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# Terminal Pleistocene lithic variability in the Western Negev (Israel): Is there any evidence for contacts with the Nile Valley?

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## Abstract:

At the end of the Pleistocene (25,000-15,000 BP), there is a shift to more arid conditions in the Negev and the Sinai corresponding to the Last Glacial Maximum. For the Nile Valley and the Levant, the lowering of the Mediterranean sea level, the expansion of the Sahara and the desiccation of some major eastern African lakes had important consequences on: (1) the general behaviour of the River Nile; (2) the landscape around the Nile Delta; and (3) sand dune mobilisation. Despite this shift to more arid conditions, there is abundant evidence for human occupation in the Egyptian Nile Valley and in the arid zone of the Southern Levant at this time. In addition, contacts between these two regions have sometimes been suggested, mainly by genetic studies, including early 'Back-to-Africa' dispersals.

This paper focuses on the analysis of six terminal Pleistocene (ca. 25,000-15,000 BP) lithic assemblages from the western Negev Desert dunes in Israel, attributed to the Early and Middle Epipalaeolithic. The analysis relies on the *chaîne opératoire* approach combined with attribute analysis that enables quantification of typo-technological differences. Results of this analysis allow comparisons with assemblages from the Egyptian Nile Valley analysed in the same way previously. This comparative analysis is then used to discuss hypotheses of potential technical diffusions between these two regions. Current archaeological evidence therefore does not support any contacts between populations between the Levant and the Nile Valley at the end of the Pleistocene.

**Keywords:** Negev Desert; Epipalaeolithic; lithic analysis; dispersal hypotheses



## 1. Introduction

### 1.1. Terminal Pleistocene dispersals out of and back into Africa

The Negev and Sinai together represent a key-location in discussions of dispersal events of modern humans out-of and back-into Africa. However, the number, routes and timing of these dispersals are highly controversial (Nielsen *et al.* 2017). Archaeological evidence supporting the ‘northern’ route out of Africa through the Nile Valley is sparse and debated (Groucutt *et al.* 2015; but see Goder-Goldberger 2013; Goder-Goldberger *et al.* 2016; Goder-Goldberger *et al.* 2017). Most evidence for Late Pleistocene connections between the Nile Valley, North Africa and the Levant, including back-to-Africa dispersals, through or from the Levant, at the end of the Pleistocene derive from genetic studies (Forster *et al.* 2007; Henn *et al.* 2012; Hodgson *et al.* 2014; Olivieri *et al.* 2006; Pennarun *et al.* 2012; Underhill *et al.* 2001). Recently published results from ancient DNA at Taforalt (Morocco), on skeletons dated to ~15,000 cal BP, provide direct evidence for genetic interactions across Africa and Eurasia (with one third of their ancestry deriving from western and eastern Africa, and two thirds from the Near East) (Loosdrecht *et al.* 2018).

However, archaeological evidence for dispersals or contacts between the two regions (Nile Valley and Levant) remains sparse and there is a lack of systematic comparisons of assemblages between the Levant and the Nile Valley. Relying on the presence of blade technology, connections between the Levant and the Nile Valley were suggested (Bar-Yosef 1987; Bar-Yosef 2013; Bar-Yosef 2017). However, the sites of Nazlet Khater 4 and Taramsa 1 are the only Upper Palaeolithic sites securely dated to Marine Isotope Stage 3 (MIS3) in the Lower Nile Valley and both represent special function quarry sites with few diagnostic tools (Leplongeon & Pleurdeau 2011; Vermeersch *et al.* 2002), lacking the el-Wad points and retouched bladelets characteristic of the Levantine Early Ahmarian (Bar-Yosef & Belfer 1977; Goring-Morris & Davidzon 2006). The lack of sites from this period in the Nile Valley hamper any thorough comparisons between these two areas, and more data are needed to discuss contacts during the Late Pleistocene.

The following period, corresponding to Marine Isotope Stage (MIS) 2, is characterised by a significant increase in the numbers of sites, both in the Nile Valley and the Negev and Sinai. Some evidence may suggest an extension of the Mushabian and Ramonian Epipalaeolithic industries of the southern Levant as far west as the apex of the Nile Delta (Debono 1948; Schmidt 1996; Tassie 2014). The unsystematic collections there include what appear to be Middle Epipalaeolithic Mushabian arch backed and scalene bladelets with microburin technique. However, no detailed comparisons were made between these two areas.

Although the Nile Valley and Sinai-Negev are obvious routes out-of and back-into Africa, very little is known of interactions between these two areas during the later Pleistocene. This paper aims to contribute to this issue by comparing lithic assemblages from the Epipalaeolithic of the Negev with assemblages from the Late Palaeolithic of the Nile Valley, both occurring during MIS 2.

### 1.2. The Early and Middle Epipalaeolithic of the Negev

The beginning of the Epipalaeolithic (EP) roughly coincides with the start of the Last Glacial Maximum (LGM) (ca. 23,000 cal BP). The palaeoenvironmental record indicates a steppic environment in the Negev throughout the Late Pleistocene (Enzel *et al.* 2008; Baruch & Goring-Morris 1997; Goring-Morris 2017). Speleothem bearing karstic caves of the northern Negev Desert indicate major periods of speleothem deposition, corresponding to humid phases between 76-25ka and 23-13ka (Vaks *et al.* 2006). A phase of dune advance and dune formation, indicating a west-east vector of winds, is documented in northern Sinai and

the western Negev, beginning at ~30,000-25,000 BP with a major phase of dune activity between 20,000-10,000 cal BP in two main phases (Ben-David & Yair 2008; Enzel *et al.* 2008; Goring-Morris & Goldberg 1990; Roskin & Tsoar 2017). This probably indicates much stronger W-SW winds than today (Enzel *et al.* 2008). Despite reduced rainfall in the northern Sinai and the western Negev during the LGM, dune encroachment would have caused seasonal damming of drainage basins, and the creation of ponds and lakes at the dune margins, therefore attracting animals and humans (Goring-Morris & Goldberg 1990; Goring-Morris 2017; Roskin *et al.* 2014; Roskin & Tsoar 2017). This would explain the marked increase in the number of sites (and thus presumably in population density) in the western Negev at that time (Goring-Morris & Belfer-Cohen 1997).

The Epipalaeolithic is characterized by a trend towards the microlithisation of chipped stone artefacts (Belfer-Cohen & Goring-Morris 2002) an increase in the number of occupations despite colder and more arid climatic conditions (Goring-Morris *et al.* 2009) and increasing territoriality, as seen in the development of style in the lithic assemblages (Goring-Morris & Belfer-Cohen 1997). Other characteristics are the emergence and intensification in the use of grinding stones (Peterson 1999; Wright 1994), funerary behaviours, aggregation sites, mobile art and ornaments (Goring-Morris 1995; Goring-Morris & Belfer-Cohen 1997; Maher *et al.* 2012).

The Southern Levantine EP can be divided into three phases: Early, Middle and Late EP, each comprising several lithic industries (Table 1). Geographic distributions of these industries (contractions and expansions) may be linked to climatic changes (Belfer-Cohen & Goring-Morris 2014; Goring-Morris 1987; Goring-Morris 1995; Goring-Morris *et al.* 2009). In particular, the Middle EP Geometric Kebaran, Mushabian and Ramonian industries are documented in the Negev and Sinai during the Bølling-Allerød (Bar-Yosef & Phillips 1977: 255-260; Goring-Morris 1987); in the case of the Mushabian and Ramonian perhaps extending as far west as the apex of the Nile Delta (Debono 1948; Schmidt 1996; Goring-Morris & Belfer-Cohen 1997; Belfer-Cohen & Goring-Morris 2014). The unsystematic collections there include what appear to include Middle Epipalaeolithic Mushabian arch backed and scalene bladelets with microburin technique. Generally speaking, the Negev Early and Middle EP sites are characterised by relatively small, short-term occupations, often associated with one or more hearths.

Table 1. Entities and approximate date ranges for the Epipalaeolithic of the Negev (Dates after Goring-Morris 2017). Abbreviations: \* Entities with habitual use of the microburin technique.

Period	Entities	Approximate date ranges (cal BP)
Early Epipalaeolithic	Masraqan (Late Ahmarian)	~25,000-20,000
	Kebaran	~23,000-18,500
	Nizzanan *	~20,000-18,500
Middle Epipalaeolithic	Geometric Kebaran	~19,000-15,000
	Mushabian - Early Ramonian *	17,750-15,000
Late Epipalaeolithic	Terminal Ramonian - Early Natufian *	15,000-13,500
	Late Natufian *	13,500-12,500
	Harifian *	12,500-11,650

Lithic variability in the EP of the Levant is apparent typologically and technologically, including the presence or absence of the microburin technique in microlith production (Goring-Morris 1987; Goring-Morris 1995; Goring-Morris *et al.* 1998; Marder 2002). Detailed refitting studies of numerous Epipalaeolithic lithic assemblages in the Negev

indicated that, despite a few inter-site and inter-industry differences, the entities there are characterised by a shared general technological homogeneity (Marder 2002). The main *chaîne opératoire* is oriented towards the production of microliths. It is further characterised by serial blade(let) production from single platform cores on locally available flint nodules. A gradual shift is demonstrated from the 'Upper Palaeolithic volumetric concept', defined by narrow fronted ('N-fronted') cores, reduced on their narrow front and used to produce standardised narrow bladelets (Goring-Morris & Davidzon 2006), to the 'Epipalaeolithic volumetric concept', defined by wide fronted ('W-fronted') and sub-pyramidal cores, with the exploitation of their wide front for the production of less regular wide bladelets (Davidzon & Goring-Morris 2003: 158). Core maintenance is minimal, usually consisting in the blunting of the cores' removal surfaces, and the removal of a few atypical core tablets and crested products, and sometimes an opposed supporting platform. In addition to typological variability amongst the Epipalaeolithic chipped stone entities, two stylistic variations are found, namely the absence or systematic use of the microburin technique (Goring-Morris 1987).

### 1.3. The Late Palaeolithic of the Egyptian Nile Valley

The later part of the Pleistocene (~25,000-10,000 BP) in Upper and Middle Egypt corresponds to an exceptional increase in the number of sites, used as a proxy for population density (see Figure 1). At a time when hyper-aridity seems to characterise most of north-eastern Africa, such 'demographic packing' may be explained by the Nile valley playing the role of a 'refugium'.

Two competing models exist for the behaviour of the Nile river and local palaeoenvironmental conditions during the LGM: a river with braided channels and a much lower discharge than today (Wendorf & Schild 1989; Schild & Wendorf 2010); or the formation of lakes created by sand dunes damming the Nile (Vermeersch 2006; Vermeersch & Van Neer 2015). In both models, there are few if any Terminal Pleistocene sediments preserved in the northern portion of the Nile Valley and its Delta (Butzer 1997: 167; Hendrickx & Vermeersch 2000; Sandford 1936; Wendorf & Schild 1989). Archaeologically, evidence for human occupation during MIS2 in the Nile Valley comes mainly from near Qena in Middle Egypt (*e.g.* Vermeersch 2000; Vermeersch 2002), from Upper Egypt (Wendorf & Schild 1976; Wendorf & Schild 1989; Schild & Wendorf 2010), as well as from Upper Nubia in Sudan (Osypiński & Osypińska 2016). Additionally, arid conditions with high Saharan dust input in the Nile margins are documented until ca. 14,600 cal BP (Revel *et al.* 2010; Revel *et al.* 2015). Nevertheless, considering that the nearby Sinai and Negev deserts have yielded abundant evidence for human occupation during MIS2 (see above), local conditions may have enabled punctuated occupations of the Delta during that period.

Archaeological data at these sites reflect dense occupations, most of them oriented towards fish exploitation, such as at Makhadma 4 (Vermeersch *et al.* 2000) or Wadi Kubbania (Wendorf & Schild 1989). There is a great variability in lithic assemblages, which led to the definition of numerous lithic industries (*e.g.*, Kubbanian, Afian, Silsilian, Fakhurian, *etc.*), some of which have the particularity of retaining some Middle Palaeolithic - Middle Stone Age characteristics, such as the Levallois method. No site, securely dated to this period, is known in the Delta region. Further south, a recently excavated site in Sudan, Affad 23, has yielded an occupation level dated to ~15-16ka, associated with a faunal assemblage dominated by medium to large-size mammals and a lithic assemblage with full Middle Stone Age characteristics, including Levallois methods (Osypiński & Osypińska 2016; Osypińska & Osypiński 2016). This raises further questions on the nature of the variability at the end of the Pleistocene in the Nile Valley and possibly complex population dynamics at that time.

