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Bronze Age microliths at Saruq al-Hadid, Dubai

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Summary

Excavations at Saruq al-Hadid, Dubai, have recovered a large assemblage of stone artefacts, including backed microliths, from a dense midden of animal bone deposited during the mid-second millennium BC. Stoneworkers at Saruq al-Hadid combined simple core reduction methods with sophisticated backing techniques to produce the microliths. Unstandardized flake blanks were backed directly, or were truncated into segments which were subsequently backed. The final stage of backing was carefully controlled and was probably accomplished using a pressure technique; the backed surface on many microliths is distinctively domed in profile. Most microliths are asymmetrical in shape and many display a distinctive scalene triangle morphology. The microliths probably functioned as armatures for arrows, although other functions are possible. Here we contextualize microlith production at Saruq al-Hadid through a review of late prehistoric microlith traditions in south-eastern Arabia and neighbouring regions of Asia and Africa. This raises intriguing but unresolved issues related to preceding technological traditions, cultural connections, and group identity.

Keywords: stone tools, backed artefacts, arrowheads, Wadi Suq period, Late Bronze Age

Introduction

Recent excavations at Saruq al-Hadid in Dubai, United Arab Emirates (Fig. 1), have identified a backed microlith technology utilized during the occupation of the site in the second millennium BC. The backed microliths are part of an assemblage of *c.*9100 stone artefacts recovered from the site's Horizon IV deposits (*c.*1750–1300 BC; Weeks et al. 2019), which span the Wadi Suq period and Late Bronze Age. Backed microliths are small flakes, under 50 mm long, that are steeply retouched ('backed') on one margin, opposite a sharp unmodified edge, or 'chord' (Fig. 2). Ethnographic and archaeological evidence indicates that backed microliths were commonly hafted individually or in series as elements of composite projectile weaponry or knives (Clark JD 1975; Schoville et al. 2017; Yaroshevich 2012).

Here we summarize the context and dating of the Saruq al-Hadid Horizon IV stone assemblage, and describe the stone-flaking technology. As the assemblage was recovered from an extensive and dense midden of animal bone, we propose that the backed microliths functioned principally as armatures for arrows. We suggest that backed microliths were one component of hunting weaponry used in south-east Arabia during the Wadi Suq period and Late Bronze Age, and perhaps into the Iron Age. Backed microlith arrowheads were made and used alongside a newly emergent metallic arrowhead technology that eventually supplanted them. We contextualize the study through reference to the development of south-eastern Arabian lithic traditions from the Late Neolithic period to the Bronze Age, and the wider occurrence of microliths in Bronze Age stone-tool assemblages in neighbouring regions of Asia and Africa. This evidence supports the development of new perspectives on Bronze Age Saruq al-Hadid and its possible place in the wider settlement systems of late prehistoric south-eastern Arabia.

The Wadi Suq and Late Bronze Age at Saruq al-Hadid

Saruq al-Hadid is an inland site located on the edge of the Rub' al-Khali desert. The site is characterized by spatially discontinuous occupation remains spread over an area of more than 1 km^2 and incorporated within dunes up to 6 m deep. Excavations have revealed complex assemblages of archaeological materials spanning several millennia (Herrmann, Casana & Qandil

Figure 1. Main picture: *Saruq al-Hadid under excavation, looking south. Major Horizon IV bone deposits are indicated with arrows;* **inset:** *map showing the location of Saruq al-Hadid.*

Figure 2. *A chert scalene microlith from Saruq al-Hadid. The unmodified edge, or 'chord', is facing left, and the scars produced in shaping the backed edge can be seen at right. The chord on this example is slightly excurvate. Scale bar 10 mm.*

2012; Nashef 2010; Casana, Herrmann & Qandil 2009). Since 2014, the site has been a focus of work by the Saruq al-Hadid Archaeological Research Project (SHARP; Weeks et al. 2019, 2018, 2017), among others.

Saruq al-Hadid and its immediate vicinity witnessed human occupation as early as the Neolithic period, as attested by the discovery of Neolithic stone tools as surface finds at the site (Al-Khraysheh & An-Nashef 2007: 96–102; Boraik Radwan 2018: 34–39) and in large concentrations at the site of Al-Ashoosh 2, located 8 km to the east (Casana, Herrmann & Qandil 2009). The presence of possible Fasad points (e.g. Boraik Radwan 2018: 35, GR 5021) indicates occupation from as early as the eighth or seventh millennium BC, while other arrowhead types indicate occupation extending into the fifth millennium BC. Additionally, hearth features excavated in the northern and western sectors of Saruq al-Hadid have been radiometrically dated from the late fourth to the third millennium BC and mid- to late third millennium BC (Herrmann, Casana & Qandil 2012: table 1). However, the earliest *in situ* features investigated by SHARP are from Horizon V, dating to the terminal Umm an-Nar period and early Wadi Suq period, with modelled radiocarbon dates of *c.*2000–1750 BC (Weeks et al. 2019). These features consist of pits and post-holes dug into the gypsum and in the dune deposits formed immediately above it. Stone artefacts occur at very low frequencies in Horizon V deposits.

