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On the Function of Late Acheulean Stone Tools: New Data From Three Specific Archaeological Contexts at the Lower Palaeolithic Site of Revadim, Israel

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ABSTRACT
The Acheulean represents one of the most widespread cultural complexes spanning from Africa to Eurasia between 1.8 and 0.2 Mya. The site of Revadim, located on the southern coastal plain of Israel, represent one of the rare opportunities allowing to perform detailed functional analysis of stone tool assemblages from such old contexts. This paper presents data originating from the functional analysis of three lithic assemblages coming from two areas of the site (B and C). Our results suggest that at Revadim most of the tools were used for the processing of soft materials, possibly related to butchering activities along with some tools used to process vegetal materials and bone. The evidence here presented highlight the use wear potentials of Revadim and its implication in the investigation of the range of activities performed by Levantine Acheulean early human groups.

KEYWORDS
Acheulean; stone tools; use wear; Revadim; Levant

Introduction

The Acheulean represents the most geographically and chronologically wide spread Lower Palaeolithic cultural complex (Bar-Yosef, 1994; Lepre et al., 2011; Stiles, 1979). Acheulean contexts are found both in Africa ad Eurasia and are dated between 1.8 and 0.2 Mya. Commonly associated with Homo ergaster/erectus the lithic assemblages are composed by flakes and flaked tools, with bifacially flaked tools, namely handaxes or Large Cutting Tools (LCT), representing the hallmark of this techno complex (Finkel & Barkai, 2018; Hodgson, 2015; Moncel, 1995; Moncel et al., 2015; Sharon, 2009). Numerous experimental works have been performed on the use of Acheulean tools, in particular regarding the function of bifaces and cleavers, highlighting the great potential of these tools in butchering and wood working activities (Gingerich & Stanford, 2016; McCall, 2005; Merritt, 2012). Yet, only few works focused on the application of use wear and/or residues analyses on Acheulean implements (Aureli et al., 2015; Domìnguez-Rodrigo et al., 2001; Nicoud et al., 2015; Santucci et al., 2016; Solodenko et al., 2015; Viallet, 2015, 2016), mainly due to the state of preservation of the artifacts, often not allowing detailed functional studies. However, these studies demonstrated that use wear and residues analyses can be performed on such old contexts, providing relevant and detailed results regarding the use of Acheulean tools. Solodenko et al. (2015) identified traces related to hide, animal tissues and wood processing on some stone tools unearthed from a particularly well-preserved context at Revadim (Israel), while Viallet (2015, 2016) identified edge damage associated to percussion activities at the Acheulean sites of Terra Amata and Lazaret Cave. Moreover, relevant results have been obtained from the analysis of two Acheulean contexts from the Italian peninsula, La Polledrara di Cecanibbio, la Ficoncella and Valle Giumentina (Aureli et al., 2015; Nicoud et al., 2015; Santucci et al., 2016). Traces associated to the working of soft or medium-hard materials were identified on the small tool composing the lithic assemblage of La Ficoncella (Aureli et al., 2015). At La Polledrara, use wear use wear analysis indicated that most of the tools were utilized in butchering activities, with several specimens exploited to process wood. Traces associated to butchering have been observed as well on some of the tools found at the site of Valle Giumentina (Nicoud et al., 2015). This paper presents new data concerning use wear analysis performed on a lithic sample coming from the late Acheulean Lower Palaeolithic site of Revadim. Use-wear analysis was performed on three lithic assemblages coming from distinct archaeological contexts at two areas of the site: Area B (Localities 23 and 24) and Area C (Layer 5). The analysis performed allowed to identify edge damage and, in

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several cases, micro wear associated to the use of the tools, providing consistent data regarding their function. The data presented in this paper provides relevant insights concerning the behavior of the early human groups of Revadim, an archaeological context representing a rare and valuable opportunity to investigate early human behavior in the Levant during the Lower Palaeolithic.

Revadim

The site of Revadim Quarry is located 40 km southeast of Tel Aviv, on the southern Coastal Plain of Israel (Marder et al., 2011) (Figure 1). During the four years of excavation, four Areas, A to D, have been excavated along with several trenches (Marder et al., 2011; Rabinovich et al., 2012). The geological sequence of Revadim has been dated through palaeomagnetic analyses (for details see Marder et al., 2011), it exhibits a normal polarity and suggests an age younger than 780 kya for the site (Marder et al., 2011). U-Th was used to date the carbonate coating present on the flint items unearthed at the site, providing dates between 300 and 500 kya, which allow to define a minimum age for the human occupation of the site (Malinsky-Buller, Hovers, & Marder, 2011). Both the lithic materials and the faunal remains unearthed at Revadim allowed to associate the site to the Late Acheulian of the Levant (Malinsky-Buller et al., 2011; Marder et al., 2011). Bifaces, choppers, scrapers, flakes and cores, along with a high frequency of recycled items compose the lithic assemblage found at the site, while *Palaeoloxodon antiquus*, *Bos primigenius* and *Dama cf.* are the most represented animals within the faunal assemblages of the site (Agam, Marder, & Barkai, 2014; Rabinovich et al., 2012; Solodenko et al., 2015).

Area B (Localities 23 and 24)

Area B spreads for 94m^2 and its associated lithic assemblage comprises 27.591 flint items (for details see Solodenko et al., 2015). Two layers have been identified in this area, namely B1 and B2, the former consisting in patches of faunal and lithic remains, while the latter is characterized by a continuous distribution of flint and bones (Marder et al., 2011). Of particular interest is the presence in Layer 2 of elephant remains including two elephant ribs, one of which exhibiting cut marks, a vertebrae plate and seven tooth fragments (Marder et al., 2011; Rabinovich et al., 2012; Solodenko et al., 2015). Localities 23 and 24 were found at the bottom of Layer B2. Both localities, placed next to each other at the same elevation, are located in the northern portion of Area B (Figure 2(a,b,c)). The assemblage of locality 23 includes 116 items and locus 24 characterized by 822 items (for details see Table 1). A number of items (5 from locality 23 and 39 from locality 24, including mainly cores and tools) were sent to the Israel Antiquities Authority for drawing purposes and could not be retrieved, thus, not available for this analysis. From the point of view of assemblage composition, several differences between localities 23 and 24 can be observed. The relatively small assemblage of Locality 23 is characterized by overall large items, a considerable number of items defined as natural flint nodules/blocks ("raw material," *n* =

