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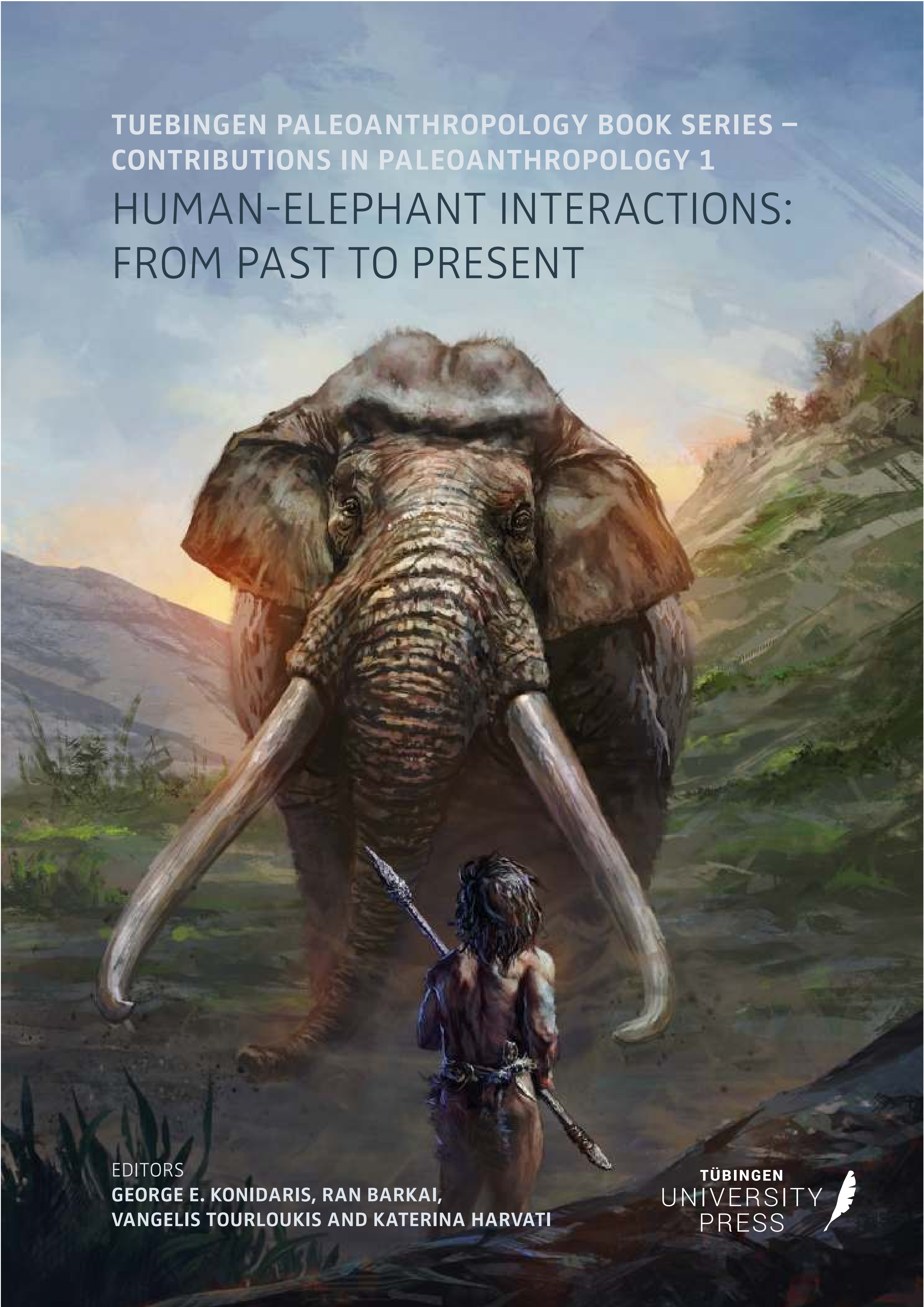

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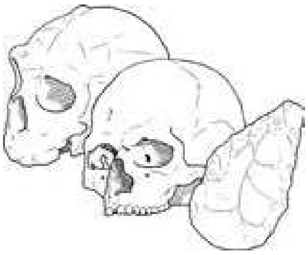

Human-Elephant Interactions: from Past to Present

George E. Konidaris, Ran Barkai, Vangelis Tourloukis and
Katerina Harvati (eds.)

Human-Elephant Interactions
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8. LOWER PALAEOLITHIC SMALL FLAKES AND MEGAFAUNA: THE CONTRIBUTION OF EXPERIMENTAL APPROACH AND USE-WEAR ANALYSIS TO REVEAL THE LINK

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ABSTRACT

The recurrent appearance, in Lower Palaeolithic sites, of lithic industries characterized by the production and use of small flakes alongside butchered elephant remains is the focus of this paper. Recent technological, use-wear and residues analyses, as well as experimental protocols, have shed light on the relevant role lithic items of small dimensions played in the tasks performed by early human groups, especially in animal carcass processing. As small flakes are frequently found in association with processed megafauna remains at Lower Palaeolithic sites, this paper explores the potential of the use-wear analysis approach in recognizing the possible nexus between small flakes and the processing of large animals, which is crucial for the behavioral adaptation of early humans in the Palaeolithic. Here, we present some of the preliminary results of the study of small flakes found at two Middle Pleistocene, Lower Palaeolithic sites; Revadim (Israel) and Fontana Ranuccio (Central Italy). These sites are characterized by rich lithic and faunal assemblages, rich in megafauna remains. The results of use-wear analysis clearly testify that in both sites small flakes were used especially for activities related to the cutting of soft material. The experiments that we carried out with replicas of small flakes strongly suggest a link between the use-wear we observed on the archaeological items and specific movements and actions related to butchering. These considerations support the hypothesis that small flakes might have played a specific role in the processing of carcasses of different prey animals, probably including megafauna.

8.1 INTRODUCTION

In recent years, it has become apparent that African, Levantine and European Lower Palaeolithic sites are no longer characterized solely by the production and use of bifaces or large cutting tools. Alongside the production of bifaces, Lower Palaeolithic lithic assemblages also include small-size items generally defined as small flakes or small

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tools (e.g., Burdukiewicz et al., 2003; Agam et al., 2015; Aureli et al., 2016; Sánchez-Yustos et al., 2016; Santucci et al., 2016; Agam and Barkai, 2018).

The production of small flakes seems to be linked to several independent production trajectories, including: 1. the use of small cores, due to the lack of sources of flint nodules available at the vicinity of the sites, as it is the case at the sites of La Polledrara di Cecanibbio and at La Ficoncella, in Central Italy (Aureli et al., 2016; Santucci et al., 2016; Rocca et al., this volume); or maximization of lithic production, for example at the site of Marathousa 1 in Megalopolis, Greece (Tourloukis et al., 2018); 2. the intentional and systematic production of small flakes for specific purposes, as evidenced by the results of use-wear analysis in various Lower Palaeolithic sites (Aureli et al., 2016; Santucci et al., 2016; Bilbao et al., 2019; Venditti et al., 2019a); 3. the recycling/re-use of flakes as core-on-flakes (Zaidner, 2013; Key and Lycett, 2014). Moreover, it was recently suggested that the presence of an intentional production and use of small flakes in Lower Palaeolithic contexts might serve as another indication of the behavioral adaptability of these early human groups (e.g., Venditti et al., 2019b).

The first evidence of the production of small flakes dates back to the African Oldowan contexts (see de la Torre, 2004; Kuman and Field, 2009). However, in Western Europe, the sites of Barranco León and Fuente Nueva 3—situated in southern Spain and dated around 1.2 Ma—show the presence of lithic assemblages made up of small flakes dating back to the Early Pleistocene as well (Toro Moyano et al., 2011).

The production of small flakes become more consistent during the Middle Pleistocene, as evidenced at the sites of La Noira-Unit III (0.68 Ma; Moncel et al., 2013) and Caune de l'Arago (0.57 Ma; Barsky, 2013) in France, and Notarchirico in Italy (640 ± 40 ka; Pereira et al., 2015; Santagata, 2016), amongst other sites. Small flake production seems increasingly common starting from 0.5 and 0.4 Ma; it is evident in some other sites, such as the Spanish site of Gran Dolina-Atapuerca, Visogliano in Italy and Boxgrove in England. (Cattani et al., 1991; Carbonell et al., 2001; Shout et al., 2014).

Alongside lithic industries including the production of small flakes, many Lower Palaeolithic sites across the Old World are characterized by faunal remains of various animal species, ranging from carnivores to medium and large herbivores, and, most prominently, by elephants (specifically, in the cases described here, *Palaeoloxodon antiquus*) (Santucci et al., 2016; Konidaris et al., 2018; Goren-Inbar et al., 2018; Panagopoulou et al., 2018; Konidaris and Tourloukis, this volume).

