The Wadi Madamagh (Petra Region, Jordan) Late Upper Paleolithic and Initial/Early Epipaleolithic Lithic Components

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ABSTRACT

Wadi Madamagh is a key site for the Late Upper Paleolithic and the Initial/Early Epipaleolithic in the Petra region of Jordan. First excavated in 1956 by Diana Kirkbride, it was subsequently tested in 1983, and excavated by two separate teams in the summer and fall of 2011. The approaches to classifying and describing the lithic industries thus have varied as a result of different technological and typological systems used by the various teams, as well as the accumulating regional data for these two temporal periods over the more than six decades since Kirkbride's excavations. Several of the authors (DIO, MN, DS, and BFB) were responsible for these separate lithic analyses and the 1983 (DS) and 2011 (DIO, MN, DS) excavations. Here, we examine our previous lithic analyses for Wadi Madamagh and then integrate these into a single set of analyses to produce a unified description for the Late Upper Paleolithic and Initial/Early Epipaleolithic at this site. Additionally, there are recently obtained calibrated radiocarbon dates for the two occupations at Wadi Madamagh. We assess these two lithic components from Wadi Madamagh in the context of the Petra region (Sabra 4-Palmview 3, Sabra 3 North, Taibeh, and Sabra 3 South). Finally, we examine the Late Upper Paleolithic and Initial/Early Epipaleolithic at Wadi Madamagh from the perspective of the eastern (inland) Levant using comparisons to the two well-investigated regions of the Wadi al-Hasa and the Azraq Basin to the northeast.

INTRODUCTION

The Late Pleistocene rockshelter site of Wadi Madamagh is in the Petra region of the western highlands of Jordan (Figure 1) and is a key site in examining hunter-gatherer strategies in an area of prehistoric Mediterranean forest with in-stream wetlands and a nearby lake (Abu-Jaber et al. 2020a; 2020b; Ramsey and Rosen 2016). It is in a small branch wadi to the Wadi Madamagh, which drains into the Wadi Abu Allelqa in the lower Petra area where numerous Nabatean and Roman ruins are present (Kirkbride 1958: 55). Downward cutting of the branch and main wadis has resulted in the site being somewhat perilously perched above the current channel and subject to erosion (Figure 2). In this paper, we examine the lithic assemblages recovered from the excavations of four different projects. In doing so, we compare the results of the analyses of three sets of lithic

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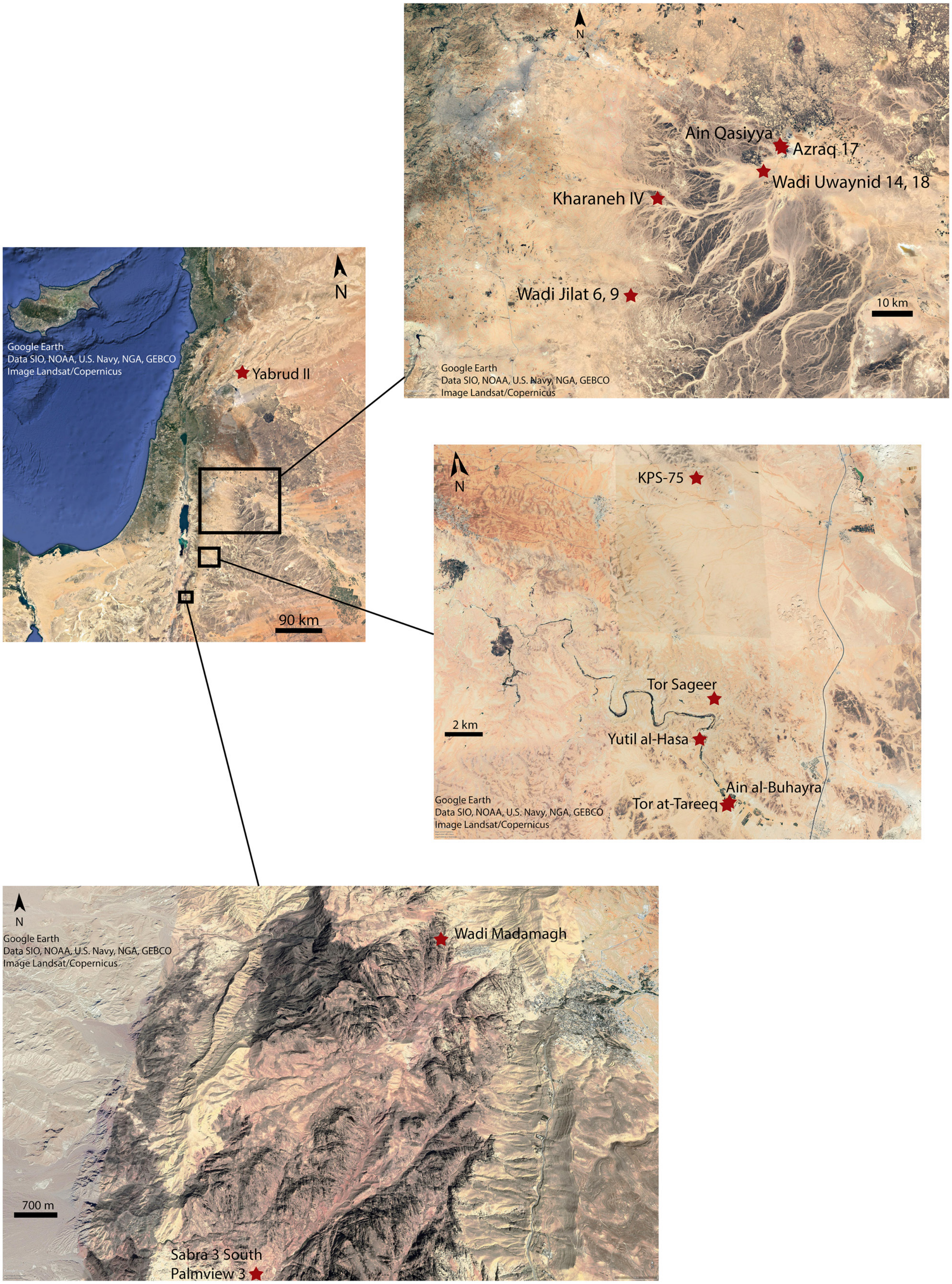

Figure 1. Locations of the sites discussed (maps compiled by D.I. Olszewski; all base images from Google Earth, Landsat/Copernicus, Data SIO, NOAA, U.S. Navy, NGA, GEBCO).

Figure 2. Wadi Madamagh in Summer 2011 looking SW. The white sandbags on the slope are approximately where Kirkbride's Trench B was situated, while the seated individual in the rockshelter to the right of the juniper tree is immediately adjacent to Kirkbride's Trench A. The individual in the center is in the North Area of the site (photograph by D.I. Olszewski).

analysts (DIO and MN, DS, BFB) and then reconcile these to produce a comprehensive overview of the typology, technology, and interpretations that can be drawn from the attributes of the lithic assemblages from this site. We then situate Wadi Madamagh within the context of the Late Upper Paleolithic (LUP) and Initial/Early Epipaleolithic (EPI) both locally (Petra region: HP-S, DS) and more widely (eastern Levant: DIO and MN, BFB).

Wadi Madamagh was first excavated in 1956 by Diana Kirkbride (1958), who placed two trenches running (approximately E-W) from the back wall of the rockshelter to the front (Figure 3). The trenches were each ca. one-meter wide, with about a one-meter baulk separating them. In her brief publication, she regarded all the lithics as belonging to the same period (now called the Epipaleolithic). Kirkbride did not backfill her two trenches. In order to understand the site better, in 1983, one of us excavated a small test section along the southern wall of Kirkbride's Trench A (Schyle and Uerpmann 1988). A relatively small sample of lithics was obtained and resulted in the preliminary recognition of two lithic components, one characteristic of the LUP and the other of the Initial/Early EPI. More recently, one of us reanalyzed a portion of the Kirkbride lithic assemblage (Byrd 2014), the results of which agree with the two lithic component assessment of Schyle and Uerpmann (1983). Both lithic components are typified by the manufacture of microliths, although the predominant types differ for the two temporal periods. In 2011, a team led by two of us returned to Wadi Madamagh to conduct excavations in portions of the remaining archaeological deposits (Olszewski and al-Nahar 2011), which have been severely degraded over the decades partially due to the open Kirkbride trenches. This research also supported the classification of lithics to the LUP and the Initial/Early EPI, as well as providing a series of radiocarbon dates for the two temporal periods. Finally, one of us also excavated in the main area of the site in 2011 (Schyle 2015), continuing the work begun by DIO and MN. These excavations were in the remnant LUP component in that portion of the site.

The degradation of the remaining archaeological deposits is due to the collapse of the sides of Kirkbride's trenches and to rodent bioturbation, which appears to have occurred after Kirkbride's excavations at the site (see Comparison and Stratigraphic Discussion of the Sections Recorded in 1956, 1983, and 2011). As such, a few intrusive Initial/Early EPI elements are now present in the LUP assemblages. The 1956 excavations have 6 microburins/Krukowski microburins (see Table 2 below), 12 complete backed microliths, and 18 backed fragments (see Table 5 below) typical of the Initial/Early EPI in the LUP occupa-

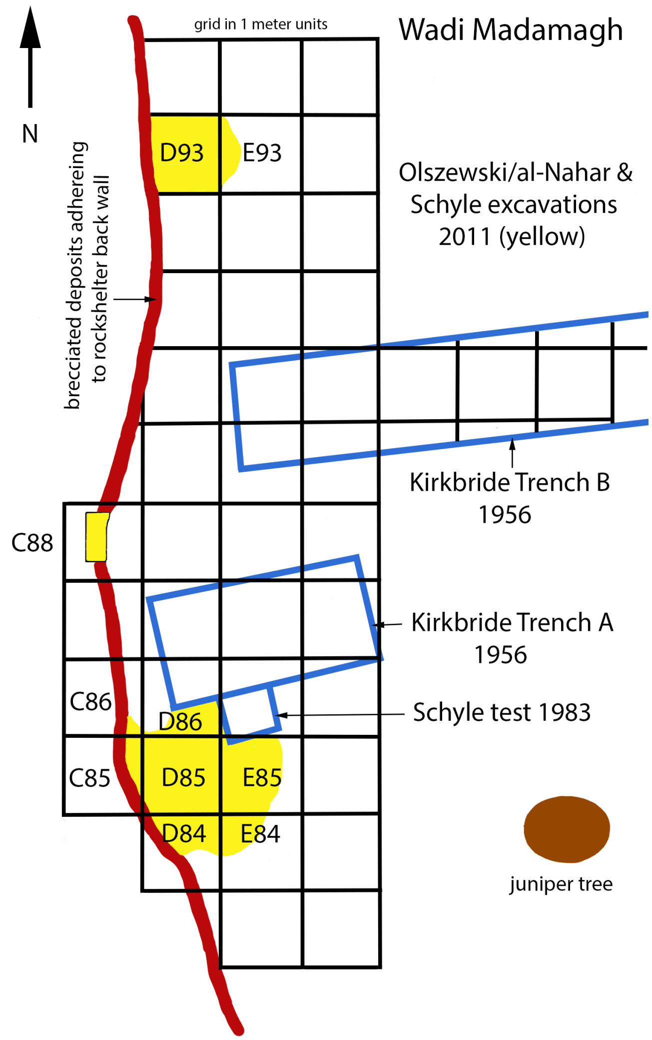

Figure 3. Plan map showing the excavations at Wadi Madamagh (map by DI Olszewski). The irregularly shaped 2011 excavations (yellow) are related to the extent of the remnant archaeological deposits. Boundaries of the Kirkbride trenches are approximate. The brown oval represents the base of the juniper tree trunk.

tion (Trench B lower). The 1983 sounding has 3 microburins and 10 backed microliths that could be attributed to the Initial/Early EPI in its LUP deposits (see Table 1 below). For the excavations in the LUP deposits in Summer and Fall of 2011, there are 14 microburins/Krukowski microburins (see Table 7 below) and 15 backed microliths (see Tables 11 and 13 below), which likely are derived from the Initial/Early EPI. However, as is noted later (see The Fall 2011 Wadi Madamagh Excavation and Analysis), a comparison of lithics recovered from rodent burrows and from surrounding undisturbed deposits showed minimal differences in the lithics. Thus, while there is evidence for intrusive elements in the LUP, the scale of this does not appear to have affected the overall characterization of the two temporal components at the site.

DISCUSSION OF THE WADI MADAMAGH LITHIC ASSEMBLAGES

The different projects, excavation seasons, and lithic analysts who have worked with the Wadi Madamagh assemblages created a situation in which somewhat dissimilar assessments of the classification of the lithic elements resulted. Several of us (DIO, MN, DS, BFB) performed all the analyses, and although these generally agree on the overall character of the LUP and Initial/Early EPI (Nebekian) at the site, they provide a good example of the disparate effects of lithic analyst perspectives on classification. The three sets of analyses are first described, and then reconciled based on discussions between the authors to produce a single, unified data set. The descriptions of the initial analyses are important because they provide some details that are not available in the combined analyses (due in part to the necessity of collapsing some categories and/or rearranging them so that the reconciliation of the different analyses could be accomplished). We present these in the order in which they were published.

THE 1983 WADI MADAMAGH SOUNDING AND ANALYSIS

In 1983, Kirkbride's (southern) Trench A was still comparatively well preserved, while her Trench B had completely collapsed and only was recognizable by a dense scatter of surface bones and artifacts. Due to the very restricted time available, it was decided to make a very limited stratigraphic "recut" into the southern section of the trench, which still had upper deposits preserved compared to the northern face of the trench. This "recut" was approximately 70 cm wide (E-W) and 20 cm long (N-S) (Figure 4) and was dug according to the strata recognizable in the section (Schyle and Uerpmann 1988: Figure 6). The thicker "natural strata" were subdivided arbitrarily into 10cm spits. The sounding was done over two days and all excavated sediments were dry sieved with a mesh of 1mm.

During excavation, it was clear that the recovered artifacts were of a different kind than those described by Kirkbride (1958) in her preliminary report. While there were some backed bladelets on and close to the surface, the majority of the microliths were represented by marginally retouched bladelets and, closer to the base of the section, by inverse retouched, comma shaped bladelets, also known as Dufour bladelets of the Roc de Combe subtype—as defined in French Classic Aurignacian assemblages (Demars and Laurent 1992: 102). After analysis, the finds from the stratigraphic subdivisions were combined into three separate assemblages with 7, 25, and 58 total tools respectively, according to the predominating microlith types—backed bladelets in the smallest topmost assemblage (surf-A1), exterior retouched ("Ouchtata") bladelets in the middle (A2–A4), and inverse retouched ("Dufour, Roc de Combe type") bladelets in the lowermost assemblage (A5–E3) (Table 1). While keeping in mind the small size of these assemblages, this sequence was tentatively interpreted to indicate the succession of a later UP "aurignacoid" industry at the base, followed by a final UP exterior retouched

Figure 4. The 1983 test sounding south of Kirkbride's Trench A (photograph by D. Schyle).

TABLE 1. THE 1983 LITHICS ANALYSIS OF THE WADI MADAMAGH SOUTH WALL SOUNDING IN TRENCH A (cf. Schyle and Uerpmann 1988).

Tools	surf-A1		A2–A4		A5–E3	
	n	%	n	%	n	%
Endscrapers	-	-	2	8.0	2	3.4
Burins	-	-	1	4.0	2	3.4
Retouched pieces	1	14.3	1	4.0	9	15.5
Subtotal Macrotools	**1**	**14.3**	**4**	**16.0**	**13**	**22.4**
Broken backed bladelets	4	57.1			4	6.9
Truncated backed bladelets	1	14.3	4	16.0		
Pointed backed bladelets	1	14.3	1	4.0	1	1.7
Subtotal Backed Bladelets	**6**	**85.7**	**5**	**20.0**	**5**	**8.6**
Inverse retouched bladelets	-	-	3	12.0	35	60.3
Exterior retouched bladelets	-	-	13	52.0	5	8.6
Subtotal Microliths	**6**	**85.7**	**21**	**84.0**	**45**	**77.6**
Total Tools	**7**		**25**		**58**	
Flakes	33	39.3	191	54.6	468	62.6
Blades	19	22.6	30	8.6	27	3.6
Bladelets	27	32.0	124	35.4	244	32.6
Cores	4	4.8	3	0.9	7	0.9
Microburins	1	1.2	2	0.6	1	0.1
Burin spalls	-	-	-	-	1	0.1
Total Debitage and Cores	**84**		**350**		**748**	
Chunks	-	-	7	1.8	13	2.1
Chips (unretouched pieces < 1g)	66	100	381	98.2	603	97.9
Total Debris	**66**		**388**		**616**	
Grand Total	**150**		**738**		**1,364**	

TABLE 2. LITHIC ANALYSIS OF THE 1956 WADI MADAMAGH ASSEMBLAGE (n in parentheses; cf. Byrd 2014).

	Trench A Deposits 4, 10, 12	Trench B Upper Deposits 1, 4, 6	Trench B Lower Deposits 7, 14, 17, 20, 21	Total %	Total n
Blade/bladelet	39.7 (186)	40.0 (181)	40.7 (440)	40.3	807
Flake	44.7 (209)	42.0 (190)	42.1 (455)	42.7	854
Core trimming element	-	0.2 (1)	-	0.1	1
Microburin	-	-	0.3 (3)	0.2	3
Krukowski microburin	0.2 (1)	1.8 (8)	0.3 (3)	0.6	12
Burin spall	-	-	0.2 (2)	0.1	2
Overshot blade	-	0.2 (1)	0.5 (5)	0.3	6
Primary element	5.3 (25)	5.1 (23)	6.8 (73)	6.0	121
Core	3.6 (17)	4.6 (21)	4.8 (52)	4.5	90
Tool	6.4 (30)	6.0 (27)	4.4 (47)	5.2	104
Subtotal (n)	**468**	**452**	**1,080**		**2,000**
Debris (n)	491	98	333		922
Indeterminate (n)	341	127	454		922
Overall Total (n)	**1,300**	**677**	**1,867**		**3,844**

bladelet dominated "Late Ahmarian"/"Masraqan" (Coinman 1993; Goring-Morris and Belfer-Cohen 1997, 2018) and finally a topmost Early EPI, nongeometric backed bladelet "Nebekian"/"Kebaran" industry (Byrd 1988; Kirkbride 1956; Olszewski 2006).

