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Abstract

Situated at the crossroads of Africa and Eurasia, the Levant is a crucial region for understanding the origins and spread of Upper Paleolithic (UP) traditions associated with the spread of modern humans. Of the two local Early Upper Paleolithic (EUP) technocomplexes, the Ahmarian and the Levantine Aurignacian, the latter appears to be unique in the endemic UP sequence, exhibiting greater similarity to the West European 'classic' Aurignacian than to the local preceding and proceeding UP entities. Previous publications have mostly focused on the similarities between the two lithic industries, and less on studies conducted on Levantine Aurignacian bone tools and ornaments. Here we present an archaeozoological, technological and use-wear study of ornaments on animal teeth from the Levantine Aurignacian layers at Manot and Hayonim caves (the Galilee, Israel). The selection of taxa, the choice of teeth, the mode of modification and the use-wear analysis exhibit clear similarities with the European Aurignacian. This, with the technology of the osseous raw material exploitation, the presence of antler simple based-points, and some lithic typotechnological features, suggests a link between the symbolic spheres of the Levantine and the European Aurignacian cultural entities. Such similarity also supports some contribution of European Aurignacians groups to the local cultural entities, intermingling with the local material culture features.

Keywords: Upper Paleolithic; Levantine Aurignacian; Human symbolic behavior; Hayonim Cave; Manot Cave

1. Introduction

It seems that postdating the modern human ‘out of Africa’ exodus, at least three discrete dispersal events took place in the early stages of the Upper Paleolithic (UP)—two from Western Asia to Europe and one from Europe to Western Asia. The similarities between the Levantine Emiran and European Bohunician, and between the Levantine Ahmari and European Proto-Aurignacian have been proposed to support movement of populations or ideas from the Levant to Europe (e.g., Skrdla, 1996, 2003; Tostevin, 2003; Bar-Yosef and Belfer-Cohen, 2014; but see also Teyssandier et al., 2010). Conversely, it appears that the similarities between the European Aurignacian and the Levantine Aurignacian, observed through comparisons of the technotypological characteristics of the chipped stone assemblages (e.g., Bar-Yosef, 1970; Goring-Morris, 1987; Shea, 2006, 2007; Shea and Sisk, 2010), can be explained as evidence of migration in the opposite direction, i.e., from Europe to the Levant (Bar-Yosef and Belfer-Cohen, 1996, 2010, 2019; Goring-Morris and Belfer-Cohen, 2006; Zilhão, 2006; Mellars et al., 2013; Belfer-Cohen and Goring-Morris, 2014, 2017; Barzilai et al., 2016) with recent dating indicating that the Levantine Aurignacian is younger than its European counterpart (Bosch et al., 2013, 2015; Douka et al., 2013; Nigst et al., 2014; Stutz et al., 2015; Alex et al., 2017; Bergman et al., 2017). Within this framework, bone tools have been considered an important proxy to trace typological similarities (e.g., Belfer-Cohen and Bar-Yosef, 1981; Bar-Yosef and Belfer-Cohen, 1996); yet the analysis of the technological aspects of the bone industry has been rather scarce (Belfer-Cohen and Bar-Yosef, 1981; Newcomer and Watson, 1984; Bergman, 1987; Coinman, 1996).

Recent studies have highlighted the importance of ornaments, be they perforated shells, or bone and teeth beads/pendants (Kuhn et al., 2001; Stiner et al., 2013; Bar-Yosef Mayer, 2015). It is now a given that understanding technological behaviors reflected in bone-implement and ornament manufacture can greatly contribute to the study of the emergence and diffusion of Eurasian UP technocultural entities as well as their intra-actions and interactions, locally and globally (Tejero et al., 2016, 2018; Yeshurun et al., 2018).

Two cultural entities are recognized in the Levantine Early Upper Paleolithic (EUP), the Ahmarian and the Levantine Aurignacian. The latter constitutes a unique phenomenon in the local UP sequence, showing greater similarity to the West European ‘classic’ Aurignacian than to the local Levantine archaeological entities preceding and following it (Gilead, 1981, 1991; Bar-Yosef and Belfer-Cohen, 1996; Goring-Morris and Belfer-Cohen, 2006; Belfer-Cohen and Goring-Morris, 2007, 2014, 2017; Barzilai et al., 2016). Besides the similarities observed in the technotypological characteristics—e.g., nosed and frontal carinated items, retouched (Dufour) bladelets, etc. (Bar-Yosef and Belfer-Cohen, 1996, 2010; Goring-Morris and Belfer-Cohen, 2006; Belfer-Cohen and Goring-Morris, 2007; Alex et al., 2017)—there are also similarities in bone and antler processing. Thus, both entities shared similar complex technical concepts of antler-working as opposed to the simpler bone-working technical concepts and had in common a recurrent but limited variety of morphotypes (mainly awls and projectile points; Tejero et al., 2016).

It seems that the use of animal raw material such as bone, mollusks and egg shells for symbolic expressions predates the manipulation of teeth in the Paleolithic. Besides a single example linked with *Homo erectus* (see Joordens et al., 2015), bone and shell ornaments are documented in contexts associated with Neanderthals (e.g.,

74 Zilhão et al., 2010; Caron et al., 2011; Romandini et al., 2014; Majkic et al., 2017;
75 Rodríguez-Hidalgo et al., 2019, but see White, 2001 and Higham et al., 2010 for
76 criticism concerning the findings from Grotte du Renne). They are also well known,
77 along with ostrich eggshell beads, among early anatomically modern human (AMH)
78 populations (e.g., Taborin, 1980; Kuhn et al., 2001; d'Errico et al., 2005; Bar-Yosef
79 Mayer et al., 2009; Texier et al., 2013 Stiner et al., 2013, Miller and Willoughby,
80 2014).

81 Perforated teeth pendants are among the earliest symbolic expressions of the
82 UP of Eurasia (White, 1992, 1993, 2002, 2007; d'Errico et al., 2003; Zilhão et al.,
83 2007). In the European Aurignacian record, the exploitation of mammal teeth—
84 including in some cases human teeth (Henry-Gambier and White, 2006)—became a
85 common practice, probably playing a role in the symbolic sphere of the hunter-
86 gatherer groups. Various teeth (incisors, canines, premolars and molars) of a large
87 spectrum of herbivores (e.g., reindeer, red deer, horse, bison, goat) and carnivores
88 (e.g., bear, wolf, fox) species were selected for the manufacture of ornaments (e.g.,
89 Barge-Mahieu and Taborin, 1991; Taborin, 2004; Vanhaeren and d'Errico, 2006;
90 Álvarez Fernández and Jöris, 2008; Moreau and Jöris, 2013; Wolf et al., 2013; Wolf
91 and Conard 2015). This behavior is well documented all over the European
92 Aurignacian domain, from the West to the East.

93 Here we present an archaeozoological, technological and use-wear study of
94 teeth ornaments from two Levantine Aurignacian assemblages, Manot Cave and
95 Hayonim Cave (Israel), located 10 km apart in the Western Galilee within the
96 Mediterranean belt. The ornaments were made mainly on the vestigial canines of red
97 deer (*Cervus elaphus*), by a perforation of the root to be suspended as pendants or
98 attached to garments. Both the manufacturing marks made during the preparation of

the items and the use-wear traces indicate that they were used as personal ornaments.

The selected taxa and teeth, the mode of modification and use wear show similarities with analogous items from the European Aurignacian, suggesting a link between the symbolic sphere of the Levantine and European Aurignacian cultural entities.

1.1. Hayonim and Manot caves

Hayonim Cave

Hayonim Cave is situated on the right bank of Wadi Izhar, about 13 km from the Mediterranean coast and 50 m above the present wadi channel, in the Western Galilee, Israel (Figs. 1 and 2; Belfer-Cohen and Bar-Yosef, 1981; Bar-Yosef et al., 2017). The Levantine Aurignacian occupation (Stratum D, comprising three consecutive layers, D4, D3, and D1–2) is quite small in extent (15 m²) but rich in material culture remains, including hearths, ash spots, evidence of ocher use, chipped stone artifacts and an impressive faunal assemblage.

The faunal assemblage was first studied by Davis (Davis, 1981, 1982) and later by Rabinovich, with special attention to the human mode of exploitation (Rabinovich et al., 1997; Rabinovich, 1998a, b). The distribution of species (number of identified specimens [NISP] layer D4 = 1479; D3 = 7012; D1–2 = 5077), is very similar in all occupation levels with mountain gazelle (*Gazella gazella*) the most common species (more than 80% of NISP), followed by Persian fallow deer (*Dama mesopotamica*, 5–6%), while other species are represented by several bones only: red deer (*Cervus elaphus*), wild goat (*Capra aegagrus*), wild boar (*Sus scrofa*),

123 aurochs (*Bos primigenius*), roe deer (*Capreolus capreolus*) and hartebeest
124 (*Alcelaphus buselaphus*); Rabinovich et al., 1997; Rabinovich, 1998a, b).

125 Regarding the flint assemblage, on the one hand there is great
126 technotypological similarity between the flint assemblages of the three sublayers of
127 Layer D. On the other hand, there is pronounced heterogeneity in the overall
128 typological components of the whole lithic assemblage (Belfer-Cohen and Bar-Yosef,
129 1981). Flakes are dominant among the debitage items (including 'core trimming
130 elements' and 'primary elements'). Within the tool categories the picture is different,
131 and tools were modified on blade/bladelet and on flake blanks equally (Belfer-Cohen
132 and Bar-Yosef, 1981: Table 2). The character of the debitage is quite irregular. The
133 number of cores is relatively high (Belfer-Cohen and Bar-Yosef, 1981: Table 1); still,
134 judging from the frequencies and types of debitage items it seems that a large
135 number of tools were made elsewhere, while some of the items produced at Hayonim
136 were taken away.

137 Typologically, the Aurignacian assemblage of Hayonim Stratum D is
138 dominated by the end-scraper category including the Aurignacian variety, i.e., nosed,
139 shouldered and lateral carinated items. The second large category is the burin group.
140 Both categories constitute more than half of the total number of tools in Layer D.
141 Borers and backed pieces are scarce while denticulates and notches are relatively
142 well represented. El-Wad points are quite scarce (0.71%) and there is a moderate
143 presence of bladelets, both in debitage and among the tools (i.e., Dufour bladelets;
144 Belfer-Cohen and Bar-Yosef, 1981: Table 2).

145 Another interesting phenomenon is the high percentage of tools with double
146 patina. It is more pronounced in certain tool groups, i.e., end-scrapers, burins,

denticulates and notches. Most of the double-patinated artifacts clearly derive from the preceding Mousterian levels exhibiting Levallois-technique characteristics including faceted striking platforms. Most probably these Mousterian items were available on the surface of the cave and the terrace due to post-Mousterian erosion (see Belfer-Cohen and Bar-Yosef, 1981; Belfer-Cohen and Bar-Yosef, 2015).

Manot Cave

Manot Cave consists of an elongated main hall (80 m long, 10–25 m wide) with two lower chambers connected from the north and the south (Figs. 1 and 2). Rock falls and colluvium apparently blocked the original entrance to the cave ca. 30 ka cal BP (Barzilai et al., 2016). During nine seasons (2010–2018), twelve areas were excavated, labeled A to L (Hershkovitz et al., 2015; Barzilai et al., 2016; Marder et al., 2017, 2018). Areas C and E yielded well-preserved UP assemblages. Both areas display thick stratigraphic profiles and are extremely rich in finds, including flint artifacts, animal bones, bone and antler tools, shells, and a little charcoal (Barzilai et al., 2016; Tejero et al., 2016; Alex et al., 2017; Abulafia et al., 2019; Marder et al., 2019; Yeshurun et al., 2019).

Area E is located at the western end of the cave, on top of the talus, at the location of the original entrance. A sequence of nine distinct archaeological horizons (Layers I–IX) was exposed, including a series of well-preserved combustion features. Based on preliminary analyses of the material culture remains, a division of the sequence into at least two phases was recently suggested (Marder et al., 2019): an early phase (Layers VIII–IV), presenting ‘classic’ Levantine Aurignacian affinities, and a later phase (Layers III–I), which demonstrates a change in focus in lithic tool typology alongside a scant osseous industry and a decrease in mollusk frequencies.

This phase is temporarily referred to as 'post-Levantine Aurignacian' (Marder et al., 2019). Layer IX, at the bottom of the sequence might represent another UP variant, different from the Levantine Aurignacian, as preliminary observations indicated an increased dominance of laminar components within the flint assemblage as well as lack of marine shells and a poor bone industry. However, this layer is yet to be thoroughly studied to obtain a more concrete definition.

The Levantine Aurignacian phase of the sequence (Layers VIII–IV) displays dense archaeological assemblages rich in flint artifacts, bone tools, animal bones and shells. Based on a sample from Layer V, the lithic assemblages comprise typical Levantine Aurignacian tools, such as nosed and carinated scrapers as well as blades displaying Aurignacian retouch. Notably, el-Wad points are missing in the analyzed sample (Marder et al., 2019). The shell assemblages include mostly *Patella*, while various specimens of the scaphopod *Antalis* were also found (Marder et al., 2019).

