Quaternary International 350 (2014) 241–253

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Aterian lithic technology and settlement system in the Jebel Gharbi, North-Western Libya

Enza E. Spinapolice [a, *], Elena A.A. Garcea [b]

[a] *Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, D-04103 Leipzig, Germany*
[b] *Università di Cassino e del Lazio meridionale, Dipartimento di Lettere e Filosofia, Via Zamosch, 43, 03043 Cassino, FR, Italy*

ARTICLE INFO

Article history:
Available online 29 September 2014

Keywords:
Aterian
Libya
Lithic technology
MSA
North Africa
Tanged pieces

ABSTRACT

The Aterian represents one of the multiple facets of the Middle Stone Age (MSA) and has become increasingly important in the context of understanding modern human origins. In this paper, we present the results of our study on the Aterian in the Jebel Gharbi, North-Western Libya, from a regional point perspective. A total of 1567 lithic objects were analysed for this work from twelve different Aterian assemblages. The results of this analysis show a wide range of economic behaviour, possibly suggesting different site functions, within the three main areas (Ain Zargha, Jefara and Wadi Ghan). It is unlikely that any of these assemblages represents a residential site. Instead, we argue that the assemblages in the study are more likely to be the result of a logistic land use. Technologically, they exhibit all the distinctive features of the Aterian technocomplexes: coexistence between Levallois and blade technology, presence of tanged pieces and bifacial foliates, as well as of "Upper Palaeolithic" tools, together with a majority of sidescrapers and endscrapers. Only a combination of these features, and certainly not one of them alone, can characterize an assemblage as "Aterian".

1. Introduction

The Aterian represents one of the multiple facets of the MSA complex and has become increasingly important in the context of modern human origins: the chronological position and geographical range of the Aterian suggest that its makers could be among those involved in the northern Out of Africa movement to the Levant (Garcea, 2009, 2012; Balter, 2011). The geographical distribution of this complex, the early presence of modern humans in North Africa (Hublin, 1992, 2001), supported by the hypothesis of a 'Green Sahara' (i.e., environmentally ameliorated) in MIS 5 (Drake et al. 2013), and the presence of "behaviourally modern traits" (d'Errico et al., 2009; Barton and d'Errico, 2012) give substance to this hypothesis.

The chronological position of this techno-complex has been debated since its definition (Richter et al. 2012). Until recently, the chronometric status of the Aterian in Northwest Africa was based mainly on radiocarbon data. However, this time range has been significantly expanded by other dating techniques. Electron Spin Resonance (ESR) dates from sites such as Mugharet el-Aliya (Wrinn and Rink, 2003) and Optically Stimulated Luminescence (OSL) and Thermoluminescence (TL) dates from Rhafas (Mercier et al. 2007), Dar-es-Soltan (Barton et al.2009; Schwenninger et al. 2010), Ifri n'Ammar (Richter et al. 2010), Contrebandiers (Schwenninger et al. 2010; Jacobs et al. 2011) and el Mnasra (Schwenninger et al. 2010; Jacobs et al. 2012) have established that Aterian technology is considerably older than traditionally presumed. The oldest dates for the Aterian date from ~145 ka (Richter et al. 2010). Hence, the chronology of the Aterian now spans from Marine Isotopic Stage 6 (MIS 6) to MIS 3. This long time span encompasses very different environmental characteristics (Drake et al. 2013). MIS 6 was largely arid, nevertheless episodes of humidity occurred up until the more widespread environmental amelioration of Stage 5 (Drake et al. 2010), associated with numerous Aterian sites. The hyper-arid condition of MIS 4 followed, which were nevertheless associated with human occupation of in the Sahara (Cremaschi et al. 1998) and the Jebel Gharbi in northern Libya (Garcea and Giraudi, 2006). However, evidence for occupation continuity has not been demonstrated (Barton and d'Errico, 2012). The most recent Aterian sites are dated to ~40 ka.

Despite their vast distribution, the huge number of sites and the increasing amount of publications on this topic, the technological and behavioural meaning of Aterian industries and settlement systems are still unclear (Bouzouggar and Barton, 2012) and most definitions of the Aterian remain problematic. Moreover, the considerable

* Corresponding author.
E-mail address: enza_spinapolice@eva.mpg.de (E.E. Spinapolice).

http://dx.doi.org/10.1016/j.quaint.2014.07.062
1040-6182/

geographic range, including the Mediterranean coast, the Sahara and the Atlantic Morocco, has to be taken into account to interpret the archaeological record and not to overlook regional traits.

Since the beginning of its research (Reygasse, 1922; Antoine, 1934), the Aterian has been characterized by its typology, and specifically by the presence of tanged tools. Here, we seek to give a more precise definition of this industry, based on its technological traits, largely shared with other MSA (in the broad sense) techno-complexes. We use a regional-scale approach that gives visibility to sites otherwise ignored and offer a viewpoint on the activities in the landscape, rather than limiting study to residential sites. We present the results of our study on Aterian assemblages in the Jebel Gharbi (OSL 08, OSL 01, SJ-06-88, SJ-00-55, SJ-02-68, SG-07-95, and SG-99-41) and combine them with the evidence published previously (from sites SJ-98-28, SJ-00-57, SJ-00-58, SJ-00-58A, and SG-00-61, cf., Spinapolice and Garcea, 2013).

2. Materials and methods

The Jebel Gharbi is a semi-arid mountain range on the northern boundary of the Sahara desert in northwestern Libya, between the Mediterranean coastal plain (the Jefara) and the Tripolitanian Plateau (Fig. 1). The Italian–Libyan Archaeological Project in the Jebel Gharbi is coordinated by the Universities of Rome La Sapienza and Cassino and started in the early 1990s to investigate the different phases of human occupation in the region. This region exhibits numerous Upper Pleistocene and Holocene sites. In this paper, we present some results on the Aterian sites.

We applied the method of *chaîne opératoire* analysis to the lithic collections from a selection of Aterian sites, utilizing qualitative and standard quantitative approaches, taphonomy (i.e. surface condition), macro-wear, and tool reduction evaluation. According to this method, lithic production systems are examined as a sequence of actions embedded in a techno-economic process (Leroi-Gourhan, 1964; Geneste, 1985, 1991; Pelegrin, 1985; Inizan et al. 1995).

Each lithic object was classified starting from its raw material, in order to obtain information on the provisioning territory and the modalities of transport. Its surface condition was recorded in order to relate it to possible post-depositional events. Breakages were attributed to use, reuse or subsequent processes. The classification of cores, which are particularly informative for the assessment of knapping methods, has been performed in order to link them to the production methods, using the identification of the number of flaking surfaces and direction, as well as the presence/absence of a prepared striking platform. The analysis of flakes took into account the type of platform, the number and direction of negative scars on the dorsal face, the shape and cross-section, the presence of hinged removals, and the presence of retouching. Where possible, the flakes are attributed to a specific knapping method and/or sequences. Unidentifiable fragments are classified as chunk, while *débris* are defined as the chips <2 cm. Retouched items are also described: the location and type of retouch are taken into account, and the strategies of reduction, recycling and reuse are tested.

Measurements were taken with an electronic caliper and directly recorded in the Entrer Trois Programme©, which is a data entry program designed to work with configuration files that record the variables to be entered and their type. The use of this program makes the entry of data faster and reduces errors, and the data can be directly recorded in an Access© database. The length, width and thickness were recorded, following conventional measurement (i.e. through the orientation of the lithic item) on all the items, and the three main axes of tangs were recorded, too.

A total of 1567 lithic objects were analysed for this work (Table 1) from twelve assemblages discovered in different field seasons. The data from the previous paper (Spinapolice and Garcea, 2013) were updated and others were added to the database.

Table 1
Technological composition of the assemblages.

Dataclass	Ain Zargha			Jefara						Wadi Ghan			Total	
	SJ-98-28	OSL 08	OSL 01	SJ-06-88	SJ-00-55	SJ-00-57	SJ-00-58	SJ-00-58A	SJ-02-68	SG-07-95	SG-00-61	SG-99-41	*N*	%
Core	46	8	0	7	0	36	9	8	2	0	13	0	129	8.2
Flake	367	12	2	36	3	11	45	33	8	0	101	27	645	41.2
Tool	171	18	10	27	1	23	28	3	5	3	18	6	313	20.0
Chunk	254	0	0	3	0	19	19	6	5	0	0	0	306	19.5
Debris	110	0	0	0	0	20	0	0	0	0	44	0	174	11.1
Total	948	38	12	73	4	109	101	50	20	3	176	33	1567	100.0
%	Ain Zargha			Jefara						Wadi Ghan			Total	
Dataclass	SJ-98-28	OSL 08	OSL 01	SJ-06-88	SJ-00-55	SJ-00-57	SJ-00-58	SJ-00-58A	SJ-02-68	SG-07-95	SG-00-61	SG-99-41	*N*	%
Core	4.9	21.0	0.0	9.6	0.0	33.0	8.9	16.0	10.0	0.0	7.4	0.0	129	8.2
Flake	38.7	31.6	16.7	49.3	75.0	10.1	44.6	66.0	40.0	0.0	57.4	81.8	645	41.2
Tool	18.0	47.4	83.3	37.0	25.0	21.1	27.7	6.0	25.0	100.0	10.2	18.2	313	20.0
Chunk	26.8	0.0	0.0	4.1	0.0	17.4	18.8	12.0	25.0	0.0	0.0	0.0	306	19.5
Debris	11.6	0.0	0.0	0.0	0.0	18.4	0.0	0.0	0.0	0.0	25.0	0.0	174	11.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1567	100.0

As there was no selection during field collection, the assemblages are considered to represent all the lithics at each site. Since the sites consist of surface scatters, we assume that they are likely to be the result of different occupations potentially comprising a wide time span. Artefact collections were only made where Upper Pleistocene surfaces were exposed and could be geologically controlled (cf., Garcea and Giraudi, 2006).

3. Regional setting and site distribution

The Jebel Gharbi is a plateau located in the north-western part of Libya. The sites are scattered in different locations: on the plateau, on the escarpment, in the plain (Fig. 1).