Two conventional radiocarbon dates on combined bone samples in the 1980s yielded results that were much too recent, most probably caused by inferior preservation of the bone samples. Today, these samples would have been refused by the laboratory due to scant collagen for measurement and thus the resulting dates from 1983 have to be rejected. Although the poor quality of the samples was stated in the preliminary report about the 1983 sounding, the dates led to a fundamental misunderstanding of the Wadi Madamagh finds (see Henry and Garrard 1988) that has been since criticized (Byrd 1988), but finally clarified only recently (Garrard and Byrd 2013; Olszewski 2006).

ANALYSIS OF THE 1956 WADI MADAMAGH ASSEMBLAGE

Although Kirkbride (1958) briefly reported on the lithics from the 1956 excavation, where she attributed all the materials to what is now called the Epipaleolithic, she never completed or published a full analysis of the assemblage. However, working with Kirkbride in the 1980s, particularly with regard to accessing her field notes, stratigraphic drawings, and photographs of the 1956 excavation, and relocating the lithic collections (aside from microliths that Kirkbride had taken out of Jordan for study), one of us (BFB) was able to study portions of the 1956 assemblage (Byrd 2014). Unfortunately, years of storage under less-than-ideal conditions resulted in deterioration of many of the cloth bags and associated tags information, so that a comprehensive study of the 1956 assemblage was not possible. Instead, only material in clearly labeled bags such that their association was definitive were focused on. Given that many of the contexts had been sorted in the 1950s (variously into debitage, cores, larger tools, and microliths), somewhat different depositional contexts were available today for each set of analyses (e.g., total assemblage analyzed vs. cores vs. macrotools vs. microliths). After completion of the analysis, the site assemblages were separated into three divisions for the materials based on the stratigraphy (as discerned from field notes and section drawings) and apparent differences in the flaked stone samples—lower Trench B, upper Trench B, and Trench A. The 1956 assemblage thus includes materials (Trench B) from an area of the site not investigated by later excavations in 1983 and 2011, with the possible exception of a small unit in the far northern part of the site dug in Summer 2011 (see below). These three contexts can then be analyzed separately to examine potential temporal and spatial patterns in lithic technology.

The three main contexts distinguished from the 1956 excavations have very similar relative frequencies of artifact classes (Table 2). Flakes are somewhat more common than blades/bladelets, and primary elements are relatively well-represented. Core trimming elements, core tablets, overshot blades, and burin spalls are rare. Cores and tools are present in moderate frequencies, although it is possible that some of these artifacts had already been removed from the bags, biasing the percentages in this table. Microburins are rare and trihedral points (the other half of the bladelet truncated by the microburin technique that has not been further modified: see Tixier 1963) are absent. Krukowski

TABLE 3. CORES FROM THE 1956 WADI MADAMAGH ASSEMBLAGE (n in parentheses; cf. Byrd 2014).

	Trench A Deposit 3	Trench B Upper Deposits 1, 2, 4, 5	Trench B Lower Deposits 7, 14, 17, 20, 21	Total %	Total n
Blade/bladelet					
single platform	73.7 (14)	58.7 (54)	52.9 (18)	59.3	86
opposed platform	10.5 (2)	12.0 (11)	14.7 (5)	12.4	18
90-degree platform	5.3 (1)	10.8 (10)	11.7 (4)	10.3	15
Flake	-	8.7 (8)	8.8 (3)	7.6	11
Fragment	10.5 (2)	9.8 (9)	11.7 (4)	10.3	15
Overall Total (n)	**19**	**92**	**34**		**145**

microburins (i.e., manufacturing failures during bladelet backing), are more frequent, especially in Trench B Upper.

Cores from the 1956 sample are typically single platform blade/bladelet cores (59.3%)—other core classes range from 7.6%–12.4% of the assemblage (Table 3). The most notable difference between site components is the higher relative frequency of single platform blade/bladelet cores in Trench A and a correspondingly lower frequency of 90-degree opposed platform blade/bladelet cores. Flake cores, in contrast, are most frequent in Trench B Lower (12.5%). There are also component differences between types with each class (see Byrd 2014: Table 3). Single platform blade/bladelet cores are typically subpyramidal, followed by pyramidal and then one-face types. However, Trench B Lower lacks single platform pyramidal cores, and has a much higher frequency of one face single platform blade/bladelet cores.

Table 4 presents the macrotools by category, although differences in relative frequency of major classes between contexts should be treated with caution given the small samples. End scrapers are the most common class and include a wide range of tool types dominated by simple end scrapers. Retouched pieces, along with notches/denticulates (dominated by denticulates with small notches) are also well-represented. Burins (with those on breaks or natural surfaces the most common), truncations, and perforators/drills are also present.

Based on complete tools, the microlith assemblage is dominated by curved pointed/double arched backed pieces (Table 5; Figure 5; see also Byrd 2014). Also common are inverse retouched bladelets, complete double truncated symmetrical pieces, and complete pieces with one truncation. Other tool types are infrequent, including La Mouillah points, pointed pieces with bilateral retouch, complete pointed pieces with no end modification, various backed pieces, and lunate forms. Overall, the backed tools are typically thin and narrow.

Notable differences in the relative frequency of microlith tool types occur between contexts. In Trench A, curved pointed/double arched backed pieces are most prevalent, are somewhat less common in Trench B Upper, while they are infrequent in Trench B Lower. Inverse retouched bladelets (Dufour bladelets), in contrast, dominate Trench B Lower, while they are much less common in Trench B Upper, and infrequent in Trench A. Several other trends can be discerned, including the higher frequency of La Mouillah points in Trench A, the higher frequency of complete backed tools with one truncation in Trench B Upper, and

TABLE 4. MACROTOOLS FROM THE 1956 WADI MADAMAGH ASSEMBLAGE (n in parentheses; cf. Byrd 2014).

	Trench A Deposits 1, 12	Trench B Upper Deposits 1, 2, 4, 5, 6	Trench B Lower Deposits 7, 14, 17, 20, 21	Total %	Total n
Endscraper	33.3 (4)	58.3 (28)	58.3 (14)	54.8	46
Burin	8.3 (1)	2.1 (1)	12.5 (3)	5.9	5
Perforator	-	2.1 (1)	-	1.2	1
Truncation	16.6 (2)	2.1 (1)	-	3.6	3
Notch/denticulate	33.3 (4)	10.4 (5)	4.2 (1)	11.9	10
Retouched piece	8.3 (1)	25.0 (12)	25.0 (6)	22.6	19
Overall Total (n)	**12**	**48**	**24**		**84**

TABLE 5. MICROLITHS FROM THE 1956 WADI MADAMAGH ASSEMBLAGE (n in parentheses; cf. Byrd 2014).

	Trench A Deposits 1, 2, 3, 12	Trench B Upper Deposits 1, 2, 4	Trench B Lower Deposits 7, 14, 17, 20, 21	Total %	Total n
Complete examples					
Lunate	1.0 (2)	-	-	0.6	2
La Mouillah point	7.1 (14)	2.2 (2)	2.8 (1)	5.2	17
Falita point	3.6 (7)	1.1 (1)	5.5 (2)	3.1	10
Curved pointed/ double arched backed	43.4 (85)	31.5 (29)	8.3 (3)	36.1	117
Arched backed with modified base	3.1 (6)	1.1 (1)	2.8 (1)	2.5	8
Double truncated, symmetric	14.7 (29)	13.0 (12)	2.8 (1)	12.9	42
Double truncated, asymmetric	1.5 (3)	3.2 (3)	-	1.9	6
One truncation	7.1 (14)	16.3 (15)	-	9.0	29
One truncation with modified base	1.5 (3)	1.1 (1)	-	1.2	4
Pointed, unmodified ends	1.0 (2)	4.3 (4)	2.8 (1)	2.2	7
Partially backed	1.0 (2)	-	-	0.6	2
Double backed	3.1 (6)	3.2 (3)	2.8 (1)	3.1	10
Inversely retouched	6.6 (13)	15.2 (14)	61.1 (22)	15.1	49
Various backed	5.1 (10)	7.6 (7)	11.1 (4)	6.5	21
Subtotal (n)	**196**	**92**	**36**		**324**
Broken examples					
Backed with truncations	59.6 (102)	70.5 (74)	16.7 (3)	60.9	179
Backed without truncations	28.1 (48)	26.7 (28)	72.2 (13)	30.3	89
Partially backed	12.3 (21)	2.8 (3)	11.1 (2)	8.8	26
Subtotal (n)	**171**	**105**	**18**		**294**
Overall Total (n)	**367**	**197**	**54**		**618**

the dearth of complete tools with a truncation in Trench B Lower. Backed/retouched fragments with truncations are also rare in Lower Trench B, while backed fragments with truncations are widespread in Trench A and Upper Trench B. When integrated with the other investigations at the site, the three discrete contexts studied from the Kirkbride excavations can be classified temporally as: LUP – Trench B Lower, and Initial/Early EPI: Trench B Upper and Trench A.

THE SUMMER 2011 WADI MADAMAGH EXCAVATIONS AND ANALYSIS

One of the main goals of the 2011 summer season by the Western Highlands Early Epipaleolithic Project (WHEEP; directed by DIO and MN) was to excavate deposits containing the Initial/Early EPI (Nebekian), particularly because severe erosion over the decades after Kirkbride's tests at Wadi Madamagh had resulted in the loss of large portions of the upper layers and the baulk wall between her trenches

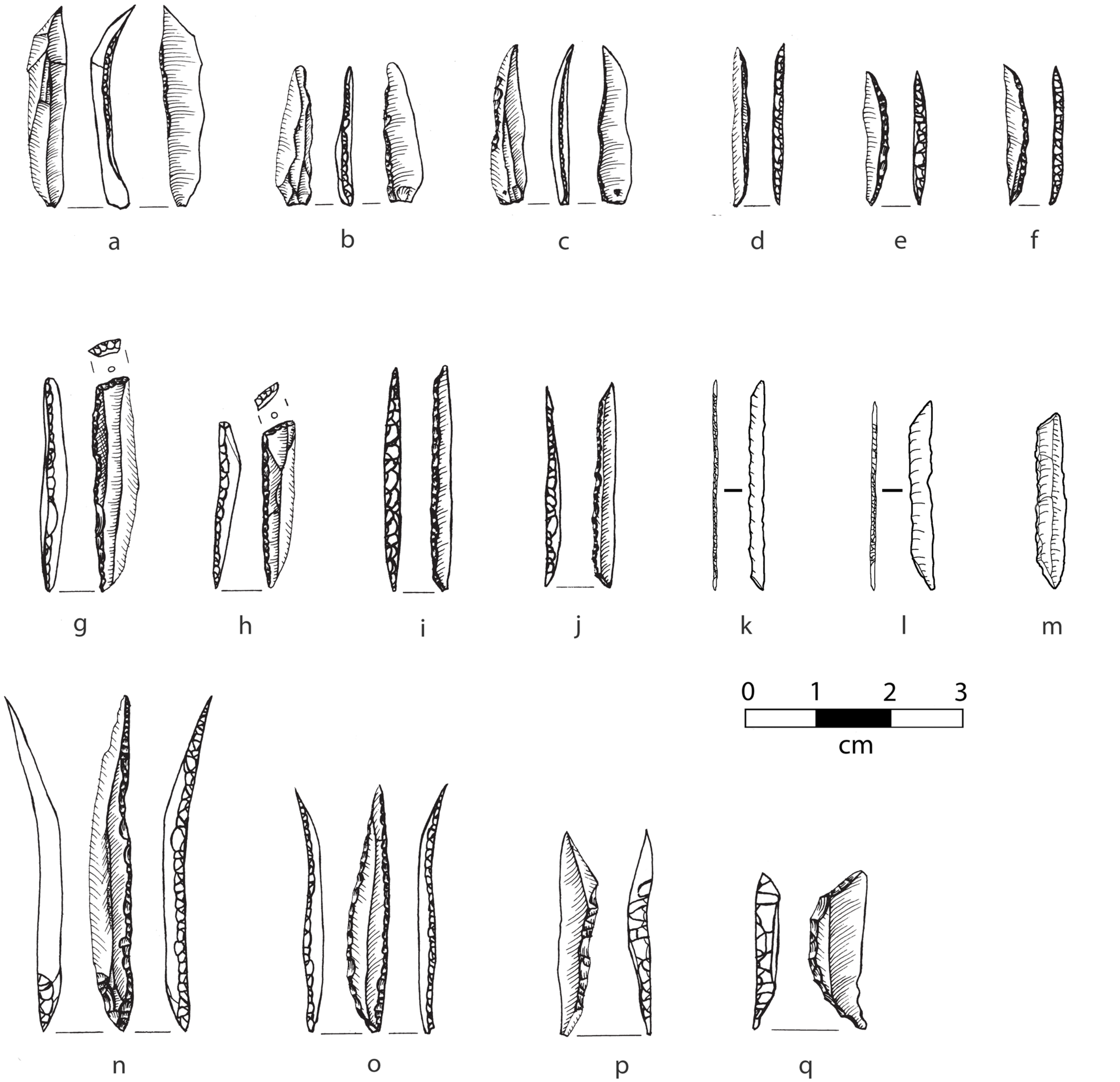

Figure 5. Wadi Madamagh microliths: a–c) LUP Dufour bladelets ; d–f: Nebekian (Initial/Early EPI) double arched backed bladelets; g–h) Nebekian backed and truncated bladelets; i–j) Nebekian trapezes; k–m) Nebekian microburin trapezes; n–o) Nebekian pointed backed bladelets; p) Nebekian La Mouillah point; q) Nebekian lunate (all drawings by Lykke Johansen [cf. Byrd 2014], except for k–m by D.I. Olszewski).

(see Figure 10 below). Approximately 1m^2 (to a depth of 55cm) in the north area where remaining deposits are much higher was investigated (see Figure 2). Additionally, a portion of a unit was placed vertically (ca. 0.5m^2) into the brecciated deposits that adhere to the rockshelter back (west) wall, being excavated about 10cm in towards the rockshelter back wall (Figure 6). Finally, units representing about 2m^2 (ranging in depth from 23cm to 40cm) were excavated into the upper deposits still remaining in the "main area" immediately south of Kirkbride's Trench A, where Schyle had dug a section cut in 1983 (see description above; Figure 7). Nebekian materials were recovered from the North area and from the upper breccia (Breccia A); the lower breccia (Breccia B) and the main area yielded LUP materials. In the main area, the overlying Nebekian deposits were lost to erosion or clandestine digging (see below) since 1956 (see Figure 10 below).

Excavation in the Main Area of the site (LUP deposits)

Figure 6. The summer 2011 vertical excavation (Unit C88) into the brecciated deposits adhering to the back (west) wall of the rockshelter at Wadi Madamagh. The green pins mark the approximate boundary between the Initial/Early Epipaleolithic (Breccia A) and the Late Upper Paleolithic (Breccia B; photograph by D.I. Olszewski). Note the more abundant fauna in Breccia B.

was complex with regard to the deposits identified. This is not surprising given that Kirkbride's notes indicate that she recognized several types of depositional contexts. Based on Munsell color, sediment composition, possible features, and intrusive rodent burrows (excavated separately), the Summer 2011 levels were mainly deposits that were adjacent to one another. In other words, the levels are not stratigraphically successional. As an example, at the end of the Summer 2011 excavations, a plan view drawn of the excavations in the Main Area shows that Levels 5, 5b, 6, 6c, 7, 8, 9, 9a, 9b, and 10, in addition to a rodent burrow, were all visible at approximately the same ground elevation. This has implications for the dates obtained for the LUP contexts (see below).

All artifacts and bone over 2.5cm in size were point provenienced using a total station. Sediment from each arbitrary 3cm level within each natural layer in each quad (usually 50cm^2) was collected, point provenienced with the total station to the center of the quad and sieved using 2mm mesh screens. Sediment samples for phytoliths and pollen also were collected; the phytolith analyses are reported in Ramsey and Rosen (2016). Pollen preservation was poor and did not yield results. Faunal analysis also was undertaken (Sadhir et al. 2020; see also Perkins 1966 for initial determinations using the 1956 Kirkbride samples).

Seven charcoal samples were submitted for AMS radiocarbon dating (Table 6). These samples were quite small (primarily charcoal flecks), thus not permitting identification of plant species. Because the excavated levels represent depositional contexts that are not in a stratigraphic succession, dates from levels with higher numbers, e.g., Level 7, are not stratigraphically lower/earlier than levels such as Level 5b. The samples returned a 2σ age range of 23,758–23,124 cal BP for the Nebekian and 25,283–22,930 cal BP for the LUP (calibrated using IntCal20, v4.4 [Reimer et al. 2020]). When using a 1σ range, all but one of the LUP dates are earlier than the Nebekian date, albeit that two of these LUP dates are only slightly earlier (Figure 8). The only LUP calibrated date that clearly overlaps with the Nebekian is the date from Level 7 in unit E85. It is possible this date overlap represents a charcoal fragment displaced downward from the former overlying Nebekian layers; it is also possible that the LUP dates from D84 Level 4 and E85 Level 6, which are just minimally earlier than the EPI date from Breccia A, represent additional displaced charcoal from the Nebekian occupation. One date from the North area produced a result that is too young (see Table 6).

In Table 7, the total debitage for the LUP and the Nebekian collected from the site during the Summer 2011 season is shown, with 8,279 pieces from the LUP and 5,756

Figure 7. The summer 2011 Main Area excavation immediately south of Kirkbride's Trench A, from above and looking NW (photograph by D.I. Olszewski). This view shows the remnant LUP deposits, which are not immediately obvious in the other photographs of the site.

TABLE 6. DATING SAMPLES FROM WADI MADAMAGH 2011 SUMMER EXCAVATIONS (all samples=charcoal).