Area C represents secondary accumulation sediments and archaeological material at the base of the western talus. The stratigraphy, based on sedimentological criteria, is divided into eight units. Following a technotypological analysis of the lithic assemblage, two cultural units were defined, the Levantine Aurignacian (Units 3, 4 and upper Unit 5), and the Early Ahmarian (consisting of the lower part of Unit 6 and Unit 7). The lower part of Unit 5 and the upper section of Unit 6 contain a mixed assemblage comprising both Levantine Aurignacian and Early Ahmarian artifacts (Abulafia et al., 2019). Alongside radiocarbon chronology, these suggest that chronocultural distinctions can be defined (Alex et al., 2017; Abulafia et al., 2019). The archaeological assemblage from the Levantine Aurignacian cultural units (ca. 1.5 m thick) is dominated by an Aurignacian lithic component similar to that described for Area E, as well as projectile points made on antler.

The rich and well-preserved faunal assemblages in Manot Cave are quite similar to those of the nearby Hayonim Cave. An archaeofaunal sequence of both Ahmarian and Levantine Aurignacian levels was studied in Area C (Yeshurun et al., 2019). The Levantine Aurignacian therein is rich in mountain gazelle remains and to a lesser extent, in Persian fallow deer. Red and roe deer, boar and aurochs are all present in small numbers. Bird hunting played some role, and tortoises and small mammals were sporadically exploited. Age and sex information on gazelles cautiously suggest that they were hunted in the summer and autumn (Yeshurun et al., 2019).

The shell assemblages from the Area C Aurignacian included *Columbella rustica* and *Nassarius gibbosulus*, which might have been used for personal ornamentation, and *Patella* sp., which was probably consumed as food (Bar-Yosef Mayer, 2019).

The Aurignacian sequence at Manot is currently dated between ~38 and 34 ka cal BP (the dates were determined through samples deriving from both talus material and a secure Aurignacian context in Area E), with a more constrained timeframe of ~37–35 ka cal BP suggested based on Bayesian models (Alex et al., 2017).

1.2. Bone tools of the Levantine Aurignacian

The bone and antler assemblages from Hayonim D and Manot Cave (mainly Areas E–C) are unique in their number of tools—almost 300 specimens—and their variety, and are comparable only to the Aurignacian assemblage of Ksâr ‘Akil (Newcomer, 1974; Bergman, 1987; Tejero et al., 2016, 2018; Yeshurun et al., 2018; Marder et al., 2019).

Both in Hayonim and Manot caves, the majority of items are bone awls and antler simple/massive base projectile points. There are also several items, both bone and antler that were most probably used in indirect percussion (namely as chisels), as has been demonstrated through both technological and experimental studies (Tartar, 2009; Tejero et al., 2012). We have also documented several retouchers, which are currently not represented in other UP Levantine sites (Yeshurun et al., 2018). Indeed, a renewed technological study of the bone tool production technology from both Levantine Aurignacian assemblages is underway, with some of it already published, e.g., the notched and incised ('decorated') bones from Hayonim (Tejero et al., 2018) as well as the preliminary study of bone tools from the ongoing excavations of Manot (Tejero et al., 2016).

Technical features of the production processes are identical in both sites. The tools shaped from bones were modified using a single, simple technique—scraping. On the other hand, antler was exploited using a combination of techniques, following a process defined by Averbouh (2000) implying a complex operational sequence. Working the antler by longitudinal splitting of antler beam fragments, typical of the European Early Aurignacian (Tejero et al., 2012) was employed by Hayonim and Manot's inhabitants, as demonstrated by the blanks and waste products characteristic of this process (Tejero et al., 2016).

Whenever the base of the antler projectile point is preserved, it is a simple/massive point, of the variety defined as 'elongated objects with a pointed distal tip, a variable cross-section (mostly elliptical) and a simple hafting system' (e.g., Hahn, 1988). Except for one split-based point from Kebara (Bar-Yosef et al., 1992, see also claims for yet another specimen, from Hayonim Cave; Belfer-Cohen and Goring-Morris, 2014), all projectile points from the Levantine Aurignacian are

simple/massive points. The known assemblage comprises ca. 150 samples so far, of which Hayonim and Manot caves have provided almost two thirds (31 and 49 specimens respectively). The rest of the projectile points were reported from Ksâr 'Akil, Sefunim and Yabroud II (Newcomer, 1974; Belfer-Cohen and Bar-Yosef, 1981; Bergman, 1987; Gilead, 1991; Tejero et al., 2016; Shimelmitz et al., 2018).

The typological and technological features, as well as the dichotomy observed between the bone and antler production in both Hayonim and Manot caves, are also observed in the Early Aurignacian sites/assemblages in Europe (see the descriptions in Tartar, 2009; Liolios, 1999; Tartar and White, 2013; Tejero, 2013, 2014; Tejero and Grimaldi, 2015).

2. Materials and methods

The studied material is housed at the National Natural History Collections of the Hebrew University of Jerusalem and the Israel Antiquities Authority (IAA), Jerusalem (Table 1). The taxonomic identification of the items is based on the comparative osteological collections of the National Natural History Collections, The Hebrew University of Jerusalem and the University of Haifa. Most of the studied items were made on red deer teeth. Published criteria were also consulted for taxonomic identification, e.g., Brown and Chapman (1991) for red deer and Brown and Chapman (1990) for fallow deer.

The distinct sexual dimorphism of red deer (Larson and Knapp, 1971; Goss, 1983), is also expressed in the shape and size of their canines (Chapman and Chapman, 1997; Fig. 3). Over the evolution of the family Cervidae, hornless ancestors predated the antlered ruminants. The size of the tusk-like upper canine teeth has tended to be

269 inversely correlated with the size of the antlers, as if 'holding on' to the former
270 compensated for the lack of the latter. As the antlers became longer, the canines
271 became shorter, eventually disappearing. In most cervids, they have been lost while
272 some species like red deer (*Cervus elaphus*) still have vestigial canines (e.g., Goss,
273 1983).

274 As changes occur through life in the shape, root and size of the canines, the
275 specimens were examined for age and sex, following the methods of d'Errico and
276 Vanhaeren (2002). Apparently, male vestigial canines are broader than those of the
277 females and with wear, the fully grown shape in young males becomes triangular.
278 Conversely, crowns of young females are pointed, and those of older specimens are
279 rectangular. The roots of vestigial male canines are square or trapezoid while those
280 of females are rectangular or V-shaped.

281 We recorded morphometric variables for each canine. Morphological variables
282 include occlusal wear stages, stages of root development, state of closure of the pulp
283 cavity, and wear removal of the distolinguocervical lobe. Metric variables include
284 crown width, length and thickness, width and length of the occlusal wear facet,
285 maximum width, apex width, root thickness and root length (Fig. 4).

286 For the description of the specimens' modification we followed the
287 methodology of Barge-Mahieu and Taborin (1991), White (1993, 2007), Vanhaeren
288 (2002) and d'Errico and Rigaud (2011), among others. We described the perforation
289 process, dimensions, location, preparation modes and perforation techniques (e.g.,
290 diameter, shape, the distance between tooth buccal and lingual edges, distance
291 between the perforation and the root base; Fig. 4).

Technological and use-wear analyses were conducted using both a stereomicroscope (magnification: 10–40×) and a scanning electron microscope. The scanning electron microscopy images (the XPS Laboratory, the Unit for Nanocharacterisation, the Harvey M. Krueger Center for Nanoscience and Nanotechnology, the Hebrew University of Jerusalem) were obtained using a FEI Quanta 200 ESEM in low-vacuum mode without preliminary treatment and with a chamber pressure of 0.38 Torr and acceleration voltages of 15–20 kV. The elemental analyses of the particles—for ocher identification—were done by Energy Dispersive X-ray spectroscopy (EDS) using EDAX detector.

3. Results

3.1. Taxonomic and sexual identification, preservation, and stratigraphic origin

The assemblage of personal ornaments recovered from Hayonim and Manot caves consists of a total of 10 perforated teeth and an unfinished pendant or preform (a tooth with an unfinished perforation; Figs. 5 and 6). Nine are vestigial canines of red deer (specimens H11, H35, H53, H157, H179, and H226 [the unfinished item] from Hayonim Cave, and specimens 105, 131, and 132 from Manot Cave); two teeth are upper incisors of a large bovid (*Bos*; specimens H152 from Hayonim and 130 from Manot). Among the red deer vestigial canines, five are left, and four are right (Table 1). It should be noted that a previous publication mentioned the presence of a horse incisor in Layer D at Hayonim (Belfer-Cohen and Bar-Yosef, 1991), which after re-examination is actually a bovid incisor (H152). A fox (*Vulpes vulpes*) perforated canine was reported from an Aurignacian context (Belfer-Cohen and Bar-Yosef, 1981) yet it derives from an area dug-in by the Natufians, and there are many

of these pieces in secure Natufian contexts. For this reason, we have decided to discard it from this study. Conversely, no bovid incisors were reported from the Natufian occupation levels.

The Hayonim pendants were found in Layers D1–2 (two items), Layer D3 and D4 (one element in each layer) and in the D sequence without exact provenience (three items). The items from Manot Cave derive from Area C, upper Unit 6 (one item), and Area E (three pieces). One of the pendants from Area E was found in Layer V (Fig. 2). Two other pieces from this area were retrieved, together with a bone awl and an incised ('decorated') bone, from a sounding pit, thus they lack a precise stratigraphic affiliation. Still, all of the above items fit technotypologically into the Levantine Aurignacian tradition (Belfer-Cohen and Bar-Yosef, 1981; Tejero et al., 2016, 2018; Marder et al., 2019).

Preservation of most of the pendants is good. Some display sediment concretion, exfoliations and desiccation fissures. Four of the Hayonim pendants have been subjected to a combustion process. In Layers D1–2 at Hayonim, isolated patches of white ash suggested that somewhere, not far away, there was a fireplace (Belfer-Cohen and Bar-Yosef, 1981). One of the pendants derived from Square H21, where there was clearly a hearth. The surface of these specimens was burned. The homogenous color and patina (dark brown and soft brown) of their surface might suggest a specific treatment rather than just having been tossed in the hearth. In one of the Manot items (M131) concretion partially covers the perforation. Except for two specimens from Manot and one from Hayonim, all the others are complete. Based on the size ratio (Table 2) and shape, the perforated red deer canines of the Hayonim and Manot belong to males.

To what extent worked teeth come from hunted animals, or were recovered through scavenging, remains unknown. Nevertheless, as noted by several authors, vestigial deer canines disperse quickly after death as they detach easily from the maxilla (d'Errico and Rigaud, 2011). This makes it more likely that the vestigial canines originate from hunted animals. Six of the teeth display incisions at the vestibular face in the junction between the crown and the root (the base of the distolinguocervical lobe). Incisions are short and thin, oblique and perpendicular, relative to the main axis of the piece. We interpret them as cut-marks to extract the canine from the alveolar cavity, which reinforces the assumption that teeth were removed from a fresh carcass.

The wear signs of Paleolithic personal ornaments indicate long-term use (see below), which makes it challenging to determine whether they were produced on site or brought in as finished products from the outside. A high degree of mobility is assumed for Paleolithic personal ornaments tied in with the mobility of their owners (d'Errico, 1993). Assessing their lifespan and tracking their movement through a given territory is indeed rather a speculative exercise. However, the presence of a preform in Hayonim, abandoned or lost before the perforation was made (Fig. 7), implies onsite production of at least some of the teeth ornaments. Moreover, the in situ working of animal raw material (bone and antler) is demonstrated by the presence, at both sites, of blanks and waste associated with the production of bone awls and projectile antler points (Tejero et al., 2016).

3.2. Description of the tooth pendants and their production techniques

All the perforations are located along the roots of the tooth. In some items (four canines and the two bovid incisors) the root surfaces were scraped prior to perforation. The manufacturing sequence is evidenced by the overlapping of the perforation marks over the scraping ones (Fig. 8B). Preparation scraping might have been done in order to clean the root and smooth the surface at the starting point of the hole. The root of the two bovid incisors was entirely scraped, while the deer canines were scraped over a small part of the root surface (Table 3).

Once the surface was prepared, the holes were made by one single technique in six cases and a combination of two techniques for the other five items. The four pendants from Manot, both the incisor and the canines, were perforated by bifacial gouging. The Hayonim items display a slightly different technical behavior, i.e., bifacial rotation in two cases, and a combination of bifacial gouging with bifacial rotation to finish the hole in five pieces (including the preform; Fig. 8A–D).

While it is tempting to argue for a particular technical behavior vis-a-vis the manufacture of the teeth pendants at each site, we should be cautious since the sample is quite small. Such a difference could be due to intra-Aurignacian chronological differences. Indeed, while high-resolution radiocarbon chronology for Manot Cave exists, the dating of Hayonim is questionable since it was done by older techniques and should be refined (Goring-Morris and Belfer-Cohen, 2002). Still, one can consider the difference observed as similar to the differences discerned in the European Aurignacian assemblages which portray flexibility in the techniques employed in ornament production (White, 2007). We can thus assume that on the whole, while sharing the selection of taxon and tooth type, the Levantine Aurignacians could have employed different techniques for the manufacture of the pendants.

