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MORPHOMETRIC ANALYSIS OF MIDDLE STONE AGE TANGED TOOLS FROM SOUTH-WESTERN LIBYA, CENTRAL SAHARA. A REGIONAL PERSPECTIVE

1. Introduction

The Aterian is a late Middle Stone Age complex of North Africa widely documented from the Sahara to the Mediterranean and chronologically spanning from around 145 ka to 30 ka (see Scerri, Spinapolice 2019 for a recent review). In the central Sahara, as the most part of Pleistocene archaeological contexts, Aterian sites are widespread but mostly undated. A notable exception is represented by the cave sites of the Tadrart Acacus mountains, in SW Libya, where geochronological data tethers the Aterian occupation to hyperarid phases of the late Pleistocene dated to ca. 70-60 ka (Cremaschi *et al.* 1998).

Outside the Acacus caves, and in particular in the lowlands, Aterian sites consist of surface scatters of variable size and density, whose attribution strongly depends on the presence of few classes of artefacts. Among these are characteristic stone tools, either pointed or not pointed forms (for example points, scrapers, end-scrapers, denticulates), characterized by the presence of a tang (see below Fig. 2f), widely accepted as to be related to hafting purposes (e.g. Iovita 2011; Tomasso, Rots 2018; see Massussi, Lemorini 2004-2005; Falzetti *et al.* 2017 for alternative views).

The chronological span of the Aterian occupation in the areas outside the Acacus mountain is not known. During the period of occupation of the Acacus caves (Marine Isotope Stage 4), the sand dunes in the surrounding lowlands should have been rather challenging environments characterized by a reduced carrying capacity; to the contrary, the widely recognised potential of mountain areas to retain water reserves also in desert regions (Williams 2014) possibly allowed the central Saharan massifs to act as a refugium under the environmental stress of the most arid phases of the Late Pleistocene. While one cannot rule out that the successful adaptation to arid environments of the Acacus peoples could have let them to cope and take advantage of the residual resources kept also by the harshest environments in the framework of seasonally organized settlement subsistence patterns (Clark *et al.* 2008), it is likely that the archaeological record from these ranges also results from earlier Aterian human occupation during wetter phases (Cancellieri, di Lernia 2013).

As stated, there are currently no absolute age determinations for Aterian archaeological contexts from areas outside the Acacus. Nevertheless, within the current state of knowledge and field research limitations, it is worth to take advantage of available geospatial and archaeological data archives to continue investigating past human dynamics and suggest likely patterns to be confirmed/confuted as soon as more evidence will be available. Accordingly, this paper aims at investigating morphometric variability of Aterian tanged tools from the SW Fezzan (Libya), both at a regional and an intra-regional scale, to help understanding some major population dynamics. As a large wealth of research proves, comparative analysis relying on stone artefacts' metric and shape attributes is able to shed light on diverse phenomena, like for example the origins of projectile weaponry or the significance of morphological variation across regions and continents (e.g. Shott 1997; Yellen 1998; Brooks *et al.* 2006; Sisk, Shea 2011). Similarly, it is here considered that the combination of morphometric and environmental variables is capable of revealing some insights on settlement pattern and human dynamics according to fluctuating econiches and variably distributed availability of resources.

2. Research area

The study area is located in the SW of the Fezzan region, in Libya, close to the border with Algeria and Niger (Fig. 1). It is approximately framed between 24°-26° N and 10°-13° E. It consists of a range of diversified physiographic features, comprising mountains, sand seas and large fluvial plains. Most of its geomorphological features are fossil and they originated in warm humid phases of the Pleistocene (interglacials) and the Early Holocene. The Acacus and Messak are elongated massifs delimited by abrupt scarps to the W and NW, respectively. The Acacus is characterized by an articulated fossil drainage network and represents the only area with diffuse presence of caves and rock-shelters famous for their Holocene rock art and archaeology (Mori 1965; Cremaschi, di Lernia 1999; di Lernia, Zampetti 2008; Gallinaro 2013). The Messak is a cuesta-type relief incised by a complex net of fossil river valleys (Zerboni *et al.* 2011). It is formed by two main massifs, the Messak Mellet, to the S, and the Messak Settafet, to the N. The landscape is dominated by a vast stone pavement marked by black varnish. The main physiographic units are residual surfaces (hamada and serir) punctuated by endorheic depressions (Perego *et al.* 2011; Knight, Zerboni 2018).

Most of the lowlands surrounding the mountains are covered by the dune-fields of the Erg Titersin, to the NW of the study area, the Erg Uan Kasa, between the Acacus and the Messak, and the Edeyen of Murzuq to the SE. The lowlands also include some large wadi systems: the Wadi Tanezzuft, W of the Acacus; the Wadi El-Ajal and the Wadi Berjuj respectively N and S of the Messak.