The Aterian sites are present in every location of the Jebel Gharbi, however they are not equally distributed. There are few sites in the southern plateau, while most of them are located on the escarpment, or in the wadis (i.e., valleys). The central part of the jebel, i.e. the Yefren area, is also characterized by a lack of settlements, probably due to the bad quality of the available local raw

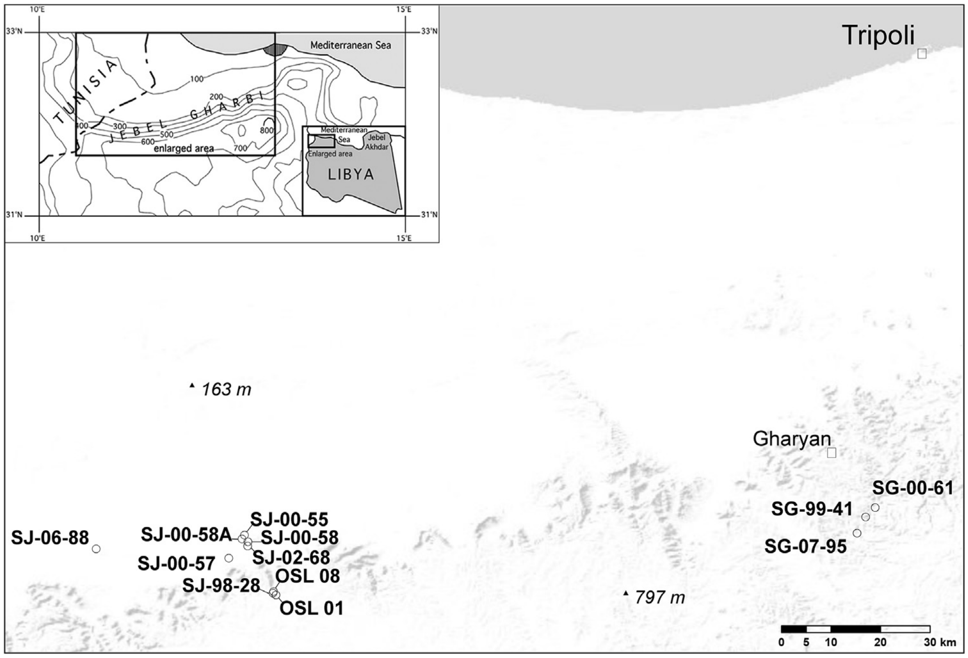

Fig. 1. Map of the Aterian sites in the Jebel Gharbi cited in the text.

material. Geochemical characterization of the main chert outcrops in the Jebel Gharbi indicated that this specific raw material was considerably different from the others available on the mountain range (Barca and Mutri, 2009).

There are three principal areas of the Jebel Gharbi where the presence of Aterian has been recorded. From west to east, these are the Wadi Ain Zargha (site SJ-98-28 and materials collected during OSL sampling), the Jefara (sites SJ-00-55, SJ-00-57, SJ-00-58, SJ-00-58A, SJ-06-88), and the Wadi Ghan (sites SG-99-42, SG-00-61, SG-07-95).

The Wadi Ain Zargha area is well-known for the Quaternary sedimentary sequence from the early MSA to the recent LSA. Here, a calcrete layer at the base of a paleosol capping the colluvial silts with Aterian artefacts was dated to 27,310 ± 320 BP by conventional radiocarbon and 30,000 ± 9000 by the U/Th method. U/Th was also employed to date other calcretes below and on top of colluvial silts with Aterian artefacts, which gave dates of 64,000 ± 21,000 and <60,000 years, respectively (Garcea and Giraudi, 2006).

The Jefara archaeological area featured a significant concentration of archaeological sites located near a spring called Ain Shakshuk, at the foot of the northern escarpment of the Jebel Gharbi around the village of Shakshuk. Several perennial springs were recognized in the surroundings (Giraudi, 2005). At Shakshuk, a soil embedded in a silty-sandy geological unit yielding Aterian artefacts was radiocarbon dated to 43,530 ± 2110 BP, and a charcoal-bearing layer embedded in the same level, was dated at 44,600 ± 2430 BP (Garcea and Giraudi, 2006).

The Wadi Ghan area, in the Western part of the Jebel Gharbi, also yielded some Aterian sites. In the upper part of the Wadi Ghan valley, close to the town of Gharyan, four levels of alluvial terraces were identified above the present wadi. The MSA stratigraphy consisted of two units: an alluvial gravel including early MSA artefacts and a silt (loess) stratigraphic unit on top, containing Aterian materials (Garcea and Giraudi, 2006).

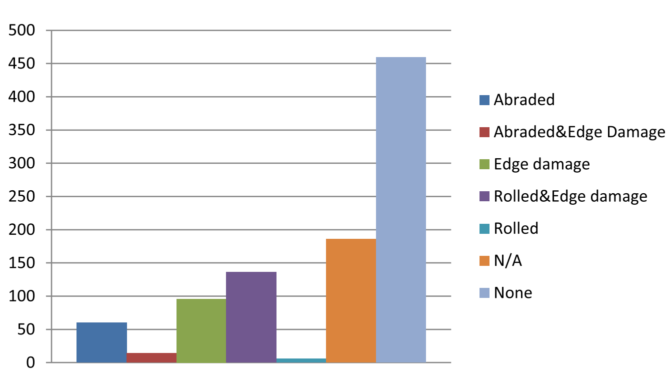

Fig. 2. Surface alterations.

4. Results and discussion

4.1. Surface status and coherence of the assemblages

The attribution of surface scatters to a specific techno-complex is a challenging task. Nevertheless, surface sites constitute the majority of the Aterian sites in North Africa, with the exception of a limited number of caves and rockshelters (Spinapolice and Garcea, 2013). Moreover, site distribution gives important information about the use of the landscape, that is missing in site-oriented studies. In the Jebel Gharbi, the Aterian is stratigraphically separated from the early MSA, as is indicated in the Wadi Ghan, where lava flows featuring rolled early MSA artefacts lie below the deposit with Aterian artefacts (Garcea and Giraudi, 2006; Garcea, 2010b).

A careful analysis of the surface condition of the artefacts was carried out. The assemblages show different levels of edge and surface alterations (Fig. 2), as is predictable in surface collections. Different degrees of alteration could have been due to different post-depositional agents, rather than mixing of artefacts from different cultural contexts. Even though the assemblages were from surface collections, they were only taken from sites with exposed palaeosurfaces within a geologically controlled stratigraphy (Garcea and Giraudi, 2006). The possibility of recycling and reuse of stone artefacts has been taken into account by an examination of double patinas and other signs of reuse and/or recycling. The coexistence of different knapping methods is thought to be a characteristic feature typical of Aterian assemblages (Spinapolice and Garcea, 2013).

4.2. Raw material availability

Raw material procurement and economy is a key element to assess territoriality and settlement system (Binford, 1980; Perlès, 1991). There variability of the raw materials from the Jebel Gharbi is not wide. Outcrops of chert are present at various locations, in the form of pebbles, cobbles and/or nodules. Three main sources have been located on the mountain range and their geochemical composition has been analysed (Barca and Mutri, 2009). Trace elements identified three main compositional groups: 1) cherts from the Wadi Bazina, Ras el Wadi and Wadi Ghan; 2) cherts from the Yefren and Aziziya areas; 3) cherts from the Nalut area.

Most sites are located rather near the chert sources, except for the sites in the plain. As good-quality chert is abundant and largely accessible locally, its availability does not seem to have influenced the knapping objectives. However, this raw material occurs in small nodules and cobbles and in some cases, quartzite was used to produce more elongated blanks (Spinapolice and Garcea, 2013).

Apart from chert acquisition, the settlement choices of the Aterian groups in the Jebel Gharbi were oriented towards areas with good availability of water. Sites are often found located close to water sources and streams. This pattern does not change in the LSA period (Barich et al. 2006; Barich and Garcea, 2008; Mutri and Lucarini, 2008).

4.3. Knapping methods

The selection of a specific knapping method is a culturally oriented choice, in the frame of a given environmental setting. Thus, understanding technological choices can provide very important insights on the behavioural meaning of a lithic techno-complex. The Aterian is characterized by the occurrence of both surface (Levallois) and volumetric knapping methods, as well as an intermediate form of production (Taramsa method) (Van Peer et al. 2010; Spinapolice and Garcea, 2013). Although it has been claimed that, apart from tanged tools, the Aterian is indistinguishable from the "Mousterian" in Morocco (Nami and Moser, 2010; Dibble et al. 2013), we think that this combination of knapping methods is a clear cultural trait of the Aterian complexes from the Jebel Gharbi, which significantly differs from "Mousterian" or early MSA methods. We also argue that the Aterian should be considered as one of the regional variants of the MSA and not as a proxy of the European Mousterian (Kleindienst, 1998; McBrearty and Brooks, 2000; Garcea, 2012).

As shown in Table 2, these methods often occur in the same site, but not all of them are always represented in every site. Opportunistic, unprepared products are 22.5% of the total. However, in the Jebel Gharbi, the Levallois method largely dominates the assemblages (43.2%), and coexists with different volumetric methods, which have been combined. These include the Taramsa, blade method and semiturning modality.

Table 2
Principal flaking methods.

