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Early Stone Age Tools Variability in the Nile Basin: a New Investigation in the Eastern Desert of Lower Atbara River, Sudan

Introduction

It is widely accepted that the Early Stone Age (ESA) stone tools in the Nile Basin belong to the Large Cutting Tool tradition (i.e. bifacial flakes), of which the handaxes and cleavers are the main types. However, their technological development and dispersal across the Nile and the Sahara from southeast Africa remain controversial including when and where? The lack of Developed Oldowan and Early Acheulean technology make the situation complex to understand. Given that the Acheulean large bifacial stone tools (including choppers, cleavers and handaxes) discoveries at Olduvai Gorge, Olorgesailie, Koobi Fora, Omo, Awash, Hadar and Gona in Tanzania, Kenya and Ethiopia, respectively, suggest clear distribution and transition of early stone tools in the Upper part of the Nile basin. However the Acheulean assemblages in the lower part of the Nile Basin are different as they contain small hand axes at selected sites such as Arkin-8, Bir Sahara, Kharga Oasis and Dakhla Oasis.

The middle part of the Nile Basin is lacking evidence due to lack of research, with the exception of single discoveries from Khor Abu Anga and Abu Hugar. The combination of the discoveries of these three parts in the Nile basin is very informative and make it easy to understand the ESA of the Nile basin.

This paper presents results of recent archaeological investigations of ESA sites in the Lower Atbara River (Eastern Desert) region of the Republic of Sudan, which shed light on a new corridor that links earlier sites of southeast Africa with those in northern Africa. Sites were recorded from a variety of landscape settings and with different densities of artifacts. The central goal of this paper is to report the techno-typological characteristics of stone tools. The assemblages present two main cultural entities: Early Acheulean (large flakes cleavers, hand axes, and bifacial points) and Middle and Late Acheulean with MSA (characterized by lanceolates, prepared core products and Levallois flakes). Miscellaneous large cutting flakes are well represented, and flint and quartz are the dominant raw materials.

1. An overview of ESA in the Nile basin

The Nile basin is here defined by the territory encompassed by the Nile valley from the southern lake complexes in Tanzania and Kenya to the Mediterranean area in the north and the eastern and western deserts. The Upper part includes Tanzania, Kenya, Ethiopia, Uganda and South Sudan), the middle part of the valley is in central and eastern Sudan, and the lower part includes the Western Desert of northern Sudan, south Egypt, up to the Mediterranean Sea.

Fossil and archaeological discoveries from African prehistoric sites continue to improve our understanding of the geographic, chronological and environmental contexts of human evolution (Semaw 2000; Klein 2009; White *et al.* 2009). There is now a broader consensus on origin of modern humans in Africa and their subsequent colonization of the rest of the world at different time-periods (Klein 2009). The oldest records of culture (in the form of stone tools) have been known from East African sites (Upper Nile Basin); and Africa holds a continuous record of Paleolithic cultures starting with the earliest Oldovan tradition up to the Later Stone Age (Klein 2009; Semaw 2000; Rots and Van Peer 2006; Abbate *et al.* 2010). The invention and gradual diversification of stone tools are believed to have greatly contributed to the survival of early hominin and the emergence of complex cultures over time.

Despite the Nile basin is important place of our understanding the emergence and dispersal of early human, not all regions of the Nile basin have seen adequate Paleolithic research, nor were they exposed to similar field approaches and classification methods (Kleindienst 2006), hindering a balanced assessment of the contribution of each region to the study of human evolution. One of the leading theoretical issues in this study is the transition from ESA (mainly characterized

by Acheulean stone tools, such as cleavers and hand axes) to Middle Paleolithic or Middle Stone Age traditions (characterized by the production of points and prepared core products). The timing and geographic contexts of this transition have not been resolved, but the answer is vital to assessing broader evolutionary issues, such as whether this transition was associated with the emergence of a new hominin lineage from upper Nile basin or if it was a result of climatic changes that compelled hominin in different regions of the Nile basin to employ new technological innovations (Clark 1988; Yellen *et al.* 2005; Shea 2008; Beyin 2013).

The very widespread distribution of Middle Paleolithic sites in the lower part of the Nile basin, across the western Desert, suggest that there were a long contact between the Nile basin and the Sahara, besides that the differentiation among the stone tools technology implies the existence of separate migration along routes across the Sahara as far as west of the Nile basin borders, with differences in adaptation. The main evidences of that comes from Dakhla Oasis, Kharga and Kurkur and other sites at ElGa'ab depression, Sai Island and Arkin-8 in northern Sudan (Chmielewski 1968; Wendorf and Schild 1980; Rose and Van Peer 2006; Tahir and Nassr 2015; Osypiński and Osypińska 2016).

In the Middle Nile basin the discoveries of central and eastern Sudan show some contacts with Eritrea and the Red Sea coastal zones, that is identified from the assemblage related to the Late Acheulean and MSA assemblages (Chmielewski 1987; Marks *et al.* 1987; Abbate *et al.* 2010; Beyin 2013), however the earlier objects show very few differences and their emergence was undertaken as the focal research target.

