini (Palma di Cesnola, 1989) and Castelcivita (Gambassini, 1997). Some oxidized glomeruli were found at Grotta della Cala (Ronchitelli et al., 2009). Traces of ochre have been identified on two tusk beads from Riparo Broion (Peresani et al., 2019a) and on several stone tools from the whole Uluzzian package of Grotta del Cavallo (Moroni et al., 2018)

Table 6: Marine and freshwater shells (•) and shell beads (x) from Uluzzian sites (compiled after: Palma di Cesnola, 1993; Fiocchi, 1998; Ronchitelli et al., 2009, Peresani et al., 2019a). Classification and nomenclature used for molluscs is based on the systematics index of S.I.M. - Società Italiana di Malacologia (www.societaitalianadimalacologia.it) and WoRMS - World Register of Marine Species (www.marinespecies.org). * The revision of the ornamental shell assemblages from Grotta del Cavallo and Grotta della Cala is currently ongoing, therefore data presented here are based on previous publications.

Class	Family	Species	Cavallo*	Cala*	Broion	Total
Gastropoda	Unidentified			•		
	Archeogastropoda unidentified			•		
	Halitidae	<i>Halotis tuberculata lamellosa</i>		•		
	Trochidae	<i>Clanculus</i> sp.		•		
	Coloniidae	<i>Homalopoma sanguineum</i>		• x		
	Cerithiidae	Unidentified genus		•		
	Triviidae	<i>Trivia mediterranea</i> (syn: <i>T. pulex</i>)		•		
		<i>Trivia</i> sp.		•		
		cf. Naticidae Unidentified genus		•		
	Cassidae	<i>Galeodea echinophora</i>		•		
		cf. <i>Galeodea</i> sp.		•		
	Ceritithiopsidae	Unidentified genus		•		
	Nassaridae	<i>Tritia incrassata</i> (syn: <i>Nassarius incrassatus</i>)		•		
		<i>Tritia neritea</i> (syn: <i>Cyclope neritea</i>)	• x			
		<i>Tritia pellucida</i> (syn: <i>Cyclope pellucida</i>)		• x		

	Columbellidae	<i>Columbella rustica</i>	• x		
	Neritidae (Freshwater)	<i>Theodoxus danubialis</i>		• x	
	Unidentified			•	
	Glycymerididae	<i>Glycymeris nummaria</i> (syn: <i>G. insubrica</i>)		•	
Bivalvia	Pectinidae	Pectinidae sp. Gen. unidentified		•	
		<i>Pecten jacobaeus</i>		•	
	Veneridae	Veneridae unidentified (cfr. <i>Callista chione</i>)		•	
		<i>Callista chione</i>		•	
	Dentaliidae	<i>Antalis</i> <i>dentalis/inaequicostata</i>	• x	• x	• x
Scaphopoda		<i>Antalis vulgaris</i>	• x	• x	• x
		<i>Antalis</i> cfr. <i>vulgaris</i>		• x	
		<i>Antalis</i> sp.		• x	
	Fustiariidae	<i>Fustiaria rubescens</i>		• x	
	Unidentified			•	

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3.3 The Protoaurignacian

405 The Protoaurignacian is characterized by a wider range of personal adornments, mainly consisting
406 of marine shell beads (Tables 7 and 8). Compared to the Uluzzian, the number of recovered beads
407 increases markedly, as does the number of sites where they have been found (Riparo Mochi - layer
408 G-, Riparo Bombrini - layer A3-A1, Grotta di Fumane - layers A2 and A1-, Grotta della Cala -
409 layers 13-10 - and Grotta di Castelcivita - layers rsa", gic and ars) (Fig.7). Concerning Riparo
410 Mochi, it should to be stressed that the stratigraphic reassessment which involved bone tools and
411 non-shell ornaments, until now has not been extended to shell beads. Hence, the data here reported
412 for this site are based on available published reports.

413

414 Ornamental species mostly include gastropods (e.g. *Tritia* sp. and other Nassaridae, *Homalopoma*
415 *sanguineum* and Trochidae) and to a lesser extent, bivalves (e.g. *Glycymeris nummaria* and other
416 Glycymerididae). Tusk specimens are generally very rare. Shell assemblages from coastal sites
417 (Mochi, Bombrini, Cala) do not show any selective preference for particular species (Fiocchi,
418 1998), however a remarkable presence of *H. sanguineum* can be noted. At Fumane, which during
419 the Protoaurignacian was located about 200 km from the Tyrrhenian coast and 400 km from the
420 Adriatic one, there was, on the contrary, a selection in favour of externally red-coloured species:
421 *Homalopoma sanguineum*, *Clanculus corallinus* and *Clanculus cruciatus* (Peresani et al., 2019b).
422 Some authors have suggested an Adriatic provenance of these shells (Bertola et al., 2013). The taxa
423 spectrum of the ornamental shells of Fumane shows analogies with the Ligurian sites, supporting

evidence for contacts between the two areas. Furthermore, the use of fossilized belemnite fragments to produce pendants is documented at Bombrini (Bertola et al., 2013; Holt et al., 2018).