Unit	Level	Area	Lab #	^{14}C Age (bp)	±	Cal BP* 1σ	Cal BP (95.4%)* 2σ	Comment
C88	Breccia A	wall breccia	AA103871	19,437	96	23725-23543 (32.6%) 23424–23223 (35.7%)	23,758–23,124	Nebekian
D93	2	north area	AA103872	12,085	69	14062–13991 (26.7%) 13943–13852 (35.0%) 13833–13812 (6.6%)	14,096–13,796	too young
D84	4	main area	AA103873	19,680	120	23837–23716 (33.0%) 23564–23407 (35.3%)	23,930–23,291	LUP
D85	5**	main area	AA103874	20,570	120	24986–24602 (68.3%)	25,118–24,330	LUP
E85	5b**	main area	AA103875	20,760	110	25200–24909 (68.3%)	25,283–24,664	LUP
E85	6**	main area	AA103876	19,510	140	23753–23655 (15.7%) 23640–23330 (52.5%)	23,805–23,118	LUP
E85	7**	main area	AA103877	19,250	150	23668–23629 (5.1%) 23341–22994 (63.1%)	23,450–22,930 (75.7%) 23,741–23,511 (19.7%)	LUP

*calibrated using IntCal20, v4.4 (Reimer et al. 2020)
**these levels are adjacent in the Main Area of the site; they are not stratigraphically successional

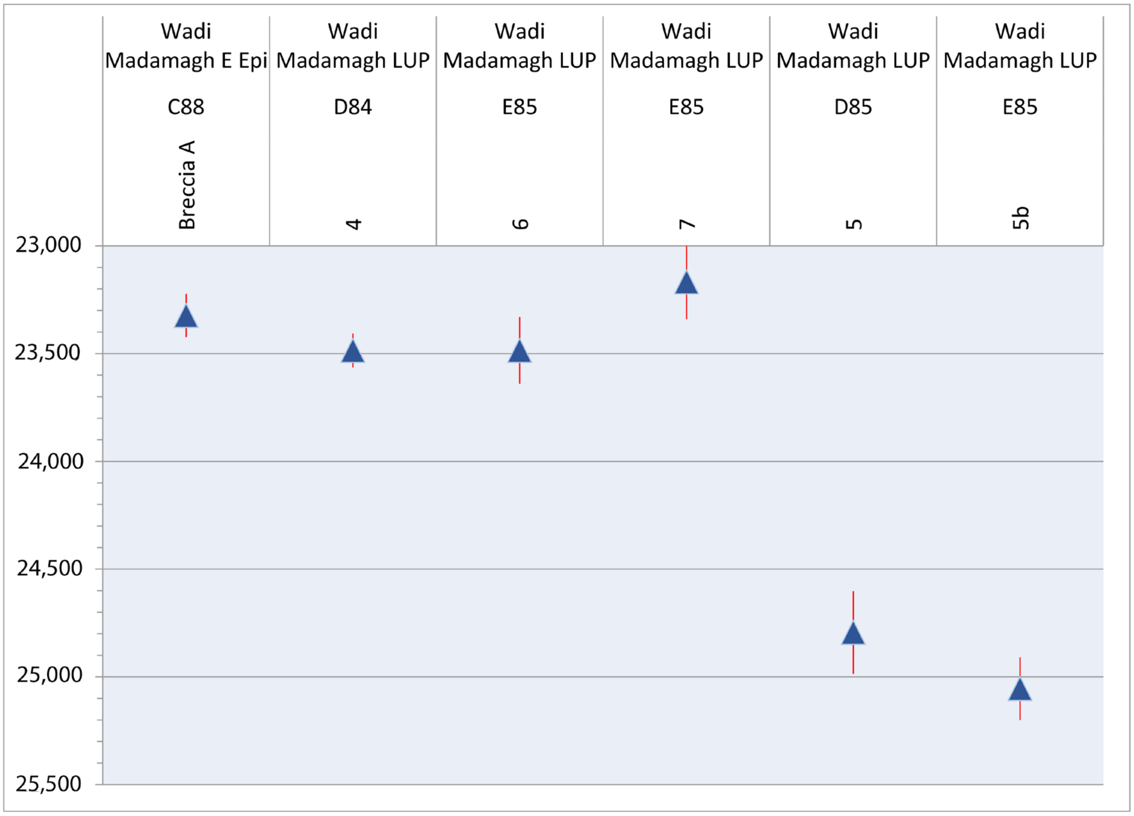

Figure 8. Calibrated BP dates from the Nebekian EPI and LUP deposits at Wadi Madamagh, shown at 1σ (IntCal20, v4.4 [Reimer et al. 2020]). Note that LUP Levels 5, 5b, 6, and 7 are adjacent to one another rather than in stratigraphic succession.

pieces from the Nebekian deposits. The medial/distal debitage category refers to non-proximal flake, blade, and bladelet fragments. Proximal flakes, blades, and bladelets are counted in the flake, blade, and bladelet categories. The small fraction (small flakes, small bladelets, medial/distal fragments of small debitage, and shatter) overwhelms the other categories.

In Table 8, the small fraction is excluded. The LUP occupation is more flake-oriented than the Nebekian. This discrepancy may be due to the higher frequency of medial/distal fragments in the Nebekian. There are slightly more blades in the Nebekian occupation compared to the LUP. However, both occupations produced almost equal frequencies of bladelets (LUP 15.1%; Nebekian 14.8%). The Nebekian also is characterized by microburins, while the few microburins in the LUP most likely are taphonomically displaced from the overlying Nebekian.

Table 9 details the Summer 2011 Wadi Madamagh core types from the LUP and Nebekian deposits. The relatively few cores in the Nebekian may mean that the frequencies of types for this occupation should be regarded with some caution. The LUP occupation is dominated by flake cores, while the Nebekian is characterized by bladelet cores. There also are somewhat more mixed cores in the Nebekian compared to the LUP occupation. Fragmentation of cores was more common in the LUP. Additionally, the LUP occupation has more of the core-on-flake type (cores made on flake blanks, some of these cores can be considered "carinated") than the Nebekian.

In the LUP deposits, regardless of blank type (flake, blade, bladelet) removed from a core, the most common type of core is single platform. This also is true for the mixed core category. In the Nebekian, this pattern also is characteristic of bladelet cores, but less so for the other core categories. In the bladelet and mixed core categories in the Nebekian occupation, frequencies of 90-degree platform and opposed platform types are slightly higher than in the LUP.

Table 10 shows the major tool classes. In both the LUP and the Nebekian, the dominant tools are the microliths. The LUP occupation is characterized by the macrotool classes of notch/denticulates, endscrapers, retouched pieces, and burins. Although Special Tools are not frequent, in the LUP these consist mainly of sidescrapers, which, in combination with endscrapers, might indicate a scraper tool focus. Given the high frequency of both microliths and microlith fragments in the Nebekian occupation, the only other relatively common tool class is retouched pieces. There also are a small number of endscrapers, burins, and notch/denticulates.

Table 11 shows the typological breakdown of the LUP and Nebekian microliths. Broken microliths were typed if possible. In this case, the proximal and distal fragments of potentially identifiable microlith fragments were counted.

TABLE 7. ALL DEBITAGE FROM THE 2011 WADI MADAMAGH SUMMER EXCAVATIONS (cf. Olszewski and al-Nahar 2011).

	LUP debitage		Nebekian debitage	
	n	%	n	%
Blade				
blade	229	2.7	175	3.0
platform blade	3	0.03	8	0.1
crested blade	-	-	1	0.01
rejuvenation blade	2	0.02	2	0.03
Bladelet				
bladelet	285	3.4	173	3.0
platform bladelet	1	0.01	4	0.07
Core tablet	2	0.02	2	0.03
Flake				
flake	925	11.2	278	4.8
rejuvenation flake	32	0.4	15	0.3
Medial/distal debitage	353	4.2	391	6.8
Burin spall	37	0.5	19	0.4
Microburin	13	0.2	95	1.7
Microburin-Krukowski	1	0.01	2	0.03
Small flakes	2,916	35.2	2,388	41.5
Small bladelets	468	5.7	202	3.5
Medial/distal small debitage	2,452	29.6	1,510	26.2
Shatter	560	6.8	491	8.5
TOTALS	**8,279**		**5,756**	

All medial fragments, as well as a few proximal or distal fragments that were not identifiable to type, were placed in the microlith fragment category. This procedure differs from some other researchers who do not include microlith fragments of any type in the counts and frequencies of specific types (see the reconciled combined microliths in Table 18 below and the discussion of these).

For the LUP occupation, the most common microlith is non-twisted, inversely retouched bladelets followed by twisted Dufour bladelets (see Figure 5). There also are some Ouchtata bladelets. On the other hand, the Nebekian occupation is dominated by double arched backed microliths (see Figure 5), followed by curved microliths (see also Byrd 2014). Curved microliths exhibit only one end with a convex truncation and are wider than the quite narrow double arched backed type. The Nebekian also has more backed and truncated, truncated, and pointed microliths compared to the LUP occupation. La Mouillah points and Qalkhan points are rare in the Nebekian. Finally, there are a small number of geometric microliths (trapeze, microburin trapeze) in the Nebekian; these are most likely variations on the double arched backed type, as they are quite narrow in width, but their truncations are angled rather than curved. In the case of microburin trapezes, these pieces have microburin scars on their ends rather than truncations[1]. There also are a small number of isosceles triangles in the Nebekian.

THE FALL 2011 WADI MADAMAGH EXCAVATION AND ANALYSIS

The Cooperative Research Centre (CRC) 806 based in Cologne, Germany, devoted to the theme of migrations of Anatomically Modern Humans (AMH) from Africa to Europe, and particularly its subproject “Eastern Trajectory,” provided part of the funding for another campaign of excavation at Wadi Madamagh. Although the time range of the Wadi Madamagh occupations did not meet exactly the greater Middle/Upper Paleolithic (MP/UP) target of the CRC-subproject, the excavation was carried out because of the precarious preservation of the site as found during a visit in 2010 (see Figure 11 below). The excavations into the remaining deposits were immediately subsequent to the campaign of WHEEP (see above), which concentrated on the Initial/Early EPI and upper LUP levels. The CRC thus concentrated on the lower part of the LUP levels in the Main Area of the site (just south of Kirkbride’s Trench A;

TABLE 8. DEBITAGE (excluding small fraction) FROM THE 2011 WADI MADAMAGH SUMMER EXCAVATIONS (cf. Olszewski and al-Nahar 2011).

	LUP selected debitage		Nebekian selected debitage	
	n	%	n	%
Blade				
blade	229	12.2	175	15.0
platform blade	3	0.2	8	0.7
crested blade	-	-	1	0.1
rejuvenation blade	2	0.1	2	0.2
Bladelet				
bladelet	285	15.1	173	14.8
platform bladelet	1	0.1	4	0.3
Core tablet	2	0.1	2	0.2
Flake				
flake	925	49.1	278	23.9
rejuvenation flake	32	1.7	15	1.3
Medial/distal debitage	353	18.7	391	33.6
Burin spall	37	2.0	19	1.6
Microburin	13	0.7	95	8.2
Microburin-Krukowski	1	0.1	2	0.2
TOTALS	**1,883**		**1,165**	

see Figure 3). During Fall 2011, about 1.5m² of the remaining deposits in the main area, up to a maximum depth of approximately 80cm, were excavated.

The stratigraphy in this part of the site is complicated and not well understood because the excavated area is small and a large part of both sections was heavily disturbed by animal burrows and natural cracks at crucial locations within the sections. The undisturbed parts were divided into an uppermost deposit of cemented bones and flints, a sandy brownish intermediate deposit, and a lower part of reddish sand; both of the latter are also rich in finds but became poorer in material towards the south. The occupational deposits rest on a sterile wadi deposit at the base. All finds >2.5cm were point provenienced. However, because most of the characteristic pieces are microliths, these were found exclusively during dry sieving and thus are only provenienced according to a quarter m² and stratigraphic units. In hindsight, this makes point proveniencing of predominantly microlithic assemblages a rather time-consuming academic procedure of unfortunately only restricted practical value, particularly when dealing with such small, excavated areas as in Wadi Madamagh.

One of the first steps of lithic analysis was the comparison of the material found in presumably undisturbed contexts to the material found from clearly disturbed contexts (cf. from cleaning and animal burrows) and unexpectedly it turned out that the differences between both contexts were minimal. Given the overall very homogenous character of the assemblage, the finds from all units excavated in Fall 2011 are thus considered as a single assemblage.

The resulting assemblage corresponds more or less to the lowermost assemblage as recovered in 1983. Blank production was overwhelmingly from cores with a single platform and a single flaking surface (Figure 9). About half of the cores are cores on flakes, with most cores on flakes typed as carinated endscrapers (Table 12; see Figure 9). Bladelets were extracted using the ventral (interior) face of thick flakes as a striking platform and exploiting a protruding convex flaking surface shaped by lateral notches. The discarded exhausted cores are difficult to interpret as to the direction of the extraction; judging from the standardized asymmetric shape of the Dufour bladelets, they were extracted in small series from right to left, if looked at from the striking surface in the striking direction on the extraction front. The debitage category in Table 12 shows the total N for the various categories (including all broken debitage) and the MNI for the debitage, which consists of all complete and proximal pieces.

Being poor in macrotools, the dominant (>60% of all tools) tool type is a highly standardized inverse retouched, comma-shaped bladelet that corresponds to what would be classified as Dufour bladelets of the Roc de Combe subtype (Table 13; see Figure 5). Marginally retouched bladelets also are present, but in rather low (10%) percentages, while backed bladelets only occur occasionally (3%) and most probably are admixtures derived from formerly over-

TABLE 9. CORES FROM THE 2011 WADI MADAMAGH SUMMER EXCAVATIONS (cf. Olszewski and al-Nahar 2011).

	LUP Cores		Nebekian Cores	
	n	%	n	%
Flake core	(43)	(26.9)	(5)	(11.6)
single platform	19	11.9	2	4.7
opposed platform	9	5.6	1	2.3
90-degree platform	4	2.5	1	2.3
pyramidal	1	0.6	-	0.0
subpyramidal	3	1.9	-	0.0
discoidal	2	1.3	-	0.0
multiple	5	3.1	1	2.3
Blade core	(3)	(1.9)	(3)	(7.0)
single platform	3	1.9	3	7.0
Bladelet core	(25)	(15.6)	(16)	(37.2)
single platform	17	10.6	12	27.9
opposed platform	1	0.6	1	2.3
90-degree platform	4	2.5	2	4.7
pyramidal	1	0.6	-	0.0
subpyramidal	2	1.3	1	2.3
Mixed core	(18)	(11.3)	(7)	(16.3)
single platform	11	6.9	2	4.7
opposed platform	2	1.3	2	4.7
90-degree platform	2	1.3	2	4.7
subpyramidal	1	0.6	-	0.0
multiple	2	1.3	1	2.3
Core-on-flake	12	7.5	2	4.7
Tested	5	3.1	2	4.7
Core fragment	54	33.8	8	18.6
TOTALS	**160**		**43**	

lying Initial/Early EPI layers. While there were no microburins recovered, the probable admixture includes one La Mouillah point, which by definition has a microburin scar, along with pointed backed bladelets, a scalene triangle, and backed bladelet fragments in the backed + geometric category shown in Table 13.

COMPARISON AND STRATIGRAPHIC DISCUSSION OF THE SECTIONS RECORDED IN 1956, 1983, AND 2011

To get an idea of how the 1956 excavation units of Trench A could be matched with the units from 1983 and 2011, we tried to superimpose the available sections of the southern face of Trench A (Figure 10). Although disappointing in detail, the result, however, helped a bit in understanding what happened to the section after the 1956 excavation. It turned out that 1956's and 1983's sections cannot be fitted satisfactorily over each other, although both were located at approximately the same position, while the 2011 section is shifted about half a meter further south. We fitted the uppermost part of the sediments preserved in 1983 just below the surface of the 1956 section and tried, at least approximately, to match the two differing backwall lines. The emerging picture shows that the different units/levels/layers separated in 1956 and in 1983 do not match at all, probably because: 1) the section of the small 1983 sounding is located about 25cm further south from the 1956 section; and, 2) the old surface of the 1956 section was not cleaned again in 1983. The base of the 1983 section also reaches a depth below the base of the 1956 section. It is also clear that there was considerable clandestine excavation between 1956 and 1983 that removed most of the upper deposits close to the

TABLE 10. TOOLS FROM THE 2011 WADI MADAMAGH SUMMER EXCAVATIONS (cf. Olszewski and al-Nahar 2011).

	LUP Tools		Nebekian Tools	
	n	%	n	%
Endscraper	25	11.0	7	3.7
Burin	13	5.7	6	3.1
Backed piece	-	-	3	1.6
Perforator	-	-	1	0.5
Truncation	-	-	2	1.0
Microlith	118	52.0	106	55.5
Microlith fragment	15	6.6	44	23.0
Notch/denticulate	30	13.2	6	3.1
Retouched piece	16	7.0	13	6.8
Special tool*	7	3.1	3	1.6
Multiple tool	2	0.9	-	-
Varia	1	0.4	-	-
Total	227		191	

*Special tool = mainly single sidescrapers

TABLE 11. ALL MICROLITHS FROM THE 2011 WADI MADAMAGH SUMMER EXCAVATIONS (cf. Olszewski and al-Nahar 2011).