In his publication, Arkell (1949) indicated that the Acheulean stone tools in Khor Abu Anga were similar to the Kenya collections in southeast Africa (Upper Nile basin). The discoveries of ESA in northern Sudan (Kadanarti and Arkin-8) compared with central Sudan, which have been already compared with Kenyan sites (Chmielewski 1968; Chaix *et al.* 2000 ; Van Peer *et al.* 2003).

This study attempts to establish cultural contacts with the southeast Africa also, but from the eastern desert of Lower Atbara River. That is chosen from two reasons: firstly geographical location of the Atbara River is in open land with Eritrea and Ethiopia, both of which contain entry points to southeast and northern Africa, respectively. Secondly, the area remained largely untouched, with some rescue studies conducted on the upper parts of Atbara River (Khashm el Girba) revealed surface occurrences of Middle Paleolithic stone tools, which are different from the other Sudanese finds (Marks *et al.* 1987, Chmielewski 1987; Shinner and Chmielewski 1971; Abbate *et al.* 2010).

There are two potential factors confounding the question of ESA stone tools transition in the Nile basin: a) Taxonomic problems – different parts of the Nile basin have been exposed to different and inconsistent taxonomic terms, hindering systematic comparison of regional assemblages across the Early and Middle Paleolithic transition, and b) Absence of direct spatial association of ESA sites (sometimes far apart in space) making it difficult to develop regional culture-histories that represent all Paleolithic facets. Moreover, new taxonomic and analytic questions are constantly emerging with every new discovery (Stout *et al.* 2010), further complicating regional comparisons of Paleolithic assemblages and the large gaps of ESA sites in the middle and upper Nile basin.

2. ESA research in the Nile basin

One clear pattern from Paleolithic records in the Nile basin is that the archaeological sites presenting the ESA are rare, if they are compared to the Middle and Upper Paleolithic. The main sites in Tanzania, Kenya and Ethiopia regarded as the standard evidence of ESA development and change. The comparative research between Upper and Lower Nile basin are lacking, although some of the studies have concentrated on the Nile and the Sahara (Leakey 1951; Arkell 1949; Clark 1966; Wendorf 1968; Isaac 1977; Gowlett 1982; Stout *et al.* 2010).

Leakey (1931) started his research on East African paleoanthropology, which resulted in comprehensive archaeological discoveries at Olduvai Gorge, Isenya, Olorgesailie, Koobi Fora, Omo, Melka Kunture, Awash and Hadar. (Fig. 1). Many of technological terms and classification methods have been cited through work in the upper part of the Nile basin.

These are main references sources to be consulted in respect to the early pioneer investigations and they provide invaluable bibliographies and summaries of early explorations in the southeast Africa (Isaac 1977; Leakey *et al.* 1969, McBrearty 1988; Rote and Van Peer 2006). The discoveries of the Rivet Valley, Turkana basin, Wadi Awash, Afar, Hadar and Gona (Fig. 1) shed light on Acheulean technological development and associated stratigraphy (Clark 1982:238).

The early exploration survey by Sandford and Arkell (1928) in Sudan shed light on some important elements of the Paleolithic to the north. This was later supplemented by many Paleolithic sites discovered by Arkell (1949) in central Sudan. The surface collections of early stone tools described from the Upper Atbara River were very promising for the Sudanese Paleolithic, however there are no continued investigations. Numerous Acheulean assemblages were recorded from the rescue fieldwork by Chmielewski (1967), The oldest sites do not reveal hand axes, however; choppers were dominant (Chmielewski 1987:7). This revealed impor-

tant information on area which was investigated by an Italian mission and some ESA with Pleistocene deposits recorded in the Middle Atbara River (Abbate *et al.* 2010). Likewise, Paleolithic sites were discovered on the Blue Nile such as Abu Hugar, which yielded a *Homo sapiens* skull from Singa, animal bones and MSA stone tools (Stringer 1979:82). The last was discovered on the Upper and Middle Atbara River and in the Bayuda Desert; the Affad depression makes the research necessary in the Eastern Desert of Lower Atbara River (Abbate *et al.* 2010; Masojć 2010; Osypiński and Osypińska 2016).

The question of the scarcity of Paleolithic sites and robust chronologies in Sudan archaeological records has not been satisfactorily answered. Moreover, the absence of ample ESA sites made it difficult to trace the origins of the MSA. The discovery of Early and Middle Stone Age assemblages from the Atbara region provides us a rare opportunity to investigate this important transition in one distinct region.

