ARCHAEOLOGICAL EVIDENCE FOR INDIGENOUS HUMAN OCCUPATION OF SOUTHERN ARABIA AT THE PLEISTOCENE/HOLOCENE TRANSITION: THE CASE OF AL-HATAB IN DOHOFAR, SOUTHERN OMAN

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Abstract: The Neolithic peopling of Arabia is a subject of increasing debate, as different scenarios are proposed to describe the relatively sudden appearance of seemingly homogeneous archaeological sites throughout the south of the Peninsula during the Early Holocene. Such sites are identified by the co-occurrence of a laminar core reduction strategy with its supposed fossile directeur, the “Fasad point.” This techno-typological package has been used by some to link these sites with an expansion of pastoralists from the Levant. A recent study of blade technologies in Southern Arabia, however, demonstrates a large degree of internal variability within these reduction strategies, whilst an inter-regional study of Fasad points reveals this artifact category to be both time-transgressive and morpho-metrically variable across parts of Southern Arabia. Archaeological findings from al-Hatab Rockshelter in Dhofar, Oman go further to challenge the notion of an expansion originating in the Levant and spreading across Southern Arabia. Here we demonstrate that an indigenous occupation with a blade technology and tanged points pre-dates the ‘Levantine expansion’ by at least four millennia. Based on the lithic assemblage from al-Hatab, we argue the Arabian Late Palaeolithic developed locally in Southern Arabia, forming part of the previously defined Nejd Leptolithic tradition. The evidence from al-Hatab in conjunction with recent genetic findings indicates that some groups in Southern Arabia have persisted there since the Late Paleolithic ca 13,000 years ago, if not earlier.

Résumé: Le peuplement néolithique de l’Arabie est devenu le sujet de nombreux débats, alors que différents scénarios ont été proposés pour expliquer l’apparition soudaine de sites archéologiques apparente homogènes à travers le sud de la péninsule au cours de l’Holocène ancien. Ces sites sont identifiés par la concomitance d’une stratégie de débitage laminaire avec son fossile directeur supposé : la « pointe de Fasad ». Cet assemblage typo-technologique est utilisé pour relier ces sites à l’expansion de pasteurs venus du Levant. Une étude technologique récente sur le débitage laminaire d’Arabie du Sud a cependant montré une forte variabilité parmi ces stratégies de débitage, alors qu’une étude interrégionale des « pointes de Fasad » révèle que ce type est à la fois trans-chronologique et de morphométrie différente suivant les régions d’Arabie. Les découvertes archéologiques dans l’abri d’al-Hatab, dans le Dhofar (Oman), contredisent le scénario d’une origine levantine, démontrant l’existence d’une occupation indigène qui possédait une technologie laminaire et des pointes pédonculées, et qui précédait « l’expansion levantine » de plusieurs millénaires. Dans cet article, nous utilisons l’assemblage lithique d’al-Hatab pour définir une nouvelle industrie au sein du Paléolithique récent d’Arabie du Sud, qui se développe localement et appelée le Hatabien. Les vestiges provenant d’al-Hatab, ainsi que les données génétiques, suggèrent que des groupes en Arabie du Sud ont perduré sur place depuis le Paléolithique récent, il y a 10 000 à 15 000 ans.

Keywords: Arabian Peninsula; Refugia; Oman; Blade technology; Late Palaeolithic.
Mots-clés: Péninsule Arabique ; Zone refuge ; Oman ; Débitage laminaire ; Paléolithique récent.
INTRODUCTION

In the early days of prehistoric research in Arabia, the off-handed remark suggesting similarities between “Qatar B-type” arrowheads documented by the Danish Expedition to Qatar, and Pre-Pottery Neolithic B (PPNB) “Byblos” points from the Levant (Kapel 1967) led scholars to assume that the Neolithic peopling of Arabia was the result of Levantine pastoralists expanding southwards during the Early Holocene climatic optimum (~11 to 8 ka BP). Recent archaeological research (Charpentier 2008; Rose and Usik 2009; Uerpmann et al. 2009; Crassard 2009; Hilbert et al. 2012; Hilbert 2013 and 2014; Charpentier and Crassard 2013) and genetic studies of modern populations in Yemen and Oman (Černý et al. 2008 and 2011; Al-Abri et al. 2012; Rose et al. 2013), however, have demonstrated a far more complex picture of human demographic history in Southern Arabia during the Terminal Pleistocene and Early Holocene.

