Records of the Australian Museum (2019)
vol. 71, issue no. 4, pp. 121–137
https://doi.org/10.3853/j.2201-4349.71.2019.1681

Records of the Australian Museum
a peer-reviewed open-access journal
published by the Australian Museum, Sydney
communicating knowledge derived from our collections
ISSN 0067-1975 (print), 2201-4349 (online)

The Flint Artefacts from two Workshops at Wadi el-Sheikh, Eastern Desert, Egypt

Stan Florek[1], Thomas Hikade[2] and Sarah Carter[1]

[1] Exhibitions and Cultural Collections,
Australian Museum, 1 William Street, Sydney NSW 2010, Australia

[2] Department of Archaeology, School of Philosophical and Historical Inquiry,
The University of Sydney NSW 2006, Australia

Abstract. A stone quarry at Wadi el-Sheikh is recognized as an important source of flint in ancient Egypt. In 1896–1897 a substantial sample of stone artefacts, from fifteen separate workshops, was collected and placed in various museums across the world. This material remains virtually unknown, including two assemblages kept in Australia, which are analyzed in this study. It is evidenced that both workshops produced predominantly flint knives and a smaller number of cleavers for distribution away from the quarry, in an earlier part of the third millennium Before the Common Era (BCE) often referred to as the Early Dynastic Period (c. 3150–2686 BCE) and Old Kingdom (c. 2686–2181 BCE). There is a strong indication that the workshops represent a tiny portion of a large supply network. Two types of tools, a pick and a hoe, are recognized as digging implements associated with a quarry, but are also present on sites in Egypt where excavation took place.

Introduction

Ancient Egypt is a prominent example of a highly-developed bronze-age civilization, later evolving into iron-age. It is often assumed that the refinement and splendour of Egyptian antiquity resulted, in large part, from the introduction of metallurgy, bronze smelting and casting that allowed production of specialized and highly effective tools—especially in contrast to the preceding stone-age period with more rudimentary technology and production capacity (Petrie, 1917; Barket & Yohe, 2011:30; Stevenson, 2011:74).

The use of copper tools and the evidence of small-scale smelting extends to the fourth millennium (and earlier), predating Dynastic Egypt of the third millennium BCE (Rothenberg *et al*., 1998:4; Stevenson, 2011:650). Their presence and the production of sophisticated vases made of basalt, diorite and other hard stone material in the Nagada culture suggests that metallurgy indeed provided the foundation for Egyptian manufacturing capacity and technical mastery (Bevan, 2007; Stevenson, 2011:65; Romer, 2012:104). Bronze tools, generally harder and more durable than copper, appeared in the Old Kingdom (Ogden, 2000:152). They were used and valued probably at the higher level of production associated with workshops servicing the royal court and high officials. However, stone tools, often made of flint, flaked in the manner familiar to humans for at least two million years, provided basic and essential hardware in daily life. Flaked stone tools were used in cutting, chopping, chiselling, carving, slicing and general processing of most of the organic and some non-organic materials, including fibre, reed, timber, bone, meat and hide—to name just a few (Kobusiewicz, 2006:459; Teeter, 2011:202; Graves-Brown, 2015; Lucarini, 2016:89–92). Such tools were used virtually throughout the entire ancient Egyptian history (Petrie, 1901b:80–81; Tillmann, 1994, 1999; Aston *et al*., 2000; Graves-Brown, 2015; Barket & Yohe, 2011:30–31; Bard, 2007:73), showing that replacement of lithic technology by metallurgy took over 3000 years (Rosen, 1996:130).

Keywords: Wadi el-Sheikh; Ancient Egypt; technology; stone tools; knives; flint extraction; quarry
Corresponding author: Stan Florek Stan.Florek@austmus.gov.au
Received: 27 February 2017 **Accepted**: 30 January 2019 **Published**: 24 July 2019 (in print and online simultaneously)
Publisher: The Australian Museum, Sydney, Australia (a statutory authority of, and principally funded by, the NSW State Government)
Citation: Florek, Stan, Thomas Hikade, and Sarah Carter. 2019. The flint artefacts from two workshops at Wadi el-Sheikh, Eastern Desert, Egypt. *Records of the Australian Museum* 71(4): 121–137. https://doi.org/10.3853/j.2201-4349.71.2019.1681

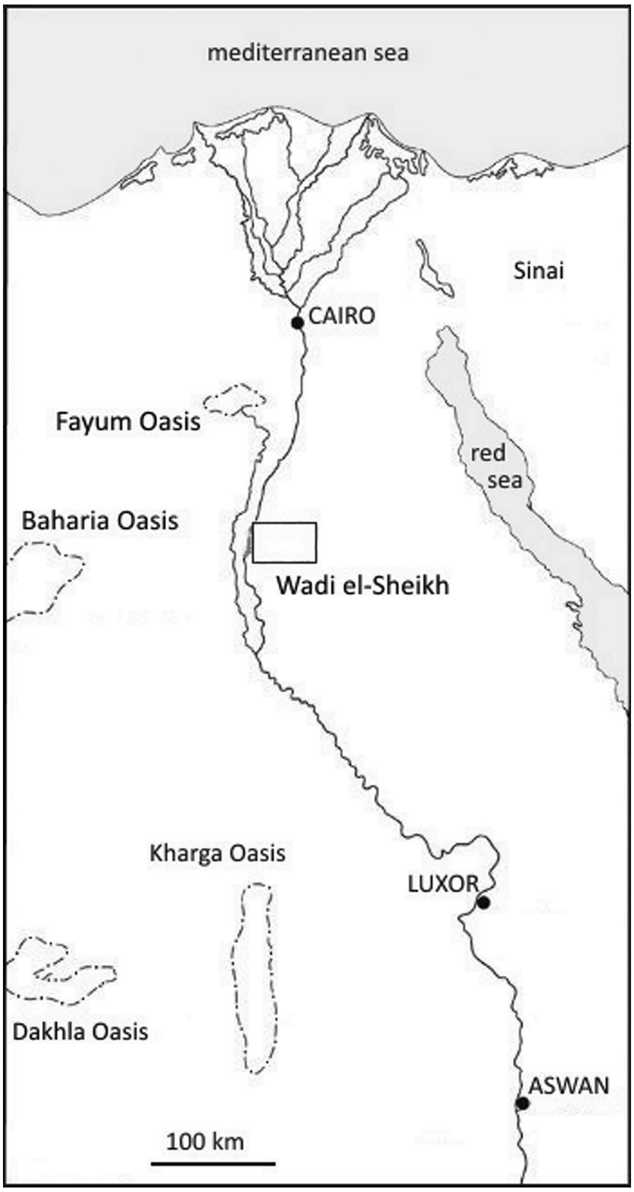

Figure 1. Location of Wadi el-Sheikh.

The great variety and richness of material culture, visual art and architecture, pictorial and written records of ancient Egypt attracted the attention of scholars and amateur enthusiasts of Egyptology from its beginning (Bard, 2007:8–15). Flaked flint tools were recognized and classified by Flinders Petrie (1902, 1903) at Abydos and in other works. But generally, an interest in flaked tools developed slowly in the last hundred years or so (Midant-Reynes, 1984; Weisgerber, 1987:166; Holmes, 1989:395–396; Svoboda, 1993; Bard, 2007:73). One of the episodes in this process dates to 1896–1897 when a prominent collector of "flints" Heywood Walter Seton-Karr (1859–1938) discovered (or rediscovered, to the benefit of Western scholars) and surveyed a complex of flint mining sites and workshops at Wadi el-Sheikh in the desert east of the Nile (Seton-Karr, 1898, 1905; Forbes, 1900; Baumgärtel, 1930).

The quarry complex is about 160 km south of Cairo (Fig. 1). The "mouth" of the Wadi is in relative proximity to the village of El Fant in the Beni Suef province. Seton-Karr estimates that from entering the Wadi at El Fant the quarry complex extends about "30 miles" (c. 48 km) southeast from the River Nile (Seton-Karr, 1898:94)—it would be only half this distance in a straight line, east of Nazlet Awlad el-Sheikh.