Such evidence can be found, for example, at Revadim (Rabinovich et al., 2012), Evron Quarry (Tchernov et al., 1994), Holon (Chazan and Horwitz, 2007), and Gesher Benot Ya'aqov in Israel (Rabinovich and Biton, 2011; Goren Inbar et al., 2018), in Greece at the site of Marathousa 1 (Tourloukis et al., 2018), at the sites of Korolevo level VI and Vértesszölös in Ukraine and Hungary (Rocca et al., 2016), in Italy, in the sites of La Polledrara (Anzidei et al., 2012; Santucci et al., 2016), La Ficoncella (Aureli et al., 2016), Castel di Guido (Saccà, 2012), Fontana Ranuccio (Segre, 2004), Venosa-Notarchirico (Piperno and Tagliacozzo, 2001), Isernia La Pineta (Gallotti and Peretto, 2015), and, finally, in Africa, at the site of Bell's Korongo (Sánchez-Yustos et al., 2016).

The stratigraphic association of small flakes and megafauna attracted the attention of the scientific community suggesting the possible use of small flakes in the processing of the fauna. It is true that, in many of these Lower Palaeolithic sites, proboscideans were not the only animals to have been butchered and consumed by Lower Palaeolithic hominins; however, several examples of single-carcass sites, with a single butchered elephant and an industry based on small flakes are of note (Anzidei et al., 2012; Santucci et. al., 2016).

The hypothesis regarding the probable use of small flakes in animal butchering activities has been increasingly addressed and investigated by several studies, often resorting to a combination of experiments and use-wear and/or residue analysis. To this regard, data on use-wear and residue analyses carried out on small flakes from layer C3 at the late Lower Palaeolithic site of Revadim have recently been published (Solodenko et al., 2015; Zupancich et al., 2018; Venditti et al., 2019c), together with supporting evidence found at the Acheuleo-Yabrudian site of Qesem Cave (Venditti et al., 2019a). These studies have shown the existence of a purposeful and systematic production of small flakes at these sites; these small sharp flakes would be used for the execution of specific stages in the butchering process, mainly in cutting gestures that necessitate accuracy and precision.

As it is becoming clear that small flakes were used in animal carcass processing at Lower Palaeolithic sites, the key point that needs to be investigated here is whether small flakes might have played a role also in the processing of megafauna. At the moment, only at the site of La Polledrara di Cecanibbio (Anzidei et al., 2012; Santucci et al., 2016) the results of use-wear analysis, as well as the spatial association between small flakes and elephant remains, have suggested that small flakes were used to butcher carcasses of elephants trapped in the swamp. Our work is based on the assumption that future studies, for example at the site of Marathousa 1 (Tourloukis et al., 2018), as well as at other relevant Lower Palaeolithic sites might reinforce the assumption that small flakes did play a role in the processing of proboscidean carcasses.

This article presents the results of the use-wear analysis of two samples of small flakes retrieved from two Lower Palaeolithic sites, located in Israel and Italy: respectively, Revadim and Fontana Ranuccio. Both sites are characterized by typical Acheulean/Lower Palaeolithic lithic assemblages, but also by a significant assemblage of small flakes and by the presence of faunal remains of large herbivores, especially elephants. This study is part of a broader research framework, aimed at investigating the function of small flakes in various Lower Palaeolithic sites in the Italian peninsula and the Levant (Israel) via use-wear analysis, residue analysis, and the experimental approach. It is an attempt to shed light on the role that small flakes possibly played in the sequence of actions related to the butchering of carcasses. There are plans to test the possible correlation between the functional inferences obtained from the small flakes and the processing of megafauna through dedicated experiments, to be carried out at a later stage.

8.2 THE EXPLOITATION OF ELEPHANTS IN THE LOWER PALAEOLITHIC

Palaeoloxodon antiquus was always an important resource for humans, and many sites in Europe, Asia, and Africa testify to this observation. *Homo erectus* began to use elephants as a source of food in Africa, around two million years ago; the consumption of proboscidean meat and fat continued until the end of the Pleistocene, when these animals became extinct in Europe, the Levant, and the Americas (Agam and Barkai, 2018). These herbivores were sought after by humans mainly because they were large in size and (Ben-Dor and Barkai, this volume), therefore, they guaranteed a significant yield of fat and meat. In fact, a single elephant provided a large amount of fat and a combination of meat and fat together, thus serving as a very important source of energy for the survival and adaptation of human groups (Piperno and Tagliacozzo, 2001; Boschian and Saccà, 2015; Guil-Guerrero et al., 2018; Ben-Dor and Barkai, this volume). Moreover, elephant bone marrow, a substance especially rich in calories and nutrients, played an important role in human diet and could be retrieved from elephant carcasses after having used the animal's meat and fat (Yravedra et al., 2012; Boschian et al., 2019). In this respect, how humans actually used the resources available in these large animals is the source of extensive debate. Were proboscideans hunted or scavenged? Or, perhaps, both strategies were applied? The large size of these animals could have been an obstacle in hunting. However, the hunting techniques and the hunting skills of early humans is still poorly understood and it could have been potentially underestimated. The possibility that early humans procured large quantities of meat and fat in other ways than scavenging is becoming an increasingly accepted hypothesis, based on available archaeological evidence (e.g., Domínguez-Rodrigo et al., 2017) and on the understanding that the high caloric intake needed for humans to stay alive at that time could not be sustained by scavenging alone (Tanner, this volume). It should be mentioned that these huge animals were also used for their bones, which served as raw material for various types of tools (Piperno and Tagliacozzo, 2001; Anzidei et al., 2012; Domínguez-Rodrigo et al., 2014; Guil-Guerrero et al., 2014; Boschian and Saccà, 2015; Santucci et al., 2016).

The presence of elephant remains in numerous Lower Palaeolithic sites across the Old and New World leads to the assumption that these animals were an important resource for human adaptation, especially because of their unprecedented caloric intake potential, that may have supported and sustained the diet, as well as other needs, of Lower Palaeolithic human groups (Agam and Barkai, 2016).

We can define an elephant's body as an "organic quarry" (Lemorini, 2018) that provides humans with a high amount of energy resources for a long time. As stated before, besides large amounts of meat and fat, an elephant may provide highly fatty and proteinaceous elements through its brain, internal organs, and marrow (Konidaris and Tourloukis, this volume), which can be preserved for a long time and may have possibly allowed efficient, long-term use of these resources by early humans, in line with the recent evidence of marrow consumption found at the Lower Palaeolithic Acheulean site of Castel di Guido (Boschian et al., 2019) and of delayed consumption of fallow deer marrow at the late Lower Palaeolithic Achaeuleo-Yabrudian site of Qesem Cave (Blasco et al., 2019). Access to the elephant carcasses by early humans was made possible by lithic tools. As mega-herbivores contain thick deposits of meat and fat, the contact of stone tools with animal bones is rather rare, and so is butchering evidence manifested as cut marks. The presence and variability of cut-marks on the bones can depend on various factors, such as cutting depth, speed in meat butchering, type of tools used, as well as other factors (Haynes and Klimowicz, 2015). This kind of trace is often found on the animal's ribs, scapula, femur, or on limbs: these parts are relatively rich in meat and fat and/or they are locales enabling easy access to internal organs (tail, anus, stomach), which probably were also favored over other parts (Haynes and Klimowicz, 2015; Reshef and Barkai, 2015). Traces of human activity on the bones of these large mammals were found, for example, in the sites of Áridos 2 (Spain), PRERESA (Yravedra et al., 2010, 2012), Revadim (Rabinovich et al., 2012), and Marathousa 1 (Konidaris et al., 2018).