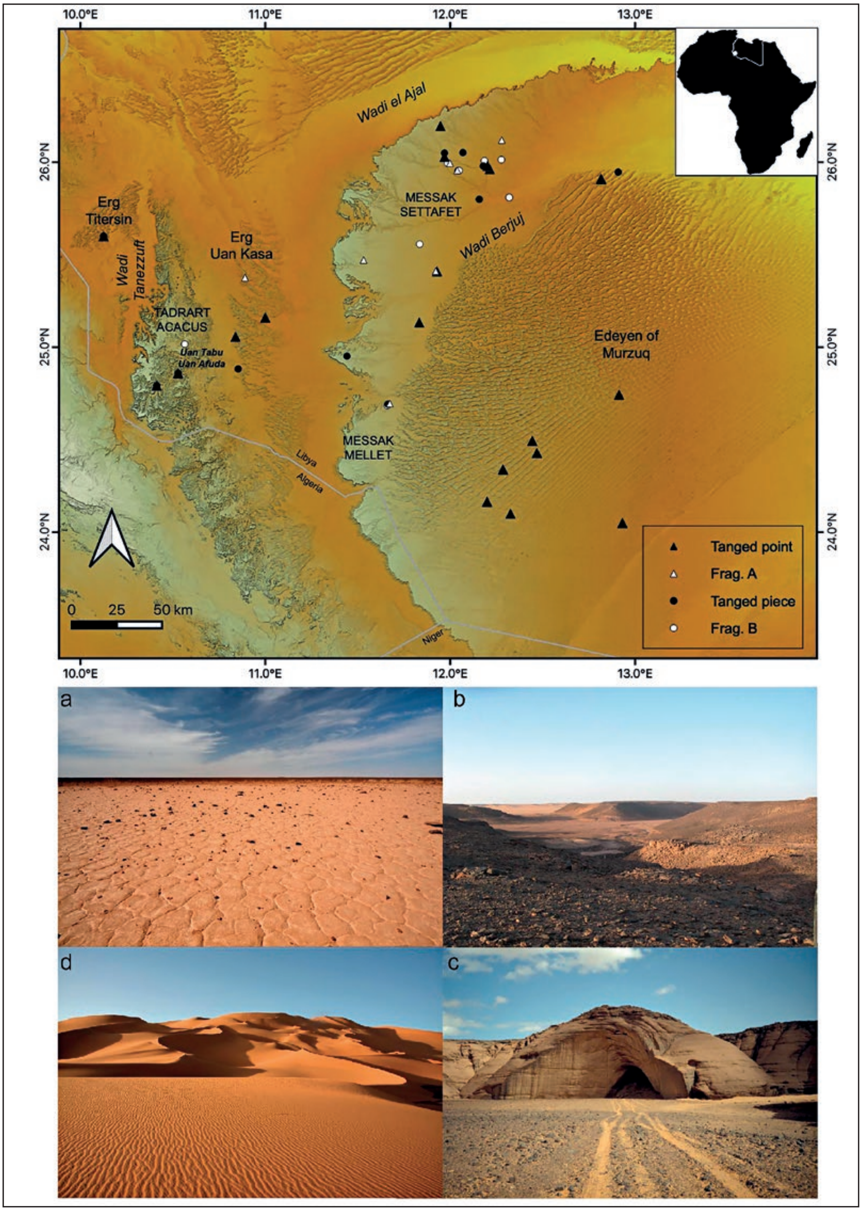

Fig. 1 – Top: map of the study area and localization of the samples comprised in this study (see text and Fig. 2 a-e for details on artefacts classification). Bottom: examples of environmental settings of the study region: a) endorheic depression and b) net of wadis in the Messak; c) the Uan Afuda cave in the Tadrart Acacus; d) a dune-field in the Wadi Tanezzuft (The Archaeological Mission in the Sahara, Sapienza University of Rome).

The Aterian archaeological record mostly consists of surface sites. In the main wadi systems the evidence is scanty and scattered. This is partly due to the early Holocene fluvial activity, which has eroded or buried most of the pre-Holocene evidences. The Erg Titersin record is made of a single Aterian site. A handful of Aterian artefacts come from northern Wadi Tanezzuft. Aterian occurrences in the edeyen of Murzuq are mostly isolated artefacts found on the serir and on the dune margins (Cremaschi, di Lernia 1998; Cremaschi *et al.* 1998; Anag *et al.* 2007; Cancellieri *et al.* 2016).

The record from the Acacus includes shelters, caves and open-air sites (Cremaschi *et al.* 1998; Cremaschi, di Lernia 1998; Cancellieri *et al.* 2016). The sites of Uan Tabu and Uan Afuda witnessed the main degree of preservation and investigation (di Lernia 1999b; Garcea 2001b) and represent the only MSA/Aterian chronological reference for the region and the wider central Sahara.

