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Acheulo-Yabrudian and Early Middle Paleolithic at Hayonim Cave (Western Galilee, Israel):
Continuity or break?

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1 The Acheulo-Yabrudian and Early Middle Paleolithic at Hayonim Cave (Western Galilee,
2 Israel): Continuity or break?

3

4 **Abstract**

5 The long archeological sequence exposed during our renewed excavations in Hayonim Cave
6 sheds new light on the striking technological changes observed at the boundary between the
7 Acheulo-Yabrudian (end of the Lower Paleolithic) and Early Middle Paleolithic in the
8 Levant, as well as on their meaning in terms of population movements. The recent, as yet
9 unpublished, technological studies highlight a clear technological break between these two
10 entities. In Hayonim, the Acheulo-Yabrudian assemblages found at the bottom of the
11 archeological sequence display the specific combination of bifacial shaping and the
12 production of thick, often cortical, flakes frequently shaped into scrapers by Quina retouch.
13 Neither of these lithic production systems is observed in the succeeding Levantine Middle
14 Paleolithic assemblages. In contrast, the Early Middle Paleolithic is characterized by the
15 expansion and diversification of the Levallois production system in its full-fledged form, the
16 emergence of a specific Laminar technology, and a high proportion of retouched tools made
17 on elongated blanks (points and blades). These technological features are unknown in the
18 previous Acheulo-Yabrudian assemblages in the cave. Based on this information, we attempt
19 to determine if the observed changes in stone tool production strategies resulted from an
20 autochthonous development or a dispersal out of Africa.

21

22 **Keywords:** Levant; Paleolithic transition; Acheulo-Yabrudian; Early Middle Paleolithic;
23 Laminar technology; Levallois technology.

24

25 **1. Introduction**

26 The nature of the cultural, behavioral, and technological changes occurring at the boundary
27 between the Lower Paleolithic (LP) and the Early Middle Paleolithic (EMP) is a topic of great
28 interest and heated debate since this is the time—the late Middle Pleistocene—during which
29 *Homo sapiens* evolved in Africa at the same time as Neandertals were evolving in western
30 Eurasia. Over the last decade in the Levant, new excavation projects and detailed
31 technological studies have highlighted the significant variability of the lithic technocomplexes
32 already long attributed to this LP/EMP boundary, and this new information has been
33 interpreted in different ways. The technical changes are sometimes attributed to a continuity
34 of occupations between the end of the LP and the EMP (autochthonous processes), and other
35 times to a cultural discontinuity, often interpreted as the result of the dispersal of new
36 populations and new ideas from Africa. In this paper, we contribute to this debate via the
37 presentation of new information on the two relevant technologies—the Acheulo-Yabrudian at
38 the very end of the LP, and the onset of the EMP—at Hayonim Cave.

39 The cultural manifestations of the late Lower Paleolithic (LLP) in the Levant include two
40 main technocomplexes, the Late Acheulian and the Acheulo-Yabrudian. Both display
41 significant variation in their technological and typological features. Usually found in a
42 stratigraphic position above the Late Acheulian, the Acheulo-Yabrudian is generally
43 considered as the latest period of the LP in the Levant, although some radiometric age
44 estimates suggest a possible overlap between these two technocomplexes (Malinsky-Buller,
45 2016a, and references therein). In this paper, we focus on the Acheulo-Yabrudian, the only
46 LLP technocomplex present at Hayonim Cave. At the very end of the LP, occurring generally
47 between 400 to 250 ka (Malinsky-Buller, 2016a, and references therein), the assemblages
48 assigned to the Acheulo-Yabrudian technocomplex (Rust, 1950; Garrod, 1956; Bar-Yosef,
49 1994; Copeland, 2000), also known as the ‘Mugharan tradition’ (Jelinek, 1982), are
50 characterized by non-Levallois blade manufacturing, and broad, thick flakes for Quina

51 scrapers, accompanied in some facies by bifaces. This technocomplex, identified only in the
52 northern and central Levant, mainly in caves but also in open-air settings (El-Kown Basin, left
53 bank of the Jordan Rift Valley; Le Tensorer, 2005-2006; Jagher et al., 2016), is composed of
54 three different facies or industries: the Acheulian (also known as the Acheulo-Yabrudian),
55 Yabrudian, and Amudian. The Acheulian/Acheulo-Yabrudian is characterized by the presence
56 of bifacial tools and flake production, with some scrapers shaped by the Quina/semi-Quina
57 retouch technique, while the Yabrudian is typified mainly by the abundant production of
58 scrapers on thick flake blanks, often using Quina type retouch, and the Amudian by a
59 significant increase in blade production and abundant 'Upper Paleolithic' tool forms. These
60 characteristic elements (handaxes, Quina scrapers, and Amudian blades) tend to occur in most
61 assemblages of the Acheulo-Yabrudian technocomplex, albeit in very different proportions
62 (Jelinek, 1990; Copeland, 2000), resulting in a remarkable technological diversity during this
63 period. The three facies are generally considered as different variants of a single cultural
64 complex (Copeland, 1975; Jelinek, 1982, 1990) that may have represented changes in
65 activities (Copeland, 1975; Jelinek, 1990; Barkai et al., 2009; Parush et al., 2016). In all these
66 variants, Levallois technology is absent (considered as intrusive when marginally present).

67 New excavation projects and numerous technological studies in the last decade have
68 highlighted a more complex situation in terms of core reduction strategies and tool
69 production. This research has contributed to the now well-documented image of the
70 technological variability of this Acheulo-Yabrudian complex. This variability includes a
71 specific core reduction method for blade production (often cortical backed blades) in the
72 Amudian (Barkai et al., 2009; Shimelmitz, 2009; Shimelmitz et al., 2011, 2016a), the
73 intentional production of thick flakes in the Yabrudian and Acheulo-Yabrudian assemblages
74 (Shimelmitz et al., 2014, 2016b; Malinsky-Buller, 2016a; Zaidner and Weinstein-Evron,
75 2016; Nishiaki et al., 2017; Weinstein-Evron and Zaidner, 2017), a bifacial technology

76 (Zaidner et al., 2006; Shimelmitz et al., 2017), and, in some cases, the remarkable presence of
77 cores on flakes (Parush et al., 2015).

78 In contrast, the EMP is characterized by a significant development and diversification of
79 Levallois production, a proliferation of elongated blanks (often retouched into points),
80 generally manufactured using Levallois and Laminar methods, and the complete
81 disappearance of bifaces and Quina-like technology.

82 Sites containing both Acheulo-Yabrudian and EMP layers are relatively rare and include
83 Misliya (Weinstein-Evron et al., 2003), Tabun (Jelinek, 1981), Hummal and El Kowm Basin
84 (Le Tensorer et al., 2011), Yabrud (Rust, 1950; Solecki and Solecki, 1986), and Dederiyeh
85 (Nishiaki et al., 2011). The deep archeological sequence at Hayonim Cave, already known for
86 its EMP assemblages (Meignen, 2011) and now extended to Acheulo-Yabrudian lithic
87 production, sheds new light on this ‘transitional’ period. Despite its limited size, the Acheulo-
88 Yabrudian lithic collection recovered from the base of the archeological sequence and
89 published here for the first time, enables us to contribute new arguments to the debate
90 concerning the striking changes observed in stone tool production strategies between the
91 Acheulo-Yabrudian and the emergence of the Middle Paleolithic in the Levant.

92

93 **2. Materials and methods**

94 Hayonim Cave is located in the Western Galilee (northern Israel), 13 km east of the
95 Mediterranean coastal plain. A long cultural sequence, extending from the Middle Paleolithic
96 to the Epipaleolithic Natufian, was unearthed by the first excavations from 1965 to 1979
97 (Bar-Yosef et al., 2005 and references therein). Middle Paleolithic layers were reported from
98 the base of the sequence in the inner part of the cave.

99 The second stage of field research was conducted from 1992 to 2000 by an international
100 team directed by O. Bar-Yosef, B. Vandermeersch and L. Meignen, focusing on the Middle

101 Paleolithic sequence. These excavations focused on two locations in the site, the Central Area
102 and the Deep Sounding at the entrance of the cave (Fig.1). Both revealed complementary
103 sedimentary sequences with some stratigraphic overlap, although the two areas are not
104 physically linked.

105 The Lower to Middle Paleolithic stratigraphic sequence (Table 1), around 6 m-thick, is
106 divided into three main geological layers (layers G, F and E) based on geological and
107 mineralogical characteristics (Weiner et al., 2002; Bar-Yosef et al., 2005). Eleven
108 archeological units were defined within these layers based on changes in the archeological
109 artifact densities. The following archeological sequence was thus identified:

- 110 (i) Layer G (Unit 11): partly exposed during the last field seasons at the bottom of the
111 Deep Sounding (Fig.1c, d). It contains Acheulo-Yabrudian finds.
- 112 (ii) Layer F (Units 10 to 7): mostly exposed in the Deep Sounding (Fig.1b), but also
113 present at the bottom of the sequence in the Central Area. The lithic finds are EMP.
- 114 (iii) Layer E (Units 6 to 1): while present at the top of the Deep Sounding deposits (Fig.1b),
115 this layer is mostly represented in the Central Area. MP assemblages characterized by
116 centripetal Levallois flaking were retrieved from its Upper Part (Units 1-3) while the
117 lithic material from the Lower Part of E (Units 6-4), initially considered as EMP,
118 requires further detailed analysis to reach a clear definition (Meignen, in prep.) and is
119 thus not presented here.

120 Geological and mineralogical studies (Weiner et al., 2002) identified an erosional
121 unconformity between layers E and F, dated to around 200 ka (Mercier et al., 2007), resulting
122 in a gap in the record of human occupation. As it is observed only on a small surface in the
123 Deep Sounding, the contact between layers G and F is not easy to characterize, but the upper
124 part of layer G, locally truncated by an erosional surface, may also suggest a gap of unknown
125 duration between layers G and F (P. Goldberg, pers. comm. 2018).

126 To explore the diachronic technological variation of these assemblages, we applied the
127 chaîne opératoire analytical approach (Boëda et al., 1990; Soriano et al., 2007; Soressi and
128 Geneste, 2011) in combination with an attribute analysis of selected criteria (Goren-Inbar,
129 1990; Bar-Yosef and Goren-Inbar, 1993; Hovers, 2009; Tostevin, 2000). We reconstructed
130 the lithic reduction sequence (i.e., lithic production systems) involved in the different
131 technical entities, as well as the processes of tool manufacture/maintenance.