Method	Ain Zargha			Jefara						Wadi Ghan			Total	
	SJ-98-28	OSL 08	OSL 01	SJ-06-88	SJ-00-55	SJ-00-57	SJ-00-58	SJ-00-58A	SJ-02-68	SG-07-95	SG-00-61	SG-99-41	*N*	%
Anvil	16	0	1	0	0	7	13	0	1	0	2	1	41	3.7
Volumetric	59	4	0	8	1	2	13	4	1	0	18	11	121	11.0
Shaping	14	0	0	14	0	2	3	1	0	0	0	1	35	3.2
Levallois	265	23	10	24	3	7	33	22	6	0	73	10	476	43.2
Kombewa	5	0	0	0	0	1	2	0	0	0	0	0	8	0.7
Unprepared	116	9	1	15	0	27	17	16	4	3	32	8	248	22.5
Other	4	0	0	0	0	0	3	0	0	0	0	0	7	0.6
N/A	105	2	0	12	0	23	9	4	3	0	7	0	165	15.0
Total	584	38	12	73	4	69	93	47	15	3	132	31	1101	100.0
%	Ain Zargha			Jefara						Wadi Ghan			Total	
Method	SJ-98-28	OSL 08	OSL 01	SJ-06-88	SJ-00-55	SJ-00-57	SJ-00-58	SJ-00-58A	SJ-02-68	SG-07-95	SG-00-61	SG-99-41	*N*	%
Anvil	2.7	0.0	8.3	0.0	0.0	10.1	14.0	0.0	6.7	0.0	1.5	3.2	41	3.7
Volumetric	10.1	10.5	0.0	11.0	25.0	2.9	14.0	8.5	6.7	0.0	13.6	35.5	121	11.0
Shaping	2.4	0.0	0.0	19.2	0.0	2.9	3.2	2.1	0.0	0.0	0.0	3.2	35	3.2
Levallois	45.4	60.5	83.3	32.9	75.0	10.1	35.5	46.8	40.0	0.0	55.3	32.3	476	43.2
Kombewa	0.9	0.0	0.0	0.0	0.0	1.4	2.2	0.0	0.0	0.0	0.0	0.0	8	0.7
Unprepared	19.9	23.7	8.3	20.5	0.0	39.1	18.3	34.0	26.7	100.0	24.2	25.8	248	22.5
Other	0.7	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	7	0.6
N/A	18.0	5.3	0.0	16.4	0.0	33.3	9.7	8.5	20.0	0.0	5.3	0.0	165	15.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1101	100.0

The Levallois method (Fig. 4) is just one of the features of Aterian technology. It is principally recurrent centripetal (44.9%) or recurrent unidirectional (31.5%) (sensu Boëda, 1994). All the phases of the Levallois sequence are present, from core initialization (1.5%), preparation of the convexity of the knapping surface (20.7%), preparation of the striking platform (16.3%), and Levallois recurrent (45.2%) and preferential products (5.6%).

Three methods of volumetric blade production were recognized (Fig. 3A–C), aiming to produce elongated blanks that may have been frequently used unretouched. Single and double platform cores ($N = 19$), and true blades ($N = 68$) attest to this production. As already noted by Tixier (1963, 1967) and Roche (1953), these cores differ from the blade cores of the European Upper Palaeolithic. The shapes of the volumetric cores and the organization of the striking platforms are only occasionally standardized into pyramidal and prismatic types ($N = 7$). More often, the cores are exploited following the main direction of their axis and are abandoned before their exhaustion. Core exploitation is conducted on the sides of the

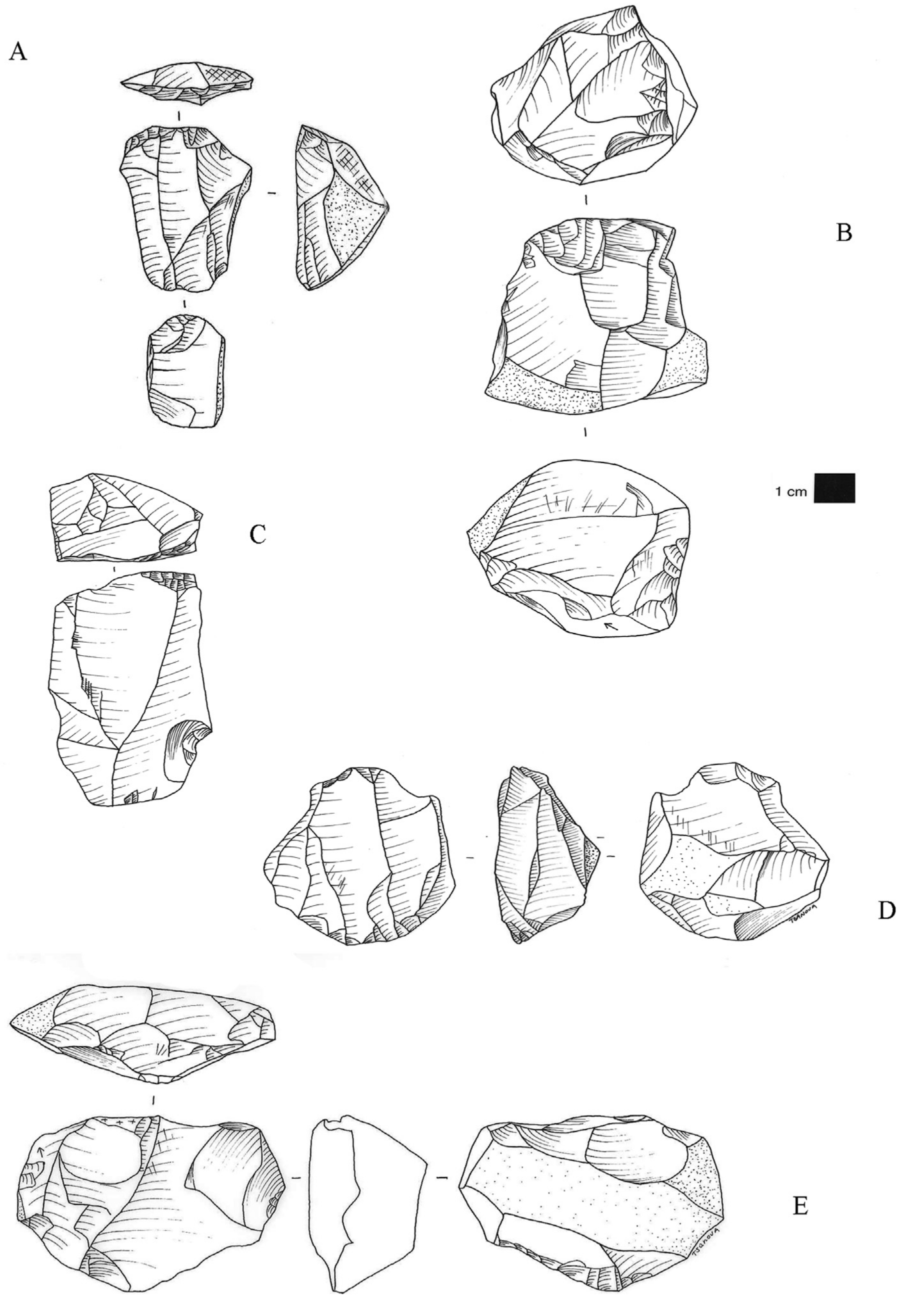

Fig. 3. A–C. Blade cores; D–E. Taramsa cores (A, C–D, from SJ-98-28; B, from SJ-00-58; E, from SG–00-61).

piece with opposite or perpendicular percussion platforms (Massussi and Lemorini, 2004–2005; Spinapolice and Garcea, 2013).

In addition, the presence of the "Taramsa method" has been observed in almost all the assemblages ($N = 25$), mostly indicated by the products and by few cores (Fig. 3D–E). The Taramsa method is designed to produce elongated flakes and sometimes true blades (Van Peer, 2004; Van Peer et al. 2010). Both reductions start from Levallois cores that are subsequently turned into volumetric cores by rotating their exploitation surface by 90°. While the Taramsa method preparation is the same as the Levallois method, it produces blanks that are morphologically different from standard Levallois blanks. These blanks are thin, elongated, with prepared platforms and skewed profiles. The scars are often unidirectional or bidirectional. It is an adaptation of the traditional Levallois method in which the production capacity of the cores significantly increases.

More opportunistic flaking behaviours, such as bipolar anvil percussion (Fig. 5C, D), complete the range of reduction sequences of the assemblages from the Jebel Gharbi, but their occurrences are generally low (Table 2). However, the low frequency of the anvil method could be attributed to its general underestimation in the lithic assemblages, due to the difficulties in recognizing its features (Grimaldi et al. 2007; Bietti et al. 2009–2010). The anvil percussion is also attested by the presence of *pieces esquillées* ($N = 12$). Other opportunistic methods include Kombewa flakes ($N = 8$) and cores on a flake ($N = 14$). Façonnage (shaping) is attested by bifaces and unifaces (see below).

Broadly speaking, the Aterian technological system shares methods of blank production with other MSA complexes, particularly the Nubian Complex. However, it shows more divergence in the toolkits, suggesting a different behaviour in those two steps of the technological operative sequence (blank production and modification).

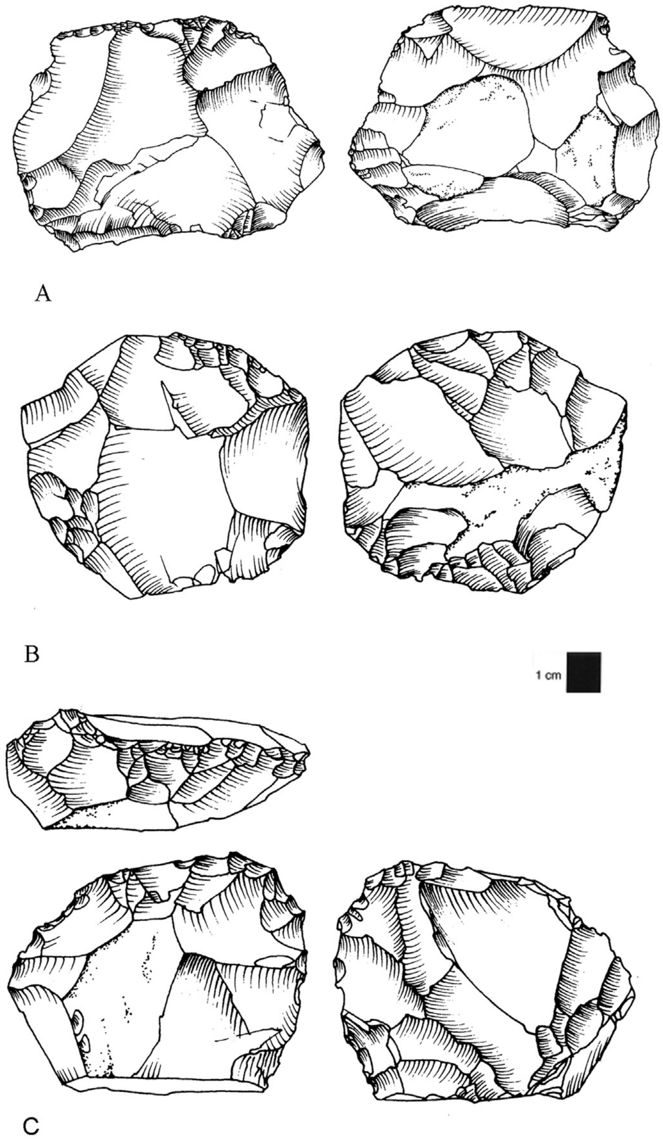

Fig. 4. Levallois cores (A, from SJ-00-57; B, from SJ-00-58; C, from SJ-00-57).