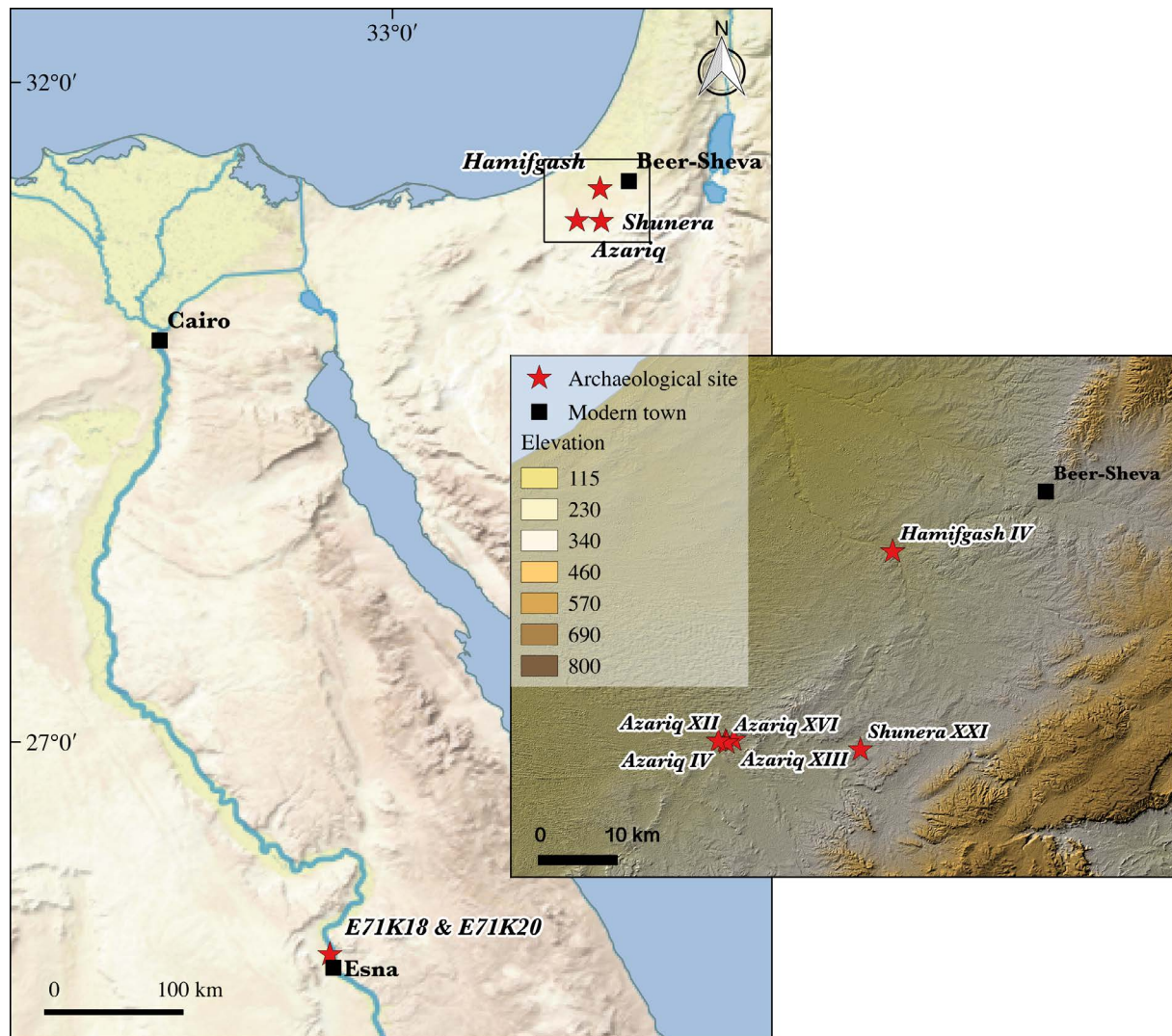


Figure 1. Location of sites mentioned in the text. Elevation map after SRTM 1 Arc-second Global elevation data available from the U.S. Geological Survey. Base map made using Natural Earth Data. Both made with QGIS.

## 2. Main research objectives

This short review contributes to highlighting several problems that have hampered testing hypothetical connections between the Levant and the Nile Valley: the lack of archaeological data, particularly in the northern part of the Nile Valley, as any posited sites are likely to be deeply buried within the delta sediments due to latter aggradation as sea levels rose following the LGM, as well as the debated palaeoenvironmental reconstructions, particularly in the lower Nile Valley. In addition, different methods, periodisation, terminologies and typologies were used to describe lithic assemblages, *e.g.*, Epipalaeolithic (EP) in the Levant *vs.* Late Palaeolithic (LP) in the Nile Valley. While recent genetic studies all seem to point to major Pleistocene interactions between the Levant and northeastern Africa, the archaeological evidence remains sparse.

The EP of the Negev and northern Sinai is relatively well known (Goring-Morris 1987). Characteristics of the lithic assemblages have mainly been described following a general typo-technological viewpoint (*i.e.*, on morphotypes of the mostly microlithic components and the absence or presence of the microburin technique), supplemented by technological analyses deriving from refitting studies (see above). Although the combination of both approaches allows thorough characterisation of EP techno-typology, in the absence of similar refitted assemblages in the Nile Valley, these data cannot be easily used in the frame of detailed

comparative analyses, where quantification of differences and similarities between assemblages are necessary.

This paper thus aims to describe and technologically analyse assemblages from the EP of the Negev, relying on both the concept of *chaîne opératoire* and the use of attribute analysis to quantify technological differences. By applying the same methods used to describe Late Palaeolithic lithic assemblages from the Nile Valley (Leplongeon 2017), this should enable: (1) examination of lithic variability within the EP of the Levant from a different perspective; and (2) systematic comparisons of Levantine assemblages with assemblages from adjacent regions and further investigate hypotheses of technical diffusion.

### 3. The sites

#### 3.1. Negev sites

The six assemblages analysed herein are assigned to one each of the entities assigned on techno-typological grounds to the Early and Middle Epipalaeolithic in the Negev and Sinai (Goring-Morris 1987) (Table 2).

The assemblages derive from systematic excavations or collections conducted by one of us in the framework of the Emergency Archaeological Survey of the Negev (Figure 1). All sites are located at the margins of the north Sinai-western Negev erg (longitudinal dune), in or deflating from sandy contexts. The sites were excavated using a 50 cm grid and sieved through a 3 mm mesh. Most are small, partially deflated ephemeral campsites with one or more hearths. They were almost completely excavated, with the exception of Azariq XII and Shunera XXI. The lithic assemblages are fresh and retain spatial integrity, as reflected in a systematic refitting program, with conjoin rates between 10-24% of the tools, cores and debitage of the studied assemblages (Goring-Morris *et al.* 1998; Marder 2002). Raw materials are readily available in nearby Eocene outcrops, or from nearby wadis as nodules, pebbles or cobbles washed downstream from the direction of the Negev highlands.

The Azariq sites are located adjacent to the confluence of Nahal Nizzana and Nahal Lavan, major tributaries draining the central Negev highlands via Wadi el-Arish to the Mediterranean. The Shunera assemblages are located near a dune-blocked seasonal playa or palaeolake ca. 15 km northeast of the Azariq area (Goring-Morris 1993), while Hamifgash is located at the confluence of Nahal Besor and Nahal Beersheva also draining the Negev highlands. Organic preservation is notoriously poor in the sandy soils of the Negev and Sinai, so that only mostly unidentifiable bone fragments, occasional marine mollusks and small fragments of charcoal were recovered. Few of the analysed sites provided reliable radiometric dates, so date estimates are based on those from the same entities elsewhere in the Southern Levant (Belfer-Cohen & Goring-Morris 2014; Goring-Morris & Belfer-Cohen 2017). The sites are described below in chronological order, from earliest to latest.

Table 2. Raw counts by class of the studied lithic assemblages (data from Goring-Morris 1987; Goring-Morris *et al.* 1998; Marder 2002).  
Abbreviations: Az. = Azariq, Ham. = Hamifgash, Shun. = Shunera

Lithic Category	Az. XIII	Az. IV	Ham. IV	Az. XVI	Az. XII	Shun. XXI
	Masraqan	Kebaran	Nizzanan	Geometric Kebaran	Mushabian	Ramonian
Primary elements	503	91	336	729	636	371
% assemblage	4.8%	2.2%	6.7%	7.8%	5.1%	3.7%
Flakes & fragments	1118	1165	556	2528	1636	1053
% assemblage	10.6%	28.5%	11.0%	27.0%	13.0%	10.6%
Blade(let)s & fragments	1677	482	471	2350	1872	2521
% assemblage	15.9%	11.8%	9.4%	25.1%	14.9%	25.3%
Core trimming elements (CTE)	324	99	170	147	261	74
% assemblage	3.1%	2.4%	3.4%	1.6%	2.1%	0.7%
incl. core tablets	85	19	17	12	45	5
% CTE	26.2%	19.2%	10.0%	8.2%	17.2%	6.8%
incl. ridge	120	41	29	33	29	18
% CTE	37.0%	41.4%	17.1%	22.4%	11.1%	24.3%
Burin spalls	17	10	10	10	16	7
% assemblage	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%
Cores	40	18	29	32	73	26
% assemblage	0.4%	0.4%	0.6%	0.3%	0.6%	0.3%
Retouched tools	1188	230	336	1251	1353	1165
% assemblage	11.3%	5.6%	6.7%	13.4%	10.8%	11.7%
Microburin technique related pieces	0	2	262	30	350	594
% assemblage	0.0%	0.0%	5.2%	0.3%	2.8%	6.0%
Chips	5569	1150	2772	2123	6278	4062
% assemblage	52.9%	28.2%	55.1%	22.7%	49.9%	40.8%
Chunks	96	838	91	164	94	86
% assemblage	0.9%	20.5%	1.8%	1.8%	0.7%	0.9%
<b>Total</b>	<b>10532</b>	<b>4085</b>	<b>5033</b>	<b>9364</b>	<b>12569</b>	<b>9959</b>

### 3.1.1. Azariq XIII

Azariq XIII (Az XIII) is attributed to the Early Epipalaeolithic Masraḡan (ca. 25,500-20,000 cal BP), and extended over ca. 75 m<sup>2</sup> (Goring-Morris 1995; Goring-Morris *et al.* 1998). While largely deflated, the probable presence of the outline of a brush hut indicate it has largely retained spatial integrity (Goring-Morris & Belfer-Cohen 2003; Goring-Morris & Belfer-Cohen 2008) (Table 1). The lithic assemblage is characterised by a standardised techno-typology, with the main *chaîne opératoire* oriented towards the choice of good quality discoidal flint nodules sometimes split into two (Figure 2a, b, which conjoin) or introduced as ready-made cores on large flakes or blades (Figure 2c). The narrow side was used as the removal surface for series of elongated, convergent bladelet blanks. These N-fronted cores were maintained by core tablet removals and a few ridge blades. The bladelets were finely retouched (Ouchtata) along one lateral edge (Figure 2f). A separate *chaîne opératoire* to produce massive blanks and tools (end-scrapers) was also noted.

### 3.1.2. Azariq IV

The small, ca. 25 m<sup>2</sup>, ephemeral site of Azariq IV (Az IV) is attributed to the Early Epipalaeolithic early Kebaran (ca. 22,000-18,500 cal BP; (Belfer-Cohen & Goring-Morris 2014; Goring-Morris & Belfer-Cohen 2017). Though mostly deflated, it included a hearth. The lithic assemblage is dominated by single platform cores (>50%) for the production of blade(let)s (Figure 3). Non-geometric microliths, mainly backed micropoints (Bar-Yosef 1970: 162-164) dominate (>85%) the retouched tools. Refitting enabled the reconstruction of the *chaîne opératoire* that is similar to, but less homogeneous than that of Azariq XIII, with single platform cores mainly exploited on their narrow elongated side (N-fronted cores), and primarily oriented towards the production of more robust bladelets (Goring-Morris *et al.* 1998).

### 3.1.3. Hamifgash IV

Hamifgash IV (Ham IV) is a small, 30 m<sup>2</sup>, *in situ* Early Epipalaeolithic Nizzanan occurrence (ca. 20,000-18,500 cal BP) eroding from a horizon of sandy-silty fluviially reworked sediments. Immediately adjacent stratigraphic correlations place it below, *i.e.*, predating, Middle Epipalaeolithic Geometric Kebaran and Ramonian occurrences (Goring-Morris 1987: 153; Marder 2002). Charcoal from one of two hearths provided two dates, one clearly aberrant. The main *chaîne opératoire* includes relatively narrow single platform cores (~75%) and, less commonly, opposed platform cores (~25%) for the production of unstandardized elongated microlith blanks. In the latter case, one platform is dominant, while the other is considered to be supporting to ensure convexity of the removal surface. The blanks were transformed mainly into arch-backed bladelet or scalene triangle forms, using the microburin technique (Figure 4). A few microgravette points are also characteristic (Goring-Morris 1987).

### 3.1.4. Azariq XVI

Azariq XVI (Az XVI) is a partially deflated Geometric Kebaran (ca. 18,500-15,000 cal BP) site, covering ca. 50 m<sup>2</sup> in an interdunal basin and yielded a hearth (Belfer-Cohen & Goring-Morris 2014). Ochre stains were noted on several blades. The large assemblage fits with the general Geometric Kebaran characteristics (Table 2), with a majority of single platform cores for the production of blades or bladelets, maintained by the removals of ridge blades and core tablets. Geometric microliths (trapezes and rectangles) dominate the



retouched tools (>70%) (Figure 5). There is a very low number of microburins (n=46), more than half being Krukowski variants (Goring-Morris 1987). Refitting enabled identification of one main *chaîne opératoire* for geometric microliths and endscrapers and two other minor *chaînes opératoires*, one for endscrapers and the other for the off-site production of massive tools (Marder 2002).

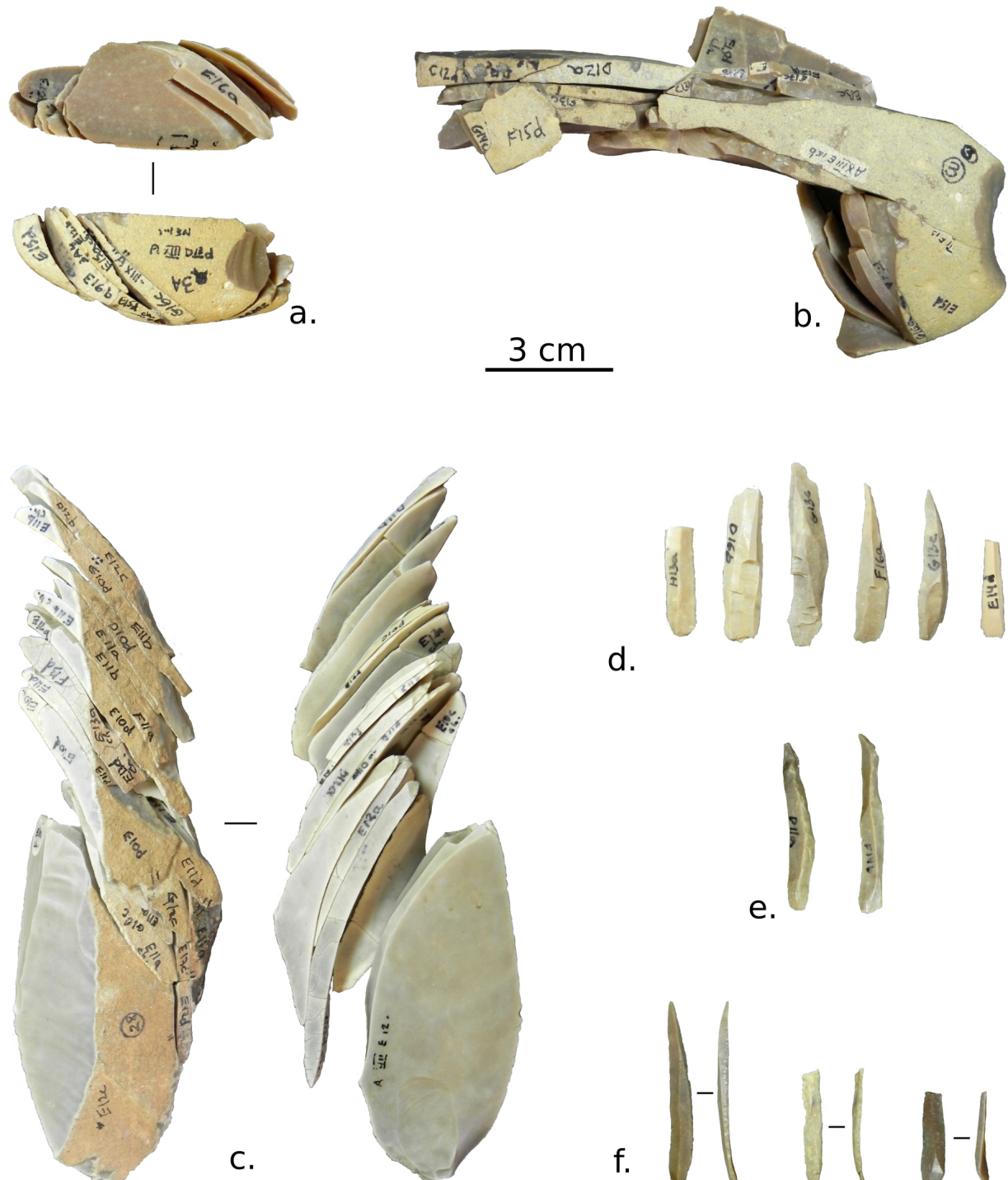


Figure 2. Azariq XIII - lithic artefacts. (a-c) refits – a refits with b, bladelet cores, (d) elongated blanks, (e) crested blades, (f) Ouchtata retouched bladelets.