Most of the perforations have a circular or subcircular shape, while two specimens have elliptical holes (Fig. 8; Table 3). These perforation forms are determined by the techniques employed. Nevertheless, some of the original circular holes seem to be slightly modified, most likely through use (see below), resulting in a subcircular form (Fig. 8A, D). The cross-section of the perforations is conical in almost all the items since they were pierced from both faces of the teeth. Perforation diameter values are quite regular in all specimens, varying between 2 and 4 mm. Holes are located at the root centered from the edges and the root distal part (the apex of the teeth). The distance from the lateral edge is also regular in all pendants. The hole is at the same range of distance from both edges (between 2 and 5 mm), and equidistant between the end of the root and the beginning of the crown. This location was likely chosen to avoid accidents during the perforation process and to ensure the solidity of the teeth against traction forces, whichever way they were used (as beads in a necklace, bracelet, attached to clothes, or other).

Four of the items from both sites bear ochre stains inside and outside of the perforation on the buccal and vestibular faces (Fig. 9; Table 4). Presence of ochre per se in the archaeological remains as well as the presence of modified ochre fragments have been considered as proof of symbolic behavior during the African Middle Stone Age (e.g., Henshilwood et al., 2009; Rosso et al., 2016, 2017), and the European and Levantine Middle Paleolithic (e.g., Hovers et al., 2003; Zilhão et al., 2010). Exponential growth in scope and quantity is observed from the beginning of the UP onward (e.g., d'Errico et al., 2003; Zilhão, 2007). In the current study, the presence of ochre also on the unfinished pendant, covering part of the uncompleted hole, can indicate that it was used for its abrasive properties, at least in Hayonim, to facilitate hole perforation. Indeed, combined with a small amount of water, ochre is

very useful in increasing the penetration power of the lithic tool used to make the hole. Still, this mineral could also have been used for decorative purposes, directly penetrating the pendants themselves or the clothes to which they were attached. One of the authors (J.-M.T.) experimentally perforated several mammal teeth, including red deer vestigial canines, by diverse techniques, in some cases using ocher (Fig. 10). Although this experiment was a didactic test rather than real testing under an experimental protocol, we have recorded interesting data. Perforating the teeth, both red deer canines and bovid incisors, using ocher as an abrasive increases the efficiency—defined as the (often measurable) ability to avoid wasting materials, energy and efforts in producing a desired result—of carrying out the task at hand. It allows us to avoid to a great extent sliding of the tool point on the teeth root surface, thus minimizing the risk of breakages; also, it shortens the time needed to perforate the tooth, ca. 10–15 minutes against 25–30 minutes without using ocher. We mention these data while being aware that the modern concept of efficient time management seems to be absent in hunter-gatherer societies, whether Paleolithic or recent (i.e., Shina et al., 2008; Polcaro, 2013).

3.3. Use-wear

Similar use-wear marks were observed on four deer canines and one of the bovid incisors. The marks consist of polish around the edge of the hole located in the distal part of the root (the surface closer to the root apex) producing a slight modification of the original perforation shape. In the area where polish is present, the striations generated during perforation by rotation were erased, while still visible along the rest of the perforation (Fig. 8A, D; Table 4).

Although it is commonly assumed that the perforated teeth were used as personal ornaments, the specifics of their use are far from clear. The ethnographic record provides us with numerous examples of variegated utilization of suspended or attached objects, not as body ornaments but rather as clothing appendages, basket and bag accessories, etc. (White, 2007). In the absence of a precise context (for instance a burial) associated with the teeth pendants of Hayonim and Manot caves, we must be prudent when considering the functional interpretation of the items. Nevertheless, technological studies of UP specimens in the European record (e.g., White, 1993; Vanhaeren, 2002; White, 2007; d'Errico and Rigaud, 2011), as well as experimental work (d'Errico, 1993; Cristiani et al., 2014b), advocate the hypothesis that the perforated teeth of Hayonim and Manot caves are indeed pendants (namely personal ornaments). Accruelement of polish inside the holes of the pendants, which had modified the original shape of the hole, suggests that the piece was worn, suspended or sewn on clothing. Indeed, a relatively long wear of at least several months seems to have been needed to produce such a polish (d'Errico, 1993). Intensive use of the pendants indicates that they had a 'long life' and we can thus assume that such symbolic elements must have been of value to their owners.

4. Discussion and conclusion

The study of the two assemblages in conjunction is most beneficial for the research of the pertinent issue detailed in the present paper. While the Hayonim specimens enforce the cultural affiliation of the findings discussed herein, the Manot specimens, especially the one from Area E layer 5 provide a more secure date for the occurrence of those ornaments.

Based on the faunal assemblages, the Aurignacians of Hayonim and Manot caves could have produced pendants on bones of any of the exploited species. Nonetheless, they decided to choose exclusively two teeth of two of the largest-bodied and least consumed species. Contrary to other symbolic expressions of the Levantine Aurignacians, which highlighted their close relationship with a particular animal, the gazelle, and whose bones were chosen to be 'decorated' by notches (Tejero et al., 2018), gazelle teeth do not seem to have been invested with symbolic meaning. White (2007) noted for the Aurignacian of southwestern Europe that dietary importance and symbolic significance seem to have been mutually exclusive.

The Aurignacian (European and Levantine) symbolic manifestations, namely personal ornaments as well as graphic, mobile and stationary art, exhibit a broad similarity. However, at the same time, region-specific characteristics of Aurignacian groups do occur (Bourrillon et al., 2017) and there is a significant variability on a continental scale (Vanhaeren and d'Errico, 2006; Wolf and Conard, 2015). The particularities of each such group are vital in order to understand the dynamics of intergroup relationships, whether reflecting kinship ties or diachronic trends (Tejero et al., 2018), as they all belong to the Aurignacian technocomplex *sensu lato*. Recent research on bone and antler tools suggests similar but also particular features *vis-à-vis* the typological and technical aspects of the exploitation of animal raw materials (Tejero et al., 2016; Yeshurun et al., 2018). Apparently, the European and Levantine Aurignacian symbolic items utilizing animal raw material exhibit such variations as well (Tejero et al., 2018).

The techniques employed to modify the Levantine Aurignacian pendants are similar to those documented in the European Aurignacian (e.g., White, 1993, 2007; Vercoutère, 2004; d'Errico and Rigaud, 2011). However, while in the Levant the ways

to perforate a tooth are limited, the methods employed by the European Aurignacians were varied, showing technical flexibility with gouging and rotation extensively documented (White, 2007).

The preference of one taxon and a particular tooth, namely the red deer vestigial canines, to make personal ornaments is a behavior shared by European and Levantine Aurignacians. Though the European Aurignacian hunter-gatherers exploited a large variety of teeth from diverse mammals, it appears that pierced red deer teeth were of importance and were worn by individuals travelling over long distances (Gravel-Miguel, 2009; Fig. 11). The apparent dissociation between consumed animals and animals whose teeth were used for ornaments is particularly marked in the case of this species. The geographic distribution of red deer pendants in the European UP does not reflect the animals' geographic distribution, since the pendants seem to have moved beyond the extent of the red deer habitat (Gravel-Miguel, 2009).

In the Levant, red deer were present during the Early UP in the Mediterranean realm, both in human-generated assemblages and in hyena den accumulations (Rabinovich, 2017; Orbach and Yeshurun, 2019; Yeshurun et al., 2019). Although this species was part of the diet of the Levantine Aurignacians, its share in that diet is anecdotal compared to that of gazelles and, to a lesser extent, Persian fallow deer. Indeed, in Area C at Manot, red deer specimens represent 1.5% of the identified species of ungulates. In Hayonim the frequencies of red deer are similar, and comprise ca. 2% of the NISP in each sublayer (D4: 27 [1.83%]; D3: 97 [1.38%]; D1–2: 112 [2.21%]). At Hayonim cave *Cervus elaphus* is represented by various body parts including both upper and lower teeth, either isolated or socketed: seven teeth (26%) out of 27 elements from Layer D4; 15 teeth (15%) out of 97 elements from

511 Layer D3; and 33 teeth (29%) out of 112 items from Layer D1-2. Among the teeth, no
512 canines other than the perforated specimens were identified (Rabinovich et al., 1997;
513 Rabinovich, 1998a, b). In Manot Cave Area C sample, there are two red deer
514 specimens in the Ahmarian (astragalus and intermediate phalanx) and three red deer
515 specimens in the Aurignacian (intermediate phalanx, humerus and unmodified
516 incisor; Yeshurun et al., 2019).

517 As a rule, prehistoric European societies in general had a strong preference
518 for the use of red deer canines as personal ornaments. Their presence in many
519 prehistoric settlements, in different contexts, including single burials with dozens of
520 them—e.g., in ethnographic examples (Binford, 1971), in the UP (Giacobini, 1999),
521 and in the Mesolithic (Cristiani et al., 2014a, b)—suggests that they possessed
522 symbolic value for both Paleolithic and post-Paleolithic societies. This could be
523 explained by the tooth's particular shape—rounded—as well as its luster and its
524 tactile qualities (White, 2007). Similar reasons have been alleged for other raw
525 materials like ivory, amber and shells (Taborin, 1993, 2004; Stiner, 2014; Bar-Yosef
526 Mayer, 2015). Indeed, deer canines were at times imitated in different raw materials
527 (bone and antler) by Paleolithic hunter-gatherer groups in Europe and the Levant
528 (White, 1989; Vanhaeren and d'Errico, 2006; Shaham, 2014).

529 Personal ornaments can come in the form of necklaces, pendants, or dress
530 decorations (Kuhn and Stiner, 2007). The use-wear of the Aurignacian Levantine
531 pierced teeth suggests usage similar to that observed for the European Aurignacians.
532 An exchange of tooth pendants between groups from different regions is possible in
533 light of the shared concepts and it could also explain the adoption of similar symbolic
534 practices for the Aurignacians groups of both Europe and the Levant. The latter is

535 reinforced by the in situ production of the pendants that is demonstrated for some of
536 the Hayonim items.

537 While the precise meaning of the message transmitted by such objects is lost
538 to us, we can nevertheless assess its significance in a particular regional context. In
539 this regard, it is interesting to note that as in the Levantine Aurignacian, in other
540 regions and material cultures a few specific types of raw materials with standardized
541 shapes were selected as personal ornaments. One example is the choice of
542 particular shells —*Nassarius*—to fabricate pendants in the African Middle Stone Age
543 and in the beginning of the UP in both the Levant and Europe (Kuhn and Stiner,
544 2007; Bar-Yosef Mayer, 2015). Another example is the particular shape of the so-
545 called ‘basket beads’ made mostly of ivory, characteristic of the Early Aurignacian in
546 southwestern France (White, 1992; Heckel, 2017).

547 An essential feature of the use of symbols is that their meaning is assigned by
548 arbitrary, socially constructed conventions, allowing the storage and visualization of
549 information externally (e.g., Henshilwood and Marean, 2003; Hovers et al., 2003;
550 Langley, 2015; Belfer-Cohen and Hovers, 2020). The objects imbued with symbolic
551 meaning reflect their use to link the individual or population to their cultural identity,
552 material culture and environment (Henshilwood and Marean, 2003).

553 As the development of UP technotypological traditions following the dispersal
554 of AMH in Eurasia, is among the most hotly debated topics, it seems essential to
555 examine and evaluate the variability among human groups, as regards both
556 differences and commonalities. Such studies are of great help in identifying the
557 directions and trajectories of dispersals and the establishment of regional territories
558 (Bar-Yosef and Belfer-Cohen, 2013). Human groups differ (Binford, 2001;

Norenzayan, 2011) and, unquestionably, the differences observed stem not only from varying external environmental circumstances (Banks et al., 2013) but also from intra- and intergroup social rules, customs, and relationships (Gelfand et al., 2011). Thus, variability in ritual and symbolic behavior undoubtedly played an important role and is a critical aspect among Pleistocene groups and/or archaeological cultures. Beyond technological skills, variability in social and spiritual dynamics lies at the core of human self-definition as a group, society, or 'cultural entity' (Bar-Yosef and Belfer-Cohen, 2013; Belfer-Cohen and Hovers, 2020).

The Levantine Aurignacians shared with their European counterparts some similarities in various spheres (technical, economic, social, symbolic) involving bone and antler production. For example, they shared similar complex technical concepts of antler working as opposed to simpler ones for bone-working and had in common a recurrent but limited variety of bone-tool morphotypes (mainly awls and projectile points; Tejero et al., 2016). However, they differed in other particulars of their material culture, i.e., both the bone/antler industries and the lithic ones (e.g., Bar-Yosef and Belfer-Cohen, 1996, 2010; Goring-Morris and Belfer-Cohen, 2006; Belfer-Cohen and Goring-Morris, 2007, 2014, 2017; Barzilai et al., 2016; Marder et al., 2017; Marder et al., 2019). Such is also the case for some symbolic elements, e.g., the notched gazelle scapulae and hyoid, which seem to have had special significance for Levantine Aurignacians (Tejero et al., 2018).

The similarity in the symbolic representations of the European and Levantine Aurignacian is especially striking when the 'symbolic' record of other UP cultures in the Levant is considered. The other EUP entity of the Levant, the Ahmarian, is commonly perceived as a local tradition, predating the Levantine Aurignacian and more extensively distributed in space and time. Symbolic expressions, including

pendants, do exist in the Ahmarian, but exclusively in the form of mollusk-shell ornaments (Bar-Yosef Mayer, 2005; Stiner, 2014). Also, the exploitation of antler, so typical of the Levantine Aurignacian, is missing from secure Ahmarian contexts, which display very few bone tools in general. It thus seems that the two EUP entities in the Levant, utilizing the same environment and having access to the same natural resources (e.g., Yeshurun et al., 2019), expressed their aesthetic or symbolic needs in distinct ways. The Levantine Aurignacian symbolic ‘package’ is truly a very distinct cultural phenomenon that is well constrained in time and space. This lends support to the notion of the Levantine Aurignacian being an incursion from the north as opposed to the locally rooted Ahmarian technocomplex (e.g., Goring-Morris and Belfer-Cohen 2006; Bar-Yosef and Belfer-Cohen, 2010, 2014; Belfer-Cohen and Goring-Morris 2014; Barzilai et al., 2016). It does not support an independent development because of the very particular nature of the material component (Tejero et al., 2018).

