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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 Ahmarian 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.,

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

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

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

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

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

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

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

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

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

As the development of UP technotypological traditions following the dispersal of AMH in Eurasia, is among the most hotly debated topics, it seems essential to examine and evaluate the variability among human groups, as regards both differences and commonalities. Such studies are of great help in identifying the directions and trajectories of dispersals and the establishment of regional territories (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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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).

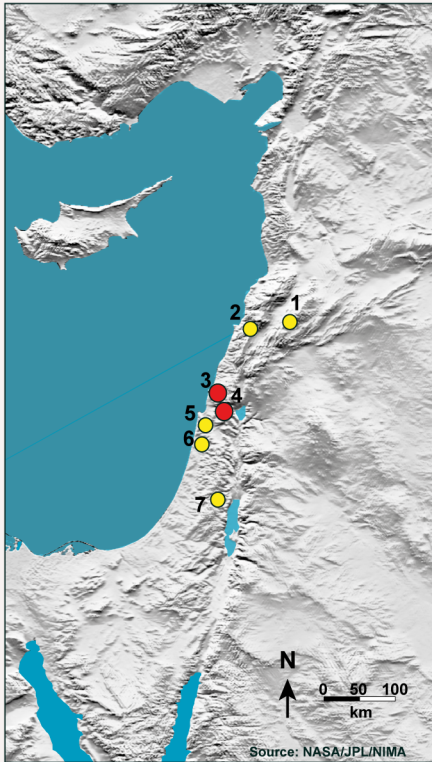
Figure 7. Preform of perforated red deer vestigial canine (H226) from Hayonim Cave. On the left, detail of the surface preparation by scraping (encircled in magenta line) and the unfinished perforation by gouging combined with rotational scraping (encircled in blue line; magnification 20×).

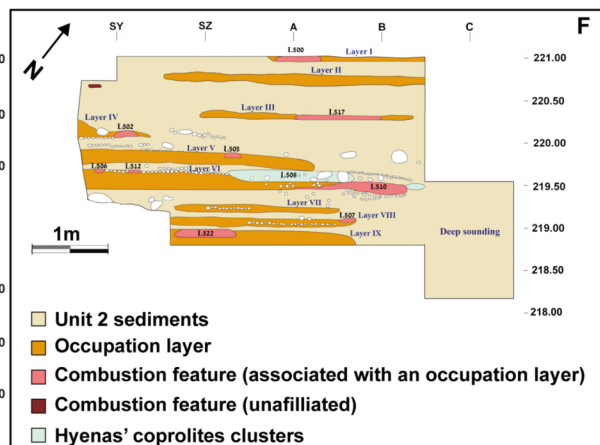
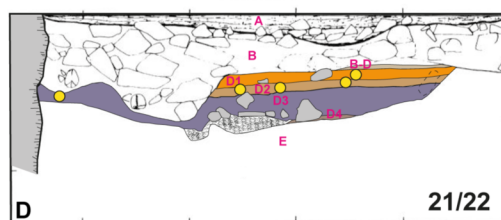
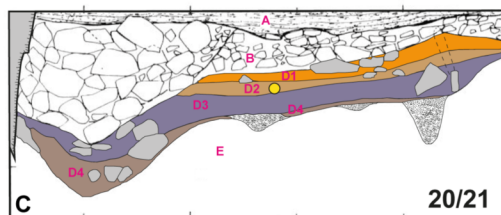
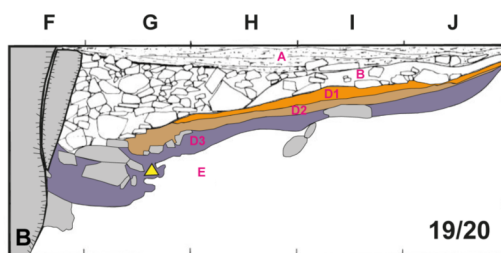
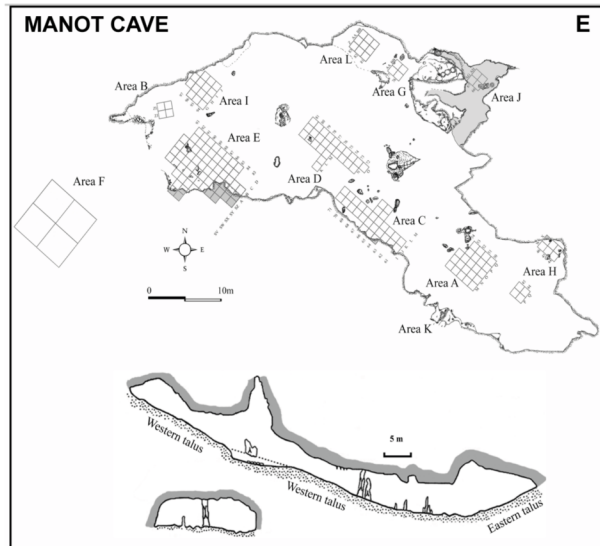
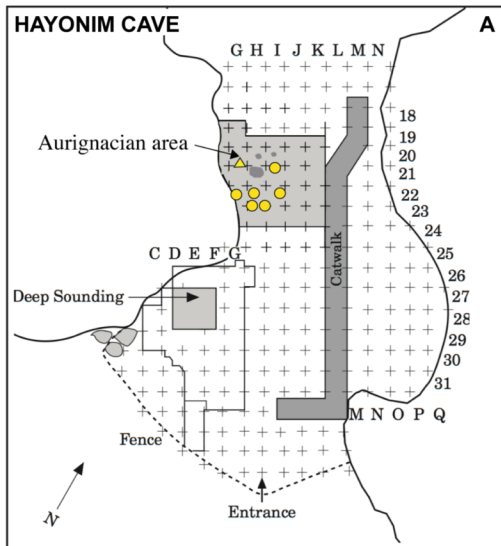
1117 **Figure 8.** Detailed scanning electron microscopy photographs of perforated red deer
1118 canines. A, B, G, H) Area of the perforation: rotation marks (in magenta) and use-
1119 wear polish (in blue). Use-wear polish masks the rotation striations (H11, H53). C, D)
1120 Marks of scraping (in brown) 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×).