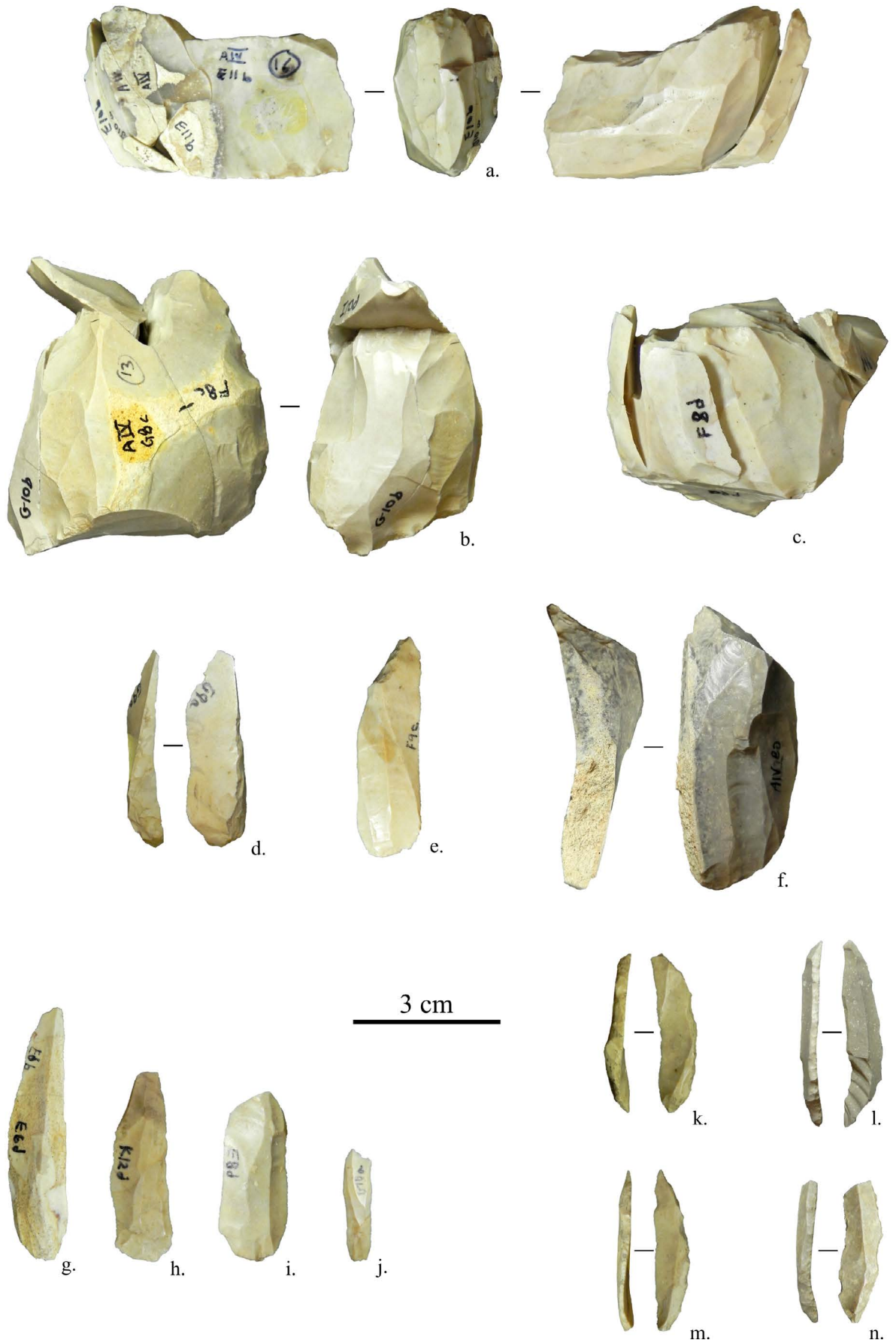


Figure 3. Azariq IV - lithic artefacts. (a-c) refits of cores with blade(lets), (a) on split; (d-f) core trimming elements; (g-j) elongated blanks, (k-n) backed micropoints.

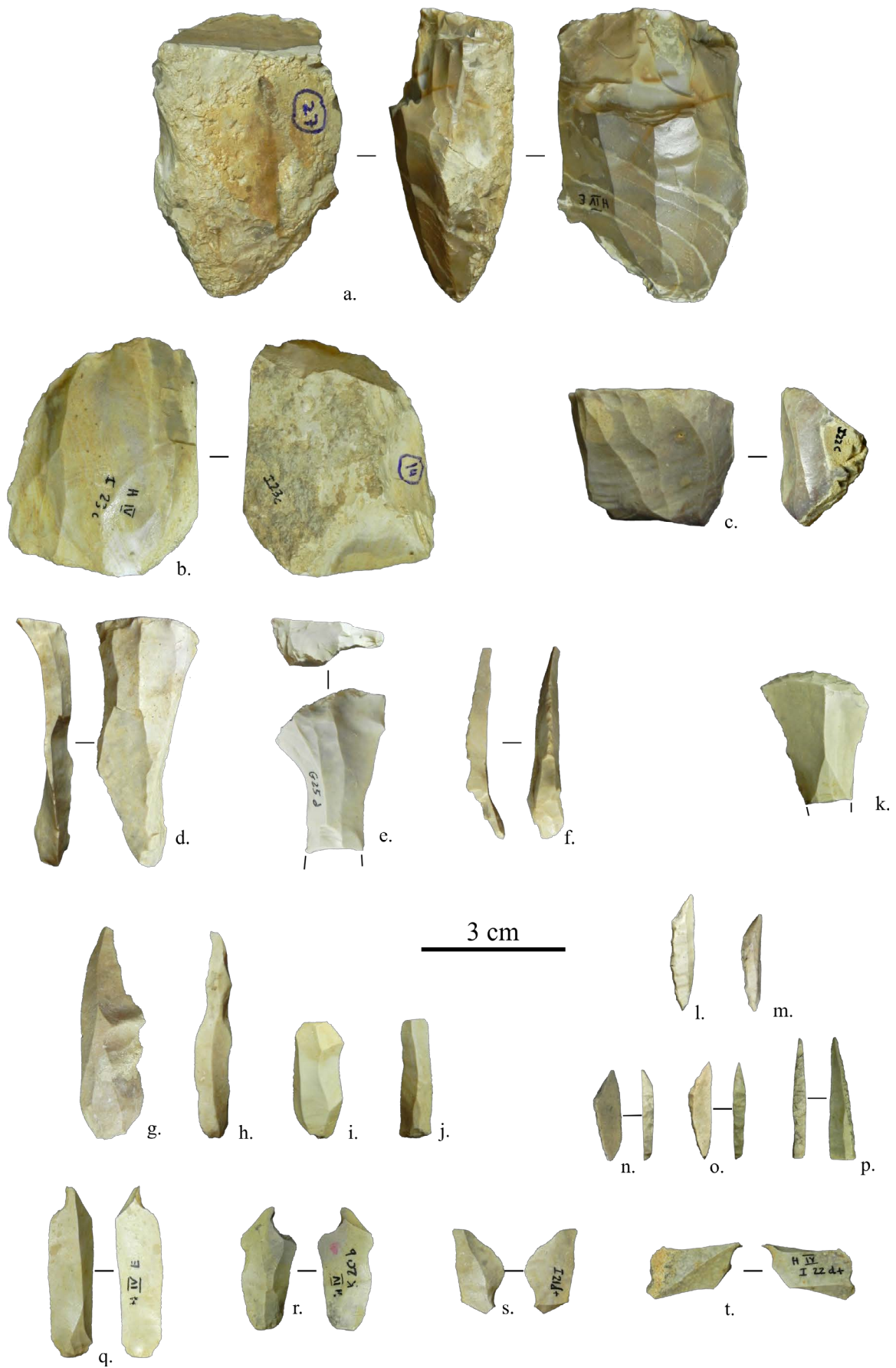


Figure 4. Hamifgash IV - lithic artefacts. (a-c) cores, (d-f) core trimming elements, (g-j) elongated blanks, (k) end-scraper, (l-o) arch-backed bladelets, (p) 'microgravette' point, (a-t) microburins.

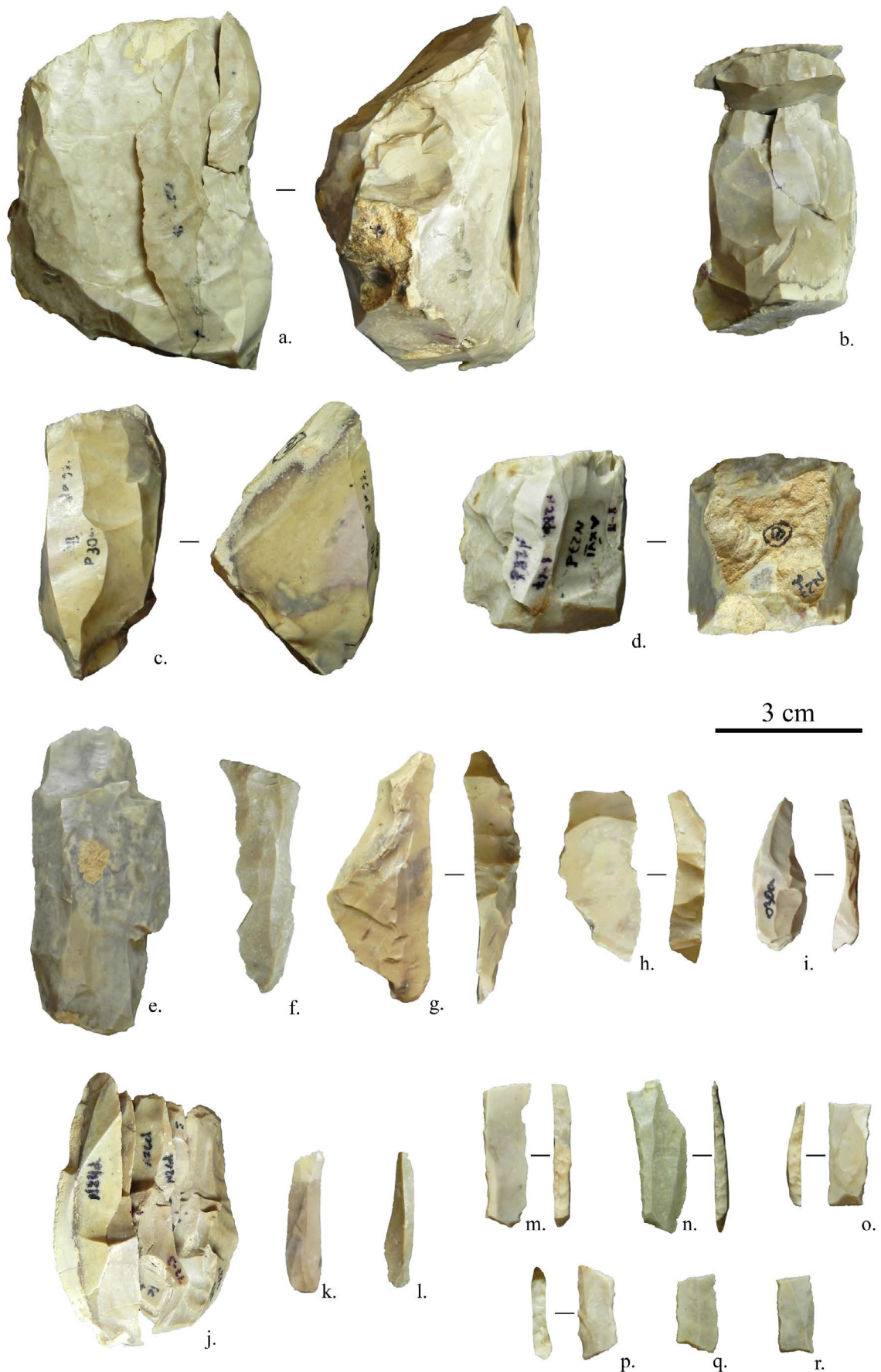


Figure 5. Azariq XVI - lithic artefacts. (a-d) cores, (e-i) core trimming elements, (j-l) elongated blanks, (m-r) geometric microliths (trapezes and rectangles).

### 3.1.5. Azariq XII

Azariq XII (Az XII) is an extensive, partially deflated Mushabian (ca. 17,750-15,000 cal BP) site within a palaeosol, extending over >100 m<sup>2</sup>. Two hearths were present within the excavated area (and at least two others were present), each accompanied by quantities of burnt stones interpreted as roasting pits (Goring-Morris 1987; Goring-Morris & Belfer-Cohen 2003). The main *chaîne opératoire* of the abundant assemblage was focused on the production of microliths, although three to four other minor *chaînes opératoires* were also noted (Marder 2002). Contrary to other Mushabian assemblages, opposed platform cores are the dominant form at Azariq XII (Goring-Morris 1987: 176). Elongated blanks were transformed into arch-backed or scalene bladelets (while some superficially look like lunates, the proximal ends are not modified) and fewer blunt backed bladelets, with only the first category manufactured using the microburin technique (Goring-Morris 1987; Marder 2002)(Figure 6).