In lower part of the Nile basin, the work on prehistory began by 1890s, through general notes of single stone artifacts. More significant research discoveries started in late 1940s. In the late 1930s, stone tools were identified by Caton-Thompson (1952), and assigned an upper stage of the Acheulean from Kharga Oasis. The main Acheulean hand axes found in situ near Cairo, contain pointed hand axes with cortical butts (Huzzayin 1941:182). The Combined Prehistoric Expedition (CPE) located numerous Middle and Late Stone Age sites in the northern Sudan and western desert (Wendorf 1968; Klees and Kuper 1992). Renewed Paleolithic archaeological research began with the rescue operations prior to the construction of the Aswan High Dam, where Acheulean stone tools are abundant. Their technology and typology were described as Upper Acheulean, with hand axes and chopping tools as the main types, while cleavers were lacking (Wendorf 1968; Chmielewski 1968; Guichard and Guichard 1965).

Wendorf and Schild (1980) classified many Upper Acheulean and MSA assemblage from Dakhla and Kharga Oasis and Bir Sahara (Fig. 1). Also, Upper Acheulean and MSA sites were reported near the Radar River on a small paleo-lake at Bir Sahara and Bir Tarfawi (Wendorf *et al.* 1987). Moreover, the recent field works in the second cataract, Dongla Reach, El-Ga'ab depression, Fourth Cataract and Bayuda desert have reported several find-spots of MSA stone tool types (Rots and Van Peer 2006:364; Masojć 2010:66; Maier 2012:112; Osypińska 2012:219; Tahir and Nassr 2015:105).

The Cologne symposium in 1990 included presentations and publications on northeast African prehistory (Klees and Kuper 1992). The ESA stone tools were

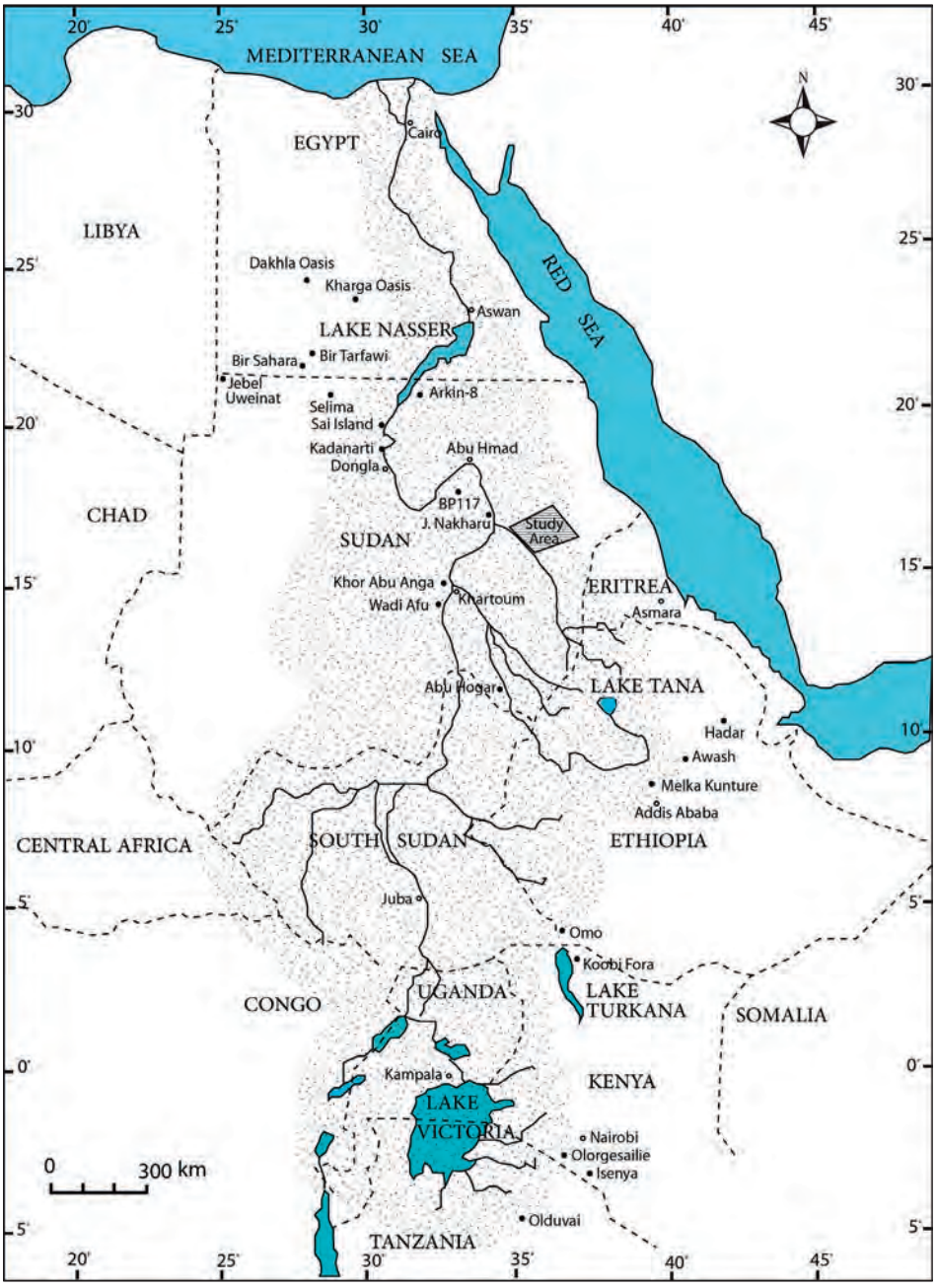

Fig. 1. ESA sites of the Nile basin mentioned in the text (illustration: A. Nassr)

described from regional similarities and connections between north and east Africa. The main problems of regional prehistory were discussed in the symposium and resulted in publications. Unfortunately the ESA evidence was sparse from the Western desert Oasis and the Nile in northern Sudan.

