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## Further diversity in the Early Neolithic of the Southern Levant: A first look at the PPNA chipped stone tool assemblage from el-Hemmeh, Southern Jordan

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### **Abstract**

We present the first analysis of a chipped stone assemblage recovered from the PPNA layers of el-Hemmeh, Southern Jordan. The sample (31,725 pieces) shows general affinities to PPNA material described elsewhere from the Southern Levant but also provides evidence for a distinctive suite of typological and technological traits. These include the presence of at least two reduction sequences, a lack of traditional PPNA point types, and an emphasis on the production of burins and tools manufactured on burin spalls. We suggest that this assemblage, together with those from other PPNA sites (WF16 and ZAD 2), provides evidence of indigenous cultural development during the Late PPNA in Southern Jordan.

### **Résumé**

Cette contribution présente l'analyse préliminaire d'un assemblage de pierres taillées provenant de niveaux datés du Néolithique précéramique A (PPNA) à el-Hemmeh, Jordanie du Sud. L'échantillon montre des affinités générales avec le matériel du PPNA décrit pour d'autres sites de la Jordanie du Sud, mais suggère également la présence de signes distinctifs au niveau typologique et technologique. Ces derniers incluent la présence d'au moins deux schémas opératoires, l'absence de pointes caractéristiques du PPNA et la prédominance de la production de burins et d'outils manufacturés à partir de chutes de burin. Il est proposé que cet assemblage, avec ceux provenant d'autres sites du PPNA (WF16 et ZAD 2), indique un développement culturel indigène pendant la fin du PPNA dans le sud de la Jordanie.

# FURTHER DIVERSITY IN THE EARLY NEOLITHIC OF THE SOUTHERN LEVANT: A FIRST LOOK AT THE PPNA CHIPPED STONE TOOL ASSEMBLAGE FROM EL-HEMMEH, SOUTHERN JORDAN

S. SMITH, J. PAIGE and C.A. MAKAREWICZ

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**Keywords:** *Southern Levant; Late PPNA; Chipped stone; Variability; El-Hemmeh.*

**Mots-clés:** *Levant Sud; PPNA récent; Pierre taillée; Variabilité; El-Hemmeh.*

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## THE PRE-POTTERY NEOLITHIC A IN THE SOUTHERN LEVANT: A LOCAL STORY...

Our understanding of the earliest Neolithic in Southwest Asia has undergone major development in recent years. The last decade has seen a wealth of spectacular new archaeological data (e.g., Schmidt 2006; Stordeur *et al.* 2000; Finlayson *et al.* 2011) and associated theoretical refinement (e.g., Smith B. D. 2007; Zeder 2011; Finlayson 2013). There is now increasing recognition that the transition from mobile forager to sedentary farmer is a protracted and multifaceted phenomenon, with

the various threads of the Neolithic tapestry, such as economy, ideology and social organization, having spatially and chronologically distinct developmental trajectories. These regional, polycentric experiments do not coalesce into the Neolithic village farming 'package' (as perhaps more traditionally perceived) until several thousand years after the beginning of the Pre-Pottery Neolithic (PPN). Although new discoveries and methodological developments are further refining our grasp of the origins and development of Neolithic economic practices (e.g., Zeder and Smith 2009; Willcox *et al.* 2008) and social organisation (e.g., Banning 2011; Baird *et al.* 2013; Wright

2014), similar advances in chipped stone studies are surprisingly lacking in the PPNA of the Southern Levant. For example, our understanding of the causes of variability both between and within PPNA chipped stone assemblages has not substantially improved in recent years. Indeed, D. Nadel's (1998) frustration that we do not understand the causes of assemblage variability either between or within PPNA sites still rings true.

The ubiquity of chipped stone, coupled with its potential to shed light on social organisation, economy and community interaction, should make lithic analysis a fruitful focus of current 'bottom up' research agendas. Indeed, the high degree of intra-site variability seen in PPNA assemblages, especially when compared with preceding periods (Nadel 1998), suggests that PPNA patterns of tool manufacture, use and discard are reflecting and articulating the wider social, ideological and economic experiments in play at this time. However, following a spate of papers which dealt explicitly with the interpretation of PPNA chipped stone variability, many of which were published around the turn of the millennium (*e.g.*, Garfinkel and Nadel 1989; Kuijt 1996 and 2001; Gopher and Barkai 1997; Ronen and Lechevallier 1999; Nadel 1998; Sayej 2001 and 2004 and references therein), relatively few attempts to explicitly resolve these issues have been made in recent years.

Currently there is no clear consensus on how, or even if, we should subdivide the southern Levantine PPNA assemblages into chronologically, functionally or regionally distinct facies (*e.g.*, Gopher 1996; Kuijt 2001; Ronen and Lechevallier 1999; Sayej 2001), leaving our understanding of cultural developments within the PPNA in an awkward and unsatisfactory state of limbo. In the Southern Levant, we know that early PPNA chipped stone assemblages are deeply rooted in Natufian technological traditions (Belfer-Cohen 1994), however, the subsequent development of PPNA knapping strategies remains unclear. Whilst detailed analyses of reduction sequences at PPNA sites in the Northern Levant have demonstrated continuity between the later stages of the PPNA and the Early PPNB (Abbès 2008; Stordeur et Abbès 2002), considerable uncertainty surrounds the nature of this transition in the Southern Levant (*e.g.*, Edwards *et al.* 2004; Finlayson *et al.* 2014).

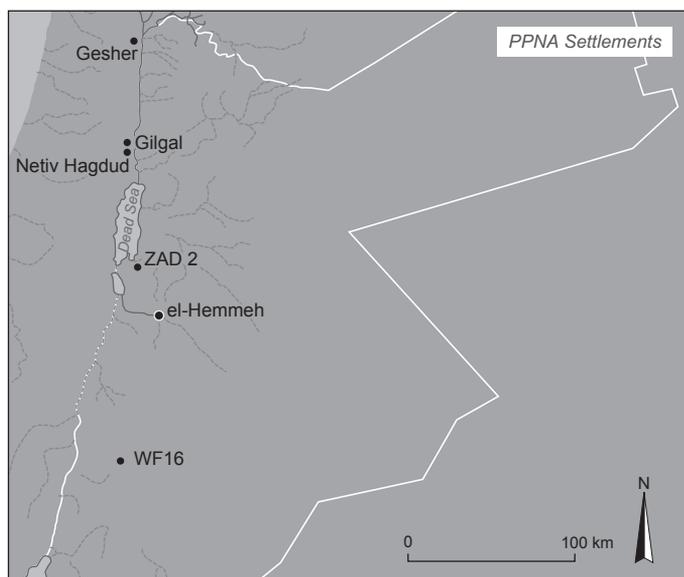
This situation is somewhat perplexing given that we now have several recent reports on chipped stone assemblages from major excavations at PPNA sites in the Southern Levant, for example Netiv Hagdud (Nadel 1997), Gilgal (Dag *et al.* 2010), WF16 (Pirie 2007), ZAD 2 (Sayej 2004) and Gesher (Garfinkel and Dag 2006). The problem here appears to be, at least in part, that even these major excavations explored relatively small proportions of sites. This, combined with the high degree of intra-assemblage variability and issues associated with the

reliability, calibration and interpretation of absolute dating sequences, and a somewhat limited consideration of chipped stone technology (Stordeur et Abbès 2002) compromises our ability to delineate broad scale patterning within and between assemblages. This is an unfortunate situation given the current emphasis on recognising local axes of variability and recent developments in interpreting other lines of archaeological evidence.

In this paper, we present an initial analysis of a sample of chipped stone recovered from the PPNA site of el-Hemmeh, located in the Wadi el-Hasa, Southern Jordan. Our primary aim here is to provide a baseline description of the main technological and typological traits of this assemblage. A core element of this is to maintain broad comparability with previously published PPNA assemblages from the Southern Levant (*e.g.* Nadel 1997; Pirie 2007; Sayej 2004) in order to discuss the el-Hemmeh assemblage in its regional context. A second aim is to consider the implications of these new data for the identification and interpretation of PPNA assemblage variability in Southern Jordan, highlighting avenues for further research. It is important to note that ongoing work on the el-Hemmeh assemblage (including detailed technological and functional comparisons between the WF16 and el-Hemmeh assemblages) holds significant potential to refine our understanding of the development of PPNA manufacture and use of chipped stone in Southern Jordan. The present paper represents the beginning of this process, demonstrating that data from analyses of chipped stone from the southern Levantine PPNA can be usefully brought to bear on wider issues of social and economic transformation in this crucial, yet stubbornly enigmatic, cultural period.