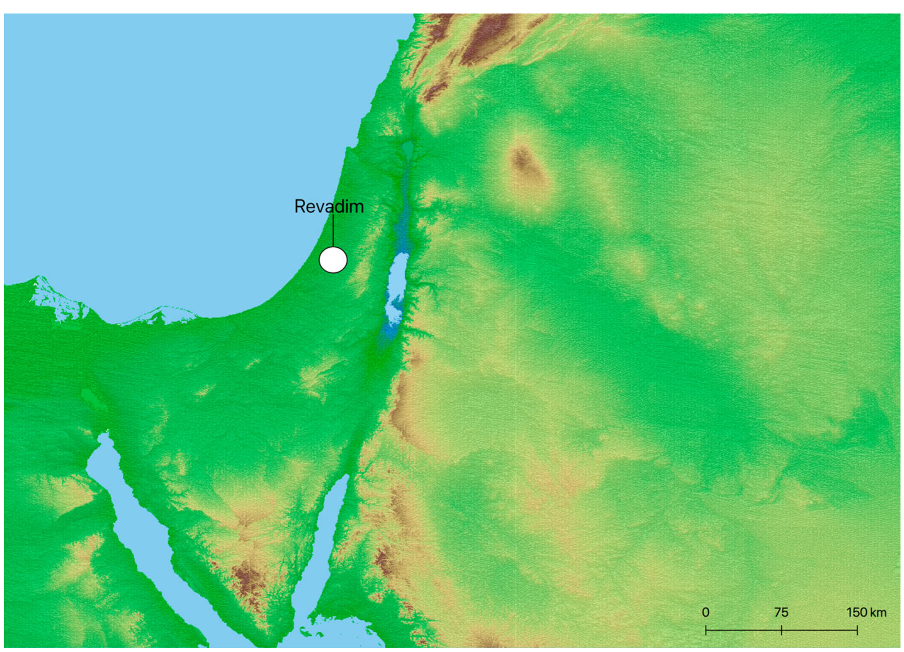

Figure 1. Localization of the Late Acheulean site of Revadim.

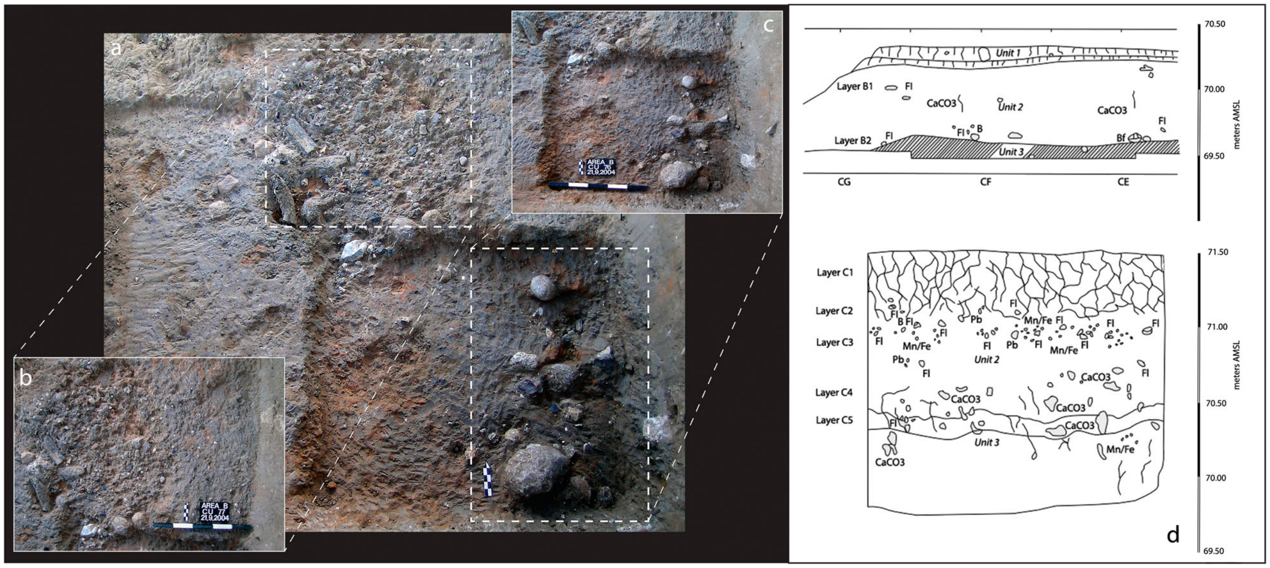

Figure 2. (a) Area B Loc. 23 and 24. (b) Area B Loc. 24. (c) Loc. 23. (d) Stratigraphic sequence of Area C.

6; 5 per cent) and cores (*n* = 5; 22 per cent). In contrast, lower frequency of cores (*n* = 22; 7 per cent), if compared to shaped items, are found in the lithic assemblage of Locality 24, with the ratio between cores and blanks being 1:13. Despite the large proportion of cores in Locality 23, no core trimming elements (CTE) were recognized

Table 1. Assemblage composition at Revadim Area B (Loc.23 and 24) and Area C Level 5.

Area B Loc. 23 and 24							Area C Level 5			
Category	Loc.23 (CU76) (North) B2	Loc.24 (CU77) (North) B2	%of débitage and shaped items Loc.23	% of débitage and shaped items Loc.24	% of total assemblage Loc.23	% of total assemblage Loc.24	Category	*N*	% of débitage and shaped items	% of total assemblage
Primary element flake	1	4	4	2	1	0	Primary element flake	57	10.7	3.3
Primary element blade	0	0	0	0	0	0	Flake	81	15.1	4.6
Flake	5	31	22	14	4	4	Broken fFlake	0	0	0
Broken flake	5	65	22	29	4	8	Blade	4	0.7	0.2
Blade	0	0	0	0	0	0	Core	28	5.2	1.6
Core	5	15	22	7	4	2	Core trimming element (CTE)	60	11.2	3.4
Core trimming elements (CTE)	0	12	0	5	0	1	Core on flake	30	5.6	1.7
Core on flake	0	10	0	4	0	1	Shaped item	221	41.3	12.7
Tool	7	84	30	37	6	10	Special spall	20	3.7	1.1
Special Spall	0	4	0	2	0	0	Recycled item	34	6.4	1.9
Sum of Débitage and Shaped Items	23	225	100	100	19	26	*Sum of débitage and shaped items*	535	100	30.6
Micro flake	3	31			3	4	Micro flake	145		8.3
Chip	81	492			70	60	Chip	721		41.3
Chunk	3	58			3	7	Chunk	330		18.9
Flaked pebble	0	15			0	2	Flaked pebble	5		0.3
Raw material	6	1			5	0	Raw material	10		0.6
Total	116	822			100	100	Total	1746		100

within the assemblage while a ratio of almost 1:1 between cores and CTE characterises Locality 24. In addition, in Locality 24 flake cores are present ($n = 10$), while being absent from Locality 23. The spatial distribution and assemblage composition might allow to suggest the definition of these two localities as specific activity areas. Indeed, Locality 23 may possibly represent a concentration of primary items (raw materials and cores) that have been brought to the site for initial stages of processing, while Locality 24 may represent an area dedicated to a more intensive manufacturing of lithic tools.