The two meters thick sequence of the Uan Afuda cave includes two levels of fallen blocks, and a reddish paleosol on the top. TL dating of the sand above the upper blocks, whose base included the MSA artefacts, gave 70 ± 9.5 ka and 73.5 ± 10 ka, in quite good agreement with OSL determinations from the same layer, which returned 69 ± 7 ka. Sand above the lower level of blocks gave a further OSL date of 90 ± 10 ka (Cremaschi *et al.* 1998) and is related to the beginning of dune aggradation inside the cave. At Uan Tabu rock shelter the Pleistocene aeolian sand is less developed than at Uan Afuda, but it includes a larger amount of Aterian artefacts (Garcea 2001b). It was OSL dated to 61 ± 10 ka (Cremaschi *et al.* 1998).

The small assemblage of Uan Afuda is made of undifferentiated and Levallois flakes and a few cores, but it lacks Aterian traits, i.e., tangs or foliates (di Lernia 1999a). At Uan Tabu the lithic artefacts testify to rather complete reduction sequences (Levallois, Laminar and Discoid) and a quite diversified raw materials inventory (Garcea 2001a). Retouched tool-kit includes side-scrapers and rare tanged tools. The assemblage might testify to a "residential" character (Cremaschi *et al.* 1998).

The Messak is incredibly rich in archaeological remains of Holocene age, particularly ceremonial monuments and rock art, attracting researchers since the 19th century (see Biagetti *et al.* 2013 and references therein). The Messak is also the district with the largest number of Pleistocene findings, identified so far by several international research projects and interventions aimed at the assessment of the impact of oil industry (Garcea 1997; Cremaschi, di Lernia 1998; Anag *et al.* 2002; Le Quellec 2009; Gallinaro *et al.* 2012; Biagetti *et al.* 2013; Foley *et al.* 2013; Foley, Lahr 2015). Generalized MSA artefacts spread throughout the entire Messak, all are open-air and are far more common than Aterian contexts (Cancellieri, di Lernia 2013). At least in few cases, Aterian artefacts were found stratified in open-air contexts, but remain undated (Cremaschi *et al.* 1998).

3. Material and methods

The assessment of metrical and morphological characters of Aterian tanged tools has been carried out collecting data from published pictures and drawings (Cremaschi *et al.* 1998; Garcea 2001a; Anag *et al.* 2007; Cancellieri, di Lernia 2013; Cancellieri *et al.* 2016) and unpublished ones (Archive of the Archaeological Mission in the Sahara, Sapienza University of Rome). The total number of artefacts comprised in this study is 68 from 45 sites distributed through the major macro areas of the study region. The most part of the analysed specimens come from the Edeyen of Murzuq and the Messak. Together they account for 75% of the sample (Tab. 1).

Area	Tanged Piece	Tanged Point	Fragment A	Fragment B	Total	%
Erg Titersin	1	1	1	-	3	4.4
Tadrart Acacus	3	5	1	-	9	13.2
Erg Uan Kasa	1	3	-	1	5	7.4
Messak	7	6	9	7	29	42.6
Edeyen of Murzuq	1	18	-	3	22	32.4
Total	13	33	11	11	68	100.0

Tab. 1 – Sample composition according to Area and Group.

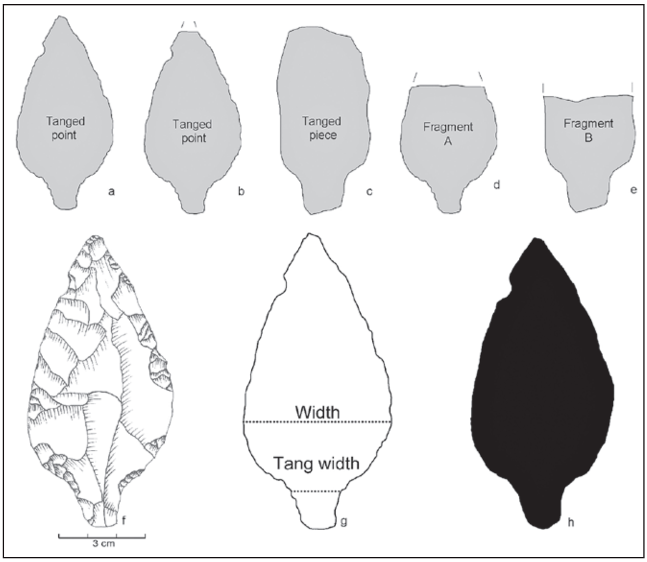

Fig. 2 – a-e) exemplification of the grouping of tanged tools adopted in this study (see text for details); f) tanged point from Uan Tabu (redrawn from Garcea 2001a); g) exemplification of the measures considered; h) filled outline of the tanged point depicted in f.

The classification of tanged tools is simplified. It can be summarized as: pointed, not pointed, and fragments. It resulted in the establishment of four classes, according to morphology and integrity (Tab. 1; Fig. 2). Tanged point (Fig. 2a, b) includes all the specimens typologically definable as points as well as some broken ones lacking a very small part of the distal end. It should be further stressed that Tanged point encompasses all those artefacts with distally converging sides, regardless of retouch. Tanged piece (Fig. 2c) includes the specimens not typologically definable as points (scrapers, flakes, blades, etc.). Fragment A are broken specimens whose edges are clearly convergent (Fig. 2d) while Fragment B are broken specimens whose edges are not convergent (Fig. 2e). Although basic, this classification introduces a differentiation to speculate further on.