## THE PPNA SETTLEMENT OF EL-HEMMEH

El-Hemmeh is a substantial Pre-Pottery Neolithic settlement located in the Wadi el-Hasa, Jordan near the modern Tannur Dam (fig. 1). Located on an alluvial fan above the wadi floodplain (Contreras *et al.* 2014), el-Hemmeh was situated in immediate proximity to in-stream wetlands present during the Early Holocene (Contreras *et al.* 2014). The earliest settlement documented at the site dates to the latter half of the PPNA; no Epipaleolithic occupation has been so far identified at the site. A moderately sized Late PPNB settlement, characterized by agglomerate architecture reaching over 2 m in height that is typical for LPPNB sites located in Southern Jordan, is also present (Makarewicz *et al.* 2006; Makarewicz and Austin



**Fig. 1** – Map showing location of el-Hemmeh and other PPNA sites mentioned in the text.

2006; Makarewicz and Rose 2011). On the western edge of the site, LPPNB architecture and well-defined pits containing red plaster construction refuse, opposed platform blades, and Jericho points were cut into the uppermost PPNA cultural deposits. A single radiocarbon determination obtained from a PPNA floor (F1 105) sealed by pise superstructure and roof collapse produced a date of 9004–8871 cal. BC (OS-48491: 9450 ± 60 uncal. BP). This compares with dates for ZAD 2 where a suite of nine radiocarbon dates are centred on the period 9200–8300 cal. BC and WF16 Trench 3 where radiocarbon dates suggest the PPNA occupation continued until the period 8500–8200 cal. BC. (Edwards *et al.* 2004; Mithen and Finlayson 2007). Additional radiocarbon dates from PPNA el-Hemmeh are forthcoming.

Architecturally, the PPNA settlement at el-Hemmeh is characterized by multiple free-standing and semi-subterranean circular and semi-circular buildings constructed out of stone or pise, and ranging in size from 2 to 8 m in diameter (fig. 2). Several structures accommodate a variety of internal features, including moulded hearths, platforms, and bin features. Although the interior spaces of these structures were swept clean of debris associated with food processing and tool manufacturing, they were frequently re-floored. After abandonment, many of the structures were transformed into midden, ash, and/or construction debris dumps; the majority of the chipped stone assemblage analysed here is derived from these secondary, and occasionally tertiary, contexts. In effect, the el-Hem-



**Fig. 2** – Structure 10 (view from East). Note female burial, raised platform and hearth in foreground as well as (probable) central post hole, cup-hole mortar and other coarse stone artefacts resting on floor.

meh lithic assemblage likely represents a concatenation of tool-making and discard events generally removed from their original spatial and relative temporal position. At this juncture, we seek only to establish the overall techno-typological characteristics of the assemblage in order to evaluate its placement in the regional picture. It is, however, important to note that this level of analysis may mask patterned technological and typological variability between different context types and structural units.

## THE PPNA CHIPPED STONE FROM EL-HEMMEH

### METHODS AND SAMPLE

The sample of material analysed here includes the majority of chipped stone recovered during the 2010-2012 seasons. This derives from the interior of a range of PPNA structures (table 1). Sampled context types include small middens, ash dumps and construction debris, *i.e.* secondary contexts located within the interiors of PPNA structures. All excavated sediments were sieved through a 2 mm screen. In cases where excavated sediments were floated in order to recover palaeobotanical material, the resulting heavy fraction (also collected using a 2 mm mesh) was also sorted to recover chipped stone.

**Table 1** – Breakdown of structures from which assemblage was sampled.

Structure	Sample	% of sample
1	5038	15.88
2	2236	7.05
3	267	0.84
4	4390	13.84
5	4903	15.45
6	6067	19.12
7	5224	16.47
8	3032	9.56
9	96	0.30
11	472	1.49
<b>Total</b>	<b>31725</b>	<b>100.00</b>

## RAW MATERIALS AND CONDITION

The raw materials selected for reduction at el-Hemmeh demonstrate procurement strategies which focused on the exploitation of both local and non-local materials. Although a high proportion of the assemblage is manufactured using locally available wadi cobbles that are often of variable quality, higher quality chert types (not presently found in the vicinity of the site) also feature prominently. Small quantities of obsidian are also present. Beyond establishing some evidence for how the landscape was exploited, the variable quality of available raw materials appears to have influenced the strategies used by knappers in reducing those materials.

Our categorisation of raw materials (table 2) is based on colour, grain size, translucency and cortex features. In total twelve categories of raw materials were defined over the course of the study including those for variable, or unidentifiable materials (due to burning, or heavy patination). Where present, the cortex of most chert types is heavily battered and thin, which is consistent with the condition of cobbles found in the wadi bed. It should be noted that these raw material types do not necessarily represent different geological rock types. For example, both material types 1 and 2 can be found in the same cobble, with the higher quality type 1 often found in ‘pockets’ towards the centre of these cobbles.

The majority of the assemblage consists of material types 2 and 4, both available in the present day wadi adjacent to the site (table 2). Non-local materials are confined to two types: obsidian (type 11) and a caramel-brown flint (type 12). Type 12 material exhibits fresh (unbattered) chalky, thick (~2 mm) cortex, which suggests procurement from the geological source rather than the wadi channel. No source for type 12 material has been identified during our surveys of the Wadi el-Hasa, but it is found

**Table 2** – Typology of el-Hemmeh raw materials according to colour, grain size, translucency and cortex.

Type	Colour	Grain size	Translucency	Cortex features (when present)
1	Grey	Fine-very fine	Opaque-medium	Battered wadi cobble
2	Grey	Coarse-medium	Opaque	Battered wadi cobble
3	Pale grey brown	Fine-very fine	Opaque	Battered wadi cobble
4	Pale grey brown	Coarse-medium	Opaque	Battered wadi cobble
5	Grey brown	Fine-very fine	Medium-translucent	Battered wadi cobble
6	Brown	Medium-fine	Opaque	Battered wadi cobble
7	Basalt	Coarse	NA	NA
8	Other coarse stone	Coarse	NA	NA
9	Unidentified or burnt	Variable	Variable	Variable
10	Other	Variable	Variable	Variable
11	Obsidian	Microcrystalline	Translucent	NA
12	Brown (caramel to red)	Very fine	Medium-translucent	Chalky, thick, not battered

in outcrops near Shawbak ~50 km to the south (Smith, personal observation). All the obsidian pieces (n=15), which comprise less than 0.1% of the entire assemblage, are either bladelet or spalls and there is no evidence for on-site reduction of obsidian material in the form of obsidian debris or cores.

In terms of condition, the assemblage is rather variable with some significant differences between and within contexts. Overall, the majority of pieces appear reasonably fresh, and show limited evidence for post depositional movement. In some contexts a high proportion of pieces have been burnt and thermally fractured pieces are reasonably common throughout the assemblage. The degree of patination present on pieces is highly variable and *ca* 40% of the assemblage is moderately-heavily patinated, whilst *ca* 20% of pieces show no patination. The degree of patination often appears linked to depositional context and also raw material type, with some (more coarsely grained) materials less prone to patination than others.

## PRIMARY TECHNOLOGY

### Cores

The core assemblage (n=232) indicates the production of bladelets was a primary production target, with bladelet

**Table 3** – Overall summary of the sampled PPNA assemblage from el-Hemmeh showing number and proportions of principle analytical categories. N.B.: Table also shows number and proportion of each category used as tool blanks.

Assemblage	Unmodified	Retouched / used	Retouched / used %	Total (n)	Total (%)
Cores	222	10	4.31	232	0.73
CTE	369	47	11.30	416	1.31
Flakes	9987	432	4.15	10419	32.84
Blades	934	223	19.27	1157	3.65
Bladelets	2240	197	8.08	2437	7.68
Spalls	165	26	13.61	191	0.60
Debris	16764	16	0.10	16780	52.89
Other	27	66	70.97	93	0.29
<b>Total assemblage</b>	<b>30708</b>	<b>1017</b>	<b>3.21</b>	<b>31725</b>	<b>100.00</b>

(17.2%) and mixed flake/bladelet cores (42.2%) dominating the assemblage. Flake cores (13.9%) and core fragments (25.9%) are also present, whilst blade cores (0.9%) are extremely rare. Many cores are fashioned on chert cobbles (types 1-4) that exhibit battered cortex, indicating that most raw materials derive from a secondary (wadi channel) source. However, other raw material types (e.g., type 12) are present, indicating that wadi cobbles were not the only material source exploited for cores at the site. The core debitage ratio is 1:62.9 (n flake + n bld + n blet + n CTE / n cores). Cores rarely served as tool blanks and were retouched in only 10 (4.3%) cases (tables 3-4).