I am underscoring here that previous Paleolithic research in Sudan focused on later time periods and most of the assemblages were described by taxonomic terms borrowed from other regions of Africa. The Eastern Desert of Lower Atbara River remained largely unexplored. Therefore, the first step in our project in the Atbara region was to located new sites through systematic survey with the ultimate goal of filling existing gaps in chronology and geographic distribution of Paleolithic sites. The location of the Lower Atbara outside of the Nile valley makes it an ideal region to investigate local developments in Paleolithic technology and broader regional connections among the different prehistoric cultures and their makers.

3. Archaeological survey in the Eastern Desert of Lower Atbara River

This study is an updated version of my doctoral research, completed in the Department of Archaeology, University of Khartoum, in 2016. The area of study is located on the eastern bank of the Atbara River upstream and south of Atbara town to the Seidon province, about 60 km along the river and following the Abu Adar depression to the east at about 80 km (Fig. 2).

During late 2013, the area was visited by the author and his colleagues from Sudan and in winter 2014, archaeological survey was carried out along the right bank of Atbara River and the deeper water channels were explored 10 km into the eastern desert. Wadi Abu Adar was investigated up to 80 km to the east (Nassr 2014:107). In late 2014, sites were revisited by the author and his colleagues from Poland for a future join project (EDAR project).

A methodology was established from geological description, archaeological survey and test excavation to achieve the general goals of the study (Nassr 2014:108-120). Several methodological approaches have been applied in previous Paleolithic researches in the Nile basin. One common approach used here was to document and investigate the ESA sites and sampling stone tools for technological and typological classification. An overview of the literature and reclassification of Khor Abu Anga assemblages was done first. Stone tools were collected from six sites and the site of Jebel Elgrian (EDAR06) was studied as a case study.

The stone tools used for this study were collected from random surface collections, and test pits at the site of Jebel Elgrian. The assemblage was divided into main classes followed by subclass with the measuring of each sub-class. A description of stone tool technology and typology was compiled with a comparative discussion on the Paleolithic discoveries in the Nile basin.

That work is based on the historical research background of the Atbara area, such as Khor Elhudi notes by Arkell and Paleolithic sites in Upper Atbara River mentioned earlier (Arkell 1949:34; Chmielewski 1987; Marks *et al.* 1987; Abbate *et al.* 2010), as well as the Late Stone Age site of Abu Darbein (Haaland and Magid 1991:39).

The lack of topographical maps of the Eastern Desert of Lower Atbara River makes it necessary to devote a description of the landscape and the present natural conditions, in order to understand the archaeological site settings. The area consists of high gravel mounds and Hudi chert outcrops, mainly close to the river bank and flats in the desert to the east. The large depression is divided into small sections, draining from east to west such as Hudi, Abu Adar and Elhelgi, breaking deeply the embankment with some short water channels. These features reflect Pleistocene and Holocene topography. The Atbara paleo-lake in the east and Elhelgi paleo-depression parallel to the river are the main aspects of the area. Profiles of sediments and outcrops of silicate rocks observed over the banks of these water channels which flow from the eastern highland desert and mountains.

Five Paleolithic sites were discovered on the eastern bank of the river, and recognized from the expanses of debitage and a few finished tools. The assemblage represented Late Acheulean and MSA technological traditions. Classical Levallois scrapers and prepared cores are dominant (Fig. 2). A few artifacts show Levallois flakes and different types of blade industries. The sites were numbered EDAR01 – EDAR06 "Eastern Desert of Lower Atbara River". Site EDAR01 (ElHudi site) was noted early by Arkell in 1949, from where some Acheulean hand axes were collected (Arkell 1949:26). Stone tools were found on the high mounds and along the channel to the east. The artifacts include hand axes, choppers, simple bifacial points made on Levallois flakes and cores with worked faces.

The sites (EDAR02 – EDAR05) discovered on the small water channels in Alkarbab and Alagageer area (Fig. 2), are mainly MSA workshops of chert. Levallois flakes and cores with simple preparation are the main features and Mousterian points are rare. The assemblage are closely similar to the sites in northern Sudan and the Bayuda desert (Wendorf 1968; Masojć 2010:66).