### 3.1.6. Shunera XXI

Shunera XXI (Sh XXI) is a large (>80 m<sup>2</sup>) partially excavated Ramonian site deflating from a dune (Goring-Morris 1987). Within the excavated area four hearths were identified, one with considerable quantities of burnt stones; a charcoal date of 12100 ± 140 BP (14141 ± 294 cal BP) is considered too young. The abundant assemblage was mainly made from flint but also from translucent chalcedony (~25% of artefacts). The main *chaîne opératoire* focused on blade-let blanks from single-platform, pyramidal cores intended for Ramon points manufactured by the microburin technique (Goring-Morris 1987; Marder 2002) (Figure 7). Minor off-site or on-site *chaînes opératoires* for the production of medium-sized tools such as endscrapers were also noted.

## 3.2. The Nile Valley sites: E71K18 and E71K20

Cultural entities of the Nile Valley during MIS2 are attributed to the Late Palaeolithic (LP). LP sites are concentrated in Upper Egypt and in the Egyptian and Sudanese Nubia (Schild & Wendorf 2010). This is the result of both the history of research in the area, strongly linked with the construction of the Aswan dam, and with the geomorphological characteristics of the Nile at that time (see above).

Here we focus on two sites, E71K18 and E71K20, located near Esna, in Upper Egypt, ca. 600 km distant from the Negev-Sinai (Figure 1). They are attributed to the Afian and Silsilian industries, respectively.

E71K18 was first described by Wendorf and Schild (1976). It is composed of five small deflated surface concentrations (localities A to E). The deflated surface is associated with a pond sediment, which, according to Wendorf and Schild's interpretation, is located above the silt and sand deposits associated with maximum aggradation and dune sedimentation in the area. The surface concentrations are not dated, but on the basis of stratigraphic correlations and lithic comparisons, a date of around 16,500-14,500 cal BP was suggested for the Afian (Schild & Wendorf 2010). However, Vermeersch and Van Neer (2015: 163) propose that instead of Nile river levels, the stratigraphy and topography around Esna might be better interpreted as Nile lake levels, similar to the one described for Makhadma (Vermeersch & Van Neer 2015; and see above). The abundant lithic remains suggest repeated or long-term (or both) occupation(s). Close and colleagues (Close *et al.* 1979) made an extensive stylistic and typological study of these assemblages, while one locality, E71K18C, was recently studied from a technological point of view by one of us (Leplongeon 2017). The production was oriented towards making wide and small elongated blanks, following a planimetric

conception of debitage, mainly relying on the principle of recurrence. Striking platforms are usually faceted and flaking surfaces were not prepared. Blanks were transformed into diverse retouched tools, composed mainly of microlithic tools: proximal truncations, backed bladelets and geometrics (mostly trapezes), occasionally manufactured using the microburin technique.

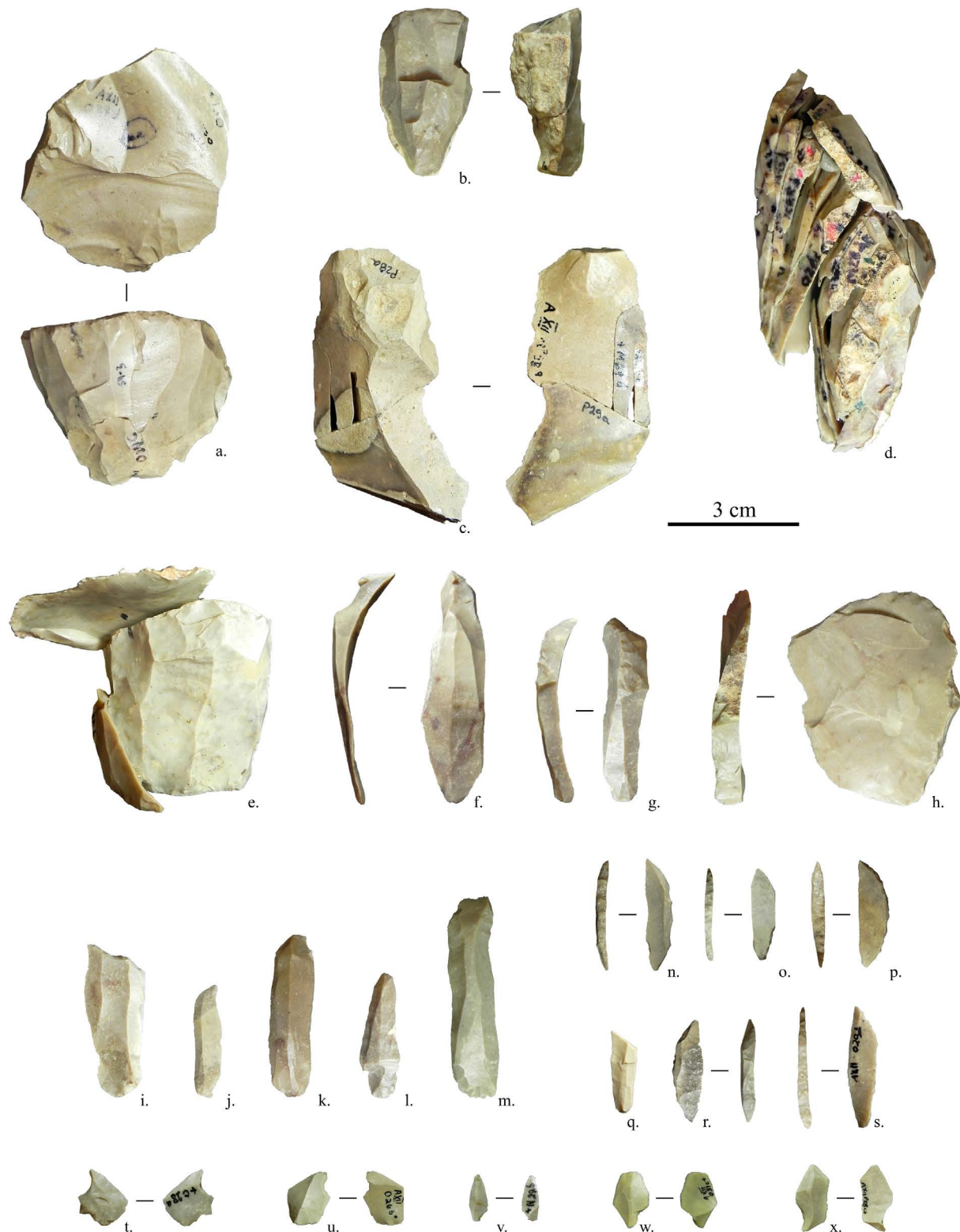


Figure 6. Azariq XII - lithic artefacts. a ,b, d, e = cores, c = refitted burin on a break on a flake, (f-h) core trimming elements, (i-m) elongated blanks, (n-s) arch-backed scalene bladelets, (t-x) microburins.



Figure 7. Shunera XXI - lithic artefacts. (a-e) cores, (f-g) core trimming elements, (h-m) elongated blanks, (n-q) microburins, (r-w) ramon points, x = unfinished microlith, y = refitted cluster of microliths.

E71K20 is located about 5 km from E71K18. It is a surface site consisting of two lithic concentrations (areas A and B). Based on the general characteristics of the lithic assemblages, it was attributed to the Silsilian industry (Wendorf & Schild 1976; Phillips & Butzer 1973; Smith 1966). Its material was recently published by one of us (Leplongeon 2017). Blank production was oriented towards making short elongated products, frequently using a volumetric conception of debitage. Contrary to E71K18C, striking platforms were simply prepared and the convexities of the flaking surface were maintained through the removal of numerous core trimming elements. Blanks were transformed into both microlithic and macrolithic retouched tools, including distal truncations, but lack the microlithic geometric component of E71K18C.

These industries are thought to be broadly contemporaneous with the Early and Middle Epipalaeolithic of the Negev, although the absence of dates directly associated with the occupations at E71K18 and E71K20, as well as the different models existing for the Nile during the LGM, make their stratigraphic and chronological contexts debatable (Close *et al.* 1979; Wendorf & Schild 1976; Schild & Wendorf 2010; and see discussions in Leplongeon 2017). However, both sites are located among the northernmost ones known along the Nile Valley, with their assemblages available for study. Both are blade(let) industries with microliths and the use of the microburin technique. They can thus be used for preliminary comparative analyses to test hypotheses of terminal Pleistocene contacts between the southern Levant and the Nile Valley.

## 4. Methods

### 4.1. Lithic analysis and sampling method

Methods used for the analysis rely on the *chaîne opératoire* approach, combined with an attribute analysis in order to best characterise each assemblage (qualitatively and quantitatively) for detailed comparative analyses. Previous studies demonstrated that all assemblages are oriented towards elongated blank production and that the main *chaînes opératoires* are dedicated to microlith production. Analysis is based on representative ‘stratified sampling’ (Table 3). Each assemblage was divided into ‘subpopulations’, *i.e.*, broad categories (cores, core trimming elements (CTE), elongated blanks, retouched tools) and complete pieces from each of these categories were randomly sampled. It did not include refitted items. One main bias relates to the use of stratified sampling; however, the aim herein is not to compare proportions between categories but rather characteristics within each category. Stratified sampling is therefore an advantage rather than an impediment.

Table 3. Studied samples. Abbreviations: CTE - core trimming element.

Site	Cores	Elongated and CTE's	Microburins	Retouched tools	Total
Azariq XIII	12	248	0	210	470
Azariq IV	8	184	0	109	301
Hamifgash IV	10	158	92	118	378
Azariq XVI	12	167	0	220	399
Azariq XII	19	174	83	116	392
Shunera XXI	6	133	107	107	353

Elongated blanks are here defined as any blank with a length:width ratio of at least 2. K-means cluster analysis (Pargeter & Pargeter 2016; Pargeter & Redondo 2016) was used to distinguish large elongated blanks (or blades) from small elongated blanks (bladelets) in the assemblages. Inter-assemblage differences were quantified using non-parametric statistical



tests, enabling analysis of non-normally distributed variables, such as Kruskal-Wallis test and post-hoc Dunn's test (Dunn 1964; Carlson 2017: 182). All statistical tests have been performed with R, R Studio and the graphs have been generated using the ggplot2 package (R Core Team 2016; RStudio Team 2015; Wickham 2009). A list and description of the variables recorded as well as the full database are presented in Supplementary Information (SI) 1 and 2. Table 3 shows the sample studied.

#### 4.2. Limitations of the study

This paper attempts to characterise lithic variability, between 25ka and 15ka, at the intra-regional scale (within the western Negev) and at the inter-regional scale (between the Negev and Upper Egypt), based on study of six assemblages from the Negev and two from the Nile Valley.

Interpretation of the results must take into account several caveats: firstly, the sample includes only one site per socio-cultural entity. It assumes that each assemblage is representative of that entity and that intra-entity variability is not apparent in the sample, although considerable intra-entity variability has been demonstrated by previous studies (Goring-Morris 1987; Marder 2002). Secondly, this analysis occurred after a major refitting programme. The artefacts analysed here are therefore, for the major part, not those that were refitted. The third relates to the different contexts of the Negev and the Nile Valley sites. In addition to the distance between the two group of sites (>800 km via the Nile Delta), while the Negev sites probably represent short-term occupations, the Nile Valley sites are probably the result of multiple occupations, which may have occurred over longer periods of time. Poor chronological control of the sites from the Nile Valley prevents any discussion of the direction of potential movements of technical diffusion (out-of or back-into Africa). Additionally, the type of material analysed (lithics) renders it difficult to distinguish between transmission of a behavioural trait with or without actual population movements, *i.e.*, with or without gene flow (*e.g.*, Premo & Tostevin 2016; Tostevin 2012). Results of the comparative analysis therefore enables us to discuss only hypothetical contacts (direct or indirect), or convergence between the two areas. In addition, this period is characterised by the development of style in lithic assemblages, at least in the EP of the Levant (Goring-Morris & Belfer-Cohen 1997), which has been interpreted to reflect increased territoriality. In this context, it is thus expected that we find marked typological differences between geographical areas. Hypothetical evidence for contacts would thus mainly consist of technological similarities.

While these limitations need to be clearly stated, in the absence of other data (sites closer to each other and more precise chronological resolution), we believe that the present comparative analysis may be considered as a first systematic attempt to investigate possible transmissions in technical behaviours between the Nile Valley and the southern Levant during the terminal Pleistocene.

### 5. Results

#### 5.1. General characteristics of cores, core trimming elements and elongated blanks

In all sites except Azariq XVI (Geometric Kebaran), most cores have a single platform with unidirectional debitage (Table 4). Cores from all sites display plain striking platforms (usually with abrasion of removal surfaces). In terms of volumetric conception, Azariq XIII (Masraqa) distinguishes itself from the other sites by the dominance of convergent N-fronted cores. Although they are present also at Azariq IV (Kebaran) and Hamifgash IV (Nizzanan), both Early Epipalaeolithic sites, they are less numerous.

Table 4. Characteristics of platform cores from sites studied.

Site	Single	Two opposed		Two non-opposed	Multiple		Total
		Bidirectional	Unidirectional successive		2 knapping surfaces	3 knapping surfaces	
<b>Az XIII</b>	<b>8</b>			<b>1</b>			<b>9</b>
<i>Cobble</i>	2						2
<i>Flake or split</i>	6			1			7
<b>Az IV</b>	<b>6</b>	<b>1</b>		<b>2</b>			<b>9</b>
<i>Cobble</i>	4	1		2			7
<i>Flake or split</i>	2						2
<b>Ham IV</b>	<b>8</b>		<b>1</b>			<b>1</b>	<b>10</b>
<i>Cobble</i>	6		1			1	8
<i>Flake or split</i>	2						2
<b>Az XVI</b>	<b>6</b>	<b>4</b>	<b>1</b>				<b>11</b>
<i>Cobble</i>	5	2	1				8
<i>Flake or split</i>	1	2					3
<b>Az XII</b>	<b>7</b>	<b>2</b>	<b>3</b>	<b>5</b>		<b>1</b>	<b>18</b>
<i>Cobble</i>	7	2	3	5		1	18
<b>Sh XXI</b>	<b>15</b>	<b>2</b>		<b>3</b>		<b>1</b>	<b>21</b>
<i>Cobble</i>	9	2		2		1	14
<i>Flake or split</i>	6			1			7
<b>Total</b>	<b>50</b>	<b>9</b>	<b>5</b>	<b>11</b>		<b>2</b>	<b>78</b>

Despite these differences, there is no significant difference in the dimensions of the cores (Table 5).