Interestingly, only seashells seem to have been used as ornaments in southern Italy, whereas, in the North, beads include examples made on hard animal tissue and stone. Teeth pendants have been recovered at Grotta di Fumane and stone ornaments occur at Bombrini (Fig. 7), where drilled and scraped soapstone beads have been recovered (Bertola et al., 2013; Holt et al., 2018). The provenance of the soapstone collected at Bombrini is almost certainly from the Apennine chain between Liguria and Emilia (Gernone and Maggi, 1998; Chella, 2002; Negrino et al., 2017; Holt et al., 2018). At Bombrini have been retrieved also bone pendants. They consist of three incised bird bone diaphysis resembling other Early Upper Palaeolithic bird bone tubular beads (Zilhão, 2007; Wright et al., 2014; White and Normand, 2015).

The non-shell ornaments from Mochi – three beads made on soapstone, resembling *craches* of red deer, two pendants made on fossil belemnite, an ivory basket-shaped bead and two teeth pendants – previously ascribed to the Protoaurignacian, have been recently attributed to the Early Aurignacian of Layer F (Tejero and Grimaldi, 2015).

Further evidence for non-utilitarian artefacts is extremely scant in the Protoaurignacian, where it is limited to northern Italy. This consists of notch and incision patterns on bones from Riparo Bombrini (the above-mentioned tubular beads), Riparo Mochi and Grotta di Fumane (Fig.7). Despite these patterns are very schematic and linear, a symbolic value could be assigned to this evidence, as the engraved motifs are arranged in a clear decorative way and their occurrence does not appear related to any functional activity. Ochre is well documented in the northern sites (Kuhn and Stiner, 1998; Bietti and Negrino, 2008; Cavallo et al., 2017) with evidence of heat treatment at Fumane (Cavallo et al., 2018).

Table 7: Presence of non-utilitarian items in Protoaurignacian sites of Italy.

	Fumane	Bombrini	Mochi	Castelcivita	Cala	Serra Cicora A
Shell ornaments	•	•	•	•	•	
Fossil shells (belemnite)		•				
Bone ornaments	•	•				
Stone ornaments		•				
Pigments	•	•	•			•
Incised objects	•	•	•			

Table 8: Marine and freshwater shells (•) and shell beads (x) found in the Protoaurignacian layers of Italian sites (Modified after Bertola et al., 2013; compiled after: Barge, 1983; Gambassini, 1997;

458 Fiocchi, 1998; Kuhn and Stiner, 1998; Stiner, 1999; Holt et al., 2018, Peresani et al., 2019b).
 459 Classification and nomenclature used for molluscs is based on the systematics index of S.I.M. –
 460 Società Italiana di Malacologia (www.societaitalianadimalacologia.it) and WoRMS - World
 461 Register of Marine Species (www.marinespecies.org).
 462
 463
 464

Class	Family	Species	Fumane	Bombrini	Mochi	Cala	Castelcivita
Gastropoda	Patellidae	<i>Patella</i> cfr. <i>ulyssiponensis</i>	•				
	Fissurellidae	<i>Fissurella</i> sp.			•		
	Haliotidae	<i>Haliotis tuberculata lamellosa</i>			•	•	
	Trochidae	<i>Gibbula albida</i>				•	
		<i>Gibbula ardens</i>				•	
		<i>Gibbula turbinoides</i>	•				
		<i>Gibbula</i> sp.	•		• x	•	
		<i>Steromphala adansonii</i> (syn: <i>Gibbula adansonii</i>)	•	•x		•	
		<i>Steromphala varia</i>	•x				
		<i>Jujubinus striatus</i>				•	
		<i>Jujubinus</i> sp.	• x		•	•	
		<i>Phorcus articulatus</i> (syn: <i>Osilinus articulatus</i>)	• x	•		•	
		<i>Phorcus richardi</i> (syn: <i>Gibbula richardi</i>)	• x				
		<i>Phorcus turbinatus</i> (syn: <i>Osilinus turbinatus</i>)				•	
		<i>Phorcus</i> sp.				•	
		<i>Clanculus corallinus</i>	• x			• x	
		<i>Clanculus cruciatus</i>	•	• x		•	
		<i>Clanculus jussieui</i>	• x	•		•	
		<i>Clanculus</i> sp.	•	•	• x	•	
		Unidentified genus	•	•	•	•	
	Turbinidae	<i>Bolma rugosa</i>			•	•	
	Coloniidae	<i>Homalopoma sanguineum</i>	• x	• x	• x	• x	• x
	Phasianellidae	<i>Tricolia pullus</i>	•			•	
		<i>Tricolia speciosa</i>				•	
	Cerithiidae	<i>Bittium latreillii</i>	•				
		<i>Bittium reticulatum</i>	•			•	
		<i>Cerithium vulgatum</i>	•			•	
		<i>Cerithium</i> sp.			• x	•	•
	Cerithiopsidae	<i>Cerithiopsis</i> sp.	•				
	Turritellidae	<i>Turritella communis</i>	• x	•x			
		<i>Turritella</i> sp.			•		
	Littorinidae	<i>Littorina obtusata</i>	•				
		<i>Littorina saxatilis</i>	• x				
		<i>Littorina</i> sp.			• x		
		<i>Melaraphe neritoides</i> (syn: <i>Littorina neritoides</i>)					•
	Rissoidae	<i>Rissoa variabilis</i>	•				