A peculiarity which repeatedly occurs in several archaeological contexts has to do with the association of butchered elephant remains and lithic industries characterized by small tools (e.g., Agam et al., 2015; Santucci et al., 2016; Agam and Barkai, 2018; Konidaris et al., 2018; Tourloukis et al., 2018); moreover, in some particular cases, use-wear analysis has indicated that small flakes were used in butchering operations (Santucci et al., 2016; Venditti et al., 2019c). It must be clarified that other stone tools besides small flakes were produced and used at many of these sites, and thus is it impossible to discuss small flakes as a separate element of the broader tool kits used by early humans. Therefore, we are not suggesting in any way that small flakes were the only category of stone-tools employed in butchering operations. On the contrary, we see small flakes as an integral element of stone tool kits, serving early humans in specific tasks alongside a wide array of other categories of stone tools. Moreover, it is clear to us that association does not mean causation, and thus the frequent presence of small flakes alongside butchered elephants cannot be regarded as direct evidence of the use of these small tools in the processing of mega-herbivores, even in cases when functional indications of the use of small flakes in butchery operations have been proven. One should also take into account the fact that, in many cases, other animals were butchered besides elephants in many of these Lower Palaeolithic sites, and one cannot rule out the possibility that stone tools, including small flakes, were used to process different animal taxa. Elephants might be included among these taxa, but they might not have been the only animal processed using small flakes. These reflections and considerations should be taken into account when trying to work out the possible relation between small flakes and elephant carcass processing. We do hope to offer a contribution to this end, and hope that technological advancements in the future may allow to identify specific animal taxa via the study of residue found on Lower Palaeolithic stone tools, and this might provide us with the required direct link between specific stone-tool technologies and the animal taxa processed using the products of these technologies. In the age of ZooMS technologies for identifying animal taxa via a molecular barcode (e.g., Buckley, 2018; Sinet-Mathiot et al., 2019), we are optimistic about the possibility of future developments that will allow to test our hypothesis using more advanced technologies.

The recurrent presence of small flakes alongside butchered elephant carcasses in Lower Palaeolithic sites brings about the following question: did small flakes play a role in the processing of animals in general and of mega-herbivores in particular? This article is an attempt to provide a general overview of the use-wear found on small flakes at the sites of Revadim (Israel) and Fontana Ranuccio (Central Italy), focusing on the use of these small flakes.

8.3 THE ARCHAEOLOGICAL SITES

8.3.1. REVADIM, ISRAEL

Revadim is a late Acheulean open-air site located in the southern coastal plain of Israel. Four seasons of excavation were conducted, from 1996 to 2004, and four areas, A to D, were excavated (Marder et al., 2011: fig. 1). The geological sequence of Revadim has been dated with palaeomagnetic analysis, indicating a normal polarity and suggesting that the site is younger than 780 kya. The U/Th analysis, which was used to date the carbonate covering flint artifacts, provided dates between 500 and 300 kya; this dating allows to determine a minimum age for the human occupation at the site (Marder et al., 2011). The lithic assemblage of Revadim is composed of bifaces, flake tools, choppers, scrapers, flakes, cores, and recycled tools. Regarding the fauna, the most represented species are *Palaeoloxodon antiquus*, *Bos primigenius* and *Dama* cf. *mesopotamica*, and other animal species including microvertebrates (Rabinovich et al., 2012). *Palaeoloxodon antiquus* is the most represented species in the macrofaunal assemblage of the Revadim site and its remains were found in all archaeological layers. Some of the elephant bones were found in Area B, which is probably where specific activities were carried out (Rabinovich et al., 2012; Solodenko et al., 2015). In this area, two layers named B1 and in B2 have been identified, with the latter characterized by a significant amount of flint items and bones (Marder et al., 2011).

In Layer B2 elephant remains have been found, such as two ribs (in one case with cut marks associated to flint tools), a vertebra, and tooth fragments (Marder et al., 2011; Rabinovich et al., 2012; Solodenko et al., 2015). At least 3 elephant individuals were identified at Area B, while an elephant skull fragment, part of a rib, and fragmented elephant teeth belonging to at least two individuals were uncovered in Area C, Layer 3 (Rabinovich et al., 2012).

Area C has been divided in two sections, C3 West and C3 East. In C3 West, five archaeological layers have been identified, from C1 to C5; layers C2 and C3 are the main occupation horizons of the sequence; they are separated by a sterile level (Marder et al., 2011). Layer C3 has the highest concentration of flint items and bones (Agam et al., 2015; Venditti et al., 2019b).

The presence of cut marks in layer B2, such as those found on the scapula and ribs and their association with lithic industry (Locality 21) leads to the possibility that elephant carcasses, as well as carcasses of other animal taxa, were butchered by hominins using flakes, retouched flakes, scrapers, and bifaces (Solodenko et al., 2015; Zupancich et al., 2018).

It should be noted that, in some cases, elephant bone fragments were used to manufacture bone tools at the site (Rabinovich et al., 2012); therefore, the *Homo*-elephant association at the site reflects both the dietary significance of elephants for human consumption and the use of parts of these large mammals for the production of bone artifacts, which might have played an important role in human-elephant relationships (e.g., Barkai, 2019).

8.3.2. FONTANA RANUCCIO, ITALY

The Fontana Ranuccio site is characterized by a fluvial-lacustrine environment and has been dated to 408 kya (Pereira et al., 2018). The site was discovered during the extraction of layers of clay mixed with amorphous volcanic materials (in Italian "pozzolana"), which exposed an impressive stratigraphic sequence beginning with levels attributed to the Villafranchian, based on the presence of *Anancus arvernensis* in the faunal assemblages as well as *Pisidium* malacofaunas (Segre, 2004).

The stratigraphy of Fontana Ranuccio is made up of volcanic or colluvial deposits. The assemblages of the Lower Palaeolithic period are found in a palaeosol, together with faunal remains such as *Palaeoloxodon antiquus*, *Equus ferus*, *Ursus deningeri*, *Cervus elaphus*, *Bos primigenius* and *Dama clactoniana* (Segre, 2004). The lithic industry of Fontana Ranuccio consists of scrapers, cores, flakes, and small flakes made of flint. It is also characterized by the presence of bifaces made of flint, lava, and bone.

8.4 METHODOLOGY

Use-wear analysis was conducted to a sample of small flakes found at the sites of Revadim and Fontana Ranuccio, using an Optical Light Microscope (OLM). The analyses were carried out at the Laboratory of Technological and Functional Analyses of Prehistoric Artefacts (LTFAPA) of Sapienza University of Rome and at the use-wear laboratory of Tel Aviv University.

For the observation of macro-traces, i.e. use-scars and use-rounding, a low magnification approach (Tringham, 1974; Odell, 1980; Lemorini, 2000) was applied, with a Nikon SMZ-745 microscope (with 10× binocular stereomicroscope eyepieces and 1× objective, magnification ranging between 0.67× and 5×, and a reflected light illumination system). This observation allowed to determine the type of action performed and the hardness (soft, medium-hard, hard) of the material worked with the tools.

The high-magnification approach was applied for the analysis of micro traces (Van Gijn, 1989; Lemorini, 2000), using an Optiphot and Nikon Eclipse microscope (with reflected light illumination and 15× and 10× eyepieces, 10× and 20× lenses and digital ToupCam cameras).

This type of observation allowed us to identify polishes and striations, which have developed on the micro surface, and to understand in detail which type of material has been worked.

Unfortunately, the alteration of the lithic surface of the small flakes from both Revadim and

PARAMETER	CHARACTERISTIC
Localisation	Ventral/Dorsal/Ventral+Dorsal/Ventral More/Dorsal More
Distribution	Close regular/Close irregular/Wide regular/Wide irregular/Overlapping/Indeterminable
Termination	Step/Feather/Hinge/Snap/Snap-Half moon shape/Indeterminable
Orientation	Oblique unidirectional/Oblique bidirectional/Transversal/Mixed/Indeterminable
Dimension	Small/Large/Mixed
Edge rounding	Low/Medium/High
Typology of worked material	Hard/Medium/Medium-Soft/Soft

Table 8.1: Parameters selected for the indication of macro-traces (F. Marinelli).

Fontana Ranuccio limited the use-wear observation to only macro-traces.

The parameters used to identify the macro-traces are listed in the following table (Table 8.1).

The interpretation of the use-wear observed on the archaeological tools was carried out by reference to a dedicated collection of experimental replicas of small flakes, which were experimentally used for the butchering of proteinaceous portions of the carcass (fat, liver, spleen).

Thanks to the macroscopic and microscopic analyses, it was possible to observe the alteration of the surface of the small flakes found at Revadim and Fontana Ranuccio, and to suggest possible mechanical and chemical processes which have occurred on the surface of these items.

8.5 RESULTS - THE SITE OF REVADIM

8.5.1. THE ARCHAEOLOGICAL SAMPLE

In addition to the small flakes analyzed in this article, layer C3 of Revadim has revealed another type of small flakes, defined as recycled small flakes. Recent technological studies have defined various recycling trajectories at Revadim, aimed at producing small items out of core-on-flakes /flaked flakes (COF-FFs) consisting of old patinated blanks or blanks originating from other knapping trajectories (Agam et al., 2015; Venditti et al., 2019b).

The recent use-wear and residue analyses of the recycled small flakes of Revadim layer C3 led to exceptional results in determining the use of these categories of tools (Venditti et al., 2019c).