The significant similarities observed between the Levantine Aurignacian of Manot Cave and Hayonim Cave are manifested through various aspects of the material culture, including typotechnological aspects of the lithic component, diet, the bone industry and the mollusk remains (Marder et al., 2019). Both sites share similar practices of iconic behavior using gazelle bones as blanks for notched items (Tejero et al., 2018). We add here yet another aspect to the symbolic sphere of Hayonim and Manot Aurignacians dwellers—the manufacture of pendants mainly on male red deer canines. This could imply the existence of cultural bonds between the two sites as well as between the Levantine and the European Aurignacian, considering the widespread of this behavior all over Europe.

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References

Abulafia, T., Goder-Goldberger, M., Berna, F., Barzilai, O., Marder, O., 2019. A techno-typological analysis of the Ahmarian and Levantine Aurignacian assemblages from Manot Cave (Area C) and the interrelation with site formation

634 processes. Journal of Human Evolution.
 635 <https://doi.org/10.1016/j.jhevol.2019.102707>.

636 Averbouh, A., 2000. Technologie de la matière osseuse travaillée et implications
 637 palethnologiques. L'exemple des chaînes d'exploitation du bois de cervidé chez
 638 les Magdaléniens des Pyrénées, Préhistoire-Ethnologie-Anthropologie. Ph.D.
 639 Dissertation, Université Paris I Panthéon-Sorbonne.

640 Alex, B., Barzilai, O., HersHKovitz, I., Marder, O., Berna, F., Caracuta, V., Abulafia,
 641 T., Davis, L., Goder-Goldberger, M., Lavi, R., Mintz, E., Regev, L., Bar-Yosef
 642 Mayer, D., Tejero, J.-M., Yeshurun, R., Ayalon, A., Bar-Matthews, M., Yasur, G.,
 643 Frumkin, A., Latimer, B., Hans, M.G., Boaretto, E., 2017. Radiocarbon chronology
 644 of Manot Cave, Israel and Upper Paleolithic dispersals. *Science Advances* 3,
 645 e1701450.

646 Álvarez Fernández, E., 2006. Los objetos de adorno-colgantes del Paleolítico
 647 Superior y del Mesolítico en la cornisa cantábrica y Valle del Ebro: Una visión
 648 europea. Ph.D. Dissertation, Universidad de Salamanca.

649 Álvarez Fernández, E., Jöris, O., 2008. Personal ornaments in the Early Upper
 650 Palaeolithic of Western Eurasia: An evaluation of the record. *Eurasian Prehistory* 5
 651 (2), 31-44.

652 Banks, W.E., d'Errico, F., Zilhão, J., 2013. Human–climate interaction during the
 653 Early Upper Paleolithic: Testing the hypothesis of an adaptive shift between the
 654 Proto-Aurignacian and the Early Aurignacian. *Journal of Human Evolution* 64, 39–
 655 55.

656 Barge-Mahieu, H., Bellier, C., Camps-Fabrer, H., Cattelain, P., Mons, L.,
 657 Provenzano, N., Taborin, Y., 1991. Objets de Parure. Fiches Typologiques de

658 l'Industrie Osseuse Préhistorique. Publications de l'Université de Provence. Aix-
659 en-Provence.

660 Bar-Yosef, O., 1970. The Epipalaeolithic Cultures of Palestine. Ph.D. Dissertation,
661 The Hebrew University of Jerusalem.

662 Bar-Yosef, O., Arensburg, B., Belfer-Cohen, A., Goldberg, P., Meignen, L., Stiner,
663 M.C., Munro, N.D., Weiner, S., 2017. Hayonim Cave. In: Bar-Yosef, O., Enzel, Y.
664 (Eds.), Quaternary of the Levant: Environments, Climate Change, and Humans.
665 Cambridge University Press, Cambridge, pp. 231-240.

666 Bar-Yosef, O., Belfer-Cohen, A., 1996. Another look at the Levantine Aurignacian. In:
667 Palma di Cesnola A, Montet-White A, Valoch A. (Eds.), The Upper Palaeolithic.
668 Proceedings of the XIII Congress of the UISPP. A.B.A.C.O Edizioni, Forli, pp. 139-
669 150.

670 Bar-Yosef, O., Belfer-Cohen, A., 2010. The Levantine Upper Palaeolithic and
671 Epipalaeolithic. In: Garcea, E. (Ed.), South-Eastern Mediterranean Peoples
672 Between 130,000 and 10,000 Years Ago. Oxbow Books, Oxford, pp. 144-167.

673 Bar-Yosef, O., Belfer-Cohen, A., 2013. Following Pleistocene road signs of human
674 dispersals across Eurasia. Quaternary International 285, 30–43.

675 Bar-Yosef, O., Belfer-Cohen, A., 2019. The Upper Paleolithic Industries of Kebara
676 Cave Kebara Cave, Mt. Carmel, Israel. In: Meignen L. and Bar-Yosef O. (Eds.),
677 The Middle and Upper Paleolithic Archaeology. Part II. American School of
678 Prehistoric Research Bulletin 51, 309-402.

679 Bar-Yosef, O., Vandermeersch, B., Arensburg, B., Belfer-Cohen, A., Goldberg, P.,
680 Laville, H., Meignen, L., Rak, Y., Speth, J.D., Tchernov, E., Tillier, A.M., Weiner,
681 S., 1992. The excavations in Kebara Cave, Mt. Carmel. Current Anthropology 33,
682 497-550.

683 Bar-Yosef Mayer, D.E., 2005. The exploitation of shells as beads in the Palaeolithic
684 and Neolithic of the Levant. *Paléorient* 31 (1), 176–185.

685 Bar-Yosef Mayer, D.E., 2015. *Nassarius* shells: Preferred beads of the Palaeolithic.
686 *Quaternary International* 390, 79-84.

687 Bar-Yosef Mayer, D. E., 2019. Upper Palaeolithic explorers: The geographic sources
688 of shell beads in Early Upper Palaeolithic assemblages in Israel.
689 *PaleoAnthropology* 2019, 105-115.

690 Bar-Yosef Mayer D.E, Vandermeersch, B., Bar-Yosef, O., 2009. Shells and ochre in
691 Middle Paleolithic Qafzeh Cave, Israel: Indications for modern behavior. *Journal of*
692 *Human Evolution* 56, 307-314.

693 Barzilai, O., HersHKovitz, I., Marder, O., 2016. The Early Upper Paleolithic period at
694 Manot Cave, Western Galilee, Israel. *Human Evolution* 31, 85-100.

695 Belfer-Cohen, A., Bar-Yosef, O., 1981. The Aurignacian at Hayonim Cave. *Paléorient*
696 7, 19-42.

697 Belfer-Cohen, A., Bar-Yosef, O., 2015. Paleolithic recycling: The example of
698 Aurignacian artifacts from Kebara and Hayonim caves. *Quaternary International*
699 361, 256-259.

700 Belfer-Cohen, A., Goring-Morris, N., 2007. From the beginning: Levantine Upper
701 Palaeolithic cultural changes and continuity. In: Mellars, P., Boyle, K., Bar-Yosef,
702 O., Stringer, C. (Eds.), *Rethinking the Human Evolution*. McDonald Institute,
703 Oxford, pp. 199-205.

704 Belfer-Cohen, A., Goring-Morris, N., 2014. The Upper Palaeolithic and Earlier Epi-
705 Palaeolithic of Western Asia. In: Renfrew, A.C., Bahn, P. (Eds.), *The Cambridge*
706 *World Prehistory*. Cambridge University Press, Cambridge, pp. 1381-1407.

707 Belfer-Cohen, A., Goring-Morris, N., 2017. The Upper Palaeolithic in Cisjordan. In:
708 Enzel, Y, Bar-Yosef, O. (Eds.), Quaternary of the Levant. Environments, Climate
709 Change, and Humans. Cambridge University Press, Cambridge, pp. 627-637.

710 Belfer-Cohen, A., Hovers, E., 2020. Prehistoric perspectives on “others” and
711 “strangers”. *Frontiers in Psychology* 10, 3063.

712 Bergman, C.A., 1987a. Ksar Akil, Lebanon. A Technological and Typological
713 Analysis of the Later Palaeolithic Levels of Ksar Akil. Vol. II: Levels XIII-VI. British
714 Archaeological Reports, Oxford.

715 Bergman, C.-A., 1987b. Hafting and use of bone and antler points from Ksar Akil,
716 Lebanon. In: Stordeur, D. (Ed.), *La Main et l’Outil. Manches et Emmanchements*
717 *Préhistoriques. Table Ronde C.N.R.S. Tenue à Lyon du 26 au 29 Novembre 1984.*
718 *Travaux de la Maison de l’Orient, Lyon*, pp. 117-126.

719 Binford, L. R., 1971. Mortuary practices: Their study and their potential. *American*
720 *Antiquity* 36, 6-29.

721 Binford, L.R., 2001. *Constructing Frames of Reference: An Analytical Method for*
722 *Archaeological Theory Building Using Ethnographic and Environmental Data Sets.*
723 University of California Press, Berkeley.

724 Bosch, M.D., Mannino, M.A., Prendergast, A.L., O’Connell, T.C., Demarchi, B.,
725 Taylor, S.M., Niven, L., van der Plicht, J., Hublin, J.-J., 2015. New chronology for
726 Ksâr ‘Akil (Lebanon) supports Levantine route of modern human dispersal into
727 Europe. *Proceedings of the National Academy of Sciences USA* 112, 7683-7688.

728 Bourrillon, R., White, R., Tartar, E., Chiotti, L., Mensan, R., Clark, A., Castel, J.C.,
729 Cretin, C., Higham, T., Morala, A., Ranlett, S., Sisk, M., Deviese, T., Comeskey,
730 D.J., 2018. A new Aurignacian engraving from Abri Blanchard, France:

731 Implications for understanding Aurignacian graphic expression in Western and
 732 Central Europe. *Quaternary International* 491, 46-64.

733 Brown, W. A. B., Chapman, N. G., 1990. The dentition of fallow deer (*Dama dama*):
 734 A scoring scheme to assess age from wear of the permanent molariform teeth.
 735 *Journal of Zoology* 221, 659-682.

736 Brown, W. A. B., Chapman, N. G., 1991. The dentition of red deer (*Cervus elaphus*):
 737 a scoring system to assess age from wear of the permanent molariform teeth.
 738 *Journal of Zoology* 224, 519-536.

739 Caron, F., d'Errico, F., Del Moral, P., Santos, F., Zilhão, J., 2011. The reality of
 740 Neandertal symbolic behavior at the Grotte du Renne, Arcy-sur-Cure, France.
 741 *PLoS One* 6, e21545.

742 Chapman, D. I., Chapman, N. G., 1975. Fallow Deer: Their History, Distribution and
 743 Biology. Terence Dalton Ltd, Lavenham.

744 Cristiani, E., Farbstein, R., Miracle, P., 2014a. Ornamental traditions in the Eastern
 745 Adriatic: The Upper Palaeolithic and Mesolithic personal adornments from Vela
 746 Spila (Croatia). *Journal of Anthropological Archaeology* 36, 21-31.

747 Cristiani, E., Živaljević, I., Borić, D., 2014b. Residue analysis and ornament
 748 suspension techniques in prehistory: Cyprinid pharyngeal teeth beads from Late
 749 Mesolithic burials at Vlasac (Serbia). *Journal of Archaeological Science* 46, 292-
 750 310.

751 Coinman, N.R., 1996. Worked bone in the Levantine Upper Paleolithic: Rare
 752 examples from the Wadi al-Hasa, West-Central Jordan. *Paléorient* 22 (2), 113-
 753 121.

754 Davis, S. J.-M., 1981. The effects of temperature change and domestication on the
 755 body size of Late Pleistocene to Holocene mammals of Israel. *Paleobiology* 7,
 756 101-114.

757 Davis, S. J.-M., 1982. Climate change and the advent of domestication: The
 758 succession of ruminant artiodactyls in the Late Pleistocene-Holocene period in the
 759 Israel region. *Paléorient* 8 (2), 25-165.

760 Douka, K., Bergman, C.A., Hedges, R.E.M., Wesselingh, F.P., Higham, T.F.G., 2013.
 761 Chronology of Ksar Akil (Lebanon) and implication for the colonization of Europe
 762 by Anatomically Modern Humans. *PLoS One* 8, e72931.

763 d'Errico, F., 1993. La vie sociale de l'art mobilier paléolithique. Manipulation,
 764 transport, suspension des objets on os, bois de cervidés, ivoire. *Oxford Journal of*
 765 *Archaeology* 12, 145-174.

766 d'Errico, F., Henshilwood, C., Lawson, G., Vanhaeren, M., Tillier, A.-M., Soressi, M.,
 767 Bresson, F., Maureille, B., Nowell, A., Lakarra, J., Backwell, L., Julien, M., 2003.
 768 Archaeological evidence for the emergence of language, symbolism, and music—
 769 An alternative multidisciplinary perspective. *Journal of World Prehistory* 17, 1-70.

