Contextualizing Curational Strategies at the Late Lower Paleolithic Site of Holon, Israel

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submitted: 23 January 2014; accepted 24 September 2014

ABSTRACT

Technological organization entails the ways in which hunter-gatherers shape, make, use, maintain, recycle, and discard stone tools. Those decision-making processes are dependent upon the mode of occupation and land-use patterns. These issues are widely discussed in both ethnographic and Paleolithic literature; however, it has rarely been demonstrated technologically in Lower Paleolithic contexts. In this paper, using the case study of the Late Lower Paleolithic site of Holon in Israel, I address questions regarding the selection of particular curational strategies differently employed for various parts of the assemblage. Tool maintenance and the byproducts of such strategies will be described and articulated within the organization of technology at Holon. In addition, I will examine the micro-environmental setting in which these curational behaviors exist. In Holon, the complexity of the curational organization can be regarded as a chosen tactic, rather than an obligatory response to a deficiency in raw material. Thus, the results of this study exemplify how possible functional needs modify the known techo-typological repertoire. The nature of this interplay has rarely been described within Middle Pleistocene contexts.

INTRODUCTION

Lithic technologies can serve as proxies of the organizational aspects of adaptive strategies in hunter-gatherer societies. Lithic assemblages are the outcome of a long chain of decision-making processes, through which lithic tool kits were designed, produced, used, maintained, and eventually discarded. All those decisions are linked to the environmental, resource-exploitation strategies of foragers and land-use strategies (Anderfsky 1994, 2009; Binford 1977, 1979; Bleed 1986; Kuhn 1995; McCall 2012; Nelson 1991; Perlés 1992).

Binford (1973, 1979) first introduced the concept of curation as an economizing behavior by hunter-gatherers. Curation was perceived by Binford as an adaptive strategy, inherent within the mode by which hunter-gatherers exploit their resources over the landscape (1973, 1979). He deployed the concept of curation to demonstrate the importance of situational adaptations of hunter-gatherers, and to explain how provisional conditions affect implimentation of various technologies (Binford 1979). His work was followed by a vast array of interpretations and explorations (Bamforth 1986; Bleed 1986; Kuhn 1992; Nash 1996; Nelson 1991; Odell 1996; Shott 1996 to name a few). Some have claimed that the term should not be employed due to its vagueness in definitions (Nash 1996). On the other hand, Bamforth (1986) pointed out that Binford's concept of curation subsumes five different aspects. Those include the manufacture of tools effective for a variety of tasks, production of tools in anticipation of use, moving tools from locality to locality, maintenance of the tools through a number of uses, and recycling to other tasks after the their "original" use has been discarded. Odell (1996) stated that if the term is to be useful its scope will have to be restricted and retain only those aspects associated with mobility and settlement patterning. Another complicating aspect that needs to be considered in regard to the concept of curation is that it is borrowed from the ethnographic realm, with many researchers pointing out the problematic nature of analogies across large temporal and contextual distance (e.g., Gifford-Gonzalez 1991; Juthe 2005; McCall 2012; Wylie 1985).

For clarification purposes, I will use in this paper two concepts, maintenance and recycling. Those are practical applications of curational behaviors. For maintenance I will follow the definition of Shott (1989, 1996)—a behavior designed to extend the use-life of an artifact. Concerning recycling in recent years a vast array of interpretations and new definitions were suggested (e.g. Amick 2007; Baker 2007; Vaquero 2011 to name a few). I follow Binford (1977: 33–34) and Odell`s definitions (1996: 59), defining recycle as the "remaking of an implement into a different kind of tool". Yet, the question remains regarding what the reasons are for the selection of one mode of economizing behaviors over another.

Bamforth (1986) suggested that raw material availability may be the triggering cause. Nelson (1991) suggested that technological strategies are not fixed types of behavior; they are situational behaviors depending on diverse variables of the natural and social environment and a range of cultural options. The need to acquire resources in different locations, to move around the landscape, and many other variables condition the technological strategies employed at a particular place and time. The situational nature of any given technological organization and the specific conditions set the circumstances for creating evolutionary models *(*Bleed 2001*)*. Such models provide a series of diverging and multiplying options to be tested rather than simple

  ISSN 1545-0031
doi:10.4207/PA.2014.ART87

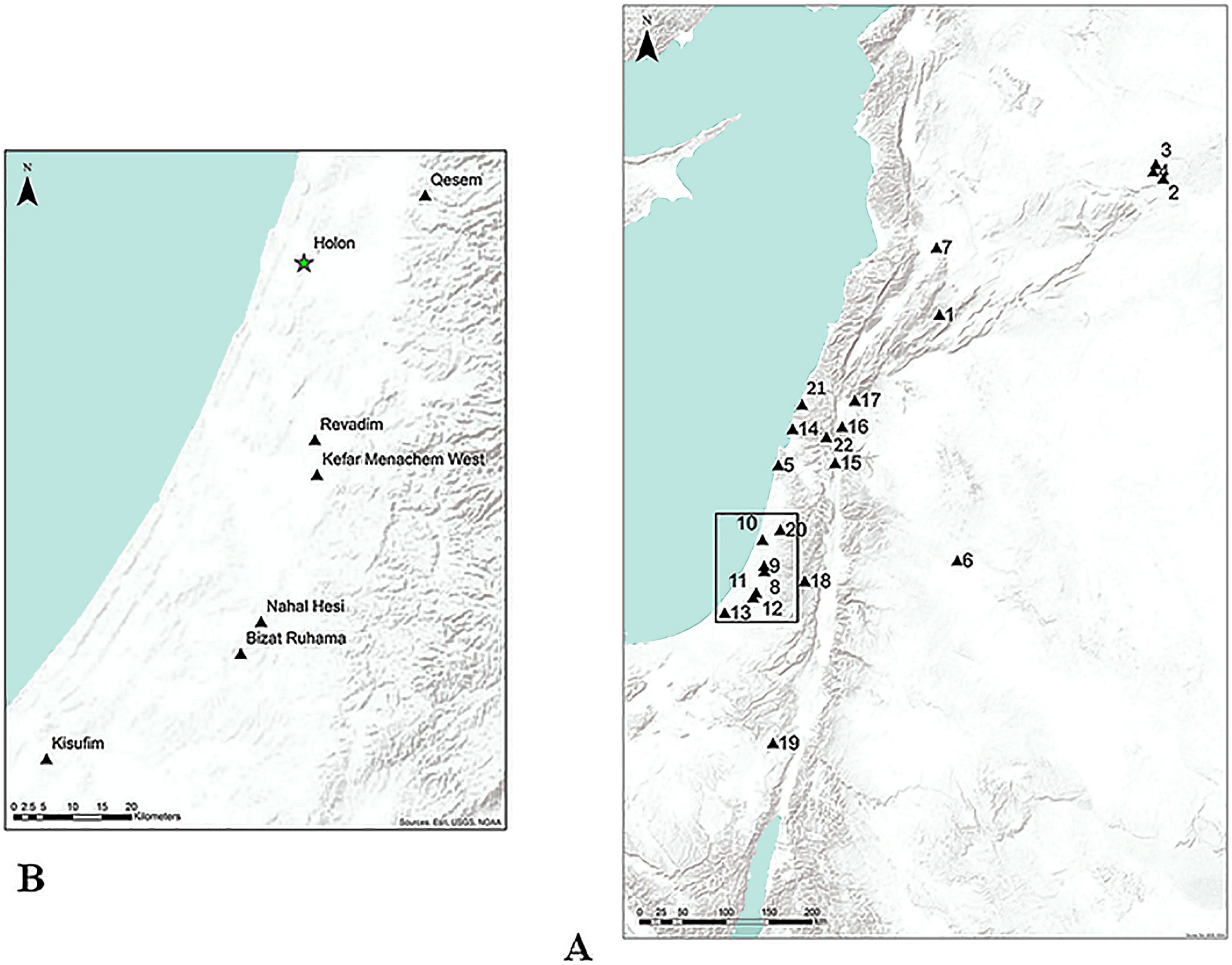

Figure 1. Map of the Levant showing the location of main Lower Paleolithic sites, in the box are those of the Coastal Plain of Israel. 1: Yabrud; 2: El Kowm; 3: Umm El Tlel; 4: Hummal; 5: Tabun Cave; 6: Azraq sites; 7: Latamne; 8: Kefar Menachem West; 9: Revadim; 10: Holon; 11: Bizat Ruhama; 12: Nahal Hesi; 13: Kisufim; 14: Evron; 15: Ubediya; 16: Gesher Benot Yaakov; 17: Berekhat Ram; 18: Umm Qatafa; 19: Nahal Zihor; 20: Qesem Cave; 21: Adlun cave sites: Bezez, Adlun Cave, and Abri Zumoffen.

linear trajectories. Anderfsky (2009) suggests viewing curation as a continuum that can be measured or evaluated. The assessment of different modes of curation, like levels of maintenance and recycling, should be studied in regard to the entire components of technological organization, in order to be able to compare different strategies with the assemblage. Thus, environmental and situational circumstances set the conditions for economizing behaviors. Accordingly, preference for one technological alternative over another should be understood as a response to changes in environmental and social circumstances. Thus, a closer examination of the situations leading to one specific choice may provide interpretive scenarios.

This paper addresses questions regarding the selection of particular maintenance strategies for unifacial tools through one case study—the Late Lower Paleolithic site of Holon, Israel (Figure 1). The behavioral facet of unifacial tool maintenance will be articulated as part of the overall organization of technology found at the site. The site, located in the central coastal plain of Israel, was excavated by the late Tamar Noy (Noy and Issar 1971; Yizraeli 1963, 1967, 1970), and later published with more detail by Chazan and Horowitz in a monograph (2007). The excavation revealed diverse faunal remains and rich lithic assemblages. A renewed analysis of the lithic material, undertaken by the author, revealed a group of unique spalls that were interpreted as re-sharpened flakes resulting from the maintenance of scrapers and retouched flakes.

In this paper, I seek to understand the role of these resharpened unifacial tools within the context of the lithic organizational system in which they were created. In addition, I will examine the micro-environmental setting in which these curational behaviors appear. Thus, I wish to present a possible scenario of environmental circumstances to which ancient hominins responded when they selected the particular maintenance technologies attested to in the lithic assemblage.

