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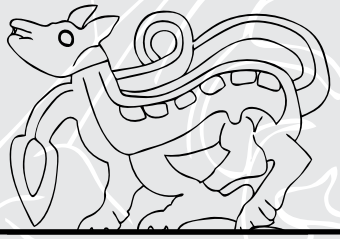

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03

Geometric microliths as chronological and cultural markers in the Sado shell middens? Reflections from Amoreiras (Alcácer do Sal, Portugal)

Microlitos geométricos como marcadores cronológicos y culturales en los concheros del Sado. Reflexiones desde Amoeiras (Alcácer do Sal, Portugal)

Diana Nukushina

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Abstract

The production of geometric microliths from bladelets has been identified as one of the main strategies of lithic production during the Late Mesolithic in southwestern Portugal. The Sado shell middens generally possess an abundance of these tools, similarly to sites found in other regions. However, systematic lithic studies are still scarce. In this work, we discuss the value of the geometric microliths as chronological and cultural markers, through the analysis of lithic remains from Amoreiras shell midden (Alcácer do Sal). First, a formal characterization of this assemblage is performed. Second, a diachronic and cultural perspective of these materials in the Sado shell middens is provided. Finally, a comparison with other Late Mesolithic and the Early Neolithic assemblages from southwestern Iberia is presented. A set of lithic remains from Amoreiras, which was recovered in the 1950s and 1960s, was subject to a techno-typological analysis, following the assumptions of the 'chaîne opératoire'. Also, a statistical analysis, including variance analysis, was performed. This work shows that the geometric microliths from Amoreiras clearly represent one of the main purposes for the debitage at this site, which presents an outstanding typological and size uniformity. The characteristics found by this study suggest the existence of a well-standardized production of geometric microliths. This production scheme would be more economic in terms of raw material requirements and production time-effort. The material and chronometrical data from Amoreiras contradicts the cultural uniformity perspective for this specific site and for the Sado shell middens in general. Moreover, in light of the presented data, a strict chrono-cultural significance of the segment dominance is difficult to sustain. Despite the standardi-

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zed production and the importance given to geometric microliths, the data provided by the forms and their variations is still insufficient for a comprehensive approach to the social issues in the Sado valley, during the Mesolithic-Neolithic transition.

Keywords: Geometric microliths; lithic industries; Sado shell middens; Amoreiras; Alcácer do Sal – Portugal; Mesolithic-Neolithic Transition

Resumen

La producción de microlitos geométricos a partir de hojitas ha sido considerada como una de las principales estrategias de producción de herramientas líticas en el suroeste de Portugal durante el Mesolítico Final. Los concheros del Sado contienen generalmente gran cantidad de estas herramientas, al igual que ocurre en yacimientos de otras regiones. Sin embargo, todavía son escasos los estudios sistemáticos realizados a estas industrias líticas. En este trabajo discutimos el valor de los microlitos geométricos como marcadores cronológicos y culturales, a partir del análisis de los materiales líticos recuperados en el conchero de Amoreiras (Alcácer do Sal). En primer lugar realizamos una caracterización formal de estas industrias. En segundo lugar ofrecemos una perspectiva diacrónica y cultural de estos materiales de los concheros del Sado. Finalmente los comparamos con otros conjuntos del Mesolítico Final y del Neolítico Antiguo procedentes del sudoeste de la península ibérica. Hemos realizado un análisis tecno-tipológico a un conjunto de piezas procedentes de Amoreiras y recuperadas en los años cincuenta y sesenta, siguiendo el modelo de 'chaîne opératoire' (cadena operativa lítica); y también un estudio estadístico, incluyendo un análisis de la varianza. Mostramos que en Amoreiras la elaboración de microlitos representa con claridad uno de trabajos principales de talla, con una considerable uniformidad tipológica y de tamaño; todo ello sugiere la existencia de una producción de microlitos geométricos perfectamente estandarizada, siguiendo un esquema productivo que sería más económico en cuanto a las necesidades de materia prima y la relación tiempo-esfuerzo. El material y los datos cronológicos procedentes de Amoreiras contradicen la uniformidad cultural habitualmente defendida para este yacimiento y en general para los concheros del Sado. Además, a la luz de los datos presentados, es difícil sostener un estricto significado crono-cultural para estos materiales. A pesar de su producción estandarizada y de la importancia dada a los microlitos geométricos, los datos proporcionados por las formas y sus variantes son todavía insuficientes para alcanzar una visión global de los aspectos sociales de la transición entre el Mesolítico y el Neolítico en el valle del Sado.