The stone artefact assemblage was recovered from a dense bone midden, labelled Horizon IV, which was deposited over several centuries across the Wadi Suq to Late Bronze Age transition, *c.*1750–1300 BC, as indicated by radiocarbon dates and associated material culture (Weeks et al. 2019). The bone layer covers at least 750 m^2 and is up to 1 m thick (Roberts et al. 2018; 2019; Weeks et al. 2018). Alongside several hundred thousand fragments of animal bone weighing more than 1 tonne, excavation in the Horizon IV midden identified hearths and a variety of material remains including ceramics, marine shell, and soft-stone vessels. Copper-based artefacts are comparatively rare, and include fourteen metallic arrowheads with typical Late Bronze Age morphologies that occur predominantly in the uppermost bone layer deposits. Stone-knapping debris (Fig. 3) is present in

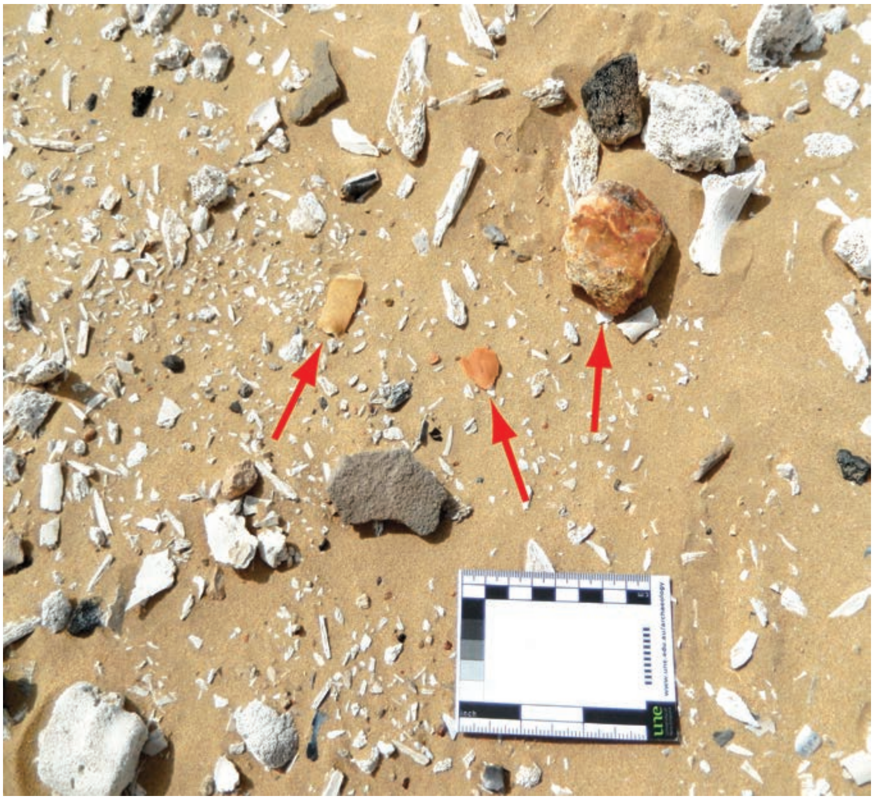

FIGURE 3. *The bone midden in Horizon IV, Saruq al-Hadid. Arrows indicate two chert flakes and a chert hammerstone in situ.*

significant densities throughout Horizon IV. Although the deposits are partly deflated, the stone artefacts are in as-struck condition, with no signs of patination, wind abrasion, or other taphonomic damage. It was possible to conjoin flakes and cores from throughout the bone layer, indicating minimal horizontal disturbance.

The radiocarbon chronology for Horizon IV shows few anomalies, particularly considering the complexity of the depositional environment. However, one radiocarbon date on wood from context 1309 produced an early Iron Age date in the ninth century BC (Weeks et al. 2019). Although intrusive materials are occasionally recorded in the uppermost deposits of Horizon IV, the dense bone deposits of context 1309 and associated ceramic and other artefact types are consistent with a Late Bronze Age dating. We conclude that the integrity of Horizon IV is good and that the stone assemblage presented here — including the microlith technology — is contextually secure.

Subsequent occupation of Saruq al-Hadid occurred intermittently from the early Iron Age to the sub-recent past (Weeks et al. 2019). Activities were particularly extensive during the early Iron Age (*c*.1250–800 BC) occupation of Horizons III and II, by which time the site appears to have become a focus for multi-community social gatherings — perhaps incorporating pilgrimage and cultic activities — and an important node in regional exchange systems (Weeks et al. 2018; Karacic et al. 2018, 2017; Contreras Rodrigo et al. 2017). Stone tools and debris are reported from early Iron Age deposits at the site but are not analysed in this paper.

Methods

The lithic analysis aimed to document the manufacturing techniques used to produce the tools recovered in the excavation. The approach, terminology, and methods follow the reduction sequence approach (Moore 2015; Moore et al. 2009), which involves classifying artefacts into technological types according to their inferred position in the reduction sequence model, and collecting attribute data from those artefacts. In reduction sequence analysis, stoneworking activities are reconstructed by identifying central tendencies in artefact morphology observed across the by-products of multiple flaking events. Here we summarize the stone technology; the full analysis will be published elsewhere (Moore et al., in preparation).