132 In this paper, we pay special attention to the hallmark of the EMP assemblages, which is
133 the production of elongated blanks. Our reconstruction of the blade reduction strategies is
134 based on the technomorphological and metric attributes of the end-products (blades, points),
135 as well as of the cores and technologically diagnostic artifacts (most often the core trimming
136 elements). Based on these analyses, we identified two different reduction strategies for blade
137 production—the Levallois and Laminar methods—previously described in detail by Meignen
138 (1998, 2000, 2011).

139 While the difficulty of determining a clear-cut division between Levallois and Laminar
140 blades should be acknowledged (see also Wojtczak, 2011; Shimelmitz and Kuhn, 2013,
141 2017), taking into account the specific volumetric organization identified on the Laminar and
142 Levallois cores (Meignen, 2011), we defined the diagnostic properties that should be expected
143 on the blades originating from each system (Fig.2). Part of the criteria we selected have
144 already been described by several other authors (Ashkenazi, 2005; Malinsky-Buller, 2016a;
145 Wojtczack, 2011). However, some specific features of the Laminar method at Hayonim lead
146 us to propose some important changes in the diagnostic criteria of the Laminar products.

147 The use of the Levallois recurrent core reduction method on relatively flat or slightly
148 convex, broad flaking surfaces (the widest face of the block) results in wide, thin and
149 elongated products, often with faceted platforms, and thin trapezoidal, or sometimes
150 triangular, cross-sections (Fig.2). On the other hand, the Laminar method (as defined in

151 Meignen 1998, 2000), identified in the form of semipyramidal and semiprismatic cores
152 (resulting from semirotating exploitation ['débitage semi-tournant']; Meignen, 2000), most
153 often results in narrow, thick blades, with thick triangular and/or trapezoidal sections
154 associated with highly oblique lateral removals, and frequently plain or slightly faceted butts
155 (Fig.2). However, in the case of the Laminar method at Hayonim, knapping was often
156 partially performed on the widest face of the block. Consequently, some wide thick blades
157 with a high trapezoidal section were also produced (Fig.2); these were not previously
158 recognized as resulting from the Laminar system (e.g., Malinsky-Buller 2016a). This
159 observation enabled us to identify Laminar products previously classified in the non-
160 diagnostic, or even in the Levallois blade categories. Some authors (Shimelmitz and Kuhn,
161 2013) avoid such a division between Levallois and non-Levallois blades, highlighting the
162 difficulties in assigning most specimens to one category or the other. Although we partially
163 acknowledge this problem, we adopted a different position in the Hayonim study (see below).

164

165 **3. Results**

166 *3.1. Acheulo-Yabrudian (layer G)*

167 The Acheulo-Yabrudian layer, excavated across only 2 m² due to the brecciated nature of
168 the deposits, is approximately 0.55 m thick. Although the sample size is small (225 pieces),
169 this assemblage is characteristic of the Acheulo-Yabrudian, with its two distinct components:
170 a flake-tool-dominated assemblage (broad thick flake production for scrapers, often with
171 Quina/semi-Quina retouch) and a bifacial component (Rust, 1950; Garrod, 1956; Jelinek,
172 1982; Copeland, 2000; Shimelmitz et al., 2014).

173 The basic composition of the layer G assemblage is presented in Table 2. This inventory is
174 clearly dominated by flakes and flake tools. Secondarily modified pieces (retouched tools on
175 flakes and bifaces) are numerous ($n = 75$) and comprise approximately 33.3% of the

176 assemblage, while debitage by-products and cores represent 56.4% and 10.2% of the
177 assemblage respectively. The cores include few specimens ($n = 6$) whose volumetric
178 organization attests the Quina reduction strategy, as defined in the European Quina
179 Mousterian (Bourguignon, 1996, 1997).

180 Flake tool-dominated assemblage The blank production method emphasizes the
181 manufacturing of large, thick, often cortical, flakes (cortex on dorsal face greater than 25% =
182 53.5%; Table 2). Flakes dominate the debitage by-products, and blades are scarce ($n = 8$). The
183 knapping was conducted with a hard hammer and an internal percussion strike, well back
184 from the edge of the striking platform. This technique identified as the ‘high-angle technique’
185 (Skinner, 1970), and later named ‘Clactonian knapping’ (Copeland 1983, 2000; Forestier,
186 1993; Zaidner and Weinstein-Evron, 2016), results in wide thick plain striking platforms,
187 often oriented at an obtuse angle (ca 100–120°) to the ventral face. The latter, as well as a few
188 asymmetrical dihedral platforms, echo the reduction system identified in the French Quina
189 assemblages (Bourguignon, 1997, 1998). Due to their morphology, the products (large thick
190 flakes with a long cutting edge relative to the size of the blank) offer great potential for
191 resharpening.

192 We identified as Levallois a small set ($n = 18$) of quite thin flakes with a more elaborate
193 striking platform. However, their state of preservation (i.e., their edges are more often abraded
194 than those of the thick flakes) suggests they are most likely the result of postdepositional
195 processes (burrowing). Retouched tools on flake blanks ($n = 41$; 18.2% of the lithic
196 assemblage; Tables 2 and 3), especially scrapers, are preferentially made on largely cortical
197 flakes (cortex greater than 50%). Scrapers of various types, but in particular simple as well as
198 déjeté and transverse scrapers (Fig.3), dominate the retouched tool assemblage (58.5%). More
199 than half of the scrapers (14 out of 24) show the scaled ‘Quina’ or ‘semi-Quina’ retouch
200 considered as typical of the Yabrudian/Acheulo-Yabrudian assemblages (Fig.3). Even though

201 the sample size is small, it is obvious that largely cortical blanks were frequently selected as
202 blanks for these Yabrudian/Quina scrapers (7 out of 14). In addition to this ‘Yabrudian’
203 component, the assemblage from Hayonim layer G contains a relatively large group of
204 bifaces.

205 Bifacial component Twenty-seven bifaces (24 handaxes + 3 bifacial items) and seven
206 fragments (most often proximal) were recovered from Unit 11, accounting for 15.1% of the
207 total assemblage (Table 2). This is a significant proportion in comparison to other Acheulo-
208 Yabrudian assemblages, such as the roughly contemporaneous assemblage of Misliya (1.1%,
209 Zaidner and Weinstein-Evron, 2016). All but one of the handaxes, made on siliceous
210 limestone, are made on flint. Many of them are patinated ($n = 12$), but only one bears traces of
211 abrasion on the edges. They are most often pointed or globally triangular in shape, though a
212 few of them ($n = 4$) display a transverse cutting tip that is usually carefully shaped.

213 Though the bifaces/handaxes are not standardized in shape and size, they tend to be
214 relatively short and quite thick (mean W/T = 1.88, min = 1.40, max = 2.42; Figs.4 and 5).
215 Their lengths range from 67 to 121 mm, with a mean length of 90.13 mm. Seventeen
216 handaxes (out of the 24 complete ones) are less than 100 mm long. They fall within the upper
217 range of the Acheulo-Yabrudian bifacial items observed in Tabun E (mean length Layers Ea-
218 Eb = 87.6 mm; Ec = 84.3 mm; Ed = 85.0 mm; Shimelmitz et al., 2017), Zuttiyeh (91.1 mm;
219 Malinsky-Buller, 2016a) and Misliya (84.62 mm; Zaidner et al., 2006) assemblages, for
220 example, and are generally smaller than the Upper Acheulian ones (Zaidner and Weinstein-
221 Evron, 2016, and references therein). Whether this small biface size as well as their delicate
222 tips can be considered as a cultural marker for the Acheulo-Yabrudian is still open to debate
223 (Weinstein-Evron and Zaidner, 2017).

224 The bifaces/handaxes are generally made on nodules ($n = 12$), and less often on large
225 flakes ($n = 4$), though in many cases, the type of blank could not be identified (11

226 'indeterminate') due to their rather intensive shaping, which masks the initial morphology.
227 Many of the bifaces have no cortex on either surface ($n = 15$), but when residual cortex is still
228 present (on 12 of them), it is generally concentrated on the proximal part, especially on the
229 butt (cortex or natural surface; $n = 10$).

230 The bifaces are often shaped by large invasive removals detached from more or less the
231 entire periphery (apart from the butt; Figs. 4 and 5). The shaping is achieved through both
232 hard hammer percussion in the initial stage (deep to lightly concave scars) and soft hammer
233 percussion in the final stages (slightly convex scars). This process results in pieces with thick
234 (or relatively thick) biconvex or planoconvex sections in their proximal part, which is often
235 more roughly shaped than the thinner distal parts resulting from a careful shaping of the tip.
236 Many bifaces (19 out of 27) show evidence of their use as a retouched tool blank ('biface-
237 support d'outil'; Boëda 1997), which means that the bifacial shaping should be considered
238 essentially as the preparation of a blank for additional retouch.

239 In the final stage, the roughly almond or oval-shaped bifacial volume is retouched in some
240 areas to create a specifically localized 'cutting/working edge' (Figs. 4a–e and 5a, b). Several
241 of these retouched units may coexist on the same piece. These bifaces thus seem to be
242 designed to support multifunctional tools. These secondary modifications may concern the
243 lateral and proximal edges, resulting in a 'scraper type' modification with a long edge
244 retouched by bifacial or unifacial removals (Fig. 4a, b) on one or two sides ($n = 5$). In some
245 cases, the opposite edge was intentionally crushed, creating a thin back (Fig. 4b) that was
246 probably intended to facilitate gripping. This may suggest the positioning of a prehensile zone
247 opposite an active zone (scraper type modification). However, these modifications most often
248 concern the apical/distal part of the tool (tip area: $n = 14$), with various combinations: only the
249 point (Fig. 5a) or the point and contiguous edge(s) (Fig. 4c–e). The tip may also correspond to
250 a transverse cutting edge ($n = 4$; 'beveled' tip; Fig. 5b), perhaps shaped by a burin-like

251 'tranchet' blow ($n = 2$). This careful preparation of the apical/distal zone resulted in a thinned
252 tip that contrasts with the otherwise thick morphology. For the sake of efficiency, the tip
253 seems to be thin not only on the periphery of the piece but also over its entire width (Nicoud,
254 2013). The less carefully worked proximal part may have been used for gripping.

255 A small set of bifaces display the scar of a last large removal that often seems to 'destroy'
256 their general shape (Fig.5c). Such pieces have been observed in Acheulian and other Acheulo-
257 Yabrudian assemblages, and have been interpreted as bifaces recycled into cores in a way that
258 mimics Levallois technology (De Bono and Goren-Inbar, 2001; Rollefson et al., 2006;
259 Shimelmitz, 2015; Shimelmitz et al., 2016b, 2017).

260 In sum, an extensive and more representative corpus of artifacts is undoubtedly necessary
261 to observe regular recurrences in tool making in Unit 11. Nevertheless, these preliminary
262 results already clearly show that Hayonim should be considered as one of the rare sites in the
263 central Levant with a classic Acheulo-Yabrudian assemblage.