	<i>Rissoa</i> sp.	•			
Aporrhaidae	<i>Aporrhais pespelecani</i>		•	•	
Triviidae	<i>Trivia arctica</i>	• x	•		•
	<i>Trivia mediterranea</i> (syn: <i>T. pulex</i>)				• x
	<i>Trivia</i> sp.		• x	• x	•
Cypraeidae	<i>Luria lurida</i>	•			
	<i>Luria</i> sp.	•		•	
Naticidae	<i>Euspira macilenta</i>	• x			
	<i>Naticarius hebraeus</i> (syn: <i>Natica hebraea</i>)				•
	<i>Euspira intricata</i>		• x		
	<i>Euspira</i> sp.	• x			
	Unidentified genus	•		•	•
Cassidae	<i>Semicassis saburon</i> (syn: <i>Phalium saburon</i>)				•
Muricidae	<i>Ocenebra edwardsii</i>	• x	• x	• x	
	<i>Ocenebrina</i> sp.	•			
	Unidentified genus	•			
Mitridae	<i>Episcomitra cornicula</i> (syn: <i>Mitra cornicula</i>)	• x			•
	Unidentified genus				•
Buccinidae	<i>Aplus</i> sp.	•			
	Unidentified genus	•			
Pisaniidae	<i>Gemophos viverratoides</i> (syn: <i>Polia viverratoides</i>)				•
	<i>Nassarius circumcinctus</i>	• x	•		•
	<i>Tritia corniculum</i> (syn: <i>Nassarius corniculum</i>)	• x			
Nassaridae	<i>Nassarius gibbosulus</i>		• x		
	<i>Tritia cuvierii</i> (syn: <i>Nassarius costulatus cuvierii</i>)				•
	<i>Tritia incrassata</i> (syn: <i>Nassarius incrassatus</i>)	• x	• x		• x
	<i>Tritia mutabilis</i> (syn: <i>Nassarius mutabilis</i>)	• x		•	• x
	<i>Tritia neritea</i> (syn: <i>Cyclope neritea</i>)	• x	• x		• x
	<i>Tritia nitida</i> (syn: <i>Nassarius nitidus</i>)		• x		
	<i>Tritia pellucida</i> (syn: <i>Tritia pellucida</i>)	• x	• x		• x
	<i>Tritia reticulata</i> (syn: <i>Nassarius reticulatus</i>)	• x	•		
	<i>Tritia</i> sp. (syn: <i>Cyclope</i> sp.)	• x	•	• x	•
	<i>Nassarius</i> sp.			• x	•
Columbellidae	<i>Columbella rustica</i>		• x		•
	<i>Mitrella gervilii</i>				•
	<i>Mitrella scripta</i>			• x	
Cancellariidae	<i>Bivetiella cancellata</i> (syn: <i>Cancellaria cancellata</i>)		•		

Bivalvia	Conidae	<i>Conus ventricosus</i> (syn: <i>C. mediterraneus</i>)		• x	• x
	Neritidae (Freshwater)	<i>Theodoxus</i> cfr. <i>danubialis</i>	•		
	Unidentified		•		•
	Noetidae	<i>Striarca lactea</i>			•
	Glycymerididae	<i>Glycymeris glycymeris</i>	•		• x
		<i>Glycymeris nummaria</i> (syn: <i>G. insubrica</i> / <i>G. violacescens</i>)	• x		• x
		<i>Glycymeris</i> sp.	•		•
		<i>Mytilus galloprovincialis</i>	•		
		<i>Mytilus</i> sp.			•
	Ostreidae	Unidentified genus	•		
	Pectinidae	<i>Pecten jacobaeus</i>			•
		<i>Chlamys</i> sp.		• x	
		Unidentified genus			•
	Cardiidae	<i>Acanthocardia tuberculata</i>			•
		<i>Cerastoderma glaucum</i>	• x		•
		<i>Cerastoderma</i> cfr. <i>edule</i>	•		
		<i>Cerastoderma</i> sp.	•		
		<i>Papillicardium papillosum</i>	•		
		Unidentified genus			•
	Veneridae	<i>Callista chione</i>			•
	Unidentified				•
Scaphopoda	Dentaliidae	<i>Antalis inaequicostatum</i>	• x	• x	• x
	Fustiariidae	<i>Fustiaria rubescens</i>			• x