During three weeks of fieldwork Seton-Karr surveyed and produced a relatively detailed map of the Wadi. He also collected 15 surface assemblages (estimated at over 500 kg of material) from separate and probably discrete stone workshops within the complex, all individually marked on his map. So far, we are unable to cross-reference individual assemblages with numbered locations on his map. Subsequently he donated or sold these assemblages to different museums in Europe, Egypt and even Australia (Weisgerber, 1987; Stevenson, 2013:80–81). One assemblage was sold to (what was then) the Mayer Museum in Liverpool (UK), together with documentation including maps and photos (Seton-Karr, 1898; Weisgerber, 1982; 1987:165).

In 1900 Henry Ogg Forbes, naturalist, ethnologist, and Director of the Museum of Liverpool published a relatively comprehensive article (Forbes, 1900), drawing on Seton-Karr's documentation and artefacts in the collection. It appears Forbes (1900, 1901) did not have the same understanding of flint artefacts as Seton-Karr, but he recognized various flint tool categories and he even sourced the reproductions of rare Egyptian images, showing the manufacture of flint knives from tombs 2 and 15 of Beni Hasan, a necropolis in Middle Egypt, about 245km south of Cairo (Newberry, 1893; Forbes, 1900:108–109; Lund, 2008, 2015; Teeter, 2011:202).

At about the same time, German geologist Max Blanckenhorn (Weisgerber, 1987:165) examined the mines of Wadi el-Sheikh and recognized the extent and importance of this complex. He also asserted a specific character of local flint that can be distinguished from other varieties of flint used in Egypt. The mines were examined again in the 1930s and 1960s (Baumgärtel, 1930, 1960); and more recently in the 1980s and 1990s (Weisgerber, 1982, 1987; Pawlik, 2000a,b, 2005).

However, it took a long time to truly recognize that Wadi el-Sheikh's mines and related workshops are possibly some of the largest (Pawlik, 2000b, 2006) and maybe even oldest of this kind in Egypt. Recently a research team from the University of Vienna embarked on a study of Wadi el-Sheikh, conducting an extensive survey in 2014 (University of Vienna Middle Egypt Project: Wadi el-Sheikh. n.d.) and excavation (Köhler *et al*., 2017; Klaunzer *et al*., 2017).

As well as a more systematic investigation of the mines, the next logical step would be to examine the Wadi el-Sheikh flint tools—their supply and circulation throughout ancient Egypt, their geographical distribution, chronological framework, and the associated technical, economic and social factors (Barket & Yohe, 2011:30–31). For this to be successful, better identification and publication of flint tools in Egyptian settlements, villages and workshops would be required. It is encouraging to see that such investigations have been initiated (e.g., Holmes, 1989; Tillman, 1992, 1999; Pawlik, 2006; Kobusiewicz, 2006; Svoboda, 2006; Hikade, 2013).

This article aims to contribute to the growing body of evidence on the importance of the Wadi el-Sheikh mines in the Egyptian system of resources and provision of tools for daily work. It is based on small collections of flint artefacts from two separate workshops kept at the Australian Museum

(AM—about 130 artefacts, register numbers prefixed with *E*) and Museum Victoria (MV—about 120 artefacts, register numbers prefixed with *X*) which Seton-Karr donated in 1900. Some of the original Seton-Karr assemblages were not listed in previous 'inventories' and are not readily accessible. The Australian Museum's collection is not mentioned in the previously published articles (Weisgerber, 1987:169–170).

We hope that the study of these two assemblages will contribute to a better understanding of the Wadi el-Sheikh mine-complex in Egyptian Pre- and Dynastic history. We are fully aware of the limitations of this study, where examination of spatial distribution within the site and even individual workshops, as well as direct determination of chronology, is virtually unavailable. But these assemblages provide an insight into flint tool production, distribution and some flint extraction methods deployed at Wadi el-Sheikh.

Assemblages from workshops

Studying flint material from Seton-Karr surface collections is difficult because what is usually taken for granted in normal archaeological practice (precise site location, its delineation, distribution of material within it), must be inferred from clues of variable reliability. From Seton-Karr's reports (1898, 1905) and other published material (Forbes, 1900, 1901; Pawlik, 2000a) we understand that both assemblages were collected from relatively distinct, discrete production areas (compare Klaunzer *et al*., 2017:9), not randomly from the wide background scatter. A few tool categories and their relative frequencies as well as numerous refits in both assemblages support this assertion. Moreover, they seem to represent small knapping areas or workshops of specific and discrete production episodes and generally not a superimposition of randomly accumulated material.

Seton-Karr, an experienced collector, must have recognized these factors in the field—as he marked on the map the areas from which his assemblages were taken. They were manageable for a small surveying party to describe and photograph and it was possible to collect entire or nearly entire knapped, surface material within them. It is unknown why Seton-Karr decided to collect only larger objects with complex patterns of flaking (leaving on site an entire subset of big and small flakes resulting from production), but it is entirely plausible he made a strategic decision to collect predominantly diagnostic and informative objects from many knapping areas instead of entire assemblages from fewer workshops—to use his short stay in the quarry in the most productive way.

In this section, we discuss the spatial and temporal integrity of material from the AM workshop in order to assess if and how the artefacts are related to each other. Such a step is essential for inferring to what degree the assemblage is a result of systematic human activity, contained in the small space and narrow time slot (e.g. measured in hours or days, not centuries or millennia). Our assemblages consist only of the flint artefacts selected and collected from the surface of a specific production area, of which the size and internal distribution pattern remain a matter of conjecture.

As mentioned the assemblage of flint artefacts at the Australian Museum (AM) consists of 130 pieces, while the Museum Victoria (MV) consists of 120 pieces (the exact number of artefacts is difficult to assess because some were refitted before and some after registration. In addition, there are a small number of artefacts clearly or likely not related to ancient Egypt in both collections and these were excluded from this study[1]). From reading Seton-Karr's reports and consultation with Alfred Pawlik (pers. comm., 5 March 2015) we understand that items in each assemblage represent a selection from a far greater pool of artefacts discarded in the workshop. In selecting material, the collector probably used intuitive criteria, predominantly including size, complexity of flaking and general shape that could be interpreted as 'intended.' Such selection left the bulk of flint artefacts, especially flakes resulting from the reduction process, on site. In the archaeological analysis such flakes are informative; they would help to better understand the reduction processes, volume of production and support inferences related to finished, or partially completed, tools that were produced in the workshop.

Both assemblages contain only two categories of "products" (unfinished and/or broken): bifacially flaked stone knives (most frequent) and bifacially flaked cleavers (the use of this term is discussed later in Classification). Two other distinct forms, picks and hoes seem to be associated mostly with digging and flint extraction. Such content indicates that both workshops were narrowly focused on production of knives and some quantity of cleavers and therefore were task-oriented, discrete entities of short duration.

It is significant that not a single artefact visibly made from a flake or blade is present in our assemblages.[2] Every artefact is made (as far as it is possible to detect) by the bi-facial flaking of a larger and elongated flint block or tabular piece until it was shaped into the intended form, and mostly discarded when it broke (Fig. 2). Complete final products were, of course, carried away (Köhler *et al*., 2017). Broken flints show that typically any piece shorter than 18 cm was discarded (with a few exceptions). This provides the first general approximation and some insight into the manufacturing process that took place in the workshops.

Refits

In the AM collection 30 artefacts (23%) are fragments (halves) that, when refitted, made 15 complete or nearly complete artefacts, predominantly knives (5, Figs 3–5) and knife preforms (possibly 5, Figs 4, 6). The remaining five are cleavers (Figs 2, 13) and possibly one crescent knife (a form infrequent in our assemblages, Fig. 9). This relatively high number of refits casts light on the integrity of the assemblage from the workshop, its spatial organization and ultimately the nature of the production process.

Seton-Karr made his collection of artefacts from 15 workshops in a relatively short time—three weeks including a cartographic survey (Seton-Karr, 1898). If he applied his collection criteria consistently he would probably have collected entire subsets of artefacts from each workshop—all recognizable larger forms with complex flaking—and this would be practically possible when workshops were contained within several square metres, not hundreds or thousands of square metres.