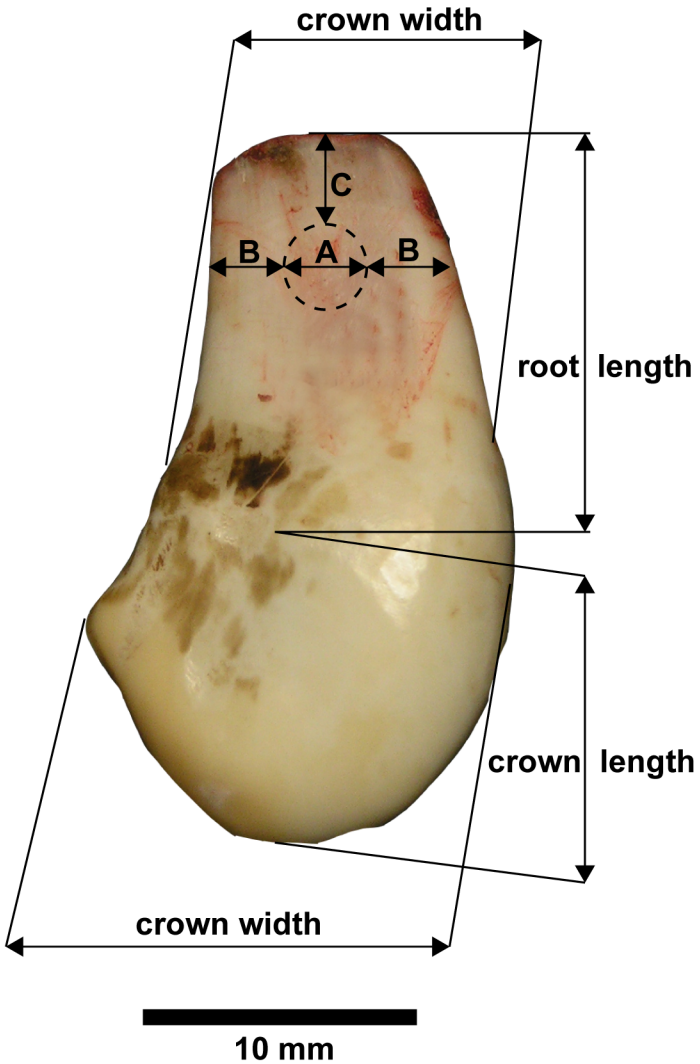
1132 **Figure 11.** Map with the location of Eurasian Aurignacian sites with worked red deer
1133 (*Cervus elaphus*) vestigial canines: 1 = Manot Cave; 2 = Hayonim Cave (Israel); 3 =
1134 Istallösko (Hungary); 4 = Sandalja (Croatia); 5 = Fossellone (Italy); 6 = Hohle Fels; 7
1135 = Vogelherd (Germany); 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 = Pêcheurs (France); 20 = Reclau
1138 Viver (Spain); 21 = Tuto de Camalhot; 22 = Grotte des Hyènes; 23 = Gatzarria; 24 =
1139 Isturitz (France); 25 = Covalejos; 26 = Cueva Morín (Spain). Image courtesy of
1140 NASA/JPL/NIMA.