465

466

467 4. Discussion

468 4.1 Bone artefacts

469

470 4.1.1 The Italian record

471

472 In the Mousterian world, bone was, indeed, an optional raw material that was opportunistically used
473 for tools that do not result from a planned sequence of actions. These tools mainly consist of
474 unmodified long bone fragments of medium or large ungulates (occasionally bear) used as
475 retouchers (Malerba and Giacobini, 1996; Jéquier et al., 2012; Thun Hohenstein and Bertolini,
476 2012; Peresani et al., 2014a; Jéquier et al., 2016; Jéquier et al., 2018; Romandini et al., 2018; Thun
477 Hohenstein et al., 2018). It is reasonable to expect that bones were primarily broken to extract the
478 marrow for food purpose, rather than to obtain blanks from which to produce tools (Boscato and
479 Crezzini, 2006 and 2012).

480

481 Specific studies on the function of Middle Palaeolithic retouchers have demonstrated their main use
482 in sharpening, blunting, shaping, and crushing cutting-edges of stone tools (Siret, 1925; Vincent,
483 1993; Armand and Delagnes, 1998; Daujeat et al., 2014), thus confirming the “retoucher”
484 nomenclature. Nevertheless, their use in other stages of the lithic production (therefore described as

hammers or anvils) is also documented by specific experimental tests (Armand and Delagnes, 1998; Rigaud, 2007; Daujeard et al., 2014; David and Pelegrin, 2009).

The longevity of bone retouchers as an artefact class, which are documented well before MIS 3 (Bertola et al., 1999; Jéquier et al., 2015; Thun Hohenstein et al., 2018), attests to a continuity of this technological tradition over several tens of millennia which extends into the Early Upper Palaeolithic based on the Fumane sequence, where similar items have been recovered in the Protoaurignacian assemblages (Jéquier et al., 2018).

The situation changes dramatically with the Uluzzian technocomplex, where different sites have yielded awls and cylinder-conical elements. Both are typical formal tools, namely functionally-specific implements (usually for piercing soft materials) within the site economy. Even if the technical scheme used to manufacture these tools remained relatively simple, the whole multi-step procedure involved in their production implies a distinct investment in time and energy for the selection and processing (i.e. disarticulating and defleshing) of suitable anatomical parts (whatever they were) from specific taxa. This selection of specific anatomical parts to be used as blanks is a fundamental step in the *chaîne opératoire*, and is indeed more challenging than the production of bone blanks by other methods (e.g., percussion).

The Protoaurignacian bone technology aligns itself substantively in continuity with that of the Uluzzian except, perhaps, as concerns the selected skeletal portions. In most cases, and notably at Fumane, the bone tools in Protoaurignacian contexts imply manufacturing strategies mainly aimed at shaping an active part from bone fragments. At Riparo Bombrini, there is evidence that blanks were produced through both indirect and direct percussion. Although Protoaurignacian implements are typologically more variable (also including points and needles), we cannot identify a genuine break between the bone industry of this techno-complex and that of the Uluzzian. The occurrence of a real distinction, marked by significant innovations in bone technology and typology, has been postulated by some authors for the Early Aurignacian, when the use of antler is introduced, and bone is also used to produce hunting weapons like split-based points (Tejero, 2014; Tejero and Grimaldi, 2015). Conversely, bone tool manufacturing has been interpreted as a subsistence activity probably related to activities others than hunting, both in the Uluzzian and in the Protoaurignacian (d’Errico et al., 2012b; Bertola et al., 2013; Peresani et al., 2016). Despite this functional homogeneity, we note that the northern Protoaurignacian displays a preference for blanks from generic diaphyseal parts, in contrast to the Uluzzian which is usually more selective and oriented to exploit specific anatomical portions. In the south the near absence of bone tools in Protoaurignacian contexts (with rare tools from Grotta di Castelcivita, Grotta della Cala, Paglicci and Serra Cicora) does not allow us to discuss possible differences with the Uluzzian.

4.1.2 The European framework

As attested in Italy, in the rest of Europe, Middle Palaeolithic bone tools are mainly retouchers, and their use has been ascertained since the Lower Palaeolithic (Blasco et al., 2013; Serangeli et al., 2015; van Kolfschoten et al., 2015; Moigne et al., 2016). Likewise, they are usually made on ungulate bone fragments, or occasionally bones of other taxa, including humans (Verna and d’Errico, 2011; Daujeard et al., 2014; Rougier et al., 2016).