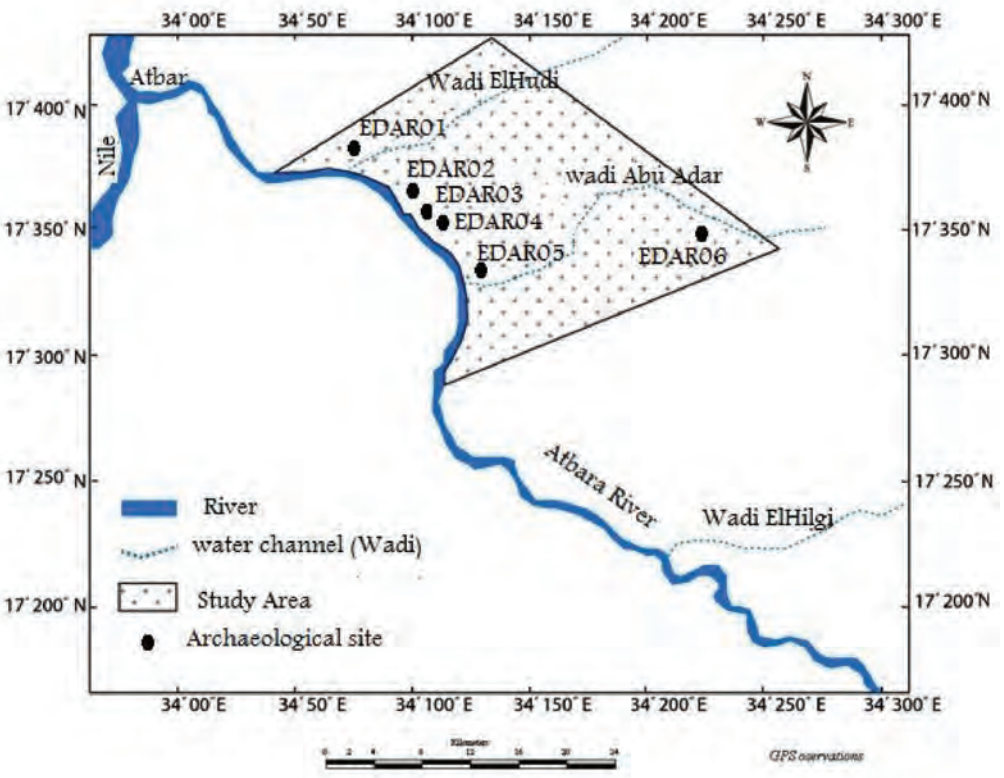

Fig. 2. Paleolithic sites discovered from the survey in the Eastern Desert of Lower Atbara River (illustration: A. Nassr)

The largest site discovered in the desert is the site of Jebel Elgrian (EDAR06), which shows an extraordinary number of large bifacial stone tools in surface context and extended over the one km from east to west and 600 m from south to north. The artifacts concentrated in multiple spaces overlooking the site, and among outcrops of quartz and chert rock in the eastern and northern parts of the site. In fact, this area may preserve evidence of groups of Acheulean camps extending from the mountains in the east to the depression in the west, stretching more than 10 km. Today, most of them were destroyed by gold mining trenches as evident from the trenches profiles and digging heaps.

Our methodological focus on the site (EDAR06) was from its location, setting and stone tools accumulated on the surface. The site is quite remarkable from the sheer amount of stone tools and debitage on the surface and with outcrops of quartz and chert. The landscape around the site seems to have been a beach on the

margin of the paleo-depression, which is different from the sites on the riverbank. The presence of such a site so far away from the river channel was in agreement with the main hypothesis of the study, during the general survey in the area.

The primary result of the archaeological survey of the site revealed several major concentrations of choppers, cleavers, hand axes, picks; discs and other debitage were deposited over long successive Paleolithic periods, owing to the environmental conditions which allowed successive habitation. The diversity of stone tools suggest that the place most favored for settlement was either on a low rocky promontory, or on patches of sand, which generally occurred in the channel of seasonal streams draining into the depression. Such large accumulations of lithics are rare in Sudan, and seem to be similar to the Olorgesailie site in the Kenya Rift Valley (Isaac 1977; McHugh *et al.* 1988), based on the location, size and concentration of stone tools on the surface (Fig. 3).

Our method involved a systematic survey with two surface cleanings of a grid of 20 x 20 m and a test excavation. The collected assemblages included stone tools, core, flakes, blades, debitage and waste in large amounts. The surface cleanings were made in different parts of the site, starting from the eastern part where

Fig. 3. Stone tools concentration on the surface, looking from the west (photo: A. Nassr)

a scatter of large Acheulean tools were found. The western part had a higher concentration of MSA artifacts. The technological features of this material suggested that the site represents multiple ESA and MSA industries.

One test excavation (3 x 3 m) was conducted at the centre of the site to recover stratified artifacts and to expose the bedrock. The dark soft soil yielded small hand axes and sharp flakes at the depth of 50 cm. Hard and compacted brown silt yielded a single flake at the depth of 50 – 140 cm. In this context, artifact were rare and the white silt with pebbles appears beneath the hard grey soil from 150 – 180 cm, where some hand axes and cleavers were also found. The basement rocks were encountered at a depth of 190 – 200 cm (Fig. 4).