If broken pieces, from the same intended product, were discarded far apart or moved apart later, they would be less likely to be collected in the same assemblage. The high number of refits suggests that the workshops were small with a high density of discarded flints (Forbes, 1900:104, second photo; Pawlik, 2006:207–208, figs 28, 30; Klaunzer *et al*., 2017:9, fig. 7). This in turn would imply that workshops resulted from production by one or a few people, working consistently in probably one or a succession of flaking episodes in a day or several days—returning to the same spot for logistical reasons such as availability of suitable flint, tools brought and left on the ground, possibly some setup such as provisional shelter, water and food supplies stored nearby (Weisgerber, 1982:202–203; Negro & Cammelli, 2010:115; Klaunzer *et al*., 2017:8). The labour cost of finding and establishing a reasonable extraction and production area would present an incentive to exploit it for as long as it provided good return without increasing the labour-cost of production.

Experimental knapping in general (performed by Florek) indicates that the flaking process is normally fast, and an experienced artisan would be able to produce a significant number of tools in several hours, as long as the supply of flint, knapping tools and some degree of work comfort were provided. One of the authors (Florek) observed broadly similar workshops in the silcrete quarry near Lake Eyre in South Australia, where stone blade-knives were produced in large numbers. Knapping workshops with high density of artefacts (flakes, preforms and discarded pieces) were located near the spot of stone extraction (shallow digging in a silcrete outcrop) and were essentially contained within an area of about 4 m in diameter (less than 12 m^2).

If broken halves were tossed aside they would still be only a few metres apart, if not they would be discarded and left virtually side by side.

Desert varnish

Desert varnish is a dark coating often found on rocks after long exposure in desert regions and its colour, which varies from shades of brown and red to black, results from a chemical process involving iron and manganese oxides (Perry *et al*., 2015). The formation of desert varnish is believed to be slow, measured in millennia (2,000 years is often quoted), but it has been observed to develop much faster, suggesting that it is dependent on specific local conditions.

Such varnish, or dark patina, is a distinctive feature of flint artefacts at Wadi el Sheikh, attesting to their long exposure to desert conditions on the ground surface (Köhler *et al*., 2017).

Desert varnish observed on the specimens from the AM workshop assemblage tends to be present only on one side of the artefacts. Most of the flints have a definite varnish on one side while the other side remains relatively "fresh"—signified by a light creamy-grey colour. In some cases, such as broken knives, varnish is on different sides of each half (Figs 3–5). This pattern suggests a relatively low level of disturbance after initial flaking took place and broken pieces were discarded. While this observation is not quantified it provides a good indication that our workshop resulted from a single or a few episodes of production closely linked in time and probably by the same person or persons, rather than being a deposit of separate production episodes unrelated to each other and far apart in time.

General pattern

The overall pattern of artefacts, their form, relative frequencies, refits, distribution (inferred) and desert varnish implies a reasonable level of integrity of the assemblage (with a few 'foreign' intrusions). This permits us to draw some tentative conclusions. In the light of such evidence it is possible to imagine that the AM workshop was used within the quarry complex as a short, possibly for one or a few days, production area where one or a few artisans from the same (?) expedition-group worked to make a sizable supply of knives, and probably some other tools. It would be interesting to assess how other assemblages collected by Seton-Karr compare to our two collections, and if there is any spatial or temporal link that could be detected between them.

The two assemblages from Wadi el-Sheikh examined for this study, AM and MV, show noticeable similarities, especially in the form of flint artefacts, their relative frequencies, refits and desert varnish. Some of these characteristics were observed systematically only for the AM collection. The MV collection provides a good comparison for classification, size of artefacts and their relative frequencies. The Museum of Liverpool collection is most useful for typological comparison, but it is difficult to extract quantified data from the report (Forbes, 1900).

Chronology

The size and extent of the Wadi el-Sheikh quarries suggest they were used as a source of flint tools for millennia (Pawlik, 2006; Köhler *et al*., 2017; Klaunzer *et al*., 2017)—perhaps in two phases of greater intensity in the 3rd and 2nd millennium BCE respectively as suggested by Hikade (2013:25). Mining shafts have been estimated to date to about 3,300–2,800 BCE, but used more extensively during the Middle Kingdom (Mangum, *n.d.*; Negro & Cammelli, 2010). It is conceivable that numerous extraction and production areas, such as our workshops, could collectively cover a period of a few millennia. Yet, as we asserted earlier, a workshop would result from very short and discrete activity anywhere in the chronological duration of the quarry. The assemblages in this study cannot be directly dated, but can be attributed to a broad chronological period on a basis of the diagnostic artefacts—predominantly stone knives. In general, the knives of this type appeared in the Predynastic Period, were most frequent in the Middle Period and persisted until the New Kingdom, to about the middle of the 2nd millennium BC (Svoboda, 2006:505–506; Kobusiewicz, 2006:455; Graves-Brown, 2010:533–540; Graves-Brown, 2015:21–22). They did not disappear completely but possibly were partially supplemented or replaced by bronze tools (Kobusiewicz, 2006:455; Graves-Brown, 2015:21–22). These types of knives, known from other dated archaeological sites in Egypt, such as Abusir, Giza, Tell Ibrahim Awad, Kom al-Ahmar, Elephantine, and some sites at the oasis such as Dakhla show an association with the Early Dynastic Period and the Old Kingdom (Svoboda 1993, 2006; Kobusiewicz, 2006; Pavlik, 2006; Graves-Brown, 2010; Hikade, 2013). Cleavers and picks (as we call them, including the adze or hoe and pick[3] as designated by Graves-Brown, 2010:561–565), are also mostly associated with the 3rd millennium BCE.

A similar conclusion is drawn by Pawlik (2006) and more recently by Hikade (2013) based on the analysis of archaeological sites Kom al-Ahmar and Elephantine respectively. In addition, both authors evaluate Wadi el-Sheikh in light of published material, identification of flint and some limited inspection of the site, indicating that the early phase[4] of the quarry relates to Early Dynastic and Old Kingdom periods (Hikade, 2013:24–25; Köhler *et al.*, 2017:13–14; Klaunzer *et al.*, 2017:5).

Both our assemblages are likely associated with 3rd millennium BCE. By sharing the same characteristics (e.g., focus on bifacially flaked knives, an apparent lack of blade artefacts, comparable relative frequency of tool categories) they appear as replication of a similar process of tool provision and therefore could represent a broader system of supply.

Classification

When analyzing the two collections (AM and MV) we realized that most artefacts we encountered, both tools and preforms, are not well documented and recognized in the literature. Some researchers are familiar with the types we encountered in these assemblages (Setton-Karr, 1898; Petrie, 1902; Forbes, 1900; Tillmann, 1992, 1994; Graves-Brown, 2010; Svoboda, 2006; Kobusiewicz, 2006; Pawlik, 2006; Hikade, 2013; Köhler *et al.*, 2017), but for some types there is no consistent classificatory framework, systematic interpretation or reliable reference (compare Holmes, 1989:395).

We recognize four major product categories: thin elongated knife (Figs 3–5), flat elongated cleaver (rectangular or triangular, Figs 12–13), thick elongated pick (Figs 15–16), and hoe or hoe-like tool (Fig. 17). We infer, and will discuss further, if and how these four tool types were systematically associated with the workshops.

Furthermore, we recognize three categories of preforms: early blank, second-stage (middle) preform and advanced preform, the last being close to the finished product (cleaver—Figs 12, 13; knife—Figs 3, 5; or pick—Fig. 14).

Table 1. Artefact categories for AM and MV.