During the Middle Palaeolithic Neandertals also produced rare bone scrapers and denticulates (see for example Hahn, 1976; Tromnau, 1983; Freund, 1987; Hardy et al., 2014), and shell scrapers

530 (Douka and Spinapolice, 2012; Romagnoli et al., 2014; Romagnoli et al., 2016). However,
531 techniques used in the making of these implements appear to largely have been transposed *en bloc*
532 from stone working and were not conceived specifically for these kinds of raw materials.
533

534 The occurrence of formal bone tools in the Mousterian is a matter of debate since decades (Villa
535 and d'Errico, 2001). However recent excavations in two Mousterian of Acheulian Tradition sites,
536 Pech-de-l'Azé I and Abri Peyrony (Soressi et al., 2013), have brought to light four smoothers (or
537 *lissoirs*) intentionally shaped by polishing. This has generated renewed interest on this topic. The
538 discovery of these objects, although representing an exception in the repetitive world of Mousterian
539 retouchers, indicates that the use of a technology like polishing in bone processing was not foreign
540 to Neandertals. Further confirmation of this is provided by the description of what may be basic
541 shaping or preparation for some bone tools from the Lower Palaeolithic site of Schöningen (Julien
542 et al., 2015).
543

544 As documented in the Italian Uluzzian, also in the other European transitional technocomplexes
545 formal bone tools are attested, even if their presence in some cases is debated. The most abundant
546 evidence of osseous tool production is claimed at the Châtelperronian site of Grotte du Renne. More
547 than 100 items, including projectile points, awls, pins, "burnishing tools," ivory baguettes, and by-
548 products of bone and ivory manufacturing have been ascribed to the Châtelperronian layers of the
549 cave (d'Errico et al., 1998). Unfortunately, the integrity of the stratigraphic sequence of the site is
550 very controversial and it does not allow to understand the role of such implements in this
551 technocomplex. A part of bone tools from Grotte du Renne, as well as a part of ornaments, have
552 been claimed to be an intrusion from the overlying Aurignacian layers, on the basis of the
553 homogeneity between the Châtelperronian and the Aurignacian remains (White, 2001). In addition,
554 a series of dates on human-modified bone and antler materials from layers V to XII
555 (Gravettian/Mousterian) suggests a mixing of the materials (Higham et al., 2010).

556 The validity of the stratigraphic sequence of Grotte du Renne has been instead stressed by other
557 authors (Caron et al., 2011; Hublin et al., 2012), that after a re-assessment of the distribution of the
558 archaeological findings by means of statistical analyses and new radiocarbon dating affirm that any
559 disturbance affects the site and the incoherent dates are due to an incomplete cleaning of the
560 samples used.
561

562 The great abundance of bone tools from Grotte du Renne stands out if compared with the paucity of
563 comparable materials in other Châtelperronian assemblages. Some awls and ornaments have been
564 claimed at the site of Quinçay (d'Errico et al., 2003), but these items have never been published.
565

566 The presence of bone tools in transitional assemblages of Central Europe is troubled. Only one bone
567 point from Ranis 2 was probably retrieved in Lincombian-Ranisian-Jermanowician (LRJ) techno-
568 complex, but it has been lost (Flas, 2007). Other possible bone tools have been claimed in other
569 LRJ sites, but their stratigraphic provenance is uncertain (Flas, 2007). Furthermore, some Szletian
570 sites yielded bone points, but probably from layers mixed with Aurignacian materials (Svoboda,
571 2001).

572 The systematic and sometimes abundant production of bone tools that has been reported from
573 several Protoaurignacian sites all over Europe (mainly from France and Spain), like Trou de la mère
574 Clochette, Grotte du Renne and Isturitz (Julien et al., 2002; Soulier et al., 2014; Tartar, 2015), can
575 be compared with the sites of Northern Italy. The sporadic presence in Protoaurignacian
576 assemblages such as those from Trou de la mère Clochette and Arbreda of split-based points
577 characteristic of the Aurignacian (Ortega Cobos et al., 2005; Tartar, 2015), has been interpreted by
578 some authors as being symptomatic of a gradual process leading from the Protoaurignacian to the
579 Aurignacian (Teyssandier and Liolios, 2008; Tartar, 2015).

580 .

581

582 4.2 *Ornaments and other non-utilitarian evidence*

583

584 4.2.1 The Italian record

585 The Late Mousterian provides only sporadic evidence of activities which do not seem directly
586 related to subsistence needs. They are documented only in two northern sites (Fumane and Rio
587 Secco) and attest the use of raptor claws, feathers and a shell for ornamental purpose (Peresani et
588 al., 2011; Peresani et al., 2013; Romandini et al., 2014b). The presence of some engraved bones or
589 stones in different Mousterian sites is not enough to assign them a symbolic or non-utilitarian value
590 (Peresani et al., 2014b).