Palabras clave: microlitos geométricos; industrias líticas; concheros del Sado; Amoreiras; Alcácer do Sal (Portugal); Transición Mesolítico-Neolítico

1. Introduction and goals

1.1. The lithic industries from the Sado shell middens

The Sado valley's shell middens can be found along a roughly 15 km long stretch of the river, around 40 to 50 km away from its current estuary, in the municipality of Alcácer do Sal, in the southern region of Portugal. These sites are primarily known for the Late Mesolithic and, occasionally Neolithic, occupations. The first excavations were performed during the 1950s and 1960s by Manuel Heleno, director of the National Museum of Archaeology (MNA) at the time. However, these works are only known through scarce and brief news (ex: Heleno 1956), and short reports written by the fieldworks collaborator Jaime Roldão (ex: Roldão 1956, 1958).

Despite a fairly long research history and the massive quantity of materials recovered in the excavations of the 1950, 1960s and the 1980s, systematic analysis of lithic industries are still scarce. Analysis of this kind were only carried out in the cases of the lithic remains recovered in Poças de São Bento (Araújo 1995-1997), Várzea da Mó, Cabeço do Rebolador (Marchand 2001) and recently Amoreiras (Nukushina 2012) and Arapouco (Diniz and Nukushina 2013). The size, method of recovery, and type of analysis made vary greatly. The analyzed assemblages have different dimensions and were obtained from methodologically diverse excavations. Also various strategies of lithic analysis were used. Furthermore, the artifacts have been taken as a whole, without considering stratigraphic differences, due to the scarcity of this information.

It has been stated that rocks of generally poor quality for knapping were exploited in the Sado valley, mainly obtained from nearby sources (Araújo 1995-1997; Marchand 2001; Pimentel *et al*. 2013). Two main strategies of lithic production have been identified: on the one hand, the production of bladelets from fine-grain rocks, using prismatic cores (mainly geared towards the manufacture of geometric microliths); on the other hand, the production of irregular flakes, from a non-standardized exploitation of the rock volumes. These flakes would be used either without retouch or, occasionally, transformed into tools. The materials which would result from core preparation and maintenance are uncommon (Marchand 2001:55; Nukushina 2012:36). Finally, tools are little diversified and often dominated by geometric microliths.

1.2. Amoreiras shell midden: archaeological data and problems

Amoreiras (Cabeço das Amoreiras or S. Romão) is a shell midden located in the left margin of Sado river at 52 m of altitude (Figure 1). This shell midden has an estimated area of 1270 m^2 (Arnaud 1989:619) and its positioning allowed an outstanding control of the river (Figure 2). It sits on the geologic formation of Vale