Table 3
Tool types.

Tool type	*N*	%
Levallois point	1	0.3
Pseudo-Levallois point	1	0.3
Mousterian point	4	1.3
Limace	1	0.3
Single straight sidescraper	15	4.7
Single convex sidescraper	6	1.9
Double straight sidescraper	11	3.4
Straight convergent sidescraper	1	0.3
Convex convergent sidescraper	3	0.9
Concave convergent sidescraper	1	0.3
Dejete sidescraper	1	0.3
Straight transverse sidescraper	4	1.3
Typical endscraper	14	4.4
Atypical endscraper	7	2.2
Typical burin	1	0.3
Atypical perforator	2	0.6
Notch	27	8.5
Denticulate	21	6.6
Alternate retouched bec	1	0.3
Flake with irregular obverse retouch	18	5.6
Flake with abrupt and alternating retouch	49	15.4
Bifacially retouched flake	7	2.2
Rabot	1	0.3
Tanged tool	86	27.0
Miscellaneous	2	0.6
Truncated-facetted piece	2	0.6
Bifacial tool	21	6.6
Unifacial tool	8	2.5
N/A	3	0.9
Total	319	100.0

4.4. Formal tools and hafting modifications

The Jebel Gharbi assemblages show a considerable presence of tools typical of the MSA, but other tool types are also present, which are more common in the Upper Palaeolithic/LSA, such as endscrapers, burins and becs, although they are never observed in significant quantities (Table 3, Fig. 6). There is no particular pattern of blank selection for tool production. The Levallois products are often selected for this purpose ($N = 124$), but the rate of retouch on the blanks that have not been attributed to a specific method is high ($N = 64$).

The tools are not intensively reduced, and their retouch is typically marginal (70.3%). Tool types include notches and denticulates ($N = 48$), sidescrapers ($N = 42$) and endscrapers ($N = 21$). Tanged tools are very frequent ($N = 86$) and are thoroughly discussed in the paragraph below. Burins, perforators, and becs are uncommon. Other types are present in very low frequencies.

The presence of possible hafting modifications (Stordeur, 1987) has been recognized through the recording of basal and/or ventral thinning, and double proximal notches: 112 lithics show potential evidence of such modifications, including tanged tools, which will be discussed separately. Most proximal modification is on retouched tools ($N = 78$). Nevertheless, blanks with basal modifications and without retouch are also relatively frequent ($N = 30$). The most common hafted tools are endscrapers and notches. Rots et al. (2011) propose a “degree of formalization” for hafted tools, evaluating the degree of investment in the production of the tool itself. This goes from “high” (foliate tools) to “very low” (sidescrapers and similar tools), with Levallois products considered as “medium.” By applying this method to our sample, based on macroscopic evidence, there is an abundant presence of “low” and “medium” formalized pieces, while pieces with ”high” investment are less numerous, including 11 bifacial foliates. In their sample from North-Eastern Africa, Rots et al. (2011) showed that specific tool classes such as hammers and projectiles were selected for hafting in the context of specialized production. The wider range of hafted tools we observe may suggest a more complex technological system.

Possible hafted tools are not correlated with an intense and scalar retouch, except for four endscrapers with scalar retouch associated with basal thinning. Consequently we cannot observe any pattern of resharpening in the haft (*contra* Scerri, 2013b). This means that hafting in the Jebel Gharbi, either did not imply a longer use life or there was a more complicated relationship between tool use and its archaeological signature (Shott, 1989), as is discussed in paragraph 4.5 This is consistent with the low investment in tool making, hence falling into the “maintainable” category, *sensu* Bleed (1986).

4.4.1. Tanged tools and bifacial foliates

Tanged tools have long been considered as the hallmark of the Aterian and represent a strong feature of regionalization, since they are not present in any other MSA assemblage. Aterian tanged tools are found across Africa, including both in the Maghreb and all the Sahara west of the Nile valley (Tillet, 2000; Aumassip, 2004; Garcea, 2009; Foley et al. 2013).

In spite of the attention given to tangs, their functional meaning and variability are still poorly investigated (Hawkins, 2001), with the exception of few recent works (Iovita, 2011; Scerri, 2013b). The interpretation of tanged pieces is related to two hypotheses: the first one is linked to the idea of the tang as an element of hafting. The Aterian has often been classified as a hafted industry (Bouzouggar and Barton, 2012). In general, hafting is widespread in North African MSA assemblages (Rots et al. 2011), and is usually attested by basal thinning. It is possible that tangs are a regional variation of this technical behaviour. Iovita (2011) and Scerri (2013b) have also linked the variability of tang morphologies to the practice of resharpening in the haft.

The second hypothesis particularly concerns Aterian points and their functions. Since Caton-Thompson (1946), these two interpretations of the tangs were assumed and seldom discussed (1946: 88) "[…]*the invention of the tanged point – probably a javelin-head – must have given the inventors, whoever they were, a decided advantage in aggressive action against rival human groups not yet so equipped* […]". The idea that tanged points were used exclusively as projectiles has a long history (Marchand and Aymé, 1935; Cadenat, 1939), although recent studies showed that Aterian points do not fall into the variability of projectile points (Shea, 2006). There is no convincing evidence of this exclusive use of Aterian points.

Tanged tools are a consistent characteristic of the Jebel Gharbi Aterian assemblages (Fig. 7, Table 5). The overall collection includes 86 tanged pieces (Table 4). These tanged pieces show a wide variability in blanks production methods, retouching, tang shape and position, and dimensions. There is no selection of predetermined Levallois blanks for making tanged pieces. However, 39.6% of them come from a Levallois reduction sequence, while 22.1% of them are on opportunistic blanks and 29.1% could not be attributed to a specific knapping method. The remaining 9.2% is equally

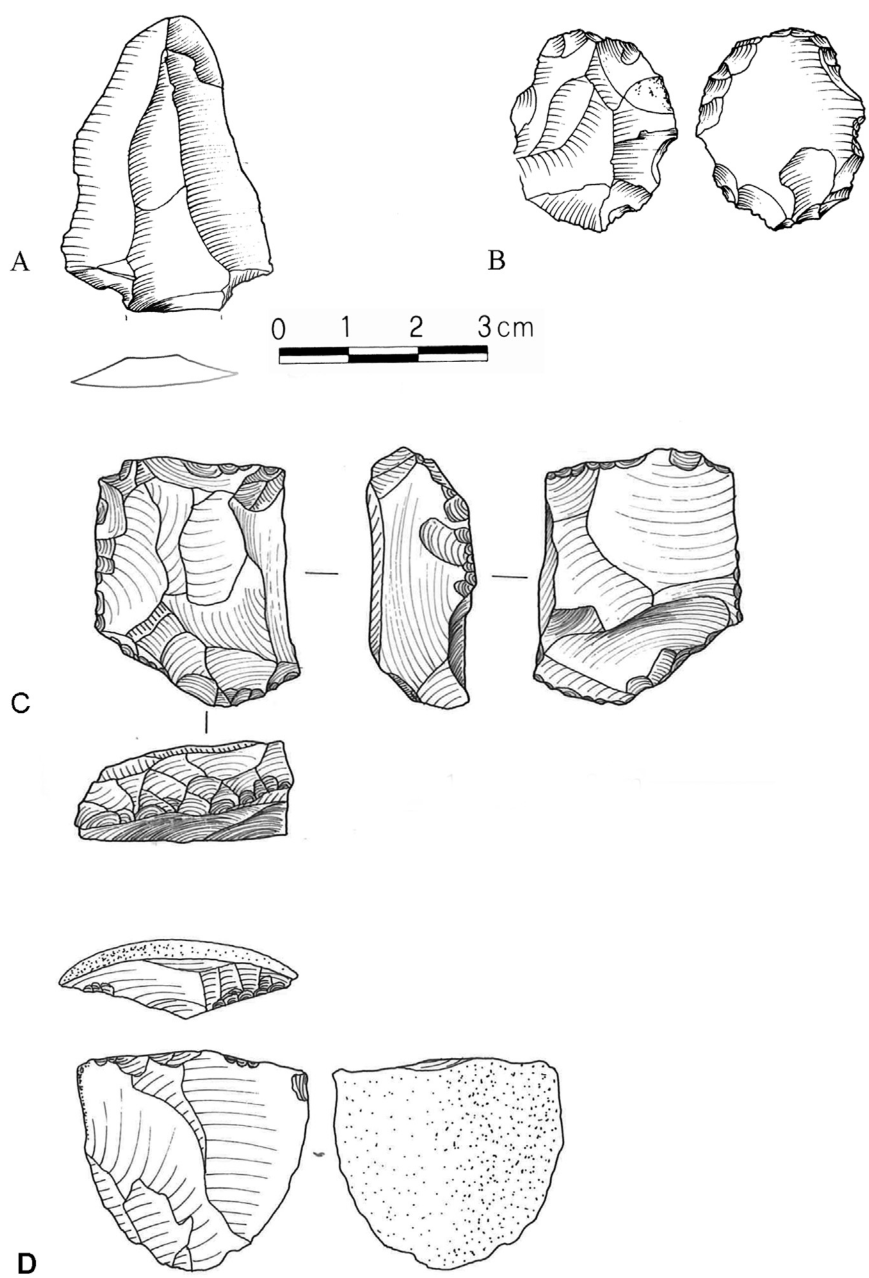

Fig. 5. A. Tanged Levallois point; B. partial bifacial tool; C. scaled piece; D. anvil core on a pebble (from SJ-00-58).