Fig. 4. Cleavers and hand axes stone tools in depth 150 cm (photo: Masojć)

While the test excavation revealed stone artifact at a depth of 150 cm, the poor sedimentary contexts and the absence of organic finds makes geological interpretations challenging. At the same time. The recovery of Acheulean bifacial beneath one and half meter of sediments might represent primary evidence of Paleolithic occupation. In addition, there are many hand axes observed in situ, in the destroyed profiles of mining trenches.

4. Early stone tools technology and typology from the Eastern Desert of Lower Atbara River

The stone tools presented here are from the assemblages that were collected from the six sites discovered from the first survey in the eastern Desert of the Lower Atbara River. The stone tools collected from sites closer to the river are closer to MSA technology, as the Levallois cores and flakes. All stone tools gath-

ered from the site EDAR06 represent Acheulean and MSA technologies and have multiple cutting edges, indicating different activities, specially the bifaces.

The area preserves ample raw material which served as local sources for stone tool production, since different rock types were identified around the site. Green chert was exposed in the banks of the water channels and the mountain, which is massive and shows moderate to weak mineral foliation, dark, coarse, grained and highly sheared. The felsites rock is common also, and has a very dark tarnish in high green and concave, fine texture and very hard. Quartz and quartzite are dominant, and have linear shapes, are fine to medium texture and very hard.

The studied assemblages show a gradual technological development. The large bifaces are the dominant type and include prepared cores with extended forward scars of flake detachment and working edges. This indicates complex developed lithic industries at the site (Fig. 5), which seems to be from between the Early Acheulean and the early MSA technology, i.e. Sangoan and Levallois.

Fig. 5. Acheulean Large bifacial cutting flakes (photo: A. Nassr)

Large regular continual flaking on both faces are the main technological features of these stone tools, with sharp working edges and pointed ends (Fig. 6). The large tools were made on cores from cortical striking platform with straight working edges. Large flakes are common, being formed by the inter-section of two large flake scars and some specimens preserve wavy scars from foreword flaking detachment and negative retouch.

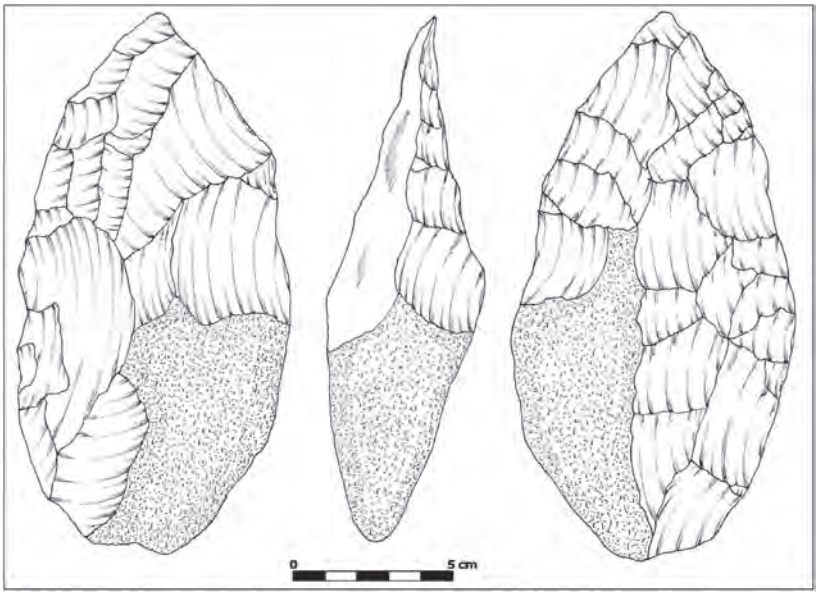

Fig. 6. Large flaking scars with sharp edges technology (drawing: A. Nassr)

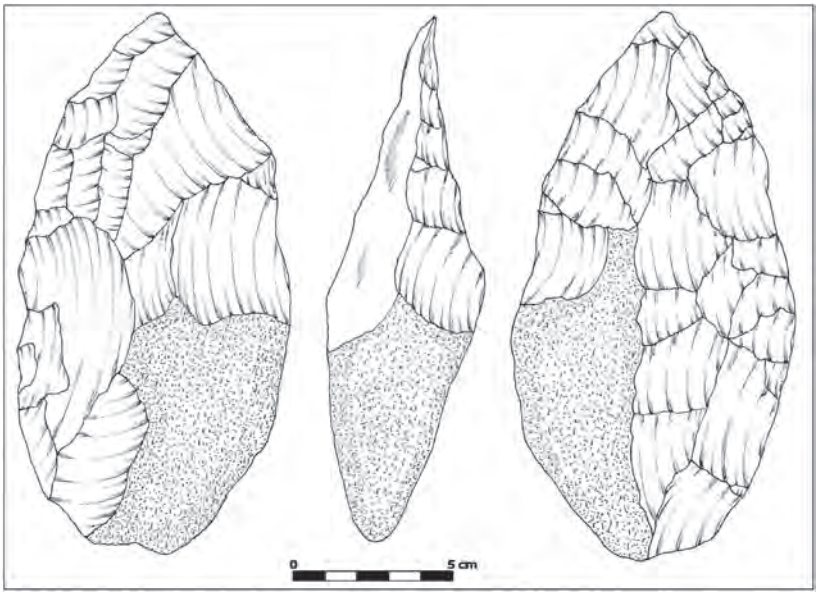

Fig. 7. Bifacial stone tools technology (drawing: A. Nassr)