THE HOLON SITE

The Lower Paleolithic site of Holon is located in the central coastal plain of Israel, c. 6km southeast of the modern city of Tel Aviv. Three seasons of salvage excavations—in 1963, 1964, and 1970—were conducted at the site by Noy (Noy and Issar 1971; Yizraeli 1963, 1967). The estimated area of excavation varies among the different publications (e.g., Chazan 2007: Figures 1.2, 1.7, 1.8; Noy and Isaar 1971; Porat et al. 1999; Yizraeli 1967); in the monograph, Chazan (2007_a) suggests an area of c. 264m^2, which will be used in this paper.

The site lies within the Pleistocene sedimentary sequences of the coastal plain of Israel. This area is composed of alternating layers of unconsolidated sands, cemented carbonate-rich aeolianites, known locally as kurkar, and mature, non-calcareous red Mediterranean sandy loam, locally dubbed hamra (Gvirtzman et al. 1984, 1997; Porat et al. 2004). The cyclic appearance of kurkar and hamra units lends itself to a correlation with major geological cycles, such as those relating to sea level or climatic changes (e.g., Gvirtzman et al. 1984, 1997; Tsoar 2000). However, it has been suggested that the influence of topography, drainage systems, and vegetal cover had a greater impact on the pedogenic processes manifested in this cyclic sequence (e.g., Sivan and Porat 2004; Yaalon 1967, 2004; Yaalon and Dan 1967).

The section exposed by Noy (Yizraeli 1967) demonstrates these complex pedogenic histories. The section comprises five geological strata from bottom to the top—Stratum E: kurkar (calcareous aeolianite), of which only the upper part was exposed; Stratum D: hamra, c. 0.5m thick; Stratum C: light gray clay of uneven thickness (1.7m to 30cm), within which the archeological layer was embedded; Stratum B: dark clay reaching a maximum thickness of 0.5m; and, Stratum A: an upper hamra layer, up to 2m thick (see Figure 2c below).

The light gray clay comprising Stratum C was further divided into three sub-layers. The upper part is characterized by an abundance of carbonate nodules. The archeological horizon lies in the middle part, in which fewer carbonate nodules are found. The lower part is sandier, with a minute amount of faunal remains. The uneven thickness of Stratum C reflects previous topographical changes of a stabilized dune. Based on the geological sequence and sediments, Netser and Chazan (2007) reconstruct a back-ridge marsh or seasonal pond in the vicinity of the site.

The lithic and faunal remains within the archeological layer are dispersed vertically over c. 60cm (Table 1; Yizraeli 1967). The faunal assemblage at the site includes cervids (fallow deer, red deer), bovids (aurochs, mountain gazelle, wild boar), and straight-tusked elephants (Davis and Lister 2007; Horwitz and Monchot 2007; Lister 2007; Monchot and Horwitz 2007). The straight-tusked elephant is known from a variety of environments, ranging from wooded to more open areas (Davies and Lister 2007). Aurochs, too, were flexible in their adaptation, as they exploited open parkland, swamps, and river valleys. Boars prefer dense thickets, forests, and riverine habitats, whereas deer are woodland dwellers, and gazelle live mainly in open parkland (Mendelssohn and Yom-Tov 1999). Two species, hippopotamus and marsh turtle, depend on a nearby permanent body of water for their existence (hippos: e.g., Jablonski 2004, and see references therein; marsh turtles: e.g., Hartman and Horwitz 2007). Thus, these species indicate the existence of

TABLE 1. COMPOSITION OF THE LITHIC ASSEMBLAGE OF HOLON.

	N	%
Debitage	1814	**61.4**
primary elements	330	18.2
flakes	1151	63.5
Kombewa flakes	37	2.0
blades	12	0.7
thinning flakes (*éclat de taille de biface*)	25	1.4
burin spalls	18	1.0
natural backed knives	12	0.7
core management pieces	198	10.9
re-sharpening spalls	31	1.7
Modified Blanks	350	**11.8**
Handaxes	107	**3.6**
Cores	184	**6.2**
Debris	493	**16.7**
chunks	26	5.3
chips	467	94.7
Hammerstones	7	**0.4**
TOTAL	2,948	

a particular micro-environment.

It is difficult to estimate the density of lithic finds at the site. The size of the excavated areas can only be estimated at over 264m^2, as there is no agreement on this among the different reports (see above). Since sieving was not performed during the excavations at the site, one should compare the density only for artifacts with at least one dimension measuring 2cm and over. Moreover, the vertical distribution also is unknown (only the maximum width). Thus a comparison with other Late Lower Paleolithic open-air sites from the area, taking into account all the above limitations and selecting as scale the number of artifacts per m^2, would reduce the degree of bias and will help set the site of Holon within its proper context.

Only 2,481 artifacts larger than 2cm were found at Holon, resulting in c. 9 items per m^2 (see Table 1). Illustrations in Yizraeli (1967: Figure 2), Chazan (2007$_a$: Figures 1.7, 1.8), and Chazan et al. (2007) show some spatial clustering. It is unknown whether the spatial variation was caused by anthropogenic or post-depositional agencies. A comparison with the finds at Revadim, a site with a similar environment, located 25km south of Holon, and with a similar spatial exposure (c. 250m^2; Marder et al. 2011), shows remarkable differences. The most ancient occupation layers at Revadim, B2 and C5, vary greatly—in B2, 2,085 artifacts larger than 2cm were found over 92m^2, resulting in approximately 22 artifacts per m^2; in C5, 686 such artifacts were found over 8m^2, with 86 artifacts per m^2 (Rabinovich et al. 2012; Solednko 2010). In Layer C3 in Area C East, representing a later phase of occupation, 11m^2 produced 5,581 artifacts, bringing the density up to 507 per m^2 (Malinsky-Buller et al. 2011a; Marder et al. 2011).

Other examples, such as Kefar Menahem West, reveal much lower numbers (38 items per m^2; a total of 751 artifacts over an area of 21m^2: Barzilai et al. 2006), but these are still much higher than those at Holon. Malinsky et al. (2011$_a$: Table 6) presented additional comparisons showing that artifact densities/numbers in Holon are relatively low. Thus, Holon appears to contain low frequencies of lithic finds, and these seem to be restricted to one ecological niche, that of a marsh.

POST- EXCAVATION TEST PROBES

In 1995, two probes (Pits A, B) were excavated, in which no archeological remains were found (Porat et al. 1999).[1] Pit A yielded six layers—a modern disturbance (20cm thick), gray-mottled yellow sand with carbonate nodules (30cm thick), brown hamra (70cm thick), black-mottled grayish clayey sand (100cm thick), yellow-brown mottled clayey sand with carbonate nodules (30cm), and brown hamra with carbonate nodules (70cm). In Pit B, the modern disturbance was thicker (220cm thick); beneath it was a sequence of gray-brown, mottled clayey sand (30cm thick), yellow-brown, mottled clayey sand (150cm thick), and at 4m below the surface, Kurkar (thickness unknown) (Porat et al. 1999: Figure 2).

The authors correlated the black-mottled grayish clayey sand and the yellow-brown clayey sand found in Pit A with the Statum B dark clay and Stratum C light gray clay in the original excavations, respectively. The Kurkar found in Pit B was attributed to the kurkar found at the bottom of Noy's section. Employing luminescence dating methods (OSL), Porat et al. (1999, 2002) and Porat (2007) dated the yellow-brown clayey sand to c. 200 ka. This layer was geologically correlated with the archaeological layer found by Noy. Samples of animal teeth that originated from the old excavations gave similar dates to the one obtained by the luminescence methods (Porat et al. 1999, 2002; Porat 2007).

In 2006, O. Marder, H. Khalaily, and the author examined nine transect test-tranches, running northwest–southeast and southwest–northeast over an area of c. 1800m^2 prior to construction (Figure 2). No archeological remains were found. Trench 3, the closest to the original excavations, located c. 30m away, contained the thickest sediment column, measuring almost 5m at an elevation similar to that of Noy's excavation (40.67–34.00 ASL; Figure 2a). Three main pedogenic units were found, described from bottom up as follows—Unit 1: light sandy hamra with laminated yellowish clay, rich in manganese and oxides nodules (at least 2.5m thick; the base was not exposed); Unit 2: red hamra mottled with gray-green clay and an abundance of manganese and oxides nodules; and, Unit 3: red hamra without carbonate nodules.

The large spatial exposure of these trenches can contribute to our understanding of the catenary relations pertinent to the landscape developmental history at Holon. The trenches exposed four main pedological facies. Both the thickness and the lateral exposure of the units indicate past topographic variations. The composite view of the sections shows the lateral extension as well as the breadth of the layers along both the north–south and east–west axes. The various appearances of hamra (Units 1, 2, 3, 3a and 3b) and of kurkar (in Trenches 6 and 9 only; see Figure 2) imply small-scale variations in the depositional environments. Neither the probes dug in 1995, nor the trenches opened in 2006, revealed a light gray clay stratum similar to the one found in Noy's excavations, in which the archeological layer was embedded. Similar light clay sediments appeared in the trenches only in laminated forms within the hamra paleosol. Furthermore, despite the close proximity of Trench 3 to Noy's excavation area, it was impossible to correlate the hamra found in the 2006 trenches with one of the two hamra paleosols exposed in the original section. Similar concerns were raised regarding the stratigraphic correlation between the 1995 probes and Noy's excavations. Marder (2009) pointed out the vast difference in thickness between Noy's Layer C (up to c. 1.7m) and the corresponding horizon in Pit A, which is only 50cm thick. However, Noy's stratigraphic section (see Figure 2c; Yizreali 1967) exhibits great lateral variations. Thus, it is most probable that the stratigraphic sequence in Pit A is incomplete, and represents only a portion of the time-span during which Noy's Layer C was formed. This consideration might impede the suggested geological correlations made by Porat et al. (1999). The Holon dates were questioned by Bar-Yosef and Belmaker (2011), Gopher et al.(2010) and Marder