591

592 In contrast, potential symbolic artefacts are well documented in Italy in the Uluzzian
593 technocomplex that has yielded, mainly as ornaments. These mostly consist of tusk shells and are
594 distributed from northern to southern Italy and even as far as Greece (Stiner, 2010), attesting to
595 possible close cultural affinities among groups even over long distances. This pattern probably
596 stems from a common origin or a sustained social interaction (or both) among makers of the
597 Uluzzian. In other words, early MHs who arrived in Italy and in the Balkans had common
598 technological and cultural traditions (see also Marciani et al., in this special issue) and were able to
599 widely diffuse this identity. In this light tusk shells could play the role of a cultural and social
600 marker, similarly to other kinds of body modifications (tattoos, scarifications, piercings, lip and
601 neck stretching etc. for which at this point there is no evidence). It is thus conceivable that their use
602 was directly tied to the mental model the individual and the group used to represent themselves vs
603 other individuals and/or groups (Boyd and Richerson, 1987; Newell et al., 1990; Nettle and Dunbar,
604 1997; McElreath et al., 2003; Vanhaeren and d'Errico, 2006; Kuhn 2014).

605

606 The uniqueness of tusk shell phenomenon is underlined by the absence of this kind of ornaments in
607 the IUP assemblages in general (Stiner et al., 2002; Campbell, 2017). Among the transitional
608 techno-complexes, the occurrence of tusk shells in the Châtelperronian of Saint Césaire (d'Errico et
609 al., 1998), is, so far, a singular exception.

610

611 The presence of colouring substances is documented in some Uluzzian sites, even with decorative
612 purposes as shown by the ochred tusk beads from Riparo Broion (Peresani et al., 2019a). This site
613 has also yielded a schematically engraved stone, that is the only evidence of this kind in the
614 Uluzzian.

615

616 In the Protoaurignacian there is a vast assortment of ornamental taxa (mostly small size gastropods)
617 in the composition of personal adornments that stands in evident contrast with respect to the
618 Uluzzian. A significant role is played by *Homalopoma sanguineum*, possibly for its typical red
619 colouration. A preference towards shells with red or yellow colourations has been noted for the
620 Upper Palaeolithic in general, maybe because these colours had a peculiar symbolic significance or
621 high visibility (Álvarez-Fernández, 2006). Concomitantly, the utilisation of tusk shells notably
622 decreases since only a few specimens are recorded in Italian and European sites (Ficocchi, 1998;
623 Zilhão, 2007; Bertola et al., 2013; Peresani et al., 2019b). This diversity between the Uluzzian and
624 the Protoaurignacian ornamental suite could be traced back to their distinct ethnic identities, which
625 could suggest different origins for these two technocomplexes. The geographical distribution
626 displayed by Protoaurignacian ornaments seems to mirror the pattern shown by bone implements, in
627 that both are very well documented and quite diverse in northern sites, where bone and stone
628 pendants are also recorded, unlike the southern ornament assemblages, which are usually very poor
629 and composed only by shells.

630

631

632

633 4.2.2 The European framework

634 Probable evidence of non-utilitarian activities, such as the occurrence of unusual objects most likely
635 intentionally collected by hominids, has been recognized in Europe since the Lower Palaeolithic. It
636 is difficult to evaluate the meaning of such collecting, but hominins' curiosity for unfamiliar and
637 bizarre objects may have played an important role (Leroi-Gourhan, 1961 and 1964). In Europe the
638 earliest records interpreted as possible "symbolic" evidence are the grooved bones from
639 Bilzingsleben (Germany) dated to 350-220,000 years ago (Mania and Mania, 1988). Engraved
640 stones and bones have been found in Europe both in Lower and Middle Palaeolithic sites (see
641 Majkić et al., 2018a and 2018b and references therein). Some Authors (Marshack, 1976; Bednarik,
642 1995; Bahn, 1996) have interpreted these objects as non-utilitarian expressions by Neandertals or
643 Pre-Neandertal hominids, whereas other scholars suggest a more prosaic function, at least for some
644 of them, assuming that they might be related to butchering practices, or even to carnivore activities
645 or other taphonomic phenomena (Bordes, 1969; Raynal, Séguy, 1986; Crémades, 1996; Wolpoff,
646 1996; d'Errico and Villa, 1997; Majkić et al., 2017). Pigments are also frequently recorded in
647 Middle Palaeolithic sites (as for example Pech-de l'Azé I) (Soressi and d'Errico, 2007); however,
648 their exploitation for non-subsistence activities has been questioned both in South African Middle
649 Stone age and in European Mousterian (Wadley, 2003 and 2005; Roebroeks et al., 2012; Dayet et
650 al., 2015; Heyes et al., 2016; Dayet et al., 2019).

651

652 During the Late Mousterian, objects interpreted as non-utilitarian are more frequent, even if they are
653 not systematic and widespread. Some of these mirror the Italian evidence, such as the use of raptor
654 claws as ornaments documented in France (Morin and Laroulandie, 2012) and in Croatia (here
655 dated to 130 ka BP) (Radović et al., 2015) or the probable use of naturally pierced bivalves as
656 ornaments and the use of pigments documented in two Mousterian sites in Spain, Cueva Antón and
657 Cueva de los Aviones (Zilhão et al., 2010) recently re-dated to 120-115 ka (Hoffmann et al., 2018a).