Artefact type	**Context**			**Total**
	1309	2008	Other	
Assayed stone	1	2	21	24
Backed microlith	1	6	87	94
Backed microlith, stage in manufacture	15	8	130	153
Truncation/Backing flake	13	6	57	76
Core reduction flake	220	170	30	420
Core, bipolar			3	3
Core, freehand percussion	8	6	83	97
Hammerstone	1		4	5
Hammerstone spall	1		1	2
Heat fracture	5	4		9
Manuport	1	2	8	11
Recycled artefact			19	19
Retouched ceramic			1	1
Retouched flake			11	11
Retouched tablet, bifacial			11	11
Stone crushing by-product	3	8		11
Truncated piece	5		31	36
Unidentified reduction by-product	15	12	1	28
Total	289	224	498	1011

Figure 4. *Flaked artefacts recorded in the analytical sample, Horizon IV, Saruq al-Hadid.*

The stone artefact assemblage was recovered from 3 mm sieves and, more rarely, hand collection at the point of excavation. As summarized in Figure 4, analysis of all artefacts was conducted for two contexts, 1309 and 2008. Partial analysis, conducted on 115 additional contexts, involved inspecting the material for 'formed objects': stones with flakes removed from them, including cores, retouched flakes, and backed microliths. A selection of these formed objects — and all the identified microliths — was included in the analysis. The analytical sample of 1011 artefacts constitutes about 11% of the recovered lithic assemblage.

Technological summary

The approach to stone reduction during Horizon IV at Saruq al-Hadid combined simple core reduction

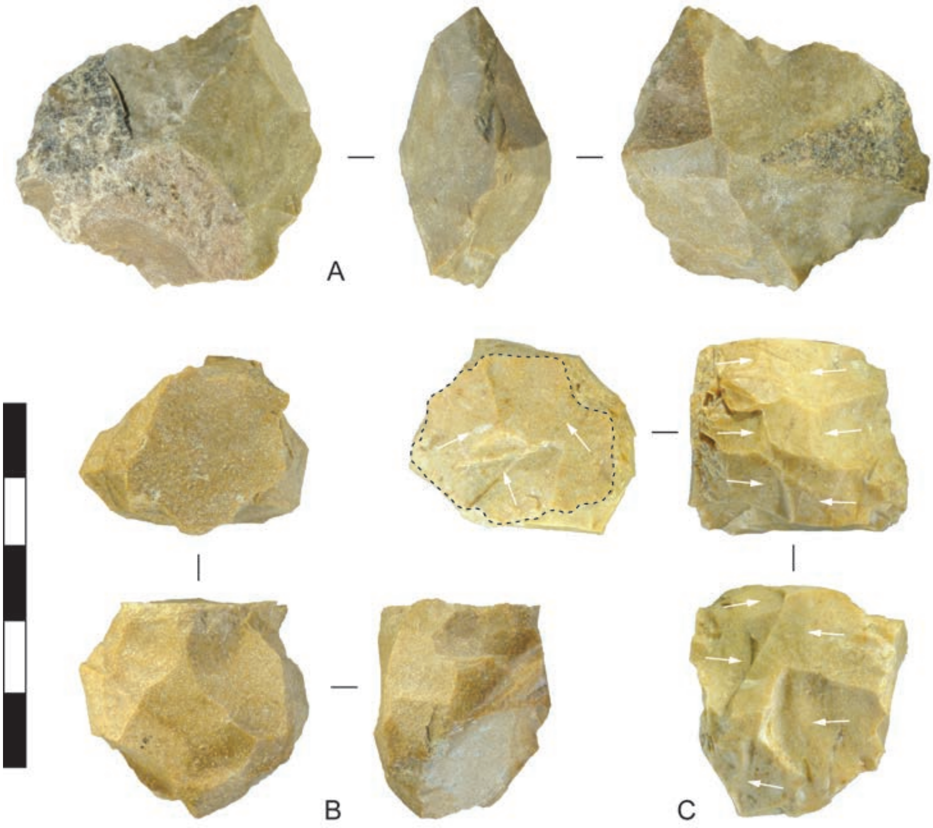

Figure 5. *Chert cores from Horizon IV, Saruq al-Hadid.* **A.** *Bifacial centripetal core;* **B.** *single platform core;* **C.** *multiplatform core with two opposed platforms. Arrows show the orientations of the principle scars, and one platform is outlined. Scale bar 50 mm.*

methods with sophisticated backing techniques to produce microliths for composite tools. Stones selected for making microliths were highly siliceous cherts and chalcedonies that were either obtained regionally as part of long-distance travel or exchange, or by scavenging and recycling artefacts from earlier sites in the vicinity of Saruq al-Hadid. These stones were small, mostly measuring less than 60 mm in maximum dimension.

Cores were reduced on site by freehand hard-hammer percussion (Fig. 5). Cores were usually held in the hand but sometimes supported on an anvil. Exterior platform angles were steep and cores were rotated during reduction at least once, and sometimes up to three times. During core rotation, platforms were identified and established on the lateral margins or distal ends of preceding flake scars. At least ten flakes, and up to twenty-eight, were struck prior to each rotation. A starting cobble's weight was reduced by about 46% on average, through percussion flaking.

Platform attributes on flakes and cores indicate that blows were struck from unprepared (often cortical) surfaces by delivering percussion blows about 2.9 ± 2.1 mm (N=243) from the core edge. Flakes were struck from both the long and short axes of cores, and frequently extended the full length of the core face. The flakes were only slightly elongated (length/width 1.22 ± 0.48, N=232) and averaged about 20.2 ± 1.0 mm (N=252) long, but dimensions vary considerably (coefficient of variation = 49.4%), indicating a lack of standardization in flake morphology. The stone-flaking strategy was not a 'blade' technology in the conventional sense.