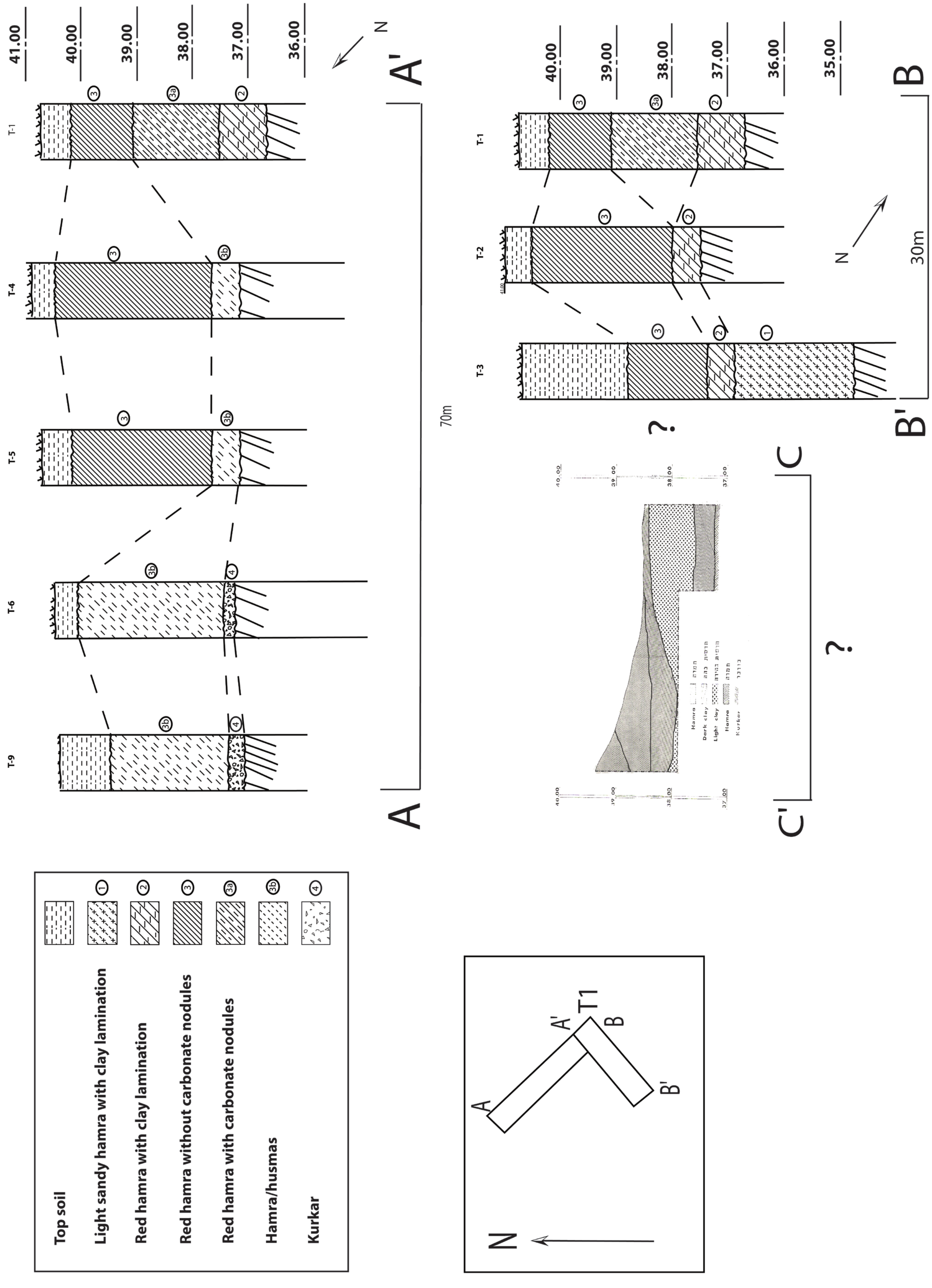

Figure 2. Composite sections of the 2006 trenches: A- A' Northeast-Southwest test tranches; B-B' Northwest-Southeast test tranches, Trench 1 is common to both sections; C-C' Yizreali original section adapted from Yizreali (1967, Figure 1).

TABLE 2. CORE TYPOLOGY.

	Cores on nodules	
	Cores with hierarchy	
Levallois cores	6	3.2
Cores with two surfaces perpendicular to each other with hierarchy	30	16.1
	Cores without hierarchy	
Cores with two surfaces perpendicular to each other without hierarchy	25	13.4
Core with three or more striking platforms	3	1.6
Alternating striking platforms cores	2	1.1
Tested core	4	2.2
Discoidal cores	5	2.7
Modified pebbles	9	4.8
Varia	11	5.9
Core fragment	7	3.8
	Cores-on flakes	
Cores on flake	39	21.0
Possible cores on flake	3	1.6
Truncated facetted	42	22.6
TOTAL	**184**	

(2009). Those authors claimed that according to our current knowledge about Late Acheulian dates, the date of Holon should be older than 200 ky, within the Middle Pleistocene time period (780,000–300,000).

Although no artifacts were found in the geological probes and trenches, they nevertheless bear archeological importance—Holon was located within a landscape of stabilized sand dunes where the archeological finds are limited to a marshy environment. The faunal remains also point toward species dependent on a nearby permanent body of water. The coastal plain of Israel consists of an environment where the rapid development and disappearance of marshes or seasonal ponds create a unique temporary ecological niche (for recent examples see Cohen-Seffer et al. 2005; Galili and Weinstein-Evron 1985; Sneh and Klein 1984; Sivan et al. 2011). The spatial distribution of low-density clusters of archeological finds at the site suggests "a cluster within the patches" pattern of distribution (Isaac et al. 1981). Thus, the marsh was a preferred locale that hominins selected as the place of their activities.

THE LITHIC ASSEMBLAGE OF HOLON

The lithic assemblage of Holon (see Table 1) consists of 2,955 pieces, of which 2,481 (83.3%) are larger than 2cm. This high ratio of large fractions is due to the lack of sieving during the excavation (Chazan 2007b, c). Flakes (81.6%) dominate the debitage. All stages of flake production are evident, suggesting on-site knapping. Pebbles used as raw material for knapping were most probably derived from the nearby paleo-Ayalon stream. Fifty-eight unmodified pebbles, larger than 5cm, and thus suitable for knapping, were found at the site. Seven additional pebbles were used as hammerstones, although the real number of hammerstones is probably higher, as several cores have signs of previous use as hammerstones (see Figure 4:1 below).

On-site knapping is evident from hammerstones, tested-cores, cortical elements, and core management pieces (CMP). However, the number of cores and cortical elements is relatively low (see Table 1). Technologically, the assemblage is dominated by selection of flakes and primary elements[2] for knapping as cores. In previous studies of the lithic assemblage of Holon, different terminologies were used for separating cores-on-flake and retouched items (Chazan 2007b). However, in the current study the defining condition for a core-on-flake is a sequence of three removals or more from the same surface (Goren-Inbar 1988; Hovers 2007 and see discussion within). This mode of flaking was the most common at the site, with 45.2% of the cores made on flakes (Tables 2, 3; Figure 3). Three variants of cores-on-flakes were found at the site—'truncated-facetted flakes' (Nahr Ibrahim cores, n=42; see Figure 3:2), cores-on-flakes (n=39; see Figure 3:1) and 'possible cores-on-flakes' (n=3) (for definitions of each category see Goren-Inbar 1988; Hovers 2007; Schroeder, 1969; Solecki and Solecki 1970). These three types differ in their preparation, but are similar in all other categories, i.e., choice of blanks, dimensions of blanks, amount and dimensions of scars removed (Table 4; see Figure 3). Nodules used as cores exhibit two main modes of flaking—with or without hierarchy (for definitions, see Malinsky-Buller et al. 2011b); both modes appear in similar quantities. Most of those with hierarchy exhibit a non-Levalloisian conception of knapping (Table 2; see Table 4; Figure 4).

The number of handaxes is high (n=107). The handaxes were made mainly on rounded pebbles, with only one handaxe made on a flake. The complete handaxes (n=57)

TABLE 3. RETOUCHED ITEMS AND DEBITAGE DIMENSIONS (in mm).

		Max. length	Max. width	Thickness	Breadth of striking platform	Depth of striking platform
Primary elements	average	33.1	22.7	9.1	14.1	5.4
	std	11.7	8.8	5.1	6.0	3.5
	n	65	65	65	34	41
Flakes	average	31.5	22.4	6.9	13.4	4.3
	std	11.0	9.1	3.5	7.1	2.6
	n	555	555	555	316	346
Core management pieces	average	34.3	23.1	9.6	11.1	4.7
	std	11.3	8.3	4.2	6.2	3.0
	n	198	198	198	140	140
Tools (including scrapers)	average	40.4	30.1	10.4	17.3	5.9
	std	11.3	9.5	4.0	9.1	3.4
	n	350	328	350	164	182
Side-scrapers	average	42.3	29.7	10.3	17.6	6.0
	std	10.9	9.7	3.9	8.4	3.4
	n	82	82	82	47	52

vary greatly in length, ranging 58mm to 195mm, and in degree of refinement (Figure 5; Chazan 2007b: Figure 4.10). Compared to the number of handaxes, the number of thinning flakes (éclats *de taille de biface*) is small (n=25). Thinning flakes are smaller in comparison to the CMP. Most of the thinning flakes are smaller than 30mm (17 out of the 25), and one item is smaller than 20mm. It is most probable that more and smaller items of this type would have been found, if sieving had been conducted during the excavation. The size of the thinning flakes can be explained as a result of transport of handaxes over the landscape. Accordingly, while the early manufacturing stages of handaxes were performed off-site, the final stages of their fashioning were executed on-site. A similar scenario was suggested for the sites of Gesher Benot Ya'aqov (Goren-Inbar and Sharon 2006), Boxgrove (Pope and Roberts 2005), and Revadim C East (Malinsky-Buller et al. 2011b).

When dividing the handaxes into three size categories (length smaller than 8cm {n=16}, 8–12cm {N=24}, and larger than 12cm {n=18}) the distribution of size shows a normal distribution, with no preference for the small-sized group, as would be expected in a re-sharpening scenario (see Figure 5:1–3). Moreover, when comparing the number of scars and the cortical coverage for each size group of handaxes, all size groups demonstrate a similar mode of shaping (see Figure 5). It thus appears that for bifacial knapping, the original size of the pebbles was the most significant factor in affecting the finished morphology of the artifacts. White (1995, 1998) proposed similar explanations for the morphological variability of the English handaxes.

Blanks modified by secondary modification constitute 14.2% of the detached pieces larger than 2cm (11.8% of the total assemblage; see Table 1). The blanks chosen for further retouch were larger in dimensions compared to the debitage (see Table 3). The toolkit contains three main components—retouched items, side-scrapers and a relatively high ratio of composite tools (Table 5).

Retouch intensity (invasiveness on the blank's surface) and extent (length along the edge) show two opposing trends. On the one hand, the retouched flakes classified according to a regular and continuous retouch (following the definition suggested by Goren-Inbar 1990: 63), show low intensity of retouch (Figure 6). On the other hand, side-scrapers as well composite tools demonstrate a high intensity of retouch. The scrapers present a more intensive stepped retouch, with invasive scars over a larger extent of a blank's edges (Figure 7). The composite tools' typological makeup differs from the one of blanks with a single tool type (Table 6). Composite tools have a higher percentage of truncations than single tools (see Figure 7:1).