Table 5. Metrics for the cores of the sites studied (in mm). Abbreviations: sd - standard deviation.

Site	count	mean length (L)	sd (L)	mean width (W)	sd (W)
Azariq XIII	5	37.8	13.2	26.0	5.4
Azariq IV	9	44.1	7.3	35.3	15.6
Hamifgash IV	10	42.1	12.6	35.0	4.8
Azariq XVI	10	45.2	9.2	41.1	8.9
Azariq XII	16	41.1	9.5	35.0	6.7
Shunera XXI	21	36.6	6.8	33.7	7.9

Core trimming elements indicate platform management through the removal of core tablets or platform blades. Convexities of the debitage volume are mainly maintained by the removal of overpassed blanks or crested products rather than by side-core products. Overpassed products tend to be more numerous in assemblages with a higher frequency of two or more platform cores, *i.e.*, Middle Epipalaeolithic assemblages of Azariq XII, Azariq XVI and Shunera XXI.

Results of the cluster analysis to distinguish blades from bladelets are consistent with previous studies and core dimensions: most assemblages were mainly oriented towards the production of bladelets.

The use of two distinct raw material categories is only present at Shunera XXI - flint (n=100) and chalcedony (n=10). Although elongated blanks on chalcedony appear slightly smaller (mean = 29.4 mm, sd=3.5) and narrower (mean=9.5 mm, sd =2.8), compared to elongated blanks on flint (respectively mean length = 32.7 mm, sd=8.9; mean width = 11.6, sd

=4.3), the differences are not significant and elongated blanks from both raw materials were lumped together.

Inter-site comparisons (see Figure 8 and Table 6) demonstrate that Azariq XIII (Masraqan) distinguishes itself from all other assemblages with much narrower elongate blanks (mean width = 7.9 mm, sd=2.6; mean length:width ratio = 4.3, sd=1.2; and mean width ranging from 11.5 to 13.5 mm, and mean length:width ratio ranging from 3 to 3.2). Elongated blanks from Shunera XXI also stand apart from the other sites by being significantly smaller than at other Middle Epipalaeolithic sites (Azariq XVI and Azariq XII), and thinner than all other EP sites. When only the smaller elongated blanks are considered, the metric differences between Azariq XIII and the other sites are still significant, while it is more nuanced for Shunera XXI (see Table 7).

Table 6 - Main statistics for elongated blanks. Abbreviations: L - Length, W - Width, T - Thickness, sd - standard deviation.

Dimensions (mm)	Elongated - all					Bladelets only				
	L	W	T	L/W	W/T	L	W	T	L/W	W/T
<b>Azariq XIII</b>	N=84					N=68				
<i>mean</i>	32.3	7.9	2.7	4.3	3.1	29.2	7.3	2.5	4.2	3.1
<i>sd</i>	8.3	2.6	0.9	1.2	0.9	4.7	1.7	0.7	1.2	1
<i>Min</i>	17.8	3.6	1.2	2.2	1.3	17.8	3.6	1.2	2.2	1.3
<i>Max</i>	67.7	18.6	6.8	8.1	6.1	37.1	12.4	4.5	8.1	6.1
<b>Azariq IV</b>	N=80					N=63				
<i>mean</i>	36.6	12.1	4.7	3.1	2.9	31.2	10.3	3.8	3.1	3
<i>sd</i>	13.1	5	2.7	0.7	0.9	6.8	2.6	1.5	0.7	0.9
<i>Min</i>	16.3	5.5	1.2	2.1	1	16.3	5.5	1.2	2.1	1.6
<i>Max</i>	82.3	32.4	16.9	5.8	4.9	43.4	15.9	7.6	5.8	4.9
<b>Hamifgash IV</b>	N=60					N=28				
<i>mean</i>	37.2	12.4	5.2	3.2	2.9	27.1	9.6	3.5	2.9	3.2
<i>sd</i>	11.3	4.5	3.2	1.1	1.2	5.2	2.4	1.7	0.8	1.2
<i>Min</i>	17.4	4.9	1.2	2	0.7	17.4	4.9	1.2	2	1
<i>Max</i>	67	23.2	18	6.4	5.3	33.9	15.2	8.2	5.1	5.2
<b>Azariq XVI</b>	N=153					N=98				
<i>mean</i>	39.4	13.5	4.2	3.1	3.7	32.1	11	3.5	3.1	3.7
<i>sd</i>	12	4.9	2.3	0.8	1.3	6	3.2	1.9	0.8	1.3
<i>Min</i>	18.4	5.1	1	2	0.7	18.4	5.1	1	2	0.7
<i>Max</i>	73.1	28.6	10.7	6.9	7.7	43	18.2	10.4	6.9	7.7
<b>Azariq XII</b>	N=139					N=72				
<i>mean</i>	40.1	13.3	4	3.1	3.8	31.4	10.4	2.8	3.1	4.1
<i>sd</i>	11	4.2	2	0.6	1.3	4.7	2.4	1.1	0.5	1.3
<i>Min</i>	21.4	5.8	1.2	2.1	1.4	21.4	5.8	1.2	2.1	2.1
<i>Max</i>	77	22.6	13.6	6.5	9.1	40	16.9	6.4	4.5	9.1
<b>Shunera XXI</b>	N=120					N=96				
<i>mean</i>	32.4	11.4	3.3	3	3.9	29	10	2.7	3.1	4
<i>sd</i>	8.5	4.1	2	0.7	1.2	4.4	2.8	1.3	0.7	1.2
<i>Min</i>	20.7	5	1.3	2	1.2	20.7	5	1.3	2	1.7
<i>Max</i>	70.6	24	12.5	5.2	7.1	37.7	16.5	8	5.2	7.1

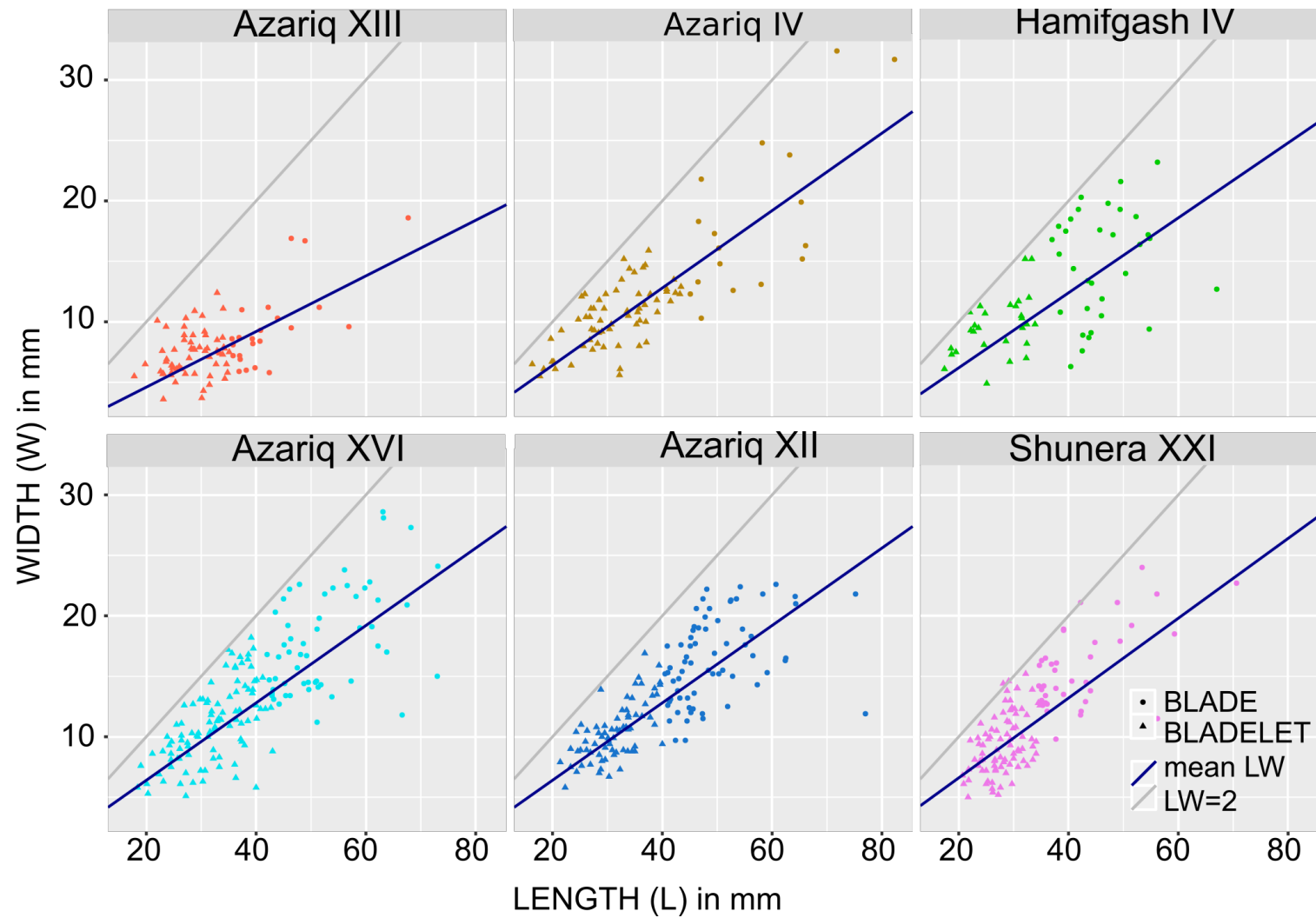


Figure 8. Biplot of length and width of complete elongated blanks.

Table 7. Results of Kruskal-Wallis tests and post-hoc Dunn's test (Carlson 2017: 182; Dunn 1964) for the comparisons of dimensions of elongated blanks between sites. Abbreviations: \*\* p-value < .01; Az - Azariq; Shun - Shunera; Ham - Hamifgash.

	Elongated (all)			Bladelets only		
	K-W Chi-square	P-value	Dunn's test	K-W Chi-square	P-value	Dunn's test
Length (L)	59.2	**	Significant only between: AzXIII & AzXII, ShunXXI, AzXVI & AzXII, ShunXXI & AzXVI	44.7	**	Significant only between: AzXVI & all but AzXII; AzXII & all but AzXVI; AzIV & ShunXXI
Width (W)	118.6	**	Significant only between: AzXIII and all others, ShunXXI & AzXII, AzXVI	74.6	**	Significant only between: AzXIII & all; AzXVI & ShunXXI
Thickness (T)	69.7	**	Significant only between: AzXIII & all but ShunXXI; ShunXXI & all but AzXIII	53.9	**	Significant only between: AzIV & AzXII, AzXIII, ShunXXI; AzXVI & AzXIII, ShunXXI; HamIV & ShunXXI
L/W	91.9	**	Significant only between: AzXIII & all others	56.5	**	Significant only between: AzXIII & all others
W/T	59.86	**	Significant for most of all, except between: AzIV & AzXIII, HamIV; AzXII & AzXVI, ShunXXI; AzXIII & HamIV, AzXVI & ShunXXI	48.9	**	Significant only between AzXIII & ShunXXI, AzXII; Az IV & AzXII, AzXVI, ShunXXI

## 5.2. Direction of core reduction, platform management and dorsal surface convexity

Complete and almost complete elongated blanks have a mean number of scar removals ranging from 4 to 5 at all sites (Table 8). They mainly display a unidirectional dorsal scar pattern. However, some significant differences are observed between the sites. In particular, Azariq XIII, Hamifgash IV and Shunera XXI have the highest frequencies of unidirectional dorsal scar patterns (72-80% against 65-70% for the other assemblages), while Azariq XVI shows the highest frequency of bidirectional scars (14% against <12% at the other sites) (Figure 9). When investigating the link between the scar patterns and dimensions of elongated blanks, there is a significant difference only at Shunera XXI between elongated blanks with unidirectional and bidirectional scar patterns, suggesting that, although few, larger bidirectional blanks (N=12, mean = 37.4 mm, sd = 8.1) were produced in earlier stages of the reduction sequences than unidirectional blanks (N=93, mean = 31.3 mm, sd = 7.9). This would explain why most of the cores are single platform cores.

Characteristics of the proximal parts of all elongated blanks display mainly plain platforms at Hamifgash IV and Azariq IV (68-72%) and linear or punctiform types at the other sites (56-70%) (Table 9). In addition, while abrasion of the platform seems to be systematic at Azariq XIII, Azariq XII and Shunera XXI (>75%), it is less frequent at Hamifgash IV, Azariq IV and Azariq XVI (20-59%). In all assemblages except Azariq IV, bulbs are mainly not to slightly salient. Experiments have demonstrated that there is no direct correlation between one attribute (such as the salience of the bulb or the presence / absence of a lip) and a specific percussion technique. However, the quantification of a combination of attributes may help to indicate predominant use of a specific technique (Tixier, 1982; Pèlerin 2000). Overall, the characteristics of the proximal parts of elongated blanks may imply the use of a soft stone hammer at Azariq XIII, while a harder hammerstone could have been used

at Azariq IV and Hamifgash IV. Although patterns are less clear for the other sites, a soft stone hammer also may be suggested (and see Marder 2002, chapter V). Detailed experiments would be necessary to confirm this.

Table 8. Number of dorsal scars and types of scar pattern of the elongated blanks. In bold: values with the highest (positive or negative) residuals of the Chi2 test (<1.2 or >1.2). Az - Azariq; Shun - Shunera; Ham - Hamifgash.