This paper presents a summary of archaeological, geochronological research conducted at al-Hatab Rockshelter, one of only a very small number of dated, stratified Terminal Pleistocene/Early Holocene sites in Oman. Al-Hatab was discovered in 2004 (Rose 2006), and excavated intermittently until 2010 by the Dhofar Archaeological Project (DAP) (Rose and Usik 2009). Two technologically and typologically related archaeological levels were found, while Optically Stimulated Luminescence (OSL) age estimates indicated that the site was initially occupied in the Terminal Pleistocene, with evidence of human activity persisting until the beginning of the Early Holocene, from roughly 13 to 10 thousand years (ka) ago. Here we describe the lithic production sequences employed by the al-Hatab toolmakers, while sedimentological and chronological results focus on depositional processes occurring within the collapsed rockshelter. In turn, we use these data to place al-Hatab within a palaeoenvironmental and temporal framework.

The Late Palaeolithic assemblage from al-Hatab provides a temporal anchor upon which to tether a related ensemble of surface scatters found across the Nejd Plateau in Dhofar, Southern Oman. Such assemblages are characterized by a similarly recurring suite of technological and typological features including: a laminar semi-tournant unidirectional mode of blank production, burins (mainly on truncations), tanged points, trifacial pieces, and the hard hammer shaping of unifacial and bifacial foliates. The widespread distribution of these Late Palaeolithic assemblages across the Southern Nejd may coincide with a brief period of heightened monsoon activity during the Terminal Pleistocene, which would have facilitated the limited expansion of an indigenous population onto the Nejd plateau, and possibly beyond.

SITE DESCRIPTION

The site comprises a partially-collapsed rock overhang located in a small tributary feeding Wadi Dawkah, at the southern end of the Nejd Plateau in a region known as Umm al Khashab (fig. 1). The tributary would have provided an important source of freshwater during periods of intensified monsoon activity, while fine-grained nodular and tabular chert outcrops that are ubiquitous in the immediately surrounding environment provided a raw material source.

Two sondages were dug, comprising a total of 16 m$^2$ (fig. 2). The stratigraphic sequence in both excavation areas is composed of interstratified, partially cemented fine-grained sand layers, and coarser sediments containing angular limestone inclusions. The archaeological horizons yielded over 2000 lithic artifacts including tools and debitage; no organic remains were recovered. Excavations revealed two archaeological levels, while geoarchaeological investigations expanded the original three sedimentary units identified in Sondage 1 (Rose and Usik 2009) by identifying a total of eight geological horizons (GH) in Sondage 2.

STRATIGRAPHY

The sequence exposed in the eastern section of Sondage 2 comprises an interstratified deposit of gravel- and silt-dominated sediments, which contain chert artifacts that were brought to the site by human action (fig. 3). GH8 is at the base of the sequence and comprises a thick (~40 cm) accumulation of well-cemented medium coarse sand, containing occasional coarse inclusions. GH8 is overlain by sequential colluvial horizons GH7, GH6 and GH5, containing most of the Late Palaeolithic assemblage, which was divided into two levels, GH7 containing the lowest level (L2) and GH5 containing the upper level (L1). GH7 and GH5 can be characterized primarily as coarse sediments, comprising fine gravels that are absent elsewhere in the exposed profile. The coarse limestone components in GH5 and GH7 are likely indicative of an increase in energy relating to fluvial deposition in a wadi environment during ephemeral flooding events. However, the lack of bedding structures and clast imbrication indicates that discharge was not sustained. GH6 is located between the fluvial/colluvial...
episodes associated with GH5 and GH7, and is composed of aeolian sand representing a phase of increased regional aridity.

Following the deposition of GH5, a change to sediments dominated by aeolian deposition was identified in GH4, which is composed of moderately compacted homogenous sands and silts. Following the deposition of GH4, a change in the orientation of the upper sediments indicates both a shift in sediment source and deposition regime at the site. While GH5-GH7 are thickest at the southern (downslope) part of the section, becoming shallower upslope towards the rockshelter, GH4 to GH1 show the opposite trend, becoming shallower downslope, suggesting that these units originate from the chemical and mechanical dissolution of the rockshelter itself. GH3 is a sedimentary unit consisting of a wide range of very poorly-sorted coarse sands. This sediment composition is indicative of colluvial deposition. The top of the sequence consists of loose sands and limestone shatter, typical of an erosional surface similar to an incipient desert pavement.