770 d'Errico, F., Henshilwood, C., Vanhaeren, M., van Niekerk, K., 2005. *Nassarius*
 771 *kraussianus* shell beads from Blombos Cave: Evidence for symbolic behaviour in
 772 the Middle Stone Age. *Journal of Human Evolution* 48, 3-24.

773 d'Errico, F., Rigaud, R., 2011. Crache perforée dans le Gravettien du sire (Mirefleurs,
 774 Puy-de-Dôme). *Paleo*22, 301-310.

775 d'Errico, F., Vanhaeren, M., 2002. Criteria for identifying Red Deer (*Cervus elaphus*)
 776 age and sex from their canines. Application to the study of Upper Palaeolithic and
 777 Mesolithic ornaments. *Journal of Archaeological Science* 29, 211-232.

778 Gelfand, M.J., Raver, J.L., Nishii, L., Leslie, L.M., Lun, J., Lim, B.C., Duan, L.,
 779 Almaliach, A., Ang, S., Arnadottir, J., Aycan, Z., Boehnke, K., Boski, P.,
 780 Cabecinhas, R., Chan, D., Chhokar, J., D'Amato, A., Ferrer, M., Fischlmayr, I.C.,
 781 Fischer, R., Fülöp, M., Georgas, J., Kashima, E.S., Kashima, Y., Kim, K.,
 782 Lempereur, A., Marquez, P., Othman, R., Overlaet, B., Panagiotopoulou, P.,
 783 Peltzer, K., Perez-Florizno, L.R., Ponomarenko, L., Realo, A., Schei, V., Schmitt,
 784 M., Smith, P.B., Soomro, N., Szabo, E., Taveesin, N., Toyama, M., Van de Vliert,
 785 E., Vohra, N., Ward, C., Yamaguchi, S., 2011. Differences between tight and loose
 786 cultures: A 33-Nation study. *Science* 332, 1100-1104.

787 Giacobini, G., 1999. Les sépultures du Paléolithique supérieur d'Italie. In: Sacchi, D.
 788 (Ed.), *Les Faciès Leptolithiques du Nord-Ouest Méditerranéen: Milieux Naturels et*
 789 *Culturels*. Société Préhistorique Française, Carcassonne, pp. 29–39.

790 Gilead, I., 1981. Upper Palaeolithic tool assemblages from the Negev and Sinai. In:
 791 Cauvin, J., Sanlaville, P. (Eds.), *Préhistoire du Levant*. CNRS, Paris, pp. 331-342.

792 Gilead, I., 1991. The Upper Paleolithic period in the Levant. *Journal of World*
 793 *Prehistory* 5, 105-154.

794 Goring-Morris, N., 1987. *At the Edge: Terminal Pleistocene Hunter-Gatherers in the*
 795 *Negev and Sinai*. British Archaeological Reports, Oxford.

796 Goring-Morris, N., Belfer-Cohen, A. (Eds.), 2003. *More than Meets the Eye. Studies*
 797 *on Upper Palaeolithic Diversity in the Near East*. Oxbow Books, Oxford.

798 Goring-Morris, N., Belfer-Cohen, A., 2006. A hard look at the “Levantine
 799 Aurignacian”: How real is the taxon? In: Bar-Yosef O, Zilhão J. (Eds.), *Towards a*
 800 *Definition of the Aurignacian*. Instituto Português de Arqueologia, Lisboa, pp. 297–
 801 314.

802 Goss, R.J., 1983. Deer Antlers: Regeneration, Function, and Evolution. Academic
803 Press, New York.

804 Gravel-Miguel, C. 2011. Exoticism of portable art and ornaments. A study of social
805 networks around the Last Glacial Maximum. Ph.D. Dissertation, University of
806 Victoria.

807 Hahn, J., 1988. Fiche Sagaie à base simple de tradition aurignacienne. In: Delporte,
808 H., Hahn, J., Mons, L., Pinçon, G., Sonnevile-Bordes, D. (Eds.), Fiches
809 Typologiques de l'Industrie Osseuse Préhistorique. Cahier I. Sagaies. Commission
810 de nomenclature sur l'industrie de l'os préhistorique. Université de Provence,
811 Paris, pp. 1-17.

812 Heckel, C.E., 2018. Reconsidering production organization in the Early Upper
813 Palaeolithic: The case for specialized production of Aurignacian beads.
814 Quaternary International 491, 11-20.

815 Henry-Gambier, D., White, R., 2006. Modifications artificielles des vestiges humains
816 de l'Aurignacien ancien de la Grotte des Hyènes (Brassempouy, Landes). Quelle
817 signification ? In: Cabrera Valdés, V. (Ed.), En el Centenario de la Cueva de El
818 Castillo: El Ocaso de los Neandertales. UNED, Santoña, pp. 73-88.

819 Henshilwood, C.S., d'Errico, F., Watts, I., 2009. Engraved ochres from the Middle
820 Stone Age levels at Blombos Cave, South Africa. Journal of Human Evolution 57,
821 27-47.

822 Henshilwood, C., Marean, C.W., 2003. The origin of Modern Human behavior.
823 Critique of the models and their test implications. Current Anthropology 44, 627-
824 651.

825 Hershkovitz, I., Marder, O., Ayalon, A., Bar-Matthews, M., Yasur, G., Boaretto, E.,
826 Caracuta, V., Alex, B., Frumkin, A., Goder-Goldberger, M., Gunz, P., Holloway, R.

827 L., Latimer, B., Lavi, R., Matthews, A., Slon, V., Mayer, D. B.-Y., Berna, F., Bar-
 828 Oz, G., Yeshurun, R., May, H., Hans, M. G., Weber, G. W., Barzilai, O., 2015.
 829 Levantine cranium from Manot Cave (Israel) foreshadows the first European
 830 modern humans. *Nature* 520, 216-219.

831 Hershkovitz, I., Weber, G.W., Quam, R., Duval, M., Grün, R., Kinsley, L., Ayalon, A.,
 832 Bar-Matthews, M., Valladas, H., Mercier, N., Arsuaga, J.L., Martín-Torres, M.,
 833 Bermúdez de castro, J.M., Fornai, C., Martín-Francés, L., Sarig, R., May,
 834 H., Krenn, V.A., Slon, V., Rodríguez, L., García, R., Lorenzo, C., Carretero, J.M.,
 835 Frumkin, A., Shahack-Gross, R., Bar-Yosef Mayer, D., Cui, Y., Wu, X., Peled, N.,
 836 Groman-Yaroslavski, I.; Weissbrod, L., Yeshurun, R., Tsatskin, A., Zaidner, Y.,
 837 Weinstein-Evron, M., 2018. The earliest modern humans outside Africa. *Science*
 838 359, 456-459.

839 Higham, T., Jacobi, R., Julien, M., David, F., Basell, L., Wood, R., Davies, W.,
 840 Ramsey, C.B., 2010. Chronology of the Grotte du Renne (France) and implications
 841 for the context of ornaments and human remains within the Châtelperronian.
 842 *Proceedings of the National Academy of Sciences USA* 107, 20234-20239.

843 Hovers, E., Ilani, S., Bar-Yosef, O., Vandermeersch, B., 2003. An early case of color
 844 symbolism: Ochre use by modern humans in Qafzeh Cave. *Current Anthropology*
 845 44, 491-522.

846 Hublin, J.-J., 2015. The modern human colonization of western Eurasia: when and
 847 where? *Quaternary Science Reviews* 118, 194-210.

848 Joordens, J.C.A., d'Errico, F., Wesselingh, F.P., Munro, S., de Vos, J., Wallinga, J.,
 849 Ankjaergaard, C., Reimann, T., Wijbrans, J.R., Kuiper, K.F., Mucher, H.J.,
 850 Coqueugniot, H., Prie, V., Joosten, I., van Os, B., Schulp, A.S., Panuel, M., van
 851 der Haas, V., Lustenhouwer, W., Reijmer, J.J.G., Roebroeks, W., 2014. *Homo*

852 *erectus* at Trinil on Java used shells for tool production and engraving. Nature 518,
853 228-231.

854 Kuhn, S., Stiner, M.C., 2007. Body ornamentation as information technology:
855 Towards an understanding of the significance of early bead. In: Mellars P., Boyle
856 K., Bar-Yosef O., Stringer C.B. (Eds.). Rethinking the Human Revolution: New
857 Behavioural and Biological Perspectives on the Origin and Dispersal of Modern
858 Humans. McDonald Institute, Cambridge, pp. 45-54.

859 Kuhn, S.L., Stiner, M.C., Reese, D.S., Güleş, E., 2001. Ornaments of the earliest
860 Upper Paleolithic: New insights from the Levant. Proceedings of the National
861 Academy of Sciences USA 98, 7641-7646.

862 Langley, M. C., 2015. Symbolic material culture in the Late Pleistocene: Use in
863 prehistory, appearance in the archaeological record and taphonomy. In: Putová B,
864 Václav S. (Eds.), The Genesis of Creativity and the Origin of the Human Mind.
865 Karolinum Charles University, Prague, pp. 57-75.

866 Larson, J. S., Knapp, S. J., 1971. Sexual dimorphism in beaver neutrophils. Journal
867 of Mammalogy 52, 212–215.

868 Liolios, D., 1999. Variabilité et caractéristiques du travail des matières osseuses au
869 début de l'Aurignacien : Approche technologique et économique. Ph.D.
870 Dissertation. Université Paris X-Nanterre.

871 Majkić, A., Evans, S., Stepanchuk, V., Tsvelykh, A., d'Errico, F., 2017. A decorated
872 raven bone from the Zaskalnaya VI (Kolosovskaya) Neanderthal site, Crimea.
873 PLoS One 12, e0173435.

874 Marder, O., Hershkovitz, I., Barzilai, O., 2017. The Early Upper Palaeolithic of Manot
875 Cave, Western Galilee. In: Enzel, Y., Bar-Yosef, O. (Eds.), Quaternary of the

876 Levant: Environments, Climate Change, and Humans. Cambridge University
877 Press, Cambridge, pp. 277-284.

878 Marder, O., Barzilai, O., Abulafia, T., Hershkovitz, I., Goder-Goldberger, M., 2018.
879 Chrono-cultural considerations of Middle Paleolithic occurrences at Manot Cave
880 (Western Galilee), Israel. In: Akazawa, T., Nishiaki, Y. (Eds.), Replacement of
881 Neanderthals by Moderns Humans: Testing Evolutionary Models of Learning.
882 Springer, Singapore, pp. 49-63.

883 Marder O., Shemer, M., Abulafia T., Bar-Yosef-Mayer, D., Berna F., Caux S., Edeltin,
884 L., Goder-Goldberger M., Hershkovitz I., Lavi R., Shavit, R, Tejero J.-M.,
885 Yeshurun, R., Barzilai O. 2019. Preliminary observations on the Levantine
886 Aurignacian sequence of Manot Cave: Cultural affiliations and regional
887 perspectives. Journal of Human Evolution. [https://](https://doi.org/10.1016/j.jhevol.2019.102705)
888 doi.org/10.1016/j.jhevol.2019.102705.

889 Mellars, P., 2006. Why did modern human populations disperse from Africa ca.
890 60,000 years ago? A new model. Proceedings of the National Academy of
891 Sciences USA 103, 9381-9386.

892 Mellars, P., Gori, K.C., Carr, M., Soares, P.A., Richards, M.B., 2013. Genetic and
893 archaeological perspectives on the initial modern human colonization of southern
894 Asia. Proceedings of the National Academy of Sciences USA 110, 10699-704.

895 Miller, J.M., Willoughby, P.R., 2014. Radiometrically dated ostrich eggshell beads
896 from the Middle and Later Stone Age of Magubike Rockshelter, southern
897 Tanzania. Journal of Human Evolution 74, 118-122.

898 Moreau L., Jöris O., 2013. La fin de l'Aurignacien. Au sujet de la position
899 chronologique de la station de plein air de Breitenbach dans le contexte du
900 Paléolithique supérieur ancien en Europe centrale. In: Bodu, P., Chehmana, L.,

901 Klaric L., Mevel L., Soriano S., Teyssandier N. (Eds.), *Le Paléolithique Supérieur*
 902 *Ancien de l'Europe du Nord-Ouest*, Actes de la Table-Ronde de Sens (Avril 2009).
 903 Société Préhistorique Française, Paris, pp. 395-414.
 904 Newcomer, M.H., 1974. Outils en os du Paléolithique supérieur de Ksar Akil (Liban),
 905 In: Camps Fabrer, H. (Ed.), 1^{er}. Colloque International sur l'Industrie de l'Os dans
 906 la Préhistoire : Abbaye de Sénanque, 18-20 Avril 1974. Éditions de l'Université de
 907 Provence, Aix-en-Provence, pp. 60-65.
 908 Newcomer, M., Watson, J., 1984. Bone artifacts from Ksar 'Aqil (Lebanon).
 909 *Paléorient* 10 (1), 143-147.
 910 Nigst, P. R., Haesaerts, P., Damblon, F., Frank-Fellner, C., Mallol, C., Viola, B.,
 911 Götzinger, M., Niven, L., Trnka, G., Hublin, J.-J., 2014. Early modern human
 912 settlement of Europe north of the Alps occurred 43,500 years ago in a cold steppe-
 913 type environment. *Proceedings of the National Academy of Sciences USA* 111,
 914 14394-14399.
 915 Norenzayan, A., 2011. Behavior. Explaining human behavioral diversity. *Science*
 916 332, 1041-1042.
 917 Orbach, M., Yeshurun, R., 2019. The hunters or the hunters: Human and hyena prey
 918 choice divergence in the Late Pleistocene Levant. *Journal of Human Evolution*.
 919 <https://doi.org/10.1016/j.jhevol.2019.01.005>.
 920 Polcaro, V., F., 2013. The concept of time, from Palaeolithic to Newtonian physics.
 921 *EPJ Web of Conferences* 58, 03001.
 922 Rabinovich, R., 1998a. "Drowning in numbers"—Gazelles dominance and body size
 923 groups in archaeozoological record. In: Buitenhuis H, Bartosiewicz L, Choyke A.M.
 924 (Eds.), *Archaeozoology of the Near East*. ARC-Publicaties, Budapest, pp. 45-71.