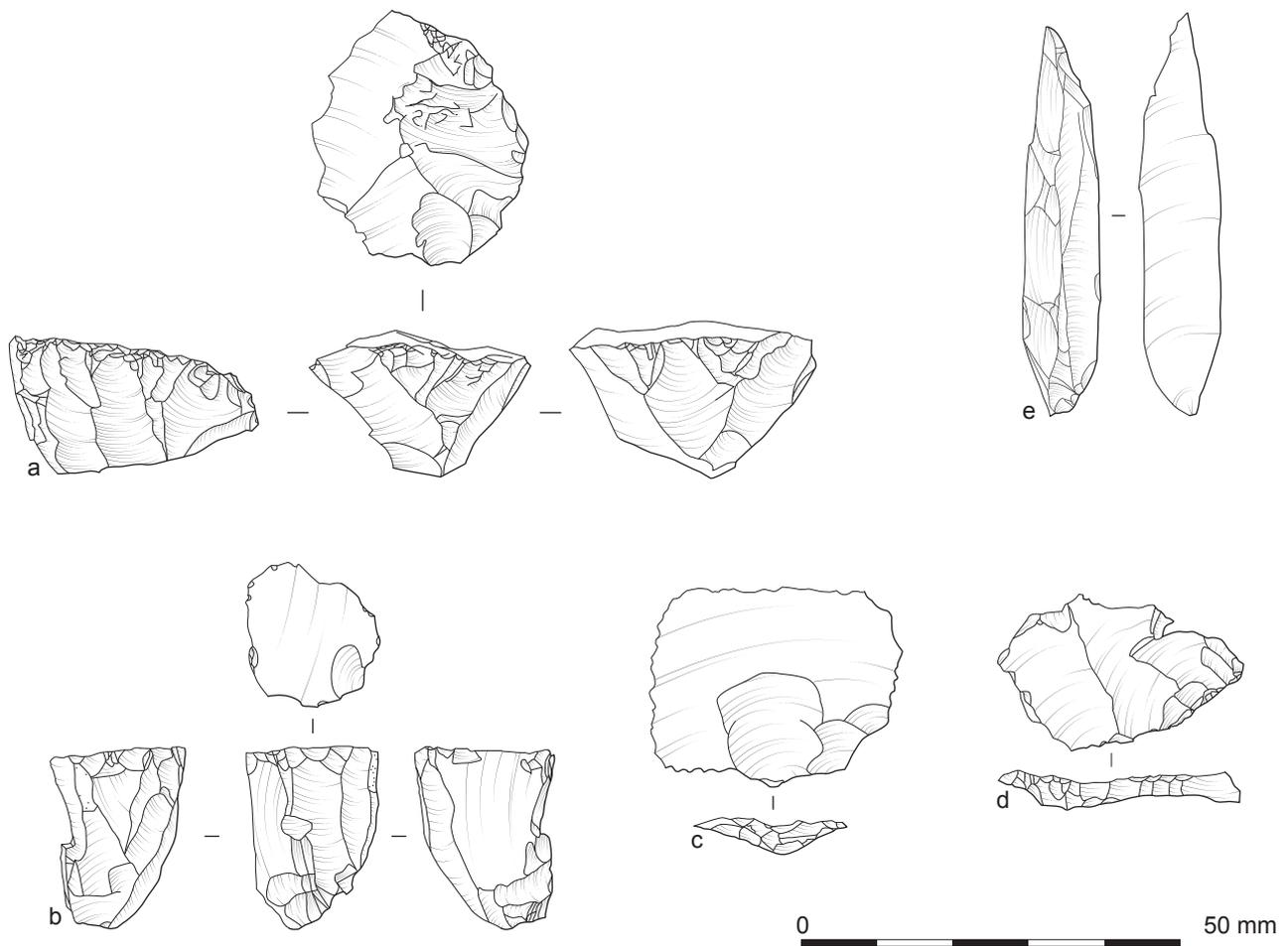
Flake cores are predominantly single platform (n=8), change of orientation (n=9) and globular/amorphous (n=10) types, although several radial examples (n=5) are also present. Some flake cores appear to be little more than tested cobbles. Flake cores are generally small (max. <50 mm) although occasional larger examples are present. Blade cores are rare (n=2), small (max. <60 mm) and appear to share technological affinities with bladelet cores (see below). The scarcity of blade cores is perhaps anomalous given the high number of blades (n=1157) in the el-Hemmeh assemblage. The simplest interpretation of this situation is that production of blades blends into the production of bladelets and that many former 'blade' cores are now unrecognisable having been reduced in size by the subsequent production of bladelets.

Bladelet cores (fig. 3: a-b) are frequently manufactured on relatively fine-grained raw material types and are dominated by single platform (n=17) (often sub-pyramidal) and change of orientation (n=17) types. These cores, particularly those on fine-grained materials, are generally small (max. <30 mm) and exhausted, often featuring multiple platforms. Bladelet cores show a higher degree of platform preparation than other core

**Table 4** – Summary of primary technology at PPNA el-Hemmeh.

Type (1)	Type (2)	N	% (of type 1)
Flake core	single platform	8	25.0
	multiple platform	9	28.1
	irreg./amorphous	10	31.3
	other/indet.	5	15.6
Blade core	single platform	1	50.0
	multiple platform	1	50.0
	irreg./amorphous	-	-
	other/indet.	-	-
Bladelet core	single platform	17	42.5
	multiple platform	17	42.5
	irreg./amorphous	3	7.5
	other/indet.	3	7.5
Mixed removals core	single platform	15	15.3
	multiple platform	37	37.8
	irreg./amorphous	27	27.6
	other/indet.	19	19.4
Core fragments	other/indet.	60	100.0
Core trimming elements	core tablets/platform rejuvenation flakes	183	44.0
	core face removals	147	35.3
	striking platform removals	60	14.4
	crested pieces	26	6.3
Flake	primary flakes	770	7.4
	other flakes	9649	92.6
Blade	primary blades	57	4.9
	regular blades	433	37.4
	irreg. blades	297	25.7
	blade fragments	370	32.0
Bladelet	primary bladelets	61	2.5
	regular bladelets	1246	51.1
	irreg. bladelets	587	24.1
	bladelet fragments	543	22.3
Spall	burin spalls	175	91.6
	other spalls	16	8.4
Debris	chips (<10 mm)	10245	79.0
	chunks	3809	27.1
	burnt shatter	2726	21.0
Other	other	93	100.0
<b>Total assemblage</b>		<b>31725</b>	

types; including evidence for the removal of CTE (particularly platform rejuvenation flakes) (fig. 3: a). These features suggest that production of blades and bladelets on high quality raw materials was a specific target of skilled core reduction at el-Hemmeh. Mixed cores were predominantly used for the production of both bladelets and flakes, and were often manufactured on battered wadi cobbles. Initial observations



**Fig. 3** – Core technology at el-Hemmeh. **a**) Single platform bladelet core (1032-750); **b**) single platform bladelet core (1025-2101); **c**) platform rejuvenation flake (967-780); **d**) platform rejuvenation flake (967-786); **e**) blade retaining partial crest (815-834).

suggest that these were initially reduced in an *ad hoc* way, *i.e.* through the removal of flakes, in order to identify ‘pockets’ of higher quality raw material which were targeted for bladelet removal.

### Core Trimming Elements

Core trimming elements (CTE) (n=416) include core tablets/platform rejuvenation flakes (44%), core face removals (35.3%), striking platform removals (14.4%) and crested elements (6.3%). The presence of CTE suggests that initial reduction of cores took place on site and that considerable care was taken to maintain certain core types at the site. CTE are relatively abundant and the core: CTE ratio is 1:1.79. A total of 47 CTE (11.3%) were used as tool blanks, mainly for the manu-

facture of non formal tools, burins and scrapers. A moderate proportion (12.8%) of scrapers are manufactured on CTE.

Crested elements (n=26) provide some details of the methods used for initial core preparation. The relatively low number of these pieces compared to the high number of cores used to produce blade/bladelet suggests that, in general, crestring was not necessary and the natural shape of cobbles/nodules allowed the production of elongated debitage without crestring. The presence of several primary blades and bladelets (see below) which feature ‘natural crests’, in the form of cortical dorsal surfaces but lack crestring, supports this interpretation. The majority of crested elements lack complete bifacial crestring, and are either secondary/tertiary blades from crested cores (fig. 3: e) or feature a single crested versant. The presence of blades with only a single crested versant suggests that cores

were occasionally reshaped during debitage. Crested elements were usually manufactured on relatively fine grained materials.

In terms of core maintenance, core tablets and platform rejuvenation flakes (n=183) (fig. 3: c-d) are primarily produced on fine-grained materials and, appear to derive from blade/bladelet or mixed bladelet/flake core types. This would accord well with the frequent presence of negative scars of tablet removals located on the striking platforms of regular bladelet cores (fig. 3: a). Dorsal scar patterns on core face removals (n=147) again suggest that these primarily relate to rejuvenation of bladelet cores and are often sidestruck (*i.e.*, at 90° to direction of removals). Striking platform removals (n=60) are more varied in form, but, as with other CTE's, seem to relate mostly to production of blades/bladelets.

## Flakes

Flakes (n=10,419) comprise 32.8% of the total assemblage and include both primary elements (n=770) and flakes from later stages of reduction (n=9649). The presence of primary elements (defined as having a dorsal face with >30% cortex) indicates that initial reduction of cores took place on site. The majority of primary flakes show battered cortex, showing that wadi cobbles were frequently exploited. Although a large number of tools (n=432) were manufactured on flakes, this equates to a small proportion (4.2%) of the flake assemblage.

Flakes are generally small (<40 mm max. dimension), although occasional larger examples (max. dimension >70 mm) are present. Flakes are often fragmentary and are manufactured on all raw material types, although the majority of flakes were manufactured on rather coarsely grained materials (*e.g.*, types 2 and 4). Flakes include many irregular and chunky examples together with some more regular examples. In general, the more regular flakes are manufactured on more finely grained raw materials, moreover, these usually have dorsal scarring consistent with removal from mixed bladelet/flake cores suggesting that these may be, in part, a by-product of blade/let production. Many flakes appear to derive from testing and initial reduction of cobbles in search of 'pockets' of higher quality raw material (*e.g.*, types 1, 3 and 5) for blade/let production.