	LUP		Nebekian	
	n	%	n	%
Ouchtata	9	6.8	3	2.0
Dufour	26	19.5	3	2.0
Inverse (other)	62	46.6	6	4.0
La Mouillah	-	-	1	0.7
Qalkhan point	-	-	1	0.7
Double arched backed	2	1.5	36	24.0
Curved	3	2.3	16	10.7
Backed and truncated	2	1.5	7	4.7
Truncated	2	1.5	5	3.3
Pointed	6	4.5	11	7.3
Double backed	-	-	1	0.7
Partially backed	-	-	3	2.0
Elongated scalene triangle	1	0.8	-	-
Isosceles triangle	-	-	3	2.0
Trapeze	2	1.5	1	0.7
Microburin trapeze	-	-	6	4.0
Other	3	2.3	3	2.0
Microlith fragment*	15	11.3	44	29.3
Total	133		150	

*only unidentifiable fragments are included in microlith fragments; most are medial pieces

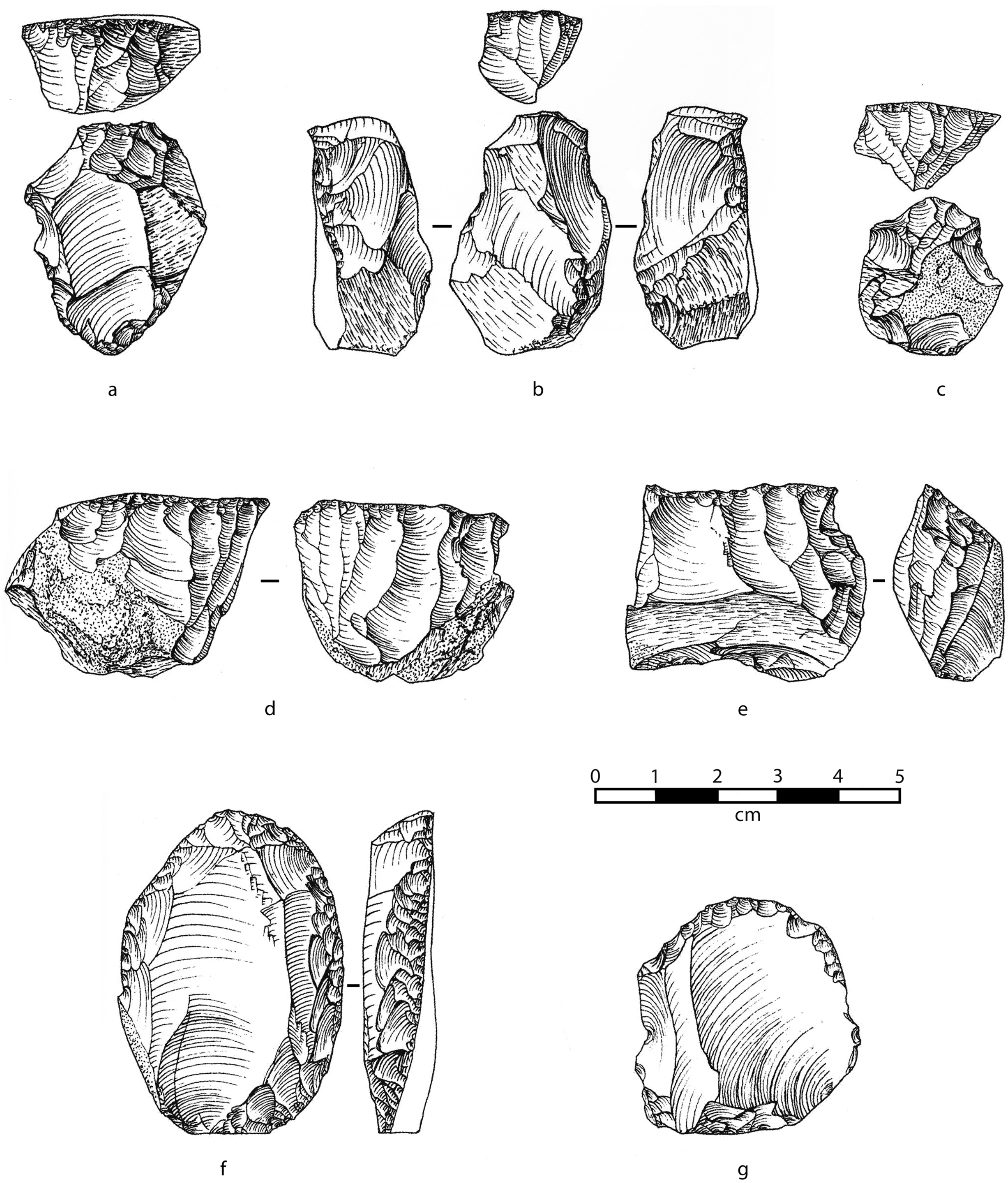

Figure 9. Wadi Madamagh LUP endscrapers and cores. a–c) carinated endscrapers; d–e) bladelet cores; f–g) flake endscrapers (drawings by Irene Steuer/University of Cologne; images permission from Jürgen Richter/University of Cologne; cf. Schyle 2015).

TABLE 12. WADI MADAMAGH FALL 2011: LATE UPPER PALEOLITHIC TOTAL DEBITAGE AND DEBRIS (cf. Schyle 2015).

	n	%	MNI	%
Flake	643	53.0	561	53.8
Blade	91	7.5	85	8.1
Bladelet	445	36.7	362	34.7
Core	35	2.9	35	3.4
Debitage and Core Subtotal	**1,214**	**13.8**	**1,043**	**11.8**
Small flake (<2cm)	2,422	69.5	1,645	75.6
Small bladelet (<2cm)	1,064	30.5	532	24.4
Small Debitage Subtotal	**3,486**	**39.5**	**2,177**	**24.7**
Debris	**4,127**	**46.8**	**-**	
Total	**8,827**		**3,220**	

backwall of the shelter and the uppermost deposits of the slope towards the east as well. This also might explain why in 1983 the trench extended much further towards the east and obviously also was a bit deeper than in 1956. The heap of earth visible in the eastern part of the 1983 section might represent at least part of the backdirt of these destructive activities (see Figure 10). The clandestine excavations removed 1956's Unit A1 completely, as well as large parts of Units A2 and A3 and smaller parts of A11 and A4 close to the backwall.

It is clear that only the very uppermost deposits of Trench A in 1956 (A1) parallel the uppermost part (Surface to A1=Nebekian) from 1983, while 1956's Unit A2 might belong partially to the LUP deposit. There actually is a small part of the stratigraphy sandwiched between the "pure" Nebekian above and "pure" LUP deposits below, in which both phases are mixed to some extent with each other and cannot be clearly separated from the two "pure" deposits. All deposits at Wadi Madamagh are believed to represent many superimposed occupations and thus even the "pure" deposits contain palimpsest assemblages that accumulated more or less continuously during long periods of perhaps up to thousands of years.

The recording of animal burrows in 1983 and 2011 shows that most of the disturbance by rodent activities probably started only after the 1956 excavation and thus are very recent, affecting mainly the area south of the south face of the 1956 Trench A. While only two smaller rodent burrows were recorded in 1983, almost half of the 2011 trench face (located ca. 50cm further south) was affected by

TABLE 13. WADI MADAMAGH FALL 2011: LATE UPPER PALEOLITHIC TOTAL TOOLS (cf. Schyle 2015).

	Cleaning etc.			Excavated Deposits			Total		
	n	%T	%Mic	n	%T	%Mic	n	%T	%Mic
Endscrapers	1	1.9	-	12	6.5	-	13	5.4	-
Retouched pieces	5	9.4	-	14	7.5	-	19	7.9	-
Notch/denticulates	-	-	-	1	0.5	-	1	0.4	-
Truncations	-	-	-	2	1.1	-	2	0.8	-
"Dufour"	34	64.2	72.3	104	55.9	66.2	138	57.7	67.6
Inverse (other)	2	3.8	4.3	14	7.5	8.9	16	6.7	7.8
"Ouchtata"	5	9.4	10.6	19	10.2	12.1	24	10.0	11.8
Other marginal exterior retouch	2	3.8	4.3	6	3.2	3.8	8	3.3	3.9
Alternate retouch	2	3.8	4.3	6	3.2	3.8	8	3.3	3.9
Backed + geometrics	2	3.8	4.3	5	2.7	3.2	7	2.9	3.4
Truncated bladelets	-	-	-	3	1.6	1.9	3	1.3	1.5
Subtotal Microliths	**47**	**88.7**		**157**	**84.4**		**204**	**85.4**	
Total Tools	**53**			**186**			**239**		

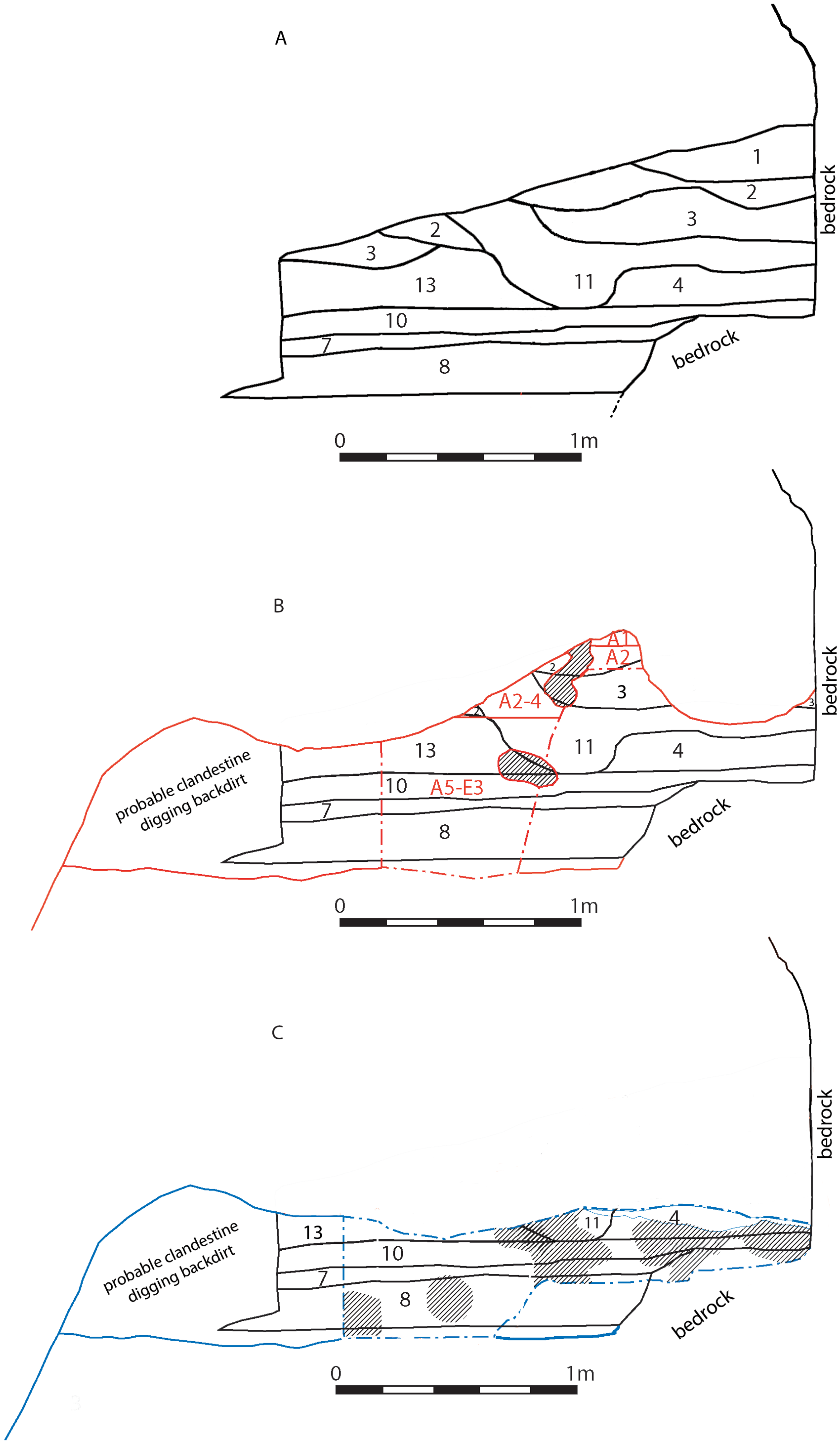

Figure 10. Wadi Madamagh Trench A South profiles of the different field campaigns: black 1956, red: 1983, blue: 2011; hatched: rodent burrows. Kirkbride's layer numbers (in black) also are preceded by an A for this Trench (see Table 14). A: 1956 Kirkbride Trench A south profile; B: 1983 Trench A south profile superimposed on the 1956 profile (Kirkbride layers no longer present have been removed); note the small, excavated sounding in 1983 indicated by the red stippled line and the much larger extension of the section towards the east (left) in comparison to 1956, as well as the moderate extent of rodent burrows. C: 2011 Trench A south profile superimposed on the 1956 profile (Kirkbride layers no longer present have been removed); note the proliferation of rodent burrows. The 2011 section is 50cm towards the south compared to the Kirkbride profile (reconstruction by D. Schyle).

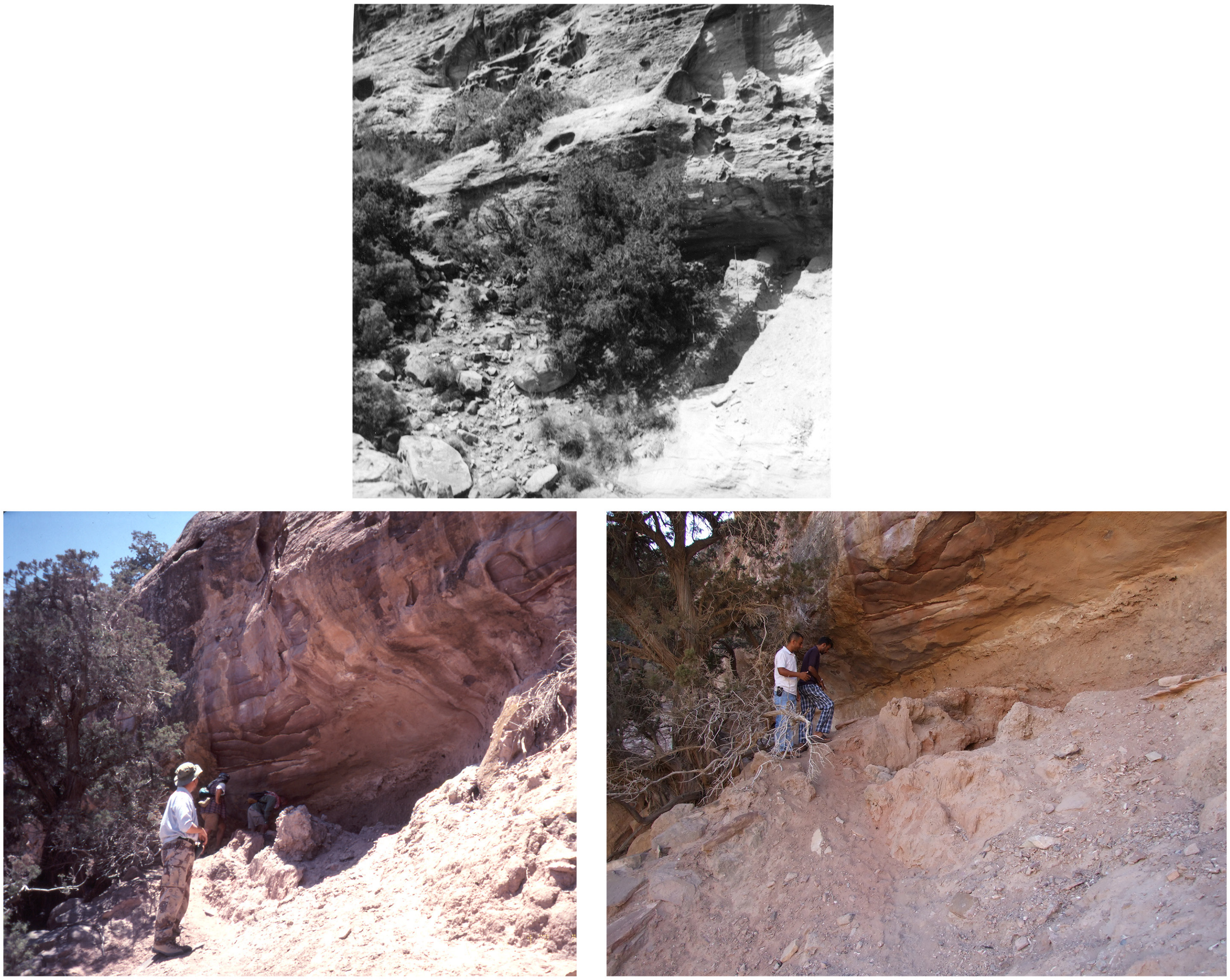

Figure 11. All views are looking SW; Comparison of the photographs shows the extensive erosion of the site over nearly six decades. Upper: 1956 Wadi Madamagh excavations. Trench B is in the foreground and Trench A mainly hidden behind the juniper tree (scanned from a negative provided to B.F. Byrd by Diana Kirkbride). Lower left: Wadi Madamagh in 2000. Both Trenches A and B are visible, although Trench B is mainly slumped (photograph by D.I. Olszewski). Lower right: Wadi Madamagh in 2010 (photograph by D. Schyle). The open trench in front of the two individuals is Trench A. Trench B no longer is visible, being infilled due to collapse of the baulks, erosion, and perhaps back fill from clandestine digging in Trench A.

rodent burrows, particularly towards the backwall of the shelter. Unfortunately, Wadi Madamagh is a sad example of how much early pioneer excavations contributed to the destruction of sites (Figure 11), in this case, additionally aggravated by the fact that the labelling of most of the finds from the old excavation was lost due to flooding in the rooms in which they were stored between 1956 and 1983.

RECONCILING LITHIC CLASSIFICATIONS AND INTERPRETING THE WADI MADAMAGH ASSEMBLAGES

As can be seen from the discussions of the Wadi Madamagh lithic assemblages above, each set of analyses used somewhat different approaches to classification. These present interesting contrasts yet fortunately can be reconciled with each other, although sometimes at the expense of some details. Additionally, the stratigraphy of the 1956, 1983, and 2011 excavations differed between these seasons. Observations by Schyle and Uerpmann (1988) suggested that potentially three occupational phases existed at Wadi Madamagh, an observation followed in part by the reanalysis of the 1956 assemblage (Byrd 2014). Reconciling the stratigraphy of the three excavation seasons, however, proved to be complicated (see above). Although not all of Kirkbride's levels in her trenches were shown in her stratigraphic profiles (published in Byrd 2014), her notes on the levels were used to assess whether the levels shown were Nebekian or LUP (notes in possession of BFB, DIO, MN, and DS).

Table 14 shows the reconciled attribution of specific excavation units to phases (LUP and Nebekian). The dif-

TABLE 14. RECONCILED ATTRIBUTION OF SPECIFIC EXCAVATION UNITS TO PHASES AT WADI MADAMAGH.