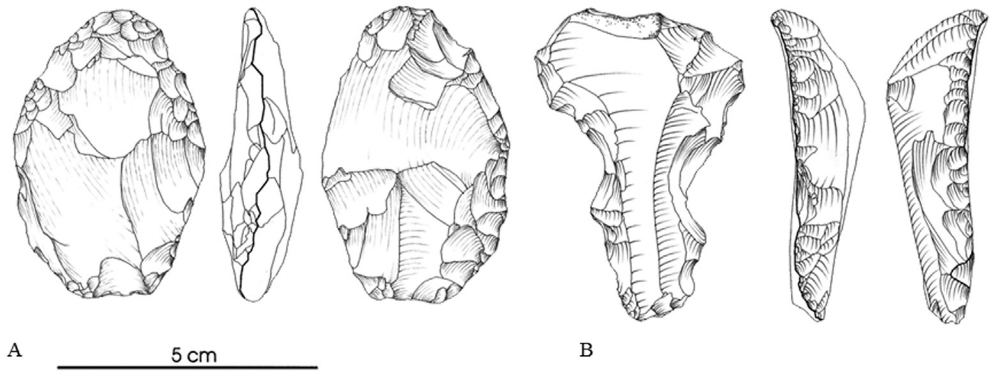

Fig. 6. A. Bifacial foliate; B. Denticulated endscraper (A, B, from SG-07-95).

distributed between blade, shaping and Kombewa blanks. Plotting the length of the unbroken tanged tools against the length of the tangs (Fig. 8) indicates that their proportion varies, and the tang could be from very short to up to half of the tool-long and the tang elongation index (Length/Width ratio) varies from 0.4 to 1.80 (σ 2.58).

Table 4
Tanged tool types (Tixier, 1958-59).

Tixier's typelist	*N*	%
Tanged Levallois flake	21	24.4
Tanged Levallois blade	1	1.2
Tanged Levallois point	3	3.5
Tanged sub-triangular flake	2	2.3
Tanged flake	29	33.7
Tanged short triangular point	3	3.5
Tanged long triangular point	1	1.2
Tanged simple sidescraper	6	7.0
Tanged transversal sidescraper	2	2.3
Tanged double sidescraper	3	3.5
Tanged convergent sidescraper	2	2.3
Tanged endscraper	3	3.5
Tanged semi-circular endscraper	2	2.3
Tanged denticulated tool	2	2.3
Tanged partially bifacial tool	2	2.3
Tanged bifacially retouched tool	1	1.2
“Moroccan” point	1	1.2
N/A	2	2.3
Total	86	100.0

the hypothesis that the tang could be a functional part of the tool. The same results were obtained on a sample from Rhafas cave analysed by de Araujo Igreja (Bouzouggar et al. 2004–2005). These results can be linked to a reuse of broken tanged pieces, especially in Rhafas, although they suggest further caution about the functional interpretation of Aterian tanged pieces. In the Jebel Gharbi, the practice of basal and/or ventral thinning could be associated with hafting, while in Scerri's (2013b) hypothesis those features are not interchangeable and do not occur on the same piece.

Tanged pieces have been classified according to Tixier's typelist (1958–59). Most tanged pieces are on a “simple flake” (33.7%) or a Levallois flake or blade (25.6%). Only 11.6% are on points, Levallois or not. Tanged sidescrapers and endscrapers represent 20.9% and all other types are only occasionally represented. In this sense, these tanged pieces have to be included in the category of hafted tools, discussed above, and considered maintainable tools with a relatively low degree of investment.

Here, as in many other Aterian contexts, the tangs are only occasionally on points/convergent blanks. Conversely, simple flakes are more often likely to be transformed with a tanged tool. This is a strong argument towards the hypothesis that tangs may not have only been used for hafting, as even the use of convergent pieces as projectile points is still under discussion. Nevertheless, in some cases, the shape and the weight of the convergent blanks associated with a tang, together with the presence of impact scars, may suggest their use as projectiles. In order to test the possible utilization of tanged pieces as projectiles (Shea, 1988; Villa and Lenoir, 2009), we systematically recorded the presence of impact scars and other diagnostic features of projectile technology (Bergman and Newcomer, 1983; Fischer et al. 1984), such as step breakages and burin-like fractures (Table 6). We also recorded these features on the entire assemblage in order to test whether there was a difference in this pattern among tanged and non-tanged pieces.

Table 5
Presence/absence of key distinctive tools in the considered sites.

	Ain Zargha			Jefara						Wadi Ghan		
Feature	SJ-98-28	OSL 08	OSL 1	SJ-06-88	SJ-00-55	SJ-00-57	SJ-00-58	SJ-00-58A	SJ-02-68	SG-07-95	SG-00-61	SG-99-41
Tangs	X	X		X	X	X	X	X		X	X	X
Bifaces	X			X		X				X		
Scrapers/notched pieces	X	X	X			X	X	X	X		X	X
“Upper Palaeolithic”	X	X	X		X	X	X				X	X

While many tangs have a classical morphology, sometimes the boundary between tanged pieces and notched/pointed types is narrow, and therefore, it is difficult to define them typologically. There are particularly short tangs (<0.5 cm) and these are unlikely to have been hafted. In some cases, the morphology of the tang can be equated with a denticulate: 22.8% of the tangs fall into this category (whereas only 34.8% of the tangs are well-defined, and 22.8% of them are shouldered. The remaining 19.6% do not fall into those categories). These pieces are often very thick and hafting can be excluded at this stage of transformation of the tools. Massussi and Lemorini (2004–2005), after a use-wear analysis, launched

Fractured tools are common and 36.04% of the tanged pieces show patterns of different breakages. The most common fractures are step breakages ($N = 12$) and bending fractures ($N = 12$). Distal fracture positions are the most common ($N = 27$). In some cases,

Table 6
Fracture types and positions.

Fracture type	Position	*N*	Total
Bending fracture	Longitudinal distal	8	
	Transversal distal	14	
	Transversal proximal	1	
	N/A	1	
	Total bending fractures		24
Burin-like fracture	Longitudinal distal	3	
	Transversal distal	2	
	N/A	2	
	Total burin-like fractures		7
Cone fracture	Transversal distal	2	
	Transversal proximal	1	
	Longitudinal distal	1	
	Total cone fractures		4
Flute-like fracture	Lateral	1	
	Longitudinal distal	1	
	Total flute like fractures		2
Flute + bending	Longitudinal distal	1	
	Transversal proximal	1	
	Total flute + bending fractures		2
Step breakage	Longitudinal distal	2	
	Multiple	3	
	Transversal proximal	3	
	Transversal distal	22	
	N/A	1	
	Total step breakages		31
N/A	Transversal proximal	1	
	Multiple	2	
	Total N/A		3
Total fractures			73

only the proximal part of the tanged piece is present, while the entire distal part was removed during their use with an impact. Sometimes, this proximal part is retouched as well, and in other cases, the impact scar is present only on the tang itself. Only one tanged piece show signs of multiple impacts.

To conclude, the results from the Jebel Gharbi show a high degree of variability within the category of “tanged pieces”, which at this stage does not allow a straightforward interpretation. It is likely that among differently hafted tools, some were projectile points. However, there were also other tools which can be broadly defined as “notched pieces.”

Bifacial foliates (Fig. 6A) are another marker of Aterian technology in North Africa, which, unlike tanged pieces, is largely shared with other MSA regional industries (Balout, 1955; Clark, 1967). For the Moroccan Aterian, it has been stated that a rise in number of foliates corresponds to a decrease in tanged tools (Bouzouggar and Barton, 2012). Bifacial foliates are relatively common in the Egyptian Western Desert, where tangs are scarce. However, in the other areas, this trend does not seem to be confirmed. In the Jebel Gharbi, both bifacially flaked pieces ($N = 21$) and unifacial ones ($N = 8$) are attested, occurring in low quantities in almost all the sites. There are also bifacially retouched flakes ($N = 7$).

Barton and d'Errico (2012) suggest that thinned bifacial foliates and tanged pieces formed part of a hunting system, which may have been linked to early archery, and Hawkins (2012) suggests their use as points in Dakhleh oasis. However, it seems that the bifacial foliates often show very different morphological characteristics compared to tanged pieces, and it is unlikely that their place in the technological system was interchangeable. Bifacial foliates are likely part of a hafted technology, that *sensu lato* includes tanged pieces. Their use, however, is still not well understood. In the assemblages from the Jebel Gharbi, only 3 bifaces and one uniface have a distal bending fracture, while 4 bifaces and 4 unifaces have traces of ventral thinning, which may be related to hafting, according to the current literature.

Bifaces are considered the ideal mobile tool (Kuhn, 1994). A high level of curation of these tools in Aterian assemblages is suggested by the frequency of broken elements, showing that they entered the archaeological record when they broke.

4.5. Site economy and hypothesis on site functions

Inter-regional studies of Aterian contexts are rare, apart from a few notable exceptions (e.g., Clark, 1993; Scerri, 2013a). The Aterian is characterized by the use of a large majority of local or semi-local raw materials (Wengler, 1991; Bouzouggar, 1997; Hawkins and Kleindienst, 2002), showing a restricted settlement pattern and/or the rarity of contacts and exchanges with other groups, possibly related with very low population density. The evidence from the Jebel Gharbi fits into this model, although some other data on the settlement pattern can be drawn from site economy.

The Jebel Gharbi assemblages show a wide range of economic behaviours, possibly suggesting different site functions within the three main areas (Ain Zargha, Jefara and Wadi Ghan). It is possible that none of these assemblages represents a permanent site, and instead are result of a logistic land use. Most of the sites can be considered workshops, occupation locations or special-use areas.

The only possible occurrence of a residential site could be SJ-98-28, where the density of the lithic scatter is higher than any other surface concentration. Moreover, the entire sequence of lithic procurement, production, use and discard is present at this site. Unfortunately, the absence of bones makes it more difficult to assess its function.

Every phase of the reduction sequence is also noticed at another site (SJ-00-58), even though the low artefact density contradicts any hypothesis of long-term occupation. At SJ-00-58, quartzite blanks, more elongated than chert ones, were exogenous, and no in situ production occurs.