264 In Unit 11, bifacial shaping was associated with a flake production and tool management
265 system that is similar in many respects to the Quina Mousterian system (Bourguignon, 1996).
266 The assemblage from Unit 11 clearly presents the distinct features of the LLP in the Levant in
267 its Acheulo-Yabrudian variant, here with a significant bifacial component (45.3 % of the
268 modified pieces) as compared to the Acheulo-Yabrudian layer at Misliya, for instance
269 (14.6%; Zaidner and Weinstein-Evron, 2016).

270 It appears that these bifaces were often used as blanks for specific tools, and the careful
271 shaping and thinning of the apical part is especially noteworthy. This characteristic was
272 previously observed on the bifaces from Zuttiyeh (Malinsky-Buller, 2016a) and Misliya
273 (Zaidner et al., 2006), but in the latter case, the proximal parts remain fully cortical, while in
274 Hayonim Unit 11, they are most often roughly shaped.

275

276 3.2. *Early Middle Paleolithic sequence (Layer F)*

277 Directly above the Acheulo-Yabrudian in the Deep Sounding, Layer F (Units 10 to 7-8),
278 dated by TL to ca. 210–220 ka (Mercier et al., 2007), is approximately 2 m thick. In these
279 units, the assemblages exhibit an entirely different set of lithic production systems, as well as
280 tool types. First, we note the total absence of bifaces and Quina-like scrapers in the tool kit.
281 The most prominent feature, however, is the blady component (also expressed in the form of
282 retouched points and blades), whose large frequencies differentiate these EMP assemblages
283 from the later Mousterian industries. More specifically, the lithic assemblage in Units 10 to 7-
284 8 is characterized by:

- 285 a. A significant proportion of elongated products (blades and elongated points; 29.2–48.9%;
286 Table 4). The lithic production is oriented mainly towards blades and, among the
287 elongated debitage products, points are represented in a low proportion (5.5–11.4%). Most
288 products have either unidirectional parallel or convergent scar patterns, the latter dominant
289 in the Levallois elongated blank category (Table 5).
- 290 b. This elongated production is not exclusive, however. In contrast to what was observed in
291 the underlying unit, the presence of a significant Levallois component (21.4–23.5%; Table
292 6) from the very beginning of this sequence should be emphasized. It includes the full
293 range of Levallois products, among which short Levallois pieces (flakes and short points)
294 are prevalent (Table 6).

295 Core reduction strategies and blank production As observed in other EMP assemblages
296 (Hummal, Tabun IX, Misliya), in these units, several simultaneously employed core reduction
297 strategies have been identified. These include:

- 298 a. The Levallois method for the ‘mixed’ production of short (flakes and points), as well as
299 elongated blanks (Boëda et al., 1990; Boëda, 1991; Shimelmitz and Kuhn, 2017).
- 300 b. The Laminar method (Meignen, 2000) for the almost exclusive production of blades,

301 ranging in size from large blades to small blades/bladelets.

302 c. A flake-oriented reduction strategy that we call ‘preferential surface exploitation’ in which,
303 in the case of Hayonim, the ventral face of a flake was most often used as a flaking
304 surface for the removal of few blanks. This core reduction method is sometimes called
305 ‘core-on-flake’ (Goren-Inbar, 1988; Hovers, 2007), a term that we avoid as it is too
306 imprecise and gives no information on the flaking organization. This flaking system is
307 quite similar to the Levallois system as the flaking is more or less parallel to a plane of
308 intersection between the flaking surface and the striking platform preparation surface, the
309 roles of which are not interchangeable. It is, however, a less formal and less productive
310 technology involving only short exploitation sequences without maintaining the lateral
311 and distal convexities, and only a slight preparation of the striking platform. It recalls the
312 notions of a ‘simple prepared core’ (White and Ashton, 2003), ‘cores with one preferential
313 flaked surface’ (Delagnes et al., 2006), a ‘preferential surface core’ (Zaidner et al., 2010)
314 and also probably part of the ‘hierarchical surface system’ described by Malinsky-Buller
315 et al. (2011).

316 In the context of the discussion on the transition from the LLP to the EMP, the
317 significant contribution of the Levallois system, with the entire range of intended products
318 (including short and elongated points; Table 6) starting from the onset of the EMP, should be
319 stressed, as was already observed by Hovers and Belfer-Cohen (2013), Shimelmitz and Kuhn
320 (2013, 2017) at Tabun IX, and by Zaidner and Weinstein-Evron (2014; and this volume) and
321 Weinstein-Evron and Zaidner (2017) at Misliya. This diversified Levallois component seems
322 to differ from the Levallois component identified in a few Upper Acheulian assemblages,
323 which are generally more homogeneous (mostly of the recurrent centripetal mode; Goren-
324 Inbar, 1985; Barzilai et al., 2006).

325 In the Hayonim assemblages, short Levallois pieces, produced alongside the elongated
326 Levallois artifacts, are abundant in all units (through 10 to 7-8; Table 6). Most of the
327 Levallois flakes, often elongated, are quadrangular in shape (Unit 7-8: 42.9%; Unit 9: 40.6%,
328 Unit 10: 50.9%), with either unidirectional parallel (31.3–45%) or convergent dorsal scar
329 patterns (32.5–38.5%), while the short Levallois points mostly display unidirectional
330 convergent removals. Overall, the predominant scar pattern of the whole Levallois component
331 is unidirectional convergent (40.7–42.1%) and the centripetal/crossed pattern is remarkably
332 underrepresented (6.3–9.3%). The short Levallois points, with their carefully prepared faceted
333 striking platforms (81.8–100%), are well represented in these lower EMP units (especially in
334 Unit 10; $n = 62$, 16.6 % of the Levallois products), where they are even somewhat more
335 common than the elongated points (Table 6). Weinstein-Evron and Zaidner (2017) considered
336 that Levallois points and triangular flakes produced by the unidirectional convergent method
337 are the major Levallois products in EMP sites. In Hayonim Units 10 to 7-8, the triangular
338 morphologies often slightly dominate the Levallois products, but they are closely followed by
339 the quadrangular morphologies mainly present among the Levallois flakes.

340 Among the elongated products (blades, points), based on the criteria previously described,
341 we identified, in Units 10 to 7-8, the simultaneous presence of the two reduction strategies for
342 blade production (Levallois and Laminar methods). Whether these two coexisting volumetric
343 concepts were implemented successively on the same block ('débitage Hummalien'; Boëda,
344 1997: Fig. 12), or on different ones, is not easy to discern on the archeological material,
345 although the former hypothesis was supported by several authors (Wojtczak, 2011, 2015;
346 Malinsky-Buller, 2016a). Wojtczak (2015) considered that both Levallois-like and Laminar
347 systems are involved in the same production sequence, thus identifying an original core
348 reduction strategy whose different steps are described in Wojtczak et al. (2014; called
349 'reduction order' in Wojtczak, 2014). However, the data from Hummal layer 6c2 do not

350 confirm this reduction scheme, clearly documenting the variability of the reduction process
351 for blade production in these EMP assemblages (Wojtczak et al., 2014).

352 Regardless, we believe it is essential to assess the role played in each assemblage by the
353 two options, although we acknowledge the difficulties of assigning some pieces to any
354 category. These two technical systems of core reduction probably had a strong influence on
355 the morpho-functional attributes of the end products, especially their ‘working edge angle’
356 (see experimental results and discussion in Hoggard, 2017 and references therein), and
357 consequently on their probable different uses. Use-wear analysis of the elongated products
358 from Hayonim is in progress (D. Wojtczak) to test the relevance of this idea to the Hayonim
359 case.

360 In the lower EMP units of Hayonim (10 to 7-8), based on the technomorphological
361 characteristics of the relevant pieces, the thick blades and points with triangular and/or
362 trapezoidal sections produced by Laminar methods (Figs. 6a, c–f, 7h, 8a, g) prevail over
363 elongated Levallois products, often with faceted striking platforms (Figs. 6b and 7e; Table 4).
364 However we must recall the number of pieces belonging to an uncertain reduction system
365 (Table 4), mainly among the heavily retouched pieces. Of note, however, is the appearance of
366 the elongated Levallois point (Table 6), which constitutes a new technical feature in this area
367 (Hovers and Belfer-Cohen, 2013; Malinsky-Buller, 2016a; Shimelmitz et al., 2016b;
368 Weinstein-Evron and Zaidner, 2017). In both reduction strategies, blades are more abundant
369 than elongated points, even if the difference is less striking in the case of the Levallois
370 production (Table 6).

371 As expected, the end-products of the two reduction systems display significant differences
372 in terms of their striking platform and morphometric attributes. The metric analyses of
373 Laminar and Levallois blades show that while no substantial differences in terms of length
374 and width (apart for length in Unit 9; $p = 0.0098$ at an alpha (significance) level of 0.05) are

375 observed, both blade categories are clearly distinct for criteria such as thickness and
376 width/thickness (W/T) ratios, as well as length/width (L/W) ratios (Table 7). These
377 distinctions are supported by the T-tests (in all units, for these three criteria, $p < 0.0001$, at an
378 alpha level of 0.05) that indicate significant differences. The same was argued for the
379 Hummal and Tabun IX assemblages (Wojtczak, 2011; Malinsky-Buller, 2016a: Table 18)
380 showing that Levallois and Laminar blade assemblages are clearly dissimilar in terms of
381 thickness and width/thickness ratios.

382 In comparison with the elongated Levallois products, blades and points made using the
383 Laminar method generally exhibit thicker butts in association with a different percussion
384 movement. This combination results in a weaker control over the morphology of the blanks,
385 which are generally thicker and less regular than the Levallois pieces with well-defined
386 faceted striking platforms.

387 The Laminar reduction strategy is also evidenced by the semirotating exploitation of the
388 cores—the flaking most often occurs on the widest face and lateral side(s) of the block—
389 which has a markedly convex debitage surface. They represent 9.2% to 29.7% of the
390 identified cores, more abundant in Unit 7-8 where they are typical. The Laminar reduction
391 method is also attested by the presence of related diagnostic technical pieces (often partial
392 crested blades; overpassing blades for core trimming or to change the striking platform
393 orientation; Figs. 6c, e and 9c, e). However, the small proportion of these technical pieces
394 suggests a relatively low investment in core shaping and maintenance in the case of the
395 Laminar reduction (cf. type D2 of Boëda 2013). In this Laminar category, unidirectional cores
396 are the most frequent (Fig. 9d, f), but specific cores with two opposed, slightly twisted (offset)
397 platforms (as apparent from the core trimming element [CTE] in Fig. 6c) were also exploited
398 following the axis of elongation mostly on the widest face (see Meignen 2000, 2007, 2011 for
399 more details).

