Symbolic emblems of the Levantine Aurignacians as a regional entity identifier (Hayonim Cave, Lower Galilee, Israel)

José-Miguel Tejero[a,b,1], Anna Belfer-Cohen[c], Ofer Bar-Yosef[d], Vitaly Gutkin[e], and Rivka Rabinovich[f,g,1]

[a]CNRS, UMR 7041, ArScAn Équipe Ethnologie Préhistorique, 92023 Nanterre, France; [b]Seminari d'Estudis I Recerques Prehistòriques, Universitat de Barcelona, 08001 Barcelona, Spain; [c]Institute of Archaeology, The Hebrew University of Jerusalem, 91905 Jerusalem, Israel; [d]Department of Anthropology, Harvard University, Cambridge, MA 02138; [e]The Center for Nanoscience and Nanotechnology, The Hebrew University of Jerusalem, 91094 Jerusalem, Israel; [f]Institute of Earth Sciences, National Natural History Collections, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel; and [g]Institute of Archaeology, The Hebrew University of Jerusalem, 91905 Jerusalem, Israel

Edited by Richard G. Klein, Stanford University, Stanford, CA, and approved February 16, 2018 (received for review October 5, 2017)

The Levantine Aurignacian is a unique phenomenon in the local Upper Paleolithic sequence, showing greater similarity to the West European classic Aurignacian than to the local Levantine archaeological entities preceding and following it. Herewith we highlight another unique characteristic of this entity, namely, the presence of symbolic objects in the form of notched bones (mostly gazelle scapulae) from the Aurignacian levels of Hayonim Cave, Lower Galilee, Israel. Through both macroscopic and microscopic analyses of the items, we suggest that they are not mere cut marks but rather are intentional (decorative?) human-made markings. The significance of this evidence for symbolic behavior is discussed in its chrono-cultural and geographical contexts. Notched bones are among the oldest symbolic expressions of anatomically modern humans. However, unlike other Paleolithic sites where such findings were reported in single numbers, the number of these items recovered at Hayonim Cave is sufficient to assume they possibly served as an emblem of the Levantine Aurignacian.

Upper Paleolithic | Levantine Aurignacian | Near East | bone tools | human symbolic behavior

The Aurignacian is one of the Upper Paleolithic (UP) traditions whose origins, definition, and diffusion are among the most debated topics related to modern human colonization of Eurasia. Far from being a homogenous entity, the Aurignacian *grosso modo* features a wide range of diversity, both diachronically (e.g., the Proto-Aurignacian, Early Aurignacian, and Evolved Aurignacian in Europe) and within each facies (e.g., refs. 1–3). According to the latest radiocarbon dates, the Levantine variety, termed "Levantine Aurignacian," seems, at least in part, contemporaneous with the European Evolved Aurignacian (4–10). Still, linking the Levantine Aurignacian with any particular phase of the European Aurignacian facies is rather problematic, as, in fact, it shares certain features with both the Early Aurignacian and the Evolved Aurignacian. Those relate to the lithic techno-typology and the bone and antler industry (5, 6, 11).

The West European Aurignacian complex is quite well known *vis-à-vis* its lithic and bone industries (e.g., refs. 1, 2, and 12–20) and personal ornaments (21–23). Its chronology, although frequently debated, is currently based on absolute dating and relative dating (i.e., stratigraphy) as well as on comparisons of the material remains, mostly lithic techno-typology (e.g., refs. 9, 24, and 25). The Levantine Aurignacian has been defined mainly on the basis of the techno-typological characteristics of the lithics, e.g., nosed and frontal carinated items, retouched bladelets (Dufour), and el Wad points, among others, and on the basis of a rich bone and antler industry. Thus far it has been reported from cave and rock-shelter sites in the Mediterranean Zone (e.g., Hayonim, Kebara, Ksar Akil, Manot, Sefunim, el Wad, Yabrud) with only rare occurrences in bordering regions (e.g., el Quseir, in the Judean desert). Considered to be of a relatively short duration (between *ca*. 37/8–34/5 ka cal. BP) (4), it interrupts a sequence of what is considered as locally evolved archaeological entities (for a detailed account of the Levantine Aurignacian, the history of its research, and its place in the Levantine UP sequence, see refs. 6 and 26–29 and references therein). We would like to suggest yet another characteristic feature, namely, a specific symbolic marker, pertaining to ritual dynamics which lie at the core of human self-definition as a group, society, or culture (12).

Evidence pertaining to human symbolic behavior in Europe dates from 40 ka onwards (23, 30–32), with that from Aurignacian contexts being rather prominent (e.g., refs. 33–37). Conversely, evidence of a symbolic nature from the Levantine UP is rather scarce (e.g., refs. 6, 27, 28, 38, and 39 and references therein).

Hayonim Cave

Hayonim Cave is situated in the Western Galilee, Israel, about 13 km from the Mediterranean coast, on the right bank of Wadi Izhar, some 50 m above the present Wadi channel (Fig. 1) (40). The Levantine Aurignacian occupation (stratum D, comprising three consecutive layers, D4, D3, and D1–2) is quite small in extent (15 m^2) but rich in material culture remains, including hearths, ash spots, evidence of ochre use, and a dense faunal assemblage. The chipped stone industry shows a high Aurignacian

Significance

The emergence and diffusion of Upper Paleolithic (UP) typo-technical traditions are among the most debated topics related to anatomically modern humans' colonization of and establishment in Eurasia. The Levantine Aurignacian represents one of the UP cultural entities in the Near East, and its origins, spread, and interrelationships with other UP entities are central to the understanding of local UP dynamics. The data we present demonstrate that the notched bones from Hayonim Cave stratum D are unquestionably anthropic marks constituting an emblem of the Levantine Aurignacian. Assessment of data from Middle Stone Age and UP sites of Africa and Europe as well as other UP sites in the Levant supports the notion that this is indeed a unique feature of the Levantine Aurignacian.