## Blades and bladelets

Blades (n=1157) comprise 3.7% of the el-Hemmeh assemblage and the overarching 'blade' category is defined as all elements where length is greater than twice width. The blade

category includes primary blades (n=57) (with more than 30% of the dorsal surface retaining cortex), regular blades (n=433) (defined in a technological manner, having parallel edges and dorsal ridges) as well as irregular examples (n=297) (which fulfil the metrical criteria for blades but exhibit irregular form and may result from more *ad hoc* debitage on simple elongated cores) as well as blade fragments (n=370). Fragments are exceptional in that they do not fulfil metrical criteria for blades, but retain sufficient technological features to confidently identify these as fragments of regular blades. The flake: blade/let ratio is 1:0.34 (n bladelet + n blade/n flake). Blades are the most frequently retouched debitage element, with 223 (19.27%) blades being either retouched or used tools.

Regular blades are the most abundant category of blades and constitute 37.4% of the blade assemblage. Regular blades are generally short (<70 mm) and relatively wide (*ca* 15 mm), and could be thought of as simply wide bladelets, although occasional larger examples are present. Platforms often show significant evidence for preparation, *e.g.* abrasion and chipping, creating small relatively isolated platforms. Metrical and technological analysis of the assemblage is ongoing in order to further explore the variability in blade production at the site.

Bladelets (n=2437) constitute 7.7% of the total assemblage and are defined as small blades where length <50 mm and width <12 mm. At el-Hemmeh bladelets were classified into the same categories as blades, comprising primary (n=57), regular (n=433), irregular (n=297) and fragmentary (n=370) types. Bladelets are more common than blades, and the assemblage has a bladelet:blade ratio of 1:0.47. In total, 197 (8.08%) of the bladelet assemblage served as tool blanks. Notably, bladelets include some very small examples (max. dimension 15 mm) although most are larger. Bladelets include three pieces manufactured on obsidian, and many, particularly regular types, are manufactured on relatively fine grained materials (*e.g.*, types 1, 3, 6 and 12) featuring well prepared platforms and feather terminations.

## Spalls

Spalls (n=191) constitute 0.6% of the total assemblage and are primarily burin spalls (n=175), manufactured on fine-grained material. The remaining spalls comprise a range of sharpening spalls, including six tranchet sharpening spalls from bifacial tools. A relatively high proportion of spalls (13.6%) were used as tool blanks.

## Microburin technique (MBT)

No evidence for the use of the microburin technique was identified in the assemblage.

## Debris

Debris (n=16780) constitutes 52.9% of the assemblage and is classified as chunks (27.1%), burnt/thermal shatter (21%) or chips (79%). Following A. Pirie (2007), chips include all material <10 mm in maximum dimension. However, the metrical criteria used to define chips varies between analysts; for example at Netiv Hagdud, Nadel (1997) defines chips as pieces <15 mm in maximum dimension. Given the large numbers of flakes between 10 mm and 15 mm in size at many PPNA sites, this analytical variability has the potential to significantly impact the proportions of both chips and flakes in PPNA assemblages, hampering attempts to compare reduction strategies between assemblages.

It should be noted that in addition to the above classes of debris, many contexts yielded large numbers of rolled angular shatter, rather like rolled chunks. These pieces are interpreted as part of the natural geology and have been excluded from the present analysis.

## RETOUCHED AND USED TOOLS

### Blank selection

The tool assemblage, which includes both retouched and used pieces (n=1017) (table 5), was manufactured on a range of blank types including flakes (42.5%), blades (21.9%), bladelets (19.4%), CTE (4.5%) and spalls (2.5%). A further 9.2% of tools are manufactured on blanks classified as 'other/indeterminate', which include many cobbles used for the manufacture of bifacial tools. The high proportion of tools manufactured on flake blanks illustrates that at least some flake production was designed to produce tool blanks, even though only 4.2% of total flakes were retouched or identified as used (table 3). The majority of tools made on flake blanks are produced in an *ad hoc* manner and are often irregular in form with minimal retouch.

Blades are the most frequently retouched/used pieces (19.3%) (table 3), and are generally used as blanks for more standardised tool types such as awls, truncations and backed and glossed blades. A high proportion of spalls are retouched (13.6%), primarily as borers. CTE, particularly core tablets and platform rejuvenation flakes, are retouched in 11.3% of cases, mostly resulting in scrapers. Bladelets are retouched in only 8.1% of cases, and are most commonly used as blanks for the manufacture of projectile points, borers and bitruncations. Together these data suggest that the term 'bladelet industry' simplifies a more complex suite of blank selection strategies.

**Table 5** – Summary of the tool assemblage from PPNA el-Hemme, showing proportions and numbers of tool types, as well as the blank types used for their manufacture.

Blank type:	Flake		Blade		Bladelet		CTE		Spall		Other / indet.		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Non Formal Tools	195	49.9	99	25.3	63	16.1	23	5.9	11	2.8			391	38.5
Used pieces	16	50.0	16	50.0									32	3.2
'Projectile' points			1	9.1	10	90.9							11	1.1
Awls	29	49.2	14	23.7	10	17.0	3	5.1	2	3.4	1	1.7	59	5.8
Borers	2	4.4	6	13.0	30	65.2			8	17.4			46	4.5
Microliths					2	100							2	0.2
Bitruncations			2	9.1	20	90.9							22	2.2
Scrapers	30	76.9	2	5.1			5	12.8			2	5.1	39	3.8
Truncations	4	13.8	13	44.8	12	41.4							29	2.9
Notch/denticulates	53	74.7	9	12.7	1	1.4	5	7.0			3	4.2	71	7.0
Burins	73	54.5	29	21.6	19	14.2	9	6.7	2	1.5	2	1.5	134	13.2
Backed blades			14	100									14	1.4
Glossed pieces			7	100									7	0.7
Bifacials	5	8.9									51	91.1	56	5.5
Multiple tools	4	22.2	6	33.3	8	44.4							18	1.8
Other/varia	5	14.7			2	5.9	1	2.9	2	5.9	24	70.6	34	3.3
Retouched frags.	16	30.8	5	9.6	20	38.5					11	21.2	52	5.1
<b>Total</b>	<b>432</b>	<b>42.5</b>	<b>223</b>	<b>21.9</b>	<b>197</b>	<b>19.4</b>	<b>46</b>	<b>4.5</b>	<b>25</b>	<b>2.5</b>	<b>94</b>	<b>9.2</b>	<b>1017</b>	<b>100</b>

## Non Formal Tools (NFT)

NFT (n=391) are the most loosely defined tool type (or amalgamation of types) in the assemblage and comprise all pieces with retouch which do not fit into other typological categories. NFT constitute 38.5% of the tool assemblage and are manufactured on flakes (49.9%), blades (25.3%), bladelets (16.1%), CTE (5.9%) and spalls (2.8%). It is possible that the retouched spalls would be better re-classified as perforators, based on the form of their tips. Flakes of all shapes and sizes were retouched in a variety of *ad hoc* ways. Blades and bladelets often show fine edge modification, often difficult to distinguish from use or accidental damage. NFT manufactured on CTE often take the form of core tablets/platform rejuvenation flakes with steep retouch, forming scraper like tools. Detailed analysis, based on the Wembach module (Baird *et al.* 1995), will provide a more detailed study of the el-Hemmeh NFT, incorporating detailed analysis of retouch type and positioning.

## Used pieces

A total of 32 pieces show macroscopic (visible to the naked eye) traces of use, but lack retouch. These constitute 3.2% of the tool assemblage and are mainly unmodified blanks with edge damage and/or rounding. As no microscopic examination of used edges has yet been undertaken, it is not possible to comment on the functions of these pieces. It is certain that a complete microscopic examination of the assemblage would identify many more used pieces. Note that the used pieces category does not include glossed pieces, which are treated separately (see below).

## 'Projectile' points

This tool class, so diagnostic of the Levantine PPN, is rare at el-Hemmeh. In total, only eleven points were identified in the assemblage and many diagnostic PPNA types, such as the el Khiam point, are extremely rare or absent. The items classified as 'projectile' points include a single fragment of a Jericho point, intrusive from PPNB layers. A possible el Khiam point takes the form of a small, pointed blade (55 x 15 mm) with bilateral notches located near to the proximal end of the blank (fig. 4: i). The base of this piece is an unmodified break and the tip is not retouched. It is likely that this piece should be reclassified as *varia*, or as a perforator (following Nadel 1997). The assemblage includes only one typical PPNA point—a possible fragment of a tanged Jordan Valley point.