Area C (Layer 5)

Area C, which has been divided in West and East sections, represents the most complete stratigraphic sequence of Revadim. Five superimposed archaeological levels (C1–C5) have been identified in C West, with C2 and C3 representing the main occupation horizons of the sequence (Marder et al., 2011). Layer C2 consists of different occupational levels and is characterized by dense concentration of lithic artifacts and faunal remains (Marder et al., 2011). Layer C3, separated from layer C2 by a sterile level, represents the layer with the highest concentration of archaeological remains of Area C. Layer C5, located in the north-eastern portion of Area C West, resembles the characteristics of layers C2 and C3, exception made for a higher percentage of bifaces and large animal bones (Marder et al., 2011). Layer C5 is the deepest layer of Area C, therefore representing its earliest evidence of anthropic activity. Layer C5 was exposed over approximately 8 square meters in the northern part of Area C to a maximum thickness of 25 cm, at the point of contact between the Gray-Brown paleosol and the Husmas (Figure 2(c)). Item density is more than 80 items per m^3, which is lower than in layers C3 and C2 where the density is 100–150 items per square meter. Based on geological evaluations, it layers C5 and layer B2 are probably contemporaries in the geological sense (Marder et al., 2011). The lithic assemblage of Layer C5 is relatively small and well defined. The assemblage includes 1746 flint items, 535 of which are débitage and shaped items (Table 2). The assemblage is composed mainly by retouched flakes ($N = 119$) and other flake tools ($N = 86$), in addition to a small number of bifaces ($N = 4$). Among the finds, tools appear at a relatively high rate (12.7 per cent), compared to other contemporaneous sites as well as in other areas at Revadim (Agam et al., 2014; Malinsky-Buller et al. 2011). It should be noted that within the lithic assemblage of Revadim three main flake production systems have been identified: (1**)** The production of large and medium items, detached through a variety of techniques (one, two or multi production platforms cores), (2**)** Prepared cores for the production of relatively predetermined flakes having clear hierarchy between the two core surfaces, obtained through the use of a method having certain similarities to the Levallois method. (3**)** Small flakes were produced through the recycling of old flakes (Agam et al., 2014; Agam & Barkai, 2018).

Table 2. Analyzed tools coming from Area B (Loc.23 and 24) and Area C (Level 5).

Tool type	Number of shaped items (Locality 23)	Number of shaped items (Locality 24)	Number of shaped items (Layer 5)
Flake	0	0	2
Retouched flake	1	16	33
Retouched primary element flake	0	4	0
Retouched broken flake	0	11	8
Retouched micro flake	2	11	0
Retouched Blade	0	0	6
Shaped special spall	0	1	6
Side Scraper	1	4	0
End Scraper	0	5	3
Awl/Borer	0	3	5
Truncation	1	2	3
Notches	1	17	9
Denticulate	0	4	4
Burin	0	1	0
Double Bulb	0	0	1
Bifaces	0	0	4
Chopper	0	1	0
Varia	1	4	
Total	7	84	85

Materials and methods

Three lithic assemblages coming from two Areas (B and C) of Revadim have been analyzed by means of use war analysis. Shaped items, comprising a total of 176 flint artifacts have been examined in order to identify wear related to use. Both a Low and High-Power Approaches (Keeley, 1980; Odell, 1981; Tringham, Cooper, Odell, Voytek, & Whitman, 1974; Van Gijn, 2010) were adopted in the analysis of the materials. At first, the materials have been analyzed at Tel Aviv University, using an Olympus-SZ-PT stereo microscope, equipped with 10x oculars and a zoom up to 7.5x allowing a maximum magnification of 75x. This permitted to evaluate the state of preservation of the materials and identify edge damage (e.g. micro chipping and localized rounding) derived from use. This first phase of analysis allowed to obtain a first dataset concerning the hardness of the materials worked and the motions adopted. A second phase of analysis was performed at the Laboratory of Technological and Functional Analyses of Prehistoric Artifacts (LTFAPA – Università Sapienza di Roma) utilizing a Nikon Eclipse

Metallographic Microscope equipped with 10x eyepieces and 5x, 10x and 20x objectives, which allowed the observation of the artifacts at higher magnifications, ranging from 50x to 200x. In this way, micro-wear, including polishes, abrasions, striations and surface micro rounding were identified and described providing more detailed information regarding the worked materials and the activities performed. In order to properly interpret the wear identified on the archaeological sample, both the edge damage and micro wear observed were compared to the experimental use wear comparison collection stored at the Laboratory of Technological and Functional Analyses of Prehistoric Artifacts (LTFAPA). In the case of two archaeological items, a chopper (11,506) and a biface (1), given their dimensions not allowing to observe them directly under the metallographic microscope, high resolution silicon casts of the edges were taken using Provil Novo Light Fast (Banks & Kay, 2003; Pedergnana & Ollé, 2017). The washing procedure of the tools, prior to their observation under the microscopes, included a first washing with hot water and soap. Then, an ultrasonic bath was performed for 15 minutes, using a demineralized water with a 2 per cent neutro phosphate detergent. Finally, the tools were rinsed again under running water in order to remove detergent residues.

Results

Area B (Loc. 23 and 24)

A total of 91 flint tools coming from Area B (Loc. 23 and 24) were analyzed in order to identify diagnostic traces of use. Most of the artifacts composing the studied assemblage were affected by severe post-depositional modifications. In most of the analyzed artifacts the edge/s exhibit an overall heavy rounding, often associated to surface patination such as glossy appearance, soil sheen and abrasions. Diagnostic use wear was identified on 8 objects (Table 3), including a chopper (11,506), four retouched flakes (11,119; CU76a-b; CU76a; CU76a-2), one un-retouched flake (14,464), one borer (CU76a) and one notch (10,413). Overall, the identified wear indicates the use of the tools for soft material processing through longitudinal motions (Figure 3). The notch (10,413) and one retouched flake (11,119) are characterized by close regular feather scars featuring an oblique orientation along with a localized medium degree of edge rounding. Edge damage is more developed over the dorsal surface of the tools and in both cases, it has been interpreted as evidence of soft material cutting. In two instances, one un-retouched flake (14,464) and one retouched flake (CU76a_2), both edge damage and micro wear have been identified (Figure 5(b)). Feather and step scars with an oblique orientation are localized over both the ventral and dorsal surfaces of the edge of artifact 14,464, while small feather scars bearing an oblique orientation are present on the dorsal surface of the retouched flake (CU76a_2). Both tools exhibit a medium to high degree of edge rounding localized on the edge, associated with smooth domed polish, developed more over their ventral surface hinting towards their exploitation for animal material cutting. Two specimens coming from Area B, a borer (CU76a) and one retouched flake (CU76a-b) are characterized by wear associable to the piercing of medium materials, which at least in one case (borer CU76a-b) are probably of animal nature characterized by a soft-medium hardness. Overlapping step scars and a high degree of edge rounding affect the tip of both tools. In one case (borer CU76a-b), the good state of preservation of the artifact allowed to identify smooth domed polish related to animal materials. Medium soft materials were worked with the retouched flake (CU76a), on which small close regular step and feather scars with an oblique orientation, associated to a medium degree of rounding have been identified on the dorsal surface of its edge. In one case, chopper (11,506), the morphological characteristics of the identified traces, consisting in a high degree of rounding localized over the central portion of the edge, associated to spots polish bearing a smooth texture and a flat topography suggest its utilization in the processing of hard material, possibly bone. Both edge damage and micro wear have been identified on the tool. A portion of the tool's edge is characterized by large overlapping step scars and high degree of edge rounding associated to smooth almost flat polish

Table 3. Area B (Loc.23 and 24) utilized tools and their interpretation based upon the analysis of both edge damage and micro wear.