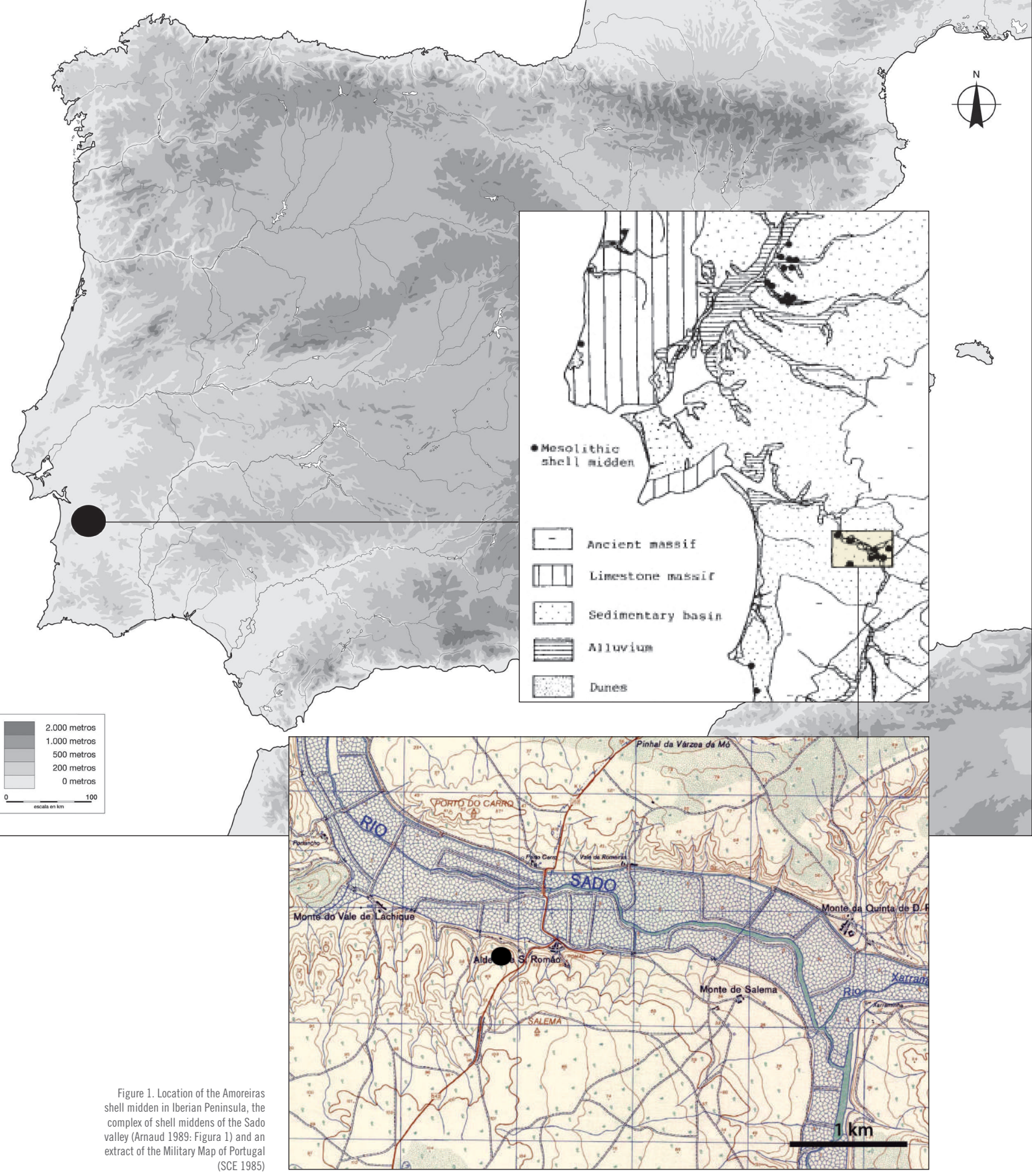

Figure 1. Location of the Amoreiras shell midden in Iberian Peninsula, the complex of shell middens of the Sado valley (Arnaud 1989: Figura 1) and an extract of the Military Map of Portugal (SCE 1985)

de Guizo, which is composed by conglomerates, sand, arkoses, pellets and limestones (Gonçalves and Antunes 1992:43).

Amoreiras was first excavated during the 1950s and 1960s under the direction of Manuel Heleno. According to J. Arnaud (2000), a 13 m long trench (Area A) (Roldão 1958), a rectangular area on the highest zone of the hill and various peripheral and small areas were excavated (Figure 3). The site was excavated through artificial levels of 25 cm (Arnaud n.d.). Thousands of archaeological materials were recovered and six human skeletons were found, but not published. The artifacts were preliminarily studied in the 1980s under the research project of J. Arnaud (1989, 2000). New excavations (1984-1986) suggested that the shell midden would have mainly developed in area, through the juxtaposition of small amounts of shells (Arnaud 1986:81). More lately, several analysis were undertaken on the anthropological (Cunha and Umbelino 1995-1997, 2001; Cunha *et al.* 2002), ceramic (Diniz 2010) and faunal remains (Albizuri Canadell 2010; Dean 2010).

Figure 2. View of the Cabeço da Amoreira hill from the Sado River (2011)