GEOCHRONOLOGY

Geochronological analyses were undertaken to ascertain the age of the assemblage and place the results from the
palaeoenvironmental reconstruction into a temporal framework. A total of four OSL ages were obtained from the stratigraphic sequence (table 1), two from each sondage. The ages from Sondage 1 provide a terminus ante quem for the burial of the two archaeological levels at al-Hatab (Unit B and Unit C), while the OSL samples from Sondage 2 come from the lower cemented strata (GH8) and from the top of the sequence (GH3). Full details of the preparation and measurement of the samples, and of the data so obtained, are given in Hilbert et al. (2015). The earliest ages at al-Hatab were obtained from the top of GH8, which deposited 19.9 ± 1.3 ka ago. The top of Unit C in Sondage 1 and the base of Unit B produced bracketing ages for the archaeological lower horizon (L2) of 12.6 ± 1.5 ka and 12.8 ± 1.0 ka (Unit C and Unit B respectively). The sample from GH3 (Sondage 2) was deposited 2.7 ± 0.2 ka ago, which was cut by a later fire pit that contained Iron Age pottery sherds. OSL age estimates provide a mean age of 12.7 ka for the archaeological-bearing units in Sondage 1, and while these ages do not provide an exact age for the Late Palaeolithic assemblages recovered here, they indicate that the sediments accumulated between ca 14 and 11 ka.

Table 1 – OSL ages for al-Hatab.

| Sample No | Depth (cm) | Sondage | GH/Unit | Age (ka ago) |
|-----------|------------|---------|---------|--------------|
| TH29-1    | 26         | 2       | GH3     | 2.7 ± 0.2    |
| AH-OSL1   | 50         | 1       | Unit B  | 12.8 ± 1.0   |
| AH-OSL2   | 65         | 1       | Unit C  | 12.6 ± 1.5   |
| TH29-2    | 69         | 2       | GH8     | 19.9 ± 1.3   |

Fig. 2 – Topographic map of the site showing the location of the two sondages.

Fig. 3 – Schematic profile of al-Hatab sedimentary sequence from Sondages 1 (a) and 2 (b); profile from Sondage 2 (c) (photo M.W. Morley).
SITE FORMATION AND PALAEOENVIRONMENTAL RECONSTRUCTION

Contiguous one centimeter sediment samples were excavated from both sondages at al-Hatab, yielding comparable sedimentological results between facies. Organic carbon and carbonate content values were measured using the standard loss on ignition (LOI) technique (Heiri et al. 2001), while laser granulometric analysis of the fine sediment fraction (<2 mm) was conducted using a Malvern Mastersizer 2000. Low frequency mineral magnetic susceptibility measurements were made using a Bartington MS2 susceptibility meter.

GH8 was deposited in a stable terrestrial environment, with only small-scale, localized colluvial activity at the time of sedimentation (fig. 4). The interface between GH8 and GH7 marks a shift in sedimentary environments at the site. The sediments of GH7, GH6 and GH5 are marked by increased fluvial activity, as channel activation caused the deposition of fine gravels and sands in a series of small channels and gullies. Grain size variations of the <2 mm fraction reveal oscillations in flow capacity, indicative of variable discharge. Lower carbonate values show a decrease in landscape stability as this material was removed from the substrate through dissolution. Peaks in particle size are consistent with the three phases of fluvial activation, with peak flows remobilizing aeolian material that had accumulated within topographic depressions around the site. Fluctuations in mean particle size most likely reflect the removal of minerogenic silts and clays during peak flow, whilst decreases in flow allow these mineral-rich fines to settle out of suspension. These units are indicative of more humid conditions and the presence of flowing water conducive to human occupation of the area.

GH4 marks another change in environmental conditions characterized by a steady increase in clay-silt content, and a rise in susceptibility values throughout the upper units, representing a decrease in the fluvial deposition of coarse stream channel material. GH3 reflects a brief return to humid conditions indicated by an increase in particle size consistent and
increased colluviation. A combustion feature (e.g., hearth), intermixed with younger archaeological remains and ceramics, marks the top of the al-Hatab sequence in Sondage 2.

The characteristics and dates of the al-Hatab stratigraphic section fit comfortably with the regional Terminal Pleistocene palaeoclimatic record (e.g., Sirocko et al. 1993; Overpeck et al. 1996; Cremaschi and Negrino 2005; Ivanochko et al. 2005; Beineke 2006; Fleitmann and Matter 2009; Preusser 2009; Fleitmann et al. 2007 and 2011). In particular, ages for occupation of al-Hatab correspond with a brief, but potentially critical period of increased humidity in Arabia, prior to the onset of the Holocene. A number of records indicate that \( \text{ca} \) 15-13 ka, a shift in the intensity and northward latitudinal position of the monsoon rain belt occurred in response to a period of rapid global warming (Parker 2009), termed the Bölling-Allerød (BA) interstadial. Palaeoclimatic records from the UAE (Wood and Imes 1995), Saudi Arabia (McClure 1976; Hacker et al. 1984; Hilbert et al. 2014) and Oman (Clark and Fontes 1990) record a phase of humidity between \( \text{ca} \) 15 and 12 ka. Additionally, numerous marine records (e.g. Schultz et al. 1998; Gupta et al. 2003; Leuschner and Sirocko 2003) also demonstrate an increase in monsoon intensity at this time, in response to teleconnective links with the North Atlantic. A return to arid conditions following the onset of the Younger Dryas is believed to have occurred by \( \text{ca} \) 13 ka (e.g., von Rad et al. 1999; Goudie et al. 2000; Gupta et al. 2003). Ages for this humid event correlate with OSL measurements at the interface of GH8 and GH7, associated with the Late Palaeolithic occupation of the site. The configuration of the archaeology bearing strata at al-Hatab, formed largely by colluviation and erosional reposition, indicates that the archaeological layers uncovered at the site are by no means analogous to an \textit{in situ} living floor. It is argued, however, based on the presence of six refittings within the lithic assemblage and the fresh condition in which the artifact edges were found, that the archaeological finds were not transported from any great distance. Given the OSL age estimates and the geoarchaeological evidence, we suggest that the artifact bearing layers accumulated by at least \( \text{ca} \) 13 ka ago, as the rockshelter was gradually eroded by low-energy fluvial and aeolian activity.