		<b>Az XIII</b> <b>(n= 140)</b>	<b>Az IV</b> <b>(n=109)</b>	<b>Ham IV</b> <b>(n=96)</b>	<b>Az XVI</b> <b>(n=153)</b>	<b>Az XII</b> <b>(n=141)</b>	<b>Shun XXI</b> <b>(n=120)</b>
nb dorsal scars	mean	4.8	5.1	3.9	5	4.5	4.7
	<i>sd</i>	<b>1.9</b>	<b>2.1</b>	<b>1.6</b>	<b>1.9</b>	<b>1.6</b>	<b>1.7</b>
Bidirectional	N	4	13	6	21	16	12
	%	<b>2.90%</b>	<b>11.90%</b>	<b>6.30%</b>	<b>13.70%</b>	<b>11.30%</b>	<b>10.00%</b>
Centripetal	N	0	2	0	4	5	1
	%	<b>0.00%</b>	<b>1.80%</b>	<b>0.00%</b>	<b>2.60%</b>	<b>3.50%</b>	<b>0.80%</b>
Unidirectional	N	111	71	69	101	100	93
	%	<b>80.40%</b>	<b>65.10%</b>	<b>71.90%</b>	<b>66.00%</b>	<b>70.90%</b>	<b>77.50%</b>
Unidirectional & lateral	N	22	19	20	24	20	14
	%	<b>15.90%</b>	<b>17.40%</b>	<b>20.80%</b>	<b>15.70%</b>	<b>14.00%</b>	<b>11.70%</b>
One direction	N	1	4	1	3	0	0
	%	<b>0.70%</b>	<b>3.70%</b>	<b>1.00%</b>	<b>2.00%</b>	<b>0.00%</b>	<b>0.00%</b>

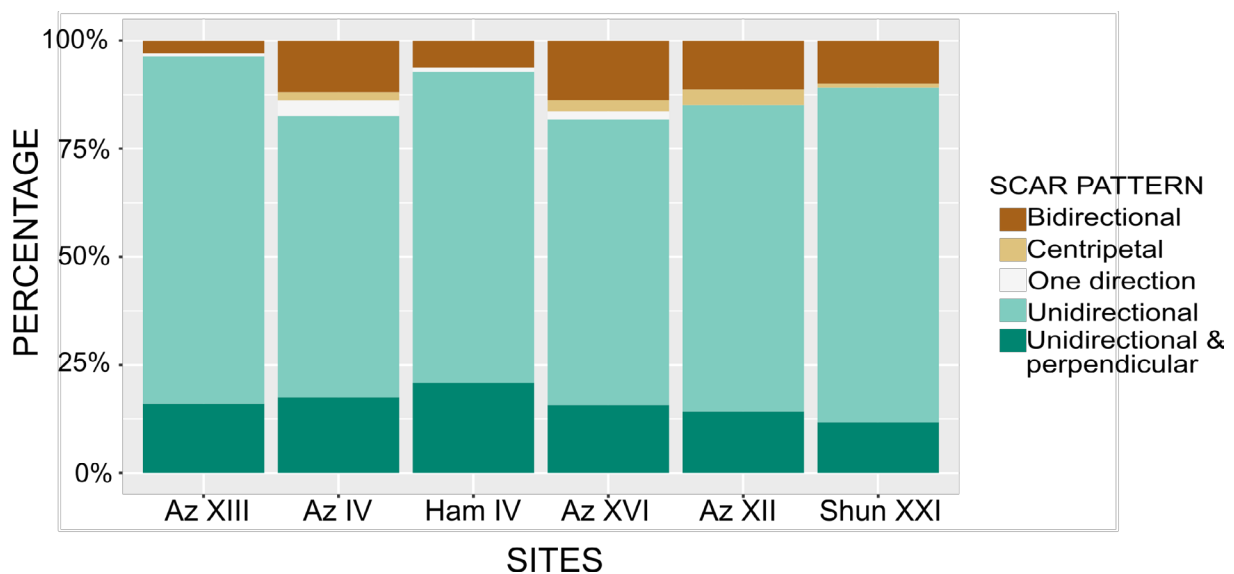


Figure 9. Relative percentages of scar patterns. Az - Azariq; Shun - Shunera; Ham - Hamifgash.

The general morphological characteristics of elongated blanks display high percentages of distally convergent blanks in all sites (33-46%), especially marked at Shunera XXI (46%). Azariq XIII has the highest frequency of regular parallel blanks (23%, against 5-14% at the other sites). Curved to very curved blank profiles dominate at all sites, although there is a higher percentage of curved blanks at Azariq XIII, as opposed to flat blanks at Hamifgash IV and Azariq IV. Distal terminations are usually feathered, particularly at Azariq XIII (~80%), although higher percentages of hinged blanks are observed at Hamifgash IV, Azariq IV and Azariq XVI (8-12%), which may indicate the at least occasional use of a hard hammerstone (Table 10).

Table 9. Main characteristics of the proximal parts of elongated blanks. In bold: values with the highest residuals of the Chi2 test. Az - Azariq; Shun - Shunera; Ham - Hamifgash.

		Az XIII		Az IV		Ham IV		Az XVI		Az XII		Shun XXI	
<b>Platform types</b>		<b>N=128</b>		<b>N=93</b>		<b>N=80</b>		<b>N=134</b>		<b>N=128</b>		<b>N=115</b>	
plain		38	<b>29.7%</b>	67	72.0%	54	<b>67.5%</b>	59	44.0%	37	<b>28.9%</b>	45	39.1%
faceted or dihedral		0	0.0%	4	<b>4.3%</b>	0	0.0%	0	0.0%	1	0.8%	0	0.0%
linear or punctiform		89	69.5%	22	<b>23.7%</b>	23	28.8%	75	56.0%	90	70.3%	68	59.1%
cortical		1	0.8%	0	0.0%	3	3.7%	0	0.0%	0	0.0%	2	1.7%
<b>Abrasion (presence of)</b>		105	<b>82.0%</b>	39	41.9%	17	21.3%	80	59.7%	96	<b>75.0%</b>	94	<b>81.7%</b>
<b>Platform Measurements (mm)</b>		<b>N=38</b>		<b>N=66</b>		<b>N=53</b>		<b>N=59</b>		<b>N=37</b>		<b>N=45</b>	
platform breadth (ptf.B)	mean	3.2		4.6		5.1		5.5		5.7		5.1	
	<i>sd</i>	2.1		2.2		3.6		3		2.4		2	
platform thickness (ptf.T)	mean	1.1		1.7		2.2		1.9		2.1		1.7	
	<i>sd</i>	0.7		0.8		2		1.2		1.4		1	
ptf.B / blank width	mean	0.4		0.4		0.4		0.4		0.4		0.4	
	<i>sd</i>	0.2		0.1		0.2		0.2		0.2		0.2	
ptf.T / blank thickness	mean	0.4		0.4		0.4		0.5		0.5		0.5	
	<i>sd</i>	0.2		0.1		0.2		0.2		0.3		0.2	
<b>Types of bulb</b>		<b>N=128</b>		<b>N=93</b>		<b>N=80</b>		<b>N=134</b>		<b>N=128</b>		<b>N=115</b>	
not to slightly salient		73	<b>57.0%</b>	25	26.9%	34	42.5%	69	51.5%	56	43.8%	57	50.0%
salient		43	33.6%	44	<b>47.3%</b>	35	43.8%	49	36.6%	60	46.9%	53	46.0%
very salient		5	3.9%	13	14.0%	3	3.8%	9	6.7%	2	<b>1.6%</b>	1	<b>0.9%</b>
Deformed or broken		7	5.5%	11	<b>11.8%</b>	8	10.0%	7	5.2%	10	7.8%	4	3.5%

Table 10. Comparisons between sites of main characteristics of elongated blanks. Significant differences are observed between the sites (Chi2 with simulate p-value). **Highlighted** values which have highest (positive or negative) residuals. Az - Azariq; Shun - Shunera; Ham - Hamifgash.

		Az XIII	Az IV	Ham IV	Az XVI	Az XII	Shun XXI
Morphology of edges	Number	N=131	N=107	N=92	N=151	N=140	N=115
	Parallel	N 30 % <b>22.90%</b>	15 14.00%	13 14.10%	17 11.30%	9 <b>6.40%</b>	6 <b>5.20%</b>
	Rounded	N 24 % 18.30%	28 26.20%	30 32.60%	57 <b>37.70%</b>	47 33.60%	30 26.10%
	Parallel-rounded	N 24 % 18.30%	20 18.70%	8 <b>8.70%</b>	19 12.60%	26 18.60%	17 14.80%
	Distally convergent	N 49 % 37.40%	38 35.50%	33 35.90%	50 33.10%	52 37.10%	53 <b>46.10%</b>
	Divergent	N 0 % <b>0.00%</b>	4 3.70%	6 <b>6.50%</b>	7 4.60%	4 2.90%	5 4.30%
	Irregular	N 4 % 3.10%	2 1.90%	2 2.20%	1 0.70%	2 1.40%	4 3.50%
	Curvature of longitudinal Profile	Number	N=138	N=109	N=96	N=153	N=141
Flat	N 9 % <b>6.50%</b>	24 <b>22.00%</b>	17 <b>18.50%</b>	16 10.50%	11 <b>7.80%</b>	15 12.50%	
Slightly curved	N 53 % 38.40%	39 35.80%	30 31.30%	47 30.70%	52 36.90%	43 35.80%	
Curved	N 59 % <b>42.80%</b>	25 22.90%	30 31.30%	54 35.30%	53 37.60%	41 34.20%	
Very curved	N 9 % <b>6.50%</b>	14 12.80%	12 12.50%	25 <b>16.30%</b>	17 12.10%	12 10.00%	
S	N 8 % 5.80%	7 6.40%	7 7.30%	11 7.20%	8 5.70%	9 7.50%	
Lateral Profile	Number	N=138	N=109	N=96	N=153	N=141	N=120
	Flat	N 111 % 80.40%	91 83.50%	69 71.90%	132 86.30%	125 88.70%	102 85.00%
	Slightly to twisted	N 27 % 19.60%	18 16.50%	27 <b>28.10%</b>	21 13.70%	16 <b>11.30%</b>	18 15.00%
Distal Termination	Number	N=142	N=115	N=106	N=153	N=141	N=120
	Feathered	N 114 % <b>80.30%</b>	73 63.50%	67 63.20%	88 <b>57.50%</b>	95 67.40%	86 71.70%
	Hinged	N 2 % 1.40%	10 <b>8.70%</b>	6 5.70%	5 3.30%	1 <b>0.70%</b>	2 1.70%
	Overpassed	N 6 % <b>4.20%</b>	11 9.60%	9 8.50%	19 <b>12.40%</b>	16 11.30%	10 8.30%
	Slightly hinged	N 0 % 0.00%	3 2.60%	13 <b>12.20%</b>	13 <b>8.50%</b>	5 3.50%	5 4.20%
	Slightly overpassed	N 19 % 13.40%	18 15.70%	10 9.40%	26 17.00%	22 15.60%	16 13.30%
	Step	N 1 % 0.70%	0 0.00%	1 0.90%	2 1.30%	2 1.40%	1 0.80%



### 5.3. Use of the microburin technique

The assemblages may be divided into two groups according to the systematic use of the microburin technique (see Tables 1 and 11). It is habitual at Hamifgash IV, Azariq XII and Shunera XXI, with relatively high microburin indices (see Table 11).

Table 11. Number of microburins and microburin indices (After Goring-Morris 1987). Abbreviations: \* Mostly Krukowski microburins. Imbt = Microburin index; Imbtr = restricted microburin index (Henry 1974).

Site	Nb microburins	Imbt	Imbtr
Azariq XIII	-	-	-
Azariq IV	1	-	-
Hamifgash IV	275	48.6	57.7
Azariq XVI	46*	3.7	4.6
Azariq XII	358	21.2	26
Shunera XXI	604	35.1	62.2

Proximal and distal microburins are almost equally represented at Hamifgash IV and Azariq XII, while mostly distal microburins are present at Shunera XXI (see Goring-Morris 1987). Proximal microburins are significantly longer at Hamifgash IV (mean length=18.4, sd=6.3) than at the other sites (mean length between 12 and 13.4 mm), while distal microburins, and in general all types of microburins are smaller at Azariq XII (mean length dist = 14.1 mm, sd=2.9; compared to mean length between 17.3 and 18.8 mm) than at the other sites (see Table 12).

Table 12. Main dimensions of microburins

Site	Segment	count	length (L) -		width (W) -		Thickness (T)	
			mean	L - sd	mean	W - sd	- mean	T - sd
Azariq XII	DIST	33	14.05	2.92	7.7	2.32	2.5	0.8
Hamifgash IV	DIST	32	18.76	6.08	8.06	2.52	2.47	0.59
Shunera XXI	DIST	92	17.3	5.63	9.05	2.72	2.68	1.13
Azariq XII	MES	6	10.48	2.46	8.12	1.34	1.95	0.5
Hamifgash IV	MES	13	14.4	4.53	10.04	4.15	2.46	0.72
Azariq XII	PROX	44	13.36	3.94	9.11	2.22	2.71	0.52
Hamifgash IV	PROX	47	18.36	6.34	9.84	2.37	2.94	0.73
Shunera XXI	PROX	15	11.97	4.05	8.75	3.09	2.62	0.61

In comparing the dimensions of microburins with those of elongated blanks, microburins are significantly narrower and thinner in all cases but one (p-value <.01, Wilcoxon Mann-Whitney test, Figure 10), indicating that the elongated blanks chosen for manufacture into retouched tools were in fact smaller than those left 'intact'.

As expected, microburins are much wider than retouched bladelets, while relative thickness does not show any specific pattern (Figure 11).

These results seem to indicate that the blanks selected to be retouched may not have the same characteristics as the complete elongated blanks found in the assemblages, so that interpretation of their characteristics must take that into account (Goring-Morris 1987: 372).