In this article, we have analyzed a sample of small flakes found in layer 3 of Area C (East and West), the layer with the highest concentration of flint items and bones of that area. For the purposes of this study, all regular flakes (not recycled ones) whose size ranges from 16 to 20 mm in length have been considered as "small flakes" (Fig. 8.1).

The lowest dimensional limit was chosen to exclude debris from the sample. From now on, we will refer to the selected items as "small flakes".

All the small flakes are made of flint and the sample includes both unretouched and retouched items. In total, 782 small flakes have been analyzed, i.e. 581 un-retouched small flakes (74%); and 201 retouched small flakes (26%). All the items show a high degree of alteration. In fact, the taphonomic processes have significantly modified the surface of the small flakes, which appears highly translucent. At a macroscopic level, small flakes have a very bright surface, with ferrous encrustations and, sometimes, dark shades. The latter may be due to the presence of oxides which confer to the lithic surface some dark tones, ranging from yellow to brown (Fig. 8.2D).

A recent work by Venditti et al. (2019c) has highlighted the presence of different types of post-depositional alterations on the surface of the recycled small flakes found at level C3 of the site. The macroscopic and microscopic analyses have revealed the presence of a brightness on the entire surface of the items, and in some cases, a modification in the color of the original flint. In fact, the surface is characterized by colors ranging from reddish to brown or from orange to yellow. These changes in color, probably due to mineral oxide and hydroxide, are defined as color patina (for more details, see Venditti et al., 2019c).

Despite the surface alteration, flake fragmentation and edge damage are very rare at Revadim, testifying that mechanical processes must have occurred at a very low rate, allowing the analysis of the macro-traces.

The whole sample was subjected to preliminary macroscopic analysis aimed at identifying the presence (or absence) of use-wear. In spite of the post-depositional factors described above, a total of 212 small flakes offered optimal conditions for use-wear analysis. Each of these flakes is characterized by a single active edge on which use-wear has developed, and by a regular morphology, rectilinear in profile.

This sample mainly consists of unretouched small flakes (79%, that is 167 out of 212 items) and, only to a lesser extent, of retouched small flakes (21%, that is 45 out of 212 items).

Figure 8.1: Small flakes from the site of Revadim. White dots mark the location of macro-traces (F. Marinelli).

8.5.2. USE-WEAR ANALYSIS OF SMALL FLAKES FROM REVADIM

Use-wear analysis has allowed to reconstruct the activities carried out using the small flakes and determine the degree of hardness of the processed material. The following charts (Fig. 8.3) show the proportion of the activities carried out using each class of small flakes (flakes, retouched flakes).

In some cases, macro-traces were not clearly

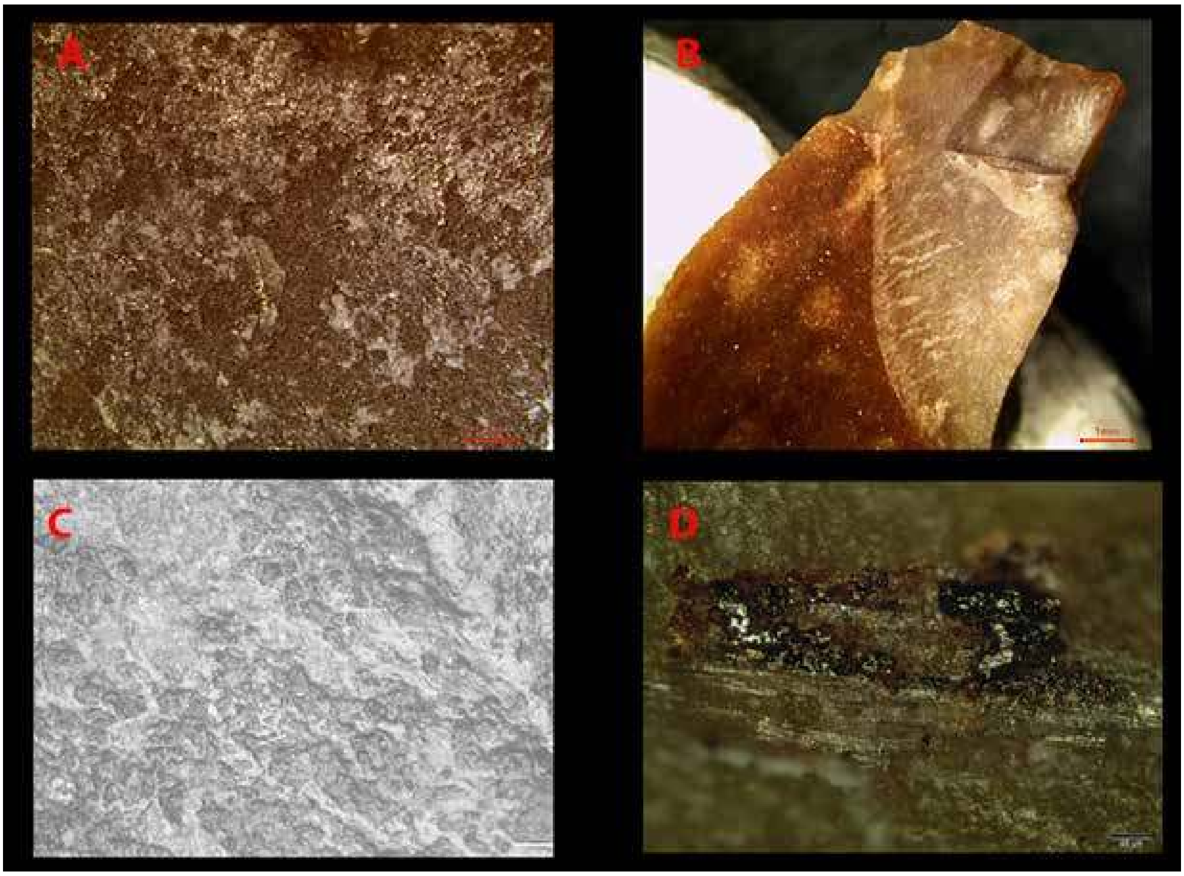

Figure 8.2: Surface alterations on the artifacts from Revadim; **A** and **C**, glossy appearance; **B**, coloured patina; **D**, oxide incrustation (F. Marinelli).

visible, due to the presence of alterations; therefore, it was not possible to identify the type of activity. In this case, the term "general working" was used.

Stereomicroscope analysis showed that in 167 out of 212 small flakes, edge removals are characterized by a close regular distribution and, in most of them (149 out of 167 items), by the feather termination (Kamminga et al., 1979).

Termination is a parameter that provides indications on the hardness of the material being worked (Tringham, 1974; Kamminga et al., 1979). A feather termination suggests that soft materials has been processed, while hinge and or step terminations suggest the contact with harder materials. Thus, the small flakes presented in this article were used specifically to process light materials.

However, as far as the direction of the traces is concerned, in most cases (100 out of 167 flakes) it can be described as oblique unidirectional, the typical direction that develops during cutting activities. As far as scraping is concerned, the direction of the edge removals is transversal to the active edge and tends to develop only on one side of the item (dorsal or ventral), since only one of them was in contact with the material being worked.

Use-wear analysis has indicated that 56% of the flakes (94 out of 167 items) were used in cutting activities, 37% (61 out of 167 items) were used in scraping activities, and 7 % (12 out of 167 items) were used in activities which could not be precisely identified, so they were classified as "general working" (Fig. 8.3A).

Regarding the retouched flakes (45 out of 212 items), edge-removals are similar to those of the unretouched small flakes described above.