Site SJ-00-57 shows a rather uncommon pattern: the number of cores exceeds that of flakes and tools. Thirteen out of 36 cores are fragments, while 8 of them show a high level of exhaustion, showing that this site has a high level of depletion (Shott, 1989a). Two scaled pieces, interpreted as exhausted and recycled cores, one *tablette* (striking platform rejuvenation) and one core on flake complete this assemblage. It is unlikely that these cores were mobile (*sensu* Kuhn, 1994) and ready to provide new blanks. It is more likely that they were exhausted and possibly recycled and/or that they were part of a system of site provisioning (Kuhn, 1992, 1995). It is possible that this site was located close to a raw material procurement site. Seven cores with one or two platforms are present, while only one is prepared for blade production, and no Levallois cores were found. It is possible that, while Levallois cores were highly mobile (sensu Kuhn, 1994), blade cores where stored in specific sites. Only five Levallois blanks were found.

Site SG-00-61 shows a different pattern, with a higher proportion of flakes over tools and a lower core/flake ratio, coupled with the widest variety of blank production in the whole area. This site also shows a greater reliance on blade methods for blank production, while the tool-kit does not show any differences (Spinapolice and Garcea, 2013). Hence, the use of this site could be related to a logistical pattern of land use, being a specialized site for blank production or processing site.

A very important element to be considered in the context of surface assemblage is the recycling/secondary use (Schiffer, 1976, 1987). Recycling is in fact one of the best expressions of the temporal nature of an archaeological assemblage (Vaquero, 2011). This was a common practice in North Africa (Hawkins and Kleindienst, 2002) as MSA/Aterian materials are found in Holocene archaeological assemblages, called “holoports” by Kleindienst (1999), and collected as raw material (McDonald, 1991). Recycling might be

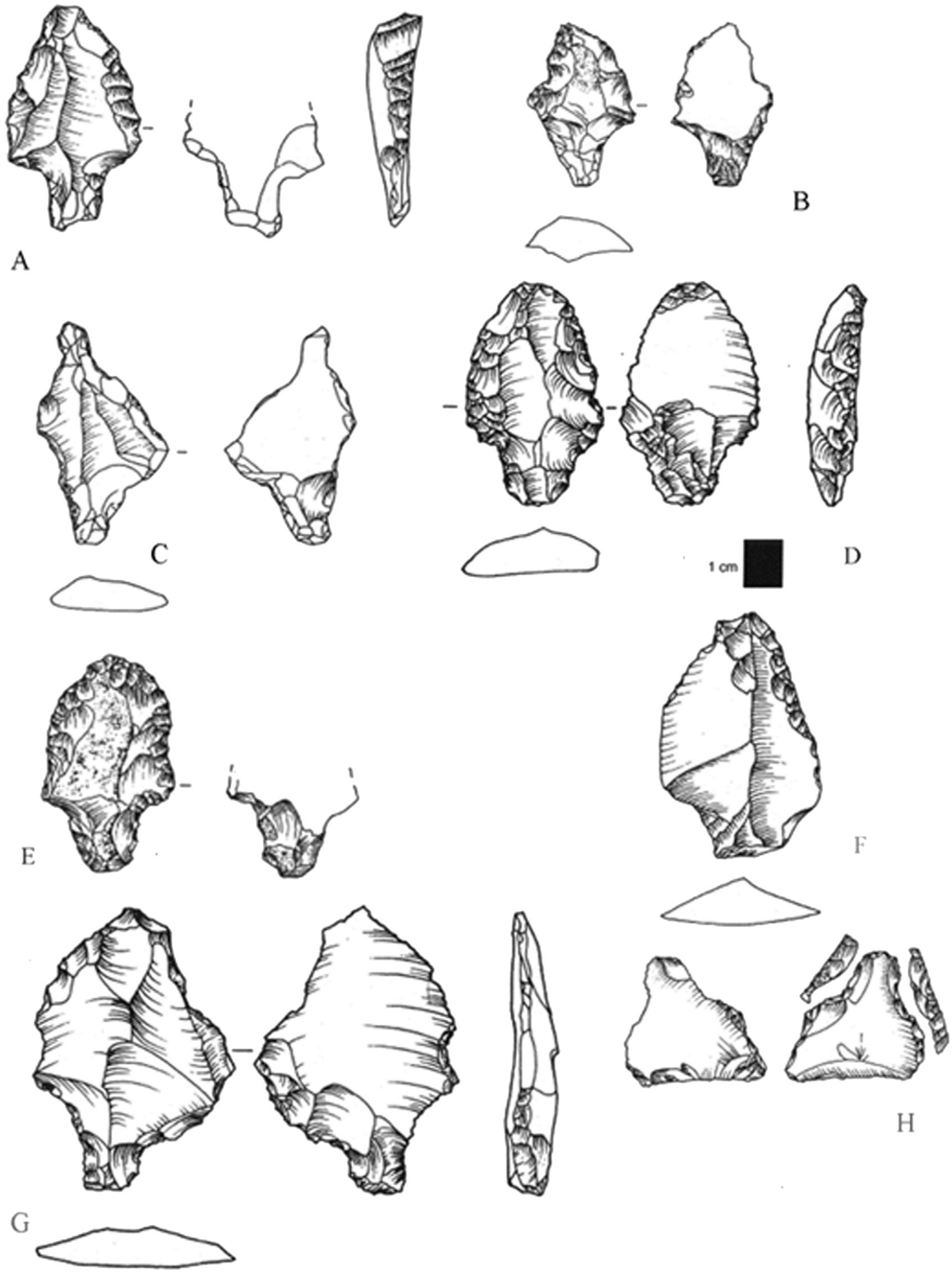

Fig. 7. A, F, G. Tanged Levallois flakes; B, E. tanged cortical flakes; C, D, H. tanged expedient and/or undetermined flakes (A, C–E, G from SJ-98-28; B, from SG-00-61; F, H from SJ-00-58A).

considered as a particular strategy of raw material acquisition, used by "lithic scavengers", which has been already observed in ethnographic societies (Binford, 1977; Camilli and Ebert, 1992; Amick, 2007). The scavenging of surface lithic materials may also be linked to a particularly arid environment (Amick, 2007), and therefore this behaviour may change diachronically according to the changes in the landscape. Apart from the technological markers that might overlap, re-use and recycling suggest that the sites were not frequented on an occasional basis, and might represent a land use pattern. Moreover, an analysis of recycling might give insights about tool design and use.

Double patina is a very good indicator for recycling. In Dakhleh Oasis, most of the recycled materials has been recognized through double patinas (McDonald, 1991). In the Jebel Gharbi, only 40 pieces show evidence of double patina and in the richest assemblage (SJ-98-28) the frequency of double patina is very low. The only exception is at site SJ-00-57 where there are 22 pieces with double patina, 31 with heavy patina and 36 with light patina. As the light

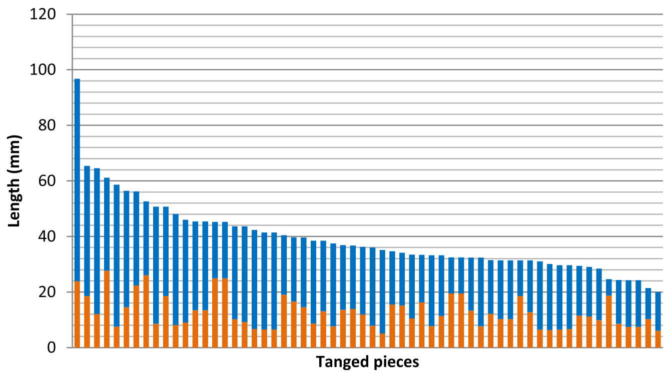

Fig. 8. Length of the tang (orange) and of the distal part of unbroken tanged pieces (blue), in mm.

patina is mostly white, and the heavy one is mostly grey and orange, it is possible that these differences represent two different occupations.

In general, this low frequency of double patina shows a limited evidence of reuse, or of its traceability, or the prevalence of this practice in a short-term context. This might be the case with cores on flakes ($N = 14$) and cores on tools ($N = 9$), although they are scattered in different sites.

The meaning of the reliance on older lithic materials is yet to be determined, but it is likely that this recycling is made in the context of a lack of good quality raw materials. The rarity of recycling in the Jebel Gharbi makes this behaviour occasional and not systematic.

5. Conclusion

This study provides elements of further discussion on the Aterian from the Jebel Gharbi (Barich et al. 2006; Garcea and Giraudi, 2006; Barich and Garcea, 2008; Garcea, 2009; Garcea, 2010a, 2012; Spinapolice and Garcea, 2013). Following the descriptions by Jacobs et al. (2012), the Aterian from the Jebel Gharbi is comparable with the Moroccan Late Aterian, dated to between 80 and 70 ka at El Harhoura 2, El Mansra and Dar es-Soltane 1, as well as at the northern sites of Taforalt, Ifri n'Ammar and Rhafas.

Technologically, the assemblages from the Jebel Gharbi exhibit all the distinctive features of Aterian technocomplexes: the coexistence of Levallois and blade technology, presence of tanged pieces and bifacial foliates, “Upper Palaeolithic” tool types, and a majority of sidescrapers and endscrapers. Only a combination of these features, and certainly not one of them alone, can characterize an assemblage as “Aterian”.

The complete understanding of the Aterian complex requires a broad comparative approach, different to many of the current methods, which are mainly based on the European-like tradition (e.g. Aumassip, 2004; see discussion in: Foley et al. 2013). Our technological analysis offers a wider point of view not based solely on typology, and the presence or absence of a tool type (i.e. the tanged piece), which is not sufficient to establish cultural entities (Spinapolice et al. 2010). Here, we have proposed an interpretation of our data in a perspective oriented to fit the Aterian in a broad MSA context. The similarity of this industry with the Nubian Complex (particularly in the knapping methods) and with other aspects of the MSA from East and Central Africa is observed (see also discussion in Spinapolice and Garcea, 2013). However, other elements, both technological and typological, are related to raw material procurement, site function and settlement systems.

Understanding the variability of this techno-complex is essential in order to contribute to the debate of the origin and dispersal of modern humans. The links with Sub-Saharan Africa have to be more deeply investigated and connected with the dispersal of modern humans from East Africa (Garcea, 2012).