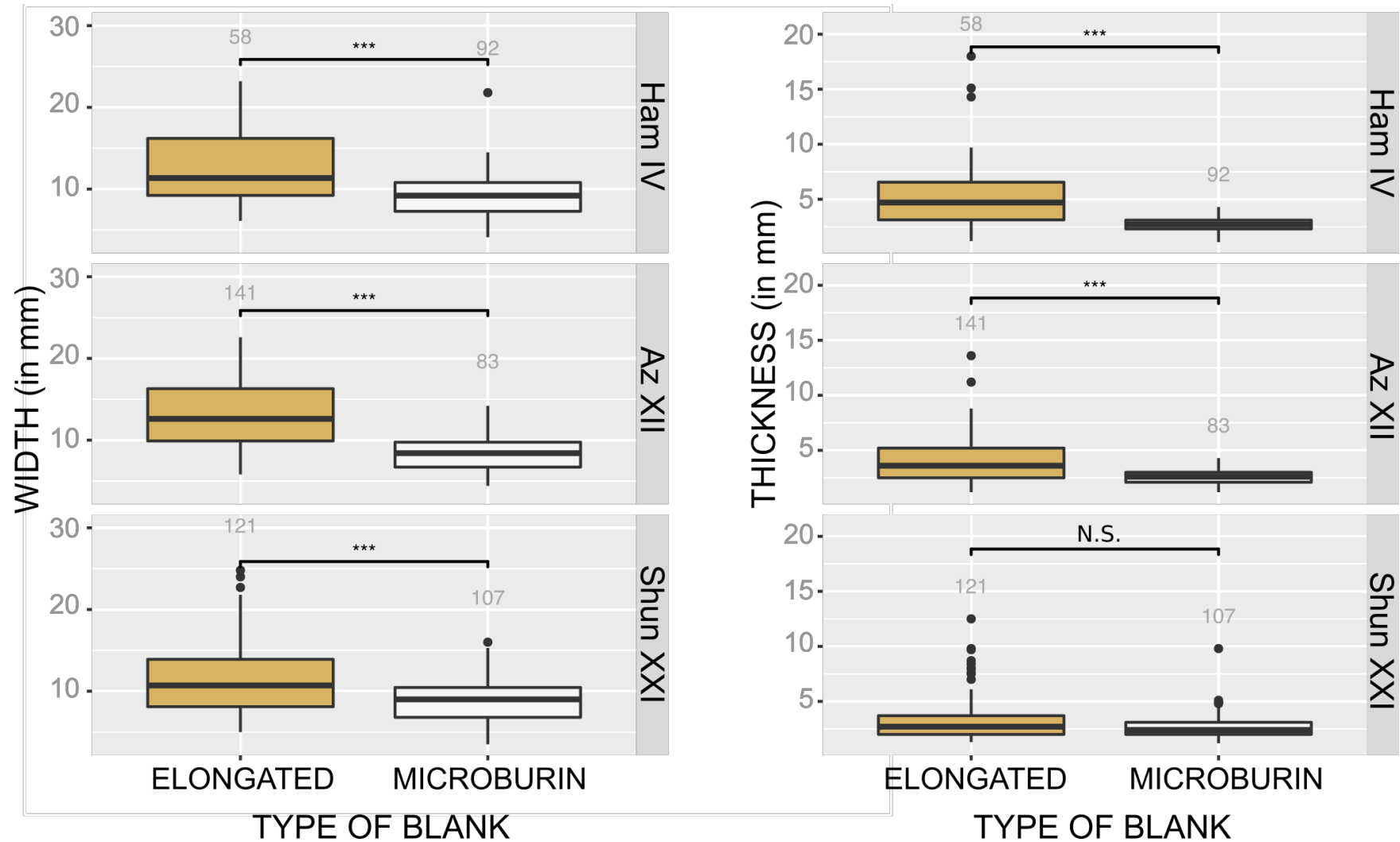


Figure 10. Comparisons of width and thickness of microburins and elongated blanks at Hamifgash IV, Azariq XII and Shunera XXI. Az - Azariq; Shun - Shunera; Ham - Hamifgash.

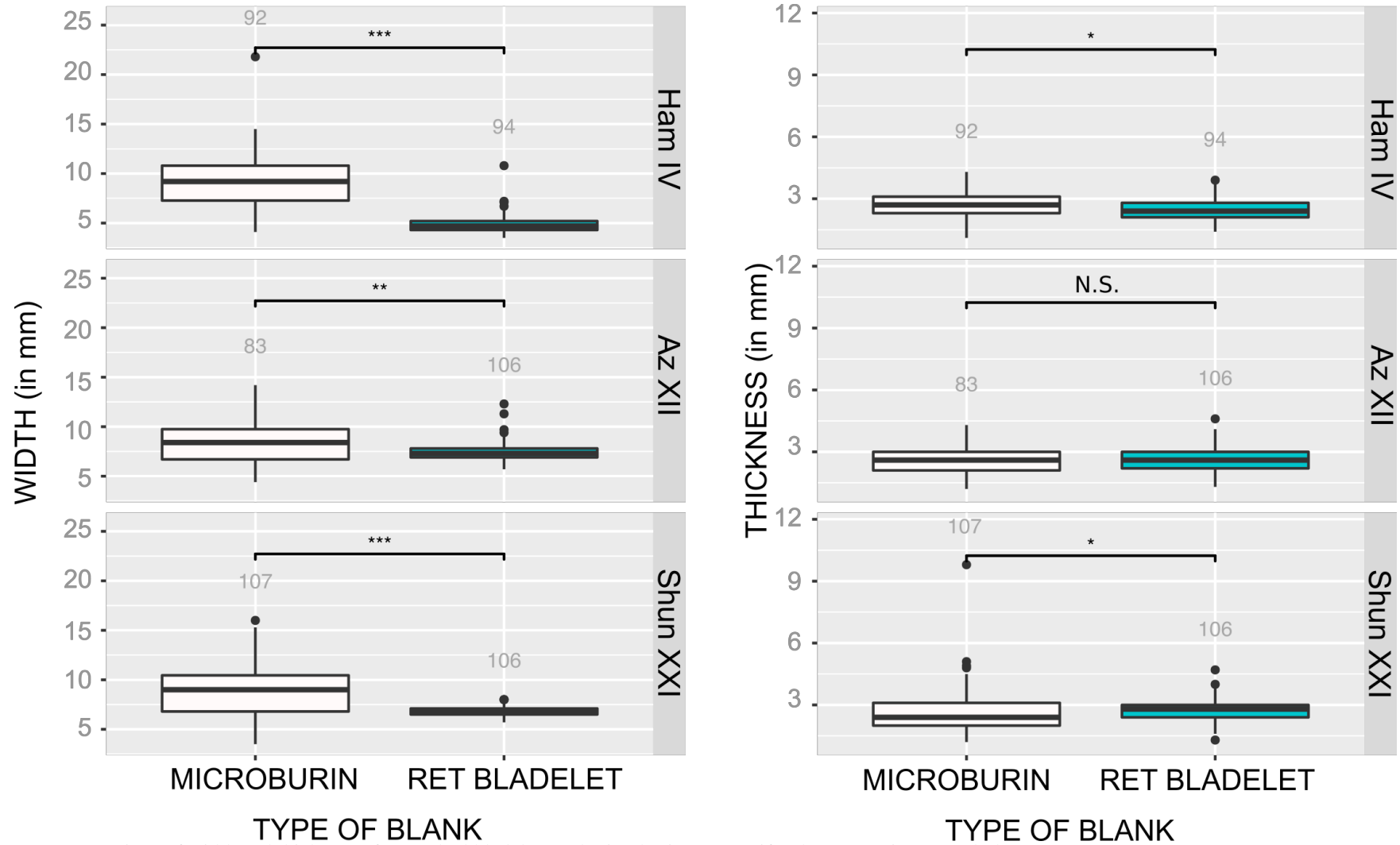


Figure 11. Comparison of width and thickness of retouched bladelets and microburins at Hamifgash IV, Azariq XII and Shunera XXI.

#### 5.4. Characteristics of retouched tools

Retouched tools are numerous (11-24% of the assemblages, excluding debris) within all assemblages (Goring-Morris 1987). The majority are microliths (83-95%). Except at Azariq XIII, where fine (Ouchtata) retouch dominates, at all other sites, backing predominates, whether or not in conjunction with the microburin technique: finely retouched bladelets at Azariq XIII, micropoints at Azariq IV, scalene and arch-backed bladelets at Hamifgash IV and Azariq XII, trapeze and rectangles at Azariq XVI, and Ramon points (straight or slightly concave backed and obliquely truncated) at Shunera XXI (Goring-Morris 1987; Marder 2002).

Most of the retouched bladelets from Azariq XIII are fragmented, making metric comparisons with other assemblages difficult. However, the dimensions of almost complete blanks were recorded following several intervals that allowed their approximate comparisons with retouched blanks from other assemblages (see Figure 12). Retouched blanks from Azariq XIII are conspicuous in comparison to the retouched blanks from the other sites by being much narrower and more slender.

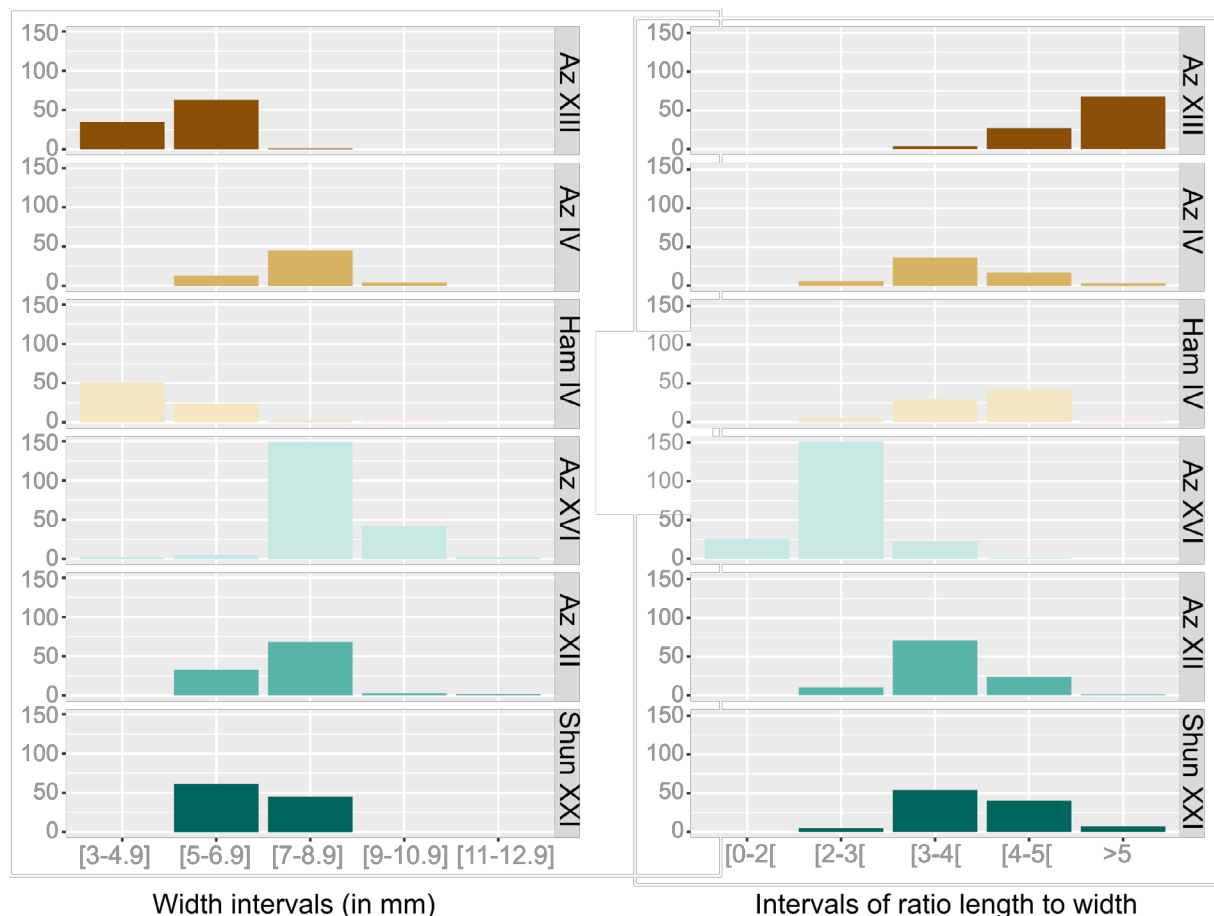


Figure 12. Comparisons of dimensions of retouched bladelets. Az - Azariq; Shun - Shunera; Ham - Hamifgash.

Microliths from the different assemblages display distinct dimensions (see Table 13 and Figure 13). The distributions of the widths is different for all assemblages except between Azariq XII and Azariq IV (Kruskal-Wallis chi-square = 313.51, df = 4, p-value < 2.2e-16, followed by p-values <.05 for the Dunn's test). However, this may reflect site-specific characteristics rather than reflecting any particular entity. Microlith dimensions from many assemblages associated with the same entity usually display significant variability (Goring-Morris 1987). However, perhaps more significant, despite this variation in dimensions, the

widths in all assemblages show a small coefficient of variation (from 7% at Shunera XXI to 20% at Hamifgash IV), indicating that control of the width was probably the most important variable in the manufacture of microliths, likely related to hafting considerations.

Table 13. Main statistics for complete microliths. Abbreviations: CV = coefficient of variation = sd/mean\*100

Site	Count	Length (L) - mean	L sd	CV* (L)	Width (W) - mean	W sd	CV (W)	Thickness (T) - mean	T sd	L/W mean	L/W sd
Azariq IV	26	29.21	3.9	13.40%	7.63	0.96	12.60%	3.31	0.93	3.89	0.71
Azariq XII	106	26.97	3.17	11.80%	7.47	0.95	12.70%	2.64	0.58	3.65	0.54
Azariq XVI	200	19.61	4.51	23.00%	8.35	0.96	11.50%	2.62	0.6	2.35	0.5
Hamifgash IV	72	19.1	2.21	11.60%	4.86	0.98	20.20%	2.45	0.43	4	0.53
Shunera XXI	106	26.58	4.35	16.40%	6.81	0.52	7.60%	2.75	0.58	3.91	0.64

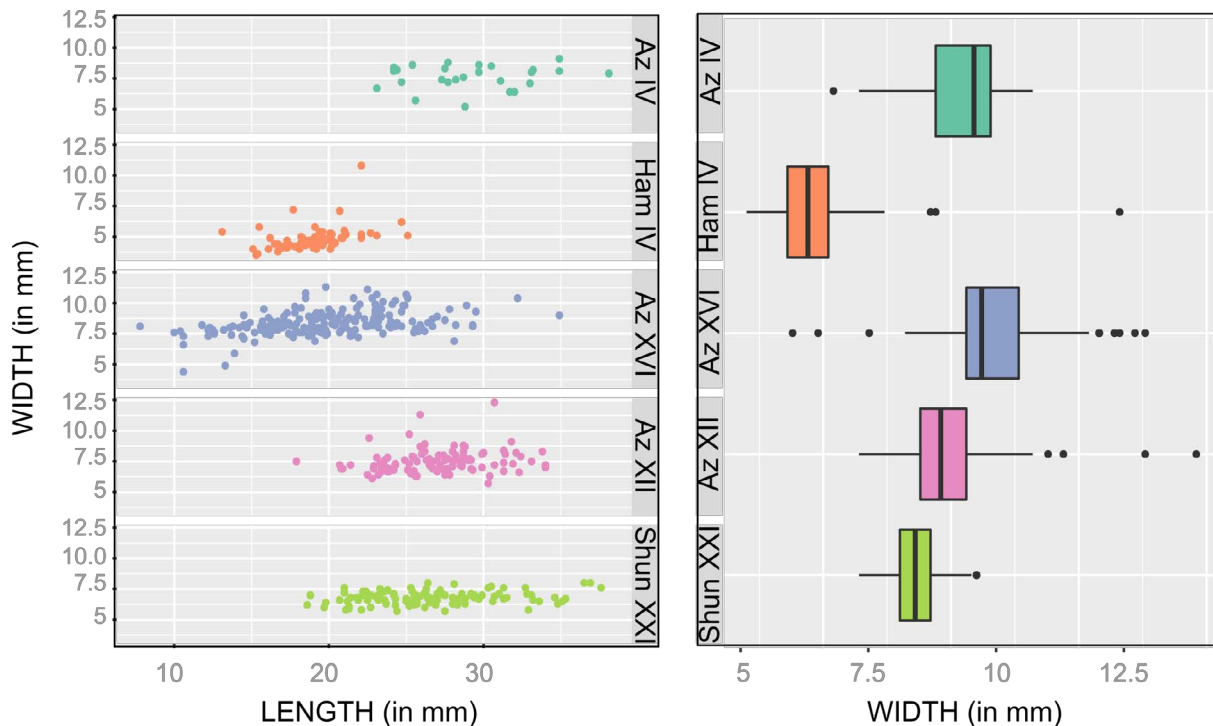


Figure 13. Biplot of lengths and widths and boxplot of widths of complete retouched bladelets. Az - Azariq; Shun - Shunera; Ham - Hamifgash.