The finishing of stone tools is affected by the texture of the stone raw material, i.e. fine vs. coarse. Some of the stone tools have a half cortical striking platform as evident on some of the hand axes, choppers and cleavers. The medium and small sized hand axes, cleavers and bifacial points are usually completely devoid of the striking platform and bifacial flaking (Fig. 7).

The main Acheulean stone tools are characterized by a typical large flake blanks for the production of choppers, cleavers, hand axes, and point. There are a few large tools made on cores. Moreover, some of the choppers, picks and hand axes are dihedral and have a flat striking platform and sharp elongated edges from the single removal. The number of flake scars are visibly greater on tools made of basalt and chert (Fig. 8).

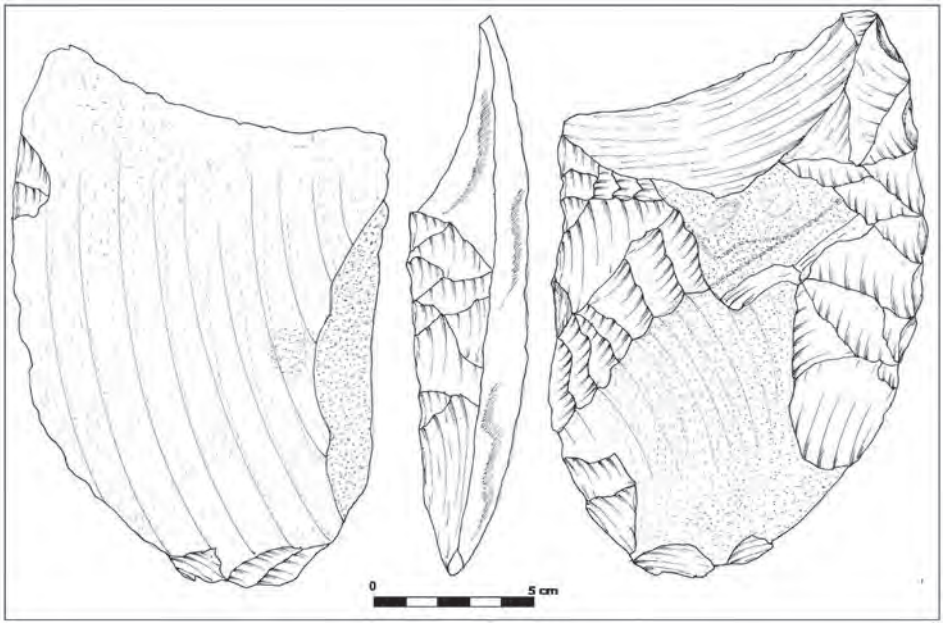

Fig. 8. Scars flaking detachment technology of cleaver (drawing: A. Nassr)

Some of the Late Acheulean and MSA stone tools were made on small flakes, which include bifacial points and Sangoan type hand axes. Others are made on Levallois flakes, prepared cores, blades and debitage such as small points and scrapers.

Unifacial stone tools are very rare. They are identified from large choppers, some flakes and small chips. The small points and picks indicate the use of spe-

cial techniques for special functions. The cleavers and knives are distinguished by a butt worked as a handle and the tip ending with sharp edges and a dorsal face, which also indicates heavy duty usages (Fig. 9).

Fig. 9. Cleavers different size made on sharp curve end and flaking edges (photo: A. Nassr)

The main technological observation is that the large Acheulean tools were targeted for their cutting edges and preparation of pointed ends. The variability observed from the artifact size and raw materials unfamiliar in the known Sudan archaeological record. The large flake production, primary core preparations are similar to the sites from the Omo Valley and Bed II in Olduvai Gorge (Howell 1976; Leakey *et al.* 1969). The sharp cutting edges, the worked butt and sloping ends are closely matched with the evidence from Olorgesailie (Isaac 1977).

From a typological point of view, the assemblages show a large variation from the Acheulean to the MSA. From the typological classification based on the assemblage description, it shows different sizes and forms of choppers, while cleavers is the dominant type with different shape and edges. The hand axes are also a dominant stone tool, and which possess many subclasses: hand axes with

a natural striking platform, hand axes with a borer end, elongated hand axes with a straight end, dihedral hand axes, foliate hand axes, small hand axes, hand axes with a cleaver end. Some of the hand axes are too large with a regular shape and continuing scars over the axis (Fig. 10).