Acknowledgments

We wish to thank the editors E. Scerri and H. Groucutt for inviting us to contribute to this volume. We are grateful to Cristina Lemorini for her comments and suggestions on a previous version of this manuscript. We thank Marina Gallinaro for support with Fig. 1. We wish to thank three anonymous reviewers for their precious comments. This research was funded in the frame of a Marie Curie Intra-European Fellowship within the 7th European Community Framework Programme. Fieldwork in the Jebel Gharbi took place under the Licence for Archaeological Excavation from the Department of Antiquities in Libya (Law of Antiquities No. 3) to the Italian–Libyan Archaeological Project in the Jebel Gharbi, co-directed by B.E. Barich and E.A.A. Garcea.

Spinapolice wrote paragraphs 4.1, 4.3, 4.4 and 4.5; Garcea wrote paragraphs 3 and 4.2. Paragraphs 1, 2 and 5 are by both authors.

References

Amick, D.S., 2007. Behavioral Causes and Archaeological Effects of Lithic Artifact Recycling. In: Tools versus Cores: Alternative Approaches to Stone Tool Analysis. S. P. McPherron. Newcastle, Cambridge Scholars Publications, pp. 223–252.
Antoine, M., 1934. Un gisement atérien en place dans les environs de l'Oued Goréa, près de Casablanca. Bulletin de la Société de Préhistoire du Maroc 1–2, 7–34.
Aumassip, G., 2004. Préhistoire du Sahara et de ses abords. Maisonneuve & Larose, Paris.
Balout, L., 1955. Préhistoire de l'Afrique du Nord: essai de chronologie. Paris.
Balter, M., 2011. Was North Africa the Launch Pad for modern human migrations? Science 331 (6013), 20–23.
Barca, D., Mutri, G., 2009. Caratterizzazione geochimica e determinazione della provenienza delle selci del Jebel Gharbi – Libia. Africa 54 (3–4), 488–497.
Barich, B., Garcea, E.A.A., Giraudi, C., 2006. Between the Mediterranean and the Sahara: geoarchaeological reconnaissance in the Jebel Gharbi, Libya. Antiquity 80, 567–582.
Barich, B.E., Garcea, E.A.A., 2008. Ecological patterns in the Upper Pleistocene and Holocene in the Jebel Gharbi, Northern Libya: chronology, climate and human occupation. African Archaeological Review 25 (1–2), 87–97.
Barton, N., d'Errico, F., 2012. North African origins of symbolically mediated behaviour and the Aterian. Origins of human innovation and creativity. North African origins of symbolically mediated behaviour and the Aterian. Development in Quaternary Science 16, 23–34.
Barton, N., Bouzouggar, A., Collcutt, S.N., Schwenninger, J.L., Clark-Balzan, L., 2009. OSL dating of the Aterian levels at Dar es-Soltan I (Rabat, Morocco) and implications for the dispersal of modern Homo sapiens. Quaternary Science Reviews 28 (19–20), 1914–1931.
Bergman, C.A., Newcomer, M.H., 1983. Flint arrowhead breakage: examples from Ksar Akil, Lebanon. Journal of Field Archaeology 10, 921–947.
Bietti, A., Cancellieri, E., Corinaldesi, C., Grimaldi, S., Spinapolice, E., 2009-2010. La percussion sur enclume en Italie centrale thyrrénienne. PALEO numéro spécial. Entre le marteau et l'enclume, 143–180.
Binford, L., 1977. Forty-seven Trips: a Case Study in the Character of Archaeological Formation Processes. Stone Tools as Cultural Markers: Change, Evolution and Complexity. Australian Institute of Aboriginal Studies, R. V. Wright, Canberra, pp. 24–36.
Binford, L., 1980. Willow smoke and dog tails: hunter–gatherer settlement systems and archaeological site formation. American Antiquity 45, 1–17.
Bleed, P., 1986. The optimal design of hunting weapons: maintainability or reliability? American Antiquity 51, 737–747.
Boëda, E., 1994. Le concept Levallois: variabilité des méthodes. Paris.
Bouzouggar, A., 1997. Matières premières, processus de fabrication et de gestion des supports d'outils dans la sèquence atérienne de la Grotte d'El Mnasra I (ancienne grotte des Contrebandiers) à Témara (Maroc). IPGQ, Bordeaux. Université de Bordeaux 1.
Bouzouggar, A., Barton, R.N.E., 2012. The identity and timing of the Aterian in Morocco. In: Hublin, J.-J., McPherron, S.P. (Eds.), Modern Origins. Springer, Netherlands, pp. 93–105.
Bouzouggar, A., Barton, R.N.E., De Araujo Igreja, M., 2004-2005. A brief overview of recent research into the Aterian and Upper Palaeolithic of Northern and Eastern Morocco. Scienze Dell'Antichità 12, 473–488.
Cadenat, P., 1939. Les objets pédonculés atériens du Koudiat bou Gherara. Bulletin de la Société de Géographie et d'Archéologie d'Oran LX.
Camilli, E., Ebert, J.I., 1992. Artifact reuse and recycling in continuous surface distributions and implications for interpreting land use patterns. In: Rossignol, J.,