Characteristics of the proximal parts enable division of the microlith assemblages into two groups: one includes more or less systematic removal of the platform and bulb (Hamifgash IV, Azariq XVI and Azariq XII, respectively 89%, 95% and 78% of the microliths), as opposed to those with less removal of the proximal extremities (Azariq XIII, Azariq IV and Shunera XXI, respectively 8%, 33% and 14%).

## 6. Discussion

Table 14 summarises the characteristics of the different assemblages studied.

Table 14. Main characteristics of the lithic assemblages studied. Abbreviations: F - flint, local sources; C - chalcedony, more distant sources; CTE - core trimming element; B - blades; Bt - bladelets; sd - standard deviation;

	<b>Azariq XIII</b>	<b>Azariq IV</b>	<b>Hamifgash IV</b>	<b>Azariq XVI</b>	<b>Azariq XII</b>	<b>Shunera XXI</b>
<b>Cultural entity</b> (years cal. BP)	Masraqan (24,000-19,000)	Kebaran (21,000-18,000)	Nizzanan (20,000-18,000)	Geometric Kebaran (17,500-14,500)	Mushabian (17,000-14,500 k)	Ramonian (16,000-15,000)
<b>Raw material</b> (flint, chalcedony)	F	F	F	F	F	F, C
<b>General count (% without chips)</b>						
<i>cores</i>	40 (0.8%)	18 (0.6%)	29 (1.3%)	32 (0.4%)	73 (1.2%)	26 (0.4%)
<i>CTE's</i>	324 (6.5%)	99 (3.4%)	170 (7.5%)	147 (2.0%)	261 (4.1%)	74 (1.3%)
<i>blades and frags</i>	1677 (15.9%)	482 (16.4%)	482 (16.4%)	2350 (32.5%)	1872 (29.8%)	2521 (42.8%)
<i>microburins</i>	-	2	262 (11.6%)	30 (0.4%)	350 (5.6%)	594 (10.1%)
<i>retouched tools</i>	1188 (23.9%)	230 (7.8%)	336 (14.9%)	1251(17.3%)	1353 (21.5%)	1165 (19.8%)
<b>Cores &amp; CTE's</b>						
<i>N- and W-fronted</i>	N	N&W	N&W	W	W	W
<i>main CTE's</i>	crested and core tablets	crested and core tablets	management convexities	crested, core tablets, overpassed	crested, core tablets, overpassed	crested, core tablets, overpassed
<b>Elongated blanks - morphometric characteristics</b>						
<i>blades (B) &amp; bladelets (Bt)</i>	<b>Bt</b>	Bt	B	Bt	B & Bt	<b>Bt</b>
<i>mean width (mm) (sd)</i>	<b>7.9 (2.6)</b>	12.1 (5)	12.4 (4.5)	13.5 (4.9)	13.3 (4.2)	11.4 (4.1)
<i>mean length to width ratio (sd)</i>	<b>4.3 (1.2)</b>	3.1 (0.7)	3.2 (1.1)	3.1 (0.8)	3.1 (0.6)	3 (0.7)
<i>unidirectional scar pattern</i>	<b>80%</b>	65%	<b>72%</b>	66%	71%	78%
<i>bidirectional scar pattern</i>	3%	12%	6%	<b>14%</b>	12%	10%
<i>distally convergent</i>	37%	36%	36%	33%	37%	<b>46%</b>
<i>regular parallel</i>	<b>23%</b>	14%	14%	11%	6%	5%
<i>longitudinal flat profile</i>	7%	<b>22%</b>	<b>19%</b>	11%	8%	13%
<i>longitudinal curved profile</i>	<b>43%</b>	23%	31%	35%	38%	34%
<b>Elongated blanks - proximal part</b>						
<i>plain butts</i>	30%	<b>72%</b>	<b>68%</b>	44%	29%	39%
<i>faceted or dihedral butts</i>	0%	4%	0%	0%	1%	0%
<i>linear or punctiform butts</i>	70%	24%	29%	56%	70%	59%
<i>abrasion</i>	<b>82%</b>	42%	21%	60%	<b>75%</b>	<b>82%</b>

### 6.1. Lithic variability in the Early and Middle Epipalaeolithic of the Negev

Comparative analysis highlighted a number of shared features among these assemblages: the primary focus on the production of small elongated, often distally convergent blanks, from mainly unidirectional cores with plain striking platforms, as well as the high percentage of retouched tools dominated by microliths. Beyond typological differences, this study also highlights some inter-assemblage differences. Azariq XIII clearly stands apart with the use of mostly N-fronted cores for the production of very slender incurvate bladelets, the probable use of soft stone hammers, the use of systematic abrasion of the striking platforms and the use of fine (Ouchtata) retouch for the manufacture of retouched tools continuing the previous Upper Palaeolithic Ahmarian tradition of minimal modification of the blanks (Belfer-Cohen & Goring-Morris 2002; Davidzon & Goring-Morris 2003), in contrast to the other Early EP industries.

The other five assemblages present more similar characteristics. However, Early Epipalaeolithic Azariq IV and Hamifgash IV include both N- and W-fronted cores for the production of blades or bladelets usually with a flat longitudinal profile and abrasion of the striking platform is not systematic. The main differences between these two assemblages are typological: at Azariq IV relatively wide and thick microliths were produced using abrupt retouch, without removing the platform or the bulb, while at Hamifgash IV small and narrow microliths were produced using the microburin technique removing the proximal part of the blank, as well as backed retouch.

The Middle Epipalaeolithic assemblages (Azariq XVI, Azariq XII and Shunera XXI) are characterised mainly by W-fronted cores for bladelet production, which were then transformed into microliths using backed retouch. Azariq XVI is notable for the higher frequency of bidirectional debitage, which likely reflects the use of an opposed platform for the maintenance of convexities (Marder 2002), the lower percentage of abrasion of the platform, and the absence of the microburin technique. However, as the aim was to produce trapeze and rectangles with near 90° angles, the microburin technique would not have been efficient (see also Marder 2002). Compared to Azariq XII, Shunera XXI is characterised by smaller and thinner elongated blanks, retouched using the microburin technique at the distal extremity, which did not lead to the removal of the proximal part of the blanks.

### 6.2. Discussing contacts between the southern Levant and the Nile Valley

The main characteristics of the lithic assemblages from E71K18C and E71K20 (for a detailed description, see Leplongeon 2017), are summarised in Table 15 and can be compared with data from Table 14. The Silsilian (E71K20) is dated to 17,500-19,000 cal BP (Schild & Wendorf 2010), while the Afian (E71K18) is attributed to the period 14,500-16,500 cal BP (Schild & Wendorf 2010). Although their chronological attribution is debated (Leplongeon 2017), there is no new information that enables us to question the original chronological attribution. As a working hypothesis they may be considered contemporaneous respectively with the Early EP and Middle EP.

All assemblages are oriented towards the production of elongated blanks. Retouched tools are numerous, and among them, backed retouch is dominant. The two Nile Valley sites show evidence for the use of the microburin technique, which is also used within the EP of the Negev. However, despite these very broad similarities, striking differences are observed in core and platform preparation. Elongated blanks tend to be larger and less elongated at E71K18C and E71K20, bidirectional scar patterns tend to have higher frequencies, which is also reflected in the types of cores. Faceted or dihedral platforms are much more frequent, and abrasion is less common. The low number of microburins, associated with a low microburin index, indicates either occasional use of the microburin technique or off-site production of

tools using the microburin technique. In addition, typological differences are also very marked. Beyond the typological variability, standardisation within categories is lower in the Nile Valley sites (*e.g.*, coefficient of variation [C.V.] of width of microliths) compared with the Negev sites.

Table 15. Main characteristics of the assemblages of E71K18C and E71K20 (After Leplongeon, 2017). Abbreviations: CTE - core trimming element.

	E71K20	E71K18C
Cultural entity	Silsilian (~18,700-17,500cal BP?)	Afian (~14,500-16,400 cal BP?)
Raw material	flint, local sources	flint, local sources
<b>General count (% without chips)</b>		
<i>cores</i>	148 (2.5%)	334 (3.3%)
<i>CTE's</i>	244 (4.1%)	156 (1.6%)
<i>blades and frags</i>	2037 (34.2%)	2240 (22.4%)
<i>microburins</i>	46 (0.8%)	379 (3.9%)
<i>retouched tools</i>	395 (6.6%)	1674 (16.7%)
Technique	hard and soft hammerstone?	hard hammerstone?
<b>Cores and CTE's</b>		
<i>N- and W-fronted main CTE's</i>	W mainly crested and overpassed products	W few, mainly overpassed products
<b>Elongated blanks - morphometric characteristics</b>		
<i>blades &amp; bladelets</i>	Blades or bladelets	Blades or bladelets
<i>mean width (mm) (sd)</i>	14.4 (3.9)	13.3 (4.2)
<i>mean length to width ratio (sd)</i>	2.8 (0.6)	2.8 (0.6)
<i>unidirectional scar pattern</i>	47%	63%
<i>bidirectional scar pattern</i>	27%	20%
<i>distally convergent</i>	43%	40%
<i>regular parallel</i>	15%	34%
<i>longitudinal flat profile</i>	18%	25%
<i>longitudinal curved profile</i>	35%	24%
	E71K20	E71K18C
<b>Elongated blanks - proximal part</b>		
<i>plain butts</i>	61%	39%
<i>faceted or dihedral butts</i>	7%	39%
<i>linear or punctiform butts</i>	30%	20%
<i>abrasion</i>	54%	18%
Use of the microburin technique		
<i>presence</i>	YES	YES
<i>Restricted microburin index</i>	12	26
<i>significant differences between microburin and elongated</i>	YES	YES
<i>significant differences between microburin and retouched (backed)</i>	NO	NO
<b>Retouched tools</b>		
<i>Main types</i>	micro- and macro-lithic retouched tools, mainly backed pieces, esp. distally backed pieces	mainly microlithic, truncations, backed bladelets and trapezes or triangles
<i>mean width (mm) (sd - CV)</i>	backed pieces: 12.5 (3.4 - 27%)	truncations: 12.2 (2.8 - 23%); trapezes or triangles: 10.8 (1.7 - 16%)
<i>type retouch</i>	abrupt	abrupt
<i>removal of proximal part for backed bladelets</i>	50%	72%



The only possible indicator of links between the Nile Valley and the Levant at that time would thus be the presence of the microburin technique. The first occurrence of its use in the Nile Valley is in the Silsilian and Afian industries (ca. 19,000-14,500 cal BP). However, while the first evidence for habitual use of the MBT in the Negev is found in the Nizzanan site of Hamifgash IV (ca. 20,000-18,000cal BP), earlier evidence within the EP of the Levant is found in the Transjordanian Nebekian entity, dated ca. 25,000-22,000 cal BP, thus suggesting an East-West diffusion of the microburin technique in the Levant (*e.g.*, Goring-Morris 1995). While further diffusion of the microburin technique from the Negev to the Nile Valley may be postulated, the marked typo-technological differences between both groups of assemblages render it unlikely. In addition, both Nile Valley assemblages display evidence for the manufacture of notched blades or bladelets in addition to abundant backed pieces, so the microburin technique may have been independently invented there.

The above comparison between Negev and Nile Valley assemblages has failed to highlight compelling evidence for contacts between the two regions at the end of the Pleistocene. Although contacts (direct or indirect) may have occurred, this is currently not visible in the archaeological record. As noted, some of these results may be due to inherent limits of the data: geographical distances between the sites, intra-entity variability not accounted for in this study, lack of sufficient chronological resolution, or a combination of these. Despite these limitations, the techno-complexes in the two areas appear very distinct.

Current archaeological evidence therefore does not support any contacts between populations between the Levant and the Nile Valley at the end of the Pleistocene. Only the above-mentioned surface collections at Helwan would signal technical diffusions between the Levant and the Nile Delta area at the end of the Pleistocene. However, these collections were made according to the 'beautiful piece' criteria, and they seem to be characterised by considerable typological diversity. Some of the backed points are consistent with an attribution to the Ramonian points or Mushabian arch-backed bladelets (Schmidt 1996, figs 3-4). Given their geographical location, they might correspond to a westward expansion of the 'territory' of the Mushabian and Ramonian, rather than contacts between two different populations. In the absence of numbers and context, it is not possible to interpret further these similarities. It is worth mentioning that palaeoenvironmental data for the Delta area still lack sufficient chronological resolution. Was the Nile Delta a stronger palaeoenvironmental barrier than previously thought? This would be consistent with recent palaeoenvironmental data from this region (*e.g.*, Muhs *et al.* 2013; Revel *et al.* 2010). In addition, the lake hypothesis for the Late Pleistocene Nile (Vermeersch & Van Neer 2015) would suggest that the Nile Valley would not have acted as a geographically continuous but discontinuous refuge area, perhaps contributing to isolating populations living up-river from northern populations. Future comparative analyses between the southern Levant and the Nile Valley may help to further discuss the topic of contacts between the Nile Valley and the Levant at the end of the Pleistocene, while detailed comparisons with the north-western African record may help to test hypotheses of east-west (or west-east) technical diffusions.

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### Supplementary Information

SI 1. Variables and main indexes used in the study.

SI 2. Database of all lithic artefacts analysed in this article.