Two analytical approaches are followed: i) one is a metric analysis, ii) one deals with shape and adopts Elliptical Fourier Analysis to discretize continuous data like artefacts outlines. The results are then compared and plotted against geographical and environmental features The metric analysis consisted in recording two measures with a screen calliper from all the artefacts: maximum artefact width (hereafter W) and maximum tang width (hereafter TW) (Fig. 2g). This because they are not – or scarcely – sensitive to fragmentation and can therefore be recorded from the whole sample. The shape analysis relied on a 2D technique applicable to closed curves, routinely adopted in biological sciences (Ferson *et al.* 1985), more rarely in archaeological research until not too long ago (Saragusti *et al.* 2005).

Current applications, computer assisted and specifically designed for the analysis of stone tools (Iovita 2010), have proven to be a powerful aid in the understanding of subjects like for example the relation between shape, size and resharpening (Iovita 2011; Iovita, McPherron 2011) and of core variables involved in shape and size predetermination in different flaking methods (Rezek *et al.* 2011; Picin *et al.* 2014), in a better understanding of the relation between shape and tools' function (Borel *et al.* 2017) or to gain insights from old collections for which context data, especially chronological ones, are lacking (Mesfin *et al.* 2020).

This study aims at investigating morphometric variability following similar protocols. To do this, it has been used the software SHAPE, developed by Iwata, Ukai (2002) for biological shape analyses. This software[1], automatically generates the contours from digital images that were re-drawn to obtain Black and White Bitmap images with well defined outlines to be best processed by the software (see Fig. 2h for an example), delineates the contour shape with the Elliptic Fourier Descriptors (EFDs), and performs the Principal Component

[1] Available at http://lbm.ab.a.u-tokyo.ac.jp/~iwata/shape/index.html (last accessed 06/06/2021).

Analysis (PCA) based on variance/covariance matrix of the coefficients for summarizing the information about shape (Iwata, Ukai 2002).

4. Results and discussion

A summary of descriptive statistics for the range of variation of the two measures (W and TW) for each group is presented in Tab. 2, while Fig. 3 shows scatterplots of absolute values for the same measures. Globally, the artefacts show widths between 23 and 67 mm (mean 38.34 mm) and tang widths between 11 and 32 mm (mean 15.29 mm). When considering the morphological groups defined *a priori* on the basis of the criteria specified in §3, a differentiation is observable by looking at the Coefficient of Variation scores

	Tanged Point		Fragment A		Tanged Piece		Fragment B		Whole sample
	W	TW	W	TW	W	TW	W	W	TW
N	33	33	11	11	13	13	11	68	68
Min	23	11	32	12	24	11	28	23	11
Max	57	26	45	20	56	32	67	67	32
Mean	37.24	14.97	38.64	14.91	37.54	16.15	42.27	38.34	15.29
Variance	64.19	14.28	20.25	8.09	106.27	32.97	181.22	83.03	15.49
St. dev	8.01	3.78	4.50	2.84	10.31	5.74	13.46	9.11	3.94
Median	38	14	39	14	33	14	34	38	14
CV	21.5%	25.2%	11.6%	19.1%		35.5%	31.8%	23.8%	25.7%

Tab. 2 – Summary of descriptive statistics. W: max artefact Width; TW: max Tang Width; measures in mm.

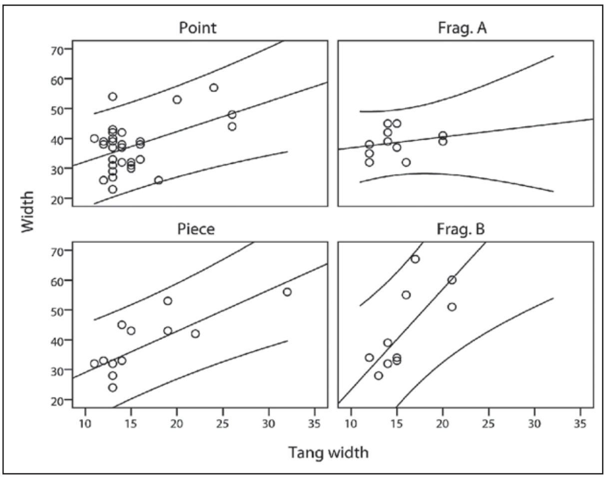

Fig. 3 – Scatter plots of Tang width on Width values (mm) for each group of tanged artefacts. Confidence intervals (95%) around linear regressions are indicated.