Fig. 10. Different types of hand axes (photo: A. Nassr 2014)

The cleavers, discoids and large hand axes are similar to the ESA artifacts from the Awash Valley in Ethiopia and other sites in Kenya (Howell 1976; Isaac 1997). On the other hand, the small hand axes are similar to the material from Khor Abu Anga and some comparable sites in northern Sudan. There are also some tools unfamiliar in Sudan and quite similar to Ethiopian specimens such as large cleavers, hand axes and *hachereaux*, which are large cutting flakes (Semaw 2000; Sharon 2006). Also, some tools are similar to Sangoan types and Tumbian productions like heavy oval hand axes, retouched scrapers and bifacial points (McBrearty 1988:382).

Fig. 11. Late Acheulean and MSA stone tools (photo: A. Nassr)

Besides that, the stone tools made on flakes such as small cleavers, bifacial points, rounded scrapers and small points and the Sangoan types (Fig. 11) are related to the Late Acheulean and MSA in central and northern Sudan (Arkell 1949; Chmielewski 1968; Van Peer *et al.* 2003; Abbate *et al.* 2010). The Sangoan types here show similar characteristics to some Late Acheulean occurrences in Kenya and Khor Abu Anga and are typical of the MSA of Sai Island (Van Peer et al 2003:189).

The MSA technological tradition is reflected from the simple type of cores with working edges, Levallois flakes and debitage. Prepared small cores with two working faces are recognized including Mousterian points and possible arrowheads. Flakes, elongated blades, Rounded scrapers, points and Levallois flakes were the main types of the assemblage indicated MSA technology (Fig. 12).

The aforementioned data indicates a long occupation of the EDAR06 site in the desert and more than the other sites in the region. It also shows the develop-

Fig. 12. MSA, Levallois stone tools on the site surface (photo: A. Nassr)

ment of widespread ESA technology and the site reveals a new face of Sudan ESA and also added a new MSA dimension for research in Sudan. This discovery will encourage future Paleolithic research in the eastern desert of the Lower Atbara River.

Conclusions

Archaeological survey and test pits in the eastern desert of the Lower Atbara River yielded new prehistoric evidence in Sudan Paleolithic and added an important assemblage to the known ESA sites in the Nile basin. The sites close to the Atbara river channel (EDAR01- 5) are quite similar to the MSA evidence from northern Sudan. However, the site EDAR06 is comparatively more different than the known Sudan Paleolithic. These Acheulean and MSA stone tools, which are difficult to compare with the Sudan record, are more or less similar to the south-east African Paleolithic.

This study of ESA stone tools revealed the following observations:

1. Our knowledge of Sudan ESA is minimal, evidence of which is primarily known from central and northern Sudan and from the surface and eroded Acheulean bifaces stone tools types.
2. The archaeological survey and test excavation in the eastern desert of the Lower Atbara River has shed light on a new region for Sudan Paleolithic research, where Acheulean and MSA stone tools are dominant.
3. The archaeological sites discovered close to the eastern bank of the Atbara River are mainly represented by MSA stone tools, which also reflects the age and channel location of the river.
4. The site of Jebel Elgrian (EDAR06) in the eastern desert of the Lower Atbara River has added a new dimension of ESA stone tools in Sudan. The materials are similar to other Sudanese sites in some aspects but differ in the main characteristics.
5. The attributes of stone tools classified from the eastern desert of the Lower Atbara River are very informative regarding the regional diversity of ESA in the Nile basin. They are similar to the early ESA found in Ethiopia and Kenya and at the same time indicate how Sudan is important for the "Out of Africa" debate.
6. The hand axes are regarded as the most common ESA stone tools of in central Sudan and the choppers are the main types in northern Sudan. In both regions, there is a lack of cleavers. Central and northern Sudan presented characteristics similar to the Upper part of the Nile basin (such as the Kenyan sites). However, the eastern desert of the Lower Atbara River revealed different Paleolithic attributes from the site of Jebel Elgrian (EDAR06). Cleavers, hand axes and choppers are the most common types, and which allow us to make a reliable comparison with ESA sites in Ethiopia and Kenya. This is indicative of the variability within the ESA of the Nile basin.

7. The variation of stone tools technology and typology from the site (EDAR06) indicates developed stone tool productions and a long occupation far from the river during the Middle and Late Pleistocene.
8. The similarities of the site's (EDAR06) assemblage with other sites along the river indicate human movement and environment change from the desert to the river in later Pleistocene. It also shows possible cultural interaction with central and northern Sudan. Sites representing such cultural entities were thus far unknown in Sudan, resulting in inadequate knowledge of the regions Paleolithic potential. In addition, the work has helped fill major gap in the Paleolithic record of the Atbara region. In its initial stage, the study has made an important contribution to ascertaining the potential of the area for future systematic field investigations and extensive systematic surveys, and excavations and dating of the Sudan Paleolithic.

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