Some 152 microliths broken in manufacture, and ninety-five finished microliths (Fig. 6), were recovered from the Horizon IV deposit. Microlith production involved two strategies that differed in the early stages of backing. Strategy A involved first truncating a relatively large flake by placing it on an anvil and striking a blow to the face. This fractured the piece into segments which were subsequently backed. In Strategy B, thin flakes — mostly less than 5 mm thick — were backed directly, without a truncation stage. The microlith was usually oriented lengthwise within the flake blank.

Figure 6. *Chert and chalcedony microliths from Horizon IV, Saruq al-Hadid. Scale bar 10 mm.*

The shape of the unmodified sharp edge (or 'chord') on finished microliths was either straight (N = 31), curved inward (N = 9) or outward (N = 25), or a mixture of both (N = 29). Final stage backing was very carefully controlled, creating delicate, needle-sharp tips on some microliths, and was probably achieved using a pressure technique. The backed surfaces on many microliths are distinctively domed (Fig. 7) from a two-step process of removing backing flakes from one platform, followed by a second set of removals from the opposite platform.

Finished microliths are elongated and very small, measuring an average 17.1 ± 2.9 mm long (N = 82) and 5.3 ± 1.2 mm wide (N = 94). Although relatively symmetrical microliths are present, most are asymmetrical, with a 'short' and 'long' leg. The short leg usually meets the long leg at about one-third of the distance from the microlith's end. This junction is often curved but is sometimes an abrupt angle, resulting in a distinctive scalene triangle morphology (N = 31). The small size of the Saruq al-Hadid microliths is consistent with stone armatures for arrows, although they may also

Figure 7. *Chert microliths from Horizon IV, Saruq al-Hadid. The right-hand views show the backed faces. Flakes with relatively deep bulbs were removed from both flake blank surfaces and propagated to about the centre of the backed face, creating a slight but distinct ridge or 'dome' where the scars meet. Scale bar 10 mm.*

have been hafted as elements in composite knives. Our attempts to identify protein residues on the microliths were unsuccessful (Fagan & Walker 2018), but microlith function can be effectively explored through experimental use-wear studies (e.g. Fullagar 2016; Goldstein & Shaffer 2017; Yaroshevich et al. 2010).

Discussion

Microlith technology arose independently in widely separated times and places as stone-using peoples converged on this approach to making effective tools from small pieces of stone. The frequent independent invention of this type of tool ranks it as a 'good trick' of stone-flaking design space (after Moore 2011; Pargeter & Shea 2019; Torrence 2002), along with techniques such as heat-treatment (Crabtree & Butler 1964), pressure flaking (Derosier 2012), blade-making (Bar-Yosef & Kuhn 1999), and bifacial retouching (Hayden 1989).

Backed microliths are often regarded as synonymous with 'Mesolithic' societies with hunting-fishing-gathering economies, who existed before the arrival of agriculturally oriented 'Neolithic' societies; however, the chronological, subsistence, and technological components of such arguments all fail under closer scrutiny (Sosnowska 2011). For instance, backed artefact assemblages emerged by 71 kya in South Africa (Brown et al. 2012), and are among the earliest evidence of complex symbolic and technological behaviours (Wurz 2013). In Western Asia, backed microlith technology is a well-known aspect of Terminal Pleistocene Epipalaeolithic societies, including for example the Kebaran, Natufian, and related traditions of the Levant, and the contemporary Zarzian tradition of the Zagros Mountains (Olszewski 1993; Belfer-Cohen & Goring-Morris 2014). It is in relation to such evidence and understandings that Crassard (2007: 313) has described the Bronze and Iron Age microlithic industry of south-western Arabia (see below) as a 'paradox' in global typo-chronological terms.

However, the archaeological record of Africa, Asia, and Australia provides numerous examples of backed microlithic traditions extending (discontinuously) from the Pleistocene to well through the Holocene (e.g. Clarkson et al. 2018; Sosnowska 2011; Biagi 2004; Rosen 1983; Clark JD 1975: 127; Clark JD, Phillips & Staley 1974: 366–367). Such evidence provides a context for a better understanding of the microlithic tradition identified at Saruq al-Hadid, and prompts consideration of the underlying reasons for the appearance of microlithic technology across such chronologically and geographically diverse lithic traditions. In this section, we review the archaeological evidence for microlithic traditions in southern Arabia and neighbouring regions in order to explore regional connections. Subsequently, we consider the function of backed microliths in south-eastern Arabia and the possible reasons for their development and/or adoption across the local transition from stone to bronze.

Microliths in southern Arabia and neighbouring regions

Microlithic traditions are comparatively rare in southern Arabia, and those documented to date tend to be spatially and/or chronologically distinct from the assemblage at Saruq al-Hadid. The earliest examples are recorded in Pleistocene southern Oman, where Rose et al. (2019: fig. 7) have described a backed microlith technology dating from 30 to 33 kya. These microliths are large compared to the Saruq al-Hadid examples and are made on formal blades rather than flakes. Other undated surface collections from southern Oman also contain backed microliths that may reflect late Pleistocene or early Neolithic traditions (Hilbert 2020). In other respects, backed microliths are not a significant part of the early to mid-Holocene Neolithic toolkit in southern Arabia, where assemblages typically include points on relatively large blades and, later in the sequence, pressure-flaked bifaces. The 'Faya' points recorded at sites in the UAE (Uerpmann H-P et al. 2013) resemble Neolithic surface finds from Saruq al-Hadid (e.g. Boraik Radwan 2018: 35). The stems on some of these were made by a backing technique, but these points pre-date Horizon IV by some 6000 or 7000 years (Uerpmann H-P et al. 2013: fig. 5).