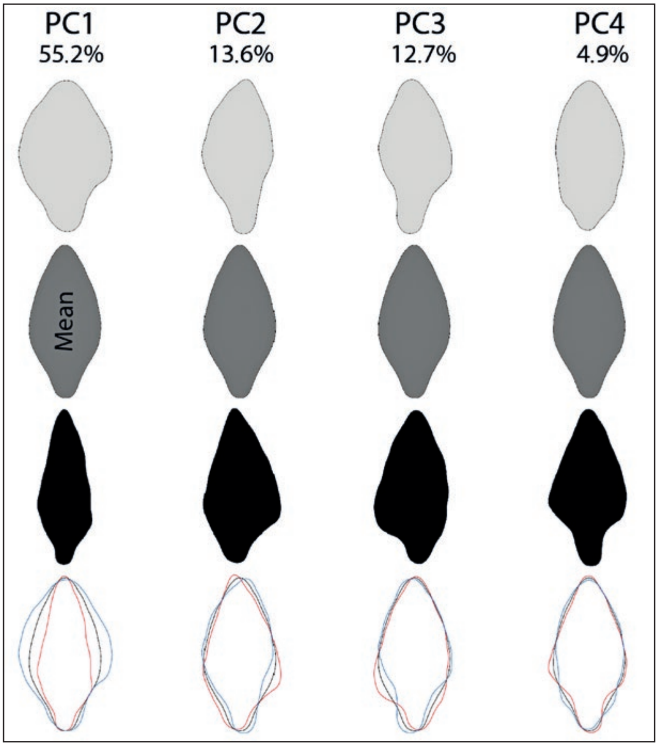

Fig. 4 – Graphic representation of variation of the first four Principal Components.

(Tab. 2), signalling wider and more scattered variations of the two measures in both Tanged piece and Fragment B than in Tanged point and Fragment A.

The extent to which a correlation exists between W and TW has been evaluated by a correlation test (Pearson). Relatively significant correlation is indicated only for Tanged piece ($r = 0.769$, $p = 0.002$) and Fragment B ($r = 0.744$, $p = 0.009$), whereas Tanged point ($r = 0.475$, $p = 0.005$) and Fragment A ($r = 0.232$, $p = 0.493$) testify to a weaker correlation (in the case of Fragment A this is not statistically significant). These figures could indicate that the width of the tang and the maximum morphological width of tanged points and fragments with convergent edges (Fragment A) are almost independent from each other, while a possible functional relation between the size of the two, among Tanged piece and Fragment B, can be tentatively envisaged as they seem to vary less independently from each other.

Shape analysis was performed on 32 whole specimens, the ones comprised in the group Tanged point (except one where most part of the tang is missing). Parameterization relied on 20 harmonics and resulted in the identification of 8 effective Principal Components. PC1 to PC4 globally account for 86.6% of total variability and describe clearly recognizable shape variations, while the remaining PC5 to PC8 show a lower incidence and denote an unclear nature. PC1 accounts for elongation while PC2 and PC3 for symmetry. PC4 is principally related to tang delineation and protrusion (Fig. 4). Almost half of total variability depends on elongation (PC1, 55.2%). PC2 (13.6%) and PC3 (12.7%) seem referable to respectively left and right asymmetry to the longitudinal morphological axis. While the lowest values of PC2 and PC3 are clearly meaningful, the upper ones are less so. Finally, PC4 (4.9%) is related to the shape and delineation of the tang, but also with the recognisability of a discontinuity between the main body of the artefact and the tang.

Regressions calculated for PC1 to PC4 on both the two metric variables W and TW are nearly not statistically significant. The only exception is represented by W on PC1 ($R^2 = 0.239$, $p = 0.005$) and W on PC4 ($R^2 = 0.311$, $p = 0.001$), suggesting that narrower points are likely to be more elongated than wider ones and to have less recognizable tangs.

In order to keep data as much aggregated as possible – given the artefacts' little sample size – while retaining a basic level of regional differentiation, the investigation of the morpho-metric variation in a regional perspective relied on a classification of the study area in only two macro-physiographic contexts. These are: 1) highlands, comprising the mountains of Tadrart Acacus and Messak, and 2) lowlands, encompassing the sand seas of the Erg Titersin, Erg Uan Kasa and Edeyen of Murzuq.

First, tangs carry information about the part of the stone tools supposedly inserted into a haft. This latter is designed in advance and keeps its characteristics over a time span much longer than the life-cycle of the stone tools it holds, and it can be speculated that more than one "spare part" could have been used with the same haft. The size of the tang is closely dependent on the haft properties, to which is adapted by the retouch. This could occur also during a final shaping phase, while the tool is already in the haft and prior to binding, in order to better fit its shape and ultimately improve binding strength (Van Peer *et al.* 2008). Tang size and morphology are thus strictly related to those of the hafts, which arguably deserved a high degree of craftsmen's curation, and similarly arguably could have also carried a significant part of non-strictly functional value (Wiessner 1983).