	1956 Levels*	1983 Levels**	2011 Levels***
Nebekian Epipaleolithic	A1, A2, A5; B1–2, B4–5	A1	D98 Levels 1–2b; Breccia A
Late Upper Paleolithic	A3–4, A10–12; B6–7, B12, B17, B14–15, B2021	A2-E3	D/E84, C/D/E85, C/D86 Levels 1–16; Breccia B

*Byrd 2014; Kirkbride 1958; note that the only 1956 levels shown in the table are those with lithics analyzed by Byrd 2014
**Schyle and Uerpmann 1988
***Olszewski and al-Nahar 2011; Schyle 2015

ficulties of this reconciliation led to the decision to discard the potential tripartite division (lower LUP, upper LUP, Nebekian EPI) of the occupations and instead use only the LUP and Nebekian as chrono-stratigraphic units to examine the lithic data.

As can be seen in Table 15, the debitage component is overwhelmingly dominated by small debitage (small flakes and small bladelets, and fragments thereof), the medial and distal segments of larger flakes and blade/bladelets, and debris (shatter, chips and chunks). The LUP occupation shows a tendency for more flakes compared to blade/lets (combined here because these were not always published as separate categories). The Nebekian has slightly more blade/let debitage compared to the LUP, although this difference is negligible. It should be noted that while blades and bladelets have been aggregated in these combined analyses, the majority of artifacts in this category are in the size range of bladelets. The low frequencies of core trimming elements (crested blade/lets, core tablets, platform [ridge] blade/lets, rejuvenation pieces) suggest core maintenance and/or preparation was not a significant aspect of on-site use of cores (see cores below). As might be expected, microburins are characteristic of the Nebekian, with examples of these found in the LUP deposits most likely the result of taphonomic displacement downwards.

Given the results of the debitage analyses, it is not surprising that cores with final flake scars are more common in the LUP levels, while the Nebekian is dominated by cores with final blade/let scars (Table 16). Most of these cores are single platform. One striking difference is the abundance of carinated elements in the LUP deposits, which are mainly on flakes. As can be seen in Table 16, cores-on-flakes are more common in the LUP and are nearly absent in the Nebekian. Many of these cores-on-flakes in the LUP can be attributed to the carinated class (see Figure 9). In Table 16, there is a separate cores-on-flakes category because DIO and MN used the cores-on-flakes classification rather than carinated classification for those cores-on-flakes that were not thick enough to show the types of removals characteristic of carinated elements. In this case, this distinction between the LUP and Nebekian may be related to the production of Dufour bladelets (see microliths discussion below).

In examining the major tool classes, both occupations show an emphasis on microliths (with or without the microlith fragment category) (Table 17). There are, however, several differences. First, the LUP use of the site yielded somewhat higher macrotool frequencies than the Nebekian. Second, the LUP occupation is, to some extent, more diverse with respect to frequencies of certain major classes, with not only the most endscrapers, but also burins, along with the higher frequencies of retouched pieces and notch/denticulates. It also has the most varia, which are mainly

TABLE 15. RECONCILED COMBINED ANALYSIS OF WADI MADAMAGH DEBITAGE.

	LUP		Nebekian	
	n	%	n	%
Flake	2,260	11.2	488	7.6
Blade/let	1,546	7.7	564	8.7
Core trimming element	80	0.4	33	0.5
Burin spall	39	0.2	19	0.3
Microburin	17	0.1	96	1.5
Krukowski microburin	6	<0.1	9	0.1
Medial/distal fragments and small debitage	10,687	53. 1	4,638	71.9
Debris (indeterminate shatter)	5,493	27. 3	607	9.4
TOTAL	**20,128**		**6,454**	

TABLE 16. RECONCILED COMBINED ANALYSIS OF WADI MADAMAGH CORES.

	LUP		Nebekian	
	n	%	n	%
Flake core				
single	27	9.7	2	1.4
opposed	9	3.2	1	0.7
90-degree	5	1.8	1	0.7
discoidal	2	0.7	2	1.4
multiple	8	2.9	5	3.6
tested	5	1.8	3	2.1
Blade/let core				
single	69	24.7	73	52.1
opposed	10	3.6	13	9.3
90-degree	11	3.9	12	8.6
Mixed core				
single	16	5.7	2	1.4
opposed	2	0.7	2	1.4
90-degree	2	0.7	2	1.4
multiple	2	0.7	1	0.7
tested	1	0.4	1	0.7
Core-on-flake	15	5.4	2	1.4
Carinated	31	11.1	1	0.7
Core fragment	64	22.9	17	12.1
TOTAL	279		140	

TABLE 17. RECONCILED COMBINED ANALYSIS OF WADI MADAMAGH TOOLS.

	LUP		Nebekian	
	N	%	N	%
Endscraper	47	8.2	33	4.5
Burin	15	2.6	6	0.8
Backed piece	-	-	3	0.4
Perforator	-	-	2	0.3
Truncation	2	0.3	4	0.5
Microlith	195	33.8	277	37.4
Microlith fragment	238	41.3	376	50.8
Notch/denticulate	31	5.4	12	1.6
Retouched piece	37	6.4	24	3.2
Multiple tool	2	0.3	-	-
Varia*	9	1.6	3	0.4
Grand Total	576		740	

*includes sidescrapers in LUP upper (n=7) and Nebekian (n=2)

TABLE 18. RECONCILED COMBINED ANALYSIS OF WADI MADAMAGH MICROLITHS*.

	LUP		Nebekian	
	n	%	n	%
Ouchtata	17	3.9	2	0.3
Dufour	93	21.5	5	0.8
Inverse (other)	44	10.2	10	1.5
La Mouillah	1	0.2	16	2.5
Double arched backed	7	1.6	127	19.4
Curved (other)	2	0.5	6	0.9
Backed and truncated	3	0.7	34	5.2
Truncated	2	0.5	1	0.2
Pointed	6	1.4	12	1.8
Double backed	2	0.5	8	1.2
Partially backed	-	-	3	0.5
Lunate	-	-	2	0.3
Triangle	2	0.5	1	0.2
Trapeze/microburin trapeze	3	0.7	31	4.7
Other	13	3.0	19	2.9
Fragment w/truncation	19	4.4	216	33.1
Fragment wo/truncation	191	44.1	97	14.9
Partially backed fragment	7	1.6	24	3.7
Fragment (indeterminate)	21	4.8	39	6.0
Grand Total	**433**		**653**	

*only complete microliths are classified to type; broken microliths are recorded in the fragment categories

single sidescrapers, in a sense adding to the "scraper" focus. Finally, by comparison, the Nebekian is not very diverse. While containing a few examples of some classes (e.g., backed pieces, perforators, truncations, varia), it primarily consists of microliths and microlith fragments.

Just as there are some differences between the LUP and the Nebekian in major tool classes, there also are differences in the emphases on certain microlith types (Table 18; these are classified to type only if complete due in part to the constraints of combining the earlier analyses). The LUP occupation has somewhat more frequent Ouchtata bladelets compared to the Nebekian. It also is typified by Dufour bladelets and microlith fragments without truncated ends. This latter element may be associated with the Dufour bladelets or Ouchtata bladelets in that these microliths do not have truncated ends. Thus, if they were broken (proximal or distal pieces), these would be small inversely retouched or exterior retouched bladelets without truncations. In the Nebekian, the character of the microlith component changes significantly. The major type is the double arched backed bladelet (also elsewhere called double curved backed or attenuated curved backed bladelets). These are typically very narrow in width. Additionally, there is just over 5% of complete backed and truncated bladelets. La Mouillah points (which have the same shape as backed and truncated bladelets) also are present. Finally, there are some narrow trapezes (sometimes with both ends as microburin scars rather than truncations; see Endnote 1). This shift in microlith type(s) is seen likewise in the microlith fragments, which are now mainly fragments with truncations (possibly representing broken double arched backed as these are the main type of microlith and/or narrow trapezes[2]), although there are still a good number of fragments without truncations (perhaps related to the La Mouillah points or the microburin trapezes).

THE PETRA REGION LATE UPPER PALEOLITHIC AND INITIAL/EARLY EPIPALEOLITHIC

A few other LUP (n=4) and Initial/Early EPI (n=1) sites have been found and investigated in the Petra region. These are briefly described and compared to Wadi Madamagh.

LATE UPPER PALEOLITHIC SITES IN THE PETRA REGION

Two of the LUP sites also contain comma-shaped, inversely retouched Dufour bladelets, thus being similar to the LUP at Wadi Madamagh. One of them (Sabra 4 – Palmview 3) was excavated (Richter and Schyle 2015; Figure 12); the other one, Sabra 2010/10, was examined during survey where only a few characteristic pieces were picked up from the natural sections. In both cases, only small parts of the origi-

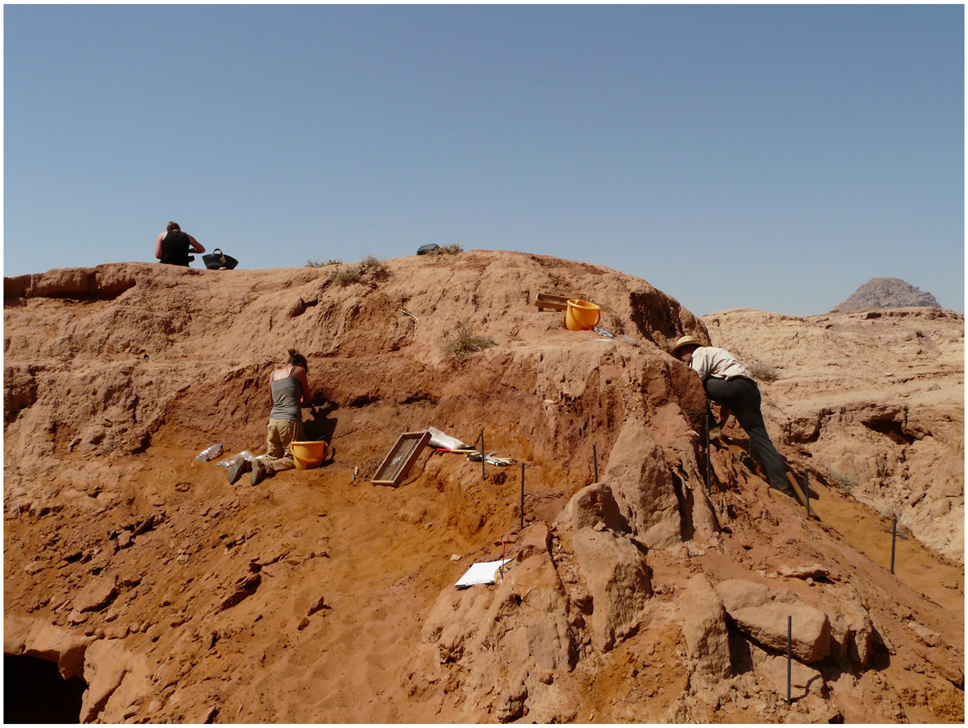

Figure 12. Sabra 4 Palmview 3 before excavation (photograph by D. Schyle, CRC 806 – Our Way to Europe).

nal sites are still preserved within the wadi deposits, while the remainder have been largely destroyed by erosional channels. The situation and assemblage from Palmview 3 were described in detail elsewhere (Richter and Schyle 2015; Parow-Souchon 2020), but it is worth noting the similarities and differences between Palmview 3 and the Wadi Madamagh LUP. Typologically and technologically, both assemblages are quite similar. Standardized comma-shaped, inversely retouched bladelets represent the most frequent tool type in both cases. They are accompanied by just a few burins and endscrapers. The small assemblage from Palmview 3 (n=83 tools) additionally includes an end-scraper on a large blade and a large blade fragment with Aurignacian retouch, otherwise not represented at Wadi Madamagh. The twisted, comma-shaped blanks of the inversely retouched bladelets were produced from small carinated cores on flakes, examples of which were found at both sites. One major technological difference between the two assemblages concerns the degree of retouch on the comma-shaped bladelets, which is more invasive at Palmview 3 than at Wadi Madamagh. Another difference is found in the percentage of the fragments of these bladelets—while at Palmview 3 only 4 of the 44 retouched bladelets are complete, about half of them are complete at Wadi Madamagh. Whether this is accidental or intentional remains open to question (Parow-Souchon 2020).

Radiocarbon samples from Palmview 3 (Table 19; Parow-Souchon 2020: cf. Table 36) and Wadi Madamagh (see Table 6) yielded similar ages from the period immediately before/at the beginning of the LGM. Two charcoal ^{14}C ages were obtained for Palmview 3, both originating from the archaeological horizon. They yielded 2σ ages of 24,776–24,220 cal BP (Beta-432085) and 25,205–24,692 cal BP (Beta-432086) (calibrated using IntCal20, v4.4 [Reimer et al. 2020]; modified from Parow-Souchon 2020: Table 36).

The few artifacts collected at Sabra 2010/10 (Richter et al. 2015: Figure I-14 and p. 19) indicate that this site remnant relates to the same kind of industry, which so far has not been reported from elsewhere in the Levant. The Sabra 2010/10 industry is more Aurignacian-like than that found

TABLE 19. ^{14}C DATES FOR PALMVIEW 3.

	Material	^{14}C Age (BP)	±	$Δ^{13}C$* (‰)	Pre-treatment	Cal BP (68.3%)* 1σ	Cal BP (95.4%)* 2σ
Beta-432085	charcoal	20,400	70	-25.4	AAA	24,620–24,330	24,776–24,220
Beta-432086	charcoal	20,720	80	-25.4	AAA	25,145–24,895	25,205–24,692

*calibrated using IntCal20, v4.4 (Reimer et al. 2020)

Figure 13. Reddish sediment remnant (center-right) containing the site of Sabra 3 South; excavations in 2015 removed part of the sediment on the left (photograph by H. Parow-Souchon).

in the "Arqov-Divshon" sites in the Negev [Goring-Morris and Belfer-Cohen 2006] and Umm el-Tlel Layer 14'b' [Soriano 1998]).

A different kind of LUP-industry was excavated outside of the Wadi Sabra at Taibeh 3 (Hussain and Richter 2015) and may be present as well at a second spot in the Wadi Sabra (Sabra 3 North). The excavation at Taibeh revealed a series of assemblages characterized by straight, exterior marginally retouched ("Ouchtata") bladelets that typologically fit to an industry that otherwise has been named "Late Ahmarian" or "Masraqan" (Coinman 1993; Goring-Morris and Belfer-Cohen 1997), although recently the use of the term "Late Ahmarian" has been generally questioned (Goring-Morris and Belfer-Cohen 2018). However, technologically it displays a wide variety of different and rather opportunistic core reduction strategies with little core preparation that clearly does not fit an "Ahmarian" affiliation in the sense that the bladelets have not been produced following one or two standardized core reduction concepts only.

Sabra 3 North was discovered in 2008, when flints were noted eroding from a black layer at the top of a natural section of wadi deposits covered by a 50cm thick cemented calcareous crust. The artifacts scattered along the steep slope below the outcrop of the black layer unfortunately did not include characteristic pieces, apart from a general UP/EPI blade/bladelet technology and the cemented crust above prevented the excavation of a larger area. Thus, its attribution to the same kind of industry remains somewhat tenuous.

Elsewhere, assemblages with a predominance of marginally retouched ("Ouchtata") bladelets are in general considered to represent the Late or Final Upper Paleolithic. The radiocarbon dates for similar assemblages cluster around the LGM and largely overlap with Initial/Early EPI dates. When found in stratigraphy, however, they so far always are found below Initial/Early or later EPI layers.

INITIAL/EARLY EPIPALEOLITHIC SITES IN THE PETRA REGION

Apart from the upper assemblage at Wadi Madamagh, the Initial/Early EPI in the Petra Area is represented by only a single assemblage, from the site of Sabra 3 South (Figure 13). Surface materials indicated the presence of the site in 2008, which was subsequently collected and excavated in 2009. Excavation occurred in an upper small sediment remnant of an overall *in situ* preserved area of 6m² (Richter et al. 2015; Parow-Souchon 2020). The excavated inventory is comparatively small, but well-preserved and, in addition to the lithic material, contains a bone tool fragment, faunal remains, charcoal, and ochre. The small bone fragment is a smoothly rounded bone tool (point?), made on a massive section without remains of trabecular bone. A spatially confined greyish discoloration of the occupation layer with associated burned lithics was interpreted as remains of a hearth. The spatial distribution of artifacts shows internal congruence, as refits were made within discrete reduction areas where single raw material nodules were recog-

TABLE 20. ANALYSIS OF SABRA 3 SOUTH DEBITAGE (excavation; cf. Parow-Souchon 2020).

	n	%
Flake	149	6.9
Blade/let	121	5.6
Core trimming element	87	4.0
Burin spall	0	0
Microburin	0	0
Krukowski microburin	1	0.0
Medial/distal fragments and small debitage	273	12.6
Debris (indeterminate shatter)	1,544	71.0
TOTAL	**2,175**	

nized (cf. Parow-Souchon 2020); additionally, one refit was achieved over the entire excavated area. The assemblage thus represents a spatially confined sample of either one or possibly two activity zones of a formerly larger single-layer site.

The technological setup is focused on blade and bladelet production from a large variety of core types. Among the debitage, flakes and blade(let)s are nearly equally numerous (Table 20). Notable is the weak representation of the microburin technique. Apart from two La Mouillah points, there is a single Krukowski microburin.

As the core inventory from the excavated assemblage was relatively small, the cores from the surface material were also included in the analysis (Table 21). The resulting overall core sample totals 54 pieces, displaying a high variability in conceptional setup. The majority focus on the production of bladelets and blades, while flake cores usually come in amorphous varieties showing an opportunistic exploitation strategy. Among the blade core reduction concepts, the narrow fronted is most numerous, but pyramidal concepts are also used, both on nodules and on flakes, thus approaching carinated forms, yet without yielding specific target products. As at Taibeh 3, reduction intensity is low, but the various reduction concepts are selected according to the individual nodule's shape to minimize preparation and maintenance efforts. Effective morphological control of the blanks was not necessary, due to subsequent extensive blank modification by backing and truncating.