Elsewhere, a small number of microliths have been reported from undated surface contexts at Neolithic MR-1 on Marawah Island (Charpentier 2004: fig. 1.1–2) and from Sharjah Tower (Millet 1988) in the UAE. The dominance of Neolithic material culture at MR-1 supports a Neolithic date, but Beech et al. (2020: 20) note the presence of 'traces of later activity' there. Backed microliths are also reported from surface collections at the Abu Dhabi Airport site (Kallweit 2004: fig. 1), where they were found alongside clearly Neolithic artefacts and tentatively identified as a new component of the

Arabian Bifacial Tradition (Kallweit 2004: 140). However, the presence of third-millennium BC ceramics and copper-based artefacts in surface assemblages from the site (Beech, Kallweit & Hellyer 2004: fig. 9; de Cardi 1997), alongside the excavated evidence from Saruq al-Hadid, raises the possibility that they may in fact be Bronze Age, as recognized by Kallweit (2004: 140).

If Neolithic in date, the examples noted above from the UAE suggest a backed microlithic technology pre-dating the Saruq al-Hadid assemblage by a few millennia. More extensive evidence for backing comes from the production of arrowheads, 'lunates', and 'perforators' at fifth- and fourth-millennium BC sites in Oman including Sharbithat, Suwayh, Wadi Shab, and Ra's al-Hamra 5 (Maiorano et al. 2018: fig. 9; Charpentier 2008: figs 9–10; Usai & Cavallari 2008; Gaultier et al. 2005; Usai 2005). Perforators differ from backed microliths by having backing on opposed edges, while microliths are backed on one edge opposite an unmodified chord. This backing tradition continued into the third millennium BC as attested by multiple backed perforators from HD-6 in Oman, a site that also produced a single backed microlith (Hilbert & Azzarà 2012: table 2). Collectively, this evidence suggests the development of a south-eastern Arabian tradition of backing small tools that extended into the Early Bronze Age (see also Buchinger et al. 2020). Direct technological links to the earliest Holocene backed artefacts — and even further back to the Pleistocene microliths of Dhofar — seem unlikely, however.

Elsewhere, obsidian backed microliths are found across south-western Arabia (Crassard 2007: fig. 154). Examples from the Tihamah coast, made on flakes rather than blades (Khalidi et al. 2018; Khalidi 2009; Crassard 2007), are dated broadly from the third to the first millennium BC. The flake blanks for the Tihamah microliths were produced by a bipolar technique rather than freehand percussion and differ in morphology from the Saruq al-Hadid examples. Khalidi et al. (2018) demonstrate that the Tihamah microliths were produced from obsidian sourced predominantly from across the Red Sea in Africa, providing one clear archaeological index (among several) for the existence of a long-lasting 'Afro-Arabian cultural sphere' (Khalidi et al. 2018: 91) within which new technological traditions — including the production of microliths — are suggested to have developed contemporaneously.

Holocene microlithic industries are also known from multiple regions surrounding southern Arabia, including north-eastern Africa (e.g. Khalidi et al. 2018; Crassard 2007: 330–332; Clark JD, Phillips & Staley 1974; Leplongeon, Pleurdeau & Hovers 2017), Iran (e.g. Hashemi 2012, ii: pls 62.2, 63.2, 65.2, 90.1, 147) and, in particular, South Asia. Archaeological research indicates the widespread distribution and long chronological persistence of 'Mesolithic' sites in Pakistan and India that are characterized by the use of backed microliths, stretching from the early Holocene into the Bronze Age and later (Biagi 2018; Coningham & Young 2015: 21–22; Sosnowska 2011). Microliths of varying typology are also recorded in Bronze Age settlements of the Harappan or Indus Valley tradition, for example at sites such as Dholavira and Surkotada in Gujarat (Bisht 2015: 498–513, fig. 8.197). Elsewhere in Gujarat, Bronze Age backed microliths are reported by Gadekar, Ajithprasad and Rajesh (2015) from excavations at Bagasra and Shikarpur, which were occupied from the mid-third millennium BC into the late or post-urban Harappan phase in the early second millennium BC, contemporaneous with Bronze Age Saruq al-Hadid. Information about the technology is so far limited, but the microliths appear to be manufactured on pressure blades rather than hard-hammer flakes, and scalene triangle variants are present (Gadekar, Ajithprasad & Rajesh 2015: fig. 2).

While such discoveries may hint at a historical connection and a technological tradition that spanned a large geographical region, the contrasting technical approaches used to produce very similar end-products reflect profound differences in technological performance and social display in these broadly contemporaneous cultures. Similarly, backed microlith technology is traditionally interpreted as a 'risk reduction' strategy for hunter-gatherers coping with highly variable climatic conditions (e.g. Hiscock 1994). This explanation is suggested, for instance, for the Omani Pleistocene backed artefact technology (Rose et al. 2019). It is tempting to extend the argument for the appearance of backed microliths in the Umm an-Nar/Wadi Suq period, as this cultural transition is contemporaneous with a hypothesized major climatic transition in south-eastern Arabia and the wider region (Jones et al. 2019: 10; Parker & Goudie 2008). However, the inefficient, material-wasting approach to producing these tools at Saruq al-Hadid, the presence of this microlithic tradition at an outpost of the Harappan state at Bagasra, and the persistence of backed microlith technologies well into the Iron Age in south-western Arabia, Africa, and India — not to mention the contemporaneous proliferation of metal tools — indicates that the correlation between microliths, hunter-gatherers, and subsistence risk is not a sufficient explanation for the appearance of these tools.