Author contributions: J.-M.T. and R.R. designed research; J.-M.T., A.B.-C., and R.R. performed research; J.-M.T., V.G., and R.R. analyzed data; and J.-M.T., A.B.-C., O.B.-Y., and R.R. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

[1]To whom correspondence may be addressed. Email: jose-miguel.tejero@mae.cnrs.fr or rivkar@mail.huji.ac.il.

This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1717145115/-/DCSupplemental.

Published online April 30, 2018.

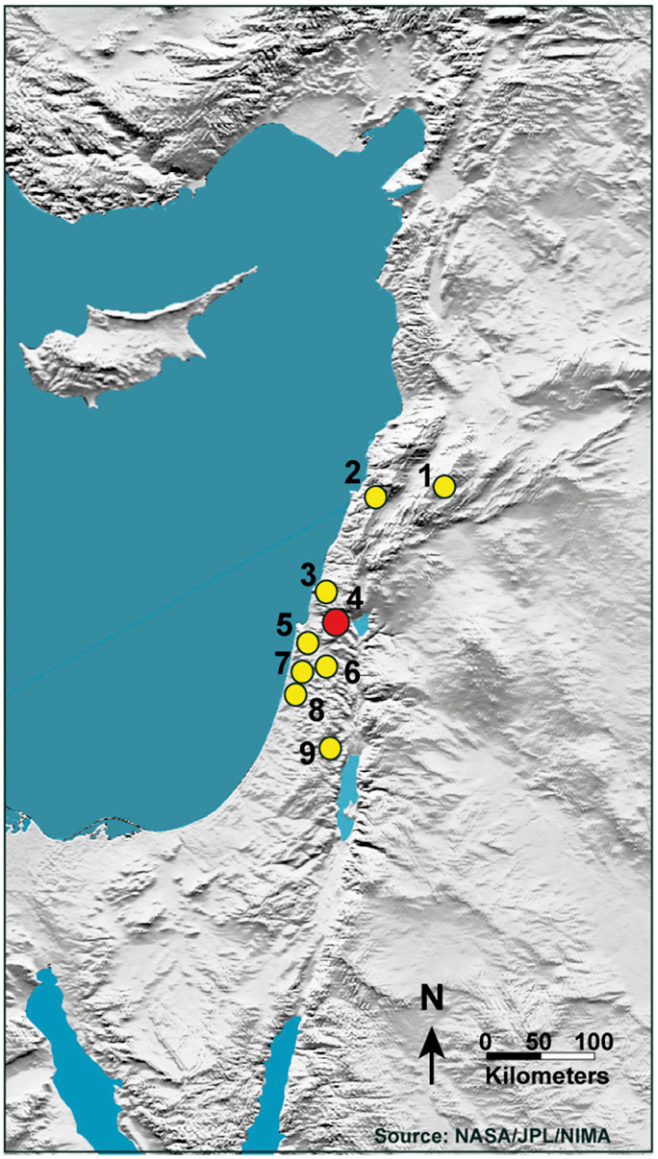

Fig. 1. Geographical location of Hayonim Cave (Lower Galilee, Israel); EUP sites with Levantine Aurignacian layers mentioned in the text. (1) Yabroud II, (2) Ksar Akil, (3) Manot Cave, (4) Hayonim, (5) Sefunim, (6) Raqefet, (7) El Wad, (8) Kebara, (9) El Quseir. Image courtesy of NASA/JPL/NIMA.

index. It also displays a number of specific traits such as a near absence of el-Wad points and a high percentage of microliths (*Hayonim Cave*) (41).

Results

The Notched Items. The notched items comprise eight scapulae and one hyoid of gazelle. The specimens were recovered throughout the entire stratum D (Table 1, *The Notched Items of Hayonim D and Other Levantine Sites*, *Spatial Distribution of the Notched Items*, and Fig. S4).

As the surfaces of the bones are well preserved, with little erosion and sediment concretions, detailed examination of the notches was possible. The scapulae and the hyoid alike each display a series of 3 up to 32 notches. Unfortunately, in only one case (scapula HD540) is the series complete, as all the others display postdepositional fractures. The location of the notches over the scapulae is repetitive, along the posterior border, over the costal aspect, the medial aspect, or near the posterior angle (Figs. 2 and 3). This location is probably dictated by the relative thickness of this part compared with other parts of the scapula and its convenient shape for producing incisions. The notches were 0.5- to 2.5-mm long; in each series they are separated by 0.5–7 mm and cover an area that varies between 12 and 52 mm in length. All the notches were made by one stroke, likely with the same lithic tool, on fresh bone, as seen in the resemblance that the notches show in their cross-section morphology (V cross-section) and angles (Fig. 4 *I* and *J* and Table S1) (e.g., refs. 37 and 42).

The notches were made on preprepared surfaces scraped perpendicularly to the notches' orientation. It is important to note that only the notched area on the bone is scraped; thus it is clearly related to the notch production (Fig. 4*A*). The notches were made by a to-and-fro sawing movement, most probably with the cutting edge of a lithic artifact. We failed to observe use wear similar to that noticed at the site of Klasies River Mouth (dated to the Middle Stone Age, MSA) (43) inside or outside the notches. There was fine sediment which was still adhering to some of them.

It is important to stress that, contrary to other Levantine Aurignacian objects made of bone, the notched scapulae were modified through a relatively complex process. The rest of the modified bone objects, mainly awls and "intermediate" pieces (chisels), most probably intended for domestic activities, were minimally modified, as in the case of the chisels, or modification was concentrated mostly at the active part, as in awls (i.e., modifying the pointed distal extremity to transform a bone splinter into an awl) (11, 18).