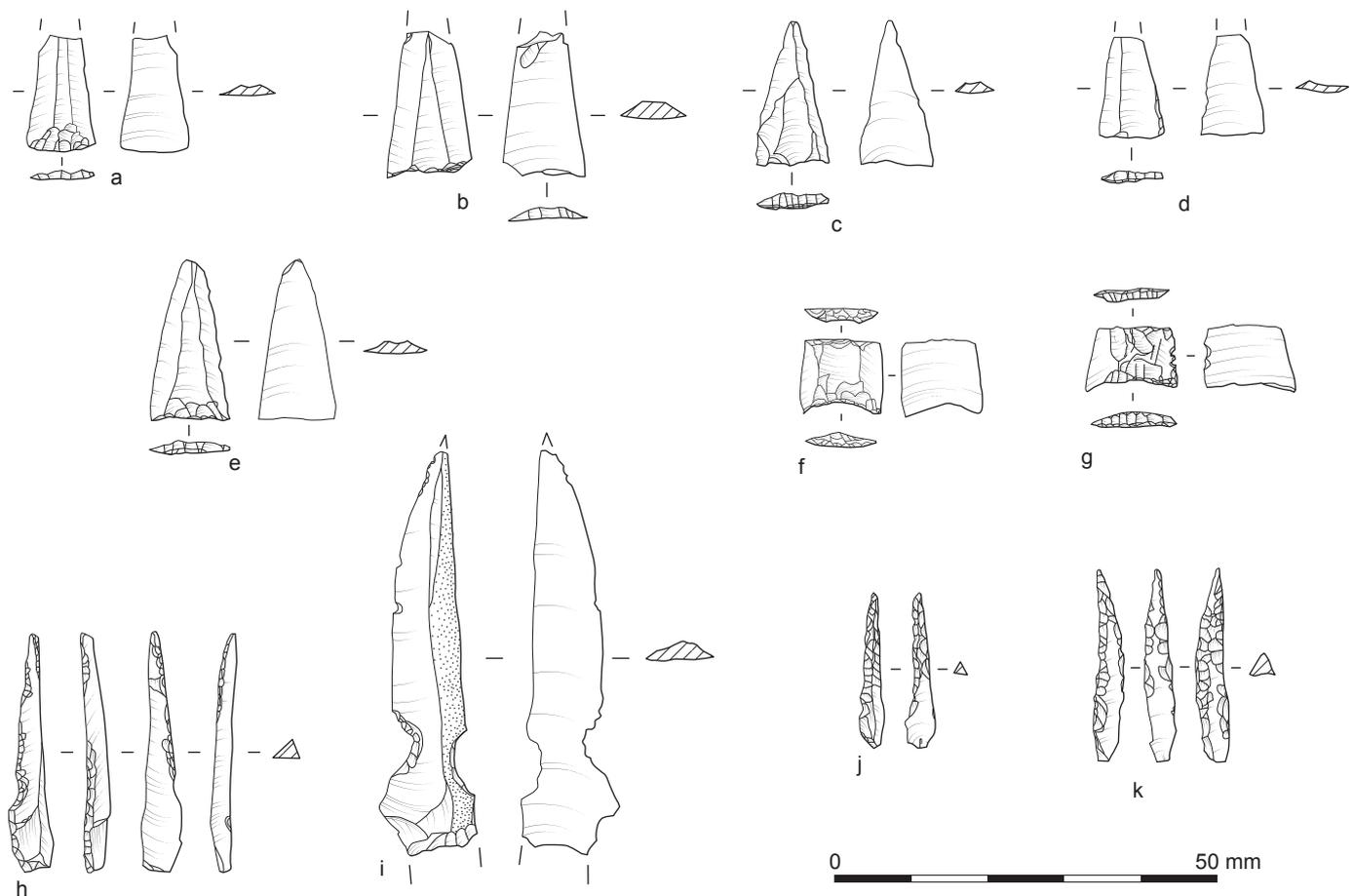
The remaining eight points are atypical but are currently assigned to the Salibiya point type (fig. 4: a-e). These small, triangular pieces are manufactured on the distal portion of pointed bladelets, usually manufactured on fine-grained raw material types. The only retouch present on these pieces is located at the tool base and takes the form of an abrupt truncation which is occasionally modified through the application of thinning Couze retouch (fig. 4: a, e). The tips of these tools are always unmodified and the pointed shape reflects the form of the bladelet blank. These pieces are small (usually *ca* 30 x 10 x 3 mm), delicate and in at least two cases have tip damage consistent with use as a projectile, *e.g.* bending fractures with 'spin offs' and 'impact' burins' (Smith S. 2007; Dockall 1997). The basal modification of these pieces is consistent with that usually applied to PPNA projectile points. However, the lack of retouch at the tip does not fit the original definition of Salibiya points provided by Nadel *et al.* (1991). The only published examples of similar tools derive from the stratigraphically Late PPNA deposits in Trench 3 at WF16 (Pirie 2007: Fig. 8.41, j, n), where they were classified as truncations.

## Awls and borers

Perforators include awls (n=59) and borers (n=46), which together constitute 10.3% of the tool assemblage. Awls are most commonly made on flakes (49.2%) but there are many examples on blades (23.7%), bladelets (17%) and spalls (3.4%).

Awls take a wide range of forms. Those on flakes feature a range of tip morphologies, usually chunky, with tips often set at an angle to the long axis of the tool blank. Awls made on blade and bladelets also take a variety of forms, but the 'bec subtype' (Dag *et al.* 2010), featuring short robust tips that are usually formed by the conjunction of a small notch and a break facet, is common. Very few awls feature bilaterally and symmetrical retouched straight tips, oriented along the long axis of the tool. As such, it is unlikely that el-Hemmeh awls were hafted to serve as drill bits.

Borers, which feature elongated points (usually formed by the convergence of (sub) parallel, steeply retouched lateral edges), are made on flakes less frequently (4.4%) than awls. Rather, borers are usually manufactured on blades (13%), bladelets (65.2%) or burin spalls (17.4%). Given their symmetrical, elongated working tips it is possible that the borers, particularly the needle like borers on spalls (fig. 4: h, j-k), may have functioned as hafted drills.



**Fig. 4** – Smaller retouched tools from el-Hemmeh. **a-e**) Salibiya points: a) 815-834, b) 864-811, c) 967-457, d) 954-133, e) 1012-740; **f**) bitruncation (815-834); **g**) bitruncation (1032-750); **h**) perforator on burin spall (1099-2807); **i**) varia- bilaterally notched pointed blade (1012-750); **j**) perforator on burin spall (1053-313); **k**) perforator on burin spall (1053-2128).

### Microliths

Microliths (n=2), defined here as bladelets featuring abrupt/semi-abrupt backing, are extremely rare (0.2%). The two identified examples are both medial fragments of backed bladelets.

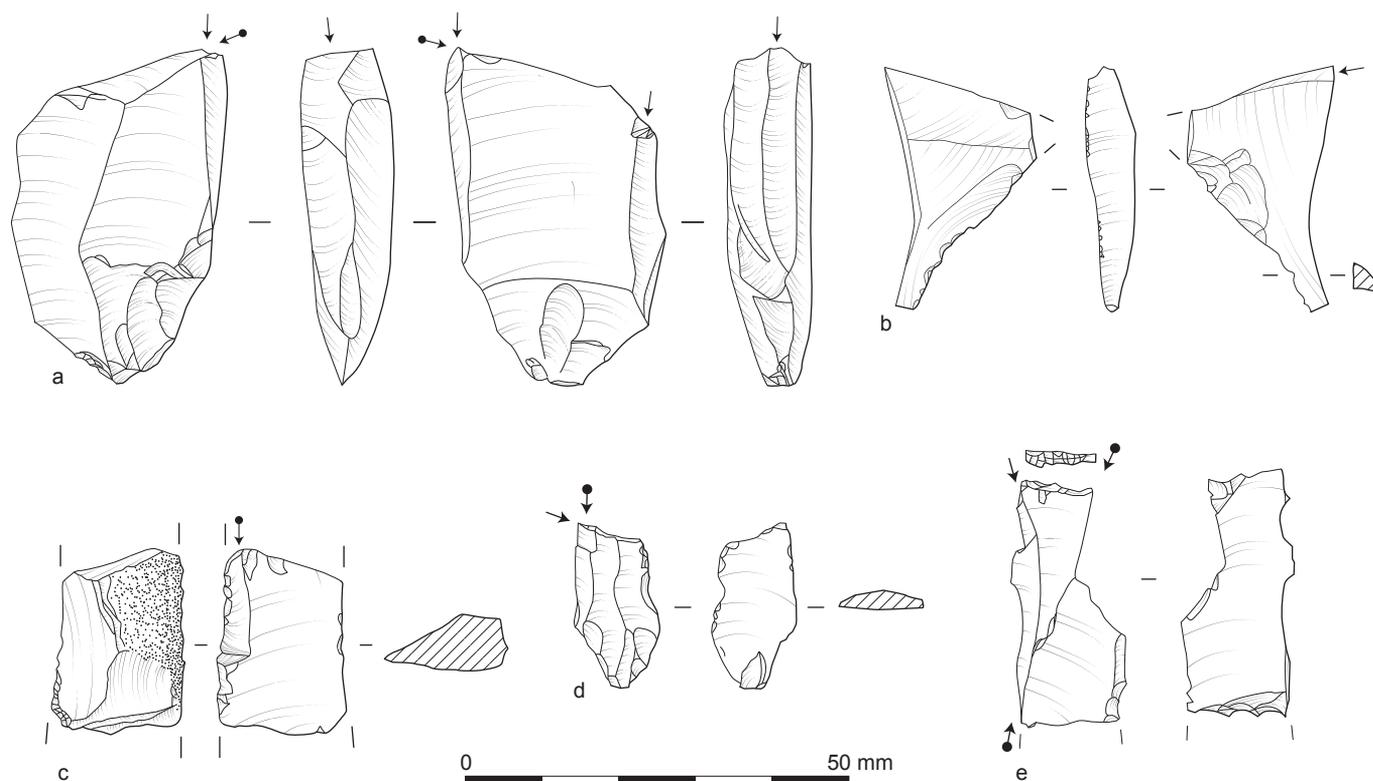
### Bitruncations

A total of 22 bitruncated blade/lets (Hagdud truncations), which constitutes 2.2% of the tool assemblage, were identified (fig. 4: f-g). These small, chronologically diagnostic, elements are either made on bladelets (90.9%) or small blades (9.1%), usually manufactured on fine grained raw materials. These are manufactured on medial sections of blanks and feature truncation (usually featuring both abrupt and Couze retouch) at both

proximal and distal ends, which take either straight or concave forms. No notched (Gilgal) bitruncations were present.