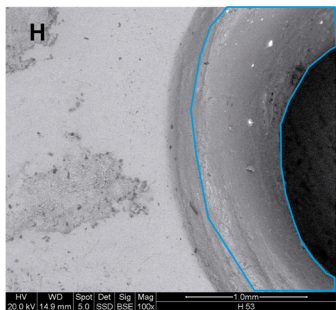
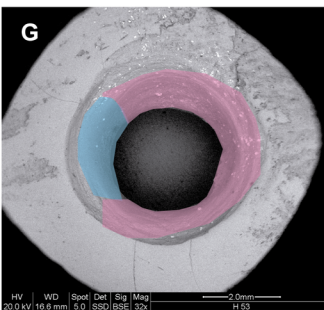
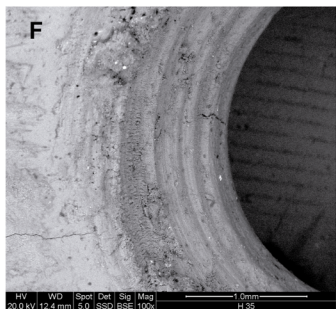
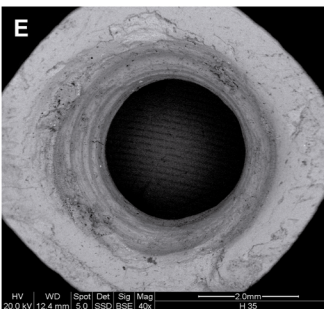
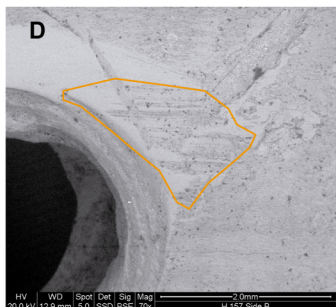
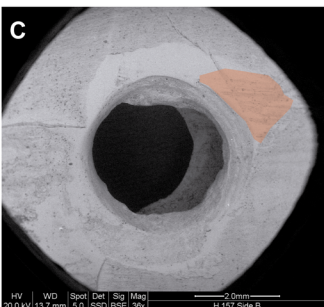
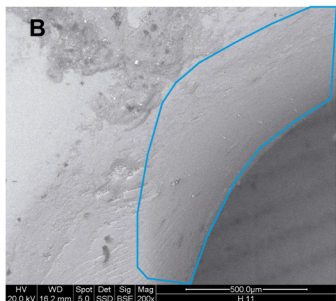
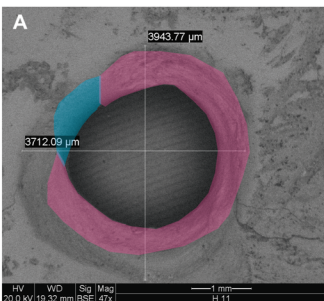
2 cm