LITHIC ASSEMBLAGE

All artifacts excavated from the site were submitted to technological, metrical and typological analysis, the parameters for which are discussed in Rose (2006) and Hilbert (2014) and largely follow methodologies for laminar assemblages defined by A.E. Marks (1976) and K. Monigal (2002). The two most prominent reduction strategies employed at the site are single platform, unidirectional-parallel blades struck from volumetric cores, alongside the shaping of bifacial implements. The lithic technological and typological features in archaeological levels 1 and 2 are, however, analogous and will therefore be dealt with as a whole (table 2).

Artifacts were manufactured exclusively on chert nodules and blocks that outcrop from the Eocene Rus Formation (Platel et al. 1992). Two distinct raw material types are found within the Rus Formation: the Gahit and Aybut chert-bearing members. Both geological members have high to moderate quality chert nodular inclusions that vary greatly in size and shape. At al-Hatab, three chert varieties have been identified: a) Gahit 1 is characterized by a thick chalky cortex, nodules of medium size (max. 25 cm in diameter) and are of light grey coloration when freshly knapped; b) Gahit 2 has a thin dark cortex, when freshly knapped the raw material presents itself in grey hues with distinct dark banding; and c) the Aybut chert is slightly translucent and yellowish in color with a thin cortex. When freshly knapped, the chert is grey with cream and slightly bluish striations. No preference was observed on the selection of a specific raw material for tool production.

| Debitage          | al-Hatab L1 | al-Hatable L2 | Total |
|-------------------|-------------|---------------|-------|
| Flakes            | 430         | 242           | 672   | (30%) |
| Blades            | 184         | 94            | 278   | (12%) |
| Bladelets         | 45          | 31            | 76    | (3%)  |
| Cortical flakes   | 140         | 59            | 199   | (9%)  |
| Cortical blades   | 40          | 9             | 49    | (2%)  |
| Débordant flakes  | 11          | 7             | 18    | (1%)  |
| Débordant blades  | 39          | 21            | 60    | (3%)  |
| BTF               | 41          | 19            | 60    | (3%)  |
| Burin spalls      | 8           | 6             | 14    | (1%)  |
| Core tablet       | 1           | 0             | 1     |       |
| Chips             | 310         | 173           | 483   | (22%) |
| Cores             | 72          | 47            | 119   | (5%)  |
| Tools             | 119         | 73            | 192   | (9%)  |
| **Total**         | **1440**    | **781**       | **2221** | (100%) |

BLANK PRODUCTION SYSTEMS

Blank production follows a strictly unidirectional-parallel orientation of removals. The majority of the 119 cores were exploited from either a narrow edge of a raw material block or the wide face (frontal) of a rounded nodule (fig. 5). Two
Fig. 5 – Cores from al-Hatab. 1, 3, 7, 13) Single platform unidirectional blade cores; 2) single platform unidirectional convergent blade core; 4-6, 8-9) single platform semi-tournant blade and flake cores; 10-11) Wa’shah cores on narrow working surface; 12) alternate opposed platform blade core (Y.H. Hilbert and V.I. Usik).
specimens show bidirectional scar patterns, however, this configuration is not the result of alternate bidirectional exploitation of the core’s working surface; rather, it indicates the interchange use of additional untapped volume on the same core. These new planes of removal were commonly placed adjacent to the main work surface (Hilbert et al. 2012)—in semi-tournant fashion stricito sensu (Delagnes 2000). This particular core reduction modality is linked to the production of blanks with parallel sides and unidirectional scar patterns (table 3). Blank manufacture is dictated by a recurrent production system with little preparation to either the striking platform or the core working surfaces.