925 Rabinovich, R., 1998b. Patterns of animal exploitation and subsistence in Israel
 926 during the Upper Palaeolithic and Epi-Palaeolithic (40,000–12,500 BP), based
 927 upon selected case studies. Ph.D. Dissertation, The Hebrew University of
 928 Jerusalem.

929 Rabinovich, R., 2017. The Archaeozoological record in a changing environment of
 930 the Late Middle to the Late Pleistocene. In: Enzel, Y., Bar-Yosef, O. (Eds.),
 931 Quaternary of the Levant: Environments, Climate Change, and Humans.
 932 Cambridge University Press, Cambridge, pp. 347-354.

933 Rabinovich, R., Bar-Yosef, O., Tchernov, E., 1997. "How many ways to skin a
 934 gazelle". Butchery patterns from an Upper Palaeolithic site, Hayonim Cave, Israel.
 935 *Archaeozoologia* 8,11–52.

936 Rodríguez-Hidalgo, A., Morales, J.I., Cebriá, A., Courtenay, L.A., Fernández-
 937 Marchena, J.L., García-Argudo, G.G., Marín, J., Saladié, P., Soto, M., Tejero, J.-
 938 M., Fullola, J.M., 2019. The châtelperronian Neandertals of Cova Foradada
 939 (Calafell, Spain) used Iberian imperial eagle phalanges for symbolic purposes.
 940 *Science Advances* 5, eaax1984.

941 Romandini, M., Peresani, M., Laroulandie, V., Metz, L., Pastoors, A., Vaquero, M.,
 942 Slimak, L., 2014. Convergent evidence of eagle talons used by late Neanderthals
 943 in Europe: A further assessment on symbolism. *PLoS One* 9, e101278.

944 Rosso, D.E., d'Errico, F., Queffelec, A., 2017. Patterns of change and continuity in
 945 ochre use during the late Middle Stone Age of the Horn of Africa: The Porc-Epic
 946 Cave record. *PLoS One* 12, e0177298.

947 Rosso, D., Pitarch, À., d'Errico, F., 2016. Middle Stone Age ochre processing and
 948 behavioural complexity in the Horn of Africa: Evidence from Porc-Epic Cave, Dire
 949 Dawa, Ethiopia. *PLoS One* 11, e0164793.

950 Shaham, D., 2014. Art Research Tools for Reading Natufian Art: A Methodological
 951 Approach and Selected Case Studies. M.A. Thesis, The Hebrew University,
 952 Jerusalem. (in Hebrew).

953 Shea, J.J., 2006. The origins of lithic projectile point technology: Evidence from
 954 Africa, the Levant, and Europe. *Journal of Archaeological Science* 33, 823-846.

955 Shea, J., J, 2007. The boulevard of broken dreams: Evolutionary discontinuity in the
 956 late Pleistocene Levant. In: Mellars, P., Boyle, K., Bar-Yosef, O., Stringer, C.
 957 (Eds.), *Rethinking the Human Evolution*. McDonald Institute, Oxford, pp. 219-232.

958 Shea, J., J., Sisk, M., L., 2010. Complex projectile technology and *Homo sapiens*
 959 dispersal into Western Eurasia. *PaleoAnthropology* 2010, 100-122.

960 Shimelmitz, R., Friesem, D.E., Clark, J.L., Groman-Yaroslavski, I., Weissbrod, L.,
 961 Porat, N., Kandel, A.W., 2018. The Upper Paleolithic and Epipaleolithic of Sefunim
 962 Cave, Israel. *Quaternary International* 464, 106-125.

963 Sinha C., Da Silva Sinha V., Zinken, J., Sampaio W., 2011. When time is not space:
 964 Evidences from Amazonian language and culture. *Language and Cognition* 3,
 965 137–169.

966 Škrdla, P., 1996. The Bohunician reduction strategy. *Quaternaria Nova* 6, 93-107.

967 Škrdla, P., 2003. Comparison of Boker Tachtit and Stránská Skála MP/UP
 968 transitional industries. *Journal of the Israel Prehistoric Society* 33, 37–73.

969 Stiner, M.C., 2014. Finding a common bandwidth: Causes of convergence and
 970 diversity in Paleolithic beads. *Biological Theory* 9, 51-64.

971 Stiner, M.C., Kuhn, S.L., Güleç, E., 2013. Early Upper Paleolithic shell beads at
 972 Üçağızlı Cave I (Turkey): Technology and the socioeconomic context of ornament
 973 life-histories. *Journal of Human Evolution* 64, 380-398.

974 Stringer, C., 2007. The origin and dispersal of *Homo sapiens*: our current state of
 975 knowledge. In: Mellars P, Boyle K, Bar-Yosef O, Stringer C. (Eds.), Rethinking the
 976 Human Evolution. McDonald Institute for Archaeological Research, Cambridge,
 977 pp. 15-20.

978 Stutz, A.J., Shea, J.J., Rech, J.A., Pigati, J.S., Wilson, J., Belmaker, M., Albert, R.M.,
 979 Arpin, T., Cabanes, D., Clark, J.L., Hartman, G., Hourani, F., White, C.E., Nilsson
 980 Stutz, L., 2015. Early Upper Paleolithic chronology in the Levant: new ABOx-SC
 981 accelerator mass spectrometry results from the Mughr el-Hamamah Site, Jordan.
 982 Journal of Human Evolution 85, 157-173.

983 Taborin, Y., 1993. La Parure en Coquillage au Paléolithique. CNRS, Paris.

984 Taborin, Y., 2004. Langage sans Paroles. La Parure aux Temps Préhistoriques. La
 985 maison des roches, Paris.

986 Tartar, E., 2009. De l'os à l'outil - caractérisation technique, économique et sociale
 987 de l'utilisation de l'os à l'aurignacien ancien. Étude de trois sites : l'Abri Castanet
 988 (secteurs nord et sud), Brassempouy (Grotte des Hyènes et Abri Dubalen) et
 989 Gatzarria. Ph.D. Dissertation, Université Paris I Panthéon-Sorbonne.

990 Tartar, E., White, R., 2013. The manufacture of Aurignacian split-based points: an
 991 experimental challenge. Journal of Archaeological Science 40, 2723-2745.

992 Tejero, J.-M., 2013. La Explotación de las Materias Óseas en el Auriñaciense.
 993 Caracterización Tecnoeconómica de las Producciones del Paleolítico Superior
 994 Inicial en la Península Ibérica. Archaeopress, Oxford.

995 Tejero, J.-M., 2014. Towards complexity in osseous raw material exploitation by the
 996 first anatomically modern humans in Europe: Aurignacian antler working. Journal
 997 of Anthropological Archaeology 36, 72-92.

998 Tejero, J.-M., 2016. Spanish Aurignacian projectile points. An example of the first
 999 European Palaeolithic hunting weapons in osseous material. *Osseous Projectile*
 1000 *Weaponry*. In: Langley, M. (Ed.), *Towards an Understanding of Pleistocene*
 1001 *Cultural Variability*. Springer, Dordrecht, pp. 55-69.

1002 Tejero, J.-M., Christensen, M., Bodu, P., 2012. Red deer antler technology and early
 1003 modern humans in Southeast Europe: An experimental study. *Journal of*
 1004 *Archaeological Science* 39, 332-346.

1005 Tejero, J.-M., Grimaldi, S., 2015. Assessing bone and antler exploitation at Riparo
 1006 Mochi (Balzi Rossi, Italy): implications for the characterization of the Aurignacian in
 1007 South-western Europe. *Journal of Archaeological Science* 61, 59-77.

1008 Tejero, J.-M., Yeshurun, R., Barzilai, O., Goder-Goldberger, M., HersHKovitz, I., Lavi,
 1009 R., Schneller-Pels, N., Marder, O., 2016. The osseous industry from Manot Cave
 1010 (Western Galilee, Israel): Technical and conceptual behaviours of bone and antler
 1011 exploitation in the Levantine Aurignacian. *Quaternary International* 403, 90-106.

1012 Tejero, J.-M., Belfer-Cohen, A., Bar-Yosef, O., Gutkin, V., Rabinovich, R., 2018.
 1013 Symbolic emblems of the Levantine Aurignacians as a regional entity identifier
 1014 (Hayonim Cave, Lower Galilee, Israel). *Proceedings of the National Academy of*
 1015 *Sciences USA* 115, 5145-5150.

1016 Teyssandier, N., 2007. *En Route Vers l'Ouest. Les Débuts de l'Aurignacien en*
 1017 *Europe*. Hadrian Books, Oxford.

1018 Teyssandier, N., Bon, F., Bordes, J.-G., 2010. Within projectile range: some thoughts
 1019 on the appearance of the Aurignacian in Europe. *Journal of Anthropological*
 1020 *Research* 66, 209-229.

1021 Texier, P.-J., Porraz, G., Parkington, J., Rigaud, J.-P., Poggenpoel, C., Tribolo, C.,
 1022 2013. The context, form and significance of the MSA engraved ostrich eggshell

1023 collection from Diepkloof Rock Shelter, Western Cape, South Africa. *Journal of*
 1024 *Archaeological Science* 40, 3412-3431.

1025 Tostevin, G. B., 2003. Attribute analysis of the lithic technologies of Stránská skála
 1026 II–III in their regional and inter-regional context. In: Svoboda, J., Bar-Yosef, O.
 1027 (Eds.), *Stránská skála: Origins of the Upper Paleolithic in the Brno Basin*. Peabody
 1028 Museum of Archaeology and Ethnology, Harvard University, Cambridge, pp. 77-
 1029 118.

1030 Vanhaeren, M., 2002. Les fonctions de la parure au Paléolithique supérieur : de
 1031 l'individu à l'unité culturelle. Ph.D. Dissertation, Université Bordeaux I.

1032 Vanhaeren, M., d'Errico, F., 2006. Aurignacian ethno-linguistic geography of Europe
 1033 revealed by personal ornaments. *Journal of Archaeological Science* 33, 1105-
 1034 1128.

1035 White, R., 1992. Rethinking the Middle/Upper Paleolithic transition. *Current*
 1036 *Anthropology* 33, 85-108.

1037 White, R., 1993. Technological and social dimensions of "Aurignacian-age" body
 1038 ornaments across Europe. In: Knecht, H., Pike-Tay, A., White, R. (Eds.), *Before*
 1039 *Lascaux: The Complex Record of the Early Upper Paleolithic*. CRC Press, Boca
 1040 Raton, pp. 277-299.

1041 White, R., 2001. Personal ornaments from the Grotte du Renne at Arcy-sur-Cure.
 1042 *Athena Review* 22, 41-46.

1043 White, R., 2002. Observations technologiques sur les objets de parure. In: Baffier, D.,
 1044 Schmider, B. (Eds.), *L'Aurignacien de la Grotte du Renne : Les Fouilles d'André*
 1045 *Leroi-Gourhan à Arcy-sur-Cure: Yonne. XXXIV^e supplément, Gallia Préhistoire*.
 1046 CNRS Editions, Paris, pp. 257-266.

1047 White, R., 2007. Systems of personal ornamentation in the Early Upper Palaeolithic:
 1048 Methodological challenges and new observations. In: Mellars, P., Boyle, K., Bar-
 1049 Yosef, O., Stringer, C. (Eds.), *Rethinking the Human Revolution: New Behavioural
 1050 and Biological Perspectives on the Origin and Dispersal of Modern Humans*.
 1051 McDonald Institute for Archaeological Research, Cambridge, pp. 287-302.

1052 Wolf S., Kind C.-J., Conard N. J., 2013. Schmuck aus dem Aurignacien von der
 1053 Schwäbischen Alb im Vergleich mit Inventaren aus dem Lahntal und dem
 1054 Rheinland. *Archäologisches Korrespondenzblatt* 43, 295-313.

1055 Wolf, S., Conard, N.J., 2015. Aurignacian personal ornaments of the Swabian Jura.
 1056 In: White, R., Bourrillon, R. (Eds.), *Aurignacian Genius: Art, Technology and
 1057 Society of the First Modern Humans in Europe*. New York University, New York,
 1058 pp 330–344.