With these expectations in mind, it has been investigated if Tang Width could suggest some meaningful variation at an intra-regional scale. As visible in Fig. 5, Tang width shows some degree of variability according to both the macro-physiographic contexts and to morphological groups. The overall coefficient of variation highlights a more dispersed range in the Highlands (CV

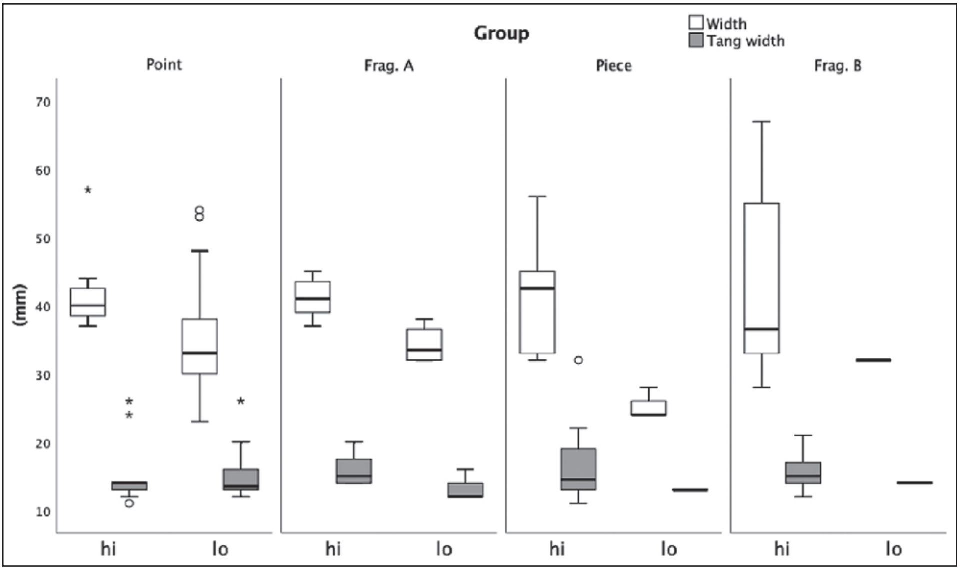

Fig. 5 – Box-plots for Tang width and Width according to group and macro-physiographic context (hi: Highlands; lo: Lowlands).

28.1%) than in the Lowlands (CV 20.1%), which is also observable in the case of morphological groupings, especially in Tanged point (CV Highlands 32.2%; CV Lowlands 21.5%) and Tanged piece (CV Highlands 36.8%; CV Lowlands 0%). One-way ANOVA test results ($F (1,66) = 3.072$, $p = 0.084$) signal no – or at most, marginally – statistically significant differences between TW of Lowlands and Highlands groups of findings. Therefore, it can be stated that, at least with the present data-set and present degree of resolution of the analysis, Tang width does not indicate significant intra-regional metric variability pattern. Although partially perceptible, differences actually do exist, but they are nevertheless hardly frameable in assumptions of either functional, economic or ecological nature.

The other side of the coin is represented by the part of the tanged tools extending out of the haft, purportedly not ruled by strict hafting constrains. This part ultimately accomplishes the functions the tool was made for. An overgeneralization could discriminate into pointed artefacts as either processing (e.g., piercing, cutting, scraping) and acquiring tools (hunting, fishing), while the not pointed specimens as processing tools only.

The Width of tanged artefacts seem to provide signs of differentiation between macro-physiographic contexts. The group Tanged point is the most complete, and its variability is observable through all the macro-areas. The lag recognizable in W between Acacus and Messak on one side (highlands), and the sand seas (lowlands), is remarkable (Fig. 5), and it can be also observed that tanged points from lowlands are overall narrower than the ones from the highlands. The same contrast between lowlands and highlands is also observable for Fragment A and Tanged piece (Fig. 5), while the variation of W in Fragment B is only observable within mountain ranges.

Overall coefficient of variation does not highlight a marked difference between highlands and lowlands (CV highlands 20.6%; CV lowlands 22.6%), whereas it reveals a quite differentiated pattern if morphological groups are considered: Tanged point width shows a less dispersed range of variation in the highlands (CV 13.2%) than in the lowlands (CV 23.4%), while Tanged piece would suggest a somewhat inverse pattern (CV highlands 21.2%; CV lowlands 9.1%). Fragment A has comparable values (CV highlands 7.5%; CV lowlands 8.4%) while Fragment B, available only for highlands, testify to a quite high dispersed range of variation (CV 31.7%).

There were statistically significant differences between overall lowland and highland groups as determined by one-way ANOVA ($F(1,66) = 16.371$, $p < 0.001$). As far as morphological groups are concerned, statistically significant differences between lowland and highland groups are also determined by one-way ANOVA for Fragment A ($F(1,9) = 13.338$, $p = 0.005$), Tanged Piece ($F(1,11) = 9.205$, $p = 0.011$) and Tanged point ($F(1,31) = 6.268$, $p = 0.018$), whereas Fragment B ($F(1,9) = 0.616$, $p = 0.453$) shows no statistically significant differences between groups.

These observable and significant differences of artefacts' width between lowlands and highlands could depend on a number of factors, none of which is solidly affordable. Nevertheless, one could conjecture on different technological traditions and chronology of occupation; on different technological responses to differentiated functional requirements ruled by the type of resources available through different environmental settings; on diverse raw materials constrains, assuming that the large availability of good quality rocks in the mountains, especially in the Messak, could have allowed and favoured the more frequent replacement of tools, whereas the minor availability of raw materials in the lowlands could have induced to rely more on re-sharpening to extend the life time of the stone tool implements.