The retouched flakes are characterized by a close regular distribution, a feather end-termination (45 out of 45 retouched flakes) and an oblique

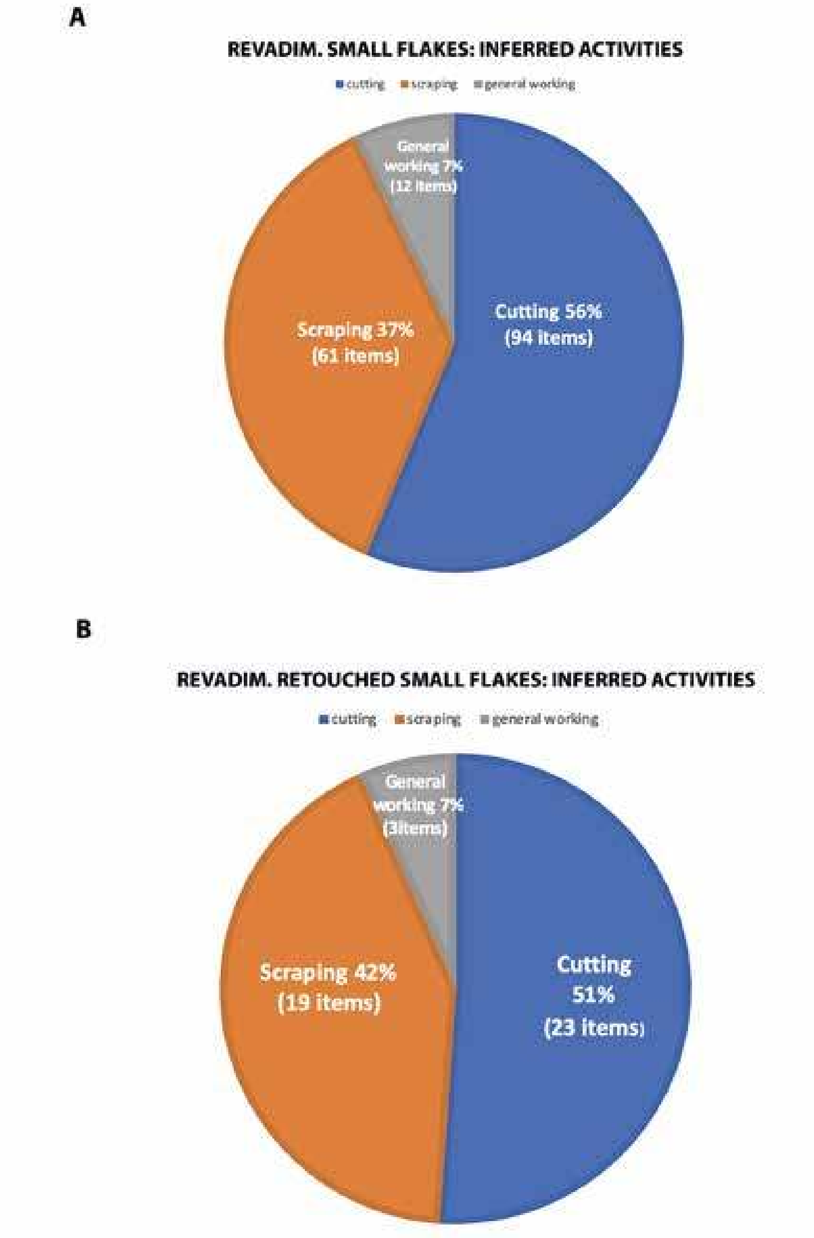

Figure 8.3: Activities inferred from the analysis of use-wear identified on the unretouched and retouched small flakes from Revadim (F. Marinelli).

unidirectional (23 out of 45) or transversal (22 out of 45) direction, interpreted, respectively, as signs of cutting or scraping activity.

Also in this case, the use-wear analysis has allowed to infer that 51% (23 out of 45 items) of the retouched small flakes were used for cutting activities, 42% (19 out of 45 items) for scraping, while 7% (3 out of 45 items) were classified as general working (Fig. 8.3B).

The analysis of the active edges of both categories of flakes indicates that traces can be found only on a small portion of the tool, in particular along the distal end of the active edge that has a naturally pointed morphology (Fig. 8.1).

This leads to the hypothesis that, probably, the parts of the tool in a "pointed" shape were especially selected or favored when carrying out activities which required greater precision (cutting ligaments, tendons, portions of the carcass which were difficult to reach with larger tools).

TYPE	SHAPE	PROFILE	CROSS-SECTION	EDGE-ANGLE AVERAGE
Un-retouched small flakes	Straight: 64%	Straight: 59%	S-S: 55%	26.9
	Concave: 17%	Concave: 19%	S-CV: 13%	
	Convex: 19 %	Convex: 22%	CV-CV: 2%	
			CV-CX: 6%	
			CV-S: 13%	
			CX-CV: 1%	
			CX-CX: 1%	
			CX-S: 3%	
			S-CX: 6%	
Retouched small flakes	Straight: 54%	Straight: 50%	S-S: 56%	27.0
	Concave: 17%	Concave: 21%	S-CV: 11%	
	Convex: 23%	Convex: 29%	C-CX: 7%	
			CV-S: 11%	
			CX-CX: 4%	
			CX-S: 11%	

Table 8.2: Morphologies of the active edge of the studied small flakes from Revadim level C3. S: straight, CV: concave, CX: convex.

As can be seen in Table 8.2, on both the retouched and the un-retouched flakes, most of the active edges have a straight shape and profile.

For activities such as cutting, this morphology is the most functional, since the tools adhere to the material being worked, allowing better performance. Furthermore, in addition to the straight design of the tools, the morphology associated with a convex shape and a convex profile also prevails. A convex morphology might have proven suitable for scraping activities, since the edge can cover a larger surface of the material being processed.

8.6 RESULTS: THE SITE OF FONTANA RANUCCIO

8.6.1. THE ARCHAEOLOGICAL SAMPLE

As regards Fontana Ranuccio in the sample analyzed we have defined as "small flakes" the un-retouched and retouched small flakes whose size ranges from 20 to 30 mm in length. In this sample there are no small flakes below 20 mm, but only debris defined as products of the debitage.

151 specimens have been analyzed: 130 un-retouched small flakes (86% of the sample) consisting of 51 complete small flakes (34%) and 79 fragmented small flakes (52%), and 21 retouched small flakes (14% of the sample) including 12 complete small flakes (8%), and 9 fragmented small flakes (6%) (Fig. 8.4A). Within the sample of retouched complete small flakes, one of them has been recycled (Fig. 8.5A). This item appears to have been heavily affected by water and its coloured patina was partly removed by retouch, aimed at renewing the active edge of the "old" and discarded blank (for more details, see Marinelli et al. 2019: pp. 62–64).

As it is the case with the lithic industry of Revadim, the items of Fontana Ranuccio are characterized by altered surfaces, which appear as very bright (Fig. 8.5B, C, D, E). When observed with a microscope, all the small flakes show a bright, leveled, and cratered micro-surface, defined in the literature as a glossy appearance (Van Gijn, 1989: p. 17; Lemorini 2000: pp. 35–37), which testifies to the occurrence of both mechanical and chemical processes (Fig. 8.5). The small flakes of Fontana Ranuccio show other types of alterations, including oxide incrustations and patinas of var-

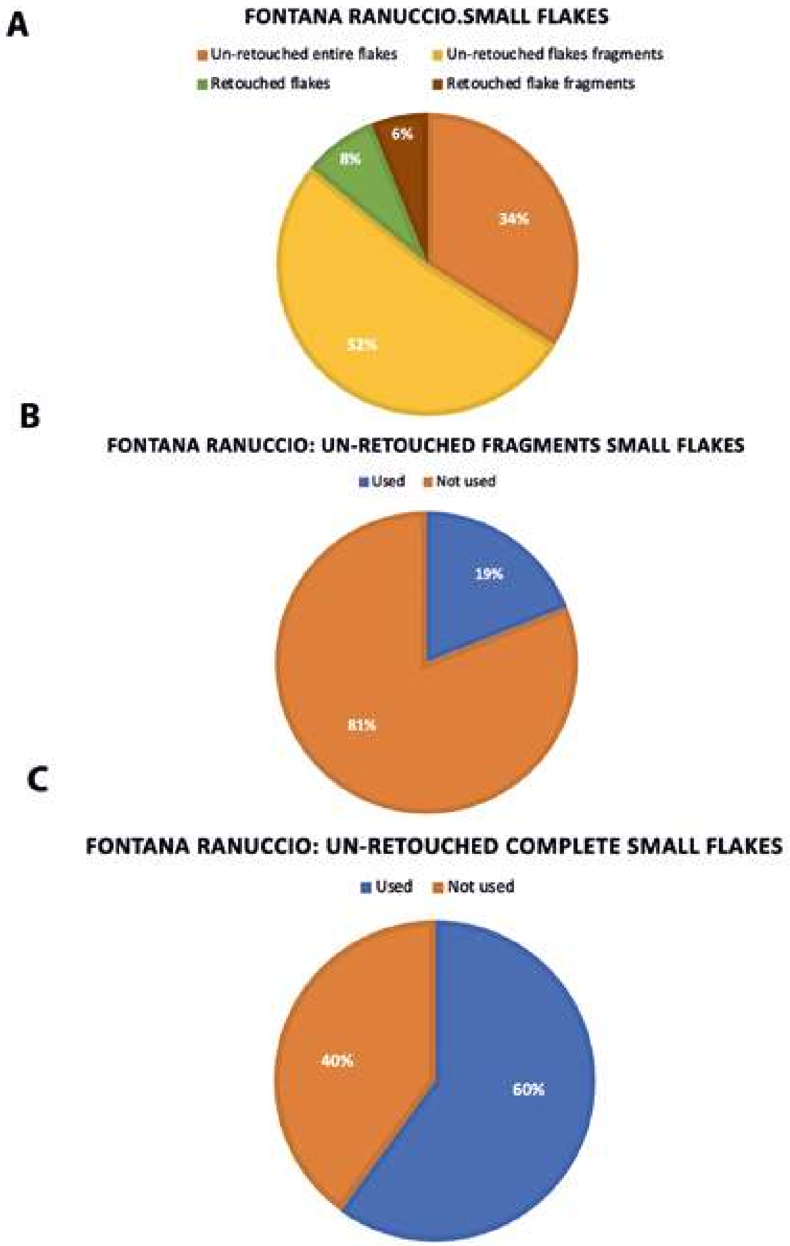

Figure 8.4: Results of the use-wear analysis on the small flakes from Fontana Ranuccio (F. Marinelli).

ious colors, ranging from yellow to brown. Due to post-depositional processes, it was possible to analyze use-wear only on 116 items (Fig. 8.6).