658

659 The Late Mousterian offers also other potential evidence of non-utilitarian artefacts. Bones showing
660 notches and incisions are documented in Europe, as, for example, a schematically engraved bone

661 found in the Final Mousterian layer of Bacho Kiro (Bulgaria) (Kozlowsky, 1982), a raven bone with
662 notches retrieved in the Micoquian layer of Zaskalnaya VI (Crimea) (Tsvelykh et al., 2014; Majkić
663 et al., 2017) and a hyena femur with a set of incisions and a cave bear cervical vertebra showing
664 subparallel marks respectively recovered in the Mousterian sites of Les Pradelles (France) (d’Errico
665 et al., 2018) and Pešturina Cave (Serbia) (Majkić et al., 2018b). Furthermore, some cave paintings
666 in Spain (La Pasiega, Maltravieso, Ardales) have been re-dated to between 65-47 ka (Hoffmann et
667 al., 2018b; Slimak et al., 2018; but cf. Pearce and Bonneau, 2018) possibly assigning them to
668 Neandertals like the deeply engraved lines in a cross-hatched pattern on the bedrock of Gorham’s
669 Cave at Gibraltar (Rodríguez-Vidal et al., 2014).

670 European transitional technocomplexes exhibit evidence of symbolic behaviour, mostly composed
671 by bone and teeth pendants, unlike the Uluzzian that is only associated with shell beads. The
672 Châtelperronian, for instance, has yielded ornaments, mostly perforated bones and pierced teeth
673 (Taborin, 1993; Granger and Lévêque, 1997; d’Errico et al., 1998; Zilhão, 2007; Caron et al.,
674 2011). Once again, the debate involving Grotte du Renne (which has yielded the most substantial
675 assemblage of ornaments) and the questioned stratigraphic integrity of some sites and/or cultural
676 attribution of some findings (e.g. Grotte des Fées and Roche au Loup) do not allow us to reconstruct
677 an effective scenario to evaluate the real extent of this phenomenon in the Châtelperronian (Rigaud
678 2001; White, 2001; Mellars et al., 2007; Zilhão et al., 2007; Riel-Salvatore et al., 2008; Higham et
679 al., 2010 and 2011; Caron et al., 2011; Hublin et al., 2012;). Further evidence of possible symbolic
680 behaviour could be the engraved motifs adorning some bone implements from Grotte du Renne
681 (d’Errico et al., 1998), but, as said above, the reliability of this evidence is affected by the
682 stratigraphic issues of the site. Nevertheless, colouring substances were frequently used in order to
683 obtain pigment powder at several Châtelperronian sites (Dayet et al., 2014).

684
685 In Central Europe, Early Upper Palaeolithic ornaments are curiously uncommon and limited to just
686 a few cases, among which a bone pendant and two pierced teeth retrieved at Bacho Kiro (Bulgaria)
687 (Kozlowski, 1982), a perforated fossil gastropod from Willendorf II (Austria) (Felgenhauer, 1956-
688 1959; Hahn, 1993), and an ivory disc with a central hole, maybe a pendant, found at Ilsehöhle
689 (Germany) (Hülle, 1977).

690 As in Italy, ornaments, as well as other records of non-utilitarian activity, are common in the
691 Protoaurignacian. In France and Spain, several sites have yielded shell ornaments, notably La
692 Laouza (Taborin, 1993), Isturitz (Normand and Turq, 2005), L’Arbreda (Maroto et al., 1996; Soler
693 Sublis et al., 2008) and Rothschild (where fossil shells were also used; Taborin, 1993; Sacchi, 1996;
694 Bon, 2002). The preference for basket-shaped beads is considered a distinctive feature of both the
695 Protoaurignacian and the Aurignacian technocomplexes (Taborin, 1993; Zilhão, 2007 and 2011).
696 This characteristic is reminiscent of the shell ornaments of the Early Ahmarian (Kuhn et al., 2001).
697 Pierced teeth (frequently fox and red-deer) are also recorded in the assemblages from Rothschild
698 (Taborin, 1993; Sacchi, 1996; Bon, 2002) and Isturitz (Normand and Turq, 2005) in France and
699 from Cueva Morin, in Spain (González Echegaray and Freeman, 1971).

700 701 **5 Conclusions**

702
703 The picture that emerges for the interval 50-36 ka cal. BP in Italy is that of a period during which
704 considerable biological, cultural and technological innovations first manifest themselves, sometimes

in apparently revolutionary ways. When considering this scenario in light of the topics discussed above, some interesting interpretations are possible. Firstly, we can note that the patchy evidence regarded as symptomatic of behavioural modernity in the Late Mousterian seems to be mostly related to the “symbolic” sphere rather than to the technological field. The Late Mousterian actually displays some activities that do not seem directly related to subsistence needs. However, these appear to have been largely anecdotal experiments, that ultimately were not shared by most Neandertal groups. It is possible that the punctuated nature of this evidence indicates the presence of distinct social, economic or cognitive structures to generate and transmit behavioural innovations across time and space among Neandertals, which could have limited the diffusion of these acquisitions. In other words, the occurrence of formal bone tools, ornamental items, colouring substances and other "non-utilitarian" elements in the Late Mousterian appears to be occasional. This would suggest that those behaviours, which were systematic and widespread in Early Upper Palaeolithic MH societies, were instead episodic among Neandertals.