In sum, the lithic assemblage of Holon shares techno-typological characteristics with other Late Lower Paleolithic Levantine sites (e.g., Revadim: Malinsky et al. 2011b; Kefar Menahem West: Barzilai et al. 2006; Naẖal Ḫesi: Y. Zaidner, pers. com. and personal observation). However, several traits within the technological organization of the Holon lithic assemblage distinguish it from other Late Acheulian assemblages. For example, the cores-on-flakes are the most common reduction sequence in the Holon assemblage; moreover, they exhibit more removals per core than at other Middle Pleistocene sites. The frequency of handaxes is relatively high (23.4% of the tools, and 4.3%

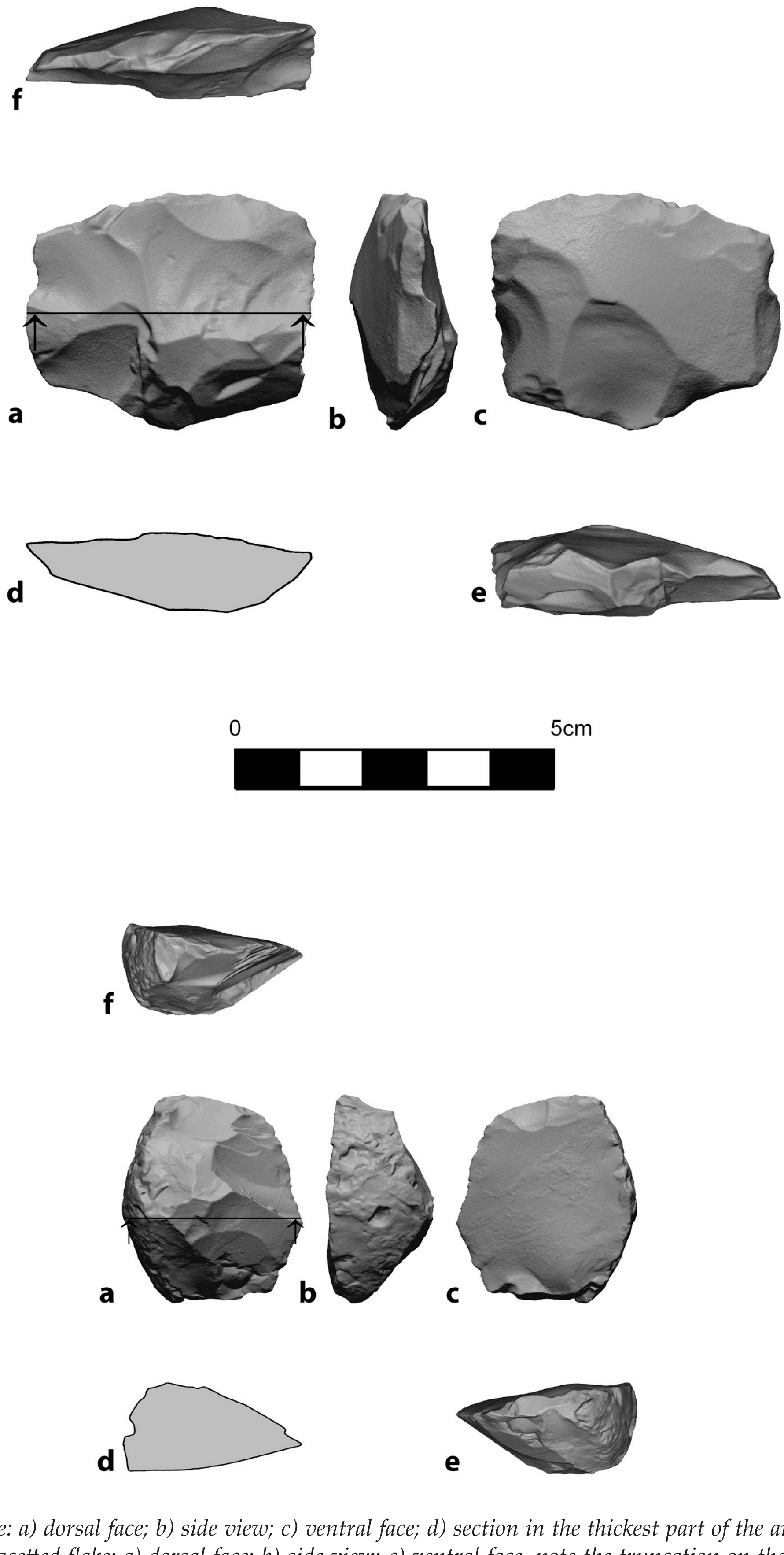

Figure 3. 1: core on flake: a) dorsal face; b) side view; c) ventral face; d) section in the thickest part of the artifact; e) bottom view; f) top view. 2: truncated-facetted flake: a) dorsal face; b) side view; c) ventral face, note the truncation on the distal end; d) section in the thickest part of the artifact; e) bottom view, note the double bulb of percussion; f) top view, showing the truncation and the later removals from it.

TABLE 4. CORE METRICS.

	Cores with two surfaces perpendicular to each other with hierarchy (n=20)	Cores with two surfaces perpendicular to each other without hierarchy (n=25)	Cores-on-flakes (n=39)	Truncated-facetted (n=42)
Core length	47.6±14.6	44.3±14.2	43.3±12.0	41.9±11.4
Core width	39.0±13.3	40.5±14.4	33.9±11.30	30.6±9.4
Core thickness	24.1±7.9	18.6±7.4	15.3±5.0	12.8±4.1
N scars (flaking surface)	15.8±7.9	6.4±3.4	9.0±4.3	5.3±4.3
Core exploitation index	52.0	39.7	48.9	31.4
Length of dominant scar	26.3±7.7 (n=14)	25.5±9.4 (n=34)	19.1±8.3 (n=28)	16.7±7.0 (n=34)
Width of dominant scar	24.4±5.5 (n=14)	18.6±5.8 (n=28)	17.5±7.0 (n=28)	15.4±6.9 (n=34)
Length of last scar	17.7±5.7 (n=26)	12.8±9.5 (n=17)	11.9±6.5 (n=26)	11.4±5.1 (n=21)
Width of last scar	17.0±5.4 (n=26)	11.6±7.0 (n=17)	13.5±5.0 (n=26)	10.3±3.4 (n=21)

of items >2cm). The number of handaxes in Holon is relatively high in comparison to other Late Acheulian sites (e.g., Marder et al. 2006). The scrapers and composite tools at Holon demonstrate a higher retouch intensity compared to other Late Lower Paleolithic sites (e.g., Revadim: Malinsky-Buller et al. 2011b; Kefar Menahem West: Barzilai et al. 2006). A reassessment of the re-sharpening process found at the site should take into account these tech-typological traits.

THE RE-SHARPENING TECHNIQUES AT HOLON

A group of 31 spalls was found in the Holon assemblage. These are divided into three categories. Two of these categories, the long sharpening flakes (hereafter LSF) and the transverse sharpening flakes (hereafter TSF), are defined according to Cornford's (1986) classifications. The LSFs (n=15) are narrow flakes, with a retouched facet lying alongside the striking platform, parallel to their longitudinal axis and at an angle to it (Figure 8). The technique creates new edges of the greatest possible length and new angles that allow the continuation of usage either without any modification or with repeated retouch of the new edge. The TSF (n=15) are short and broad flakes (Figure 9:2–4). They share some affinities with the LSF, yet their morphology is more quadrangular, thus having less of the edge's length removed than in the LSF.

The third category is part of bifacial fashioning, stemming from the rejuvenation of the handaxe`s tip. Bordes (1971: Figure 11:1–2) termed it "coup de tranchet", and it is also known as a tranchet blow (Inizan et al. 1999: Figure 34:1–2). Coup de tranchet removes both sides of the handaxe and sometimes part of the tip as well. This mode of shaping and its byproducts are common on Northern European Late Lower Paleolithic handaxes (Kelley 1955; Lamotte 2001; Soriano 2001; Tuffreau et al. 2008). Only one such item is found in the Holon assemblage (see Figure 9:1).

At Holon, LSF and TSF appear in equal numbers. The shape and size of the re-sharpening spalls is diverse (see Figures 8 and 9:2–4). The average length of the complete spalls (n=16) is 32.1±5.3mm, and they are 19.6±5.8mm wide. The largest spall is 45mm in length, whereas the smallest is 18mm long. Although these types vary in their morphologies and dimensions, their previously retouched edge was removed with the same technological procedure. All spalls contain one plain side. This plain face is the previous ventral face of the "parent tool." From this face, the retouch originated. In most of the Holon spalls, the left side is plain (n=27; see Figure 8:2, 3, 4, 6; Figure 9:3–4); in three items the right side is plain (see Figure 8:1, 5; Figure 9:2). Most of the blanks bear none or very little cortex (up to 25%).