Blank morphologies are in agreement with the technological parameters observed on the cores, making it possible to reconstruct reduction modalities used at the site (table 3). In terms of shape, blades and bladelets are either rectangular with parallel edges or show divergent as well as convergent sides; flakes, on the other hand, tend to be trapezoidal in shape and have expanding sides (fig. 6). Scar patterns on blanks are consistent with the overall pattern observed on the

| Table 3 – Technical characteristics of the debitage from al-Hatab. |
|------------------------|----------------|----------------|----------------|----------------|
| Debitage               | Flake          | Blade          | Bladelet       | Cortical       | Débordant/CTE*  |
| **Striking platforms** |                |                |                |                |                |
| Cortical               | 84             | 19             | 2              | 56             | 13             |
| Unfaceted/Straight     | 356            | 138            | 29             | 89             | 44             |
| Dihedral               | 16             | 3              | 0              | 4              | 3              |
| Punctiform             | 13             | 9              | 2              | 5              | 0              |
| Faceted                | 15             | 2              | 1              | 1              | 1              |
| Crushed                | 60             | 40             | 14             | 27             | 11             |
| Transverse             | 5              | 0              | 1              | 0              | 1              |
| Undetermined           | 123            | 67             | 27             | 66             | 1              |
| **Blank shape**        |                |                |                |                |                |
| Parallel               | 120            | 102            | 26             | 46             | 17             |
| Expanding              | 287            | 45             | 19             | 78             | 42             |
| Convergent             | 84             | 59             | 29             | 22             | 10             |
| Ovoid                  | 82             | 5              | 0              | 50             | 5              |
| Irregular              | 78             | 18             | 2              | 19             | 4              |
| Undetermined           | 21             | 49             | 0              | 33             | 0              |
| **Blank midpoint cross section** | | | | | |
| Flat                   | 72             | 3              | 1              | 22             | 1              |
| Triangular             | 214            | 116            | 45             | 36             | 9              |
| Lateral steep          | 136            | 28             | 6              | 43             | 57             |
| Trapezoid              | 184            | 117            | 22             | 9              | 25             |
| Irregular              | 44             | 19             | 2              | 9              | 4              |
| Convex                 | 9              | 0              | 0              | 96             | 0              |
| Undetermined           | 13             | 0              | 0              | 10             | 0              |
| **Blank scar pattern** |                |                |                |                |                |
| Unidirectional         | 393            | 138            | 34             | 73             | 41             |
| Unidirectional-crossed | 137            | 14             | 11             | 54             | 12             |
| Unidirectional-parallel| 64             | 57             | 11             | 0              | 10             |
| Converging             | 32             | 49             | 19             | 1              | 3              |
| Bidirectional          | 21             | 8              | 0              | 6              | 1              |
| Radial                 | 8              | 2              | 0              | 0              | 6              |
| Lateral crested        | 3              | 3              | 0              | 0              | 1              |
| Transverse             | 10             | 3              | 1              | 5              | 2              |
| Crested                | 3              | 1              | 0              | 0              | 2              |
| Undetermined           | 1              | 3              | 0              | 109            | 0              |

* Core trimming elements
cores, which show primarily unidirectional scar patterns as opposed to complex scar patterns (e.g., crested, radial, transverse). These patterns occur outside of a simple unidirectional blank production system and may relate to changes in orientation of the core. Bulbs of percussion are pronounced and lipped platforms are rare, suggesting the use of stone hammer percussion. Striking platforms are primarily unfaceted, and either straight resulting from a single blow to the cores striking platform, or showing a slightly convex natural surface. A considerable amount of debitage has crushed striking platforms, which may indicate the use of a percussion method with a soft-stone hammer (Pelegrin and Inizan 2013). A small
The amount of blades shows signs of edge grinding between the working surface and striking platform, a technique often connected with Upper and Late Palaeolithic blade industries (Inizan et al. 1992; Demidenko and Usik 1993; Pelegrin 2000; Monigal 2002).

The morphological parameters discussed above indicate that the reduction modalities used at al-Hatab are characterized first and foremost by their simplicity. Blades and bladelets were produced as long as sufficient convexity allowed for the reduction of elongated, parallel-edged blanks; they were produced using the same reduction system and share basic morphologies, that the differences between the artifact categories used throughout the analysis are purely metrical (bladelets being narrower that 12 mm). Flakes, which make up for a large part of the total debitage, resulted from the lack of core working surface convexity or the use of short cores with wide working surfaces. In order to maintain core working surface convexity, core trimming elements (CTE) and/or débordant blades were struck from the edges of the cores. Due to the plentiful high quality raw material found both in the immediate vicinity and widely across the Nejd Plateau, the toolmakers may have used this simple unidirectional reduction method because there was no need for complex core maintenance strategies. Alternatively, this simple reduction technique may be due to cultural constraints related to the technical know-how possessed by the Late Palaeolithic flintknappers, which is to say that debitage costly core preparation and maintenance were not part of their technical repertoire.