400 Much less represented among the cores, the Levallois method for elongated blank
401 production is attested by only a few characteristic Levallois blade cores with a relatively
402 flat/slightly convex flaking surface (Fig. 9a). The method is recurrent, which means that a
403 series of wide, thin (in section) elongated blanks, extending down the greater part of the core
404 length, were struck from prepared platforms at one or both ends of the core (here the flaking
405 is most often bidirectional).

406 Like in the Hummalian industry (Copeland, 1985; Wojtczak, 2011, 2015), in Hayonim
407 Units 10 to 7-8, bladelets are associated with the production of blades. They represent only a
408 minor component of the assemblage, however. Bladelet cores most often follow the same core
409 reduction strategies as for the large and small blades (Fig. 9f). They may thus represent the
410 final stage of the laminar production. However, bladelets were also produced through an
411 independent reduction strategy, from nucleiform burins and small bladelet cores (Fig. 9b),
412 also identified in the Hummalian assemblage from Hummal (Wojtczak et al., 2014). The
413 bladelets are never shaped by retouch.

414 It is worth mentioning that in Hayonim Units 10 to 7-8, like in many other EMP
415 assemblages, cores with blade removals at their last stages are relatively rare (10–24.3%).
416 This might be the result of changing reduction strategies through the life history of the cores.
417 Some cores that were initially used for blade production may have ended with flake removals.

418 As a final remark, it should be noted that from ca. 250 to 160 ka, in most of the EMP
419 blade oriented industries, both reduction strategies coexisted in each assemblage, but they
420 occurred at different frequencies (Meignen 2000, 2007). The Laminar concept seems to be
421 dominant in assemblages such as Abu Sif, Hummal, and the lower layers of Emanuel, and is
422 less pronounced at Hayonim (Ashkenazi, 2005; Meignen, 2007; Wojtczak, 2011, 2014;
423 Goder-Goldberger et al., 2012). In other cases, blade production was mostly realized using the
424 Levallois core reduction method at the expense of the Laminar concept, as for instance at

425 Tabun IX and the Emanuel upper layers (Meignen, 1994, 2007; Goder-Goldberger et al.,
426 2012; Shimelmitz and Kuhn, 2013; but see Malinsky-Buller, 2016a; Shimelmitz and Kuhn,
427 2017 for discussions about Tabun IX). Monigal (2002) already recognized these two general
428 tendencies, which she considered as chronologically successive. However, currently available
429 radiometric dates do not support this hypothesis of chronologically distinct groups (Meignen,
430 2007, 2011; Valladas et al., 2013; Hershkovitz et al. 2018). Rather, these lithic productions
431 express the intra EMP technological variability.

432 Retouched tools Another major feature of the lower units is their quite high ratios of shaped
433 tools (20.2–31.2%; Table 8), and even more striking, their high proportion of tools made on
434 blades/elongated blanks (44.9–78.1%; Table 9). In the lower units at Hayonim, some variation
435 is observed in the tool kit composition, but the elongated retouched points and retouched
436 blades always prevail (35.5–62.4%; Table 8), the latter being more abundant than the points.

437 As previously noted in other EMP assemblages (Hummal: Wojtczak, 2015; Misliya:
438 Zaidner and Weinstein-Evron, 2014; Weinstein-Evron and Zaidner, 2017; Tabun IX:
439 Copeland, 1985; Shimelmitz and Kuhn, 2017), the elongated retouched points are highly
440 variable (Figs. 7d, h and 8b, c, g), not only in terms of their production method, but also in the
441 location and extent of the retouched zone and thus in their overall morphology (especially in
442 terms of symmetry/asymmetry; see Boëda 2013), probably resulting in distinct tools in terms
443 of use. We observed significant variability in the intensity and type of retouch: many
444 elongated items were heavily transformed by scalar (sometimes steep) retouch localized at the
445 tip and/or more or less spread along the lateral edges (Fig. 8b, c, g), while in some cases the
446 secondary modifications did not significantly alter the contour of the original blank (Fig. 7a,
447 b, d), probably in relation to Laminar vs. Levallois core reduction.

448 The retouch is often considered to be the result of resharpening or recycling artifacts (e.g.,
449 Dibble, 1987, 1988; Kuhn, 1990, 1992). However, it may also result from the regularization

450 of the working edge, and even more significantly from establishing the morphofunctional
451 properties of the intended tool (concerning the active zone as well as the prehensile area).
452 Some reduction strategies such as Levallois, for example, produce blanks which most often
453 correspond closely to the planned morphology of the final tools, and the Levallois blanks are
454 thus left unretouched (and probably used as such) or are lightly retouched (e.g., Fig. 7a, b;
455 Boëda, 1997, 2013; Meignen et al., 2009; Boëda et al., 2013; Shimelmitz and Kuhn, 2017).
456 Conversely, core reduction with a weaker control of core shaping and blank removal results in
457 less regular blanks, quite diverse in shape, requiring a greater retouching investment to
458 achieve the intended morphofunctional characteristics. This could be the case at Hayonim
459 (Units 10 to 7-8), most often on the elongated blanks produced using the Laminar method,
460 which is associated with less careful control of the morphology of the end-products (irregular,
461 less standardized blades and elongated points; e.g., Fig. 8a, g). Depending on the morphology
462 obtained through the core reduction, in some cases, a phase of localized or intensive
463 retouching is then necessary to create the intended functional characteristics, i.e., mostly the
464 forms and angles of the working edges and morphology of zones suitable for prehension
465 (Boëda, 2013; Boëda et al., 2013; Shimelmitz and Kuhn, 2017; for retouch function see also
466 Groman-Yaroslavski et al., this volume).

467 In assemblages such as Tabun IX, for instance, where elongated products were mostly
468 struck from Levallois cores, the secondary modifications, when present, did not significantly
469 alter the initial shapes of the Levallois blanks. In such cases, the original shapes were
470 probably suitable for their function (Shimelmitz and Kuhn, 2017). In the Hummal
471 assemblages, Wojtczak (2015:635) indicated that “thick blades with a high cross-section are
472 often retouched, but the elongated, rather flat cross-sectioned products, which often resemble
473 a Levallois blank, are not modified.”

474 In Hayonim Units 10 to 7-8, the tool kits also include other shaped tools, in lesser
475 quantities, among which Mousterian tools on short blanks (i.e., scrapers; Fig. 8f) prevail
476 (Table 8). Those with flat, invasive inverse retouch are noteworthy (Fig. 7f). The group of
477 'Upper Paleolithic tool types,' much less frequent (2.9–5.9%), is mainly comprised of typical
478 burins (in addition to the nucleiform burins probably intended for bladelet production, as
479 mentioned above; Fig. 8d, e). This observation does not accord with the common view of
480 numerous Upper Paleolithic tools in the EMP (Marks, 1981, 1992; Bar-Yosef, 1994; Shea,
481 2003), a situation observed in only a few EMP assemblages, most often characterized by the
482 Levallois method for the production of elongated blanks (see Meignen, 2011).

483 In summary, the EMP at Hayonim is characterized by two main reduction strategies, the
484 Levallois method, with its diversified production of thin, regular blanks, and the Laminar
485 method, which focused on the dominant production of blades of different sizes. The
486 development of the short Levallois production, including the triangular morphologies (points
487 and flakes), is noteworthy. These two flaking systems, resulting in products with different,
488 and probably complementary, functional properties fulfilled the technical needs of the cave
489 inhabitants.

490

491 **4. Discussion**

492 The Hayonim sequence, together with those at Tabun, Yabrud, Misliya and Hummal,
493 provides new data on the technological changes observed at the boundary between the LLP
494 and EMP in the southern Levant, where a clear technological break is evidenced between the
495 Acheulo-Yabrudian and the EMP. As described above, the former is characterized by bifacial
496 shaping (inherited from the Acheulian and still in use) associated with the production of thick,
497 often cortical, flake blanks for scrapers through a core reduction strategy that bears a strong
498 resemblance to the much later Quina Mousterian assemblages from Europe (Bordes, 1955;

499 Jelinek, 1982; Dibble, 1991). Both the blank production system and the tool management
500 strategy (manufacture and maintenance) are considered to be similar in both industries in
501 Europe and the Levant (Bourguignon, 1997). This lithic production system, previously
502 unknown in the Levant and elsewhere, clearly represents a post-Acheulian technical
503 innovation.

504 Neither of these lithic production systems (bifacial shaping and the Quina-like reduction
505 strategy) is observed in any of the following Levantine Middle Paleolithic assemblages. We
506 must stress the total loss of this Quina-like system, a specific technical innovation that was
507 limited in time and space, much like the Quina Mousterian in Europe (Bourguignon, 1997;
508 Delagnes and Meignen, 2006; Delagnes et al., 2007; Jaubert, 2011). The presence of these
509 two lithic production systems in these two regions and during different time frames can
510 probably be explained by repeated independent inventions ('phénomène de convergence'; see
511 the discussion by Kuhn 2013).

512 Conversely, the EMP is characterized by the total disappearance of bifacial shaping
513 and Quina-like productions, and by the coexistence of Levallois and Laminar reduction
514 systems, including a significant 'blady' component in the same assemblages. The high
515 proportions of retouched tools shaped on elongated products (blades and points) are also
516 noteworthy. Moreover, from the onset of the EMP, around 250–230 ka (as evidenced at
517 Misliya; Valladas et al., 2013), the Levallois flaking system appears in a fully-fledged form,
518 with the whole range of end products—flakes, blades and even more importantly, pointed
519 Levallois blanks. The latter constitutes a new component in the tool kit (Hovers and Belfer-
520 Cohen, 2013; Malinsky-Buller, 2016a; Shimelmitz et al. 2016; Weinstein-Evron and Zaidner,
521 2017; Zaidner and Weinstein-Evron, this volume)) that largely expanded later in the Late
522 Levantine Middle Paleolithic.

523 Some authors have suggested that the blade manufacturing identified in the EMP may
524 represent a regional development of the blade production already seen in the LLP Amudian
525 industries (not represented at Hayonim), thus serving as evidence for cultural continuity based
526 on this component (Jelinek, 1982; Bar-Yosef, 1982; Copeland, 1985; Wojtczak, 2015;
527 Shimelmitz et al., 2016b). However, careful observation of the available data shows that these
528 two blade-producing industries are clearly distinct in the overall technological organization of
529 their production.