Studying the spalls can provide us with insights about the parent tools from which they were removed. The mode of retouch on the spalls varies greatly—fine retouch, flat, scalar, as well as stepped retouch (see Figures 8 and 9:2–4). Similarly, the degree to which the retouch penetrates the blank also is diverse. Several spalls exhibit invasive retouch, up to 15mm wide. Within this group, a few bear several phases of retouch; in even fewer cases, the final stages of retouch show minimal modification. In other spalls, the

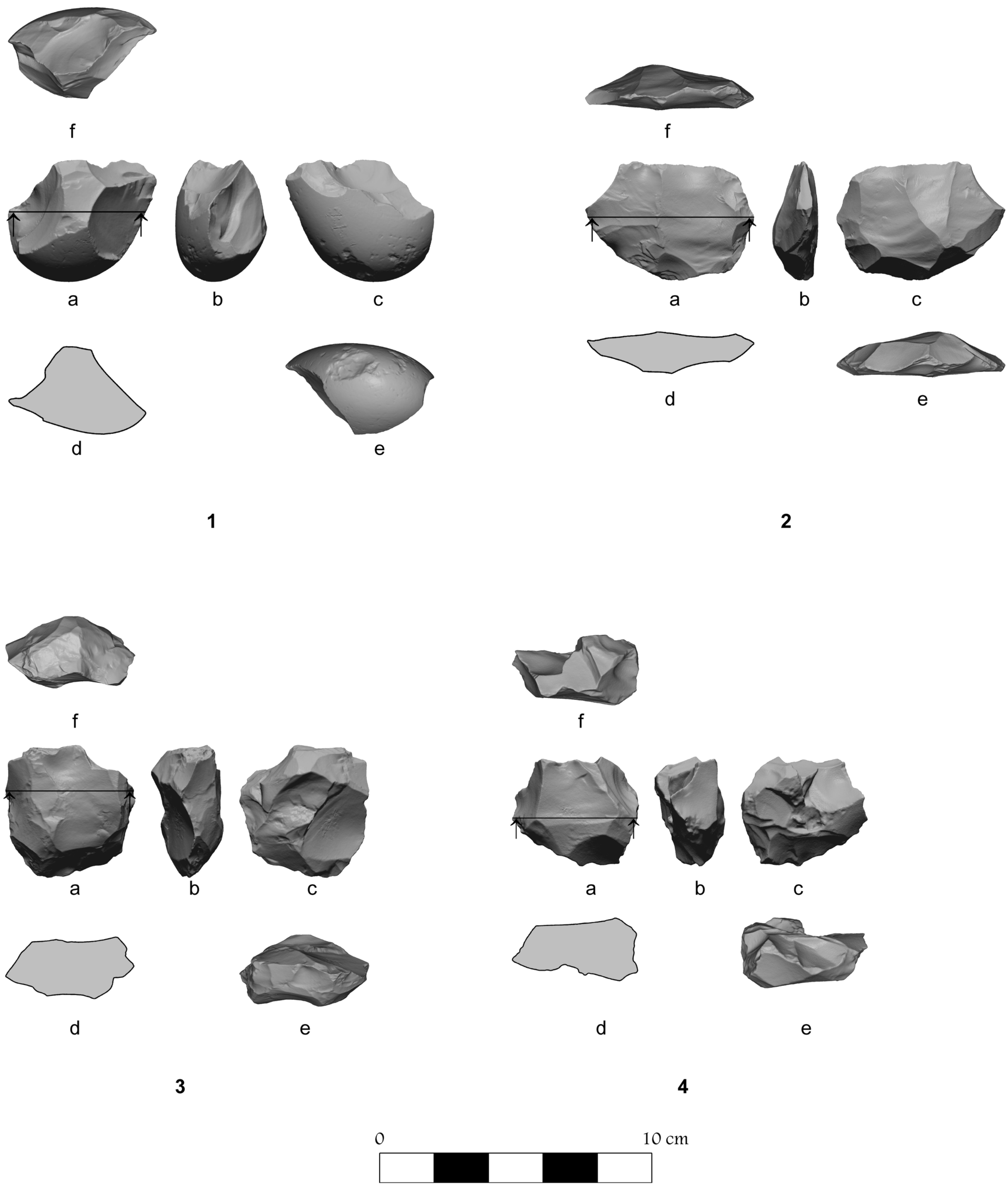

Figure 4. 1: cores with two surfaces perpendicular to each other without hierarchy used previously as hammerstone (view e); 2–3: cores with two surfaces perpendicular to each other with hierarchy; 4: core with three or more striking platforms.

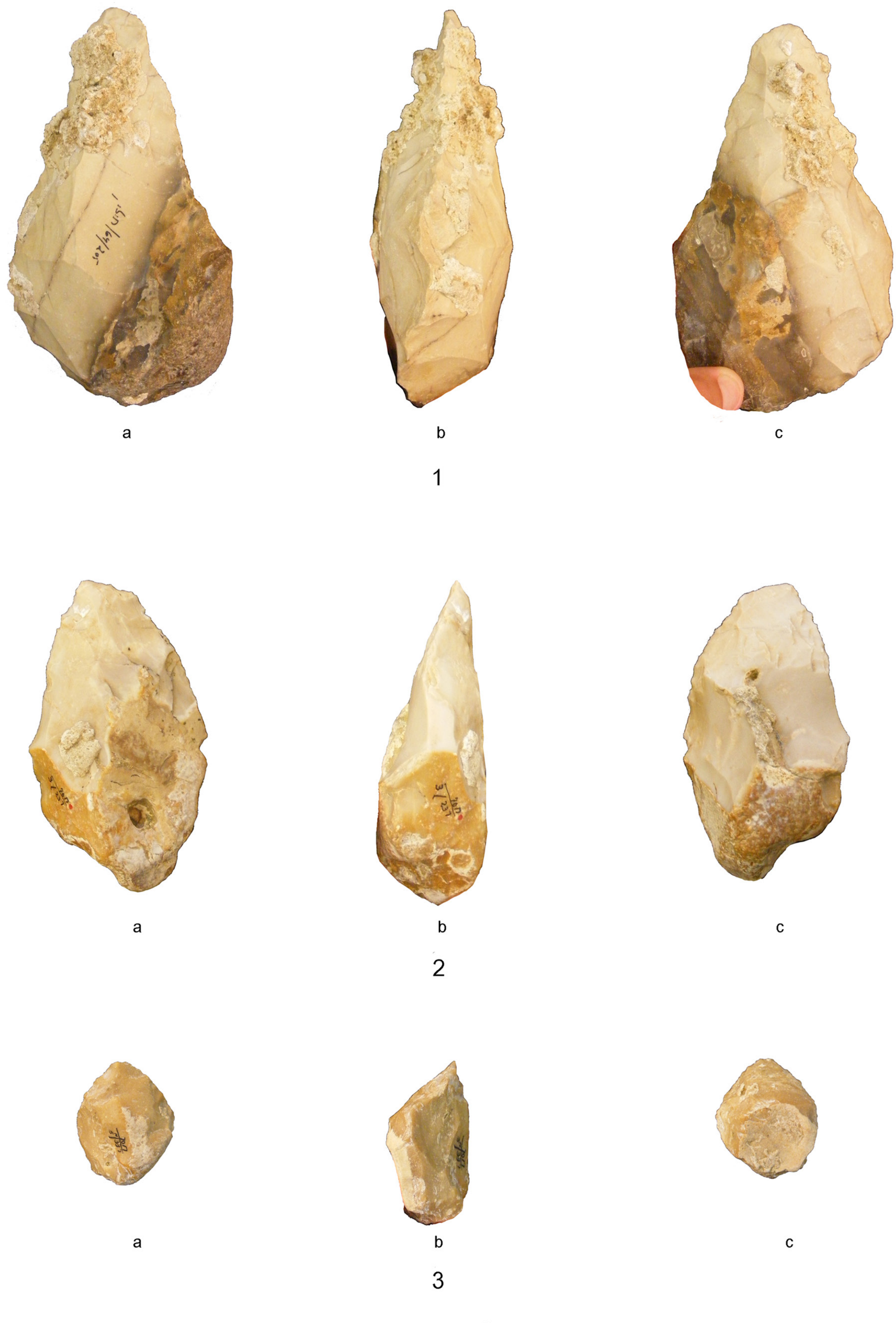

Figure 5. 1: handaxes larger than 12cm; 2: handaxes between 8–12cm; 3: handaxes smaller than 8cm; note the similarities in cortex coverage, numbers of scars and mode of shaping despite the variations in their sizes.

TABLE 5. FREQUENCIES OF RETOUCHED ITEMS.

	N	%
Handaxes	107	23.4
Retouched items	92	20.1
Scrapers	82	17.9
Composite tool	73	16.0
Truncation	25	5.5
Isolated removal	24	5.3
End scrapers	17	3.7
Burin	15	3.3
Awl	3	0.7
Notch	6	1.3
Varia	13	2.8
	457	**100**

degree of penetration is minimal, up to a few millimeters at most (see Figure 8: 3, 5; Figure 9:2). Another important aspect is the alteration in the angle of retouch. Two angles were measured on each spall—the angle of the retouch on the parent tool and the current angle. The current angle was measured in order to calculate the "new" angle, by deducting the current angle from 180^0 (Figure 10:3–6). The results show that the "old" angle, on the parent tool, measured 60˚–70˚, while the "new" angle measures 50˚–60˚. Thus, the removal of the spalls contributed to the creation of a new edge with a sharper angle.

The motivation for selecting a certain type of parent tool is not obvious. The diversity among the spalls in both mode of retouch and level of intensiveness implies that the Holon parent tools chosen for maintenance were both scrapers and retouched items. It does not seem reasonable to correlate it with a higher level of utilization, since the mode of exploitation found on the spalls is diverse, exhibiting both low and high extensiveness of retouch. As can be seen, the variable nature of the re-sharpening flakes hampers our attempts to make a straightforward calculation of the ratio of spalls to unifacial tools. The scrapers and retouched items do not bear any traces similar to those found on the removed spalls. Hence, it is most probable that after the new edge was created, it was retouched again, used, and only then discarded. Thus, without the presence of the spalls, we would not have been able to reconstruct the maintenance tactics at Holon.

The maintenance of unifacial tools evident at Holon is unique in the Middle Pleistocene record of the Levant. Thus far, it has not been reported in other Levantine Late Lower Paleolithic assemblages (e.g., Lev 2010: 114–118), or the one Middle Paleolithic assemblage in this region (Zaidner et al. 2014). Assemblages with similar techno-typological characteristics do not contain these kinds of spalls (e.g., Kefar Menahem: Barzilai et al. 2006; Revadim: Malinsky-Buller et al. 2011a). In Holon the technical reasons for choosing those maintenance techniques lie in the creation of a new edge with a fresh and sharper angle that provided for the possibility for additional retouch. The question remains, however, of how these maintenance behaviors fit within the organization of the technology evident in other facets of the lithic assemblage.

DISCUSSION

The lithic assemblages at Holon represent a mixture of provisioning strategies. Handaxes seem to have been brought into the locality already knapped, most probably as finished products and only the final stages of shaping were done on-site. The ratio of handaxes within the retouched assemblage, as well as in the general assemblage, is remarkably high in comparison to other open-air Levantine Acheulian sites. Yet, there are few indications that the handaxes were maintained; very few thinning flakes were found at the site compared to the high number of handaxes found at the locality.

On-site knapping at Holon is evident in the hammerstones, tested cores, cortical elements, and CMPs in the assemblage. Technologically, the Holon assemblage is characterized by a high frequency of cores-on-flakes, similar to other Late Lower Paleolithic assemblages (e.g., Barkai et al. 2010; Malinsky-Buller et al. 2011b).