Microliths: function

Crassard (2007: 329) has proposed that backed microliths in south-western Arabia were components of projectile weapons. Alternative functions, including as components of sickles used for agricultural purposes as seen in the Epipalaeolithic Levant, are not supported by the archaeological contexts in which southern Arabian microliths occur, or by any surface characteristics ('sickle gloss') related to such activities (see also Buchinger et al. 2020:144). This is especially true at Saruq al-Hadid, a hunting site located in an arid environment unsuitable for agriculture. We follow Rosen (2013) in identifying backed microliths from Saruq al-Hadid as armatures for arrows.

While surviving ancient examples of composite arrowheads incorporating backed microliths are comparatively rare, an exception is provided by Egypt, where large numbers of well-preserved arrows with microlith armatures have been found with a main usage period spanning the period from the First Dynasty to the New Kingdom, thus overlapping with Horizon IV at Saruq al-Hadid. J.D. Clark et al. (1974) review the morphology of these tools, concluding that backed microliths were primarily used as arrow armatures by the African Later Stone Age, and document the persistence of this technology into the first millennium AD in southern Sudan.

On Egyptian arrows, the backed microlith is typically mounted with mastic at the tip of the arrow with the chord oriented at a right angle to the arrow shaft, creating what are referred to as 'transverse' arrowheads (Clark JD, Phillips & Staley 1974: 324, 367, 374–375; Clark JD 1975; see also Binneman 1994). By the New Kingdom (1550–1069 BC), the transverse arrowhead was supplemented with two additional microliths hafted as barbs further down the arrow shaft (Clark JD, Phillips & Staley 1974: 350).

Egyptian microlith arrow armatures are lunate in shape and pressed lightly into the hafting mastic so that they detached into the prey on impact (Clark JD, Phillips & Staley 1974: 372). The transverse mounting system on Egyptian arrows is thought to allow considerable depth of penetration because the chord would cut a wide pathway into the prey for the arrow shaft to follow (Clark JD, Phillips & Staley 1974: 374; Schoville et al. 2017). During the historic period, transverse- or oblique-mounted microlith arrowheads were favoured by hunters in Africa to increase the amount of blood loss, allowing for easier tracking of wounded animals (Clark JD 1975). Transverse microlith arrows were also use in Europe (Clark JGD 1952: fig. 22.4; Yaroshevich 2012: fig. 1) — presumably invented independently there — and are portrayed in an eighth- to seventh-century BC relief carving of a hunting scene in Yemen (Maraqten 2015: 210–211, fig. 4), attesting to the effectiveness of mounting microliths in this way.

In Egyptian art, microlith-armed arrows are associated with game hunting and metal arrowheads are associated with warfare, although J.D. Clark et al. (1974: 374) propose that arrows embedded in the remains of soldiers at Deir el Bahari (2125–1985 BC) were armed with microliths (see also Goldstein & Shaffer 2017; Lahr et al. 2016). Similarly, Potts (1998: 200) and Yule and Robin (2007) discuss the complex and partially conflicting evidence from pre-Islamic Arabic poetry, rock art, and other material remains, regarding the use of the bow and arrow during hunting and warfare.

Regardless, the presence of composite arrows in Horizon IV at Saruq al-Hadid is significant regionally for understanding long-term developments in hunting traditions and technology. Yule (2018: 57) has identified a 'continuous and blossoming tradition' in arrowhead technology in Egypt and Western Asia across the transition from stone to metal, but notes that the sequence in south-eastern Arabia lacks this continuity. Specifically, bifacial stone arrowheads disappear from the local lithic repertoire after the Late Neolithic (*c.*3200 BC), more than a millennium before the appearance of copper-based arrowheads in the Late Bronze Age or Wadi Suq period (Yule 2018; Magee 1998).

It is unclear what sorts of projectile weaponry, if any, were used in south-eastern Arabia during the intervening millennia. Aside from the recently identified arrowheads at Sharbithat in southern Oman (Maiorano et al. 2020; 2018: fig. 10), the published lithic assemblages of the fourth and third millennia BC do not contain clear examples of projectile points (Choimet 2016; Hilbert &

Figure 8. *A Neolithic stone arrowhead from Saruq al-Hadid, Horizon IV. Scale bar 10 mm.*

Azzarà 2012; Usai & Cavallari 2008; Gaultier et al. 2005; Usai 2005; Uerpmann M 1992), nor do contemporaneous assemblages of copper-based artefacts from the region, which typically incorporate blades with cutting and/or thrusting capacity alongside a range of tools and decorative items including blade axes, awls, fishhooks, and rings (e.g. Giardino 2018; Yule 2018: pl. E; Benton 1996: 145–162; Frifelt 1995: 188–197). While Potts (1998) notes that the socketed spearheads that characterize the terminal Umm an-Nar and Wadi Suq periods may have functioned as either thrusting or throwing weapons, projectile technologies related to use of the bow and arrow are conspicuous by their absence.