TOOLS

The al-Hatab toolkit is made up of a combination of both formal and informal tools. The formal types include burins, many of which were made on truncations (fig. 7), endscrapers, perforators, notches, bifacial foliates, and miscellaneous heavy-duty tools (table 4). Informal tools consist of a wide range of marginally retouched blades, flakes, cortical elements and débordant blanks. Burins were almost exclusively manufactured on elongated blanks, mostly thick blades or débordant elements with either lateral step or trapezoidal cross-sections. Single burins on truncation, dihedral burins and single burins on natural surface are the most common types, while multiple burins, either on truncation or dihedral, are rare. The majority of endscrapers were made on thick cortical flakes and blades, suggesting that such blanks were deliberately chosen for this purpose. These range from simple endscrapers to transverse, ogival and thumbnail endscrapers.

| Table 4 – Tool count. |
|-----------------------|
| Tools               | Count | Percentage |
| Single burin on natural surface | 6   | 3%          |
| Single burin on snap     | 1   | 0.50%       |
| Single burin on truncation | 6  | 3%          |
| Dihedral burin            | 7   | 4%          |
| Multiple burin on truncation | 2 | 1%          |
| Multiple dihedral burin   | 2   | 1%          |
| Burins subtotal           |     | 13.50%      |
| Double notch              | 3   | 2%          |
| Notch                    | 16  | 8%          |
| Notches subtotal          |     | 10%         |
| Tanged point              | 2   | 1%          |
| Partially retouched point | 7  | 4%          |
| Unifacial point           | 1   | 0.50%       |
| Projectiles subtotal      |     | 5.50%       |
| Endscraper on retouched piece | 4 | 2%          |
| Ogival endscraper         | 4   | 2%          |
| Transverse endscraper     | 4   | 2%          |
| Thumbnail scraper         | 7   | 4%          |
| Simple endscraper         | 20  | 10%         |
| Endscrapers subtotal      |     | 20%         |
| Bilateral sidescraper     | 2   | 1%          |
| Sidescraper               | 16  | 8%          |
| Sidescrapers subtotal     |     | 9%          |
| Bifacial preform          | 5   | 3%          |
| Bifacial foliate          | 2   | 1%          |
| Bi-pointed bifacial       | 2   | 1%          |
| Bifaces subtotal          |     | 5%          |
| Retouched blank           | 52  | 26%         |
| Denticulate               | 7   | 4%          |
| Perforator                | 11  | 6%          |
| Truncated piece           | 3   | 2%          |
| Total                     | 192 | 100%        |

Among the formal tools are a range of bifacial foliates and projectile points; the latter are identified on the basis of morphological characteristics, the presence of a hafting element (retouch of proximal part) and a pointed distal end. In addition to two tanged points, a wide variety of partially retouched blades and bladelets with convergent sides were documented, as well as one distal fragment of a unifacial point. The tanged points show obverse and abrupt retouch at their base to form the tang, and both are manufactured on bladelets. The bifacial implements found at al-Hatab share a common set of technological and morphological parameters. They were likely shaped by stone hammer percussion given the deep striking platforms observed on the bifacial thinning flakes, as well as the rough,
Fig. 7 – Tools from al-Hatab. 1-2) Tanged points; 3) distal fragment of unifacial point; 4-6) partially retouched points; 7) laterally retouched blade; 8) truncated blade; 9, 11) burins on straight truncation; 10) burin on convex truncation; 12-13) burins on concave oblique truncation; 14-17) various bifacial pieces (Y.H. Hilbert).
DISCUSSION

THE HATABIAN

In terms of lithic technology and typology, the al-Hatab assemblage is characterized by distinctive traits that have been observed across a series of surface sites found in Dhofar. The consistent appearance of these particular tool types, in combination with the numerical ages, supports these assemblages as representing a legitimate Late Palaeolithic industry of Southern Arabia that is both temporally and geographically constrained. As it was first identified and dated at al-Hatab, the name 'Hatabian' is here suggested for this industry. Distinctive traits of the Hatabian, which differentiate it from other Nejd Leptolithic facies, are its simple laminar blank production systems and the presence of diverse bifacial and trifacial implements manufacture by stone hammer shaping. Blanks are produced from unidirectional-parallel blade and flake cores (fig. 8), which have little or no striking platform preparation. Those blanks selected for secondary modification typically include blades and bladelets with parallel and convergent sides, as well as thick débordant blades and cortical elements.