8.6.2. USE-WEAR ANALYSIS OF SMALL FLAKES FROM FONTANA RANUCCIO

The use-wear analysis carried out on the small flakes of Fontana Ranuccio has allowed to infer the type of activity carried out using these tools. As regards the un-retouched flake fragments, use-wear was found only on 12 items (19%) (Fig. 8.4B).

The large amount of fragments which do not show signs of use-wear leads to the hypothesis that these fragments were by-products of the debitage process, or the residual parts of tools fractured during use.

Among the un-retouched complete small flakes,

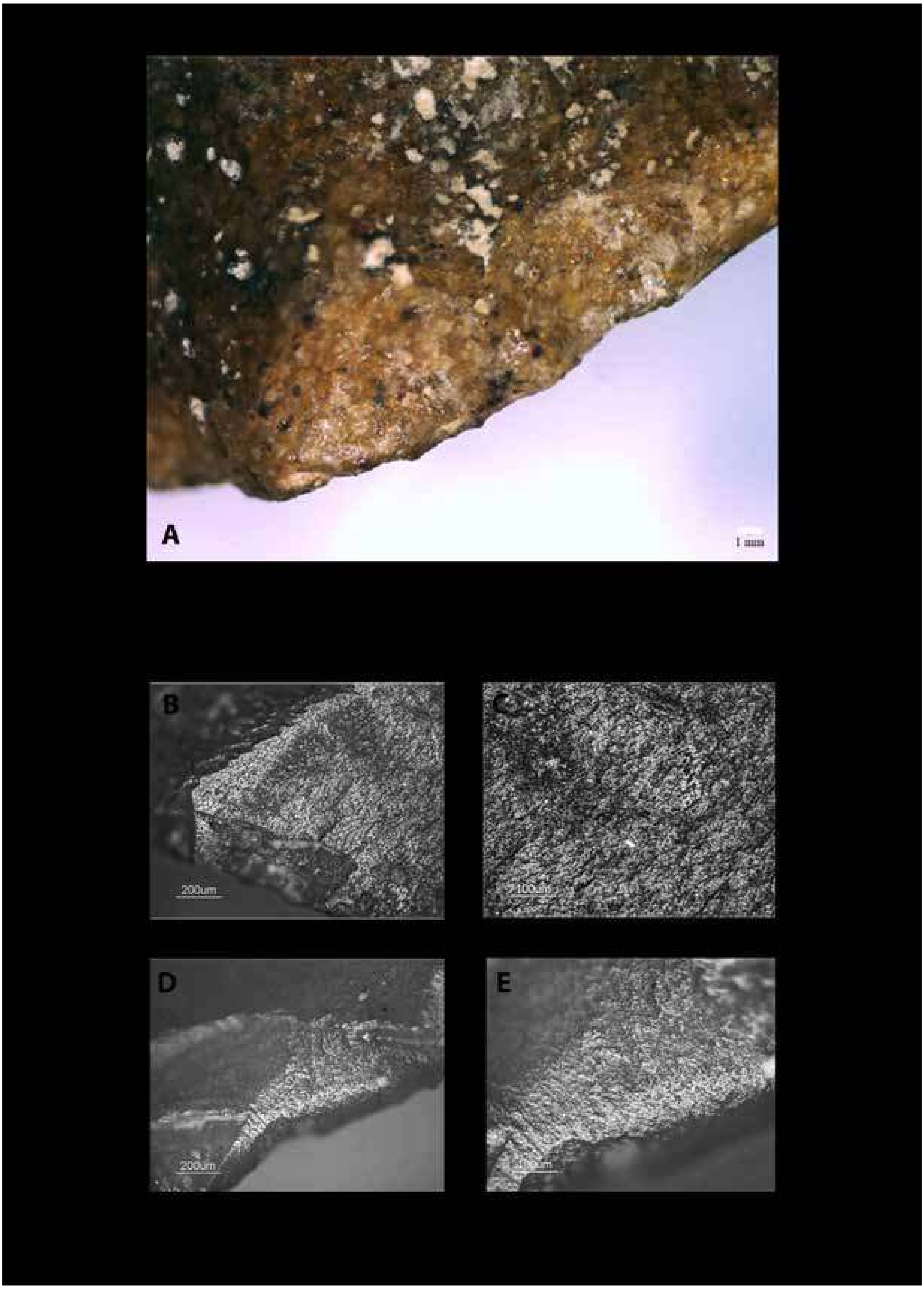

Figure 8.5: Surface alterations on the studied small flakes from of the items of Fontana Ranuccio (F. Marinelli).

Figure 8.6: Small flakes from the site of Fontana Ranuccio. White dots mark the location of macro-traces (F. Marinelli).

on the other hand, 22 items (60%) show signs of use-wear, while 15 items (40%) do not (Fig. 8.4C).

Both fragments and complete small flakes have a close regular distribution, feather-step end-terminations (9 out of 12 small flake fragments; 18 out of 22 un-retouched complete small flakes) and transversal (5 out 12 small flakes fragments; 4 out of 22 un-retouched complete small flakes) or oblique unidirectional (7 out of 12 small flake fragments; 18 out of 22 un-retouched complete small flakes) direction of use.

The identification of these characteristics has allowed to infer the activities carried out using these small flakes. Regarding the un-retouched small flakes, in 18 cases cutting was recognized, while scraping was identified in four cases. As for the fragments, traces attributable to cutting activities were identified in seven cases, and to scraping activities in five cases.

Similar considerations can be made for the retouched small flakes. 14 items (70%, 11 complete and 3 fragmented) have macro-traces. As already observed on the un-retouched small flakes, the retouched flakes have a close regular termination, feather-step end-terminations and transversal or oblique unidirectional directions of use.

In this case too, the analysis has allowed to infer that cutting activities (six cases) and scraping activities (five cases) on lightly resistant and resistant materials were carried out.

The location of the macro-traces on the un-retouched and retouched small flakes is similar. In fact, the macro-traces are often situated at the end of the edge. As it is the case also in Revadim, it seems that the hominins were looking for naturally pointed functional units originated from the intersection between lateral straight edge and the distal end of the small flake.

The preference of tools with pointed functional units was already proposed for the small tools from the site of Ficoncella (Aureli et al., 2016). Three categories of small tools were defined by the techno-morpho-functional approach: spina, mini-rostrum and rectilinear edge.

Mini-rostrum category is represented by items with a pointed area given by the intersection of a concave and a straight edge. The use-wear analysis carried out on this category of tools identified edge-removals on a single mini-rostrum. These use traces develop on the end portion of its straight edge. However, these traces are the remains of edge-removals developed on the previous edge resharpened to create the mini-rostrum (Aureli et al., 2016). Therefore, the mini-rostrum itself has no use-wear; it only keeps the vestiges of the previous use of the small item. Besides mini-rostrum, also the spina category from Ficoncella seems not to bear any use-wear.

Thus, even if the pointed areas were intentionally produced, it is not possible, at the moment, to affirm that they were actual active edges.

On the contrary, the Ficoncella rectilinear edge category includes various items with use-wear developed in sharp active edges with a straight delineation.

In this case, the use-wear analysis testifies cutting activity on medium and medium/soft material. Therefore, the use-wear analysis confirms that these small flakes had a high cutting potential and very robust edges particularly appreciated at Ficoncella to process material of different hardness (Aureli et al., 2016).

However, the small flakes of Revadim and Fontana Ranuccio are characterized by the presence, in almost all cases, of sharp-cornered areas due to the intersection of a lateral sharp and straight edge with the distal end of the flake. Therefore, in the case of these two sites, it would seem that small lithic industries presenting such characteristic morphology were used.