1059 Yas'ur, G., Ayalon A., Matthews, A., Zilberman, T., Marder, O., Barzilai, O., Boaretto,
 1060 E., HersHKovitz, I., Bar-Matthews, M., 2019. Climatic and environmental conditions
 1061 in the Western Galilee, during Late Middle to Upper Paleolithic period, based on
 1062 speleothems from Manot Cave, Israel. *Journal of Human Evolution*,
 1063 <https://doi.org/10.1016/j.jhevol.2019.04.004>

1064 Yeshurun R., Schneller-Pels N., Barzilai O., Marder O., 2019. Early Upper Paleolithic
 1065 subsistence in the Levant: Zooarchaeology of the Ahmarián–Aurignacian
 1066 sequence at Manot Cave, Israel. *Journal of Human Evolution*.
 1067 <https://doi.org/10.1016/j.jhevol.2019.05.007>

1068 Yeshurun, R., Tejero, J.-M., Barzilai, O., HersHKovitz, I., Marder, O., 2018. Upper
 1069 Palaeolithic bone retouchers from Manot Cave (Israel): A preliminary analysis of
 1070 an (as yet) rare phenomenon in the Levant. In: Hutson, J.M., García-Moreno, A.,
 1071 Noack, E.S., Turner, E., Villaluenga, A., Gaudzinski-Windheuser, S. (Eds.), *The*

1072 Origins of Bone Tool Technologies. Römisch-Germanisches Zentralmuseums,
1073 Mainz, pp. 287–296.

1074 Zilhão, J., 2006. Aurignacian, behavior, modern: issues of definition in the
1075 emergence of the European Upper Paleolithic. In: Bar-Yosef O, Zilhão J. (Eds.),
1076 Towards a Definition of the Aurignacian: Proceedings of the Symposium Held in
1077 Lisbon, Portugal, June 25-30, 2002. Instituto Português de Arqueologia, Lisbon, pp.
1078 53-70.

1079 Zilhão, J., 2007. The emergence of ornaments and art: An archaeological
1080 perspective on the origins of “behavioral modernity”. *Journal of Archaeological*
1081 *Research* 15, 1-54.

1082 Zilhão, J., Angelucci, D.E., Badal-García, E., d’Errico, F., Daniel, F., Dayet, L.,
1083 Douka, K., Higham, T.F.G., Martínez-Sánchez, M.J., Montes-Bernárdez, R.,
1084 Murcia-Mascarós, S., Pérez-Sirvent, C., Roldán-García, C., Vanhaeren, M.,
1085 Villaverde, V., Wood, R., Zapata, J., 2010. Symbolic use of marine shells and
1086 mineral pigments by Iberian Neandertals. *Proceedings of the National Academy of*
1087 *Sciences USA* 107, 1023-1028.

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1091 **Figure captions**

1092 **Figure 1.** Location of the sites mentioned in the text: 1 = Yabroud-II; 2 = Ksâr ‘Akil; 3
1093 = Manot Cave; 4 = Hayonim Cave; 5 = Sefunim; 6 = Kebara; 7 = El Quseir. Image
1094 courtesy of NASA/JPL/NIMA.

Figure 2. On the left, spatial distribution (A) and stratigraphic location (B–D) of perforated teeth from Hayonim Cave (red deer canines = yellow circles; bovid incisor = yellow triangle) plotted over the West–East sections of Stratum D. The Aurignacian area is shown in soft gray and hearths in dark gray in the cave plan (modified from Stiner et al., 2001: Fig. 1). On the right, the Manot Cave, general plan (E) and cross-section (F), with the location of the excavation areas and schematic composite section of the occupation layers in Area E. Based on the northwestern excavation sections.

Figure 3. Red deer vestigial canines of female (left) and male (right). Note the different morphology of both the root and crown.

Figure 4. Red deer vestigial canines: recorded morphometric variables (after d’Errico and Vanhaeren, 2002): A = perforation; B = distance between tooth buccal and lingual edges; C = distance between the perforation and the root base.

Figure 5. Red deer canines (A, B; specimens M105, M131) and bovid incisor (C; specimen M130) of Manot Cave (1, 2, 3).

Figure 6. Red deer canines (A–C; specimens H11, H53, H157) and bovid incisor (D; specimen H152) of Hayonim Cave (1–4). Image courtesy of Assaf Uzan (photographer).

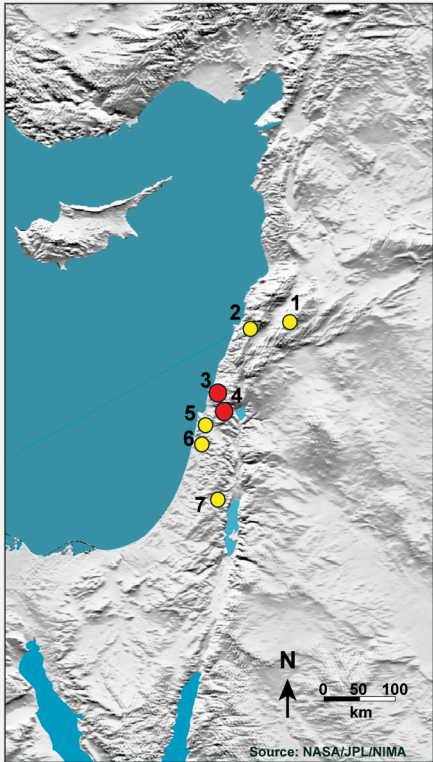
Figure 7. Preform of perforated red deer vestigial canine (H226) from Hayonim Cave. On the left, detail of the surface preparation by scraping (encircled in magenta line) and the unfinished perforation by gouging combined with rotational scraping (encircled in blue line; magnification 20×).

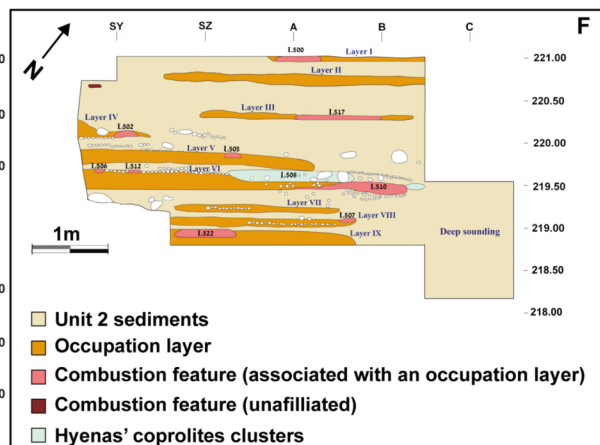
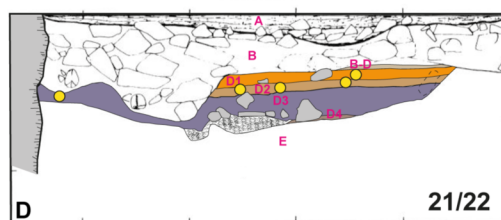
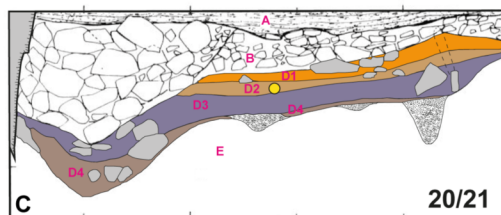
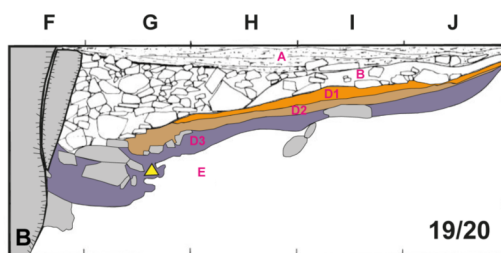
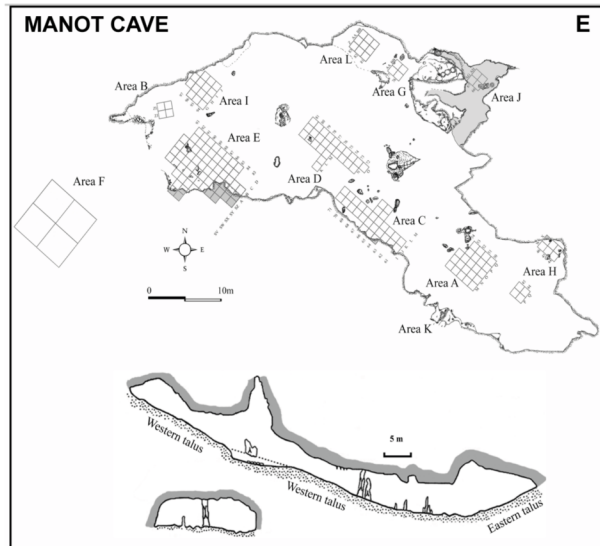
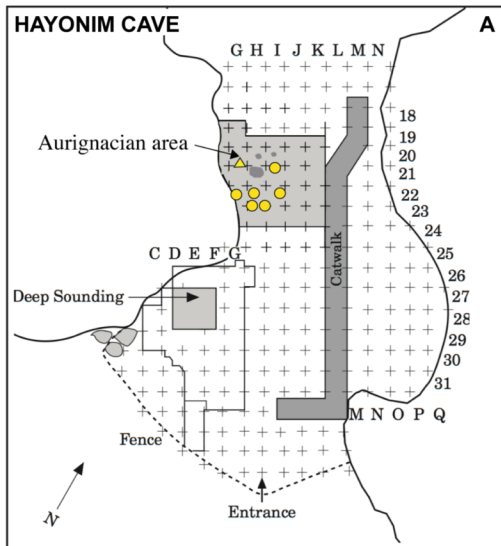
1117 **Figure 8.** Detailed scanning electron microscopy photographs of perforated red deer
1118 canines. A, B, G, H) Area of the perforation: rotation marks (in magenta) and use-
1119 wear polish (in blue). Use-wear polish masks the rotation striations (H11, H53). C, D)
1120 Marks of scraping (in brown) outside the hole to prepare the perforation zone. Note
1121 that scraping striations were cut by the perforation, showing the operational
1122 sequence, namely first preparation of the root and then perforation of the tooth
1123 (H157). E, F) Striations due to rotation action to perforate the tooth (H35).
1124 Magnifications: 32–100×.

1125 **Figure 9.** Detailed scanning electron microscopy photograph of an ocher stain on
1126 one of the red deer canines (H35) on top. The analysis shows the elements of the
1127 ocher stain composition on the bottom. Magnification: 1000×.

1128 **Figure 10.** Red deer canine perforated experimentally using ocher to increase the
1129 penetration of the lithic tool (A). Detailed microscopy photograph of the holes in
1130 lower (B) and upper (C) faces of the canine root showing the scraping striations and
1131 the ocher stains inside the perforations (detail scale 1 mm; magnification 15×).

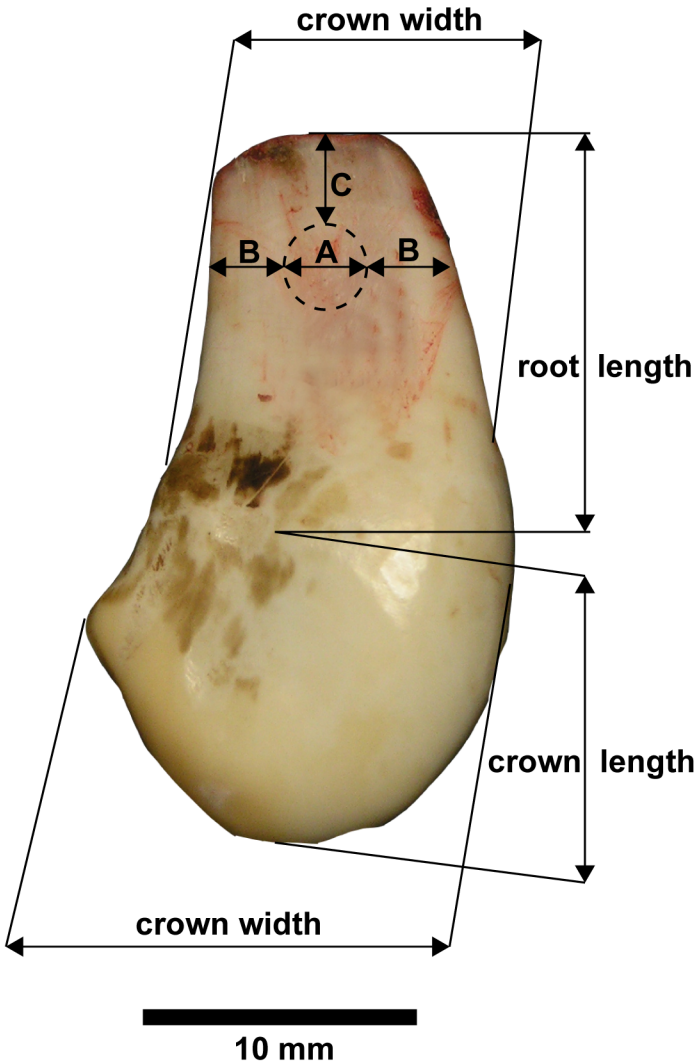
1132 **Figure 11.** Map with the location of Eurasian Aurignacian sites with worked red deer
1133 (*Cervus elaphus*) vestigial canines: 1 = Manot Cave; 2 = Hayonim Cave (Israel); 3 =
1134 Istallösko (Hungary); 4 = Sandalja (Croatia); 5 = Fossellone (Italy); 6 = Hohle Fels; 7
1135 = Vogelherd (Germany); 8 = Spy; 9 = Princesse; 10 = Goyet; 11 = Trou Magrit
1136 (Belgium); 12 = Saint Césaire; 13 = La Quina; 14 = Rois; 15 = La Ferrassie; 16 =
1137 Castanet; 17 = Le Piage; 18 = Balauziere; 19 = Pecheurs (France); 20 = Reclau
1138 Viver (Spain); 21 = Tuto de Camalhot; 22 = Grotte des Hyenes; 23 = Gatzarria; 24 =
1139 Isturitz (France); 25 = Covalejos; 26 = Cueva Morín (Spain). Image courtesy of
1140 NASA/JPL/NIMA.