Label	Tool type	Length (mm)	Width (mm)	Thickness (mm)	Activity	Worked material
11,119	Retouched flake	59	34	18	Cutting	Soft
CU76a-b	Retouched flake	20	34	5	Piercing	Animal tissues
CU76a	Retouched flake	22	5	2	Cutting	Soft/medium
CU76a-2	Retouched flake	32	17	7	Cutting	Animal tissues
14,464	Flake	53	34	13	Cutting	Animal tissues
CU76a	Borer	20	16	10	Piercing	Medium
10,413	Notch	21	44	13	Cutting	Soft
11,506	Chopper	75	103	42	Chopping	Hard animal Material (Bone)

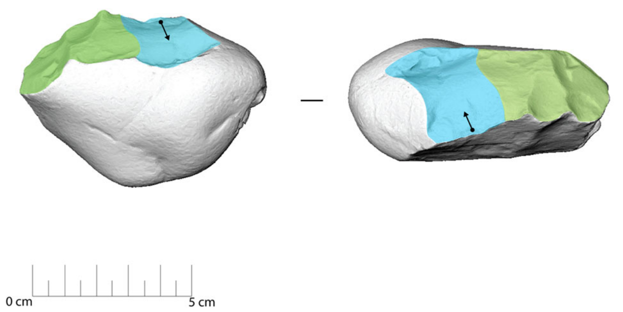

Figure 3. Chopper (15,506). The original edge of the tool is highlighted in green, while in blue the detachment referable to its exploitation as a core.

affecting the high point of the edge's surface (Figure 7 (a)). Given the morphological features of the active area of the tool, the identified use wear represents a remain of the use of the tool as a chopper before being exploited/recycled as a core (Figure 4).

Area C (Layer 5)

A sample of 85 flint artifacts have been analyzed in order to identify preserved use wear. As for Area B (Loc. 23 and 24) the majority of the tools suffered post-depositional modifications at different degrees. Mechanical alteration is the most represented kind of

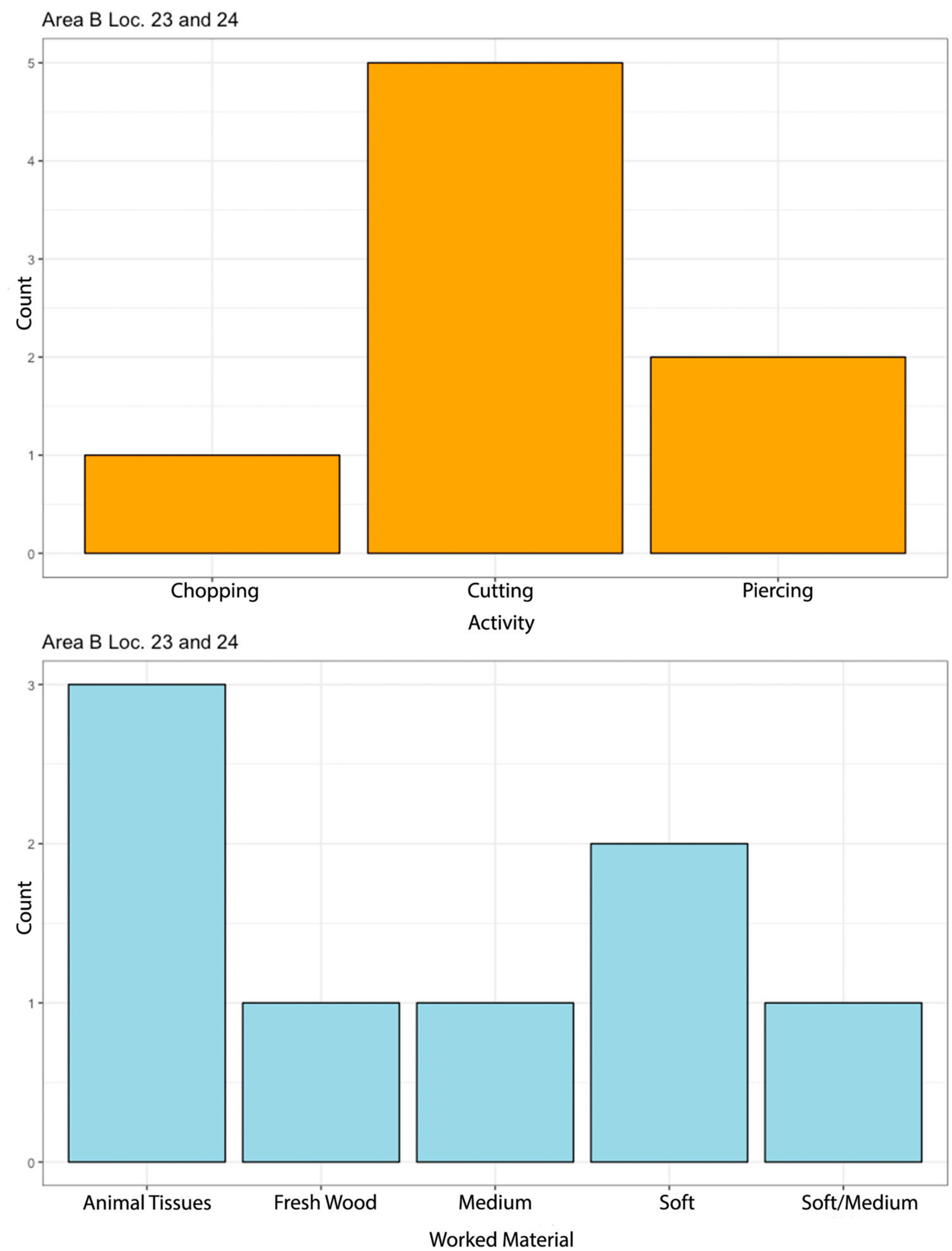

Figure 4. Bar charts showing the range of worked material sand activities recorded in Area B (Loc. 23 and 24) at Revadim.

Table 4. Area C (Level 5) utilized tools and their interpretation based upon the analysis of both edge damage and micro wear.