	AM	%	MV	%
blank early	4	3.4	1	0.8
blank middle	10	8.6	2	1.7
cleaver	14	12	26	22
pick	8	6.9	25	21.2
hoe	4	3.4	5	4.2
knife complete	5	4.3	1	0.8
knife fragment	48	41.4	47	39.8
knife blank	8	6.9	7	5.9
knife crescent	7	6	3	2.5
double sided biface	4	3.4	1	0.8
unclassified	4	3.4	—	—
total	116	99.7	118	99.7

Blanks

Early blanks range from just under one kilogram to nearly 1.5 kg. They are elongated, thick, bifacially flaked forms. It is difficult to infer into what implement they were intended to be made. There are only four such blanks in the AM collection (two unbroken) and one in the MV collection. It is not clear why they were discarded and why so few are present.

Early blanks could have been abandoned because of a lesser than expected flaking quality of flint or the artisans were testing a number of flint nodules brought to the workshop without any intention to turn them into an actual tool. It could be that workers ran out of time or incentive to complete a particular task. A combination of these factors may be taken into account. The relative rarity of early blanks may also be explained by the fact that they are less likely to break, and therefore are usually developed into a more advanced stage or actual finished tool. Finally, it is difficult to know if the collector selected a small sample of early (heavy) blanks for logistic reasons, while collecting in more systematic manner lighter, advanced forms.

Early blanks provide an insight into the 'typical' reduction process, which involved large elongated pieces of flint flaked bi-facially. All flaked tools associated with workshops were elongated, while cleavers and knives were also thin. For a complete knife an artisan would have flaked off well over one kilogram of material and over half a kilogram for an average cleaver. The workshop would contain a large volume of waste flakes resulting from the reduction process (Hikade, 2013:25; Köhler *et al.*, 2017:30). This also provides evidence for a basic reason for which production took place at the quarry—transporting early blanks out of the quarry would be an extremely inefficient strategy, consuming and wasting a lot of energy and effort.

Second-stage blanks (12) are significantly lighter (379 g on average—including halves and fragments) and thinner pieces (up to 2.4 cm). Some are still too general and could be potentially made into either cleaver or knife. Other blanks show the relatively clear characteristic of a preform for either a cleaver or a knife. A cleaver preform tends to be rectangular or, more commonly, triangular and thicker (up to 2.7 cm); a knife preform tends to be narrower and pointed at both ends, curved on one side and nearly straight on the other, and is generally thinner (up to 1.5 cm).

The comparable pick preform, at this stage of production, is thick and usually distinctive enough to be classified as an incomplete tool, where only minimal flaking, by volume, is required to give it a final shape (Fig. 14).

It proved impractical to separate advanced preforms from nearly finished tools. Although some knife or cleaver fragments have well developed edges and fully worked surfaces, others need more thinning and the surface shows a substantial amount of cortex. In essence all broken pieces are unfinished or almost finished products and can be considered advanced preforms. Several knife fragments (especially so in the MV collection) were made of thin pieces of tabular flint (compare Lucarini, 2016:89; Klaunzer *et al.*, 2017:16), meaning they were already very thin and light while the edges needed to be fully formed and a good amount of cortex remained, sometimes on both sides. This shows that some economizing strategy was deployed, where numerous knives were not made from large early blanks but flat pieces which required far less reduction, although they were potentially more prone to breakage.

Table 2. Complete (refitted) knives (Australian Museum).

collection	length	width	thickness	weight
		numbers		
E9681	23	6.5	1.2	222
E9688	26	7	1.6	248
E9616	21	8	1.6	332
E9617	19	6.5	1.2	170
E9595	24	10	1.5	450
X6846	22	8	1.8	311
average	22.5	7.7	1.5	289

Knives

Six "complete" knives (refitted/reconstructed from two pieces) illustrate that, with slight variation, they conform to a broader form dated to the 3rd millennium BCE (Kobusiewicz, 2006; Graves-Brown, 2010; Hikade, 2013). The knives are quite thin (c. 1.5 cm on average), elongated (c. 22.5 cm on average) and broad (c. 7.7 cm on average—compare Svoboda, 2006:505). The knives weigh 289 g on average, ranging from 170–450 g. There are five knives in the AM collection (prefix E) and one in the MV collection (prefix X). The knife from the MV collection is close to average in size and weight, but slightly thicker.

These knives tend to be broader and pointier at the distal end and narrower and less pointy at the proximal end (Graves-Brown, 2010:538–539; types 3, 7, 8). The smallest knife (E9617) and one advance preform (E9614) have an overall shape resembling a spearhead, with the upper edge curved nearly as much as the lower (Fig. 3), but a visible asymmetry and size allows them to be classified as knives.

Knife fragments (halves) comprise 65 artefacts (56% of the total) in the AM collection, and 52 (44%) in the MV collection. They are, on average, almost exactly half the length (11.5 cm) of the complete knives (22.5 cm). The quantity of knives and their fragments strongly indicates that knives were the main object of production in both areas represented by the AM and MV collections.

Furthermore, we identified 8 (6.9%) knife blanks (or preforms), in the AM collection and 7 (5.9%) in the MV collection. In different stages of reduction, they illustrate an intermediate stage of knife manufacture (Figs 4–6). Such preforms underwent bifacial reduction, aiming to form quite thin, elongated forms, slightly pointed at both ends, and reasonably broad until they broke. Complete knives were undoubtedly carried away from the quarry. We believe early blanks (c. 650–880 g) were less likely to break and hence the relative scarcity of such blanks in both assemblages. Conversely, the blanks (and their fragments) in the advance stage of reduction (c. 130–340 g) are more numerous and are usually significantly thinner and lighter. Six such blanks in the AM collection are longer than 18 cm but only 2 of them are unbroken (others are made of two parts).

Table 3. Knife fragments, including preforms.

	total	knives	%
Australian Museum	116	73	63
Museum Victoria	118	59	50

Most of the knife fragments appear similar to the complete (reconstructed) knives (Graves-Brown's types 3, 7, 8; also Svoboda, 2006:505–506; Pawlik, 2006:198, fig. 8 and p. 200, fig. 16). They appear relatively straight (or nearly straight) on one edge and curved (to different degree) on the other edge, as well as a variously pointed or slightly rounded end (Figs 7–8). A few fragments are so broad and curved at one edge (Fig. 11) that they may represent what we call a crescent knife (Graves-Brown, 2010:543; type 1). Few artefacts in the AM collection may be interpreted as preforms of crescent knife (Fig. 9).

Some knife fragments are finely crafted, suggesting workshop production was not to provide nearly complete tools but rather fully finished products, ready for distribution and use. This assertion is supported by a finishing touch detected on a few knife fragments. Bifacial flaking of thin pointed forms would encounter an acute technical problem at the pointy end. Even light pressure or tapping would likely break the narrow tip. So, to prevent this from happening, the last tiny flake was removed not from the edge (in a right angle direction to the edge) but from the tip in the longitudinal direction, thus creating what technically looks like a micro-burinated tip. It is worth noting that such a technique was used in the production of Middle Palaeolithic points of southern African industries (e.g., Still Bay—Soriano *et al*., 2015, fig. 9.7), reinforcing the view that Egyptian flint artisans inherited and adapted a very old technical tradition of superbly mastered craftsmanship. This also validates our understanding that the Egyptian civilization emerged from African roots with some technical and cultural preconditions embedded in a long human history, bridged via the Neolithic progress (Kobusiewicz, 2006:449; Briois *et al*., 2012:188–189; Wengrow *et al*., 2014; Stevenson, 2016; Lucarini, 2016:96).

We observed that some knife fragments were further modified (e.g., E9627 Fig. 10), as though an attempt was made to reshape them into smaller, nearly complete knives, or simply any functional knife. These partially repaired and discarded knives suggest that ultimately, they were considered unacceptable. They also suggest that, possibly, some larger fragments, such as longer sections of broken knives, were successfully re-modelled and taken away from the quarry. This may explain, at least partially, why flint assemblages not from quarry sites, often contain knives that vary in form and size (e.g., Svoboda, 2006; Graves-Brown, 2010; Pawlik, 2000b:5; Lucarini, 2016:88).

It is possible that tanged knives represent an early stage of further modification (adjustment) through use, which would continue via re-sharpening and ultimately result in their disappearance as recognizable tool form (e.g., Svoboda, 2006:504–506).