### Scrapers

Scrapers (n=39) form 3.8% of the tool assemblage and are most often manufactured on flakes (76.9%), although also occasionally occur on CTE (12.8%) and blades (5.1%) as well as single examples found on a core and a cobble. The two examples on blades are endscrapers, whilst those on CTE take a diverse range of forms. Scrapers occur on flakes of all sizes, but the majority are on relatively large (between 40 and 100 mm max. dimension) and thick blanks. These feature steep retouch, creating scraper edges with a wide range of morphologies. Scrapers are made on a wide range of raw materials.



**Fig. 5** – *a*) Multiple burin (954-126); *b*) burin on a spall (954-1113); *c*) burin (954-1113); *d*) burin (954-133); *e*) multiple burin on a truncation (1053-2128).

## Truncations

Truncations (n=29) form 2.9% of the tool assemblage and are manufactured on flakes (13.8%), blades (44.8%) and bladelets (41.4%). Truncations take a range of forms, and there is little evidence of standardisation. Several of the truncated bladelets are on fine grained raw materials and feature Couze retouch, raising the possibility that these are broken/unfinished bitruncations or points.

## Notch/denticulates

Notch/denticulates (n=71) form a diverse tool type which constitutes 10% of the tool assemblage. The majority of these are manufactured on flakes (74.7%) although examples occur on all blank types.

## Burins

Burins (n=134) are the most abundant of the formal tools types identified at el-Hemmeh, forming 13.2% of the tool

assemblage (fig. 5). Burins are manufactured on all blank types, as well as occasionally occurring in combination with other retouch types (see below, Multiple tools). There are many types of burins in the assemblage, including single and multiple burins featuring both longitudinal and transverse removals. Burin blows were initiated on a range of surfaces, including break facets, truncated margins, remnant platforms and terminations. Several burins (*e.g.*, fig. 5: *a*) resemble bladelet cores, which use the lateral margins of flakes as a removal surface, and there may be a blurred transition between these artefact classes. However, in the el-Hemmeh assemblage these burins are clearly distinct from pieces defined as cores. Burins occur on all raw material types, although fine-grained (particularly type 12) material appears to have been the scene of particularly intensive burination. Use of such a reduction strategy suggests burin removals were used to maximise use of the relatively rare fine-grained raw materials. The presence of many burins and associated spalls in the assemblage (table 4) shows that burins spalls were produced on site.

## Backed blades

Backed blades (n=14) constitute 1.38% of the assemblage. Many of these pieces are fragments, and feature backing from a range of directions. Notably, the assemblage includes four 'chronologically distinctive bifacially' backed blades, or Beit Tamir knives (fig. 6: c). These include some, relatively large (*ca* 85 x 30 mm) examples and feature a range of, often irregular, bifacial backing along one lateral margin. Several similar pieces also feature a well-developed polish/gloss on the opposite margin and these are described below (Glossed pieces).

## Glossed pieces

Gloss, or well-developed polish, was identified on only seven pieces, all of which are blades. Gloss was observed on blades of a wide range of sizes (max. length 90 mm, min. length 40 mm) and, in all cases, was present on a single lateral margin and associated surfaces. Although use-wear analysis has not yet been conducted on these pieces, the nature and distribution of gloss is consistent with use of these items as sickles.

Two of the glossed blades lack any retouch, three feature light retouch on the polished margin, whilst two feature more robust retouch/backing on the unpolished margin. The backed examples both have backing predominantly from one direction with occasional scars on the opposite face creating short lengths of irregular and patchy bifacial backing; as such these may represent Beit Tamir sickles (fig. 6: b, d). One such piece has a black residue (bitumen?) patchily adhering to the backed margin (fig. 6: d).

## Bifacials

Bifacial pieces (n=56) constitute 5.5% of the tool assemblage, and although a few (8.9%) are manufactured on flakes, most bifacial pieces are manufactured on 'other/indeterminate' blanks, frequently including small cobbles. At el-Hemmeh, this is a diverse tool type which includes both formal bifacial tools together with more irregular pieces, many of which may be rough outs or unfinished pieces. Bifacial tools are made on a wide range of raw material, although medium or even coarsely grained flint/chert seems to have been preferred. The sample also includes several pieces manufactured on basalt and limestone. One of the limestone bifacials exhibits polish.

In total, 34 of the 56 bifacial tools can be categorised to a specific type. These include 15 small picks (maximum dimen-

sion *ca* 120 mm), often formed on battered chert cobbles. These items feature a range of morphologies, retouch types (bifacial and trihedral) and qualities of finish. The sample includes several possible rough outs, 16 small (max. dimension *ca* 100 mm) axes and (rare) chisels, many of which show signs of tranchet sharpening (fig. 6: a). Detailed typological analysis of these pieces is on-going.

## Multiple tools

A total of 18 pieces were classified as 'multiple tools'; usually these feature a burin removal on retouched blanks of various kinds. Field observations suggest that these pieces are often manufactured on fine-grained raw material types.

## Other/varia

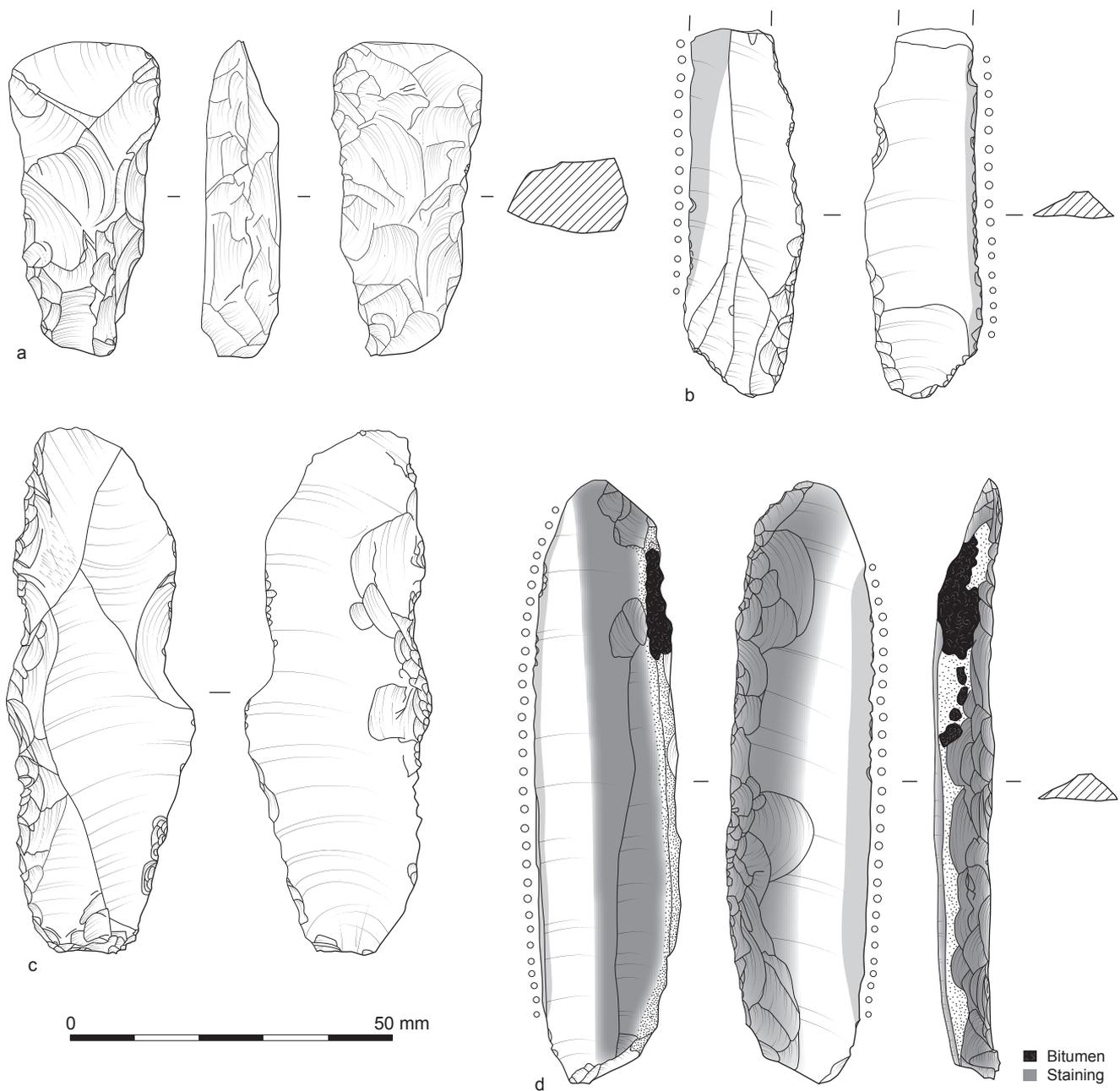
A total of 24 pieces, 3.3% of the tool assemblage, were classified as 'other/varia'. These include a wide range of irregular retouched pieces on a wide range of blank types and raw materials.