The transformation of flakes and primary elements into cores is interpreted as a strategy of economizing raw material (Hovers 2007; 2009 for further discussion). If recycling is taken to mean the "remaking of an implement into a different kind of tool" (Odell 1996: 59), flakes turned into cores indeed reflect this type of behavior. Moreover, there is a shift in the role of the artifact when a flake turned into a source of blanks, a process that requires the application of a different conceptual framework to the very same artifact. Yet, on the other hand, some scholars suggest those cores-on flakes are not an expedient reduction sequence, but rather a repeated behavior (Hovers, 2007), and sometimes even planned in advance (Bourginoun et al. 2004). At Holon, the reduction sequence of the cores-on-flake is interpreted as a systematic production system. The frequency of cores-on-flakes as well as the level of utilization exceeds those of other Late Lower Paleolithic sites (see above).

The raw material economy of the retouched components cannot be interpreted in a straightforward manner. The blanks used for retouch in the Holon assemblage were chosen due to their larger size in comparison to the debitage (see Table 3). These retouched items contain a high proportion of composite tools and highly retouched scrapers. It is possible that, similar to the handaxes, retouched tools also were transported into the site. It remains unclear whether the act of retouching was done on-site or not. Retouched tools may have been brought into the site after they were retouched, or they may have been carried in as blanks and then retouched on-site. There is no positive evidence to support or refute either of these scenarios.

Maintenance, on the other hand, was done on-site. The removal of previous edges and the creation of new ones

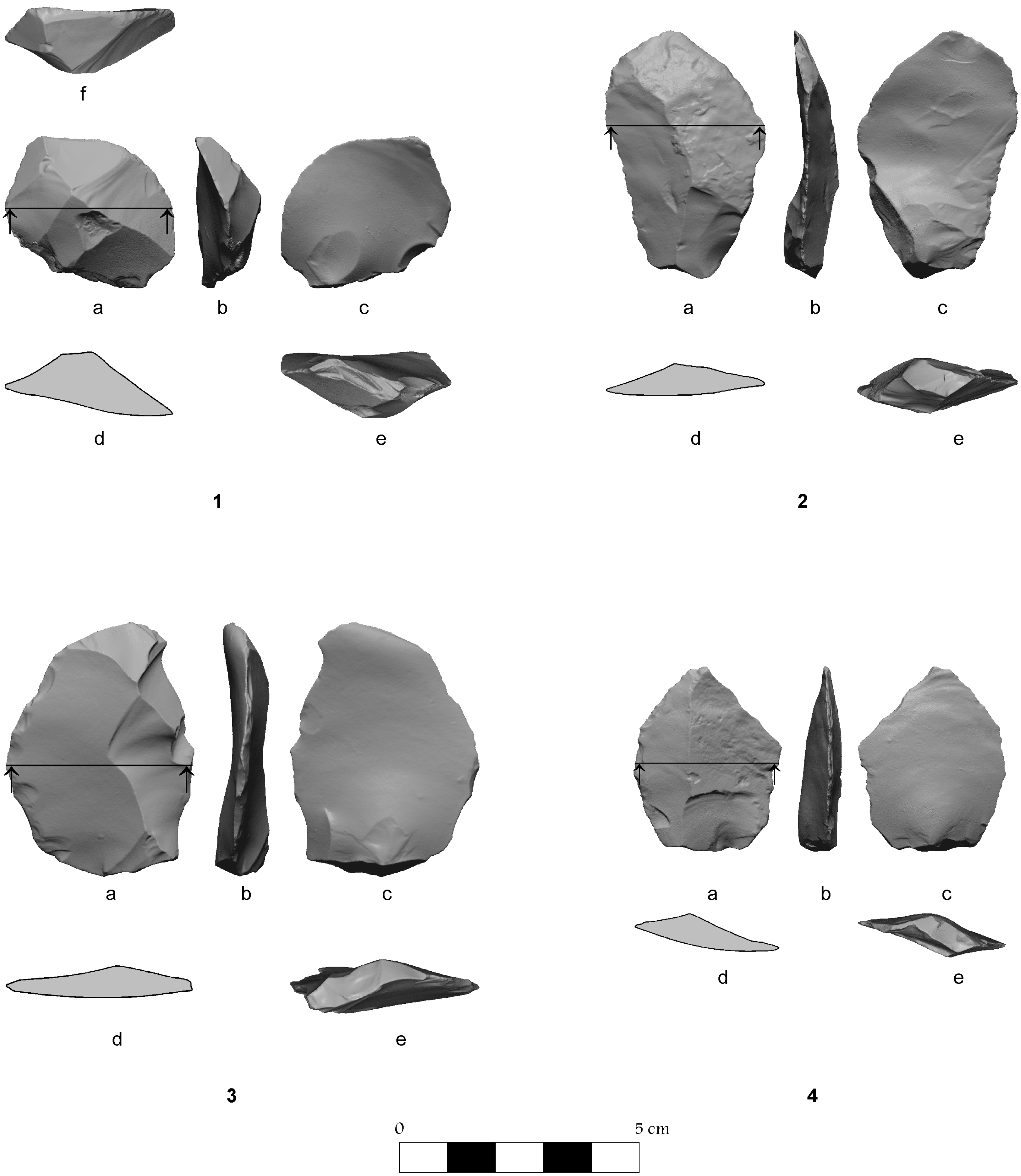

Figure 6. Retouched items.

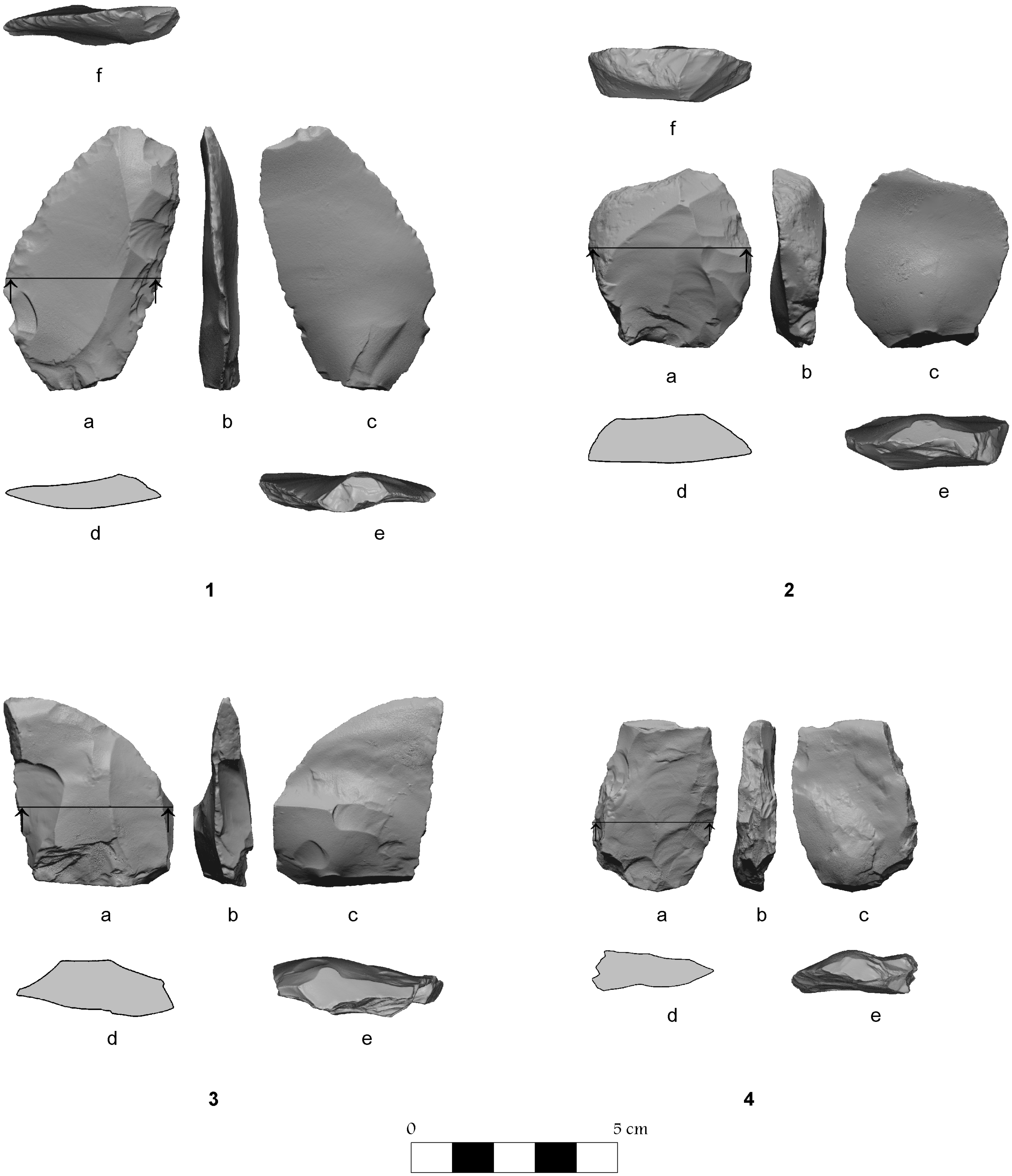

Figure 7. 1: composite tool: double sidescraper and truncation; 2–4: sidescrapers.

TABLE 6. COMPOSITE TOOLS—TYPOLOGICAL MAKEUP.