Our identification, with 73 (63%) of all artefacts in the AM collection directly associated with knife production; and 59 (50%) of all artefacts in the MV collection, provides good insight as to the main purpose of flint reduction in both workshops. However, 24% of artefacts in the AM collection and 50% in the MV collection represent three other tool categories, cleaver, pick and hoe.

Cleavers

Flat and mostly trapezoid/triangular forms we call cleavers are known under a variety of terms—mainly implying their function—such as axe, plane, hoe and chisel.[5] Our preferred term, cleaver, implies that it is not an imitation of metal Bronze-age tool or even Neolithic axe but a flaked tool with an old ancestry (Paleolithic) and its own specific characteristic in manufacture, use and re-sharpening.

Cleavers and their preforms account for 14 (12%) pieces in the AM collection and 26 (22%) in the MV collection. They are flat, tabular, elongated forms; some are rectangular, but most are triangular (or trapezoid/triangular), broadly similar to forms illustrated in Forbes (1900: figs 9–17), Petrie (1902: plate XX) and Pawlik (2006:202, figs 18–21). There are a few cleavers neatly shaped (in a technical sense) while many are not fully formed or complete. Such a distinction may not be significant as most cleavers with a sharp cutting edge are effective tools (we consider the cutting edge to be the broad end of an elongated triangle; the narrow, pointed or round end would be equivalent to a handle). A cleaver with a developed working edge is a fully functional tool, regardless of how much and how finely or crudely its other edges are formed or how much its surface is worked over. Several cleavers have a slightly curved cutting edge (Fig. 12). Like knives, they would be re sharpened during use, gradually becoming shorter, lighter and less recognizable as morphologically distinctive tools.

The cleavers in our assemblages, characterized by bifacial flaking, are, on average, 16.5 cm long, 10 cm wide, nearly 2.7 cm thick (range including preforms: 1.7–4.5 cm). Generally the straight cutting edge, calculated for 40 cleavers, is nearly 9.8 cm wide on average (range: 8.0–11.5 cm). The average weight is close to half a kilogram (484 g). Cleavers in the AM collection are slightly longer, wider, thicker and heavier (AM: 563 g, MV: 406 g).

Picks

Picks and their preforms comprise 8 (6.8%) pieces in the AM collection and 25 (21.2%) in the MV collection. It would appear that picks were often made from coarser, less glossy flint, or perhaps silicified limestone (Köhler *et al.*, 2017:18) which probably would be compatible with tools designated for robust work where more force than fine cutting was required.

A pick is an elongated tool with a broad and thick body and distinct knob-like handle formed at one (proximal) end (Forbes, 1900, fig. 37; Köhler *et al.*, 2017, fig. 10)[6]. A narrow chisel-like working edge is formed at the distal end by flaking back from the dorsal to the ventral side to produce a chisel-type edge, with a steep or low angle (Figs 15–16). The body has a distinctly flat dorsal side while its ventral side can be flat (rectangular-trapezoid cross section Figs 15–16) or with a crest (triangular cross section Fig. 14). Most such picks in the AM collection are flat on the ventral side. Forms with a crest are predominantly in the MV collection.

It is tempting to assert that picks were used for mining flint in the quarry (Weisgerber, 1987:169; Köhler *et al.*, 2017:12). A chisel-like cutting edge would be suitable to penetrate the soil and break through an eroding limestone layer of desert surface and subsurface deposits. “Mr. Seton-Karr has suggested that these ‘truncheons’, as he names them, were tools used at mines by the artificers … in the fabrication of other stone implements, or to dig the flint nodules out of the limestone in which they occur.” (Forbes, 1900:99). Longer picks with a more acute cutting edge (low angle between dorsal and ventral surface e.g., less than 40°) may be closer to the original form which, through use, would be transformed to shorter picks with a steep cutting edge (close to 80°) often looking battered and irregular. The AM collection picks are consistently close to 20 cm in length and, apart from one unfinished piece, have longer, more protruding cutting edges. The MV picks show more variation in size, but one third are shorter than 19 cm and many have a short, battered, steep cutting edge. If the variation of picks between the AM and MV collections can be interpreted (despite being a small sample), it is possible that in the first workshop they were mostly manufactured and used less intensely, while in the second workshop they could be manufactured and used more heavily—for digging on the spot or very near—hence shortened through use.

Hoes

Four pieces in the AM collection and five in the MV collection resemble hoe-head tools (Forbes, 1900, fig. 42). The body is generally shorter than that of a pick (by 5 cm), as well as being narrower and nearly pointed at the proximal end. The working edge is broad and with flaking back onto the ventral side it resembles a platform of a core with an extremely low angle (Fig. 17). In a very broad sense it is similar to a cone with an extremely slanted platform (stone tool specialists may be justified in calling it a core). The form of the proximal end, especially compared to a pick, suggests that these hoe-like tools may have been fitted with a handle.

It is possible that this tool of wedge-like form was used for digging or scraping soil or rocky detritus, where its broad working edge (core’s platform) would be used as the hoeing “end”, penetrating less compact loam and scooping it towards a digger.

We conceive that the flint “hoe” may not have been suitable for prolonged use and hence not expected in an agricultural context, but it was easy to make where the supply of flint was plentiful and to attach an impromptu handle if necessary.

Picks and flint “hoes” combined could be considered sufficient mining tools to break compact loam and remove smaller detritus from the pit or shaft. We hope future research will help to clarify or modify this assertion.

Discussion

The analysis of two small assemblages of flint conducted in this study is insufficient to draw any broad inferences about the Wadi el-Sheikh Quarry complex, but it helps to confirm, in a systematic manner, its use for the provision of daily tools in the 3rd millennium BCE. And it helps to confirm that the tools produced in two analyzed workshops were predominantly flint knives. Such knives, of various types, may not be as common in the archaeological deposits of ancient Egyptian settlements (e.g., Kobusiewicz, 2006; Hikade, 2013), because their numbers would rapidly deplete through use, re-sharpening and recycling (Svoboda, 2006; Lund, 2008). The quarry site provides a different perspective of the use of knives and their supply and demand. Our study is not designed to quantify such matters in a wide geographical and chronological context. But if the knives were used in a similar way, for a great variety of tasks in everyday life (e.g., Ikram, 2000), as better documented with metal knives in Roman and Medieval times, for instance, we would have to consider a massive collective demand (compare Kobusiewicz, 2006:459). And yet, via a recycling process, flint knives would whittle away, in a metaphorical and actual sense (Svoboda, 2006), in Egyptian households and workshops, where they would appear as a numerically minor component of daily utensils.

Our two assemblages cast light on the supply of flint tools, but some assumptions and hypothetical estimates are necessary. How many tools did each workshop produce? Broken knives and cleavers left on the ground provide us with important clues. It is likely that broken fragments represent relatively regular production errors, whereby every flaking session would result in a portion of broken preforms and nearly complete products. For example, if for every 100 knives attempted or completed, 25 were broken, we could infer they indicate 75 completed knives produced and taken away from a workshop. While true that the percentage of error is variable and unknown, we intend to provide only an indicative volume of production to illustrate the role of workshops in a provisioning system rather than to quantify the system itself.

If we assume, for example, a very high production error (breakage) of 25%, the AM workshop would have supplied 219 knives and MV 177 knives. With a lower, and probably more realistic, breakage rate of 10%, AM would have supplied approximately 657 (c. 190 kg) knives and MV 531 (c. 153 kg) knives.

For an illustrative purpose alone[7], if all 15 assemblages collected by Seton-Karr produced a comparable number of knives (594, c. 172 kg each on average), collectively they would supply 8,910 knives of a total weight of almost 2.6 tonnes. All this could have been supplied by a team of two or three artisans and two donkeys going to the quarry every third week of the year for about three to five days each time. Ten such teams, not an unrealistic assumption, would produce 89,100 knives (about 25.7 tonnes) annually. We suggest that while individual workshops reflect only a short production episode, collectively they could represent a significantly large network for the production and distribution of knives in the region (Barket & Yohe, 2011:27).