The excavated tool inventory of Sabra 3 South consists of 55 formal tools, which make up 2.7% of the total assemblage (Figure 14). An overview is given in Tables 20–23. The tool assemblage is heavily dominated by nongeometric microliths (Tables 22–23). The microliths are strongly fragmented; the majority of these fragments are, however, large enough to be still identifiable to type. When fragments are included, backed and truncated specimens are the most numerous (Figure 15: 1–5, 9–10), but there are also a considerable number of Ouchtata bladelets and a wider range of

TABLE 21. SABRA 3 SOUTH CORES (excavation and surface; cf. Parow-Souchon 2020).

	n	%
Flake core	(15)	
single	4	7.4
opposed	1	1.9
discoidal	10	18.5
Blade/let core	(23)	
single	22	40.7
opposed	1	1.9
discoidal	-	-
Mixed core	(3)	
tested	3	5.5
Carinated	11	20.4
Core fragment	2	3.7
TOTAL	**54**	

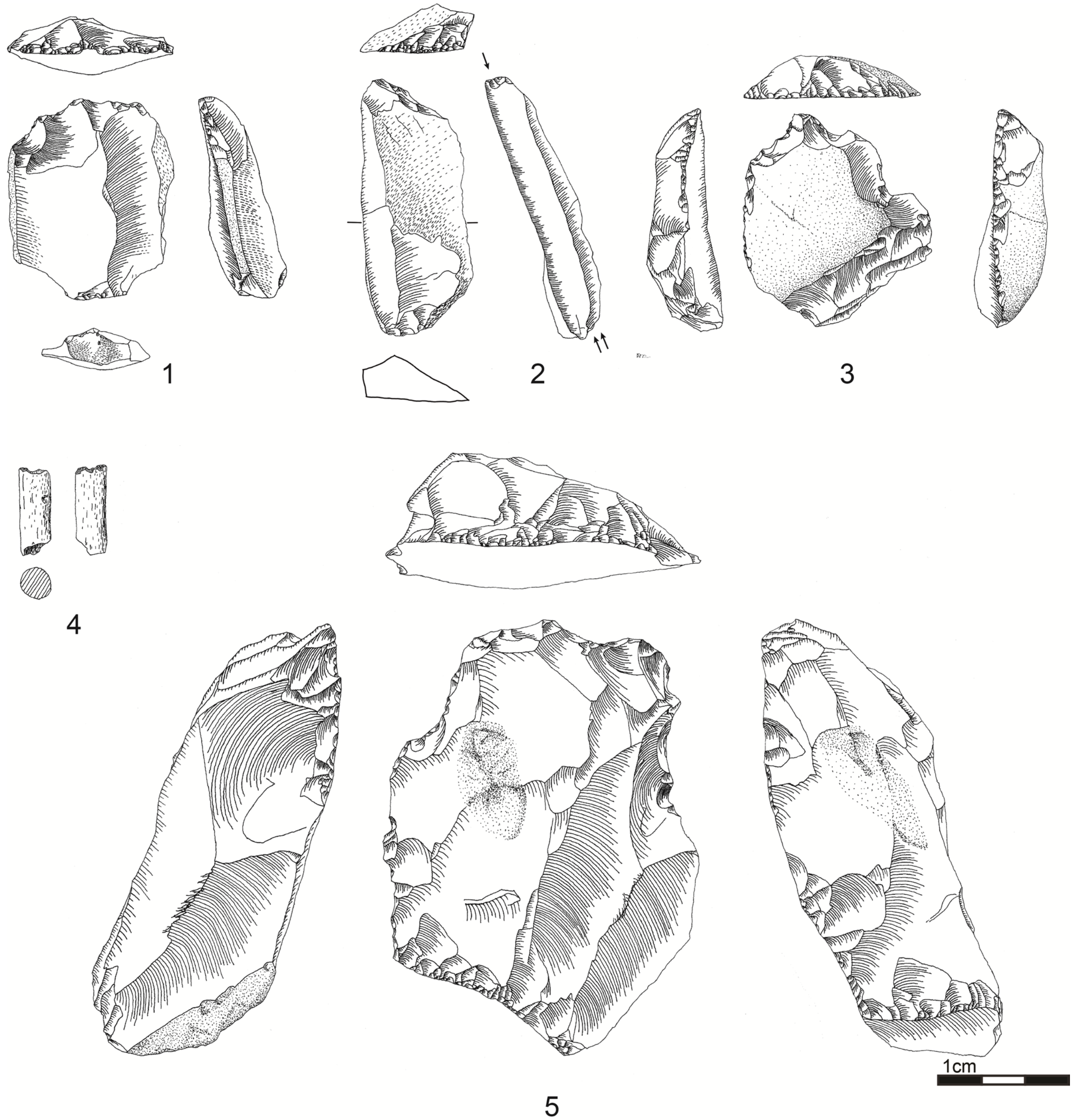

Figure 14. Sabra 3 South macrotools: 1) endscraper; 2) burin on oblique truncation; 3) denticulated endscraper; 4) bone tool fragment; 5) heavy duty denticulate (drawings by H. Parow-Souchon).

other backed types, including low frequencies of La Mouillah points (Figure 15: 8), truncations, double arched backed bladelets, and a single Asymmetrical Trapeze A. The double arched backed microliths are, by definition, truncated and do not show any evidence of microburin scars. In this regard, the microlith assemblage from Sabra 3 South is quite dissimilar to that of the Nebekian in upper Wadi Madamagh, which is dominated by the double arched backed type along with a moderately high incidence of microburin technique (restricted microburin index of 27.5, calculated according to the formula in Goring-Morris 1987).

WADI MADAMAGH IN THE CONTEXT OF THE LATE UPPER PALEOLITHIC AND INITIAL/EARLY EPIPALEOLITHIC OF THE EASTERN LEVANT

To provide a broader context for Wadi Madamagh, we briefly compare these LUP and Initial/Early EPI assemblages to those of other eastern Levantine regions—the Wadi al-Hasa and the Azraq Basin, both of which also had in-stream wetlands and/or marsh contexts (see Figure 1). Because the combined results of the analytical methods for Wadi Madamagh required typing of complete microliths

TABLE 22. ANALYSIS OF SABRA 3 SOUTH TOOLS (excavation; cf. Parow-Souchon 2020).

	n	%
Endscraper	6	10.9
Burin	1	1.8
Backed piece	-	-
Perforator	-	-
Truncation	-	-
Microlith	27	49.1
Microlith fragment	14	25.5
Notch/denticulate	1	1.8
Retouched piece	3	5.5
Multiple tool	-	-
Varia*	3	5.5
Total	55	

*no sidescrapers are present in Sabra 3 South

only, we use this method in the following tables. Additionally, we note that we did not include shatter/debris in the debitage calculations, nor did we include core fragments in the core assemblage counts/frequencies.

THE WADI AL-HASA REGION

Extensive Late Pleistocene research in the Wadi al-Hasa region began with sites identified by the survey projects of MacDonald et al. (1980; 1982; 1983). These were continued by Clark et al. (1992, 1994). Additionally, two sites were identified on the Kerak Plateau to the north (C. Bartlett 2010, personal communication; Schurmans 2001). Of the 12 sites test-excavated between 1984 and 2012, 3 contained LUP levels and 4 had Initial/Early EPI occupations. In the following discussion, we provide descriptive information for the debitage, cores, and macrotools, with both descriptive and tabular data for the microliths. These microlith tables include a column for Wadi Madamagh based on the combined tables above, which facilitates the comparisons. We note, however, that classifying microliths to type using only complete microliths underrepresents certain types in the assemblages that might otherwise be counted from fragments (see Discussion).

The Late Upper Paleolithic in the Wadi al-Hasa (27,500–24,100 cal BP)

The three sites with LUP occupations are Ain al-Buhayra, Areas A and B at Yutil al-Hasa, and the lower occupation at

TABLE 23. ANALYSIS OF THE SABRA 3 SOUTH MICROLITHS* (excavation; cf. Parow-Souchon 2020).

	n	%
Ouchtata	10	24.4
La Mouillah	2	4.9
Double arched backed	2	4.9
Backed and truncated	6	14.6
Truncated	3	7.3
Fragment w/truncation	10	24.4
Fragment wo/truncation	6	14.6
Double backed	1	2.4
Asymmetrical trapeze A	1	2.4
Total	41	

*only complete microliths are classified to type; broken microliths are recorded in the fragment categories

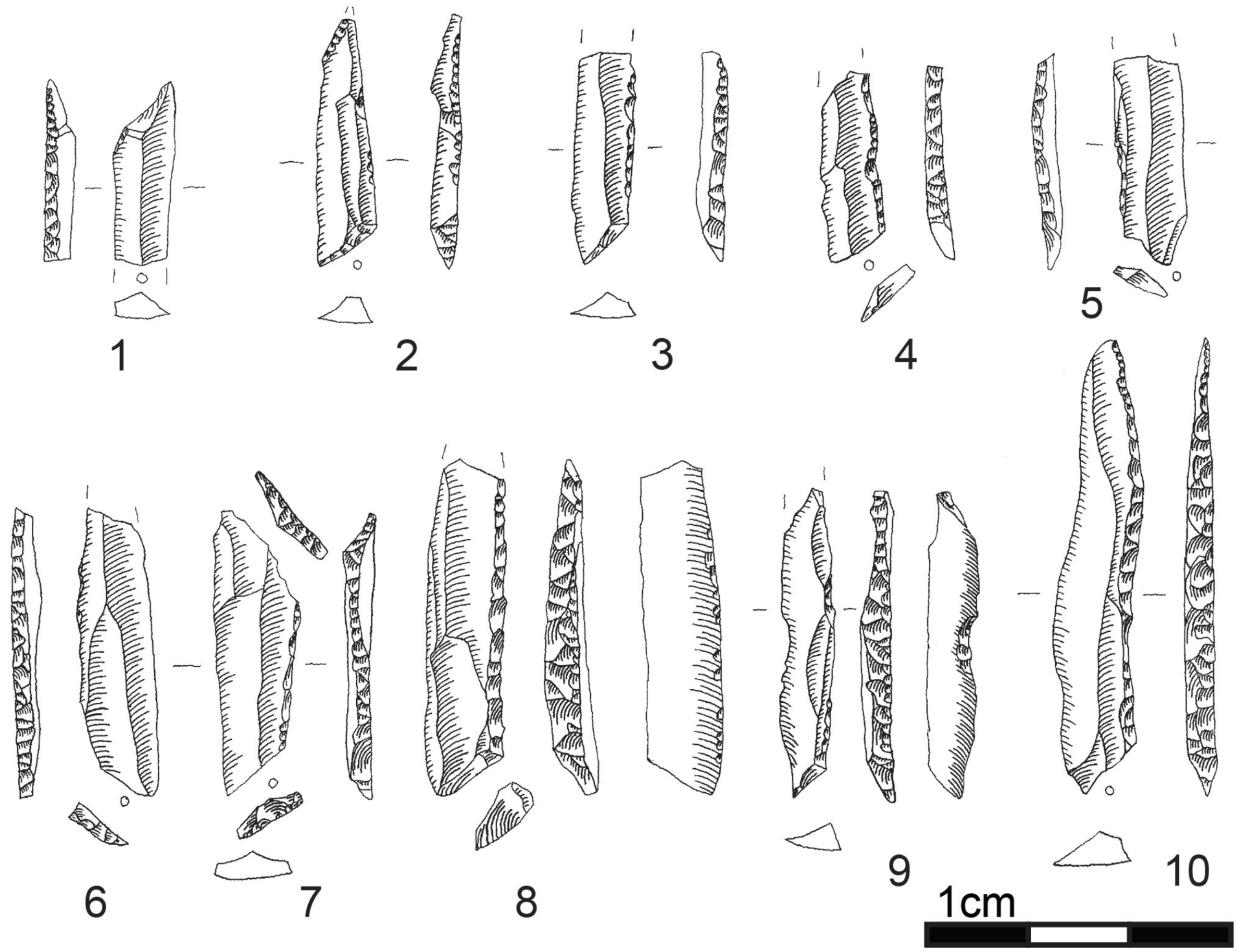

Figure 15. Sabra 3 South microliths: 1–5, 9–10) obliquely truncated and backed bladelet; 6) bladelet with back curved by abrupt retouch; 7) prototrapeze; 8) La Mouillah point (drawings by H. Parow-Souchon, redrawn after Irene Scheuer).

Tor Sageer. Of these, Ain al-Buhayra and Yutil al-Hasa Areas A and B are relatively similar, while Tor Sageer (lower occupation) is somewhat more like the LUP at Wadi Madamagh.

Debitage and cores from these three LUP sets of occupations can be generally described as follows. Flakes are slightly more prevalent than blades/bladelets, and within the blade/bladelet category, bladelets are the most common[3]. A small number of burin spalls are present in the assemblages. The majority of cores are single platform, with final removal scars most often indicating blade/bladelet manufacture. Interestingly, the LUP debitage from Wadi Madamagh is more flake-oriented (see Table 15). This pattern is replicated in the LUP Wadi Madamagh cores, where final removals are more often those of flakes (see Table 16), although the majority of cores are single platform.

Excavations by Clark et al. (1988) and Coinman (1993, 2003; Olszewski et al. 1998) at open-air Ain al-Buhayra revealed an extensive LUP occupation situated at a spring (E units) in proximity to a large marsh/in-stream wetlands in the eastern portion of the Wadi al-Hasa (Rech et al. 2017; Winer 2010; see Figure 1). Radiocarbon dates for the spring area indicate a 2σ range from 27,315 to 23,726 cal BP (calibrated using IntCal20, v4.4 [Reimer et al. 2020]). Analyses of the lithic assemblage documented a Late Ahmarian (sometimes referred to as "Masraqan") set of occupations in the spring area. The macrotool assemblage has almost equal representation of retouched pieces and endscrapers, along with some burins and a few truncations, notches, perforators, and multiple tools. Microliths are dominated by Ouchtata bladelets, with a smaller frequency of el Wad points (Table 24). Nearly all of the fragments without truncation could be typed as Ouchtata, which would considerably increase the representation of these pieces. A high frequency of fragments without truncation is present also at Wadi Madamagh, but examination of these fragments indicates that the majority are from Dufour/inverse microliths rather than Ouchtata bladelets.

Yutil al-Hasa, ca. 3km northwest of Ain al-Buhayra, was excavated in Areas A and B in 1984 and in Area A in 1998 (see Figure 1; Clark et al. 1988; Coinman et al. 1999; Olszewski et al. 1990). The rockshelter is on a finger ridge above the Wadi al-Hasa, which in this area of the drainage was an in-stream wetlands (Ramsey and Rosen 2016; Rech

TABLE 24. COMPARISON OF THE MICROLITH COMPONENT AT WADI AL-HASA LATE UPPER PALEOLITHIC SITES AND WADI MADAMAGH.*

	Ain al-Buhayra		Yutil al-Hasa Areas A & B		Tor Sageer lower		Wadi Madamagh	
Microlith Type	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Ouchtata	61	12.1	15	5.8	11	5.8	17	3.9
Dufour	?	?	2	0.8	10	5.3	93	21.5
Inverse (other)	?	?	-	-	3	1.6	44	10.2
El Wad	26	5.2	-	-	-	-	-	-
La Mouillah	-	-	-	-	1	0.5	1	0.2
Double arched backed	-	-	-	-	1	0.5	7	1.6
Curved (other)	-	-	-	-	5	2.6	2	0.5
Backed and truncated	-	-	1	0.4	8	4.2	3	0.7
Truncated	-	-	4	1.5	3	1.6	2	0.5
Pointed	-	-	1	0.4	1	0.5	6	1.4
Double backed	-	-	-	-	-	-	2	0.5
Partially backed	-	-	-	-	1	0.5	-	-
Trapeze	-	-	1	0.4	2	1.1	3	0.7
Triangle	-	-	-	-	-	-	2	0.5
Other microlith	-	-	2	0.8	-	-	13	3.0
Fragment w/truncation	-	-	10	3.9	37	19.6	19	4.4
Fragment w/o truncation	416	82.5	153	59.8	52	27.5	191	44.1
Partially backed fragment	-	-	11	4.3	20	10.6	7	1.6
Fragment (indeterminate)	-	-	56	21.9	34	18.0	21	4.8
Grand Total	**503**		**256**		**189**		**433**	

*For consistency with the Wadi Madamagh combined analysis, only complete microliths are classified to type.

et al. 2017; Winer 2010). The lithic assemblage from this part of the site was identified as Late Ahmarian, with radiocarbon dates indicating a 2σ age of 27,300–26,447 cal BP (calibrated using IntCal20, v4.4 [Reimer et al. 2020]). Macrotools are predominantly retouched pieces, followed by notch/denticulates; endscrapers and burins are about evenly represented. Special tools include a number of sidescrapers; there are few perforators. In the microliths, although the frequency of complete Ouchtata bladelets appears quite modest (see Table 24), among the fragments without truncation, most could be typed as Ouchtata, which would augment the frequency of this microlith type, making Yutil al-Hasa similar to Ain al-Buhayra rather than to Wadi Madamagh.

The site of Tor Sageer is situated in a tributary wadi to the Wadi al-Hasa, about 2km (as the crow flies) to the northeast of Yutil al-Hasa (see Figure 1). It was excavated in 1997 and 1998 and is a small rockshelter above the current wadi floor (Coinman et al. 1999; Olszewski 2016; Olszewski et al. 1998), which prehistorically was an in-stream wetlands (Ramsey and Rosen 2016). The lower strata (II, III, V) contain the LUP deposits, which are radiocarbon dated at 2σ to between 27,198 to 24,199 cal BP (calibrated using IntCal20, v4.4 [Reimer et al. 2020]). In the macrotools, the most common classes are retouched pieces and notch/denticulates, followed by endscrapers. Other macrotools are rare, although the presence of three adzes is noteworthy as they may have been woodworking tools. Ouchtata, Dufour, and backed and truncated complete microliths are the most frequent types (see Table 24), with fragments being mainly those without truncations. If these fragments were typed, then the frequency of Ouchtata, Dufour, and inverse would increase). Tor Sageer would thus share some resemblance to Ain al-Buhayra in Ouchtata pieces, but a similarity to the Wadi Madamagh LUP in Dufour/inverse microliths. The backed and truncated pieces in the LUP at Tor Sageer are most likely displaced downward from the Initial/Early EPI in Stratum I, as they are found primarily in the underlying Stratum II.