Notches and Cut Marks. The data pertaining to bone artifacts require detailed taphonomic research to identify the various agents and activities that modify bones, in particular butchery-related activities *contra* other, intentional bone modifications.

Surface modifications of the Hayonim D fauna remains were studied and described in detail (refs. 40 and 41 and *Supporting Information*). Cut marks were observed on the head, trunk, and limbs of gazelles, suggesting that the entire consumption process, from skinning to limb severing and meat filleting, took place on site in a repetitive, methodical way. In particular, the gazelle's scapulae exhibit signs of both filleting and dismemberment. Cut

Table 1. Hayonim D notched bones

Specimen ID	Location	Taxa	Anatomic element	Layer	Square	Elevation top (cm)	Elevation bottom (cm)
10,110	HUJI	*G. gazella*	Hyoid (great cornu, R)	D1-2	I22a	230	—
HD231	HUJI	*G. gazella*	Scapula	D3	F21	—	—
HD537	IMJ	*G. gazella*	Scapula (R)	D	—	—	—
R538	HUJI	*G. gazella*	Scapula (L)	D3	G19	240	260
R539	HUJI	*G. gazella*	Scapula (R)	D1-2	H21,d	220	225
HD540	IMJ	*G. gazella*	Scapula (L)	D1-2	I21 c+a	220	225
HD541	IMJ	*G. gazella*	Scapula (R)	D1-2	G21 c	230	235
R7049	HUJI	*G. gazella*	Scapula (R)	D1-2	G21 c	230	235
R7053	HUJI	*G. gazella*	Scapula (L)	D1-2	H19	210	214

HUJI, National Natural History Collections, Hebrew University of Jerusalem, Israel; IMJ, Israel Museum Jerusalem, Israel.

Fig. 2. Anatomical position of four notched gazelle scapulae from Hayonim D, plotted over complete gazelle scapulae from the comparative mammalian collection of the National Natural History Collections at the Hebrew University of Jerusalem.

marks are most common on the distal scapulae, encircling the glenoid cavity. Cuts appear on lateral and costal surfaces around the neck and over the neck's distal border, while short cutting marks are also noticeable over the posterior and anterior borders on the scapula blade (Figs. 3 and 4 *B* and *D* and Fig. S1). These marks are known to result from the dismemberment of the scapula from the humerus. Longitudinally oriented filleting marks were seen along the supra and infraspinous fossae and up and down the medial face of the scapula. Cut-marked scapulae are relatively abundant (D1–2: 27%; D3: 22%; and D4: 30%), with a few filleting marks observed over the blade of the scapula (D4: 1%; D3: 4%: D1–2: 1%) (Fig. S1) (44, 45).

Thus, we had the opportunity to compare the notches on the artifacts discussed herein with those on numerous modified bones of the same species. Notches were differentiated from cut-marks on the basis of three main criteria: (*i*) anatomical location on the bone; (*ii*) size of the marks; and (*iii*) mode of manufacture.

First, the two show a clear disparity regarding anatomical location. While the intentional notches on gazelle scapulae from Hayonim Cave D were always observed on the posterior border of the scapula, the butchery marks are variously located, depending on the specific activity performed. The notches are significantly wider (1.2–1.5 mm vs. 0.3–0.5 mm) and longer (4–4.5 mm vs. 1.2–1.5 mm) than the cut marks (Fig. 4 *E*–*H*, Fig. S2, and Table S2).

The notches were made on preprepared scraped surfaces by sawing motions (see above) markedly different from the production of the cut marks or hack marks (Fig. 4 *C* and *E* and Fig. S3).

The notches observed on the delicate gazelle hyoid also clearly indicate an intentional choice of a specific surface to produce the desired marking accurately (Fig. S3).

Discussion

What Do the Notched Bones Mean? Flat, notched bones may have conveyed certain information, thus serving as means of intra- and intergroup communication (46). Nevertheless, since the items from Hayonim (and from the other Levantine Aurignacian sites, Kebara and Manot Caves; see below) are not complete, it is difficult to evaluate their possible role. If we assume that these objects did convey some kind of information, they may have been worn as distinctive personal objects attached to clothes or as pendants. Indeed, pendants made of organic materials of a similar size-range and heavier than gazelle scapulae are still used by some African indigenous peoples, such as the Himba (Namibia), to indicate women's marital status (47). Be that as it may, it is unlikely that the scapulae were meant to be hung from their proximal end, as this part is thin and fragile. It is perhaps more likely that they