If the procurement of flint knives was indeed organized in such or a similar manner it would be consistent with our assertion that finished knives, rather than blanks, were produced and transported out of the quarry (compare Pawlik, 2006:196–198), because any excess of weight would compound the logistics of transport and distribution. There is also compelling evidence that pack-animals in Egypt were typically overloaded with excessive burdens (Rossel *et al*., 2008:3719).

We believe that the small, compact and focused character of the workshops, combined with a general knowledge of the environmental quality of the Eastern Desert, permits us to broadly infer both the human involvement and duration of work performed. Environmental constrains would induce a working team to be small and operate for a short period of time. In normal, usually arid conditions, food and water for people and pack animals would be brought to the mining complex (Köhler *et al*., 2017:30). At least half a day's journey each way (approximately 20–30 km) and two days of effective flint extraction and manufacturing of stone tools would require a sizable quantity, in volume and weight, of water alone. On the other hand, we estimate two artisans could produce close to 600 flint knives in two days—close to the load limit of around 170 kg, for two donkeys. Thus, our hypothesis is that each of our workshops could reflect an expedition of two artisans with two donkeys for a total period of three days (a similar estimate was made independently in Köhler *et al*. 2017:32–33). It is possible that we underestimate or overestimate the speed and efficiency of the production, but we feel that in general our calculation is realistic. It is also possible that these expeditions were larger and that they would result in many workshops similar to those included in this study. However, we believe each workshop of comparable size would translate to roughly 3 days, 2 people and 2 animals, operating as an autonomous unit or as part of a larger group.

The same logistic concern for transporting a large volume of products from the quarry would justify our hypothesis about the "mining tools". We believe that picks and hoes are tools associated specifically with the quarry and with construction sites where excavation into bedrock was required, on which we comment below.

The mining tools were made and used within the quarry and, to our knowledge, rarely occur in typical domestic (village or urban) sites, or in temple and sepulchral contexts[8]. These heavy-duty and heavy tools (picks weigh around 636 g on average, but there are some close to and over 1 kg) were probably made, used and discarded within the quarry as the plentiful supply of flint did not offer any incentive for their curation, i.e. they were readily made when needed and also readily discarded.

We observed that the pick tools generally appear in a more advanced state of use in the MV assemblage (where they are more numerous) and in a less advanced stage of use in the AM assemblage, where some pick blanks and at least one "freshly" made tool are present. Such variation invites the question: were picks also produced for use beyond the quarry and transported out of it for distribution? Our material does not permit us to address this directly with supportive evidence. We can only hypothesize that picks were produced in smaller quantities because, compared with knives, they were more specialized tools and, being heavy, rigorously selected for transport. What was left in the workshops were used picks with battered cutting edges and complete specimens which were considered less worthy and/or unnecessary to transport. We believe that for specific construction projects (e.g., tomb or temple), special system of provisioning of "mining tools" was required (discussed briefly in Köhler *et al*., 2017:5–6) and workshops where such tools were made may be discovered in the Wadi el-Sheikh Quarry complex and in other quarries.

Seton-Karr (1905) recognized a pick tool used for excavation at Thebes and he links this to his previous observation of such tools at Wadi el-Sheikh Quarry. Other researchers also recognized pick tools in graves (Armant, south of Thebes) where it can be interpreted as associated with digging (Myers & Fairman, 1931:224).

One tool that may have been rare, and probably carried by the craftsmen, was a hammer-stone. Only one such tool (from Seton-Karr collections) is known to date, and is illustrated in the report from the Museum of Liverpool collection (Forbes, 1900:93; figs 39–40). It is possible that a hammer-stone of sufficient quality (tough probably basaltic "spherical" rock) would be brought to the quarry and valued for its rarity and essential service. We hypothesize that a hammer-stone in serviceable form would rarely be discarded. However, it must also be considered that such a tool would be less likely recognized as an artefact and more easily overlooked by casual or amateur collectors.

If the same breakage ratio (10%) is assumed for the cleaver, the AM workshop would supply 150 cleavers (84.4 kg), and the MV workshop 260 cleavers (105.5 kg). For the same illustrative purpose, all 15 workshops would supply approximately 3,075 cleavers (1,490 kg). A cleaver is a heavy-duty chopping tool used for working wood, bone and relatively soft rock such as limestone. Unlike a pick it is a more universal tool, expected to be present in ordinary domestic sites as well as in special workshops (Hikade, 2013). In addition, a cleaver would be associated with masonry sites where blocks or plates of limestone or sandstone were manufactured. Indeed, cleavers appear more frequently in archaeological sites throughout Egypt (e.g., Petrie, 1901a). This tool would also be re-sharpened and possibly recycled.

Conclusions

Our study of two flint assemblages from Wadi el-Sheikh illustrates that metal tools augmented rather than replaced stone tools and related technology in the 3rd millennium and even earlier in Egypt (Hikade, 1910:8–9). We know from other sources that this parallel use of stone and metal technology continued through nearly the entire history of ancient Egypt (Graves-Brown, 2015; Barket & Yohe, 2011:30–31).

The kind of tools prevalent in the workshops strongly suggests that flint knives were produced in quite a standardized and focused manner for distribution and use away from the quarry. A few examples of short knives, probably remade from broken fragments, and crescent knives indicate a degree of opportunism in fulfilling production quotas by economizing on time and labour invested at the quarry.

The form and quality of broken pieces left in the workshops indicate that knives were more likely produced in their final stage, ready for use, rather than as preforms to be completed beyond the quarry. The reason for this was probably a need to economize the logistics of transport, which in turn was dictated by the sizable volume and weight of knives manufactured in the workshops. We estimate each small workshop, active for a period between one and three days, would supply several hundred knives—an average load of about 170 kg.

Both workshops produced a smaller number of cleavers for distribution and use beyond the quarry. The nature of the evidence makes it more difficult to demonstrate in which state of completeness these tools would be transported from the quarry. But it is reasonable to expect that the same logistical need for economizing on the transport load that we observed with knives would apply to cleavers. As heavy-duty tools, the need for fine-finished cleavers was probably less important, but it would be motivated mainly by the imperative to reduce the overall volume of each tool to its optimal weight. However, broken fragments of cleavers left in the workshops show few examples of well-finished tools.

Our study confirms that the pick was a digging tool, predominantly associated with construction and mining sites. A sizable collection of picks (33) from two workshops permits us to draw some inferences about their typology, manufacture and use. The context suggests picks combined some of the qualities of a pick and chisel, capable of digging compact soil as well as soft rock such as lime and sandstone.

Nine hoes recorded in the workshops could be considered as digging tools used to penetrate less compact soil and remove debris from shallow excavations to allow better access to flint. In the lack of contextual evidence other than from quarry sites this interpretation must be considered preliminary.

The specialized nature of the workshops, focused on the production of flint knives and a smaller number of cleavers, indicates an organized supply system rather than an incidental provision of stone tools by an impoverished social group (Graves-Brown, 2010:129). The similar opinion is implied by the title "Chert for the Masses …" of the article by Klaunzer and his co-workers (Klaunzer *et al*., 2017). We believe that the kind of tools and the manner of their provision, also suggest they were manufactured and distributed for general rather than specialized use. We imagine that for major construction projects, a supply of flint tools would be organized on a larger scale. It seems likely that the sizable mining shafts documented in the Wadi el-Sheikh complex could be associated with the large scale production and provision of tools for specific and highly organized work teams.

Figure 2. Preform of a cleaver, AM E9582, 20 cm long, 658 g. Scale 5 cm.

Figure 3. Knife, AM E9617, 19 cm long, 170 g. Scale 5 cm.

Figure 4. Preform of a knife, AM E9616, 21.5 cm long, 332 g. Scale 5 cm.

Figure 5. Knife, AM E9681, 23 cm long, 222 g. Scale 5 cm.

Figure 6. Preform of a knife, AM E9595, 24 cm long, 450 g. Scale 5 cm.

Figure 7. Knife-fragment, AM E9637, 8.5 cm long, 34 g. Scale 5 cm.