The backed microliths from Saruq al-Hadid, spanning the mid-second millennium BC, appear in the period immediately preceding and alongside the first documented appearance of metal arrowheads in south-eastern Arabia. The newly identified tradition of producing composite arrowheads from backed microliths may thus fill some of the long evidential gap in local bow and arrow use between the Late Neolithic and the mid-second millennium BC. In this context, it is also worth noting the multiple instances of bifacial Neolithic stone arrowheads found in third- and second-millennium BC contexts in south-eastern Arabia, as at Al-Ashoosh (Contreras et al. 2016: fig. 6), Tell Abraq (Potts 2000: 49–50), Al-Qusais (Taha 2009: 126–127, table IV), and Saruq al-Hadid itself (Fig. 8). While such items have typically been seen as ephemera in their late contexts of deposition, these recycled arrowheads might legitimately be regarded as functional and filling a gap in the local repertoire of projectile weaponry that expanded from the mid-second millennium BC with the appearance of the earliest metal arrowheads.

Microliths and the transition from stone to metal

The co-occurrence of stone and metal arrowheads across second-millennium BC sites in south-eastern Arabia could provide an interesting example of the continuity of stone technology after the development of metallurgy, a significant topic for lithic analysts (Rosen 1997; Runnels 1982). Most complex societies eventually adopted metals to replace many of the cutting tools and weapons previously made from stone, but the reasons for this transition are not obvious. While metal is exceptional for its ability to be cast and recycled, it requires considerable labour to mine and specialized knowledge to smelt and process. In contrast, stone tools are functionally equivalent to metal in most essential tasks, are made from materials that are economical to procure, and can be created using widely available skill sets, qualities that have ensured that stone-flaking technology endured alongside metal through prehistory (e.g. Graves-Brown 2015; Frieman 2012; Erikson 2010; Kardulias 2003; McLaren 2008), into the historic period (Clark JD 1990; Whittaker 1996; 2001a; 2001b), to the present day (Whittaker 2004; Possehl 1981; Buck 1982). Understanding such continuities is complicated not only by the intangible social or symbolic meanings assigned to various materials, which clearly influenced their adoption in specific social contexts, but also by the tacit values and practices of archaeologists, which have tended to focus attention on emergent metal technologies at the expense of exploring continuity in stone-tool use (Greenfield 2013).

Rosen (2013) has recently reviewed shifts in Near Eastern lithic technology in the Bronze and Iron Ages, from the fourth to the early first millennium BC. He views the transition from stone-dominated to metal-dominated technologies as due, in part, to the way that stone tools were integrated into specialized economic systems. For metal tools to replace stone tools, 'values associated with both production and use' must have changed to favour metals (Rosen 2013: 146). The economic structures in complex societies encouraged the development of metallurgical specialists, but their products could only replace stone if the economics for production warranted it. Rosen illustrates his thesis through the example of Middle Bronze Age sickle technology in the Levant. Initially stone sickle segments were made from standardized Canaanean macroblades, which were produced by highly specialized flintknappers who learned skills at lever pressure or indirect percussion over a long period of apprenticeship. 'Large Geometric' sickle segments eventually replaced them, made by comparatively ad hoc stone-flaking methods. The skills necessary to produce sickles substantially devolved to the point-of-use by the sickle-making artisans themselves because, in contrast to standardized Canaanean blades, Large Geometric stone blanks required substantial modification to haft successfully. Rosen proposes that this devolution was driven in part by social transformations and disruptions at the end of the third and beginning of the second millennium BC that involved 'urban collapse, rural florescence, urban resurgence' (Rosen 2013: 146–147). These processes caused the disappearance of highly skilled Canaanean blade-making artisans, and the devolution of stoneworking to the sickle makers provided an economic and social context for the wholesale adoption of metal sickle blades: sickle-makers found it more economical to abandon labour-intensive stone-flaking in preference for 'cheap' metal counterparts produced by metallurgical specialists from an entirely different technological tradition.

The microlithic technology at Saruq al-Hadid may document a similar process, also occurring at the advent of metallurgical technology. Throughout the world backed microliths are typically made by retouching blade blanks produced by direct percussion, indirect percussion, or pressure through the application of highly specialized stoneworking methods. Microliths at Saruq al-Hadid, however, were made on simple ad hoc flakes, with high levels of flintknapping skill suggested only in the final backing stage of tool production, probably by the arrow-making artisans themselves at the time when arrows were assembled. The limited evidence of immediately antecedent stoneworking technologies, both at Saruq al-Hadid and in south-eastern Arabia more widely, as well as the long gap in specific evidence of lithic arrowhead production, complicates our assessment. Nevertheless, expanding the view back to the Neolithic, highly skilled blade-making and bifacial pressure flaking was practised in settlements across the region in the millennia preceding the Bronze Age. This pattern is analogous to the changes in Levantine sickle production discussed by Rosen (2013), and following his model, the devolution of specialist stoneworking skills to the point-of-use arrow-making artisans at Saruq al-Hadid may have provided the social and economic context for the replacement of stone arrowheads with metal, which began perhaps as early as the Wadi Suq period and which was essentially complete by the early Iron Age.