Label	Tool type	Length (mm)	Width (mm)	Thickness (mm)	Activity	Worked material
18	Retouched flake	31	22	5	Cutting	Soft
73	Retouched flake	23	3	2	Cutting	Soft
80	Retouched flake	38	31	12	Cutting	Soft
139	Retouched flake	39	20	8	Cutting	Soft
172	Retouched flake	37	34	8	Cutting	Soft
176	Retouched flake	29	16	4	Cutting	Soft
197	Retouched flake	28	20	10	Cutting	Soft
67	Retouched flake	60	41	12	Cutting	Animal Tissues (Fresh Hide)
65	Retouched flake	35	22	10	Scraping	Medium
24	Awl	39	20	12	Cutting	Soft
192	Retouched broken flake	40	25	18	Cutting	Medium
108	Retouched blade	81	24	11	Cutting	Medium
213	Truncation	34	24	7	Cutting	Medium
123	End scraper	72	44	18	Scraping	Dry Wood
1	Biface	150	85	37	ND	Wood

post-depositional modification in Area C5, while glossy appearance and soil sheen are present but not as frequent as in Area B (Loc. 23 and 24). 15 tools (Table 4) coming from Area C5 exhibited diagnostic use wear, five of which bear both edge damage and micro wear. Most of the tools were used to process soft, medium materials and animal tissues, mostly through longitudinal motions. Edge damage in the form of feather scars with oblique orientation and a low to medium degree of localized edge rounding has been identified on 9 artifacts, including retouched flakes (18, 73, 80, 139, 172,176 and 197) and an awl (24) coming from Area C and interpret as cutting of soft materials. On one retouched flake (67), micro wear was identified. The morphological features as the smooth texture and domed topography of the micro polish identified over the tool's dorsal and ventral edge surfaces suggest its use for cutting animal materials, most probably fresh hide (Figure 5(c)). Edge damage associated to the processing of medium materials was identified on four artifacts comprising one retouched blade (108), one truncation (213), one retouched broken flake (192) and one retouched flake (65). The tools are characterized by step scars associated to a localized medium degree of rounding affecting their edges. In the case of items 108, 213 and 192 the scars orientation indicates a longitudinal motion, while a transversal activity can be proposed for the retouched flake (65). Both edge damage and micro wear were identified on one end scraper (123) (Figure 5(a)). Close regular step scars bearing a transversal orientation and a medium degree of localized edge rounding developed on the edge of the artifact along with smooth reticulated polish allowed to define the use of the tool for dry wood scraping. Polish and edge damage were identified also on a biface (1) (Figure 6(b)). Step scars, with an oblique bidirectional orientation affected the central portion of tool's edge along with a medium to high degree of edge rounding and a smooth reticulated polish. Both edge damage and micro wear hint towards the use of the biface to process medium materials, probably of vegetal nature (wood).

Post depositional modification (PSDM)

The observation, at low and high magnifications, of the lithic samples coming from Area B (Localities 23 and 24) and C (Layer 5) of Revadim allowed to identify the post depositional processes (PSDM) affecting the tools, providing useful hints in regard to the taphonomic processes occurring at the site. Within the analyzed assemblages, the most represented PSDM include rolling, mechanical alterations (e.g. fracturing of the edge), glossy appearance and soil sheen. These affect large areas or the entire surface of the artifacts and, in most of the cases, prevent the identification and interpretation of use wear. At low magnifications, within the Area B (Loc. 23 and 24) lithic assemblage, the most represented kind of PSDM include mechanical alteration and rolling which lead to the fracturing of the tool's edge/s and rounding. At higher magnification, the tools surfaces are affected by glossy appearance, soil sheen and white patina at different development stages.

While in Area B (Loc. 23 and 24) (Figure 7) the artifacts have been subject to different kinds of PSDM, including various types of surface patination, in Area C5 most of the tools suffered mechanical alteration (Figure 8). These lead to the fracturing of the objects' edge/s which in some cases prevented the analysis of use wear. Overall, at higher magnification, the surfaces are mostly preserved and the most common form of patination is represented by a glossy appearance.

Both in Area B and C, the tools are affected by alterations caused by the movements of the artifacts within the soil. This data is in accordance with what has been suggested by the sedimentological, micromorphological and granulometric analyses, regarding the accumulation

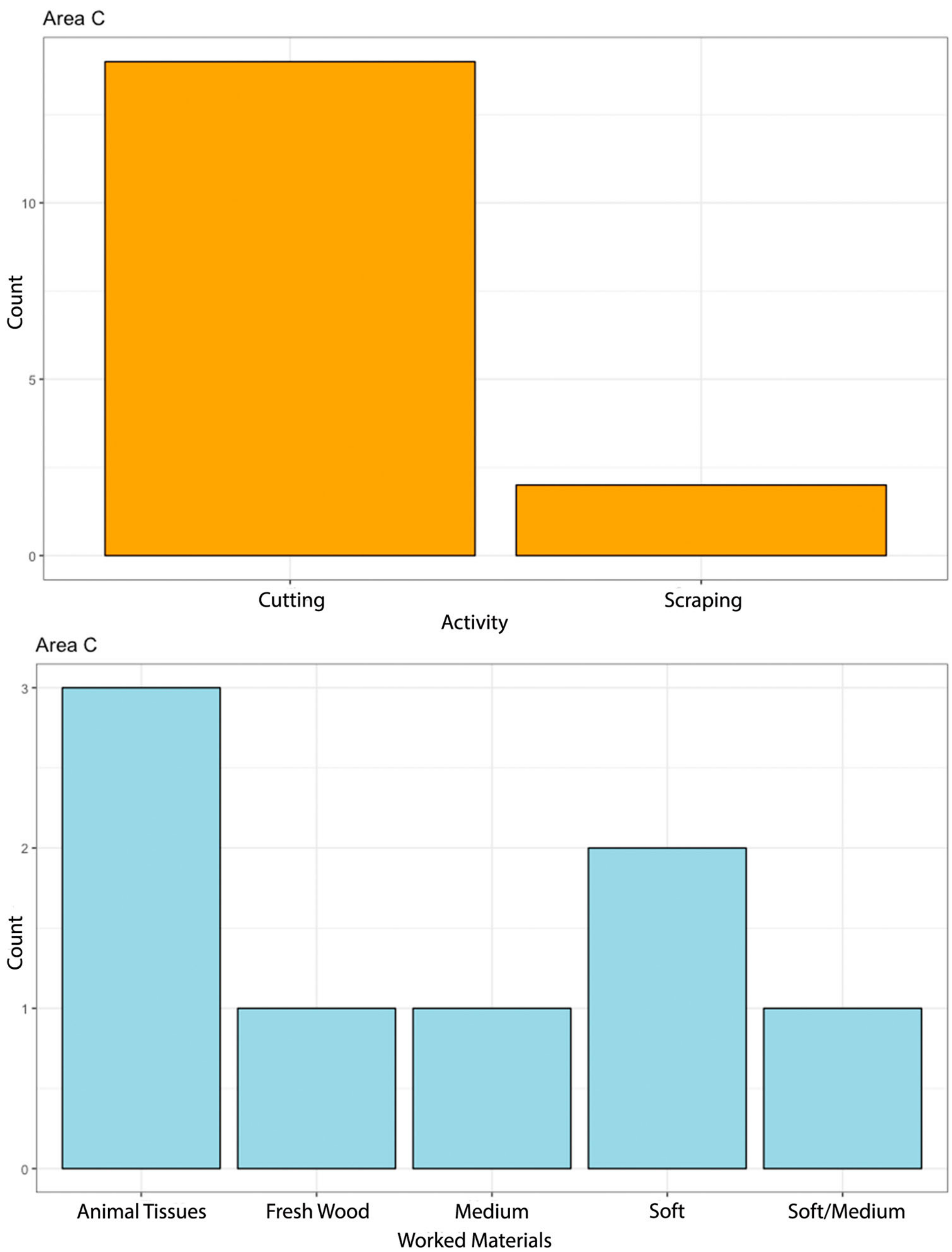

Figure 5. Bar charts showing the range of worked material sand activities recorded in Area C (Layer 5) at Revadim.