Figure 8. Knife-fragment, AM E9639, 9.5 cm long, 44 g. Scale 5 cm.

Figure 9. Preform of crescent knife, AM E9581, 17 cm long, 330 g. Scale 5 cm.

Figure 10. Fragment of a short knife, AM E9627, 12.5 cm long, 82 g. Scale 5 cm.

Figure 11. Fragment of crescent knife, AM E9666, 15.5 cm long, 190 g. Scale 5 cm.

Figure 12. Fragment of a cleaver, AM E9692, 13 cm long, 344 g. Scale 5 cm.

Figure 13. Advanced preform of a cleaver, AM E9602, 23.5 cm long, 722 g. Scale 5 cm.

Figure 14. Preform of a pick with crest, AM E9661, 21 cm long, 848 g. Scale 5 cm.

Figure 15. Pick, AM E9653, 21 cm long, 482 g. Scale 5 cm.

Figure 16. Pick, MV X6810, 19 cm long, 594 g. Scale 5 cm.

Figure 17. Hoe, AM E9660, 13 cm long, 250 g. Scale 5 cm.

Acknowledgments. We wish to thank several people who made this study possible, including Dion Peita, Collection Coordinator at the Australian Museum for providing financial support and encouragement; Dr Elizabeth Bonshek, Senior Curator for Pacific Cultures, and Penelope Ikinger, Collection Manager for International Indigenous Collections at the Museum Victoria for access and assistance in studying material under their care; Dr Alfred Pawlik from the University of the Philippines Diliman for sharing with us his observations at Wadi el-Sheikh Quarry; Dr Val Attenbrow form the Australian Museum for insightful comments; two reviewers who helped to improve this paper; Allison Dejanovic for her support and lending us equipment, Charlotte Kowalski and Vickie Tran for their assistance in processing data and images; Jane Roy, Peter Dadswell and Penny Zylstra for generous help in editing. All photos and a digital drawing (Fig. 16) were produced by Stan Florek.

References

Aston, B. G., J. A. Harrell, and I. Shaw. 2000. Stone. In *Ancient Egyptian Materials and Technology,* ed. P. Nicholson and I. Shaw, pp. 5–77. Cambridge: Cambridge University Press.

Bard, K. A. 2007. *Introduction to the archaeology of ancient Egypt*. Oxford: Blackwell Publishing.

Barket, T. M., and R. M. Yohe. 2011. A technological evaluation of the flint blade-core reduction sequence at Wadi El-Sheikh, Middle Egypt. *Lithic Technology* 36: 27–38. https://doi.org/10.1179/lit.2011.36.1.27

Baumgärtel, E. J. 1930. The flint quarries at Wadi el-Sheykh. In *Ancient Egypt,* ed. F Petrie, pp. 103–108. London and New York: Macmillan.

Baumgärtel, E. J. 1960. *The Cultures of Prehistoric Egypt II.* Oxford and London: Oxford University Press.

Bevan, A. 2007. *Stone Vessels and Values in the Bronze Age Mediterranean*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511499678

Briois, F., B. Midant-Reynes, and M. Wuttmann. 2012. Neolithic occupation of an artesian spring: KS043 in the Kharga Oasis, Egypt. *Journal of Field Archaeology* 37(3): 178–191. https://doi.org/10.1179/0093469012Z.00000000018

Forbes, H. O. 1900. On a collection of stone implements in the Mayer Museum, made by H. W. Seton Karr, in Mines of the Ancient Egyptians discovered by him on the plateaux of the Nile Valley. *Bulletin of the Liverpool Museum* 2: 77–115.

Forbes, H. O. 1901. The age of surface flint implements of Egypt and Somaliland. *Bulletin of the Liverpool Museum* 3: 48–61.

Graves-Brown, C. A. 2010. *The Ideological Significance of Flint in Dynastic Egypt*. (Volume 1), thesis submitted to University College London for the Degree of Doctor of Philosophy, Institute of Archaeology, University College London.

Graves-Brown, C. A. 2015. Dagger-like flint implements in Bronze Age Egypt. In *Flint Daggers in Prehistoric Europe,* ed. C. J. Frieman and B. V. Eriksen, pp. 19–31. Oxford & Philadelphia: Oxbow Books.

Hikade, T. 2010. Stone Tool Production. In *UCLA Encyclopaedia of Egyptology,* ed. W. Wendrich. Los Angeles: University of California. http://digital2.library.ucla.edu/viewItem.do?ark=21198/zz0025h6kk

Hikade, T. 2013. Elephantine XXXV: The lithic industries on Elephantine Island during the 3rd Millennium BC. Archäologishe Veröffentlichungen 121. Wiesbaden: Harrassowitz Verlag.

Holmes, D. 1989. The predynastic lithic industry of Upper Egypt: a comparative study of the lithic traditions of Badari, Nagada, and Hierakonpolis. *British Archaeological Reports International Series* 469 pp. Oxford: BAR.

Ikram, S. 2000. Meat processing. In *Ancient Egyptian Materials and Technology,* ed. P. Nicholson and I. Shaw, pp. 656–671. Cambridge: Cambridge University Press.

Klaunzer, M., F. Mustar, and E. C. Köhler. 2017. Chert for the masses… mining archaeology in Wadi el-Sheikh. A preliminary report. *Metalla* 23.1: 2017, pp. 3–18

Kobusiewicz, M. 2006. Stone knapping tradition in Old Kingdom Dakhleh. In *Archaeology of Early Northeastern Africa Studies in African Archaeology* 9, ed. K. Kroeper, M. Chlodnicki, and M. Kobusiewicz, pp. 449–461. Poznan: Poznan Archaeological Museum.

Köhler, E. C., E. Hart, and M. Klaunzer. 2017. Wadi el-Sheikh: a new archaeological investigation of ancient Egyptian chert mines. *PLoS ONE* 12(2): e0170840. https://doi.org/10.1371/journal.pone.0170840

Lucarini, G. 2016. Early Craftsmen of the desert. Traces of predynastic lithic technology at Farafra during the Mid-Holocene. In *The Oasis Papers* 6, *Proceedings of the Sixth International Conference of the Dakhleh Oasis Project,* ed. R. S. Bagall, P. Davoli, and C. A Hope, pp. 87–98. Oxford: Oxbow Books. https://doi.org/10.2307/j.ctvh1dstn.13

Lund, M. 2008. Egyptian flint work part I "SHT SF. W"—chipping butcher knives in ancient Egypt. *Chips* 20(3): 4–13.

Lund, M. 2015. Some observations and experiments regarding depictions of flint knapping in the Old and Middle Kingdoms. In *Experiment and Experience Ancient Egypt in the Present,* ed. C. Graves-Brown, pp. 113–137. Swansea: Classical Press of Wales. https://doi.org/10.2307/j.ctvvnbgg.11

Mangum, M. (no date). The Lost Art of Egyptian Lithics. University of Birmingham. [Accessed 26 October 2016] http://www.birmingham.ac.uk/research/activity/connections/Essays/MMangum.aspx

Midant-Reynes, B. 1984. La Taille des Couteaux de Silex duType Gebel el-Arak et la Dénomination du Silex en Égyptien. In *Origins an Early Development of Food-Producing Cultures in North-EasternAfrica,* ed. K. Krzyzaniak and M. Kobusiewicz, pp. 261–264. Poznań: Polish Academy of Sciences & Poznań Archaeological Museum.

Myers, O. H., and H. W. Fairman. 1931. Excavations at Armant 1929–1931. *Journal of Egyptian Archaeology* 17: 223–232. https://doi.org/10.1177/030751333101700143

Negro, M., and M. Cammelli. 2010. The flint quarries of Wadi el Sheikh (Eastern Desert of Egypt). *Sahara* 21: 107–117.

Newberry, P. E. 1893. *Beni Hasan I. Archaeological Survey of Egypt I*. London.

Nicholson, P., and I. Shaw 2000, eds. *Ancient Egyptian Materials and Technology*. Cambridge: Cambridge University Press.