	Sidescrapers	Burin	Truncation	Notch	Miscellaneous	Retouched item	Isolated removal	Total
Side-scrapers	8		12	1	7	4	4	**36**
End-scrapers	1							**1**
Burins		1				1	1	**3**
Truncations		1	2			2	2	**7**
Retouched items	4	1	1		9	2		**17**
Miscellaneous	1		1			1		**3**
Isolated removals					1	3		**4**
Awls		1			1			**2**
Total	**14**	**4**	**16**	**1**	**18**	**13**	**7**	**73**

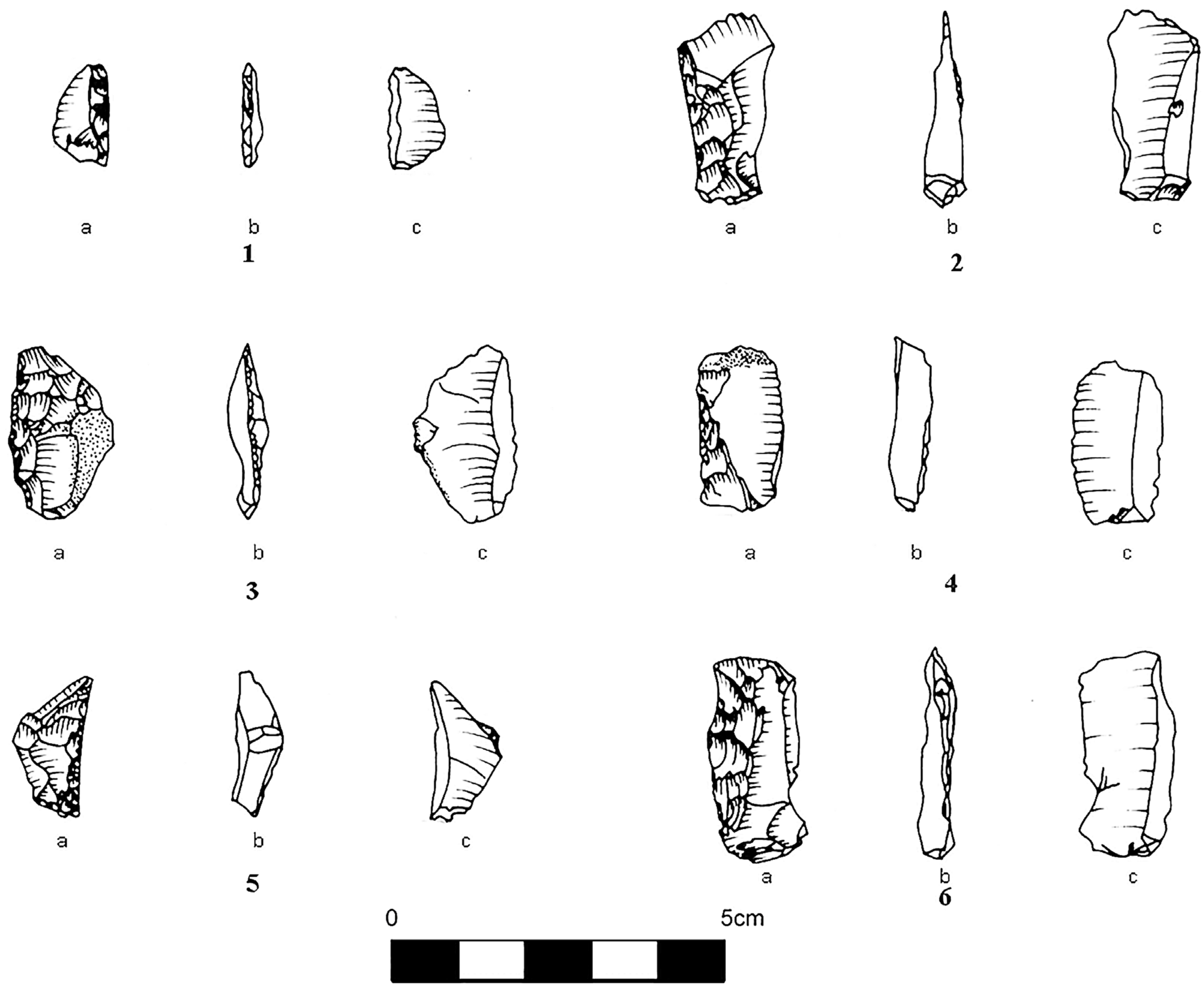

Figure 8. 1, 5: long sharpening flakes removed from the right side of scraper or retouch item; 2, 3, 4, 6: long sharpening flakes removed from the left side of scraper or retouch item. Note the plain side from which the retouch stems, as well the variations in the mode of retouch and intensiveness of retouch.

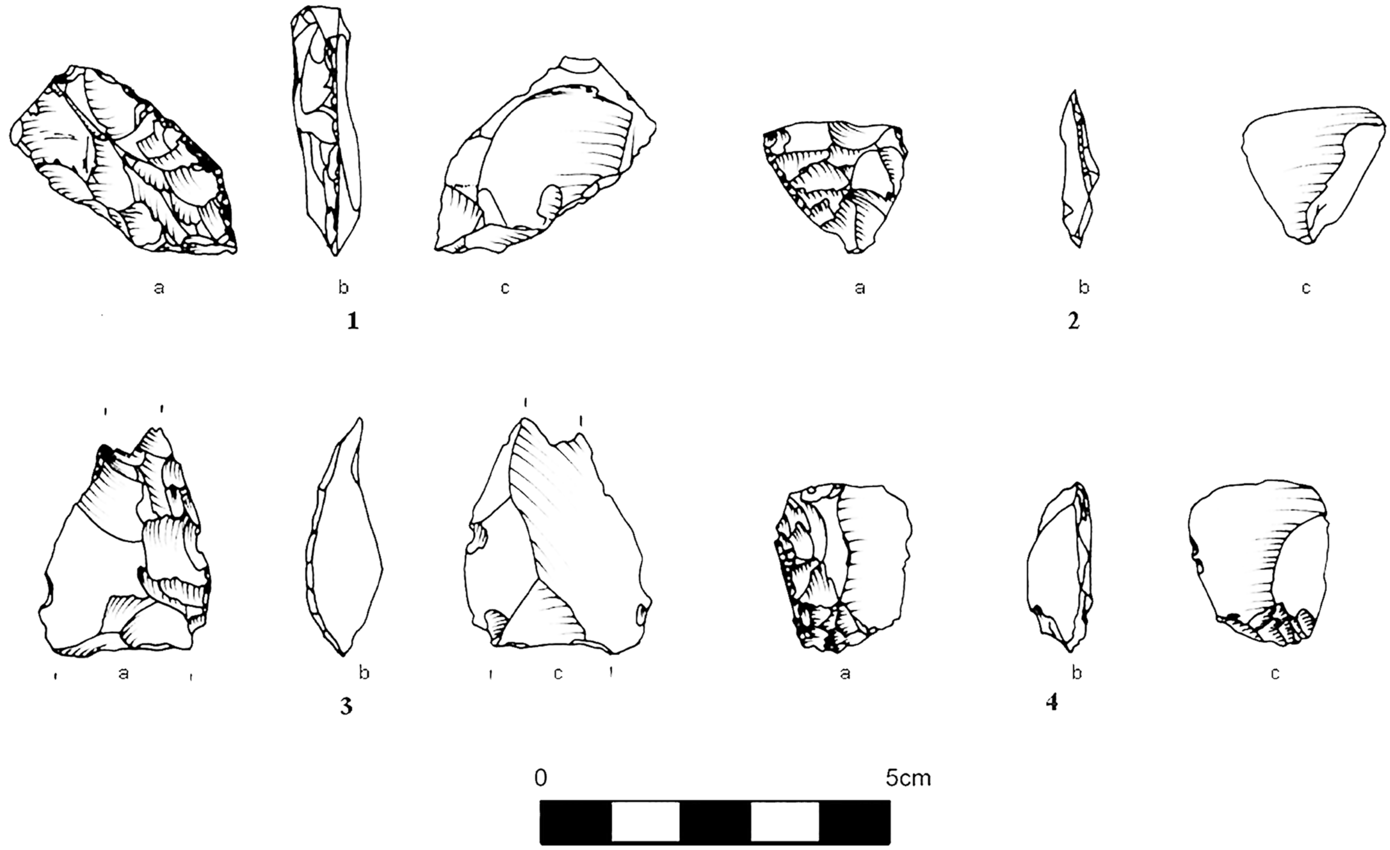

Figure 9. 1: "coup de tranchet" stemming from the rejuvenation of the handaxe's tip; 2, 4: transverse sharpening flakes removed from the left side of previous scraper or retouch item. 3: transverse sharpening flakes removed from the right side of previous scraper. Note the plain side from which the retouch stems, as well the variations in the mode of retouch and intensiveness of retouch.

represent a maintenance stage that is rarely described at Middle Pleistocene sites[3]. This technological procedure extends the use-life of the tools, fitting the definitions of Shott (1989, 1996). Odell (1996: 62) distinguishes between tool maintenance as an event and as a process. As an event, it occurred when margins become dull. While as process, it refers to the concept of "maintainable" tool, which can be made so that if it is not appropriate for the task it can quickly be brought back to the functional state (Bleed 1986). Such tools are modular in design and relate more to expedient tool use, when need arises. At Holon, the maintenance of unifacial tools fits more closely to the concept of "maintainable" tools. The removals of the spalls signify a stage, after which another retouch set occurs—bringing the tool back to its functional state.

Without the presence of the maintenance spalls we could not have identified this technical procedure. The role of the spalls was to remove the existing retouched edge of the parent tool, so as to create a new and sharper edge. Two typological types were suggested to be the parent tools—scrapers and retouched items (see Figure 10). The technological reading of the spalls shows great diversity in size, mode of retouch, and the extent to which the retouch penetrated the blank. Nevertheless, those spalls share a common goal—creating a new edge, that later was retouched again, as none of the retouched items bear signs of a spall removal. It is possible that such retouched items were taken out of the site.

The lithic assemblage of Holon serve as a rare opportunity within Middle Pleistocene record for unpacking the term of curation into various strategies, each performs differently and enables a distinction between different aspects within the concept. As stated by Bamforth (1986) and Odell (1996), curation subsumes different perspectives—planning depth, maintenance, and recycling, all taking part within technological organization. Concerning the movement of raw material, the selected strategy was provisioning of place. Provision of place involves a supply of raw materials or finished implements, such as the handaxes into the locality (Binford 1979; Kuhn 1995). This mode of behavior greatly increases the potential efficiency of conducting a broad spectrum of tasks (Kuhn 1995). Handaxes can be perceived as personal gear, a toolkit already prepared for use (Binford 1979). This would have minimized the risk of failure to exploit unexpectedly encountered resources, as well as the cost of carrying around bulky and heavy lithic packages. Interestingly, there are few indications that those handaxes were heavily maintained. Another aspect of raw material economization is the selection of flakes and primary elements as source for further making new blanks. At Holon, cores-on-flakes are an expedient, opportunistic economizing behavior, yet at the same time reflects an or-