of the archaeological materials in an active fluvial environment (Malinsky-Buller et al., 2011; Marder et al., 2011). Thus, water activity can be identified as the main cause of the heavy rounding, fracturing and patinas affecting the artifacts. This phenomenon appears stringer in Area B, indicating a higher energy taphonomic environment of compared to Area C (Layer 5), which caused the frequent fracturing and heavy rounding of the tool's edges. Moreover, especially in Area B (Loc. 23 and 24) the analysis of the materials at high magnifications allowed to identify two main types of surface alterations affecting the tools: soil sheen and glossy appearance (Figure 9). Usually, these kinds of PSDM are created by the deposition of the artifacts in soils with an acidic nature (ph. less than 4) (Van Gijn, 2010) and characterized by the presence of water (Burroni, Donahue, Pollard, & Mussi, 2002; Levi Sala, 1986) which in the case of Localities 23 and 24 in Area B were more severe than in Area C5, leading to the development of more or less uniform sheen on the tools' surfaces (Figure 10)

Discussion

Despite its age, the type of context and the degree of preservation of the materials, the three analyzed

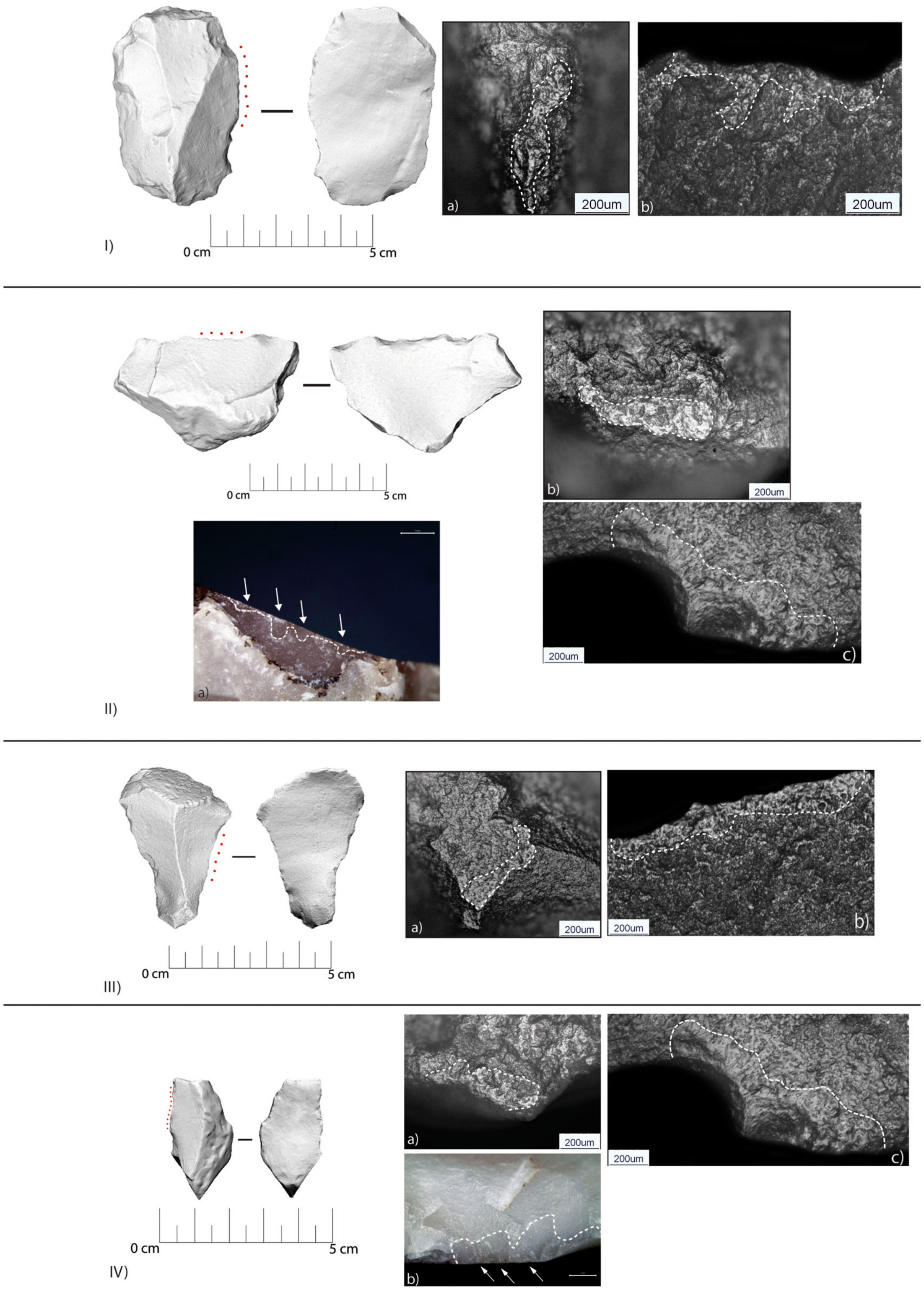

Figure 6. Tools from Area B (Loc. 23 and 24) and Area C (L.5). I) End scraper (123) used to process dry wood; (a) polish identified on artifact 123; (b) experimental polish derived from dry wood processing. II) Flake (14,464) used to cut through animal materials; (a) edge damage observed over the dorsal surface of the tool's edge; (b) polish identified on artifact 14,464; (c) experimental polish derived from animal material processing (removing meat from bone). III) Retouched flake (67) exploited to cut animal materials (fresh hide); (a) polish identified on artifact 67; (b) experimental polish derived from fresh hide processing. IV) Flake (CU76a) exploited to process animal materials; (a) polish identified on artifact CU76a; (b) edge damage observed over the dorsal surface of the tool's edge; (c) experimental polish derived from animal material processing (removing meat from bone). Red dotted line indicates the utilized edge area. White dashed lines indicate the polish and edge damage observed on both the archaeological and experimental tools. White arrows indicate the orientation of the edge damage. LTFAPA use wear comparison collection.