As experimentally demonstrated (see below), the sharp-corner allows to penetrate in the fleshy tissues and to have greater control in those butchering steps where bigger precision was required. In addition, a tool with a straight edge guarantees a larger adherence of the entire active edge to the surface of the material to be processed during cutting activity.

8.7 COMPARISON BETWEEN THE SMALL FLAKES OF REVADIM AND FONTANA RANUCCIO

The results of the use-wear analysis of the small flakes of Revadim and Fontana Ranuccio show that in both sites small flakes were used especially for the cutting—and, to a lesser extent, scraping—of materials of soft consistency. Moreover, in both sites, the small flakes show signs of use-wear in limited and well-circumscribed portions of the active edge (Figs. 8.1, 8.6). In fact, the macro-traces are almost always located on distal or proximal corners. Probably, the most pointed or angular areas of these items were the ones most frequently selected for use.

Because in both sites numerous faunal remains belonging to animal species of various sizes were found and because the small items found in these sites were especially used to process lightly resistant materials, it is reasonable to suggest that these tools may have been part of the toolkit used for butchering activities.

A recent work (Venditti et al., 2019c), carried out on small recycled flakes from Revadim, which were found in the same level as the small flakes described here, has proven that these tools were used in butchering activities. In fact, on the basis of the identified residues and the FTIR analyses, the presence of fat, bone, and collagen fibers was confirmed. These results, together with the use-wear analysis and the experiments, have confirmed the role played by these small recycled flakes during butchering, especially in cases where precise gestures were required (Venditti et al., 2019c).

A first series of experiments allowed to verify that, despite their small size, these tools guarantee

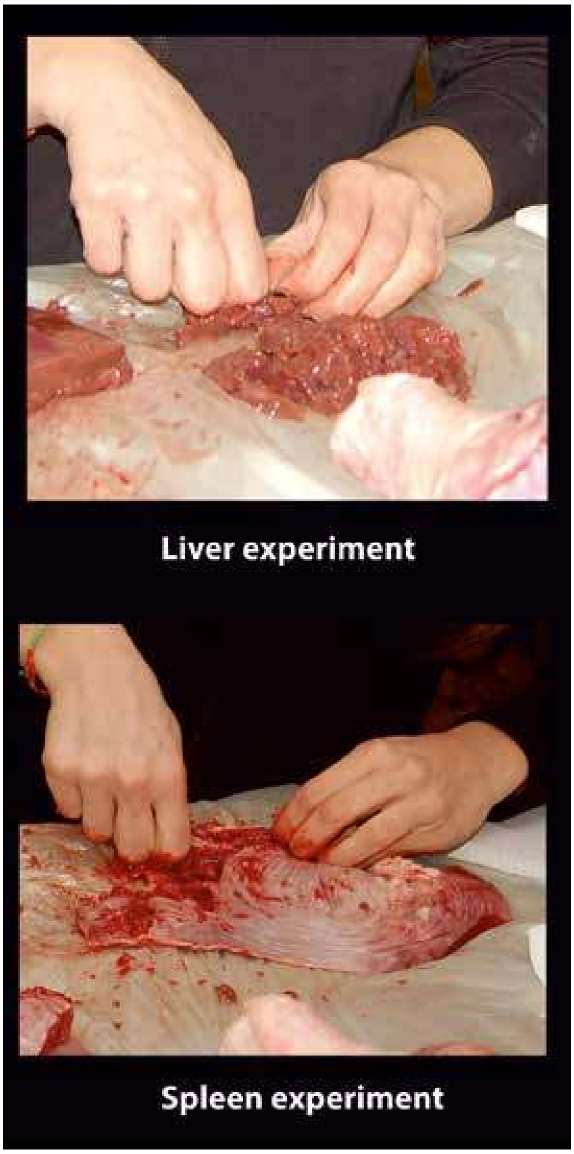

Figure 8.7: Liver and spleen experiments (F. Marinelli).

Figure 8.8: Hide and meat experiments (F. Marinelli).

excellent prehension. In these tools the best grip area is near the butt. This area was probably able to provide greater support for the grip and therefore the tool could be grasped more easily.

As for small flakes and retouched small flakes from Revadim and Fontana Ranuccio, in order to test the possible involvement of these items in butchering activities, we carried out experiments on fresh hide, fleshy tissues (cutting off from bones), and on those parts of the animal's body particularly rich in energy resources, using replicas of small flakes.

8.8 EXPERIMENTS

We carried out dedicated experiments using four replicas of small flakes made with flint from the vicinity of the Revadim site. The experimental replicas were made via direct percussion with a hard hammerstone. We tested the proficiency of these small flakes in cleaning off fat from the inner part of a fresh hide, taking off portions of meat from chest, and cutting the liver and spleen of an adult sheep in slices (Figs. 8.7, 8.8).

Cutting resulted to be the prevailing action;

only during the processing of the fresh hide scraping was also used. Each experiment lasted one hour. The experiments allowed us to verify the effectiveness of the small flakes in slicing muscles and fat organs and collecting fat from the interior side of the hide.

The first experiment was carried out on the liver. The performed action, namely cutting, was carried out with an oblique unidirectional movement (Fig. 8.9A). Despite its very small size, the tool was functional, especially when precision movements—such as the cutting of small portions of tissues—were performed.

The second experiment, the spleen processing, took longer. The cutting activity was carried out with an oblique unidirectional movement (Fig. 8.9B). The greater amount of time required to perform the activity compared to the experiment previously mentioned was due to the fact that the texture of the spleen is more elastic than the liver and, therefore, cutting took longer. In spite of that, the small flake was functional and the prehension was also excellent.

The third experiment consisted of scraping and cutting the fat layer of the inner side of a fresh hide of a sheep. In this case, the tool was involved in two types of activities: first, it was used to remove the adipose layer of the hide with a combined action of cutting or scraping (Figs. 8.8A, 8.9C). Then, we used it to cut the hide and divide it into two halves. The movements were mainly one-way oblique and, only in fewer cases, transversal. The tool was functional for both activities and the prehension was also very good.

The last experiment consisted of removing meat from the ribs of a sheep (Figs. 8.8B, 8.10). This type of activity made it possible to understand even more in depth the degree of efficiency of the small flakes in more precise activities, such as the removal of ribs from the rib cage aimed at improving the collection of residual portions of meat from the bones (Fig. 8.10A). The tool has proven very effective, especially in the areas where ribs connect, where the space between one rib and the other is reduced (Fig. 8.10B). Despite its small size, the tool

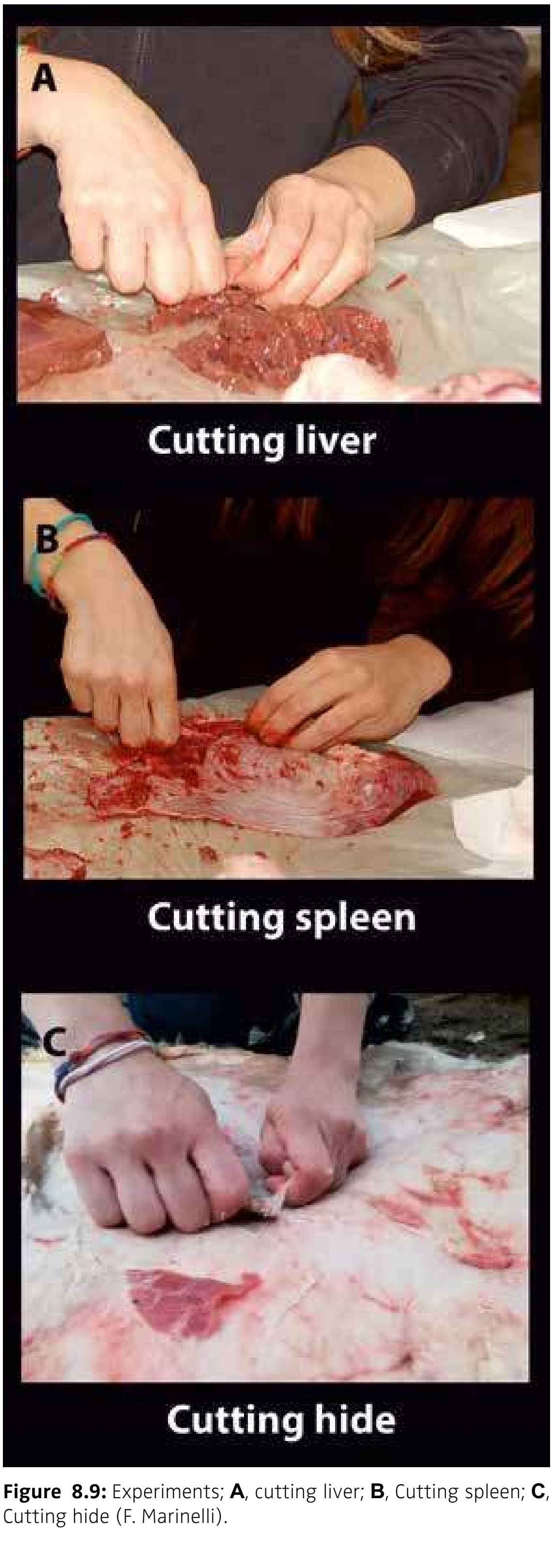

Figure 8.9: Experiments; **A**, cutting liver; **B**, Cutting spleen; **C**, Cutting hide (F. Marinelli).