Ogden, J. 2000. Metals. In *Ancient Egyptian Mmaterials and Technology*, ed. P. T. Nicholson and I. Shaw, pp. 148–176. Cambridge: Cambridge University Press.

Pawlik, A. 2000a. Excursionen zu den Silex-Bergbaurevieren im Wadi el-Sheich bei el-Hiba. *Göttinger Miszellen* 177: 49–56.

Pawlik, A. 2000b. Stone tool production and flint mining in ancient Egypt. *Hukay* 2: 3–9.

Pawlik, A. F. 2006. The lithic industry of the pharaonic site Kom al-Ahmar in Middle Egypt and its relationship to the flint mines of the Wadi al-Sheikh. In *Stone Age Mining Age Der Anschnitt, Beiheft* 19, pp. 193–209. Bochum: Deutsches Bergbaumuseum.

Petrie, W. M. F. 1901a. Royal Tombs of the First Dynasties Part II. *Memoir of the Egypt Exploration Fund* 21. London.

Petrie, W. M. F. 1901b. *The Arts and Crafts of Ancient Egypt*. (2nd edn). London and Edinburgh: T. N. Foulis.

Petrie, W. M. F. 1902. *Abydos Part I*. Memoir of the Egypt Exploration Fund 22. London. https://doi.org/10.2307/623935

Petrie, W. M. F. 1903. *Abydos: Part II.* Memoir of the Egypt Exploration Fund 22. London.

Petrie, W. M. F. 1917. *Tools and Weapons*. London: British School of Archaeology in Egypt.

Perry, R. S., V. M. Kolb, B. Y. Lynne, M. A. Sephton, N. McLoughlin, M. H. Engel, L. Olendzenski, M. Brasier, and J. T. Staley Jr. 2005. How desert varnish forms? In *Proc. SPIE 5906*, ed. B. H. Gilbert, V. Levin, A. Y. Rozanov and G. R. Gladstone, pp. 276–287. San Diego: Astrobiology and Planetary Missions Publication.
https://doi.org/10.1117/12.626547

Romer, J. 2012. *A History of Ancient Egypt: From the First Farmers to the Great Pyramid*. New York: Thomas Dunne Books.

Rosen, S. A. 1996. The Decline and Fall of Flint. In *Stone Tools: Theoretical Insights into Human Prehistory,* ed. G. H. Odell, pp. 129–155. New York: Springer.
https://doi.org/10.1007/978-1-4899-0173-6_6

Rossel, S., F. Marshall, J. Peters, T. Pilgram, M. D. Adams, and D. O'Connor. 2008. Domestication of the donkey: timing, processes, and indicators. *Proceedings of the National Academy of Science of the United States of America* 105(10): 3715–3720.
https://doi.org/10.1073/pnas.0709692105

Rothenberg, B., C. T. Shaw, F. Hassan, and A. A. A. Husein. 1998. Reconnaissance survey of ancient mining and metallurgy in the Mersa Alam Region, Eastern Desert of Egypt. *Institute for Archaeo-Metallurgical Studies* 20: 4–9.

Seton-Karr, H. W. 1898. Discovery of the Lost Flint Mines of Egypt. *The Journal of the Anthropological Institute of Great Britain and Ireland* 27: 90–92.
https://doi.org/10.2307/2842853

Seton-Karr, M. H. W. 1905. How the tomb galleries at Thebes were cut and the limestone quarried at the prehistoric flint mines of the E. Desert. *Annales du Service des Antiquites d'Egypt* 6: 176–184.
https://archive.org/stream/discoverylostfl00kargoog#page/n4/mode/2up

Seton-Karr, H. W. 1906. *Flint Implements of the Fayum, Egypt*. Washington.

Soriano S., P. Villa, A. Delagnes, I. Degano, L. Pollarolo, and J. J. Lucejko. 2015. The Still Bay and Howiesons Poort at Sibudu and Blombos: understanding Middle Stone Age technologies. *PLoS ONE* 10(7): e0131127.
https://doi.org/10.1371/journal.pone.0131127

Stevenson, A. 2011. Material culture of the predynastic period. In *Before the Pyramids*, ed. E. Teeter, pp. 65–74. Chicago: Oriental Institute of the University of Chicago.

Stevenson, A. 2013. Egypt and Sudan: mesolithic to Early Dynastic period. In *World Archaeology at the Pitt Rivers Museum: A Characterisation,* ed. D. Hiks and A. Stevenson, pp. 60–89.

Stevenson, A. 2016. The Egyptian Predynastic and State Formation. *Journal of Archaeological Research* 24(4): 421–468.
https://doi.org/10.1007/s10814-016-9094-7

Svoboda, J. 1993. Lithic Industries from Abusir, Lower Egypt. *Origini (Roma)* 17: 167–219.

Svoboda, J. 2006. The Kings's Knives: chiped lithics from the Neferra's Mortuary complex. In *Abusir IX: The Pyramid Complex of Raneferef: The Archeology,* ed. M. Verner, pp. 502–509. Praha: Czech Institute of Egyptology.

Teeter, E., ed. 2011. *Before the Pyramids.* Chicago: Oriental Institute of the University of Chicago.

Tillmann, A. 1992. *Die Steinartefakte des dynastischen Ägypten, dargestellt am Beispielder Inventare aus Tell el-Dab'a und Qantir. (PhD thesis University of Tübingen).* Tübingen: University of Tübingen.

Tillmann, A. 1994. Die Steinartefakte. In *Pharaonen und Fremde: Dynastien im Dunkel. 194. Sonderausstellung des Historischen Museums der Stadt Wien in Zusammenarbeit ... 8.Sept.–23. Okt.1994. 194. Sonderausstellung des Historischen Museums der Stadt Wien,* ed. I. Hein, pp. 105–109, 257. Wein: Eigenverlag der Museender Stadt.

Tillmann, A. 1999. Dynastic stone tools. In *Encyclopedia of the Archaeology of Ancient Egypt*, ed. K. A. Bard, pp. 262–265. London: Routledge.

University of Vienna Middle Egypt Project: Wadi el-Sheikh. (No date). Online publication: Ägyptologie Wien: Institut für Ägyptologie, Universität Wien. [Accessed 6 January 2016]
https://www.univie.ac.at/egyptology/WadielSheikh.html

Wengrow, D., M. Dee, S. Foster, A. Stevenson, and C. B. Ramsey. 2014. Cultural convergence in the Neolithic of the Nile Valley: a prehistoric perspective on Egypt's place in Africa. *Antiquity*, 88: 95–111.
https://doi.org/10.1017/S0003598X00050249

Weisgerber, G. 1982. Altägyptischer Hornsteinbergbau im Wadi el-Sheikh. *Der Anschnitt* 34: 186–210.

Weisgerber, G. 1987. The Ancient Flint Mines at Wadi el-Sheikh (Egypt). In *The Human Uses of Flint and Chert: Flint Symposium, Brighton.* ed. G. de Sieveking and M. H. Newcomer, pp. 165–171. Cambridge: Cambridge University Press.

Endnotes

1 A few Levallois cores are present in the MV collection—compare Kobusiewicz, 2006:458; Köhler *et al*., 2017.

2 A few flakes are from "foreign" flint and/or clearly associated with Palaeolithic. One flake, resulting from reduction process is in the AM assemblage.

3 One pick in Graves-Brown (2010:565) is assigned to the New Kingdom after Seton-Karr (1905)—it is far larger than any in our assemblages in AM and MV but similar in morphology.

4 Excluding Neolithic and Palaeolithic use of the site.

5 Lack of terminological consistency makes this tool category less visible and not systematically described and classified, along with some other bifacial artefacts of the Neolithic and Bronze-age periods (Holmes, 1989:395).

6 Somewhat similar tools were associated with a gold mine at Bakari and described as the earliest type of mining tools (Rothenberg *et al*., 1998:7, fig. 4), however the nature of the published evidence makes it difficult to compare them systematically with our picks.

7 As we do not have qualitative and quantitative data on other workshop-assemblages collected by Seton-Karr.

8 Unless they were discarded at the construction site where the excavation was performed (Seton-Karr, 1905).