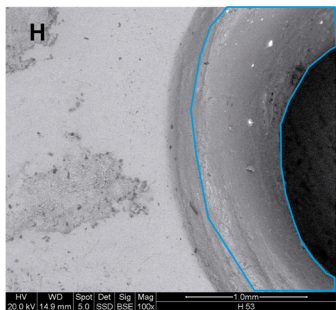
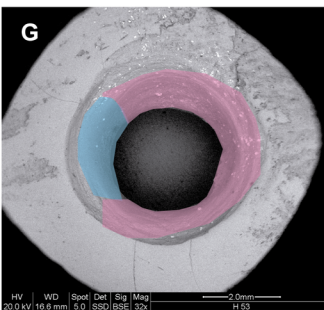
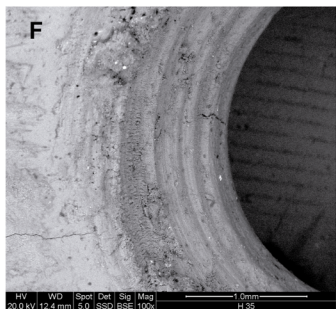
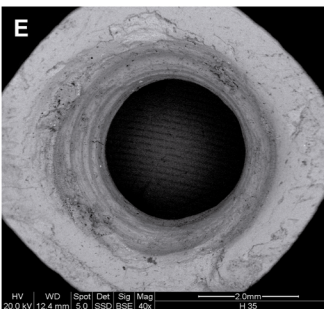
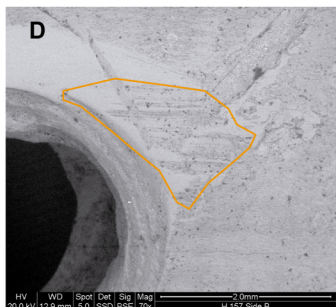
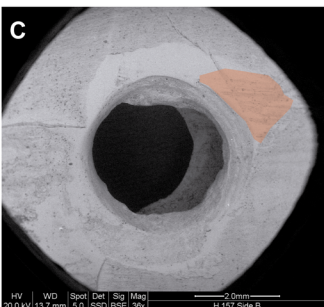
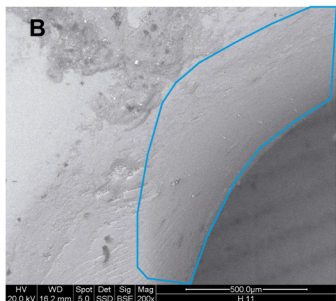
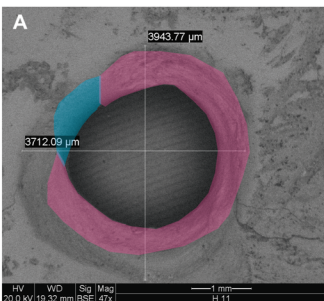
2 cm



A**M105**
2 mm**B****M131****C**
10 mm**M130**

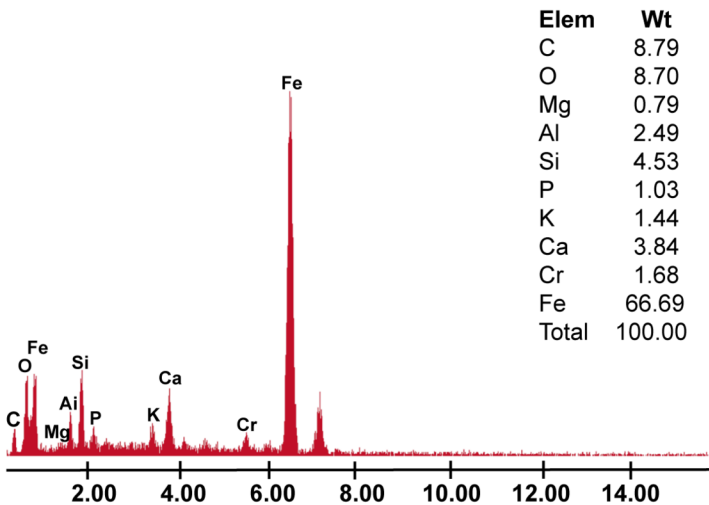


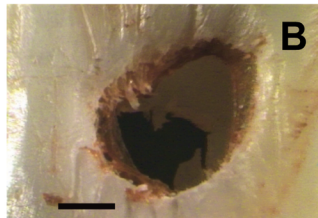
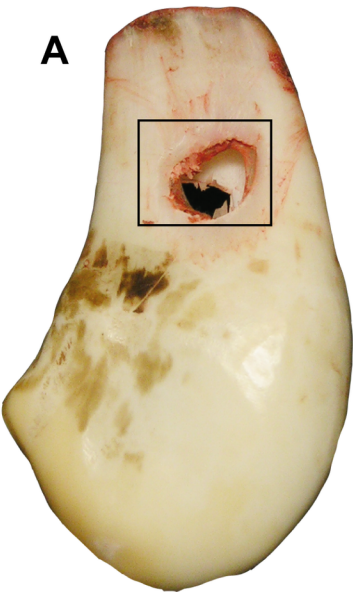
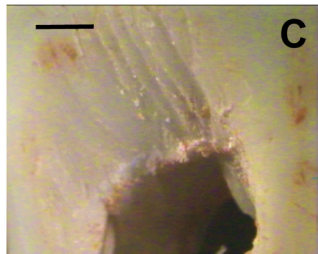






Label A: H35



A**B****C**

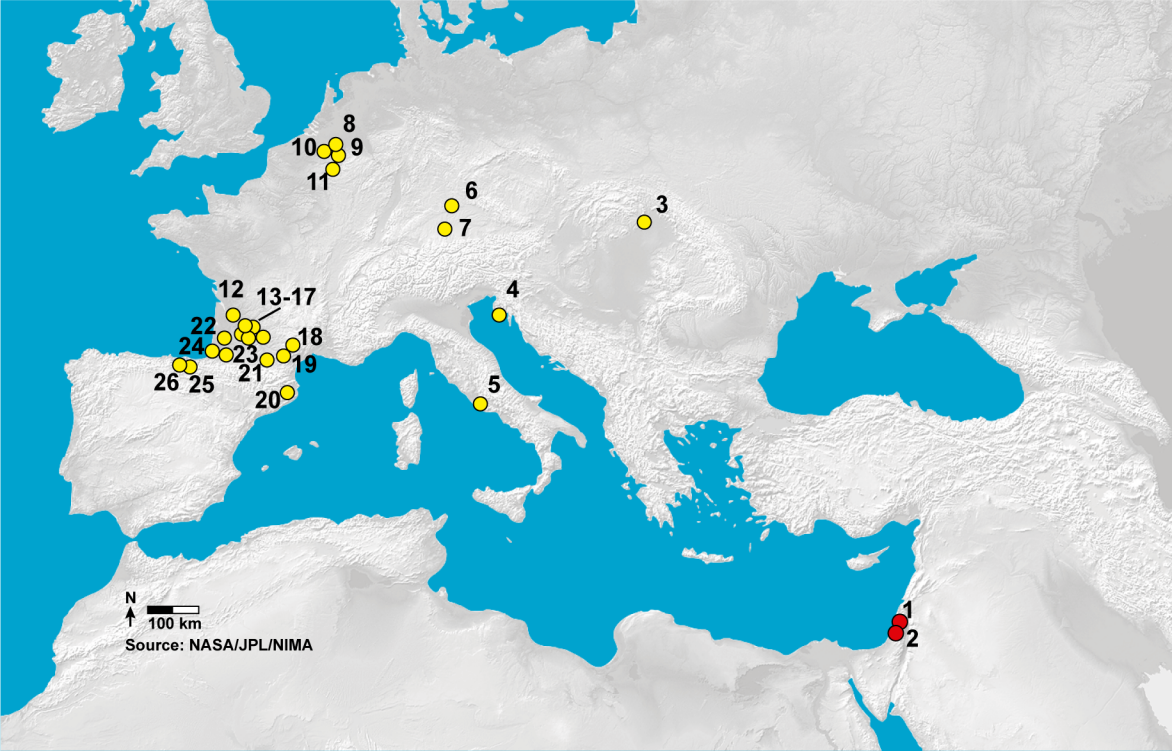


Table 1

Pendants from Hayonim and Manot caves.

Site	Number	Area	Unit	Layer	Square	Species	Tooth	Sex	Side
Hayonim cave	H11	—		D	H22/I22	<i>Cervus elaphus</i>	vestigial canine	male	right
Hayonim cave	H35	—		D	H21a	<i>Cervus elaphus</i>	vestigial canine	male	left
Hayonim cave	H53	—		D	H22d	<i>Cervus elaphus</i>	vestigial canine	male	right
Hayonim cave	H157	—		D1-2	I22d	<i>Cervus elaphus</i>	vestigial canine	male	left
Hayonim cave	H179	—		D	F22	<i>Cervus elaphus</i>	vestigial canine	male	left
Hayonim cave	H226	—		D2	H22	<i>Cervus elaphus</i>	vestigial canine	male?	right
Hayonim cave	H152 ^a	—		D4	G20	<i>Bos primigenius</i>	incisor	—	
Manot cave	105	E	2	5	SY89b	<i>Cervus elaphus</i>	vestigial canine	male	right
Manot cave	130	C	6	—	j66d	Bos	incisor	—	
Manot cave	131	E	test pit	—	c87	<i>Cervus elaphus</i>	vestigial canine	male	left
Manot cave	132	E	test pit	—	c86	<i>Cervus elaphus</i>	vestigial canine	male	left

^a This specimen was first described as a horse tooth (Belfer-Cohen and Bar-Yosef, 1981)

Table 2

Red deer vestigial canines pendants morphometry (d'Errico and Vanahaeren, 2002; see Fig. 4).

Number	Root length	Root width	Root apex width	Root thickness	Ratio L/T	Crown L	Crown W	Crown T	Length of occlusal surface	Width of occlusal surface	Wear stage of occlusal surface	Root apex	Pulp cavity	Distolinguocervical lobe
H11	17	11	8	5	3.4	12	15	8	17	8	highly	closed	not visible	absent
H35	15	12	8	5	3	—	12	—	—	—	—	just closed	not visible	-
H53	17	11	8	5	3.4	9	10	8	20	10	highly	closed	not visible	absent
H157	15	8.5	7	4	2.2	12	12	7	12	6	affected	open	visible	present
H179	15	8	5	4	3.7	8	10	5	12	6	affected	closed	not visible	present
H226	10	8	5	5	2	8.5	7	5	6	3	highly	closed	not visible	absent

105	9	12	8	4	3	13	—	9	6	4	affected	closed?	visible?	present
131	11	12	8	5	2.2	11	11	8	11	8	affected	closed?	not visible?	present
132	11	8	5	4	2.7	9	10	6	10	7	affected	closed	not visible	present

Abbreviations: L = length; W = width; T = thickness.

Table 3

Detail description of the pendants perforation of Hayonim and Manot Caves.

Number	Type	Preparation of the surface	Perforation procedure	Perforation shape	Diameter (mm)	Distance between tooth buccal and lingual edges (mm)	Distance between the perforation and the root base (mm)
H11	perforation	scraping	bifacial gouging + rotational scraping	subcircular	4 × 3.8	3.5/4	4
H35	perforation	scraping	bifacial gouging + rotational scraping	circular	4 × 4	5/5	8
H53	perforation	—	bifacial rotational scraping	circular	4 × 4	3.5/4	6
H157	perforation	scraping	bifacial gouging + rotational scraping	subcircular	3 × 3.5	2.5/3	8
H179	perforation	—	bifacial rotational scraping	circular	3 × 3	2/2	6
H226	unfinished perforation	scraping	—	—	—	—	—

H152	perforation	scrapping	bifacial gouging + rotational scrapping	subcircular	4 × 5	2/2	15
105	perforation	—	bifacial gouging	subcircular	2 × 2.5	3.5/3.5	3
130	perforation	scrapping	bifacial gouging	oval	5 × 3	3/3	6
131	perforation	—	bifacial gouging	oval	4 × 2	3/4	3
132	perforation	—	bifacial gouging	subcircular	2 × 2.5	2/3	2

Table 4

Use-wear marks and ocher stains (see Fig. 9).

Number	Use wear marks	Use-wear marks location	Ochre stains	Ocher stains location
H11	polish	Upper (distal) part of perforation	no	—
H35	no	—	no	—
H53	polish	Upper (distal) part of perforation	yes	root and crown bucal face
H157	polish	Upper (distal) part of perforation	no	—
H179	no	—	no	—
H226	—	—	yes	root (bucal and vestibular faces)
H152	no	—	no	—
105	polish	Upper (distal) part of perforation	no	—
130	polish?	Upper (distal) part of perforation	no	—
131	—	—	yes	root and crown bucal and vestibular faces
132	polish?	Upper (distal) part of perforation	yes	inside the perforation