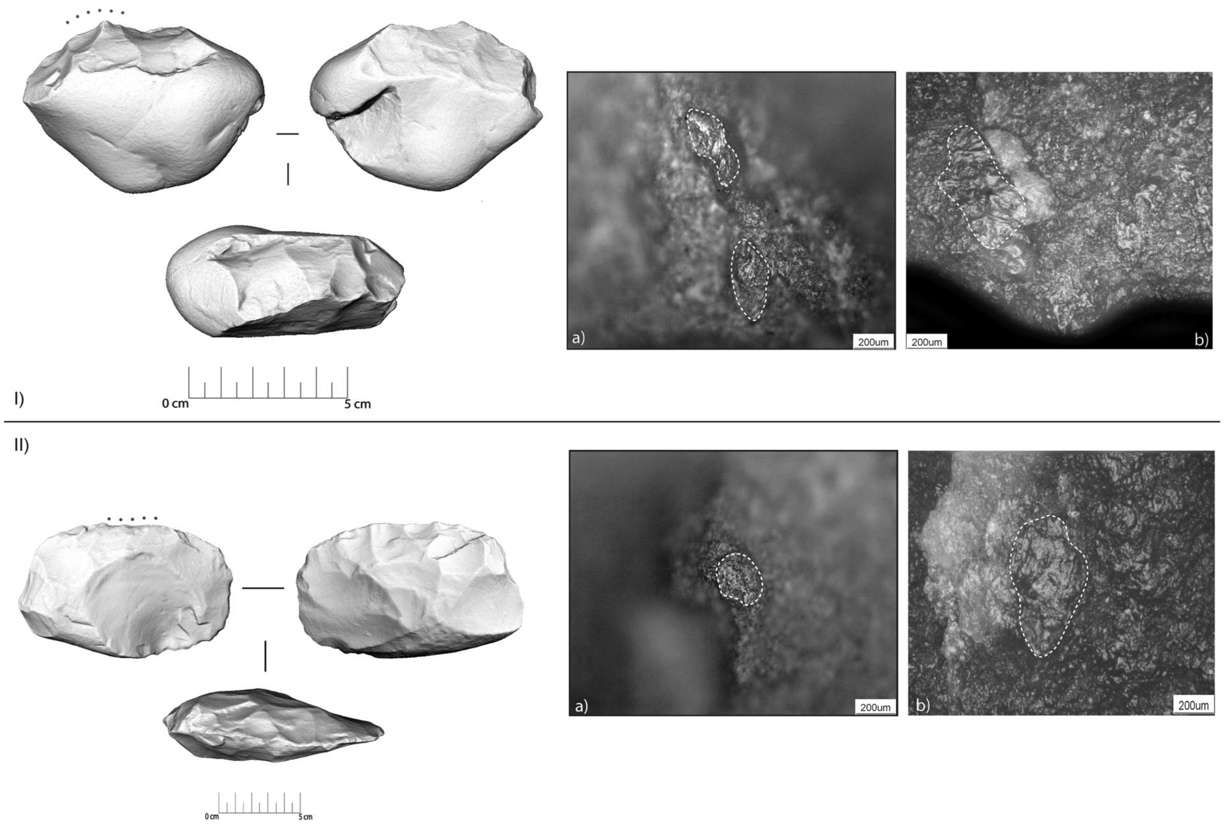

Figure 7. I) Chopper (11,506) from Area B bearing traces of bone processing; (a) polish identified on artifact 11,506; (b) experimental polish derived from breaking bones (cow bone). II) Biface (1) exhibiting traces suggesting its use to work vegetal materials, probably wood; (a) polish identified on artifact 1; (b) experimental polish derived from wood processing through thrusting motions. Red dotted line indicates the utilized edge area. White dashed lines indicate the polish and edge damage observed on both the archaeological and experimental tools. White arrows indicate the orientation of the edge damage. LTFAPA use wear comparison collection.

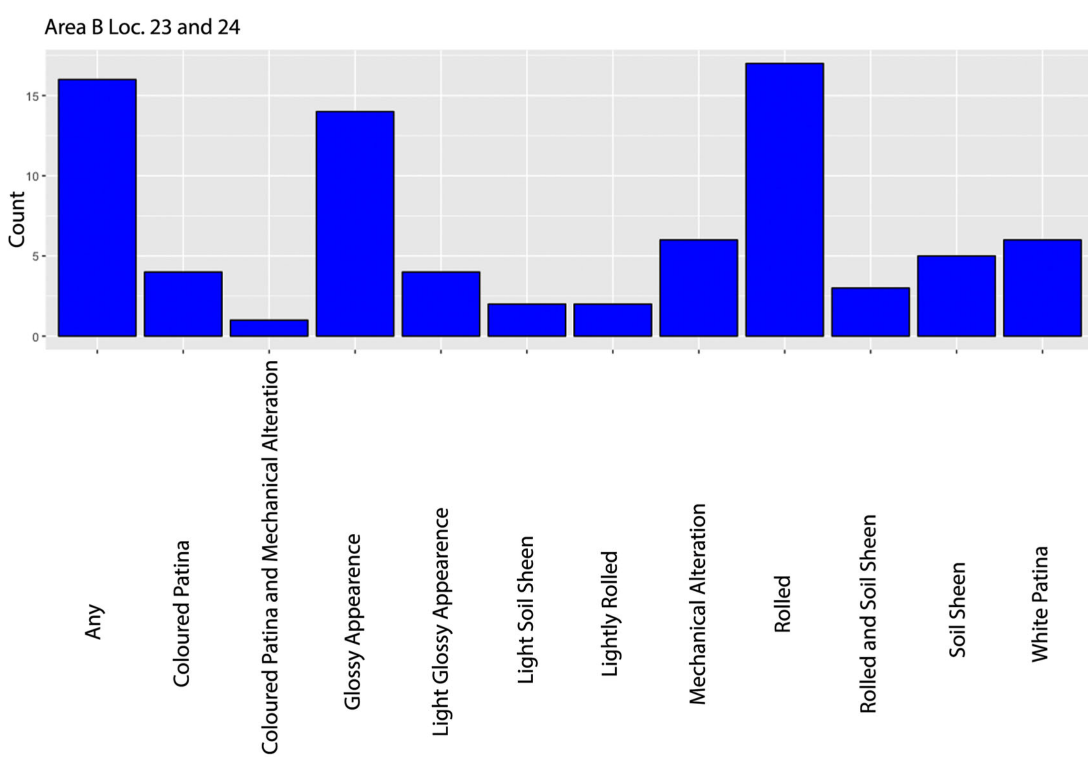

Figure 8. Post depositional modifications affecting the lithic assemblage of Area B (Loc. 23 and 24) of Revadim.