Formal tools include burins on straight and oblique truncations, dihedral as well as multiple burins, endscrapers, ogival endscrapers, sidescrapers, notches as well as a variety of projectile points and armatures show equally diversified characteristics ranging from simple, marginally retouched bladelets to points exhibiting hafting tangs. Bifacial implements are characterized by thick, generally biconvex to plano-convex midpoint cross-sections and oval to bi-pointed silhouettes. Less frequent than the bifacial component, but still part of the Hatabian tool repertoire, are elongated ovate unifacial points (fig. 9).

Hatabian-like assemblages are widely distributed across the Nejd plateau and have been found as far as Central Oman and the Hadramawt plateau in Yemen. In Central Oman, bifacial foliates as well as “Light Blade” surface sites have been reported (Jagher 2009). These 5 to 8 cm long blades are described as simple blanks showing low standardization in shape, having generally plain striking platforms and commonly unidirectional dorsal scars. Foliates found across the Huqf in Central Oman show generally bi-convex, and in rare occasions plano-convex cross-sections (Jagher and Pümpin 2010; Jagher et al. 2011).

A similar method to al-Hatab’s unidirectional-parallel/convergent blade reduction strategy is known from Hadramawt, Yemen, where it has been named the “Wa’shah” method (Crassard 2008a and b). The Wa’shah method consists in generating a dihedral core working surface by using débordant blades from the lateral peripheries of the core, after this step one elongated convergent blade is removed from the center of the core working surface. These elongated and convergent blades are further modified by semi-abrupt to abrupt direct retouch at its base; this tool type was named the “Wa’shah points” (Crassard et Bodu 2004). Both the reduction method and the characteristic Wa’shah point are thus far undated in Yemen, save for their relative chronological attribution at HDOR 419 where Wa’shah debitage was found in sediments superimposed by Early Holocene strata (Crassard 2008a). This debitage has been found across Late Palaeolithic sites in Dhofar (Hilbert et al. 2012; Hilbert 2014) and transcend the thus far identified Late Palaeolithic industries of Dhofar. Which is to say that the Wa’shah method occurs at both Hatabian and Khashabian (Hilbert 2014: 179-181) sites spanning the Terminal Pleistocene and the Early Holocene.

THE HATABIAN INDUSTRY IN AN INTER-REGIONAL CONTEXT

While it seems clear that the Hatabian gave rise to the Early Holocene Khashabian industry in Dhofar, given their virtually identical technological and typological aspects, the source of the former remains a mystery. The suite of tool types found at Hatabian localities, produced on simple hard-hammer blades, shows little similarity to coeval stone tool assemblages found in North Africa (e.g., Tixier 1963; Lubell 2001; Vermeersch 2009 and 2012). Furthermore, there are no similarities to Late Stone Age (LSA) assemblages from East Africa (Ambrose 1998). Characteristic Near Eastern Epipalaeolithic features such as backed blades and bladelets, geometric micro-liths, lunates, and complex laminar reduction strategies (Bar-Yosef 1980; Goring-Morris 1987 and 1995; Henry 1997) that utilize core tablets and crested for core maintenance are also missing in the Late Palaeolithic of Dhofar. The occurrence of bifacial foliates at Hatabian sites is also significant, since
Fig. 8 – Various Hatabian single platform cores from across the Nejd Plateau. 1-2, 6, 8) Single platform unidirectional blade cores; 3, 5) Wa’shah cores; 4, 7, 9-10) single platform semi-tournant blade and flake cores (Y.H. Hilbert).
Fig. 9 – Various Hatabian tools found associated with diagnostic blade scatters across the Nejd. 1-2) Wa’shah points; 3) perforator; 4) partially retouched point; 5) unifacial point; 6-9) various burins; 10) endscaper on blade; 11-13) ogival endscrapers; 14) sidescraper; 15) notch; 16-18) bifaces (Y.H. Hilbert).
bifacial reduction is rare\(^1\) in the Levant during the Terminal Pleistocene. As such, the Hatabian industry has no known analogues outside of Southern Arabia. This geographic patterning indicates that, rather than being the product of an expansion from outside the Peninsula, the Hatabian emerged and diversified locally within Southern Arabia.

During the last glacial maximum (LGM \(ca\) 20-18 ka), Southern Arabia became hyperarid, with the inter-tropical convergence zone (ITCZ) and associated monsoon rain belt located far south of the interior under increased glacial boundary conditions. As such, any populations present in Arabia during this time would have been confined to environmental refugia capable of supporting flora and fauna conducive to human subsistence (Marks 2009). It is possible that certain regions of Southern Arabia, such as the Omani littoral and the Yemeni highlands, received some small amount of precipitation during this time. Indeed, while hyper-arid conditions persist across much of Arabia today, the high mountain ranges in Southern Yemen receive up to 500–700 mm of monsoon rainfall per year, while the Dhofar mountains and coastal plain in Southern Oman receive 250-300 mm rainfall per year.