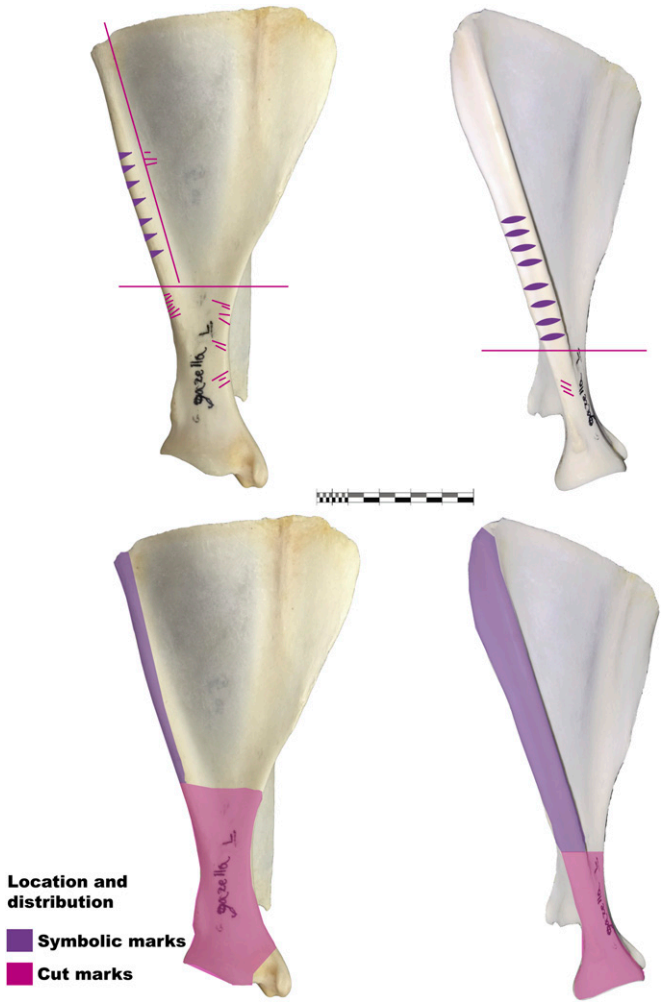

Fig. 3. Anatomical position of the symbolic marks (notches, in purple) and cut marks (magenta) over gazelle scapula, reconstructed from the Hayonim D items.

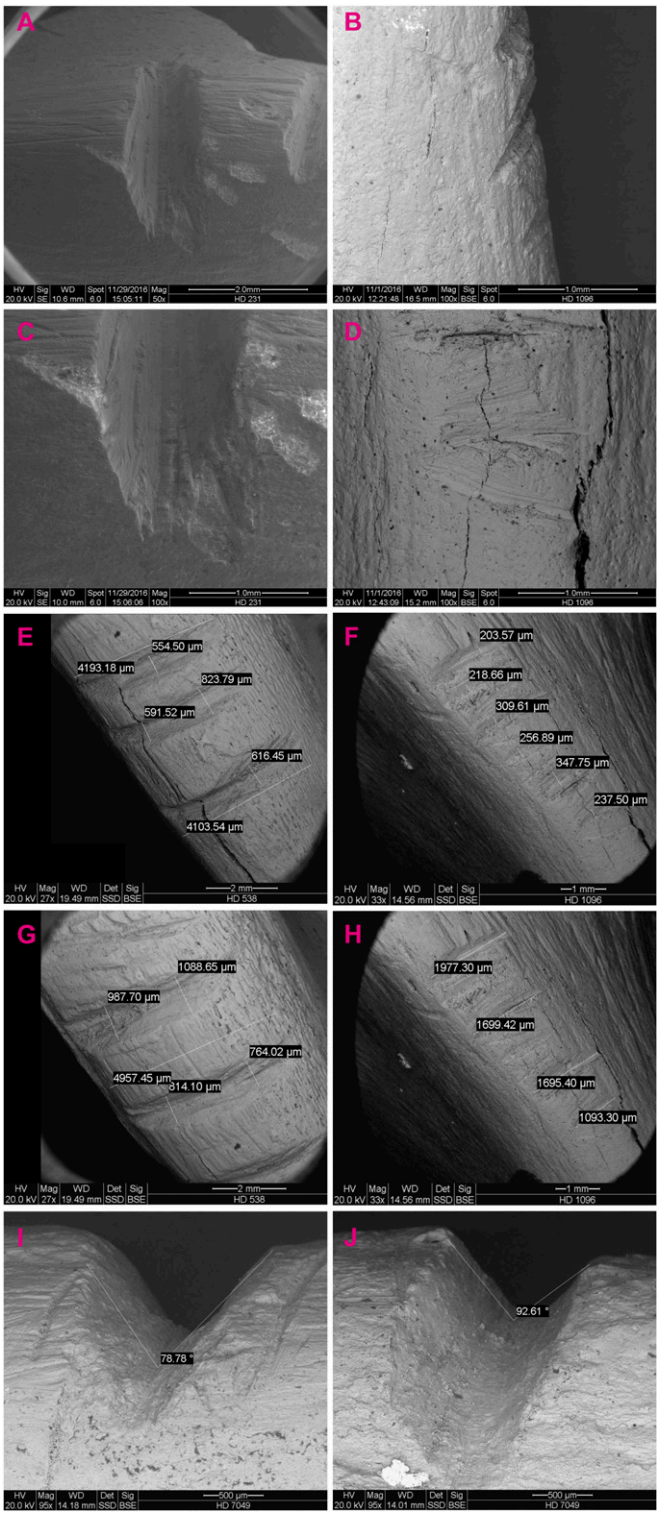

Fig. 4. Detailed scanning electron microscopy photographs of notches and cut marks from Hayonim D showing their morphology, size, and cross-section. (*A*) A notch cuts the scraping preparation marks (perpendicular striations). (*A*–*D*) Note the different morphology of notches (HD231) (*A* and *C*) in comparison with cut marks (HD1096) (*B* and *D*). (*E*–*H*) The difference in notch size (R538) (*E* and *G*) compared with that of the cut marks (HD1096) (*F* and *H*). (*I* and *J*) Scanning electron microscopy images of two notches' inner cross-section angles. Scanning electron microscopy images were obtained using a FEI Quanta 200 ESEM. (Magnifications: 27×–100×).

had pieces of string encircling the scapula at its neck (nearer to the distal end). However, microscopic analyses have not shown any use-wear traces for any such scenario.

Some authors suggested that this type of mark could be linked with a notation system marking lunar phases (e.g., ref. 48). However, the notches discussed here were most probably made in one session, on fresh bone, and likely by the same lithic tool; therefore this hypothesis is improbable (e.g., refs. 49 and 50; see *Further Discussion of Notched Bone Significance in the Levantine Aurignacian* for further discussion).