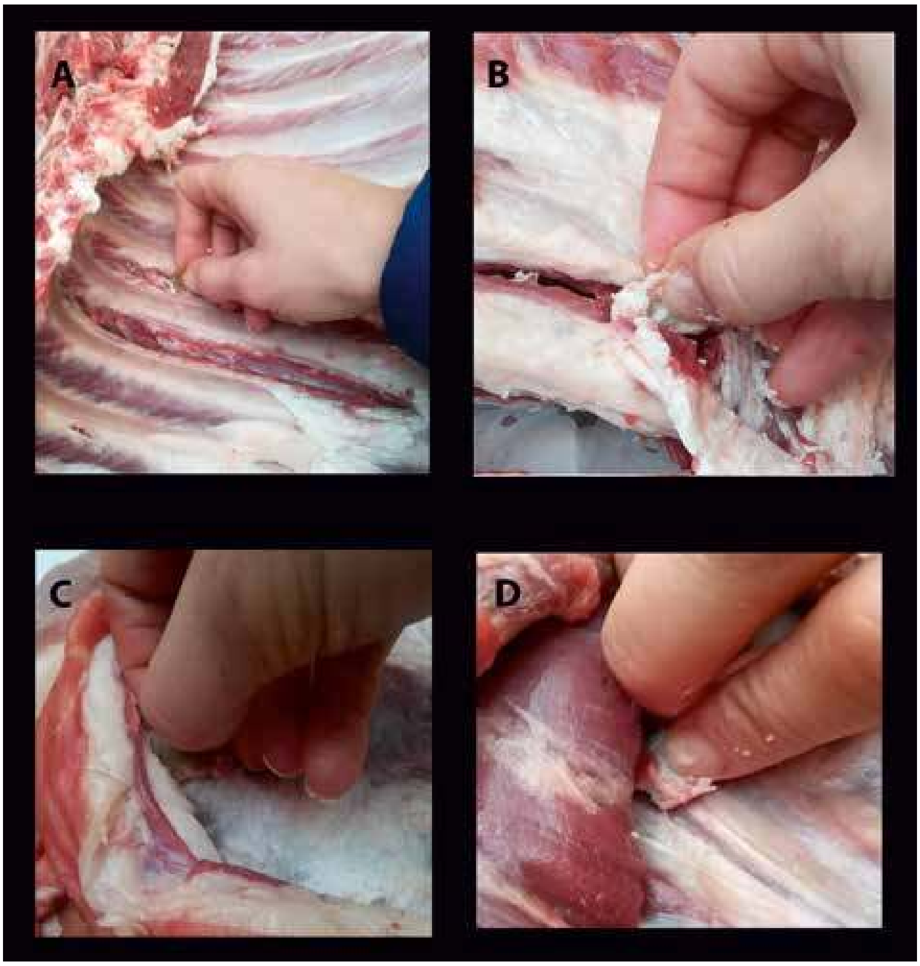

Figure 8.10: Meat experiment; **A**, removal of the ribs from the rib cage; **B**, detail of the cutting activity near the rib; **C**, removal of the meat from rib cage; **D**, detail of small flakes in the cutting activity (F. Marinelli).

was functional even in areas where meat was more abundant (Fig. 8.10C, D). The movements carried out here were mainly oblique unidirectional.

During this experiment, we noticed that in areas with larger amounts of meat the tool had to penetrate more in depth to reach the rib. So, in all situations that required greater penetration and precision from the tool, a small portion of the small flake was used. In our case, the distal portion of the small flakes was the most frequently selected and effective, since pointed areas reinforce the penetration potential of the tool.

The results of these experiments were fundamental to assess the effectiveness of these small flakes in various types of activities. Small flakes performed very effectively in slicing fat organs and collecting fat from the inner side of fresh hide (subcutis). Their gripping efficiency was very high during all the processing, leading to the hypothesis that these tools, despite their small size, may have allowed to perform these kinds of activities to a very high degree of effectiveness.

8.9 CONCLUSIONS

The study of use-wear found on the small flakes of Revadim and Fontana Ranuccio led to interesting considerations regarding their use. Although the items were altered, it was nevertheless possible to carry out the analysis of the macro-traces and, therefore, to interpret archaeological data. The small flakes from both sites were subjected to macroscopic and microscopic inspections in order to document the degree of preservation of their surface. These observations allowed to identify that a glossy appearance affects these lithic industries, probably connected to a combination of mechanical (abrasive) and chemical phenomena.

Where possible, use-wear analysis has allowed to detect macro-traces of activities such as cutting, for the most part, and scraping, in fewer cases. The processed materials are quite homogeneous and, for the most part, consisting of soft materials at Revadim and soft/soft-medium materials at Fontana Ranuccio, suggesting that, in the latter, materials with a harder consistency were worked as well.

All the observations made on the archaeological small flakes were matched with the results of the experimental protocols.

This first phase of experiments confirmed the efficiency of the small flakes in cutting and scraping of soft highly proteinaceous animal tissue, suggesting that the use-wear found on the archaeological items could be related to specific sequences of exploitation of the body parts of carcasses.

The comparison of the experimental and the archaeological data has highlighted that small flakes were used in activities where their pointed morphology—at the end of their active edge—and sharpness allowed to easily penetrate and cut soft animal tissues, even the most fibrous and tenacious and the fattest and slimiest ones.

As noted in the study of the small flakes of Fontana Ranuccio and Revadim and of other small lithic industries of the late Lower Palaeolithic (Anzidei et al., 2012; Aureli et al., 2016; Santucci et al., 2016; Venditti et al., 2019b, c) hominins were constantly after tools of small size with sharp usable areas. Based on the techno-morpho-functional and use-wear analysis it is possible to hypothesize that the generic category of small flakes is composed of several subgroups characterized by slightly different morphologies which were most probably used in specific tasks. It is probable that small flakes with straight edges were suitable for cutting activities, while those with more pointed areas were chosen for actions that required a precise starting marked on the material worked by the first incision impressed by the pointed or the sharp-corner. Besides the prevalent cutting use, a small number of small flakes were used for scarping activities for which at the site of Fontana Ranuccio a convex morphology of the edge was chosen for this activity.

Therefore, we would like to suggest that in complex activities such as butchering which may consist of different sequences of actions due to the size and the state of preservation of the carcass, the category of small flakes with a straight edge and a sharp-corner at the end, having a high potential of cutting, could be very effective in areas more difficult to be accessed with larger tools.

Despite the very small size of the items (from 16 to 30 mm in length), the experiments highlighted that their prehension was optimal. This griping potential of the small flakes found at Revadim and Fontana Ranuccio is still under study. Therefore, in this article we prefer to not discuss any further this functional aspect, which certainly deserves specific discussion after the dedicated experimental protocols currently in progress (for a general discussion of griping and small tools, see Rots, 2010; Chazan, 2013).

A second phase of experimentation to be carried out in the future will focus on butchering experiments performed on animals of various sizes, aimed at verifying the efficiency of small flakes on different kinds of carcasses.

Furthermore, to confirm the possible direct correlation between small flakes and megafauna, we hope we will be able to organize a butchering session on these large animals.

The data presented in this article are part of a preliminary attempt at investigating the role played by small flakes in the processing of animal carcasses by early humans in the Lower Palaeolithic period. According to these data, small flakes seem to be highly suitable for the processing of soft animal tissue, and they seem very efficient especially for the processing of the fat portion of carcasses. We hope these results, together with future studies and experiments, will help deciphering the intriguing possible nexus between small flakes and megaherbivores.

AUTHOR CONTRIBUTIONS

Conceptualization, F. M.; investigation, F. M.; supervision, C. L. and R. B.; writing–original draft, F. M., C. L. and R. B.; writing–review and editing, F. M., C. L. and R. B.

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