Microlithic traditions and identity

As noted previously, microlithic traditions have been tied to both subsistence and group identity. In South Asia and elsewhere, microliths are regarded as a *Leitfossil* (index fossil) of the Mesolithic 'other', living a mobile or dispersed hunter-gatherer existence alongside sedentary farming communities from the Neolithic period onwards (cf. Sosnowska 2011: 102, 116). Characterized by greater or lesser degrees of contact and associated social, economic, and genetic exchange, these interactions have sometimes been considered as 'symbiotic' (Coningham & Young 2015: 21–22; Possehl 2002). Similar arguments are made regarding long-lasting microlithic traditions in eastern Africa that extend into the second millennium AD, which are seen by J.D. Clark (1975: 127) as 'an integral part of the tool-kit of hunting/gathering groups that continued to live in symbiosis with pastoral or mixed farming peoples working iron and other metals'. Elsewhere, Rosen (2003) identifies re-emergent Early Bronze Age microlithic stone tool traditions of the Negev with nomadic pastoralists, who expanded their subsistence base beyond animal herding to include a range of activities that underpinned their viability and required a tight economic integration with sedentary urban communities.

Such perspectives are relevant to recent discussions of Saruq al-Hadid and its place in the wider late prehistoric settlement context of south-eastern Arabia, which have arrived at divergent conclusions. While some authors (Herrmann, Casana & Qandil 2012: 64; Contreras et al. 2016: 6) have characterized the site, and nearby Al-Ashoosh, as seasonal settlements of nomadic pastoral groups that were (presumably) separate from contemporary sedentary groups, others (Weeks et al. 2018; Karacic et al. 2017) have emphasized the site's material connections to coastal and inland settlements and suggested that the inhabitants of Saruq al-Hadid were members of a dispersed but integrated 'multi-sited community'.

The occurrence of microlithic technology at Saruq al-Hadid — a Bronze Age specialized hunting site — and its absence on contemporary sedentary settlements thus raises interesting and challenging possibilities in relation to functional and cultural differentiation of sites in second-millennium BC south-eastern Arabia. Depending on the perspective employed, Saruq al-Hadid could be considered as the archaeological footprint of a distinct, mobile hunter-gatherer or pastoral community that interacted with separate sedentary communities. Alternatively, microliths at Saruq al-Hadid might be seen as a component of a task-oriented toolkit used by members of largely sedentary communities who undertook logistical mobility for seasonal hunting activities, a component that would be invisible on sedentary sites.

In fact, such differences extend beyond the simple presence or absence of backed microliths: all categories of lithic artefacts and production debris are much rarer on contemporaneous sedentary settlement sites, with large-scale excavations producing very small lithic assemblages at sites such as Tell Abraq, Kalba K4, and Shimal SX (Magee et al. 2017: table 4; Potts 2000: 50; D. Eddisford, personal communication, 11/2019; C. Velde, personal communication, 11/2019). While excavation methods (i.e. limited sieving) may have impacted stone-tool recovery in some cases (Buchinger et al. 2020:139), and the burial environment certainly obscured lithic discoveries in others (e.g. at Shimal SX, where thick accretions of calcium carbonate prevented the identification of small items even when sieving was employed), the dramatic differences in stone artefact frequency hint at real differences in the material record of these sites and the activities undertaken at them. To further complicate the picture, on other Bronze Age sites such as Al-Ashoosh and Al Sufouh 2 that are characterized by short-term occupation analogous to that at Saruq al-Hadid and where lithic artefacts are comparatively common, microliths have not been reported (Contreras et al. 2016; Driesch et al. 2008; Gruber et al. 2005). A similar situation seems to prevail at the coastal Wadi Suq period site of RJ-1 in Oman (Monchablon et al. 2003: 34, 36, fig. 4).

The Levantine archaeological example and South Asian historical and ethnographic case studies discussed above highlight the potential complexity of such cultural interrelationships, and the difficulties that might arise in differentiating them in archaeological contexts based purely on material evidence, especially in cases where ethnically distinct groups may have been tightly integrated economically. This aspect of Bronze Age Saruq al-Hadid remains to be better explored and understood from both theoretical and material perspectives.

Conclusions

Excavations at Saruq al-Hadid have produced a large assemblage of stone tools of secure provenance dated broadly to the mid-second millennium BC. Analyses of the complete assemblage are ongoing (Moore et al., in preparation), but the technological study presented here has highlighted the *in situ* production of microlithic stone tools used in the manufacture of composite projectile points for hunting wild animals. This aspect of the Saruq al-Hadid lithic technology has few close parallels in the region, and the site presents a new facet of the indigenous development of stone-tool technology in Bronze Age south-eastern Arabia. The evidence is significant for understanding the long-term development of hunting traditions and technology in Arabia, particularly the use of the bow and arrow in a critical period covering the transition from stone to metal arrowhead technology. Additionally, the lithic evidence has the potential to shed light on a range of aspects of Wadi Suq period and Late Bronze Age societies in the region, including logistical mobility for the purposes of subsistence, the functional differentiation of sites, and possibly group identity and interconnections.

A better understanding of these complex issues will require more research, including close technological comparisons with preceding lithic traditions in south-eastern Arabia and contemporaneous microlithic traditions in neighbouring regions. Moreover, these lithic traditions will require contextualization through a comprehensive assessment of the occurrence and nature of stone tools and debris in known second-millennium BC settlements, a topic that until now has received little attention.

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