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

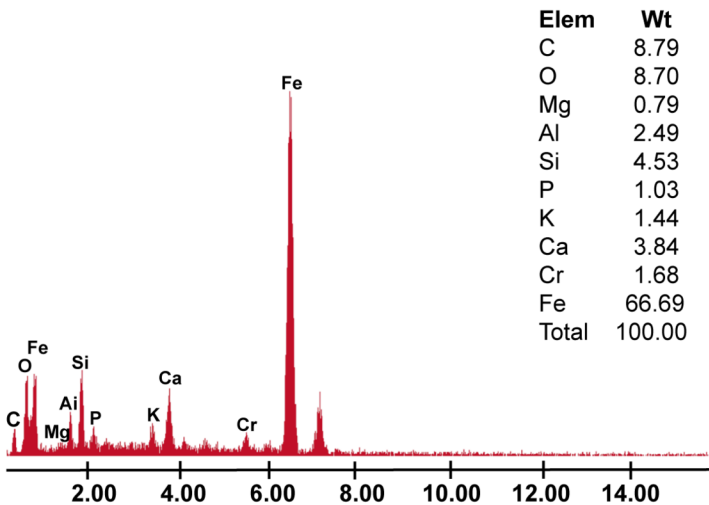


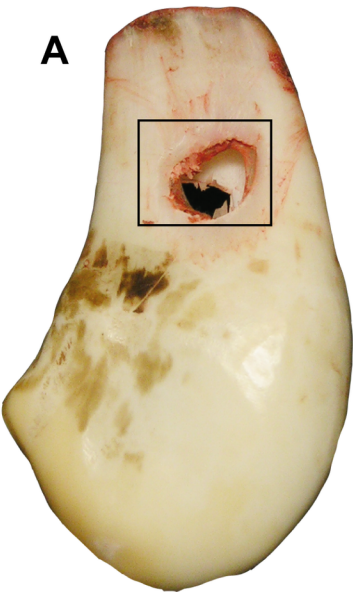
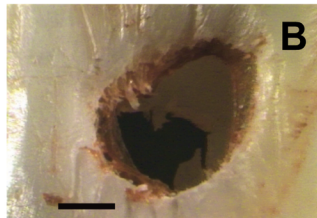
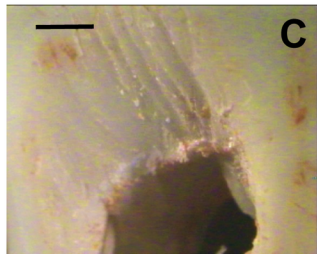






Label A: H35



A**B****C**

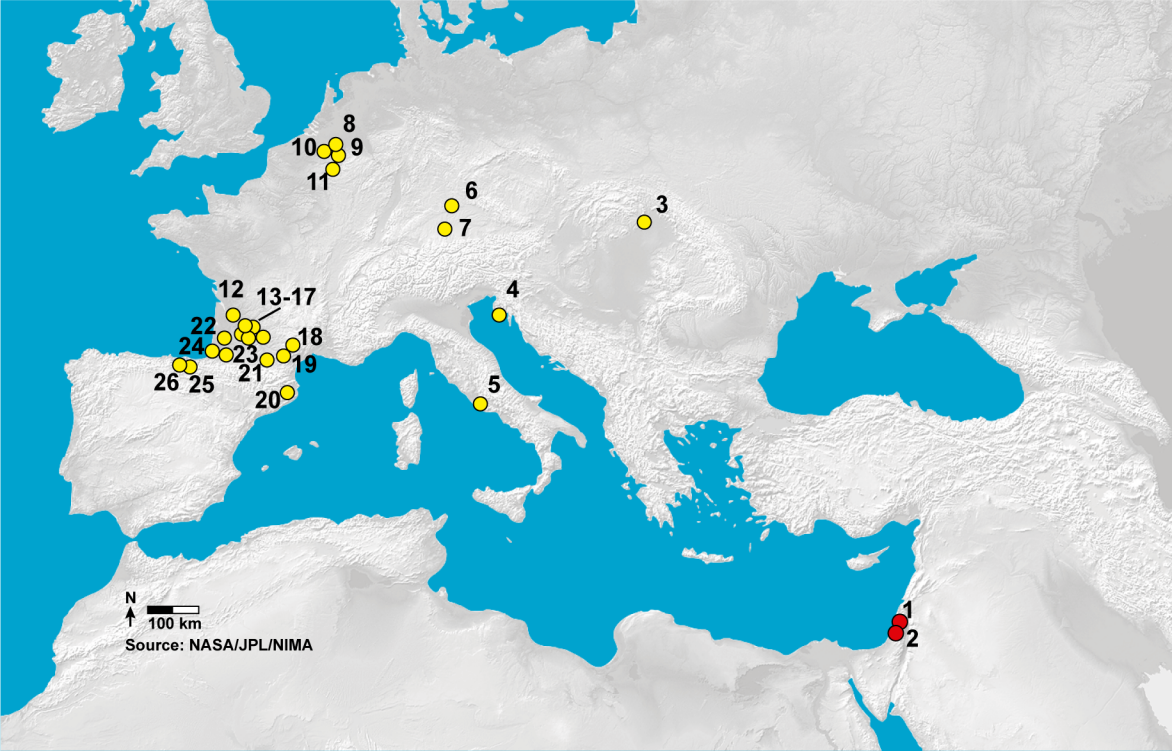


Table 1

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	Distolingual cervical 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