530 First, there are clear differences in the production methods and morphofunctional
531 characteristics of the intended products. The Amudian, also reported at Tabun, Yabrud and
532 Qesem (Shimelmitz, 2009; Shimelmitz et al. 2011, 2016b), is characterized by systematic
533 blade production through a volumetric (non-Levallois) core reduction strategy with a high
534 degree of investment in raw material selection; no specific core-shaping and maintenance is
535 observed, but instead, a self-maintenance of the flaking surface and core volume by follow-
536 through blows removing overpassed and marginal ('débordant') pieces; the reduction strategy
537 is intended to produce a series of blades with a long sharp cutting edge opposite a back (often
538 cortical or retouched; Meignen, 1994; Monigal, 2001; Barkai et al., 2005, 2009; Shimelmitz et
539 al., 2011, 2016b). In contrast, in the EMP blade production at Hayonim, for instance, we
540 observe a more or less developed core shaping/maintenance of the flaking surface and
541 faceting of the striking platform, depending on the débitage system adopted (intensive core
542 shaping for the Levallois, quite low investment for the Laminar system; Marks and Monigal,
543 1995; Meignen, 2000, 2007; Monigal, 2001; Wojtczak, 2011; Shimelmitz and Kuhn, 2013,
544 2017).

545 More importantly, there are differences in the realm of tool manufacture/management. In
546 the case of the Amudian industries, the blade blanks with long cutting edges were frequently
547 used unretouched or lightly transformed (Barkai et al., 2009; Shimelmitz et al., 2011), mostly

548 for use in butchery activities (Lemorini et al., 2006). In contrast, in most EMP assemblages
549 (Hayonim, Hummal, Misliya, Abu Sif; Neuvville, 1951; Copeland, 1985; Meignen, 2007;
550 Wojtczak, 2011, 2015; Zaidner and Weinstein-Evron, 2014; Weinstein-Evron and Zaidner,
551 2017), the elongated tools were quite intensively shaped (especially the Laminar component),
552 with the exception of Tabun IX, in which most of the elongated pieces were lightly
553 transformed, probably in relation to the dominance of the Levallois method, which resulted in
554 well-controlled morphologies (Shimelmitz and Kuhn, 2017). Use-wear analysis of EMP tools
555 in Misliya shows diversified uses for the elongated retouched points, probably in relation to
556 the different core technologies and secondary blank modifications (Groman-Yaroslavski et
557 al., 2016).

558 All these features suggest that in the Amudian, the main technical investment was in the
559 raw material selection and core exploitation, as well as the production of well-controlled end-
560 products mainly used as such (the production of blanks that do not need further shaping;
561 Shimelmitz et al., 2014, 2016b), versus the greater technical investment in blank retouching in
562 the EMP. These observations clearly argue against the idea of continuity in blade production
563 through the LLP to EMP transition (Meignen, 1994, 2007; Monigal, 2002).

564 Therefore unlike the long and complex nonlinear mosaic pattern of change observed
565 during the transitional phases in eastern Africa or western Europe at more or less the same
566 time (Soriano, 2000; Tryon et al. 2005; Moncel et al., 2011, 2012; Hovers and Belfer-Cohen,
567 2013; Tryon and Faith, 2013; Adler et al., 2014; Malinsky-Buller, 2016b; Hérissou et al.
568 2016, and references therein), in the Levant between the end of the LLP (Acheulo-Yabrudian
569 in Hayonim) and the EMP, a marked technological break is observed in the lithic technical
570 sphere, and might be linked to social or biological changes (Hovers and Belfer-Cohen, 2013;
571 Malinsky-Buller, 2016a; Zaidner and Weinstein-Evron, 2016; Hershkovitz et al., 2018;
572 Malinsky-Buller and Hovers, 2019).

573 The meaning of these striking changes in lithic technology is still largely debated. The
574 spread of the Levallois concept observed at the beginning of the EMP could be related to
575 another aspect of lithic technical organization, namely hafting and composite tools (Boëda,
576 1997, 2013; Bonilauri, 2010; Kuhn, 2013; Bonilauri, 2015; Shimelmitz et al., 2016b). Hafted
577 tools are now largely documented as part of the Middle Paleolithic technical repertoire
578 (Anderson-Gerfaud and Helmer, 1987; Boëda et al., 1996; Bonilauri, 2015; Rots, 2015), even
579 in the EMP (Rots, 2013; Groman-Yaroslavski et al., 2016, and this volume).

580 One of the key aspects of the Levallois technology, in tandem with increased control over
581 core configuration/maintenance, is undoubtedly its capacity to systematically produce
582 relatively thin blanks with long regular cutting edges and acute edge angles (Boëda, 1997;
583 Delagnes and Meignen, 2006). Significant variability in the overall contour and size of the
584 intended products is observed as a consequence of the numerous methods of initialization and
585 production. At the same time, however, a high degree of standardization of their proximal part
586 (similar narrow butts) is recognized in relation with the carefully prepared striking platform.
587 Faceting increases the precision of the percussion gesture and the control of the blank
588 removal, resulting in the regularity of the morpho-functional characteristics of the blank's
589 proximal part (Boëda, 1997, 2013; Bonilauri, 2010, 2015). This, in turn, facilitated different
590 types of hafting (axial, lateral; Bonilauri, 2010, 2015).

591 This option contrasts, for example, with the broad thick flakes/scrapers of the Acheulo-
592 Yabrudian (at Hayonim Unit 11, and other sites such as Tabun, Qesem, Misliya, Dederiyeh),
593 whose cutting edges opposite to their cortical 'back' most likely enabled a relatively easy
594 manual prehension that suggests hand-held tools (Boëda, 2013; Shimelmitz et al., 2014,
595 2016b; Zupanchich et al., 2015). The same hypothesis can be proposed for the Acheulo-
596 Yabrudian bifaces previously described in Hayonim Unit 11, Misliya, Jamal, Tabun, for

597 instance (Shimelmitz et al. 2016b, and references therein), with their thick cortical or roughly
598 shaped butt that is well adapted for gripping by hand, as well as for the Amudian blades with
599 their often cortical back opposite to the cutting edge (Lemorini et al., 2006; Shimelmitz et al.,
600 2016b). The large development of Levallois technology may thus reflect a significant
601 innovation in term of tool ergonomics, with a shift from hand-held tools during the LLP to the
602 commonly hafted tools in the EMP (Boëda, 1997, 2013; Hovers and Belfer-Cohen, 2013;
603 Kuhn, 2013; Shimelmitz et al., 2014, 2016b; Groman-Yaroslavski et al., 2016).

604 The expansion and diversification of the Levallois system at the onset of the Middle
605 Paleolithic raise the issue of its origin. The possible arrival of exogenous populations or new
606 ideas should be considered (Foley and Mirazón-Lahr, 1997; Mirazón- Lahr and Foley, 2003;
607 Malinsky-Buller, 2016a; Bar-Yosef, 2017; Weinstein-Evron and Zaidner, 2017; Hershkovitz
608 et al., 2018; Malinsky-Buller and Hovers, 2019; Zaidner and Weinstein-Evron, this volume).
609 Though human fossil remains directly associated with EMP are rare, the recently published
610 maxilla from Misliya Unit 6, associated with EMP artifacts dated to ca. 185 ka, suggests that
611 early modern humans were most probably the producers of the Levantine EMP (Weinstein-
612 Evron and Zaidner, 2017; Hershkovitz et al., 2018). These results attest to the first appearance
613 of early *H. sapiens* in the Levant and suggest an out-of-Africa expansion of *H. sapiens* earlier
614 than the generally accepted younger wave (90 to 120 ka) of the Qafzeh/Skhul hominins.
615 These new data have been used to lend weight to a dispersal scenario explaining the
616 ‘appearance’ of the Levallois technology in the Levant (Hershkovitz et al., 2018).

617 However, the presently available archeological information does not show any
618 unquestionable link with African lithic productions developed earlier than 250 ka, i.e., before
619 the onset of the Levantine EMP. Even if Levallois technology is documented in eastern
620 African sites at around 300 ka, most of these early Levallois productions appear to be oriented
621 towards the production of Levallois flakes through preferential or recurrent centripetal

622 methods (Tryon et al., 2005; Shea, 2008; Tryon and Faith, 2013). Tryon et al. (2005) did note
623 some diversification of the Levallois reduction strategies during the Early Middle Stone Age,
624 around 200–250 ka, marked by the sporadic development of Levallois point production in the
625 sequences of the Kapthurin Formation (Koimilot 2; Tryon, 2006) and more extensively in the
626 Gademotta/Kulkuletti site complex (Wendorf and Schild, 1974; Douze, 2013; Sahle et al.,
627 2014; Douze and Delagnes, 2016). Moreover, the Early MSA assemblages from ETH-72-1, a
628 site dated to between 280 to 184 ka (therefore included in our discussion) display an increase
629 in Levallois points slightly modified by localized retouch. However, unifacial/bifacial shaping
630 was still the dominant process used to produce convergent tools. Elongated Levallois and
631 Laminar items are described (blade production) but in low frequencies (Douze, 2013; Sahle et
632 al., 2014). Therefore, even if we acknowledge the presence of the Levallois point component
633 and the tendency toward convergent tools shared by the early MSA in this area and the
634 Levantine EMP, the main characteristics of the Levantine EMP are not observed in these
635 African sites. The early MSA convergent tools differ from the Levantine EMP points, most
636 often manufactured on elongated blanks and never bifacially transformed. Moreover, the
637 characteristic intensive production of retouched blades and elongated retouched points that we
638 described above for the EMP is unknown in eastern Africa. Therefore, while the fossil
639 evidence supports a scenario of an African origin of the EMP hominins (Hershkovitz et al.,
640 2018), this assumption does not seem to be unequivocally supported by the archeological
641 data.

642 These statements should, however, be tempered as it is unlikely that specific lithic
643 assemblages can be equated with human populations—but if this is true, such criteria should
644 not be used to track population movements among and within major regions. Tryon and Faith
645 (2013) insisted on the difficulties involved in finding archeological signals of AMH dispersal
646 ‘Out of Africa.’ As the archeological record generally reflects adaptations to social and

647 physical environments, it seems unlikely that the technical repertoire of dispersing
648 populations would have remained strictly identical to that of the parent populations. We must
649 keep in mind that the observed differences could also result from the long geographical
650 distances between northeastern Africa and the Levant, as well as the unknown period of time
651 between the early MSA of Gademotta and the Levantine EMP due to the low degree of
652 resolution of our dating methods.

653

654 **5. Conclusions**

655 A new technological analysis of lithic assemblages from Hayonim cave, found in a
656 securely dated context, broaden our knowledge of the widely discussed technological and
657 cultural changes observed at LLP/EMP transition (end of MIS8 to the beginning of MIS7).
658 Most of the features of the lithic assemblages at Hayonim confirm the sharp technological
659 break already observed in several sites of the same period.