The Uluzzian, in contrast, is characterized by innovations in the main hallmarks of “modern human behaviour”: from lithic technology (see Marciani et al., in this special issue) to bone technology and ornaments. Among personal ornaments, exclusively made on shells, tusks appear to be a sort of distinctive features of the Uluzzian because of their frequency and distribution. The same uniformity is suggested by bone tools.

The Protoaurignacian differs from the Uluzzian especially in the domain of personal ornaments and displays, even internally, some geographical differentiation in the amount and assortment of both ornaments and bone tools. Going south, the depletion of some typical features usually connected to ethnic identity could be anthropologically consistent with the notion of a spread from the north of this techno-complex.

Interpretations proposed in our state of art account on bone tools, ornaments, and other non-utilitarian objects are mainly working hypotheses that we planned to investigate more in depth in further studies that are going to include newly discovered materials from ongoing excavations in the most important transitional sites in Italy.

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1573 **Figures**

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Fig.1 Localization of the MIS3 Italian sites yielding bone tools and/or ornaments and other non-utilitarian items. The Italian Peninsula shows a sea level of 70 m below the present-day coastline, based on the global sea-level curve (Benjamin et al., 2017) but lacking the estimation of post-MIS3 sedimentary thickness and eustatic magnitude (sketch map courtesy by S. Ricci, University of Siena).

1581
 1582 Fig. 2 Mousterian bone retouchers from Grotta di Fumane showing percussion traces: *Cervus*
 1583 *elaphus* metacarpal and close-up of the percussion traces (layer A6) (1). Double retoucher made
 1584 from *Alces* or *Megaloceros* tibia and close-up of the percussion traces (layers A5+A6) (2).

Grotta del Cavallo

Grotta La Fabbrica

Grotta della Cala

Grotta di Castelvita

Riparo Broion

Grotta di Fumane

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Fig. 3 Uluzzian bone tools. Grotta del Cavallo (layers EIII, EII-I, D) (1-8). Grotta della Cala (layer D14) (9). Grotta di Castelvita (layers upper rsi, rpi, rsa”) (10-14). Grotta La Fabbrica (layer 2) (15). Riparo Broion (layer 1g) (16-19). Grotta di Fumane (layer A3) (20-21) (Modified after d’Errico et al., 2012b; Peresani et al., 2016, Villa et al., 2018; Peresani et al., 2019a).

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ig. 4 Protoaurignacian bone tools. Riparo Bombrini (layers A3-A1): pointed tool (1), fragmentary
tool (2) needle (4) and awls fragments (3, 5-7); Grotta di Fumane (layers A2-A1): split based point
recovered at the interface between layers A1 (Protoaurignacian) and D3 (Aurignacian *sensu lato*)
(8), awls (9-10) and distal portion of a needle or a awl (11); Grotta Paglicci (layer 24): awl (12);
Grotta della Cala (layers 12-13) fragmentary bone points (13-14).

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 1599 Fig.5 Eagle claws with cut marks from Riosecco and Fumane and close-up of the anthropic signs
 1600 indicating their intentional removal (1). The *Aspa marginata* recovered at Grotta Fumane (layer A9)
 1601 and zoom on the striations on the inner lip. The striations are consistent with the presence of a
 1602 thread, attesting the use of the shell as a pendant (2) (Modified after Peresani et al., 2013).

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Fig. 6 Uluzzian ornamental assemblages. Riparo Broion: *Antalis vulgaris* (1-2 and 4-5), *Antalis inaequicostata* (3), *Theodoxus danubialis* (6). Grotta della Cala: *Antalis vulgaris* (7-8), *Glycymeris nummaria* (15-16), *Homalopoma sanguineum* (9), *Clanculus corallinus* (10). Grotta del Cavallo: *Tritia neritea* (17), *Columbella rustica* (18), *Antalis* sp. (19-30).

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Fig.7 Ornaments and other non-utilitarian items from Italian Portoaurignacian sites. Grotta di Fumane: sample of the ornamental shells, *Tritia mutabilis* (1), *Homalopoma sanguineum* (2), *Tritia*

1614 *pellucida* (3), *Glycymeris nummaria* (4), teeth pendants (5-6), engraved rib from a medium-sized
1615 ungulate (7). Riparo Bombrini: sample of the ornamental shells (8-10), worked steatite fragments
1616 (11-15), fragmentary steatite pendant (16), bird bone with notches and incisions (17). Grotta della
1617 Cala: sample of ornamental shells, *Homalopoma sanguineum* (18-23). Grotta di Castelvita:
1618 sample of ornamental shells, *Pecten jacobus* (24) *Homalopoma sanguineum* (25).

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