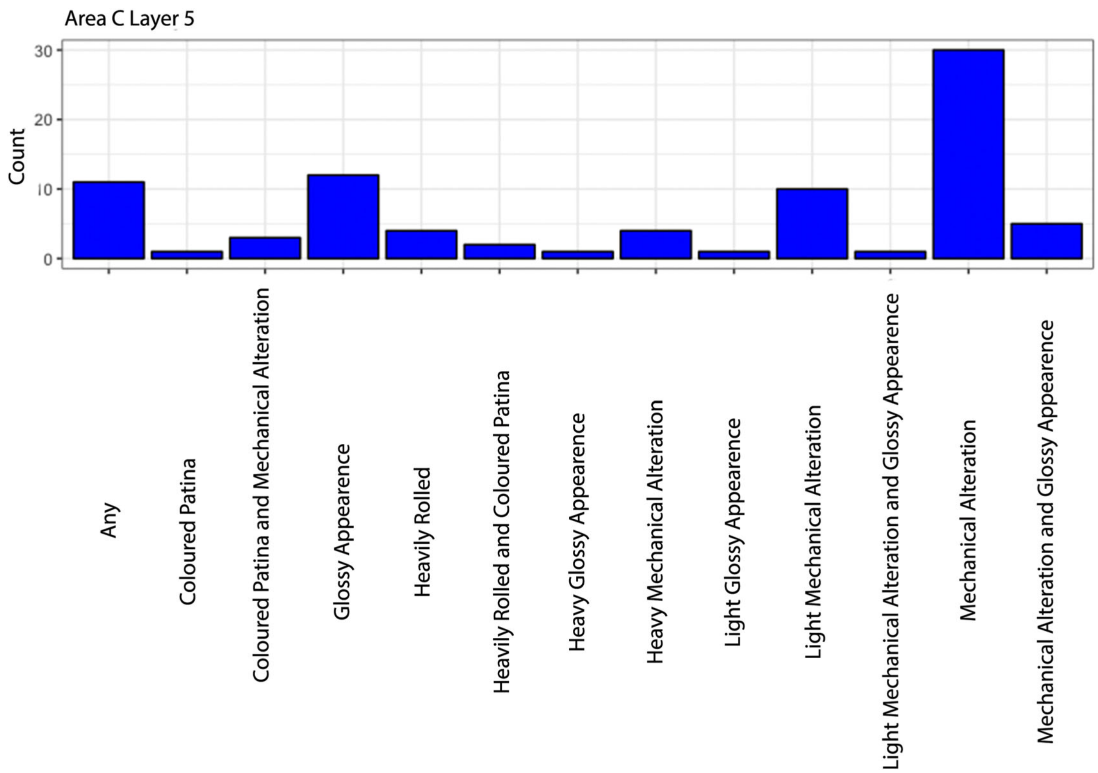

Figure 9. Post depositional modifications affecting the lithic assemblage of Area C (Layer 5) of Revadim.

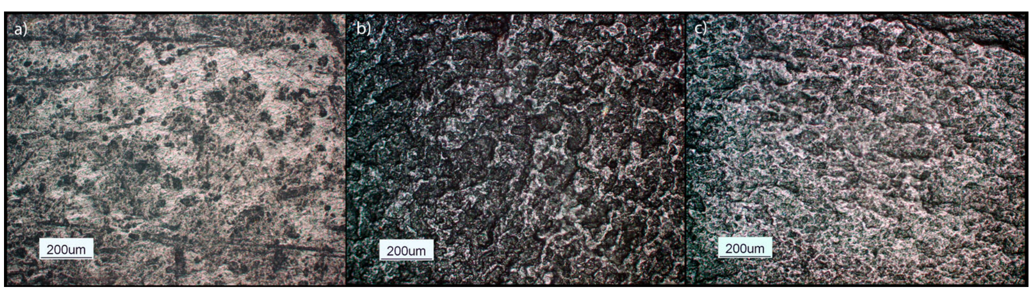

Figure 10. Examples of PSDM affecting the archaeological assemblages of Revadim. (a) glossy appearance; (b)–(c) different degrees of soil sheen.

assemblages from Revadim allowed to provide interesting results regarding the use of flint tools at the Revadim late Acheulian site. From a functional perspective, within the lithic assemblages of Areas B (Localities 23 and 24) and C (Layer5), no major difference was noted. In both areas most of the tools were used to process soft materials, mostly through longitudinal motions that can be associated to cutting activities. The few cases where micro wear related to animal material processing was identified lead to hypothesize the use of these tools for butchering activities, probably the removing of meat from bone. Of particular interest is a chopper (11,506) coming from Loc. 24 of Area B, exhibiting wear related to the processing of hard animal material, possibly bone through percussion. In the case of this tool it was also possible to define at least in part its life-history. Indeed, through a careful analysis of its edge, it is possible to hypothesize a change in its function, from tool to core. The processing of wood and vegetal substances have been identified on several tools coming from both areas, indicating the exploitation of vegetal matter by the early hominins at Revadim. In Area C5 a biface and an end scraper (1 and 123) exhibit use wear that allowed interpreting their use respectively to process vegetal material (1) and to scrape dry wood (123). Two artifacts from Area B (CU76a and CU76a-b) exhibit traces related to piercing medium materials, which as suggested by the micro wear identified in one of the specimens (CU76a-b) can be associated to animal matter, probably fresh hide. Overall, the results of this analysis corroborate the functional evidence obtained from a first use wear analysis performed at the site, where Solodenko et al. (2015) identified traces of animal and vegetal processing on several stone tools coming from Area B (Loc. 21). Moreover, the results obtained so far are in accordance with the few works focusing on the use of stone tools in Lower Palaeolithic and Early Stone Age contexts. Indeed, use wear related to soft material processing and butchering activities has been identified on stone tools coming from the African Early Stone Age and European Lower Palaeolithic sites as Koobi Fora (Keeley & Toth, 1981), Kanjera South (Lemorini et al., 2014), Boxgrove (Mitchell, 1998) and Shoningen (Rots, Hardy, Serangeli, & Conard, 2015). At Kanjera South (Lemorini et al., 2014), Shoningen (Rots et al., 2015) and Olduvai Gorge (Domìnguez-Rodrigo et al., 2001) wood working and vegetal materials processing were recorded as well, as in the case of some of the tools coming from Area B (Localities 23 and 24) and C (Layer 5) presented in this paper, highlight the role of vegetal matter in such early contexts. Furthermore, the microscopic analysis of the lithic tools from Revadim allowed identifying the post-depositional modification affecting the artifacts and thus contributing to the overall understanding of the taphonomic processes ongoing at the site. In both areas, mechanical alteration, in the form of rounding, fractures and surface abrasion represents the most common post-depositional phenomenon. This kind of alterations indicate that in both areas the artifacts moved within the sediments, due to the water activity affecting the site, and had been subject to compressions as well. Surface patination in the form of soil sheen and glossy appearance affects the tools as well. These are more frequent in Area B (Localities 23 and 24) than in Area C5, suggesting a difference in the level of acidity of the soil leading to surface alteration.

Conclusions

The results presented in this paper provided interesting evidence related to the use of Acheulean stone tools at the late Lower Palaeolithic site of Revadim. Analyzing two different areas of the site, Area B (Loc. 23 and 24) and Area C (L.5), no major differences have been noted in the use of stone tools. Moreover, in Area B, despite the different composition of the assemblages within localities 23 and 24, hinting at defining them as two specific activity areas, no differences in the use of stone tools was recorded. Our results indicate that in both areas, most of the tools were used for the processing of soft and animal materials, suggesting their principal exploitation for butchering activities, along with other tasks including wood and vegetal working. Interestingly, vegetal and woody materials seem to be processed using 'well curated tools' as suggested by the traces identified on a biface and an end scraper coming both from Area B (loc.23 and 24) and C (Layer 5). This evidence may indicate, similarly to what have been observed at the Italian Lower Palaeolithic site of Valle Giumentina (Nicoud et al., 2015), a preference towards the use of unretouched tools in butchering activities, and the use of more curated objects in the processing of wood and vegetal materials. This may coincide to a different role played by these tools in the life of the early human groups of Revadim, Unretouched flakes, used in carcass processing were probably discarded just after their use, while retouched tools as scrapers and bifaces were utilized for longer periods and possibly transported by the early human groups at Revadim. Overall, the data gathered so far, provided new evidence related to the use of stone tools at Revadim along with new insights related to the behavior of Acheulean hominins during the Lower Palaeolithic in the Levant.

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No potential conflict of interest was reported by the authors.

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