Notched Gazelle Bones as a Regional Entity Emblem of the Levantine Aurignacian. Notched flat bones are among the oldest symbolic manifestations of anatomically modern humans (AMH) (30, 32, 46, 51, 52). They have been documented from the MSA in Africa as well as from the Eurasian UP Aurignacian entities (Proto-Aurignacian, Early Aurignacian, and Levantine Aurignacian) (Fig. S5). Recently, a similar type of decorative pattern has been reported from a late Middle Paleolithic level at Zaskalnaya (Crimea) attributed to a Neanderthal occupation (37).

The Aurignacian symbolic manifestations, namely personal ornaments as well as graphic, mobile, and stationary art, of Eurasia seem to show a significant variability on a continental scale (23, 53). Indeed, Aurignacian groups do exhibit a broad similarity of graphic expression; however, at the same time, regional-specific characteristics do occur (54). Characterizing these diverse entities is thus crucial to understand the dynamics of the interrelationships between them, whether reflecting kin-ties or diachronic trends.

Three notched bones are known from the African MSA sites of the Klasies River Mouth and Border Caves (South Africa) (46). In Europe, Middle Paleolithic Micoquian and early UP Proto-Aurignacian contexts have yielded single examples found respectively in Zaskalnaya VI (37) and Riparo Mochi (Italy) (20). Early Aurignacian notched bones ($n = 11$) were reported from diverse regions of Europe (Belgium, southwest France, and Central Europe). Most sites have yielded only one or two items, and apparently the diversity is not related to regional variations, as it is observed both within sites (e.g., La Quina, Castanet, Princesse) and between sites in the same region (e.g., Castanet and Cellier in Dordogne; Brassempouy and Isturitz in southwest France) (Table S3 and references therein).

It is interesting to compare the diversity observed in the notched bones of the European Early Aurignacian with the uniformity of the Levantine Aurignacian ones. The diversity of the European items is evident in the type of raw material used, the animal taxa selected, the anatomical elements employed, and the types of decorated objects. The notched pattern is documented on bone, antler, and ivory pieces deriving from reindeer, red deer, bovid, and mammoth. The anatomical elements include antler beam, mammoth tusk, teeth, a hyoid, a rib, a metapodial, and other unidentified limb bones. Notches occur on antler and bone splinters, on personal ornaments (e.g., elongated bone pendants), and on domestic tools such as polishers (*lissoirs*) (Table S3).

To date, the Levantine Aurignacian record comprises 15 items. Contrary to the European evidence, the Levantine Aurignacian assemblage of notched bones displays evident homogeneity. One raw material is employed (bone), one taxon is selected (gazelle, *Gazella gazella*), and almost exclusively one anatomical element is chosen (scapula) (*The Notched Items of Hayonim D and Other Levantine Sites* and Table S3).

The notched items were retrieved from several Levantine Aurignacian cave sites (Hayonim, Manot, Kebara, and perhaps Emireh) (55, 56), implying the plausible notion that notched gazelle bones constituted an emblem of the Levantine Aurignacian entity.

The choice of gazelle bones is not surprising, as this is the animal most widely hunted and exploited by the inhabitants of Hayonim and Manot Caves (44, 45, 57, 58). Indeed, there is evident bias in the selection of bone, since only scapulae and hyoid—two very thin

and brittle bones—were chosen for notching. Use of other raw material for symbolic objects or decorations is evidenced in the five tooth pendants (of red deer, fox, and horse) recovered in the Aurignacian levels of Hayonim (*Hayonim Cave*) (41). We may perhaps assume that deer canines, horse and bovid incisors, and gazelle scapulae and hyoid had a particular significance for the Levantine Aurignacians. Nonetheless, while teeth were exhaustively exploited by the European Early Aurignacians, the notched gazelle scapulae and hyoid clearly constitute a particularity of the Levantine Aurignacian. These items were modified by a specific technique which included preparatory scraping of the surface before the meticulous notching. Such bone modification is barely known from Europe, where it was applied only in the production of polishers (59, 60), items which are rare in the Levantine Aurignacian (11, 41). Actually, throughout the entire duration of the Eurasian Aurignacian techno-complex, most of the bone items used were either unmodified fragments (e.g., retouchers) or fragments prepared expediently by simply scraping the distal (active) part of the tool (e.g., awls or chisels) (11, 16, 18, 59, 60).

It is probably not a coincidence that only two types of osseous items, the antler projectile points (*Hayonim Cave*) and the "symbolic" objects, show evidence of considerable technical investment: Both item types are involved in two critical aspects of the complex system of hunter-gatherer's organization. While antler hunting tools were crucial for a stable meat supply that was of paramount importance for the survival of the group, the symbolic items (i.e., the notched scapulae) were equally important within the social intra- and intergroup ambit of these communities, probably embedded in a complex communication system.

The Levantine Aurignacians shared with their European counterparts some similarities regarding different spheres of existence involving bone and antler productions. Thus, they shared similar complex technical concepts of antler working as opposed to the simpler bone-working technological concepts and had in common a recurrent but limited variety of morpho-types (mainly awls and projectile points) (11). However, they differed in other particulars of their material culture, *vis-à-vis* both the bone/antler industries and the lithic ones (e.g., refs. 5–8, 26–29, 61, and 62). Some of these particularities, e.g., the preference for different deer taxa for antler exploitation (reindeer, red deer, and megaceros in Europe as opposed to Persian fallow deer and red deer in the Levant), can be safely attributed to the different ecological niches. Others, like the different types of hunting tools, need to be evaluated with regard to the cultural background. Such is also the case with the notched gazelle scapulae and hyoid, which seem to be of a special significance for the Levantine Aurignacians.