The Initial/Early Epipaleolithic in the Hasa Region (25,300–21,800 cal BP)

The four sites with Initial/Early EPI deposits include Yutil al-Hasa Areas C and F, Tor at-Tareeq, Tor Sageer upper, and KPS-75 lower. Although the excavation seasons were by three separate projects, one of us (DIO) was present for most of these, including the lithic analyses. It should be noted, however, that lithic data from the 1984 and 1992 seasons at Tor at-Tareeq (Neeley 1997; Neeley et al. 2000) are not available to us in a form that easily translates into the analyses presented here. As a result, we use the data from the 2000 (DIO) and 2012 (DIO and MN) seasons only.

During the Nebekian occupations at these four sites, there is variability in the predominant blank types, with more flakes at Yutil al-Hasa and Tor Sageer and more blade/bladelets at Tor at-Tareeq and KPS 75. Bladelets are the most common form within the blade/bladelet category. All these sites have some burin spalls, as well as microburins. Final flake scars on cores are primarily blade/bladelet for all the sites except Yutil al-Hasa, where flake scars are somewhat more evident. Single platform cores are characteristic for these sites. The Wadi Madamagh Nebekian has an almost equal representation of blade/bladelets and flakes in the debitage, but the cores are dominated by final removal scars indicating blade/bladelets (see Tables 15 and 16).

In addition to LUP occupations in Areas A and B, Yutil al-Hasa yielded Initial/Early EPI in Areas C and F (Clark et al. 1994; al-Nahar and Olszewski 2016). Both areas are within the same rockshelter as Areas A and B but situated further to the southwest. Radiocarbon dates from Area C yielded a 2σ occupation range between 25,238 to 23,994 cal BP, while a radiocarbon date from Area F is 22,941 to 22,422 cal BP (calibrated using IntCal20, v4.4 [Reimer et al. 2020]). Macrotools include retouched pieces and notch/denticulates as the most frequent types, followed by endscrapers. There also are a number of burins and truncations; backed pieces and perforators are rare. As seen in Table 25, among the complete microliths, the most common are the double arched backed form. Fragments with a truncation make up a considerable portion of the microlith assemblage from Yutil al-Hasa Areas C and F; many of these may be broken double arched backed pieces because these are the majority type in the complete microlith assemblage (see Endnote 2). The trapezes include a few microburin trapezes, with the category of other having some bitruncated microliths. Compared to the Wadi Madamagh microliths (see Table 25), there are far fewer double arched backed bladelets. This is interesting given that the radiocarbon date from Area F at Yutil al-Hasa is comparable in age to the Nebekian at Wadi Madamagh. However, the dates from Area C at Yutil al-Hasa are a bit earlier, so that perhaps the smaller frequency of double arched backed microliths at Yutil al-Hasa partially reflects chronological differences in these assemblages.

Tor at-Tareeq is an open-air site on a hill side in the eastern Hasa basin, close to the Pleistocene marshes (Olszewski and al-Nahar 2014; Rech et al. 2017; Winer 2010). The site was identified during survey of the south bank of the Wadi al-Hasa by MacDonald et al. (1983) and is approximately 15m by 12m in size. Several excavations were conducted during the seasons of 1984, 1992, 2000, and 2012 (Clark et al.1988; 1992; Olszewski and al-Nahar 2012; Olszewski et al. 2000; 2001). Tor at-Tareeq has several EPI occupations, the earliest of which date to the latter part of the Nebekian Initial/Early EPI. The 2σ radiocarbon dates range from 21,890 to 18,280 cal BP (calibrated using IntCal20, v4.4 [Reimer et al. 2020]) (Clark et al. 1988; Neeley et al. 2000). The macrotools include retouched pieces followed by notch/denticulates; other common macrotools are truncations, endscrapers, and burins. There are a few backed pieces and perforators.

As seen in Table 25, the most common complete microlith type is the double arched backed form. It is evident also that fragments with truncations have a high proportion followed by indeterminant fragments. Fragments with truncation may be mainly broken double arched backed pieces (see Endnote 2). When compared with Wadi Magdamagh, it is noticeable that complete double arched backed microliths are much more common than at Tor at-Tareeq, perhaps reflecting changes related to the chronologically later occupation for the Initial/Early EPI at Tor at-Tareeq. Furthermore, indeterminant fragments are far fewer at Wadi Madamagh than at Tor at-Tareeq. In the other category of microliths, there are bitruncated, as well as wide trapezes and triangles, which are intrusive from the overlying Middle EPI occupation. It should be noted, as before, that Wadi Madamagh, unlike Tor at—Tareeq, has no occupations later than the Early EPI. Thus, for Wadi Madamagh, there is not an issue of taphonomic mixing of later microliths into the Early EPI deposits at this site.

As well as an LUP set of occupations (described above), Tor Sageer has Initial/Early EPI in its upper deposits (Olszewski 2016). There are no direct radiocarbon dates for the Initial/Early EPI occupation, however, it post-dates 24,199 cal BP based on the dates available for the LUP at this site (see above). Among the macrotools, the most common types are retouched pieces. Notch/denticulates are the next most frequent, and there are equal numbers of endscrapers and burins. Less common are backed pieces, truncations, and perforators. There also is one adze. Within the complete microliths (see Table 25), double arched backed, backed and truncated, and curved types are the most frequent. Geometric forms include microburin trapezes (see Endnote 1). The most common category among the broken microliths is those with a truncation. The Tor Sageer microlith assemblage somewhat more closely resembles that from Yutil al-Hasa Areas C and F. When compared to Wadi Madamagh, the Tor Sageer microliths follow the same pattern in having the highest representation of double arched backed bladelets, although the frequency of this category at Wadi Madamagh is higher.

KPS -75 is situated on the Kerak Plateau, which forms the northern edge of the Wadi al-Hasa drainage system. The site was first identified in 1997 by C. Bartlett (2010, personal communication). It is a small rockshelter (ca. 3m x 2m) with a larger occupation area in front of it. No radiocarbon dates are currently available for the site occupations. Based on the lithic assemblages, three Initial or Early EPI occupations were identified. Stratigraphically, the Nebekian occupation is lowest; there is a probable Qalkhan occupation in the middle deposits, and the Qalkhan or an undetermined Early EPI is in the uppermost deposits (al-

TABLE 25. COMPARISON OF THE MICROLITH COMPONENT AT THE WADI AL-HASA INITIAL/EARLY EPIPALEOLIHTIC SITES AND WADI MADAMAGH.*

	Yutil al-Hasa Areas C & F[1]		Tor at-Tareeq[2]		Tor Sageer upper		KPS-75 Lower[3]		Wadi Madamagh	
Microlith Type	n	%	n	%	n	%	n	%	n	%
Ouchtata	4	0.4	5	0.4	1	0.3	1	0.2	2	0.3
Dufour	1	0.1	1	<0.1	-	-	-	-	5	0.8
Inverse (other)	-	-	2	0.1	1	0.3	1	0.2	10	1.5
La Mouillah	12	1.2	3	0.2	6	1.8	6	1.1	16	2.5
Qalkhan point	2	0.2	2	0.1	1	0.3	6	1.1	-	-
Double arched backed	63	6.3	27	2.0	20	6.1	78	14.7	127	19.4
Curved (other)	26	2.6	12	0.9	18	5.5	9	1.7	6	0.9
Backed and truncated	9	0.9	5	0.4	19	5.7	9	1.7	34	5.2
Truncated	15	1.5	9	0.7	4	1.2	5	0.9	1	0.2
Pointed	7	0.7	12	0.9	6	1.8	7	1.3	12	1.8
Double backed	12	1.2	14	1.0	6	1.8	4	0.8	8	1.2
Partially backed	5	0.5	3	0.2	2	0.6	5	0.9	3	0.5
Lunate	3	0.3	1	<0.1	-	-	1	0.2	2	0.3
Triangle	4	0.4	9	0.7	1	0.3	6	1.1	1	0.2
Trapeze	12	1.2	8	0.6	9	2.7	14	2.6	31	4.7
Other	3	0.3	28	2.1	1	0.3	2	0.4	19	2.9
Fragment w/truncation	436	43.6	506	37.7	100	30.3	216	40.8	216	33.1
Fragment wo/truncation	172	17.1	228	17.0	60	18.2	68	12.8	97	14.9
Partially backed fragment	53	5.3	45	3.4	20	6.1	16	3.0	24	3.7
Fragment (indeterminate)	162	16.2	423	31.5	55	16.7	76	14.3	39	6.0
Grand Total	**1,001**		**1,343**		**330**		**530**		**653**	

*For consistency with the Wadi Madamagh combined analysis, only complete microliths are classified to type.

[1]Yutil al-Hasa includes the 1993 Area C and the 2010 Areas C and F lithics.

[2]Tor at-Tareeq includes the 2000 and 2012 lithics; analyses from the 1984 and 1992 seasons are not included due to recording on paper forms and lack of easy comparability in the microlith categories used in earlier seasons.

[3]The analysis here includes only the lowermost deposits at KPS-75; there are later Early EPI occupations as well.

Nahar and Olszewski 2016; al-Nahar et al. 2009). For the Nebekian occupation, the macrotools have an abundance of retouched pieces followed by notch/denticulates and endscrapers. Other common macrotools are burins and truncations. There are a very few backed pieces, core tools, and perforators. As shown in Table 25, the most common complete microlith is the double arched backed form, although they are fewer than at Wadi Madamagh. The geometrics include a few microburin trapezes (see Endnote 1), however, their proportion is less than at Wadi Madamagh. Fragments with truncations at KPS-75 are more frequent than at Wadi Madamagh; it is likely that these fragments at both sites are mainly from the double arched backed bladelet microlith type (see Endnote 2).

THE AZRAQ REGION

The Wadi Madamagh site results also can be compared with a regional study of late Quaternary hunter-gatherers in the Azraq Basin, a large inland drainage basin along the edge of the Fertile Crescent in east-central Jordan (Garrard and Byrd 2013). Today, the basin includes dry steppe, subdesert, and oasis environments, and at various times during the late Quaternary it had more extensive springs and wetland settings. Field investigations took place in three localities: Wadi Jilat, Wadi Uwaynid, and the center of the Azraq Basin (see Figure 1). The study included detailed reporting of flaked stone assemblages and rigorous dating of 11 open-air sites and 19 occupation horizons that included both short-term occupation events and thicker occupation deposits (see Garrard and Byrd 2013 for details). Although these three localities are a considerable distance from Wadi Madamagh—some 160–210 kilometers and a 34–46 hours walking distance (Byrd et al. 2016), they provide a useful broader regional comparison.

As noted for the Wadi Hasa study, analytical and classification methods varied somewhat between the Azraq Basin project and the current composite study of Wadi Madamagh. Some differences include how broken debitage and tool fragments were classified, and whether bladelet sized truncations lacking lateral retouch are considered microliths (yes for the Wadi Madamagh study) or not (as is the case for the Azraq Basin project). Similarly, the Azraq Basin project placed much less importance on retouch type (both fine and inverse) as a microlithic tool type determiner than the Wadi Madamagh study.

Late Upper Paleolithic (30,000–24,000 cal BP)

Three LUP occupation horizons dating to 30,000–24,000 cal BP are distinguished in the Azraq Basin (Jilat 6 Basal Phase, Jilat 9, and Uwaynid 18 Trench 2 Lower phase) based on radiocarbon dates, stratigraphy, and paleoenvironmental context (Garrard and Byrd 2013: Table 8.2). A fourth occupation horizon (Azraq 17 Trench 2) may also date to this period based on techno-typological similarities. Lithic assemblages from each vary greatly in size, and although the soundings at Jilat 6 and Uwaynid 18 produced very small samples, they underlie well-dated Initial EPI occupation horizons with very different microlithic traditions.

Overall, diverse reduction strategies were present at these sites—dominated by blade/bladelet reduction (typically creating narrow ended or broad-faced single platform cores), supplemented by multi-platform blade/bladelet cores and flake core reduction. Flake debitage was often almost as frequent as blade/bladelet debitage. Tool blanks were highly varied, with frequent use of flakes, overshot blades, and primary element blanks. The most prevalent tool classes were end scrapers, burins and non-standardized retouched pieces. Microliths (backed or retouched bladelet tools) are present in highly varied frequencies, and typically made with Ouchtata or marginal retouch (often on the interior side; interior retouched were not typed as inversely retouched) and only occasionally backed or truncated (Table 26).

Several trends can be noted when comparing the Azraq Basin sites to the LUP assemblage from Wadi Madamagh. Flake cores are well-represented at both (always more than 22%) and flake debitage is also common (especially in comparison to Initial EPI assemblages). The tool assemblages, however, have similarities and differences (Table 27). Notably, Wadi Madamagh has a much higher frequency of microliths (75.1%) as opposed to Azraq Basin sites (mean 32%) although there is considerable variation in the Azraq Basin. In terms of non-microlithic tools, both Wadi Madamagh and the Azraq Basin sites have substantial numbers of endscrapers, burins, retouched pieces, and notches/denticulates, although endscrapers are more frequent in the Azraq Basin. Microliths share similarities and differences. Both the Wadi Madamagh and Azraq Basin microliths are infrequently truncated, and marginal retouch or Ouchtata retouch (steep on a thin edge) is most frequent, although some steep abrupt retouch also is present. In the Azraq Basin, this retouch occasionally extended to the distal and proximal ends. A notable microlithic difference between the two locations is that in the Azraq Basin interior retouch is very rare and Dufour bladelets of the Roc de Combe subtype are absent.

Initial Epipaleolithic (24,000–21,300 cal BP)

Four occupation horizons (Jilat 6 Lower, Uwaynid 14 Lower and Upper, and Uwaynid 18 Upper) in the Azraq Basin are assigned to the time span of 24,000–21,300 cal BP. They include three short-term occupation events and one (Uwaynid 18) with thicker occupation deposits indicative of more sustained occupation (Garrard and Byrd 2013). Three of the occupation horizons are tightly dated; the undated Jilat 6 Lower microliths are almost indistinguishable, visually and statistically, from those from Uwaynid 14 Lower. These sites represent the earliest classic manifestation of the EPI in the southern Levant, referred to as the Initial EPI (terminology used in the Azraq Basin distinguishes between an Initial and later Early EPI occupations).

All four assemblages are assigned to the Nebekian flaked stone industry. Excavation at each produced a moderate-sized sample and, as a whole, represent the most homogeneous group of flaked stone artifacts from any time period studied in the Azraq Basin. Bladelet production from narrow single platform cores overwhelmingly dominates the assemblages. Tools are almost exclusively comprised of microliths. Most are small, narrow double arched backed/curved pointed bladelets (Table 28), with length:width ratios of 5.4 or greater. Importantly, Nebekian microliths are made almost exclusively with the microburin technique, representing the earliest habitual use of this blade/bladelet truncation technique in the Levant. Moreover, retouch is almost exclusively steep abrupt exterior backing, along with some semi-steep exterior and steep bipolar backing. There is also a temporal trend towards longer and wider double truncated tools with straighter backed edges and oblique truncations when the Lower and Upper Phases at Uwaynid 14 Trench 1 are compared.

In comparison to the Azraq Basin assemblages, Wadi Madamagh had a lesser reliance on blade/bladelet production. This is most notable in terms of the frequency of flake cores (9.9% vs. 2.5% in the Azraq Basin). The tool assemblages are, however, very similar with both having a dominance of microliths, with endscrapers and retouched pieces infrequent but somewhat more common than burins or notches/denticulates. Truncations, which generally occur in small quantities, are not included as microliths in the Azraq study. In both localities, when looking at tool forms

TABLE 26. COMPARISON OF THE MICROLITH COMPONENT AT THE AZRAQ BASIN LATE UPPER PALEOLITHIC SITES AND WADI MADAMAGH.*

	AZ 17 Trench 2		UW 18 Trench 2 Lower 15g-15q		WJ 9		WJ 6 Basal		Wadi Madamagh	
Microlith Type	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**N**	**%**
Ouchtata	70	70.0	3	75.0	5	22.0	1	20%	17	3.9
Dufour	-	-	-	-	1	4.0	-	-	93	21.5
Inverse (other)	-	-	-	-	-	-	-	-	44	10.2
El Wad	-	-	-	-	-	-	-	-	-	-
La Mouillah	-	-	-	-	-	-	-	-	1	0.2
Double arched backed	-	-	-	-	-	-	-	-	7	1.6
Curved (other)	-	-	-	-	-	-	-	-	2	0.5
Backed and truncated	-	-	-	-	-	-	-	-	3	0.7
Truncated	-	-	-	-	9	39.0	-	-	2	0.5
Pointed	-	-	1	25.0	-	-	-	-	6	1.4
Double backed	3	3.0	-		1	4.0	-	-	2	0.5
Partially backed	-	-	-	-	-	-	-	-	-	-
Trapeze	-	-	-	-	-	-	-	-	3	0.7
Triangle	-	-	-	-	-	-	-	-	2	0.5
Other microlith	1	1.0	-	-	2	9.0	-	-	13	3
Fragment w/truncation	9	9.0	-	-	1	4.0	2	40%	19	4.4
Fragment wo/truncation	14	14.0	-	-	3	13.0	2	40%	191	44.1
Partially backed fragment	-	-	-	-	1	4.0	-	-	7	1.6
Fragment (indeterminate)	-	-	-	-	-	-	-	-	21	4.8
Grand Total	**97**		**4**		**23**		**5**		**433**	

*For consistency with the Wadi Madamagh combined analysis, only complete microliths are classified to type.

of complete/nearly complete microliths, double arched backed bladelets are the dominant microlithic type, along with much lower frequencies of backed and truncated microliths (see Table 28). The double arched backed bladelets are of similar size and length:width ratio (see Garrard and Byrd 2013: Figure 9.6) and manufactured in the same manner—ends typically truncated by the microburin technique and then backed primarily by abrupt exterior retouch (see also Byrd 2014). One notable difference is the higher frequency of trapezes/microburin trapezees (see Endnote 1) at Wadi Madamagh; these microliths are absent in the Initial EPI of the Azraq Basin but present in subsequent Early EPI assemblages. Along with very similar microlithic tool assemblages from Kharaneh IV Sounding 3 Layers 6 and 6a in the Azraq Basin (Muheisen 1983), recent excavations in Area A at Kharaneh IV (Macdonald et al. 2018), possibly Ayn Qasiyya also in the Azraq Basin (Richter 2011), and Yabrud II Layers 6 and 7, where the term Nebekian originated (Rust 1950: 4), in southern Syria, these sites appear to represent a coherent lithic industry with shared attributes that were present over a wide swath of the arid and semiarid eastern Levant.