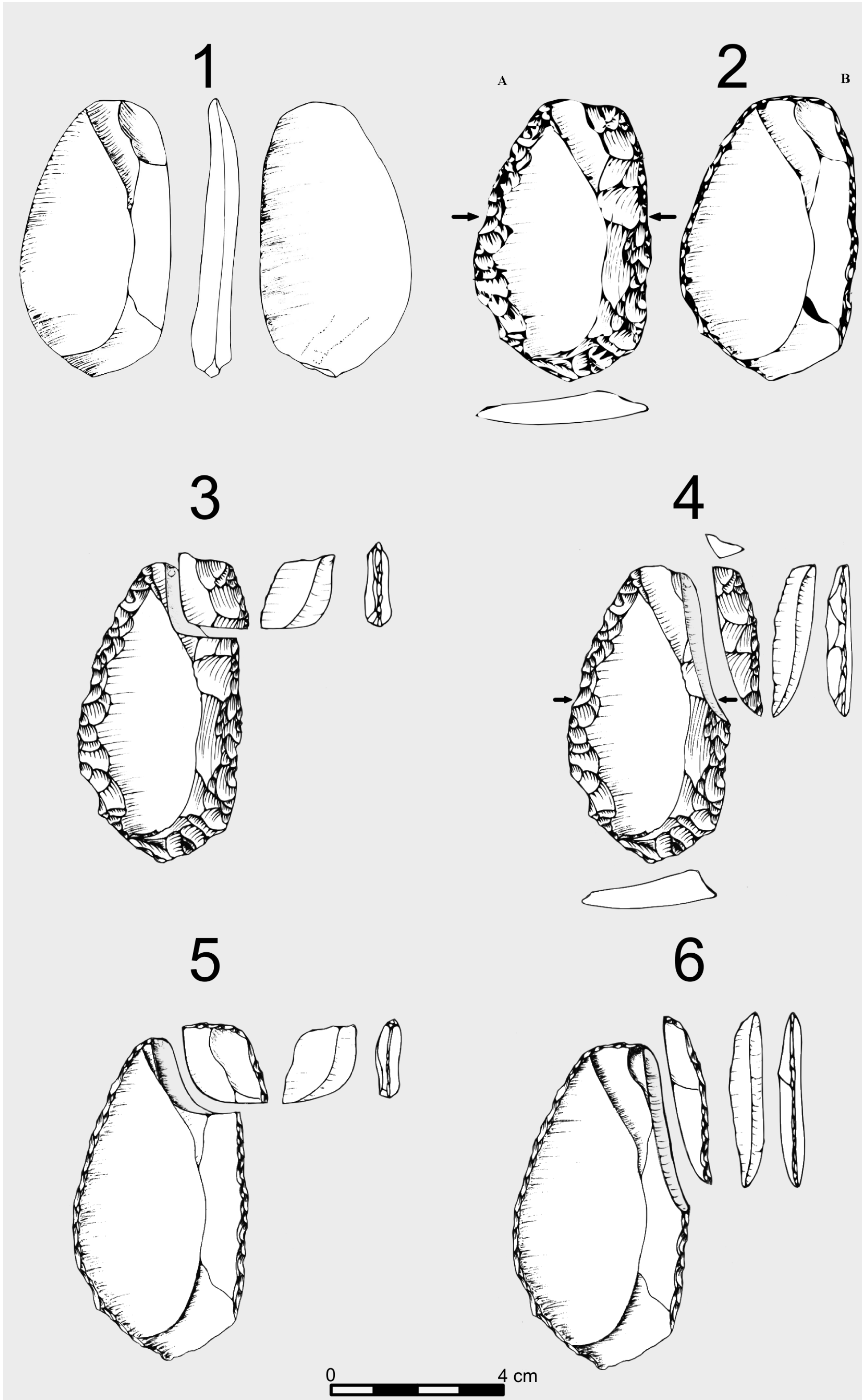

Figure 10. Schematized reconstruction of the stages of maintenance techniques of sidescrapers and retouched items in Holon. 1: blanks selection; 2A: retouch into a sidescraper; 2B: retouched into retouched item; 3: removal of transverse sharpening flakes from sidescraper. 4: removal of long sharpening flakes from side-scraper. 5: removal of transverse sharpening flakes from retouched item. 6: removal of long sharpening flakes from retouched item.

ganized and designed practice within a structured system of lithic production.

Although re-sharpening is widely discussed in the literature, it has rarely been demonstrated technologically in Lower and Middle Paleolithic contexts of Europe (for exceptions see Bourguignon 1992; Conford 1986; Fonton et al. 1991; De Loacker 2006; Roebroeks 1988; Roebroeks et al. 1997). The spatial and temporal distribution of such maintenance techniques in the Lower and Middle Paleolithic record in Europe is patchy outside assemblages with Quina retouch (Bourguignon 1996; Hiscock et al. 2009). Thus, when one appears, we must go beyond description, and contextualize the reasons for adopting such a technical strategy. In terms of cost/benefit ratio, it is hard to assess the merits of maintenance for unifacial tools. On the one hand, re-sharpening can economize raw material by minimizing transport cost. On the other hand, re-sharpening reduces the size of the tool, alters the morphology of the edge, and diminishes the potential for future renewal of the scraper's edge (Kuhn 1995). More importantly, economizing behaviors of this sort are conditional and are adopted in response to changes in circumstances. Thus, in order to suggest contextually reliant explanatory narratives (time- and place-dependent scenarios), one should explore the conditions that stimulated the preference of such economical solutions (Holdaway and Douglas 2011).

One such explanatory scenario perceives maintenance techniques as an organizational response to raw material shortage (Bamforth 1986). Following this interpretive line, the scarcity of raw material is suggested as the cause for re-sharpening techniques in several European assemblages. At La Cotte de St. Brelade, an Early Middle Paleolithic site on Jersey Island, England, sharpening flakes were found in different quantities within each of the assemblages of the long depositional sequence. Conford (1986) suggested there was a correlation between the changing frequencies of sharpening flakes and the availability raw material. An analogous scenario was suggested for Layer 4 at Coustal Cave, in Corrèze, France, where scrapers made on jasper, a rare raw material, were re-sharpened (Fonton et al. 1991).

At Maastricht-Belvedere in the Netherlands, however, a different interpretive scenario was suggested. The use of this technique to maintain the tools was interpreted not as a response to raw material deficiency, but rather as a deliberate choice to "minimize" the energy invested in the toolkit (De Loacker 2006; Roebroks 1988; Roebroks et al. 1997). This distribution of maintenance techniques over large areas and within varied contexts of deposition refutes cross cutting explanatory scenarios. Accordingly, the appearance of these techniques may imply a functional response to a problem, a solution adopted to satisfy some type of need that necessitated creating new, sharper active edges.

At the site of Holon, it is unlikely that raw materials were a constraint. Within the assemblage there is suitable raw material—unmodified pebbles larger than 5cm—and it is quite probable that these could be found in the immediate vicinity, as they were abundant in the nearby streams. As seen above, the small number of lithic items from Holon, on one hand, and the detailed environmental data from the site on the other, lend themselves to a high-resolution reconstruction of a contextual behavioral scenario. What components of the environmental circumstances could have led to this multifaceted technological organization seen at Holon? Several landscape studies have shown that even minor variations in topography, plant ecology, and hydraulic conditions, can be highly significant in shaping hominin behavior (e.g., Blumenschine and Peters 1998; Potts et al. 1999; Tactikos 2005).

We cannot rely on negative evidence. Thus, by default, we focus on the macrofauna remains from the Paleolithic sites as the main source of information regarding hominin diets. Most of the macrofauna species are not daily water dependant (see exceptions above in the Holon faunal assemblage), thus their daily foraging range is large, by far larger than the immediate locality were their remains have been found. The ecological variation between the coastal plain sites probably lies in the finer resolution—the micro-habitat and most likely the vegetation and its local biomass. However, the current amount of plant biomass in the coastal plain of Israel is not equivalent to the potential food available. Furthermore, estimating the potential food available in a habitat would be misleading if it is based upon our meager data currently available about present edible vegetation, the possible need for pyro-technology or other technologies for processing these resources, and the lack of data from the Paleolithic sites themselves (see discussion in Hovers, 2009: 196–207 and references therein). Importantly this kind of potential food resource is not equally available year-round. Ethnographic and simulations analysis pointed out that in patchy environments, where resources are spatially clustered and not homogeneously distributed over the landscape, plant resource harvesting must be timed accurately (Kelly 1995; Metcalfe and Barlow 1992). The fact that plants constitute relatively low return resources often renders their transport to a base camp an inefficient strategy (Kelly 1995). In the current state of our knowledge, we could not state that the vegetal resources are the determinant factor for the observed variations in the technological organization of lithic assemblages at this given period and geography. The possible linkage between the specific environment and possible implications of such a micro-habitat upon behavior suffers from causation by association. However, in the future, more in-depth studies would enable further testing of this proposition or modeling in the future (e.g., Blumenschine and Peters 1998).

The site of Holon was located near a seasonal or short-term marsh, with a relatively high abundance of cutting edge and renewal and maintenance of sharp edge in unifacial tools found there, not paralleled at other Late Acheulian sites. The described maintenance technique of unifacial-retouched items is the only facet of economizing behaviors at the site. This kind of technological organization can be regarded as a chosen tactic, not as an obligatory response to a deficiency of raw material. The case study of Holon exhibits a situational modification that extended the common techo-typological repertoire of the Late Acheulian, probably due to functional demands. This kind of behavior is rarely described within Middle Pleistocene contexts. It highlights complex economical decision-making processes leading to narrow, specific technological behaviors. The causes of those behaviors may be butchery, hunting, or possibly vegetal processing in an ephemeral ecological niche. These types of assemblages appear only later, in the Upper Pleistocene (Sharon and Oron 2014). Putting the Holon maintenance strategies in context, both technological organization and landscape, highlights the flexibility in the adaptive solutions within the Middle Pleistocene record.

ACKNOWLEDGMENTS

I wish to thank O. Marder and H. Khalaily for allowing me to use their unpublished data concerning the Holon test trenches. I would like to thank E. Hovers and Y. Zaidner for reading earlier versions of the paper. I also want to thank N. Goren-Inbar and A. Sumner for their help and generous support. Dafna Straus edited the manuscript. Figure 1 was produced by M. Birkenfeld; Figure 2 was produced by A. Bogdanovsky; Figures 3–7 were produced by the Computerized Archaeology Laboratory at the Institute of Archaeology, The Hebrew University, using methods described in Grosman (et al. 2008). I also wish to thank O. Harush and A. Ovadia from the Computerized Archaeology Laboratory, Institute of Archaeology, The Hebrew University. Figures 8–10 were drawn by M. Ulman; Figure 10 also has contributions from U. Schattner and R. Ekshtain. In addition, this manuscript benefitted greatly from the comments of two anonymous reviewers.

ENDNOTES

1. As the exact location and extent of the original excavation is unknown, the distance between the probes and the original excavation is unclear. Porat et al. (1999) estimate the distance at 8m.
2. Primary elements are classified as flakes with more than 50% cortex.
3. Lev (2010) discussed 21 scraper spalls, a minute percentage of artIfacts in comparison to the lithic assemblages at Qesem cave.

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