Variability between lowlands and highlands have been evaluated also according to the results of 2D shape analysis of tanged points, which revealed quite meaningful regional data patterning. Fig. 6a shows a comparison of tanged points PC1 from lowlands and highlands sites. As observable, the range of variation of PC1 of the former fully encompasses the whole range of the latter. It can be also observed that PC1 of tanged points from the highlands are mostly included in the positive range of values, while lowlands tanged points PC1 also extend well into the negative ones. By a morphological point

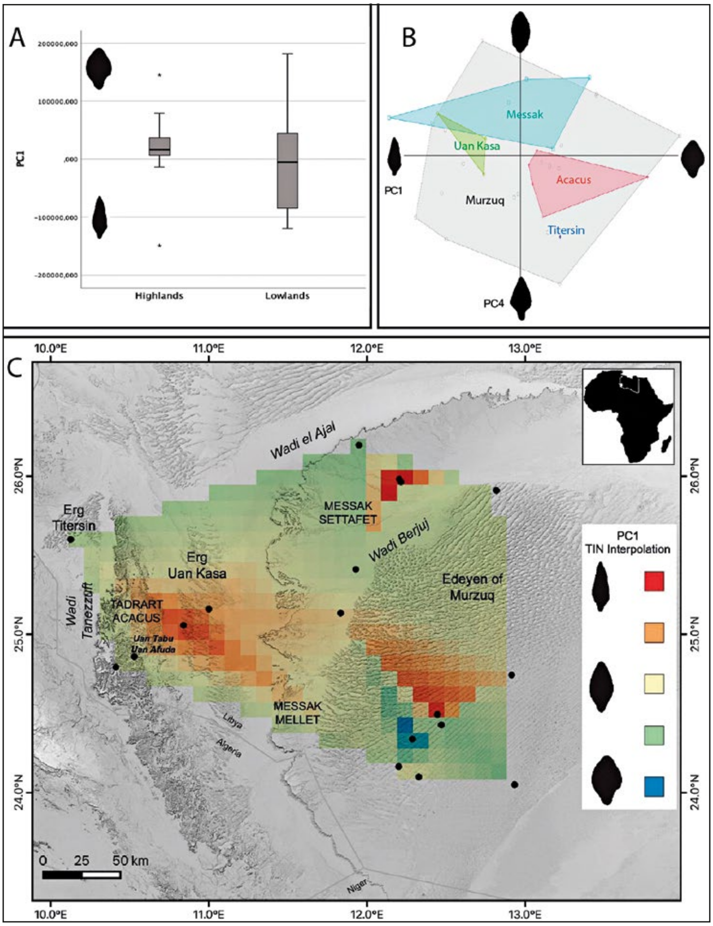

Fig. 6 – a) box-plots for Tanged point PC1 according to macro-physiographic context; b) scatter plot and convex hulls for PC1 and PC4 (tanged points) according to area; c) TIN Interpolation of tanged points PC1 scores; black dots indicate the localization of the tanged points included in the analysis.

of view, these figures can be grossly translated into the recognition that tanged points from the highlands are generally little elongated and rather "stocky"; on the other side, tanged points from the lowlands encompass a wider range of morphological configurations.

Finer insights can be gained by looking at the single areas. The ranges of variation of PC1 of tanged points from Tadrart Acacus and Messak (highlands) and Erg Uan Kasa and Erg Titersin (lowlands) visible in Fig. 6b draw almost non-overlapping areas, while the variability of the specimens

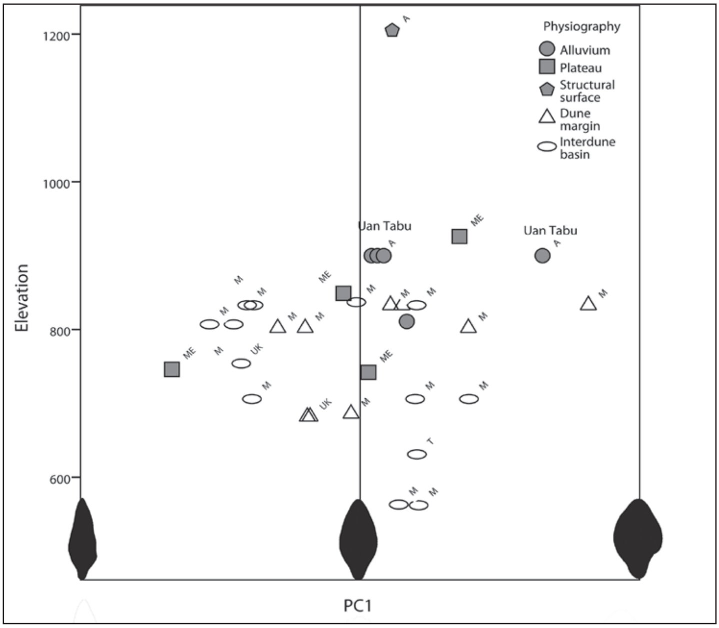

Fig. 7 – Scatter plot of Elevation on PC1 (tanged points), per physiography and area (solid symbol: highland; empty symbol: lowland). A: Acacus; ME: Messak; UK: Uan Kasa; T: Titersin; M: Murzuq.