DISCUSSION

The case study of Wadi Madamagh with respect to differences in classificatory approaches to its lithic assemblages and comparisons to other sites both intra- and inter-regionally has several implications for reconstructions of prehistory. One benefit to the present study is that the authors are the researchers who performed all the lithic analyses from all the sites discussed and were able to standardize these to a large extent. This differs from some studies where re-

TABLE 27. COMPARISON OF MAJOR TOOL CLASSES FROM LATE UPPER PALEOLITHIC COMPONENTS AT AZRAQ BASIN SITES AND WADI MADAMAGH.

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	Azraq 17 Trench 2		UW 18 Trench 2 lower		WJ 9		WJ 6		Wadi Madamagh	
Tool Class	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Endscraper	33	19.2	-	-	119	48.4	3	27.3	47	8.2
Burin	9	5.2	7	41.2	18	7.3	3	27.3	15	2.6
Backed piece	-	-	-	-	-	-	-	-	-	-
Perforator	-	-	-	-	3	1.2	-	-	-	-
Truncation	3	1.7	-	-	11	4.5	-	-	2	0.3
Microlith	74*	43.0	2	11.8	3	1.2	1	9.1	195	33.8
Microlith fragment	23	13.4	2	11.8	5	2.0	4	36.4	238	41.3
Notch/denticulate	-	-	1	5.9	10	4.1	-	-	31	5.4
Retouched piece	25	14.5	5	29.4	58	23.6	-	-	37	6.4
Multiple tool	5	2.9	-	-	9	3.7	-	-	2	0.3
Varia	-	-	-	-	10	4.1	-	-	9	1.6
Grand Total	**172**		**17**		**246**		**11**		**576**	

*includes 70 marginally retouched/Ouchtata bladelets

searchers must compare their analyses from a site or sites with analyses done by others that are available in various publications. Regardless, comparisons, as discussed below, are not always as straight-forward as they might seem.

CLASSIFICATORY APPROACH DIFFERENCES

As discussed earlier in the sections on the site of Wadi Madamagh, it was necessary in creating the combined lithics tables to compromise on how certain lithic types were documented. The heart of this issue revolves around whether artifacts were complete or broken, and it applies not only to microliths (in particular) but also to categories of debitage. For debitage, this is treated by several researchers as a matter of identifying complete, proximal, medial, and distal pieces (e.g., Byrd 1989: 39–41; Dibble et al. 1995: 37; Hiscock 2002; Valla 1984: 34). Those that are complete or proximal often are counted in a particular class such as flakes or blades. Those that are medial or distal are combined into a broken blank or debris category. This approach thus largely avoids overcounting the artifacts in a particular debitage type or class.

This issue is more complicated when it comes to assessing tools. Macrotools are often counted in their type/class regardless of being broken, presumably because the fragments that are identifiable to class/type are not likely to be double counted (e.g., a regular endscraper has only one end that is distinctive to this type; the same may be said for most (but not all) burin types, perforators/borers, sidescrapers, truncations, and so forth). One could argue, however, that double counting in broken macrotools might be more prevalent for classes such as notch/denticulates, retouched pieces, and backed pieces.

Microlith types are the most problematic. Because they are small and usually relatively thin and/or narrow (in some cases), they are susceptible to more frequent breakage due to either cultural or natural taphonomic processes. If only complete microliths are classified to type, as was done here in the combined analyses of Wadi Madamagh, then this approach may underrepresent certain types (compare Tables 11, 13, and 18). Another example is in Table 29, which shows this contrast in the description of the LUP at Tor Sageer. The use of the broken microlith component, however, almost certainly overrepresents certain types. One solution might be to use distal and proximal microliths in classifying by showing these as, for example, "broken double arched backed"; here, the total counts in a broken type could be divided by two prior to percentage calculations to help mitigate overrepresentations. Beyond this, there are certain types, such as Dufour or other inverse that could include not only the proximal and distal ends, but also the medial segments. In this case, one could divide the broken counts for a type such as Dufour by three prior to percentage calculations.

Unfortunately, most publications of LUP and EPI lithic assemblages do not necessarily state if microliths that were typed were only those that were complete or if they also include all or some broken microliths. And this is not an issue that can be resolved by knowing archaeological "kinships" in the sense of who studied with a particular mentor and/or who works with whom. Two of us (DIO and BFB), for example, studied under the late Arthur J. Jelinek, but we developed different approaches to analysis (BFB preferring the complete microlith approach and DIO the approach that includes some broken microliths).

TABLE 28. COMPARISON OF THE MICROLITH COMPONENT AT THE AZRAQ BASIN INITIAL EPIPALEOLITHIC SITES AND WADI MADAMAGH.*

	UW 14 T2 Lower Phase		UW 14 T2 Upper Phase		UW 18 Trench 2 Upper 14b-15f		WJ6 Lower Phase		Wadi Madamagh	
Microlith Type	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Ouchtata	-	-	-	-	-	-	-	-	2	0.3
Dufour	-	-	-	-	-	-	-	-	5	0.8
Inverse (other)	-	-	-	-	-	-	-	-	10	1.5
La Mouillah	-	-	-	-	-	-	3	2.5	16	2.5
Double arched backed	58	21.0	11	6.6	174	42.3	9	7.6	127	19.4
Curved (other)	-	-	-	-	2	0.5	-	-	6	0.9
Backed and truncated	20	7.2	25	15.0	19	4.6	13	10.9	34	5.2
Truncated	10	3.6	12	7.2	14	3.4	8	6.7	1	0.2
Pointed	-	-	1	0.6	-	0.0	-	-	12	1.8
Double backed	-	-	2	1.2	5	1.2	1	0.8	8	1.2
Partially backed	-	-	1	0.6	-	-	-	-	3	0.5
Lunate	-	-	-	-	-	-	-	-	2	0.3
Trapeze	-	-	-	-	-	-	-	-	31	4.7
Triangle	-	-	-	-	3	0.7	-	-	1	0.2
Other microlith	-	-	2	1.2	5	1.2	-	-	19	2.9
Fragment w/truncation	135	48.9	65	38.9	128	31.1	51	42.9	216	33.1
Fragment wo/truncation	29	10.5	33	19.8	39	9.5	33	27.7	97	14.9
Partially backed fragment	19	6.9	14	8.4	18	4.4	1	0.8	24	3.7
Fragment (indeterminate)	5	1.8	1	0.6	4	1.0	-	-	39	6.0
Grand Total	**276**		**167**		**411**		**119**		**653**	

*For consistency with the Wadi Madamagh combined analysis, only complete microliths are classified to type.

Finally, we also note the widely acknowledged issue that there are differences between observers in how they type. One example of this among the authors may be the recognition (or not) of "trapeze" forms in the Initial/Early EPI. Whether an observer decides that a truncated end on a microlith is curved or oblique is particularly difficult when the microlith is quite narrow in width. Thus, for example, two of us (DIO and MN) recognize trapezes in the Initial/Early EPI based on a judgement of "more oblique" rather than "more curved," as well as backed bladelets with microburin scars at the distal and proximal ends (see Endnote 1). These microburin scars are oblique rather than curved (lending a trapeze shape to the microlith), and possibly represent "unfinished" microliths (which could end up as either double arched backed or trapeze in form once truncated). Another issue related to the microlith category is whether truncated bladelets are placed in microliths or in truncations (a macrotool class). DIO and MN place these in microliths, while BFB does not (except in this paper where analyses were standardized as much as possible).

INTRA- AND INTER-REGIONAL COMPARISONS

We have provided some comparisons for Wadi Madamagh within the Petra region, and also to other areas of the eastern Levant (Wadi al-Hasa and Azraq Basin) where we have worked. The Wadi Madamagh LUP lithic assemblage configuration, particularly its abundance of Dufour bladelets, does not appear to be widespread or common in the Levant (Schyle 2015a). Among the examples of LUP assemblages with frequent Dufour bladelets (either twisted Roc de Combe or straight types) are Ksar 'Akil, Lebanon (Berg-

TABLE 29. CONTRAST BETWEEN CLASSIFYING ONLY COMPLETE MICROLITHS VS. INCLUDING FRAGMENTS IN THE LATE UPPER PALEOLITHIC (Strata II, III, V) AT TOR SAGEER (WHNBS-242) IN THE WADI AL-HASA.

	LUP without microlith fragments typed		LUP with microlith fragments typed*	
	n	%	n	%
Ouchtata	11	5.8	21	11.1
Dufour	10	5.3	12	6.3
Inverse (other)	3	1.6	17	9.0
La Mouillah	1	0.5	6	3.2
Double arched backed	1	0.5	1	0.5
Curved (other)	5	2.6	15	7.9
Backed and truncated	8	4.2	25	13.2
Truncated	3	1.6	8	4.2
Pointed	1	0.5	20	10.6
Double backed	-	-	4	2.1
Partially backed	1	0.5	21	11.1
Trapeze	2	1.1	2	1.1
Other microlith	-	-	3	1.6
Fragment w/truncation	37	19.6	na	-
Fragment wo/truncation	52	27.5	na	-
Partially backed fragment	20	10.6	na	-
Fragment (indeterminate)	34	18.0	34	18.0
Grand Total	189		189	

*Analyses of the 1997 and 1998 assemblages did not record microlith fragments as proximal, distal, or medial. Thus, this column includes the types of all fragments where it was possible to determine their probable type.

man 1987; Ohnuma and Bergman 1990) and Umm el-Tlel, Syria (Ploux 1998; Ploux and Soriano 2003). Arqov-Divshon assemblages in the central Negev and Nahal Rahaf 2 rockshelter in the southern Judean Desert also have twisted Dufour bladelets (Barzilai et al. 2020; Belfer-Cohen and Goring-Morris 2017). Although their absolute chronology is not known, these assemblages are usually attributed to the period from ca. 30,000–25/23,000 cal BP (Belfer-Cohen and Goring-Morris 2017). Further afield, such assemblages are also known from Warwasi (Ghasidian et al. 2019; Olszewski 2009) and Yafteh (Bordes and Shidrang 2009; Shidrang 2015), both in the Iranian Zagros Mountains. The twisted bladelets attribute is a product of striking bladelets off carinated scrapers and/or carinated burins (e.g., Almeida 2001; Belfer-Cohen and Grosman 2007; Olszewski 2007). This points to use of similar technological strategies by nonrelated groups. The Nebekian Initial/Early EPI also is not known from all of the Levant, but instead appears to be found only east of the Jordan Rift Valley (Byrd 1988; Olszewski 2006), where one of its defining traits is the early use of microburin technique in microlith manufacture. Its eastern distribution might be linked to generally steppic habitats, however, Nebekian EPI sites are associated with Mediterranean forested regions (e.g., Wadi Madamagh: Cordova 2007: 163), wet steppe (e.g., Jabrud: Byrd et al. 2016), and/or are in proximity to wetlands (most sites: Abu Jaber et al. 2020a, b; Garrard 2013; Ramsey and Rosen 2016; Rech et al. 2017).

In the comparisons provided in the previous sections, it is not surprising that there is variability between the comparable lithic assemblages during both the LUP and the Initial/Early EPI, as it is widely acknowledged that such diversity has many potential underlying factors. These can include types of activities at sites, duration of site occupation episodes, chronological changes in lithic manufacture techniques and resulting tool types, and perhaps the specific types of food resources that were hunted or gathered in particular locales. For example, Wadi Madamagh, Yutil al-Hasa, Tor Sageer, and KPS-75 are all rockshelters, while Sabra 3 North, Palmview 3, Taibeh 3, Tor at-Tareeq, and the Azraq Basin sites are open-air contexts. Moreover, while the mammalian fauna is mainly gazelle at most of these sites that yield animal bone elements, Wadi Madamagh is unusual in its focus on wild goats (Sadhir et al. 2020). Finally, while the sites that have been dated primarily occur during the LGM, Tor at-Tareeq is at the end of the LGM when climatic conditions were transitioning into a wetter and warmer interval.

Sorting out precisely which of these or other factors has precedence as an explicator for inter-assemblage diversity in the LUP and Nebekian EPI that we discuss, however, is not ultimately the goal (e.g., Dibble et al. 2017; Phillipps et al. 2022). Instead, we note that all these assemblages represent aggregates of lithic artifacts that accumulated at specific locales (Rezek et al. 2020), possibly over hundreds of years as sites were repeatedly visited and revisited. Each locale thus has a distinct life-history that resulted in the accumulations, as well as the frequencies of particular artifact types that emerge from these aggregates. What was left behind or taken away by those who used the sites, and what was manufactured on-site as opposed to off-site are only small subsets of each site's life-history and they cannot be parsed into discrete events.

What the accumulated lithic assemblages of the aggregates do have potential for, however, is to allow examination of what has been called the "practice of stone artifacts" (e.g., Rezek et al. 2020). In other words, stone artifacts at a site are residuals or precipitates of processes such as discard (deliberate or accidental) that become part of ecological inheritance in a landscape (Iovita et al. 2021). People returning to a site in the past did so at least in part because it contained these residuals, which potentially served as a source of stone, thus limiting the need to travel elsewhere to obtain this resource. In this case, the residuals or precipitates of stone artifact aggregates reflect an aspect of human niche construction (Iovita et al. 2021). For a site such as Wadi Madamagh, for instance, the emergent patterns from the aggregates of an LUP with Dufour bladelets and a Nebekian Initial/Early EPI with narrow, double-arched backed bladelets, can be considered against site features that likely were invariant to a great degree (e.g., rockshelter protection from the elements, the long-term proximity of wetlands, and the presence of wild goats characteristic of rugged topography) and others that were more variable both during and between the LUP and the EPI (e.g., number of visits, duration of occupations, specific tasks, changes in hunting strategies, etc., e.g., Clark 2020). These are entanglements of factors that are relevant to site aggregate formation, just as are processes such as sediment deposition and erosion. Understanding the life-history of a site is thus more than the stone artifacts that it contains.

THE PLACE OF WADI MADAMAGH IN EASTERN LEVANTINE PREHISTORY

Kirkbride's excavations and brief description of Wadi Madamagh (Kirkbride 1958), although not entirely accurate by today's standards wherein two sets of occupations (LUP and Initial/Early EPI) now are recognized, were among the early research efforts into this timeframe for the eastern Levant. Reanalysis of a portion of the lithics that she recovered from the site in 1956 (Byrd 2014) led to the recognition that the EPI occupations contained lithics that were attributable to the Nebekian industry identified at Jabrud (Syria) by Rust (1950; see Byrd 1988). Subsequently, EPI sites in the Azraq Basin and the Wadi al-Hasa provided dates for the Nebekian, indicating that this industry was present during the Last Glacial Maximum and its immediate aftermath, and that it documented the earliest use of the microburin technique in the Levant.

What is more difficult to assess is the relationship of the Nebekian to preceding LUP industries. The Nebekian appears to be found only in the eastern Levant, where it occasionally overlaps spatially with the Kebaran EPI (well-known from the western Levant), e.g., at Ayn Qasiyya in the Azraq region (Richter 2011). While the LUP from Wadi Madamagh is sometimes characterized as a variant of the Levantine Aurignacian (e.g., Schyle 2015) due to the presence of Dufour bladelets and carinated elements, LUP industries with these lithic elements are not yet widely known elsewhere in the eastern Levant. More pertinently, because the LUP does not contain microburin technique, and its types of microliths usually feature marginal (Ouchtata) retouch rather than backing and/or Dufour bladelets, as is the case at Wadi Madamagh, there are no clear identifiable lithic links between the Nebekian and the LUP, other than a general emphasis on bladelets and microliths.

Although it is often archaeological practice to propose explanations for change, such as new groups moving into an area with their distinctive lithic components or technologies, these types of interpretations are then confounded by the question of where, exactly, such new groups originated, as well as a lack of precision in chronological dates (even at the 1σ range, such dates do not indicate absolute contemporaneity within or between regions/industries). Instead of following this interpretive pathway, we instead return to the perspectives discussed in the previous section. That is, we note that lithic assemblages are aggregates of materials for which one cannot separate out individual events. This means that attempts to find links between preceding and subsequent lithic industries are exceedingly difficult because we cannot "see" the exact nature of a preceding industry as we do not know it except in a general framework (the aggregate).

In summary, as a site, Wadi Madamagh is significant as a record of lithic variability between and within aggregates, which are identified as LUP and Initial/Early EPI. These sets of occupations exemplify diversity within categories, i.e., microlith forms, which are not standardized types (see Shea 2022). Wadi Madamagh is, however, just one site from a landscape of sites for these temporal periods. Understanding the implications of at least some of the changes in lithics that are documented would require setting Wadi Madamagh within its prehistoric Petra landscapes, an endeavor that is only minimally possible as only 4 LUP and 1 EPI sites are known from this region.

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DATA STATEMENT

All data used for interpretations are presented in the tables included in this article.

ENDNOTES

[1]The term "microburin trapeze" is used here to distinguish this type from "true trapezes." Microburin trapezes are narrow width microliths with a trapeze shape. They have a backed lateral edge, but the distal and proximal ends are not truncated; instead, these ends are characterized by microburin scars (see Figure 5). Nongeometric microlith dominated entities, such as the Nebekian, do sometimes contain small numbers of geometric microliths, including true trapezes (as documented for Wadi Madamagh and sites in the Wadi al-Hasa region). This does not mean that these Early EPI components should be confused with geometric microlith entities found in the Middle and Late EPI periods. In point of fact, later geometric microlith assemblages also contain nongeometric microliths, which does not alter the overall interpretation of these as Middle or Late EPI. The same standards should apply also to Early EPI entities that include the presence of some geometric microliths. Our descriptions, including the term "microburn trapeze," are efforts to document the variability within lithic assemblages and speak to the issue of nonstandardization in microlith forms (see Shea 2022).

[2]We cannot provide data on the frequency of convex vs. oblique truncations on microlith fragments, as fragment ends were not always typed in the various sets of analyses. Thus, it is not possible to directly link the fragments with truncation to double arched backed or narrow trapeze microliths. Instead, we note the possibility of such linkages.

[3]Frequencies for Ayn al-Buhayra were calculated based on all debitage (including small flakes and shatter).

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