660 In the absence of any potential ‘ancestral’ industries in the region, a clear discontinuity in
661 the technological repertoire should be accepted. However, the meaning of such discontinuity
662 remains subject to debate. Demonstrating cultural ties between large regions, such as eastern
663 Africa and the Levant, is a difficult challenge. The hypothesis of the influx of new
664 populations into the Levant bearing a new cultural package has been suggested several times
665 (Foley and Mirazón-Lahr, 1997; Malinsky-Buller 2016a; Weinstein and Zaidner, 2017;
666 Hershkovitz et al., 2018)—especially recently based on the *H. sapiens* remains recovered at
667 Misliya. As discussed above, however, the lithic technological data are not totally convincing
668 unless we accept the idea of an adaptation of the toolkit to the new environments. Still, this
669 should be seen as a working hypothesis that must be tested with additional data.

670 It is also possible that our knowledge of the technological variability among the different

671 EMP assemblages is still insufficient to track the possible technological influences from
672 exogenous or even local populations. A significant effort is now needed to precisely record an
673 already suspected technological variability in the EMP features, such as the role of short
674 Levallois blanks (flakes and points) versus blade production (the latter always
675 overemphasized in the definition of EMP; see Shimelmitz and Kuhn, 2013 for comments), the
676 emphasis on elongated retouched points versus retouched blades (which seems to be more
677 variable than generally assumed), and the actual significance of Levallois points in all the
678 EMP sites.

679 At the same time, more studies of the pattern of chronological changes observed from the
680 beginning of the EMP to the later MP are needed. Preliminary results from Hayonim suggest
681 that through layer E (the archeological sequence following the assemblages presented here),
682 some important technological changes in the main lithic components of the EMP took place
683 during MIS 6. A non-linear trend in the decrease of blade production in layer Lower E and the
684 sudden expansion of the Levallois centripetal method in layer Upper E, circa 140 ka, are
685 observed. Together with the assemblages from Nesher Ramla clearly dominated by broad
686 Levallois centripetal flakes (Zaidner et al. 2014, 2018), the lithics from Hayonim upper E
687 document a new technological shift in lithic production during the later part of MIS 6. The
688 technological and chronological data presently available thus confirm the onset of the
689 Levallois centripetal method, classically associated with the arrival of early *H. sapiens* in MIS
690 5 sites such as Qafzeh and Skhul, at an earlier period than previously thought.

691 Only a more comprehensive and long-term perspective on the main technological, behavioral
692 and biological changes from the onset of the EMP to the later MP will enable us to better
693 understand the processes involved in the observed variability of the cultural manifestations
694 through this period.

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696

697

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1077

1078 **Figure captions**

1079 **Figure 1.** Map of the excavated areas in Hayonim Cave, with the location of the Deep
1080 Sounding and Central Area. a) View of the Deep Sounding at the cave Entrance. b) North
1081 wall of the Deep Sounding showing Layers E and F. c) Lower part of the Deep Sounding
1082 showing diagenetically altered hearths within Layer G, overlain by the more geogenic
1083 deposits of Layer F. d) Hearth structures at the top of Layer G.

1084

1085 **Figure 2.** Comparison of Levallois versus Laminar blade diagnostic features from Hayonim
1086 Layer F (early MP).

1087

1088 **Figure 3.** Acheulo-Yabrudian tools from Hayonim Layer G: a, d) transverse scrapers; b)
1089 convergent scraper; c) simple convex scraper; e) déjeté scraper; f) scraper + endscraper. a, b,
1090 c, d, f with Quina or semi-Quina retouch; b, c, f are double-patinated.

1091

1092 **Figure 4.** Acheulo-Yabrudian bifaces from Hayonim Layer G used as blanks for retouched
1093 tools (biface-support d'outils): a, b) scraper-type modification (b associated with intentional
1094 crushing on the opposed edge); c–e) modification of point and contiguous edge(s). Secondary
1095 modifications are denoted in blue and intentional crushing in green.

1096

1097 **Figure 5.** Acheulo-Yabrudian bifaces from Hayonim Layer G used as blanks for retouched
1098 tools (biface-support d'outils): a) point modification only; b) 'beveled' tip; c) recycled biface
1099 (double patina); d) biface only partially flaked on one face. Secondary modifications are
1100 denoted in blue.

1101

1102 **Figure 6.** Early Middle Paleolithic blades from Hayonim Layer F: a, d, f) Laminar blades; b)
1103 Levallois blade; c, e) core trimming elements from the Laminar system showing flaking
1104 organized from two opposed twisted striking platforms.

1105

1106 **Figure 7.** Early Middle Paleolithic retouched tools and Levallois point from Hayonim Layer
1107 F: a, b) slightly retouched Levallois points; c) short broad-based Levallois point; d) retouched
1108 Levallois point (tip shaped by oblique truncation); e) retouched Levallois blade; f) convergent
1109 scraper on ventral face; g) Levallois blade with invasive retouch on the ventral surface; h)
1110 retouched elongated point on a Laminar blank.

1111

1112 **Figure 8.** Early Middle Paleolithic retouched tools from Hayonim Layer F: a) double
1113 retouched blade; b) heavily retouched point (?); c, g) elongated retouched points; d)
1114 nucleiform burin; e) burin; f) convergent scraper.

1115

1116 **Figure 9.** Early Middle Paleolithic cores and core trimming elements from Hayonim Layer F:
1117 a) bidirectional Levallois core; b) nucleiform burin; c) partial ridge blade; d) unidirectional
1118 Laminar core for blade production; e) overpassed blank showing the bidirectional exploitation
1119 of a small blade core from two opposed twisted striking platforms; f) core for bladelet
1120 production.

1121

1122

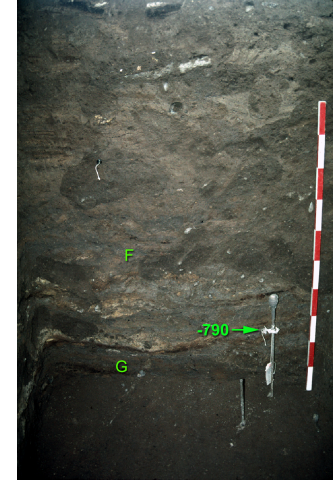
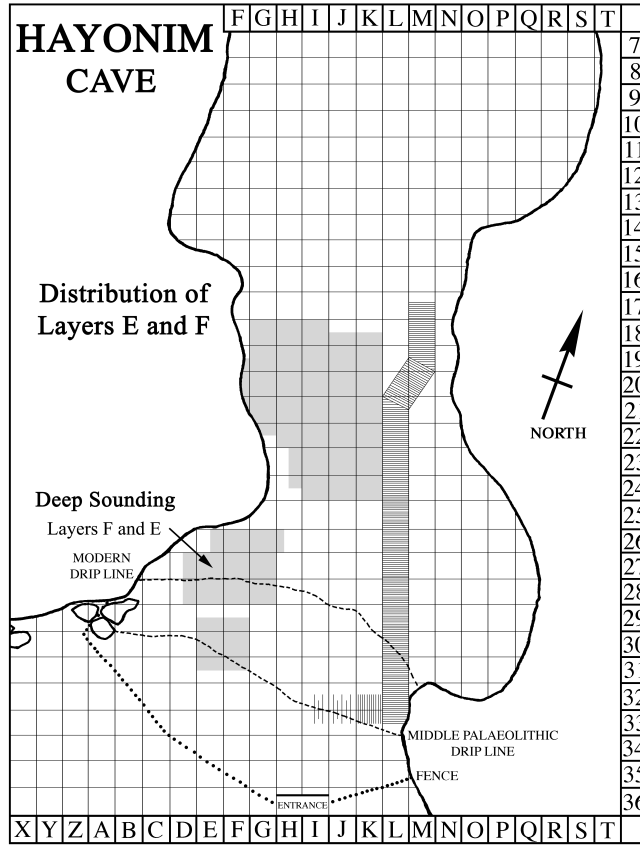
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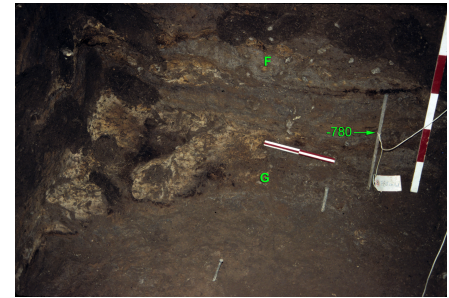
a



b



c



d

Levallois

Laminar

Cross sections



wide thin triangular



narrow thick triangular



wide thin trapezoidal



narrow thick trapezoidal



wide thick trapezoidal

Lateral removals

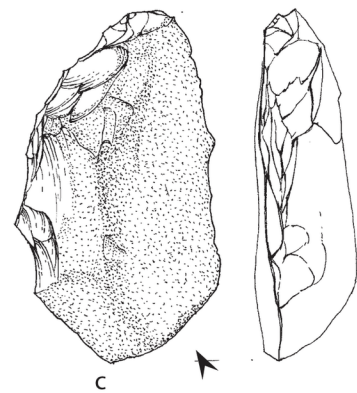
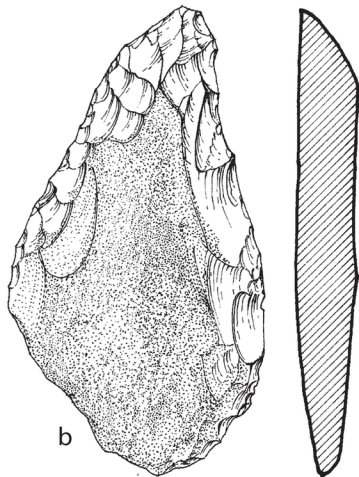
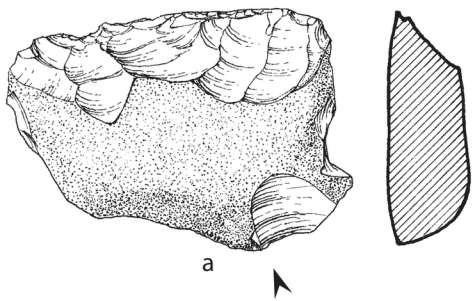
Slightly oblique
Acute edge angles