The items described above elucidate a facet of the Levantine Aurignacian and lend support to the hypothesis that, despite certain correspondences between the Early European Aurignacian and the Levantine Aurignacian, these two entities display some idiosyncrasies. It seems that, in contrast to the European Aurignacian facies, which represent a longer temporal sequence and a wide geographic spread and thus exhibit greater variability in their techno-complex, the unique and unified phenomenon of the notched bones reflects on both the homogeneity of the Levantine Aurignacian and the possibility of strong ties between its various communities; perhaps reflecting its limited geographic spread and its relatively short-lived presence in the region.

Materials and Methods

The study of the modifications of the bones from Hayonim D was done by R.R., and selected cases were reexamined by J.-M.T. Comparative taphonomic collections available at the National Natural History Collections of the Hebrew University of Jerusalem were the base for comparison. The entire medium-large mammals assemblage from the Hayonim D layers was identified to species (by R.R.), and the unidentified bone fragments were revised for this study by J.-M. T. The comparative corpus of gazelle scapulae with cut marks is composed of more than 10 specimens, while the comparative hyoid corpus includes 12 items. Anatomical description followed Sisson's (63) nomenclature. We followed Villa and Mahieu (64) in assessing the nature of the fractures affecting the specimens, distinguishing between fresh fractures (straight or spiral fracture planes) and postdepositional fractures (saw-toothed, stepped, or irregular perpendicular) different from those observed on fresh bone.

Technological analysis was conducted using both a stereomicroscope (magnification: 10–40×) and a scanning electron microscope. The scanning electron microscopy images (The XPS Laboratory, The Unit for Nanocharacterization, The Harvey M. Krueger Center for Nanoscience and Nanotechnology, The Hebrew University of Jerusalem) were obtained by V.G. using an FEI Quanta 200 ESEM in low-vacuum mode without any preliminary treatment and with a chamber pressure of 0.38 Torr and acceleration voltages of 15–20 kV.

ACKNOWLEDGMENTS. We thank Assaf Uzan for photographing the analyzed specimens (Fig. 2 and Figs. S1, S3, and S5); Debby Hershman, Ahiad Ovadia (The Israel Museum), Omry Barzilai, Natalia Gubenko, and Alegre Savariego (Israel Antiquities Authority) for granting access to material and for sharing ideas; Liliane Meignen for comments on the Kebara notched item; and the reviewers for their insightful comments. The analytical work was funded by CNRS UMR 7041 ArScAn Équipe Ethnologie Préhistorique (Director P. Bodu), Ministry of Economy and Competitiveness Project HAR 2017-86509, Grup de Recerca de Qualitat de la Generalitat de Catalunya SGR2017-00011 (Director. J. M. Fullola), and the Irene Levi Sala CARE Archaeological Foundation (Project: Bone and Antler Hunting Weapons During the Early Upper Palaeolithic in the Levant) (J.-M.T.). The material is curated at the National Natural History Collections, the Hebrew University of Jerusalem. Some of the notched items are displayed at the Israel Museum, Jerusalem.

1. Bon F (2006) A brief overview of Aurignacian cultures in the context of the industries of the transition from the Middle to Upper Paleolithic. *Towards a Definition of the Aurignacian*, eds Bar-Yosef O, Zilhão J (Instituto Portugues de Arqueologia, Lisboa, Portugal), pp 133–144.
2. Teyssandier N (2007) *En Route vers l'Ouest. Les Débuts de l'Aurignacien en Europe*, British Archaeological Reports. International Series (Oxbow Books, Oxford), Vol 1638.
3. Hublin J-J (2015) The modern human colonization of western Eurasia: When and where? *Quat Sci Rev* 118:194–210.
4. Alex B, et al. (2017) Radiocarbon chronology of Manot Cave, Israel and Upper Paleolithic dispersals. *Sci Adv* 3:e1701450.
5. Bar-Yosef O, Belfer-Cohen A (1996) Another look at the Levantine Aurignacian. *Proceedings of the XIII Congress of the UISPP,* The Upper Palaeolithic, eds Palma di Cesnola A, Montet-White A, Valoch A (A.B.A.C.O Edizioni, Forli, Italy), Vol 6, pp 139–150.
6. Bar-Yosef O, Belfer-Cohen A (2010) The Levantine Upper Palaeolithic and Epipalaeolithic. *South-Eastern Mediterranean Peoples Between 130,000 and 10,000 Years Ago*, ed Garcea E (Oxbow Books, Oxford), pp 144–167.
7. Goring-Morris N, Belfer-Cohen A (2006) A hard look at the "Levantine Aurignacian": How real is the taxon? *Towards a Definition of the Aurignacian*, eds Bar-Yosef O, Zilhão J (Instituto Portugués de Arqueologia, Lisboa, Portugal), pp 297–314.
8. Belfer-Cohen A, Goring-Morris N (2007) From the beginning: Levantine Upper Palaeolithic cultural changes and continuity. *Rethinking the Human Evolution*, eds Mellars P, Boyle K, Bar-Yosef O, Stringer C (McDonald Institute, Cambridge, UK), pp 199–206.
9. Wood RE, et al. (2014) The chronology of the earliest Upper Palaeolithic in northern Iberia: New insights from L'Arbreda, Labeko Koba and La Viña. *J Hum Evol* 69:91–109.
10. Higham T, et al. (2011) Precision dating of the Palaeolithic: A new radiocarbon chronology for the Abri Pataud (France), a key Aurignacian sequence. *J Hum Evol* 61:549–563.
11. Tejero J-M, et al. (2016) The osseous industry from Manot Cave (Western Galilee, Israel): Technical and conceptual behaviours of bone and antler exploitation in the Levantine Aurignacian. *Quat Int* 403:90–106.
12. Bar-Yosef O, Belfer-Cohen A (2013) Following Pleistocene road signs of human dispersals across Eurasia. *Quat Int* 285:30–43.
13. Knecht H (1991) *Technological Innovation and Design During the Early Upper Paleolithic: A Study of Organic Projectile*. PhD dissertation (New York University, New York).
14. Liolios D (1999) *Variabilité et Caractéristiques du Travail des Matières Osseuses au Début de l'Aurignacien: Approche Technologique et Économique*. PhD dissertation (Paris X Nanterre University, Nanterre, France).
15. Teyssandier N, Liolios D (2008) Le concept d'Aurignacien: Entre rupture préhistorique et obstacle épistémologique. *Bull Soc Anthropol Préhist* 105:737–747.
16. Tartar E (2012) The recognition of a new type of bone tools in Early Aurignacian assemblages: Implications for understanding the appearance of osseous technology in Europe. *J Archaeol Sci* 39:2348–2360.
17. Tartar E, White R (2013) The manufacture of Aurignacian split-based points: An experimental challenge. *J Archaeol Sci* 40:2723–2745.
18. Tejero J-M (2014) Towards complexity in osseous raw material exploitation by the first anatomical modern humans in Europe: Aurignacian deer antler work. *J Anthropol Archaeol* 36:72–92.
19. Tejero J-M, Christensen M, Bodu P (2012) Red deer antler technology and early modern humans in Southeast Europe: An experimental study. *J Archaeol Sci* 39: 332–346.