## Retouched fragments

Fifty-two fragmentary pieces were classified as retouched fragments.

## DISCUSSION: EL-HEMMEH AND THE LATE PPNA IN SOUTHERN JORDAN

The initial analysis of the chipped stone assemblage from PPNA el-Hemmeh provides an opportunity to consider both the reduction sequences employed at the site and to discuss the implications of these data in the wider context of the southern Jordanian PPNA. In this way, these data enable some general points to be made regarding our understanding of Early Neolithic cultural developments in this region. It should be reiterated that analyses of the assemblage is on-going and future work will facilitate a more detailed analysis of the assemblage, exploring detailed metrical and technological variability at both inter and intra site levels.



**Fig. 6** – Larger retouched tools from el-Hemmeh. **a)** Tranchet axe (954-133); **b)** Beit Tamir? sickle (1453-686); **c)** Beit Tamir knife (1042-750); **d)** Beit Tamir? sickle (1329-426). Note bitumen and staining on (d).

#### THE PPNA CHIPPED STONE ASSEMBLAGE FROM EL-HEMMEH

The assemblage is characterised by the on-site production of small debitage items from a variety of core types. Retouched

tools are most commonly manufactured on flakes, although most tools on flakes are *ad hoc* in nature. Blade/lets were used to manufacture a range of more formal tools including burins, perforators, Beit Tamir knives and bitruncations. Flakes dominate the assemblage and are mainly produced on unstandard-

ized, irregularly shaped cores manufactured on locally available wadi cobbles of variable quality. Our understanding of the techniques of blade/let production at the site is in its infancy, however, it is clear that this process was more standardised and often involved the use of higher quality (non-local) raw materials. Blade/let production most commonly commenced with the removal of a 'natural crest' from small nodules of raw material, although the assemblage also includes a range of elements indicating that in some cases artificial crests (usually with cresting on one versant only) were created both before and during blade/let production. Blade/let cores were regularly maintained during debitage through the removal of platform rejuvenation and core face removal flakes.

The presence of primary elements, crested elements, CTE and significant quantities of debris in the assemblage suggest that all stages of core reduction and tool manufacture occurred on site. However, at the present level of analysis, it is not clear whether this applies equally to all raw material types and it remains possible that some reduction of certain raw materials (*e.g.*, type 12) was carried out elsewhere.

The assemblage appears to have been influenced by resource constraints imposed by the availability and accessibility of raw material. Initial interpretations suggest that different qualities of raw materials were subject to different reduction strategies intended to produce a range of different debitage and tool elements. Finely grained raw materials (*e.g.*, types 1, 3 and 12) appear to have been primarily targeted for the production of blades and bladelets, whilst more coarsely grained materials (*e.g.*, types 2 and 4) are more often present as irregular flakes. In terms of secondary technology, more coarsely grained flakes were often retouched into a range of non-standard tools including retouched flakes, scrapers and notches. In contrast, small blades and bladelets, often manufactured on more finely grained raw materials, were more commonly targeted for the production of more standardised tool types such as perforators or truncations. Experimental reduction shows that whilst some finely grained raw material types (*e.g.*, types 1 and 3) occur locally, often in 'pockets' within cobbles that are characterized by a more coarse-grained matrix, other types appear to have been collected from primary (geological) sources further afield (*e.g.*, type 12). Regardless of their original source, these more finely grained and higher quality raw material types were the focus of the skilled production of small blades and bladelets, which were then subsequently targeted for the manufacture of a specific range of tool types. The relatively high degree of preparation, trimming and changes in core platform orientation visible on cores produced from these high quality materials further supports this interpretation.

Typologically, the assemblage is dominated by non-formal tool types, including irregularly retouched flakes and blade/lets. Formal tool types include burins, bifacial pieces (including tranchet sharpened axes and chisels), backed blades, glossed pieces, bitruncations and perforators. The lack of typical PPNA points in the assemblage is notable and the only PPNA points in the assemblage have been tentatively classified as an atypical variety of the Salibiya point. Burins take a wide range of forms and are manufactured on a range of raw materials, although these appear to be predominantly manufactured on high quality raw materials. Perforators are an abundant tool type, as is typical of the southern Levantine PPNA, and at el-Hemmeh this tool class is represented by a range of awls and borers. It is noteworthy that awls are generally of irregular form, featuring short robust tips, set at an angle to the main axis of the blank. As such, it is unlikely that the majority of these could have served as hafted perforators or drill bits as has been suggested at other PPNA sites (Smith S. 2007; Ronen *et al.* 1994). However, the assemblage does include a range of symmetrical retouched burin spalls, which may have functioned in this manner.

More generally, a defining feature of the el-Hemmeh assemblage is that tools manufactured on bladelets do not exhibit the strong preference for bilateral symmetry that is characteristic of southern Levantine PPNA assemblages (Nadel 1994). It may be that symmetrical bladelet tools may have been replaced at el-Hemmeh by symmetrical tools manufactured on burin spalls. From a functional perspective (*e.g.*, Grace 1989), it is clear that the tips of retouched burin spalls (*e.g.*, fig. 4: h, j-k) feature bilateral symmetry and could have functioned in a similar way to the symmetrical awls and borers that characterise many other southern Levantine PPNA assemblages. On-going use wear analysis and experimental replication is evaluating this possibility.

The above characterization of the el-Hemmeh assemblage fits relatively comfortably with chipped stone techno-typological traditions described from other PPNA sites in the Southern Levant (*e.g.*, Nadel 1997; Pirie 2007; Dag *et al.* 2010; Sayej 2004). However, the emerging picture also indicates a range of distinctive technological and typological features that distinguish the el-Hemmeh material from several of these southern Levantine PPNA assemblages. Understanding the cause(s) of these distinctive features is a key challenge and these likely reflect raw material availability, site function as well as cultural and chronological factors. Notably, the assemblage appears to contain at least two distinct components. The first of these involved the procurement of relatively high quality raw materials which were used for the skilled production of small

blades and bladelets. These debitage items were then used as blanks for the production of a range of relatively standardised formal tool types including burins, bitruncations, backed blades and perforators. The second component is focussed on the use of locally abundant relatively coarse grained raw materials that were used for non-standardised production of flakes which in turn were fashioned into a range of non-formal tool types in an *ad hoc* manner. The bipartite division of the Late PPNA el-Hemmeh assemblage into 'skilled' and more make-shift components is significant and perhaps foreshadows the more clear differentiation between naviform and *ad hoc* core reduction techniques which characterises MPPNB assemblages in the region (Quintero and Wilke 1995).

#### VARIABILITY WITHIN THE PPNA: AN UPDATE FROM SOUTHERN JORDAN

The unusual technological and typological features of the assemblage from el-Hemmeh, allied to its chronological placement, have the potential to shed light on Late PPNA cultural developments in Southern Jordan, aiding delineation of patterns of chronological and regional variability in the cultural development of the southern Jordanian Neolithic. We should note that this is not an attempt to undertake detailed comparative analyses between southern Levantine PPNA chipped stone assemblages (Sayej 2004) nor is it our aim to extensively review the division of the PPNA into Khiamian and Sultanian industries. Discussion of this, rather vexed, issue is hampered by the lack of reliable and precise dating of PPNA occupations in the region and by considerable methodological variation between analysts in the way in which assemblages are recorded, described, and reported. Rather, the following section will provide a general comparison of key technological and typological features of the el-Hemmeh assemblage with that recovered from other relatively Late PPNA occupations in Southern Jordan, outlining what we see as a more suitable, bottom-up, interpretation of the presently available data.