Highly oblique
More obtuse edge angles

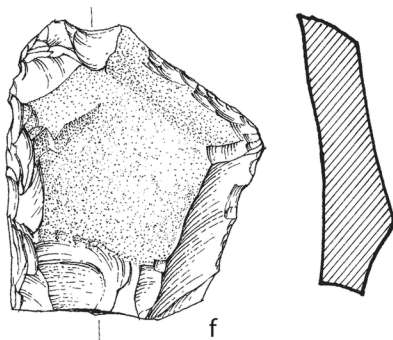
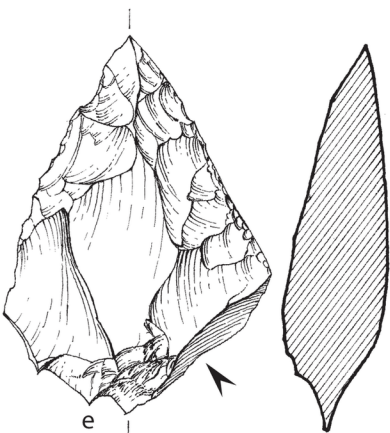
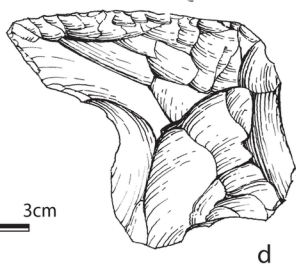
Striking platforms

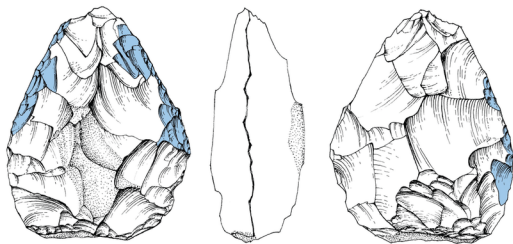
Faceted or dihedral

Plain or roughly faceted

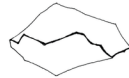
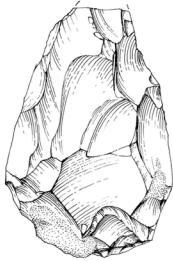
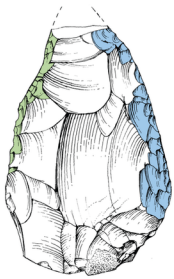


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a



b

0 3 cm

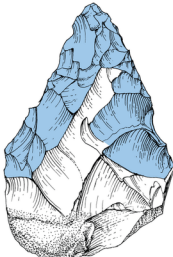
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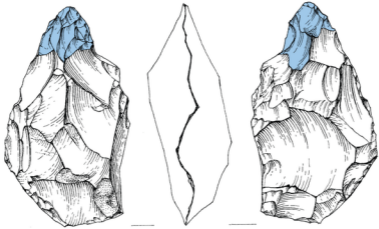


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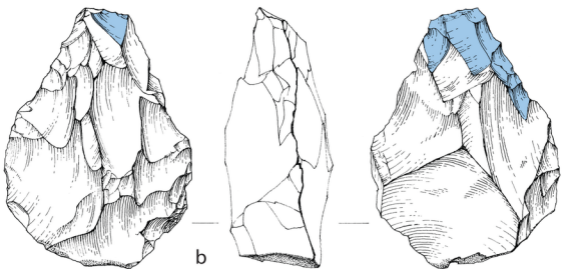


e

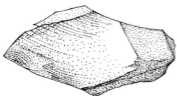




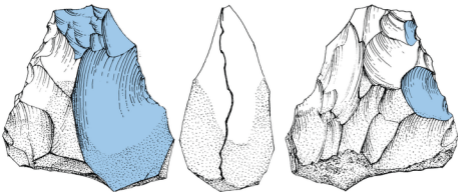
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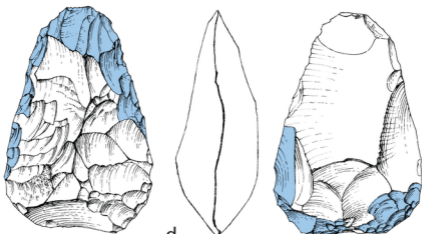
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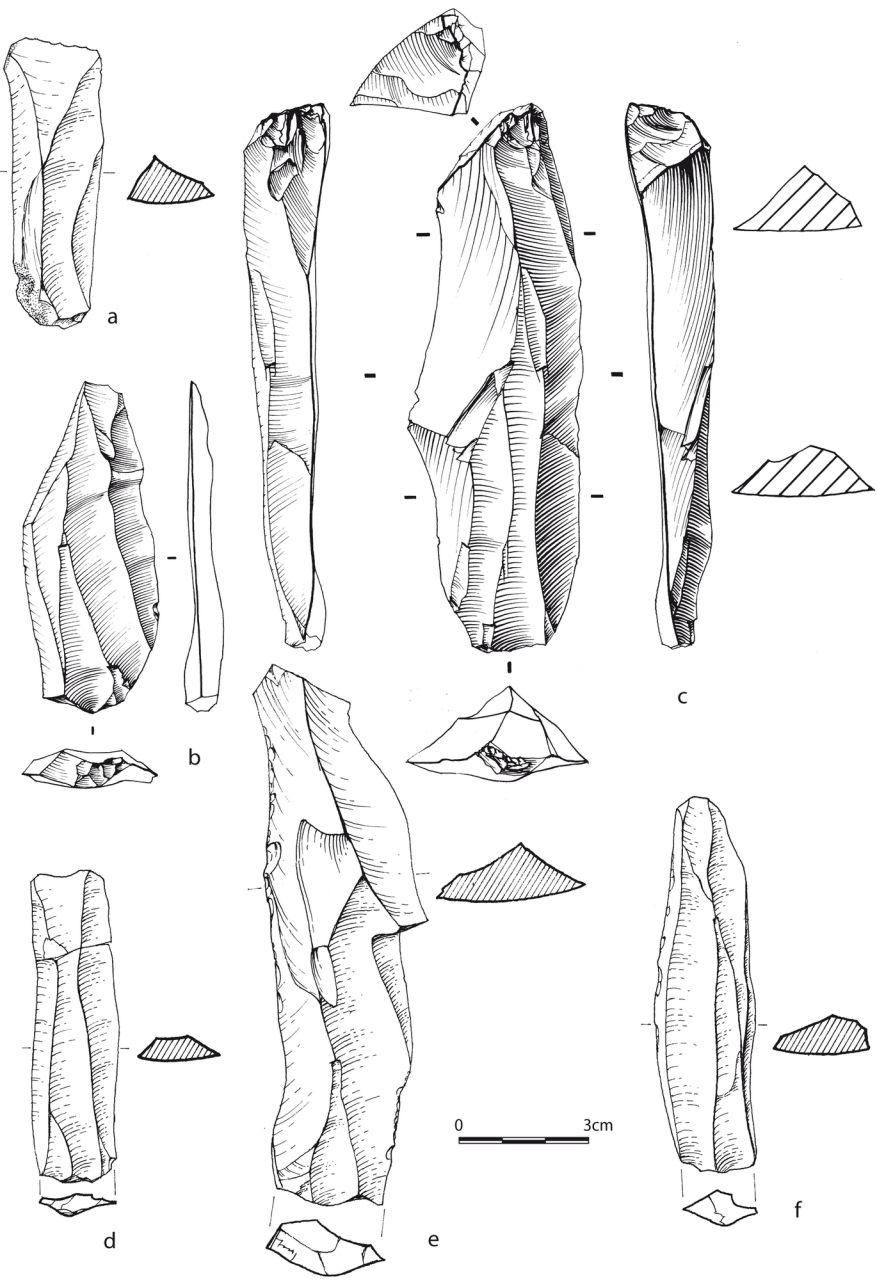
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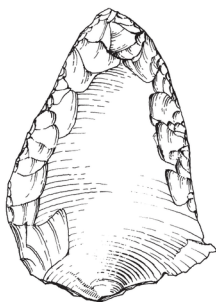
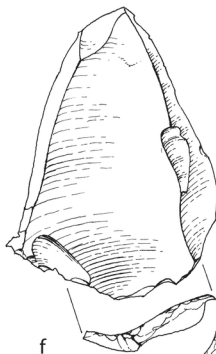
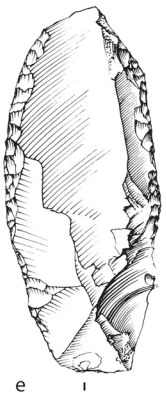
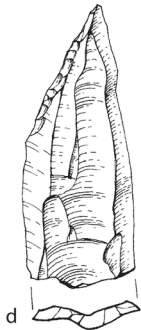
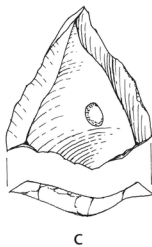
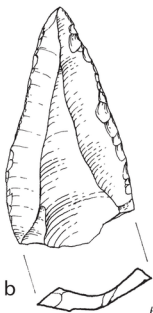


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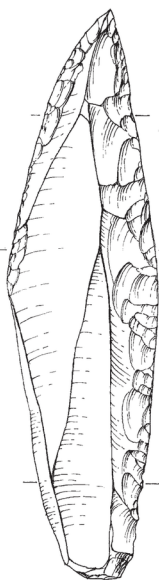
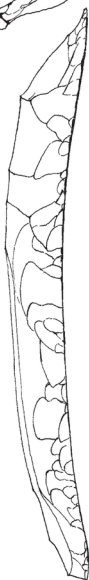
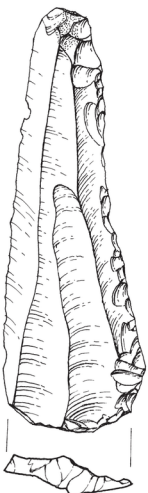