from Murzuq nearly encompasses the variability of the whole region. Further examination of the relationship between morphometric variability and environmental characters is done by considering the elevation of the findings and their physiographic contexts (Fig. 7). The sites are globally comprised between ca. 500 and ca. 1200 m asl. The highest elevation is registered at site AT8, located on a structural surface in the Acacus (Cremaschi *et al.* 1998). The lowest elevations are recorded in the most depressed interdune basins of the Murzuq basin. Most of the findings, though, are at elevations comprised between ca. 700-900 m asl and come from dune margins and interdune basins in the lowlands, alluvia and plateaux in the mountains.

While no obvious connection can be recognized between the environmental and morphometric features above discussed, it can nevertheless be remembered that the most part of shape variation of tanged points from the highlands is limited to the positive values of PC1. Among these are the ones from Uan Tabu, which are the only dated Aterian artefacts in the region and the wider central Sahara. If cautiously keeping them as reference, it can be speculated that specimens with similar features from undated sites could broadly belong to a chronological span comparable to the Aterian of the Acacus. Recalling that the occupation of the mountain ranges in hyperarid MIS4 is in accordance with their nature of refugia, while in the same time span the sandy lowlands should have been far less productive environments (Cancellieri, di Lernia 2013), the presence of tanged artefacts of an "Acacus appearance" in the lowest interdune depressions of the sand seas (Figs. 6c, 7) could suggest that the arid survival skills of MIS4 Aterian humans allowed them to take advantage also of residually productive environmental niches within an overall drying environment.

According to this hypothesis, the high morphometric variability exhibited by the Edeyen of Murzuq sample could be the result of multiple dynamics of human occupation within shifting environmental conditions including the cyclically earlier wetter phases recognized in the region in the late Middle Pleistocene and Late Pleistocene (Drake *et al.* 2008; Geyh, Thiedig 2008), during which lowlands could have been capable to fully sustain a complex human settlement-subsistence system. In this scenario, the scarcity of more elongated and narrower tanged points within the mountain ranges could suggest that these areas played a different role in the framework of subsistence-settlement-systems relying more on the resources provided by the lowlands.

An alternative and possibly more parsimonious interpretation is that the tanged points of an "Acacus appearance", like those of Uan Tabu, pertain to the material culture of a residual Aterian occupation confined to mountain environments deriving from an earlier more variable artifactual base, like i.e. that recognized in the Edeyen of Murzuq.

5. Conclusions

Although based on a relatively small sample, this study further confirms that geospatial analysis of archaeological and environmental data is a fertile approach. The analysis of size and shape of Middle Stone Age tanged tools in a regional perspective, in fact, has highlighted significant data patterning throughout the study area, especially if macro-categorization (like e.g., highlands vs lowlands) is adopted. The morpho-metric variability recognized at an intra-regional scale revealed meaningful connections with specific physiographic settings. However, the weight and role of environmental variables and of cultural dynamics is currently far to be understood.

While acknowledging that shape and size variation are far to be chronological or cultural markers, and being equally aware of the limits and pit-falls of chrono-typological approaches, it has to be admitted that surface sites in highly deflated desert contexts provide few indicators other than artefacts' morphological variability. It is thus suggested, on the basis of the observations carried out in this study, that at least part of the variability encountered depends on different technological traditions carried by human groups through different chrono-environmental settings.

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ABSTRACT

Morphometric characters of Middle Stone Age stone artefacts from SW Fezzan (Libya, Central Sahara) are investigated. The raw data set is composed of illustrations of tanged pieces from surface scatters and from one stratified and dated site. Both metric and shape analyses are used. The first is carried out on the basis of maximum artefact width and tang width from the whole data set; the second adopts Elliptical Fourier descriptors obtained from 2D contours of tanged points. The geospatial analysis of morphometric variability in a regional perspective shows some meaningful variations between artefacts coming from "highland" and "lowland" physiographic contexts. While the latter encompass most of the regional variability, the former seem to show a narrower range of variation, which could depend on a number of reasons including diverse chronology of occupation, different technological traditions or ecological constraints. The general data patterning is here interpreted in the light of the hypothesis that the water resources kept by the mountainous areas also under environmental stress possibly

allowed them to act as a refugium during the most arid phases of the late Pleistocene. An intense occupation of the lowlands during similar chronological time frames and environmental conditions is less likely because of an inferable lower carrying capacity. The regional artefacts' morphometric variability could thus mirror the population dynamics reconstructed so far for the study area: the record from the mountain ranges testifies for a residual occupation of humans skilled in arid survival, while the lowlands possibly hosted more varied population dynamics especially during cyclically earlier wetter conditions.