In terms of the regional picture, the 'unusual' typological, and (to a lesser extent) technological, features of the el-Hemmeh assemblage are also present, to varying degrees, at other PPNA sites in Southern Jordan. The assemblages from ZAD 2 (Sayej 2004; Edwards *et al.* 2004) and WF16 Trench 3 (Pirie 2007; Mithen and Finlayson 2007) have both yielded dates indicating occupation in the latter portion of the PPNA and both share distinctive traits with the assemblage from el-Hemmeh. In both these assemblages projectile points are rare, accounting for just 0.7% (n=11) of the ZAD 2 tool assemblage

and only 2.9% (n=5) of the retouched material from WF16 Trench 3 (Sayej 2004; Pirie 2007). This stands in contrast to other, earlier PPNA collections from Southern Jordan where projectile points form a far larger proportion of assemblages. For example, at Dhra' points comprise 14.4% (n= 203) of tools (Sayej 2004) whilst in the combined assemblage from Trenches 1 and 2 at WF16 points comprise 20.4% (n= 86) of retouched tools (Pirie 2007).

In this context it is noteworthy that at least two distinctive 'el-Hemmeh style' points (which lack any retouch at the tip) were recovered from WF16 Trench 3, where they were classified as truncations (Pirie 2007). On the basis of the overall size and form of these pieces, and the fact that at el-Hemmeh several of these pieces have tip damage that is diagnostic as use as projectiles, we prefer to see these as projectile points whose unusual form may have chronological significance. The presence of tranchet sharpened bifacials at el-Hemmeh is also important. This tool type is present at both the ZAD 2 and WF16 Trench 3 assemblages but is absent from earlier phases (Trenches 1 and 2) at WF16 and from earlier PPNA assemblages from Southern Jordan such as Dhra' (Goodale *et al.* 2002).

The tool assemblages from Late PPNA contexts, including ZAD 2, WF16 Trench 3 and el-Hemmeh, all feature a decline in the proportion of typical PPNA projectile points and the presence of tranchet sharpened bifacials; typological features which distinguish these from earlier PPNA assemblages in Southern Jordan. However, it is important to note that considerable typological variability remains even within this suite of assemblages. For example, burins are extremely rare in earlier PPNA assemblages from the region accounting for *ca* 1% of tool assemblage from WF16 Trenches 1 and 2 and *ca* 0.1% of that from Dhra'. Burins become important relatively abundant at el-Hemmeh and WF16 Trench 3 where they account for 13.2% and 6.9% of the respective retouched assemblages, but constitute only 0.8% of the tools from ZAD 2. This demonstrates typological diversity even within relatively short stretches of space and time.

At the present level of analysis, discussion of technological change within the PPNA of Southern Jordan is necessarily limited. However, similarities with the 'unusual' technological features visible in the el-Hemmeh assemblage may also be found at WF16 Trench 3. Here, Pirie (2007: 248) indicates that the Trench 3 assemblage differs from those derived from Trenches 1 and 2, with respect to raw material usage and core reduction and maintenance strategies. The assemblages from Trenches 1 and 2 show the regular use of locally available wadi cobbles as a raw material source, these are usually medium

grained and opaque, yet the Trench 3 assemblage is characterised by the increased use of a non-local, fine-grained, translucent caramel-brown flint with chalky cortex similar to the el-Hemmeh raw material type 12. The Trench 3 assemblage is also characterised by a greater concern for core maintenance demonstrated by an increase in the proportion of core preparation and maintenance (Pirie 2007).

Although these observations are preliminary and hampered by both a lack of precise chronological control and by inter-analyst variability in the recording and description of assemblages, these data suggest technological and typological trends during the latter portion of the PPNA in Southern Jordan. These trends do not conform easily to the notion of the simple bipartite division of the PPNA into a short lived Khiamian and a longer ‘village based’ Sultanian facies as traditionally defined (*e.g.*, Ronen and Lechevallier 1999). Nor do the present data compare easily with the evidence for a local development of opposed platform (ultimately naviform) blade production as occurs in Late PPNA and EPPNB contexts in the Northern Levant (Abbès 2008). The lack of a naviform component throughout the latest PPNA, and absence of Late PPNA technologies being employed at EPPNB sites in the region is consistent with the earliest PPNB in Jordan representing the movements of groups utilizing naviform core technologies into the Southern Levant (Finlayson *et al.* 2014; Barzilai *et al.* 2007).

The data reported here suggest Southern Jordanian Late PPNA assemblages are characterised by a range of typological and technological features including a sharp reduction in the number of projectile points, the presence of tranchet sharpened bifacials and an increasing concern with core maintenance and the use of relatively high quality, non-local raw materials. Whilst certain aspects of this trend echo those features claimed to be diagnostic of the shift from Khiamian to Sultanian, for example, J. Crowfoot-Payne (1983: 665) argued that: “[...] the Sultanian is a development from the Khiamian, with the gradual addition of core-tools and the disappearance of a microlithic element, and ultimately of the Khiamian point itself.” There are substantial problems with defining the distinctive el-Hemmeh (and indeed the WF16 Trench 3) assemblage as representing the Sultanian. Firstly, the suite of traits which characterise these assemblages appear extremely late in the PPNA sequence, which does not fit the model of a PPNA split into a short lived Khiamian and a longer Sultanian period. Rather, Late PPNA assemblages of the el-Hemmeh type appear to be a short lived Late PPNA phenomenon in Southern Jordan. It is important to note that we are not arguing that the Khiamian and Sultanian do not exist

(either in Southern Jordan or elsewhere); rather we maintain that this simple bifurcation of the PPNA into the Khiamian and Sultanian masks important regional and chronological variability.

So, under what framework should we seek to understand variability in lithic technologies in this unusual period? How do we interpret the increase in the production of burins, at WF16 and el-Hemmeh for example? Pointing out that other sites of the same period feature an increase in such production is a starting point, and does not in itself give us much useful information about past human behaviour. This is far from the first time lithic analysts have become frustrated with the utility of typological designations in providing us with information about past people that we can “hang our hat on” (Tostevin 2012). Aspects of these technological and typological shifts should spur future research into their causes. Are these changing patterns purely ‘cultural’ or are these typological and technological shifts related to shifts in the kinds of work that were being performed at Late PPNA sites?

The marked decline in projectile points may provide a promising avenue for such research. This is a puzzling trend given the numerical importance of projectiles in earlier PPNA (and indeed Natufian and Epipalaeolithic sites) and later PPNB assemblages (Shea 2013) and there are several possibilities concerning their near absence in the Late PPNA, which include:

- 1) Projectile points were produced in similar quantities to the earlier PPNA, but those points were more often deposited away from the types of sites that we are excavating;
- 2) Unmodified blanks were being used as projectile points, and we have not yet identified them;
- 3) Other tool types (*e.g.*, truncations and bitruncations) were being used as components of projectile weaponry, and essentially replaced other points;
- 4) Hunting with stone tipped projectiles was not practiced in the Late PPNA of Southern Jordan.

Ongoing research is evaluating these possibilities, particularly through use wear analysis of the el-Hemmeh and WF16 material. If any of the above turns out to be the case, it will influence how we understand society and economy at the end of the PPNA. Clarifying this question would help us to better understand how these cultures pivoted around the distinctive and heterogeneous subsistence practices in use during the Late PPNA (Finlayson *et al.* 2014), which gives us some context in which to interpret these assemblages. This is one example of a line of inquiry that could be geared towards inferring changes

in past human behaviour based on variation in stone tool technologies across time and space.

## CONCLUSION: A LOCAL STORY...

In summary, this preliminary analysis of the chipped stone assemblage from PPNA el-Hemmeh provides a glimpse of the potential for chipped stone to engage with current Early Neolithic research agendas, which call for a focus on bottom-up construction of models based on site specific data. Whilst the el-Hemmeh assemblage is broadly consistent with current definitions of PPNA chipped stone assemblages, it contains a range of technological and typological traits which push the boundaries of these definitions. Moreover, these distinctive features are shared, to various degrees, by assemblages from other sites in Southern Jordan, including WF16 Trench 3 (Pirie 2007) and ZAD 2 (Sayej 2004). On this basis we suggest that these assemblages should be understood as a distinctive, indigenous southern Jordanian cultural entity, the 'Late PPNA'.

The Late PPNA is not defined solely on typological grounds but also includes a preliminary technological dimension. As such, the shift to the Late PPNA in Southern Jordan seems more likely to be grounded in wider cultural transformations and is less likely to represent intra-site sampling issues, taphonomic processes, or allegations of functional variability, which have stymied the division into Khiamian and Sultanian (*e.g.*, Garfinkel and Nadel 1989; Sayej 2004). Such a shift, encompassing raw material collection, core reduction and maintenance as well as changes in the presence/absence and frequency of specific tool types suggests a wider transformation in PPNA lifeways than that represented by typological change alone, and represents the outcome of a new range of technological choices (Lemmonier 1993) made by PPNA tool makers. Further, the shift to the Late PPNA appears to be accompanied by concurrent shifts in architecture, in particular the use of free-standing stone buildings, and the emergence of new animal exploitation strategies (Finlayson *et al.* 2014). Whilst our analyses are ongoing and more detailed and comparative work is clearly required to better define the technological and typological

features of the Late PPNA in this region, we believe that these data suggest significant potential for PPNA chipped stone to address Early Holocene cultural developments in a fluid and flexible manner. Indeed it is this kind of bottom up data that should form the building blocks of a research agenda concerned with exploring local responses, adaptations and transformations associated with the origins of the Neolithic.

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