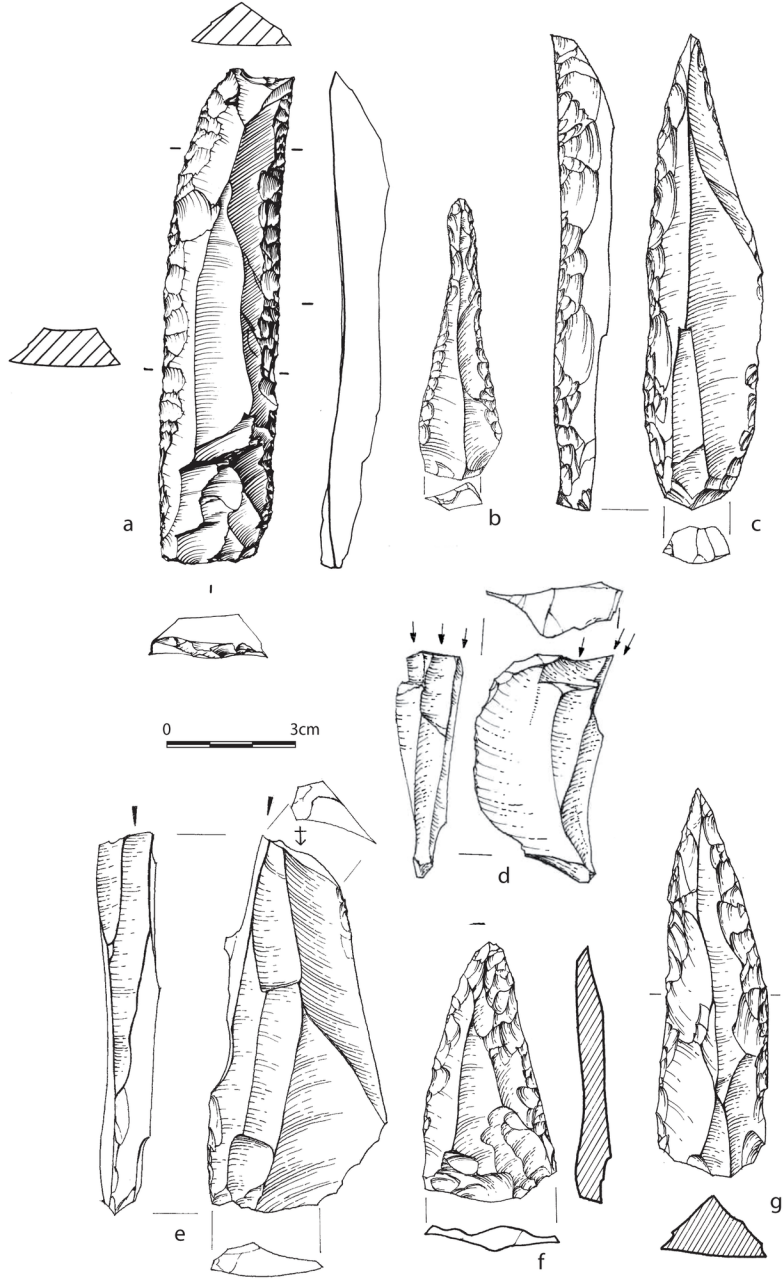
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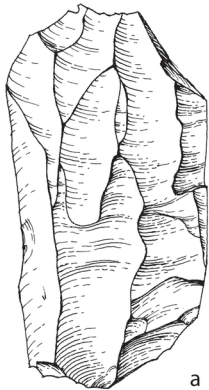




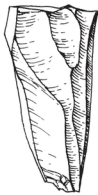
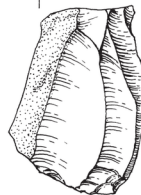
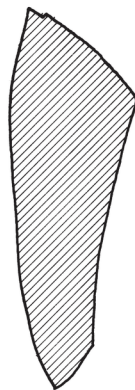
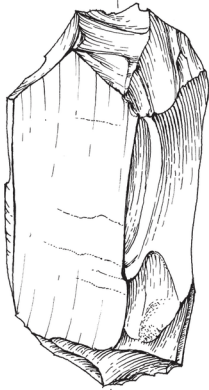
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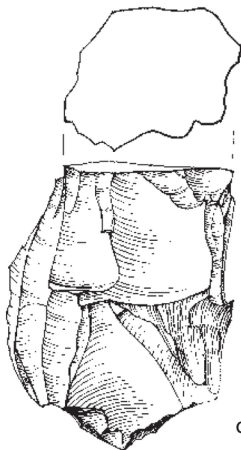
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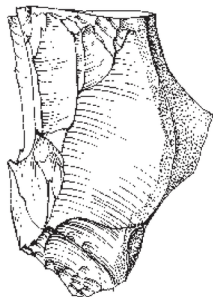
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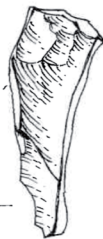
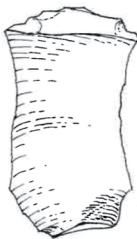
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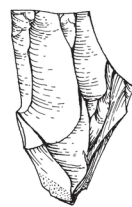
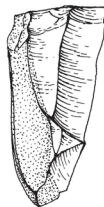
d



e



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f

Table 1

Geological and archaeological stratigraphy of Hayonim cave (adapted from Mercier et al., 2007, based on P.Goldberg, pers. comm. 2018).

Layer E	Layer F	Layer G
Predominantly anthropogenic	Predominantly geogenic (clay with quartz silt)	Predominantly geogenic
Hearths, ashes, burnt layers	Isolated burned areas and numerous scatters of charcoal pieces	Large hearths at the top and charcoal flecks below
Some silt and clay	Generally horizontal; locally some dip toward interior	Inclined to east; truncated by Layer F in Deep Sounding
Generally horizontal	Phosphatized/ highly diagenetically altered	Phosphatized/ highly diagenetically altered
Phosphatized and locally calcified		
Archaeological Units 1 to 6	Archaeological Units 7 to 10	Archaeological Unit 11
Units 3 (Upper E) to 4–5 (Lower E): ca. 135 to 185 ka (TL dates)	Layer F top and bottom: ca. 210–220 ka (TL dates)	No available dates

Table 2

General lithic counts of Hayonim layer G (Acheulo-Yabrudian). Totals are indicated in bold.

Category	<i>n</i>	% ^a	% ^b
Cortical flakes	54		
Cortical blades	5		
Cortical broken /debris	9		
Total cortical items	68	53.5	
Non cortical flakes	30		
Non cortical blades	3		
Non cortical broken/debris	26		
Total non-cortical items	59	46.5	
Totaldebitage	127		56.4
Cores	23		10.2
Retouched tools	41		18.2
Bifaces	27 + 7 fragments		15.1
Total shaped pieces	75		33.3
Total	225		

^a Percentages out of 'total complete blanks'.

^b Percentages out of 'total lithic production including cores'.

Table 3

Typology of the Acheulo-Yabrudian assemblage of Hayonim layer G.

Types	<i>n</i>	Quina retouched	semi-Quina retouched
		only	only
Retouched blade/one side	3	1	1
Retouched point	1		
Single side-scraper	8	1	3
Double side-scraper	1		1
Convergent scraper	1		1
Déjeté scraper	6	2	3
Transverse scraper	3	1	
Scraper on ventral face	1		
End-scraper	1		
Truncated flake	1		
Notch	3		
Denticulate	2		
Miscellaneous/retouched flake	10		
Total	41	5	9

Table 4

Percentage and composition of elongated products (blades and points) in the different units (10 to 7-8, early MP) of Hayonim layer F.

	Total	Total elongated products		Laminar system		Levallois system		Uncertain system	
	all blanks ^a	<i>n</i>	<i>n</i>	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b
Unit 10	1616	472	29.2	171	36.2	102	21.6	199	42.2
Unit 9	1760	657	37.3	239	36.4	161	24.5	257	39.1
Unit 7-8	810	396	48.9	137	34.6	83	21.0	102	36.6

^a Includes retouched and unretouched items.

^b Percentages out of the 'total elongated products'.

Table 5

Dominant dorsal scar patterns of elongated products in the different units (10 to 7-8, early MP) of Hayonim layer F.

Elongated	Unit 10		Unit 9		Unit 7-8	
Levallois	<i>n</i> = 95		<i>n</i> = 143		<i>n</i> = 79	
products						
	Unid. conv.	42.1%	Unid. conv.	39.2%	Unid. conv.	44.3%
	Unid.parall.	30.5%	Unid. parall.	38.5%	Unid. parall.	31.6%
Laminar	Unit 10		Unit 9		Unit 7-8	
products	<i>n</i> = 88		<i>n</i> = 144		<i>n</i> = 64	
	Unid. conv.	35.2%	Unid.conv	41.0%	Unid.conv	34.4%
	Bidir.	29.6%	Unid. parall.	45.1%	Unid. parall.	35.9%

Abbreviations: Unid. conv. = unidirectional convergent; Unid. parall. = unidirectional parallel; Bidir.= bidirectional.

Table 6

Absolute and relative frequencies of the main categories of Levallois products in the different units (10 to 7-8, early MP) of Hayonim layer F.

	Total all blanks ^a	Total Levallois blanks		Levallois flakes		Short Levallois points		Levallois blades		Elongated Levallois points	
		<i>n</i>	%	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b
Unit 10	1616	373	23.1	209	56.0	62	16.6	64	17.2	38	10.2
Unit 9	1760	376	21.4	186	49.5	29	7.7	139	37.0	22	5.9
Unit 7-8	810	190	23.5	79	41.6	28	14.7	56	29.5	27	14.2

^a Includes retouched and unretouched items.

^b Percentages out of the 'total Levallois blanks'.

Table 7

Metrics of the elongated products (blades and points) from the Laminar and Levallois systems from Units 10 to 7-8 (early MP) of Hayonim layer F. Standard deviations are shown in parentheses.

		Laminar ^a					Elongated Levallois ^b					
	<i>n</i>	Mean L	Mean W	Mean T	L/W	W/T	<i>n</i>	Mean L	Mean W	Mean T	L/W	W/T
Unit 10	63	66.4 (15.4)	25.2 (6.1)	10.1 (3.7)	2.7 (0.7)	2.7 (0.7)	42	61.4 (11.9)	26.1 (4.5)	6.0 (1.7)	2.4 (0.4)	4.5 (1.0)
Unit 9	119	68.1 (16.4)	24.7 (6.8)	9.3 (3.0)	2.8 (0.6)	2.8 (0.7)	57	61.3 (15.1)	25.1 (6.2)	5.8 (1.8)	2.5 (0.5)	4.5 (1.0)
Unit 7-8	64	72.7 (17.0)	25.5 (6.8)	10.7 (3.7)	2.9 (0.7)	2.5 (0.6)	31	66.4 (16.5)	26.8 (5.5)	6.8 (2.5)	2.5 (0.3)	4.3 (1.2)

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

^a Refers to elongated products (blades and points) from the Laminar system.

^b Refers to blades and elongated points from the Levallois system.

Table 8

Absolute and relative frequencies of the main groups of retouched tools in the different units (10 to 7-8, early MP) of Hayonim layer F.

Unit	Total	Retouched tools		Retouched blades		Elongated points		Total blades + elongated points		Short retouched point		Scrapers		Upper Paleolithic tools	
		<i>n</i>	%	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b
Unit 10	1616	327	20.2	60	18.4	56	17.1	116	35.5	30	9.2	109	33.3	18	5.5
Unit 9	1760	413	23.5	150	36.3	62	15.0	212	51.3	25	6.0	101	24.5	12	2.9
Unit 7-8	810	253	31.2	96	37.9	62	24.5	158	62.4	17	6.7	33	13.0	15	5.9

^a Includes retouched and unretouched items.

^b Percentages out of the 'total retouched tools'.

Table 9

Relative frequencies of retouched tools on elongated blanks (blades and points) in Units 10 to 7-8 (early MP) of Hayonim layer F.

Units	Identifiable tool	Retouched tools on elongated blanks	
	blanks ^a	<i>n</i>	%
Unit 10	287	129	44.9
Unit 9	354	226	63.8
Unit 7-8	237	185	78.1

^a Refers to complete flaked blanks.