After the LGM at \(ca\) 15-13 ka, a brief but potentially critical wet phase occurred within some parts of Arabia, associated with the Bölling-Allerød interstadial. Climatic amelioration during this humid phase would have led to the expansion of vegetation and freshwater resources in Arabia that were previously restricted to ecological refugia located in the southern-most regions of the Peninsula. In this respect, we may consider the possibility of local cultural development within isolated refugia during the last glacial, in which localized technological developments emerged, recorded by lithic analysis and attributed to local industries like the Hatabian. Importantly, upper-catchment areas such as Umm al Khashab would have been the first interior ecological zones to receive freshwater, fed by the northward incursion of monsoon rainfall penetrating the Dhofar escarpment orographic barrier.

There are elements within the genetic structure of modern South Arabsians compatible with the assertion of an indigenous population derived from Pleistocene hunter-gatherers. Some modern Arabs exhibit highly diversified mtDNA haplogroup lineages with coalescent age estimates indicating that they may have persisted in Southern Arabia from the Late Pleistocene through the LGM (Černý et al. 2008 and 2011; Al-Abri et al. 2012). Two mtDNA lineages are of particular interest to the hypothesis proposed here: preHV1 (aka R0a) (Černý et al. 2008) and R2 (Al-Abri et al. 2012). The highest frequency of R0a and its derivatives are found in parts of Yemen (25%) (Černý et al. 2008), Saudi Arabia (22%) (Abu-Amero et al. 2008) and Oman (16%) (Abu-Amero et al. 2007) and hint at the expansion of this haplogroup from within Southern Arabia. Additional work across Yemen and Southern Oman has lead to the identification of the relatively rare haplogroup R2. As a younger sister of JT, R2 was dated to the Late Glacial / post-LGM (~18–21 ka ago) by coalescent age estimates and can be divided into two sub-haplogroups, which are called R2a and R2b (Al-Abri et al. 2012). Variability within the R2 haplogroup indicates that, upon arrival in Southern Arabia, a relatively long endemic development followed. After a bottleneck release at ~13 ka, R2 spread to other areas within the Arabian Peninsula and diversified (Al-Abri et al. 2012; Rose et al. 2013).

Late Palaeolithic sites attributed to the Terminal Pleistocene / Early Holocene wet phase(s) were found along wadis across the now dry plateau and open deserts of Southern Arabia (Amirkhanov 1994; Zarins 2001; Rose and Usik 2009; Hilbert 2014). Little evidence has been found in the coastal zone, the southern slopes of the escarpment, or the summit grassland\(^2\) in Dhofar. Additional prehistoric survey is required in Southern Arabia, in particular the Yemeni highlands that receive the highest amount of annual rainfall in the Peninsula, to better articulate the extent of this refugia and to search for additional Late Palaeolithic sites in this area.

CONCLUSION

The archaeological, geochronological and geoarchaeological evidence from al-Hatab Rockshelter in Dhofar demonstrates, in corroboration with the genetic and palaeoenvironmental data presented here, the presence of human groups in Southern Arabia before the onset of the Early Holocene wet phase. The archaeological signature of these groups, the Hatabian industry, appears to have emerged locally, given the lack of coeval counterparts outside of Southern Arabia. We suggest that the Early Holocene populations of Southern Arabia are rooted in the Terminal Pleistocene population of this area, an assertion previously suggested by H. Amirkhanov (2006), based on his work

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1. Studies of the Geometric Kebaran layer I2.A at Umm-el-Tlel have revealed ten bifacial pieces (Alcalde et al. 2013) showing that these tools are not totally absent from Levantine Terminal Pleistocene archaeological record.

2. Save for a few sites found on the Dhofar Escarpment recorded by Cremaschi and Negrino (2002: 328-333) and Newton and Zarins (2010: 250), which unfortunately have provided limited archaeological finds making their attribution beyond general categories, such as Upper, Ep-, or Late Palaeolithic, difficult.
in Central and Eastern Yemen. That is not to say we entirely discard the possibility of some cultural transmission or population movement between Southern Arabia and the northern parts of the Peninsula during the Early Holocene, as envisioned by some researchers (Drechsler 2007). The archaeological data available at this time, however, indicates that these interactions were probably restricted to areas north of the Rub’ al Khali (Crassard et al. 2013; Hilbert et al. 2014). In addition to the archaeological evidence presented here, the hypothetical South Arabian refugium is supported by the two genetic history particular mtDNA markers L R2 and R0a. Our model predicts that sites predating the Hatabian industry, perhaps as early as the LGM, will be found somewhere in the South Arabian Highlands.

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