20. Tejero J-M, Grimaldi S (2015) Assessing bone and antler exploitation at Riparo Mochi (Balzi Rossi, Italy): Implications for the characterization of the Aurignacian in Southwestern Europe. *J Archaeol Sci* 61:59–77.
21. White R (1995) Ivory personal ornaments or Aurignacian age: Technological, social and symbolic perspectives. *Le Travail et l'Usage de l'Ivoire au Paleolithique Superieur*, eds Hahn J, Menu M, Taborin Y, Walter P, Widemann F (Istituto Poligrafico e Zecca dello Stato, Rome), pp 29–62.
22. White R (2007) Systems of personal ornamentation in the Early Upper Palaeolithic: Methodological challenges and new observations. *Rethinking the Human Revolution: New Behavioural and Biological Perspectives on the Origin and Dispersal of Modern Humans*, eds Mellars P, Boyle P, Bar-Yosef O, Stringer CB (McDonald Institute, Cambridge, UK), pp 287–302.
23. Vanhaeren M, d'Errico F (2006) Aurignacian ethno-linguistic geography of Europe revealed by personal ornaments. *J Archaeol Sci* 33:1105–1128.
24. Zilhão J, d'Errico F (2003) The chronology of the Aurignacian and transitional technocomplexes. Where do we stand? *The Chronology of the Aurignacian and of the Transitional Technocomplexes. Dating, Stratigraphies, Cultural Implications*, eds Zilhão J, d'Errico F (Instituto Portugués de Arqueologia, Lisboa, Portugal), pp 313–348.
25. Davies W, White D, Lewis M, Stringer C (2015) Evaluating the transitional mosaic: Frameworks of change from Neanderthals to *Homo sapiens* in eastern Europe. *Quat Sci Rev* 118:211–242.
26. Belfer-Cohen A, Goring-Morris N (2014) On the rebound–A Levantine view of Upper Paleolithic dynamics. *Modes de Contacts et de Déplacements au Paléolithique Eurasiatique* (ERAUL, Liege, Belgium). 140–ArchéoLogiques, Liège, ed Otte M, Vol 5, pp 27–36.
27. Belfer-Cohen A, Goring-Morris N (2014) The Upper Palaeolithic and Earlier Epi-Palaeolithic of Western Asia. *The Cambridge World Prehistory*, eds Renfrew AC, Bahn P (Cambridge Univ Press, Cambridge, UK), Vol 3, pp 1381–1407.
28. Belfer-Cohen A, Goring-Morris N (2017) The Upper Palaeolithic in Cisjordan. *Quaternary of the Levant. Environments, Climate Change, and Humans*, eds Enzel Y, Bar-Yosef O (Cambridge Univ Press, Cambridge, UK), pp 627–637.
29. Barzilai O, Hershkovitz I, Marder O (2016) The Early Upper Palaeolithic period at Manot Cave, Western Galilee, Israel. *Hum Evol* 31:85–100.
30. d'Errico F, et al. (2003) Archaeological evidence for the emergence of language, symbolism, and music–An alternative multidisciplinary perspective. *J World Prehist* 17: 1–70.
31. d'Errico F, Julien M, Liolios D, Vanhaeren M, Baffier D (2003) Many awls in our argument. Bone tool manufacture and use in the Châtelperronian and Aurignacian levels of the Grotte du Renne at Arcy-sur-Cure. *The Chronology of the Aurignacian and of the Transitional Technocomplexes: Dating, Stratigraphies, Cultural Implications*, eds Zilhão J, d'Errico F (Instituto Portugés de Arqueologia, Liboa), pp 247–270.
32. Zilhão J (2007) The emergence of ornaments and art: An archaeological perspective on the origins of "behavioral modernity". *J Archaeol Res* 15:1–54.
33. Zilhão J, et al. (2010) Symbolic use of marine shells and mineral pigments by Iberian Neandertals. *Proc Natl Acad Sci USA* 107:1023–1028.
34. Peresani M, Fiore I, Gala M, Romandini M, Tagliacozzo A (2011) Late Neandertals and the intentional removal of feathers as evidenced from bird bone taphonomy at Fumane Cave 44 ky B.P., Italy. *Proc Natl Acad Sci USA* 108:3888–3893.
35. Soressi M, et al. (2013) Neandertals made the first specialized bone tools in Europe. *Proc Natl Acad Sci USA* 110:14186–14190.
36. Rodríguez-Vidal J, et al. (2014) A rock engraving made by Neanderthals in Gibraltar. *Proc Natl Acad Sci USA* 111:13301–13306.
37. Majkić A, Evans S, Stepanchuk V, Tsvelykh A, d'Errico F (2017) A decorated raven bone from the Zaskalnaya VI (Kolosovskaya) Neanderthal site, Crimea. *PLoS One* 12: e0173435.
38. Garrod DAE, Bate DMA (1937) *The Stone Age of Mount Carmel. Excavations at the Wadi-Mughara* (Clarendon, Oxford), Vol 1.
39. Gilead I (1991) The Upper Paleolithic period in the Levant. *J World Prehist* 5:105–154.
40. Bar-Yosef O, et al. (2017) Hayonim Cave. *Quaternary of the Levant. Environments, Climate Change, and Humans*, eds Enzel Y, Bar-Yosef O (Cambridge Univ Press, Cambridge, UK), pp 231–240.