Wandsnider, L.A. (Eds.), Space, Time and Archaeological Landscapes. Plenum Press, New York, pp. 113–136.
Caton-Thompson, G., 1946. The Aterian Industry: its Place and Significance in the Palaeolithic World. Royal Anthropological Institute of Great Britain and Ireland, London.
Clark, J.D., 1967. Atlas of African Prehistory. University of Chicago Press, Chicago.
Clark, J.D., 1993. The Aterian of the Central Sahara. In: Krzyzaniak, L., Kobusiewicz, M., Alexander, J. (Eds.), Environmental Change and Human Culture in the Nile Basin and Northern Africa until the Second Millennium B.C. Poznan Archaeological Museum, Poznan, pp. 49–67.
Cremaschi, M., di Lernia, S., Garcea, E.A.A., 1998. Some insights on the Aterian in the Libyan Sahara: chronology, environment, and archaeology. African Archaeological Review 15 (4), 261–286.
d'Errico, F., Vanhaeren, M., Barton, N., Bouzouggar, A., Mienis, H., Richter, D., Hublin, J.J., McPherron, S.P., Lozouet, P., 2009. Additional evidence on the use of personal ornaments in the Middle Paleolithic of North Africa. Proceedings of the National Academy of Sciences 106 (38), 16051–16056.
Dibble, H.L., Aldeias, V., Jacobs, Z., Olszewski, D.I., Rezek, Z., Lin, S.C., Alvarez-Fernndez, E., Barshay-Szmidt, C.C., Hallett-Desguez, E., Reed, Denn, K., Richter, D., Steele, T.E., Skinner, A., Blackwell, B., Doronicheva, E., El-Hajraoui, M., 2013. On the industrial attributions of the Aterian and Mousterian of the Maghreb. Journal of Human Evolution 64 (3), 194–210.
Drake, N.A., Blench, R.M., Armitage, S.J., Bristow, C.S., White, K.H., 2010. Ancient watercourses and biogeography of the Sahara explain the peopling of the desert. Proceedings of the National Academy of Sciences 108, 458–462.
Drake, N.A., Breeze, P., Parker, A., 2013. Palaeoclimate in the Saharan and Arabian Deserts during the Middle Palaeolithic and the potential for hominin dispersals. Quaternary International 300, 48–61.
Fischer, A., Hansen, P.V., Rasmussen, P., 1984. Macro and Micro wear traces on lithic projectile points. Journal of Danish Archaeology 3, 19–46.
Foley, R.A., Maillo-Fernandez, J.M., Mirazon Lahr, M., 2013. The Middle Stone Age of the Central Sahara: biogeographical opportunities and technological strategies in later human evolution. Quaternary International 300, 153–170.
Garcea, E.A.A., 2009. The evolutions and revolutions of the Late Middle Stone Age and Lower Later Stone Age in north-west Africa. In: Camps, M., Szmidt, C. (Eds.), The Mediterranean from 50 000 to 25 000 BP: Turning Points and New Directions. Oxbow Books, Oxford, pp. 51–66.
Garcea, E.A.A. (Ed.), 2010a. South-Eastern Mediterranean Peoples between 130,000 and 10,000 Years Ago. Oxford.
Garcea, E.A.A., 2010b. The spread of Aterian peoples in North Africa. In: Garcea, E.A.A. (Ed.), South-eastern Mediterranean Peoples between 130,000 and 10,000 Years Ago. Oxbow Books, Oxford, pp. 37–53.
Garcea, E.A.A., 2012. Modern human desert adaptations: a Libyan perspective on the Aterian complex. In: Hublin, J.-J., McPherron, S.P. (Eds.), Modern Origins. Springer, Netherlands, pp. 127–142.
Garcea, E.A.A., Giraudi, C., 2006. Late Quaternary human settlement patterning in the Jebel Gharbi, Northwestern Libya. Journal of Human Evolution 51, 411–421.
Geneste, J.M., 1985. Analyse lithique d'industrie moustériennes du Périgord : une approche technologique du comportement des groupes humains du Paléolithique moyen. Université de Bordeaux 1, Bordeaux.
Geneste, J.M., 1991. L'approvisionnement en matières premières dans les systèmes de production lithique : la dimension spatiale de la technologie. Treballs d' Arquelogia 1; Tecnologìa y Cadenas Operativas Lìticas.
Giraudi, C., 2005. Eolian sand in peridesert northwestern Libya and implications for Late Pleistocene and Holocene Sahara expansions. Palaeogeography, Palaeoclimatology, Palaeoecology 218, 161–173.
Grimaldi, S., Spinapolice, E., Cancellieri, E., Corinaldesi, C., 2007. Osservazioni sperimentali sulla percussione su incudine. In: Atti della XL Riunione Scientifica Strategie di insediamento fra Lazio e Campania in età Preistorica e Protostorica, Roma, 30 Novembre–03 Dicembre 2005.
Hawkins, A.L., 2001. Getting a Handle on Tangs: Defining the Dakhleh Unit of the Aterian Technocomplex – a Study in Surface Archaeology from the Western Desert of Egypt (PhD dissertation). University of Toronto.
Hawkins, A.L., 2012. The Aterian of the Oases of the Western Desert of Egypt: adaptation to changing climatic conditions? In: Hublin, J.-J., McPherron, S.P. (Eds.), Modern Origins. Springer, Netherlands, pp. 157–175.
Hawkins, A.L., Kleindienst, M.R., 2002. Lithic raw material usages during the Middle Stone Age at Dakhleh Oasis, Egypt. Geoarchaeology 17 (6), 601–624.
Hublin, J.-J., 1992. Recent human evolution in Northwestern Africa. In: Aitken, M.J., Mellars, P.A., Stringer, C.B. (Eds.), The Origin of Modern Humans, the Impact of Science-based Dating. Philosophical Transactions of the Royal Society of London, London, pp. 185–191.
Hublin, J.-J., 2001. Northeastern African Middle Pleistocene hominins and their bearing on the emergence of Homo sapiens. In: Barham, L., Robson-Brown, K. (Eds.), Human Roots: Africa and Asia in the Middle Pleistocene. Western Academic & Specialist Press, pp. 99–121.
Inizan, M.-L., Reduron-Ballinger, M., Roche, H., Tixier, J., 1995. Préhistoire de la pierre taillée t. 4-Technologie de la pierre taillée. CREP, Meudon.
Iovita, R., 2011. Shape variation in Aterian tanged tools and the origins of projectile technology: a morphometric perspective on stone tool function. PLoS ONE 6 (12), e29029.
Jacobs, Z., Meyer, M.C., Roberts, R.G., Aldeias, V., Dibble, H., El Hajraoui, M.A., 2011. Single-grain OSL dating at La Grotte des Contrebandiers (Smugglers Cave), Morocco: improved age constraints for the Middle Paleolithic levels. Journal of Archaeological Science 38 (12), 3631–3643.
Jacobs, Z., Roberts, R.G., Nespoulet, R., El Hajraoui, M., Debenath, A., 2012. Single-grain OSL chronologies for Middle Palaeolithic deposits at El Mnasra and El Harhoura 2, Morocco: implications for Late Pleistocene human environment interactions along the Atlantic coast of northwest Africa. Journal of Human Evolution 62 (3), 377–394.
Kleindienst, M.R., 1998. What is the Aterian? The view from Dakhleh Oasis and the Western Desert, Egypt. In: Marlow, M., Mills, A.J. (Eds.), The Oasis Paper: Proceedings of the First International Symposium of the Dakhleh Oasis Project. Oxbow Oxford, pp. 1–14.
Kleindienst, M.R., 1999. Pleistocene Archaeology and geoarchaeology of the Dakhleh Oasis: a status report. In: Churcher, C.S., Mills, A.J. (Eds.), Reports from the Survey of Dakhleh Oasis, Western Desert of Egypt, 1977–1987. Oxbow Books, Oxford, pp. 83–107.
Kuhn, S.L., 1992. On planning curated technologies in the Middle Paleolithic. Journal of Anthropological Research 48, 798–809.
Kuhn, S.L., 1994. A formal approach to the design and assembly of mobile toolkits. American Antiquity 59 (3), 426–442.
Kuhn, S.L., 1995. Mousterian Lithic Technology and Raw Material Economy: a Cave Study. Princeton University Press, Princeton.
Leroi-Gourhan, A., 1964. Le geste et la parole I. Technique et langage, Paris.
Marchand, H., Aymé, A., 1935. Recherches stratigraphiques sur l'Atérien. Bulletin de la Société d'Histoire Naturelle d'Afrique du Nord XXVI.
Massussi, M., Lemorini, C., 2004-2005. I siti Ateriani del Jebel Gharbi: caratterizzazione delle catene di produzione e definizione tecno-funzionale dei peduncolati. Scienze Dell'Antichità 12, 19–28.
McBrearty, S., Brooks, A.S., 2000. The revolution that wasn't: a new interpretation of the origin of modern human behaviour. Journal of Human Evolution 39, 453–563.
McDonald, M.M.A., 1991. Systematic reworking of lithics from Earlier cultures in the Early Holocene of Dakhleh Oasis, Egypt. Journal of Field Archaeology 18 (2), 269–273.
Mercier, N., Wengler, L., Valladas, H., Joron, J.-L., Froget, L., Reyss, J.-L., 2007. Rhafas Cave (Morocco): chronology of the Mousterian and Aterian archaeological occupations and their implications for Quaternary geochronology based on luminescence (TL/OSL) age determinations. Quaternary Geochronology 2, 309–313.
Mutri, G., Lucarini, G., 2008. New data on the Late Pleistocene of the Shakshuk Area, Jebel Gharbi, Libya. African Archaeological Review 25 (1–2), 99–107.
Nami, M., Moser, J., 2010. La Grotte de Ifri n'Ammar. Le Paléolithique Moyen. Tome 2. Frankfurt, Reichert Verlag, Wiesbaden.
Pelegrin, J., 1985. Réflexion sur le comportement technique. In: Otte, M. (Ed.), La signification culturelle des industries lithiques. BAR International Series, 239, Oxford, pp. 72–91.
Perlès, C., 1991. Économie des matières premières et économie du débitage : deux conceptions opposées?. In: 25 ans d'études technologiques en préhistoire. Bilan et perspectives. APDCA, Antibes.
Reygasse, M., 1922. Note au sujet de deux civilisations préhistoriques africaines pour lesquelles deux termes nouveaux me paraissent devoir être employés. X LVIe Congrès de l'Association Française pour l'avancement des sciences, pp. 467–472.
Richter, D., Moser, J., Nami, M., 2012. New data from the site of Ifri n'Ammar (Morocco) and some remarks on the chronometric status of the Middle Paleolithic in the Maghreb. In: Hublin J.-, J., McPherron, S.P. (Eds.), Modern Origins: a North African Perspective. Springer, Netherlands, pp. 61–78.
Richter, D., Moser, J., Nami, M., Eiwanger, J., Mikdad, A., 2010. New chronometric data from Ifri n'Ammar (Morocco) and the chronostratigraphy of the Middle Palaeolithic in the Western Maghreb. Journal of Human Evolution 59 (6), 672–679.
Roche, J., 1953. La grotte de Taforalt. L'Anthropologie 57, 375–380.
Rots, V., Van Peer, P., Vermeersch, P.M., 2011. Aspects of tool production, use, and hafting in Palaeolithic assemblages from Northeast Africa. Journal of Human Evolution 60 (5), 637–664.
Scerri, E.M.L., 2013a. The Aterian and its place in the North African Middle Stone Age. Quaternary International 300, 111–130.
Scerri, E.M.L., 2013b. On the spatial and technological organisation of hafting modifications in the North African Middle Stone Age. Journal of Archaeological Science 40 (12), 4234–4248.
Schiffer, M.B., 1976. Behavioural Archaeology. Academic Press, New York.
Schiffer, M.B., 1987. Formation Processes of Archaeological Record. University of New Mexico Press, Albuquerque.
Schwenninger, J.L., Collcutt, S.N., Barton, N., Bouzouggar, A., Clark-Balzan, L., El Hajraoui, M.A., Nespoulet, R., Debénath, A., 2010. A new luminescence chronology for Aterian cave sites on the Atlantic Coast of Morocco. In: Garcea, E.A.A. (Ed.), South-Eastern Mediterranean Peoples Between 130,000 and 10,000 Years Ago. Oxbow, Oxford, pp. 18–36.
Shea, J., 1988. Spear points from the Middle Paleolithic of the Levant. Journal of Field Archaeology 15 (4), 441–456.
Shea, J., 2006. The origins of lithic projectile point technology: evidence from Africa, the Levant and Europe. Journal of Archaeological Science 33, 823–846.
Shott, M., 1989. On tool class use lives and the formation of archaeological assemblages. American Antiquity 50, 9–30.
Spinapolice, E.E., Delagnes, A., Jaubert, J., 2010. Tracking human migrations through the lithic record: a challenging task. In: XXVIIe congrès préhistorique de France, Settlement Dynamics of the Middle Paleolithic and Middle Stone Age. UISPP Session (Commission 27). Bordeaux – Les Eyzies, 31 mai–5 juin 2010.
Spinapolice, E.E., Garcea, E.A.A., 2013. The Aterian from the Jebel Gharbi (Libya): new technological perspectives from North Africa. African Archaeological Review 30 (2), 169–194.

Stordeur, D. (Ed.), 1987. La main et l'outil: manches et emmanchements préhistoriques. Maison de L'Orient Méditerranéen, Lyon.
Tillet, T., 2000. Sahara. Paléomilieux et peuplement préhistorique au Pléistocène supérieur. L'Harmattan, Paris, pp. 127–158.
Tixier, J., 1958–59. Les pièces pédonculées de l'Atérien. Libyca 6–7.
Tixier, J., 1963. Typologie de l'Epipaléolithique du Maghreb. In: Mémoires du centre de recherches anthropologiques, préhistoriques et ethnographiques. A.M.G, Alger, Paris.
Tixier, J., 1967. Procédés d'analyse et questions de terminologie dans l'étude des ensembles industriels du Paléolithique récent et de l'Épipaléolithique en Afrique du Nord-Ouest. In: Bishop, W.W., Clark, J.D. (Eds.), Background to Evolution in Africa, pp. 771–820. Chicago.
Van Peer, P., 2004. Did middle Stone Age moderns of sub-Saharan African descent trigger an upper paleolithic revolution in the lower Nile valley? Anthropologie XLII (3), 215–225.
Van Peer, P., Vermeersch, P., Paulissen, E., 2010. Chert Quarrying, Lithic Technology, and a Modern Human Burial at the Palaeolithic Site of Taramsa 1. Upper Egypt, Leuven.
Vaquero, M., 2011. New perspectives on recycling of lithic resources using refitting and spatial data. Quartar 58, 113–130.
Villa, P., Lenoir, M., 2009. Hunting and hunting weapons of the Lower and Middle Paleolithic of Europe. In: Richards, M., Hublin, J.J. (Eds.), The Evolution of Hominid Diet. Springer, Leipzig, pp. 59–86.
Wengler, L., 1991. Choix des matières premières lithiques et comportement des hommes au Paléolithique moyen. In: 25 ans d'études technologiques en préhistoire-XI rencontre Internationales d'Histoire d'Anitibes, Antibes. APDCA.
Wrinn, P.J., Rink, W.J., 2003. ESR dating of tooth enamel from Aterian Levels at Mugharet el Aliya (Tangier, Morocco). Journal of Archaeological Science 30, 123–133.