41. Belfer-Cohen A, Bar-Yosef O (1981) The Aurignacian at Hayonim Cave. *Paéorient* 7: 19–42.
42. d'Errico F (1991) Microscopic and statistical criteria for the identification of prehistoric systems of notation. *Rock Art Res* 8:83–89.
43. d'Errico F, Henshilwood CS (2007) Additional evidence for bone technology in the southern African Middle Stone Age. *J Hum Evol* 52:142–163.
44. Rabinovich R (1998) "Drowning in numbers"–Gazelles dominance and body size groups in archaeozoological record. *Archaeozoology of the Near East*, eds Buitenhuis H, Bartosiewicz L, Choyke AM (ARC-Publicaties, Budapest), pp 45–71.
45. Rabinovich R, Bar-Yosef O, Tchernov E (1997) "How many ways to skin a gazelle"–Butchery patterns from an Upper Palaeolithic site, Hayonim Cave, Israel. *Archaeozoologia* 8:11–52.
46. Henshilwood CS, d'Errico F (2011) *Homo Symbolicus: The Dawn of Language, Imagination and Spirituality* (John Benjamins, Amsterdam).
47. Van Wolputte S (2003) *Material Culture in Himbaland, Northern Namibia*, African Pastoralis Studies Series (Royal Museum for Central Africa, Tervuren, Belgium), Vol 1.
48. Marshack A (1972) Upper Paleolithic notation and symbol: Sequential microscopic analyses of Magdalenian engravings document possible cognitive origins of writing. *Science* 178:817–828.
49. White R (1982) The manipulation of burins in incision and notation. *Can J Anthropol* 2:129–135.
50. d'Errico F (1996) Marshack's approach: Poor technology, biased sciences. *Cambridge Archaeol J* 6:111–117.
51. Mcbrearty S, Brooks AS (2000) The revolution that wasn't: A new interpretation of the origin of modern human behavior. *J Hum Evol* 39:453–563.
52. Henshilwood CS, d'Errico F, Watts I (2009) Engraved ochres from the Middle Stone Age levels at Blombos Cave, South Africa. *J Hum Evol* 57:27–47.
53. Wolf S, Conard NJ (2015) Aurignacian personal ornaments of the Swabian Jura. *Aurignacian Genius: Art, Technology and Society of the First Modern Humans in Europe*, eds White R, Bourrillon R (New York University, New York), pp 330–344.
54. Bourrillon R, et al. (2017) A new Aurignacian engraving from Abri Blanchard, France: Implications for understanding Aurignacian graphic expression in Western and Central Europe. *Quat Int*, 10.1016/j.quaint.2016.09.063.
55. Davis SJ-M (1974) Incised bones from the Mousterian of Kebara cave (Mount Carmel) and the Aurignacian of Ha-Yonim cave (Western Gallilee), Israel. *Paéorient* 2:181–182.
56. Barzilai O, Gubenko N (2018) Rethinking Emireh Cave: The lithic technology perspectives. *Quat Int* 464:92–105.
57. Bar-Yosef O, et al. (1992) The excavations in Kebara Cave, Mt. Carmel. *Curr Anthropol* 33:497–550.
58. Yeshurun R, et al. (2013) Humans and carnivores in the Upper Paleolithic of Manot Cave, Upper Galilee, Israel: Preliminary zooarchaeological results. *11th Archaeo-Zoology of Southwestern Asia and Adjacent Areas Working Group Meeting* (University of Haifa, Haifa, Israel), pp 1–12.
59. Tartar E (2009) *De l'Os à l'Outil–Caractérisation Technique, Économique et Sociale de l'Utilisation de l'Os à l'Aurignacien ancien. Étude de Trois Sites: L'Abri Castanet (Secteurs Nord et Sud), Brassempouy (Grotte des Hyènes et Abri Dubalen) et Gatzarria*. PhD dissertation (Université Paris I Panthéon-Sorbonne, Paris).
60. Tejero J-M (2013) *La Explotación de las Materias Óseas en el Auriñaciense. Caracterización Tecnoeconómica de las Producciones del Paleolítico Superior Inicial en la Península Ibérica*, British Archaeological Reports. International Series (Archaeopress, Oxford), Vol 2469.
61. Marder O, et al. (2013) The Upper Paleolithic of Manot Cave, western Galilee, Israel: The 2011-12 excavations. *Antiquity* 87.
62. Marder O, Hershkovitz I, Barzilai O (2017) The Early Upper Palaeolithic of Manot Cave, Western Galilee chrono-cultural, subsistence, and palaeo-environmental reconstruction. *Quaternary of the Levant. Environments, Climate Change, and Humans*, eds Enzel Y, Bar-Yosef O (Cambridge Univ Press, Cambridge, UK), pp 277–284.
63. Sisson S (1958) *The Anatomy of the Domestic Animals* (W. B. Saunders, Philadelphia).
64. Villa P, Mahieu E (1991) Breakage patterns of human long bones. *J Hum Evol* 21: 27–48.