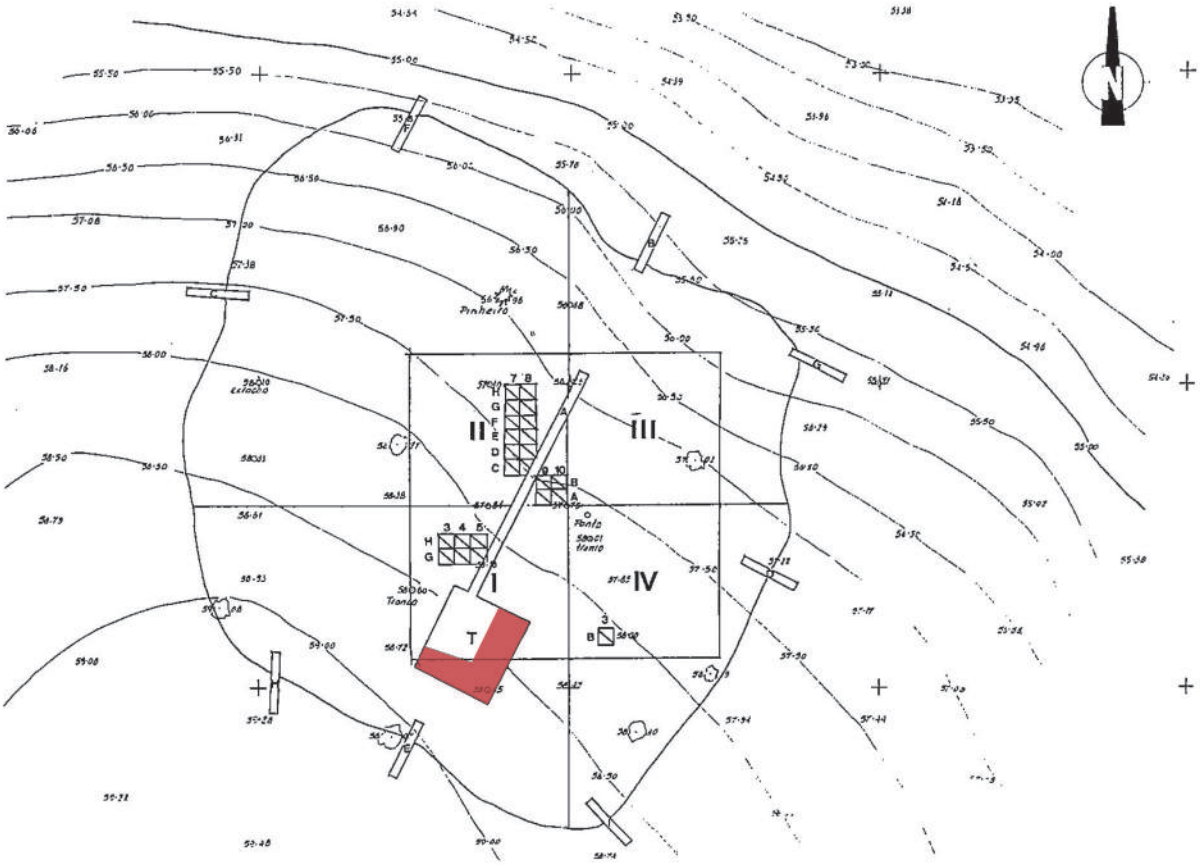

Figure 3. Excavation areas at Amoreiras shell midden (map from Arnaud 2000:Figure 6) and indication of the provenance of the studied lithic materials

Despite the relative scarcity of studies, Amoreiras has been cited as one of the most recent Sado shell middens with probable interactions between Mesolithic and Neolithic groups (Arnaud 2000:32; Zilhão 1998:30). Arnaud (2000) proposed an occupation centering around the transition between the 6th to 5th millennium BC, during the Neolithization process. Arnaud's argument is based on the presence of ceramic fragments with cardial decoration in the lowest levels of the area excavated in the 1980s, and the radiocarbon dating of carbon and shell samples (Table 1). The relatively 'recent' aspect of the midden was also addressed by Marchand (2001, 2005), focusing on the large amount of segments among the geometrics, as Arnaud refers in passing (1989). The site was inserted in the last phase of the chronological and typological model proposed for the Late Mesolithic of central and southern Portugal. More recently, the dating of the 'skeleton 5' from Amoreiras –Beta-125110: 7230±40 14C BP (Cunha and Umbelino 2001:Table 1)– has caused the site's chronology to be rethought, placing its occupation around the 7th and the beginning of the 6th millennium cal BC (Diniz 2010). Several occupations during the Neolithic were recognized in the analyses

REFERENCE	SAMPLE TYPE	CONTEXT	$\delta^{13}C$ (‰)	^{14}C BP	ΔR	Cal BC, 1σ	Cal BC, 2σ
Q(AM85B2a)	Carbon	c. 2a (level B)	-	5990±75	-	4981-4791	5198-4707
Q(AM85B2b)	Shell	c.2b (level B)	-	6370±70	-170±60	5210-4989	5306-4872
Beta-125110	Bone (Homo)	Skeleton 5	-20,8	7230±40	-	6204-6030	6212-6020

Table 1. Radiocarbon dates for the Amoreiras shell midden. Bibliographical references: Q(AM85B2a) e Q(AM85B2b) (Arnaud, 2000); Beta-125110 (Cunha and Umbelino 2001). ΔR value (years 14C) calculated from the datation of the samples from Vale de Romeiras (Soares 2004). Calibrations obtained by using the program CALIB rev. 6.1.0. (Stuiver and Reimer 1993) and the curve IntCal09 for Q(AM85B2a) and Beta-125110 and Marine09 for Q(AM85B2b)(Reimer *et al.* 2009)

of pottery remains (Diniz 2010), which increased the controversy surrounding the site. A preliminary analysis of the animal remains from the 1980s campaigns (Albizuri Canadell 2010) found only wild species, with the exception of dog. Despite the reduced sample size, the absence of domestic fauna in a site apparently occupied by different Neolithic groups (Diniz 2010:52) suggests, in our opinion, a temporary character of the post-Mesolithic occupations.

1.3. Aims of the lithic analysis

Given the dissimilar interpretations and the research problems around Amoreiras, a systematic analysis of the lithic remains from the excavations carried out by Heleno seemed crucial to characterize this material component. This analysis (Nukushina 2012, in detail) attempted to identify the main strategies of the lithic production, and eventually the presence of Early Neolithic typological and technological characteristics of central and southern Portugal (Carvalho 2008a; Manen *et al.* 2007; Marchand and Manen 2010) in the site, to shed light on the problematic of the post-Mesolithic occupations of Amoreiras.

2. Methodology

A sample of the lithic materials from the central area excavated by Heleno ('extension of the excavation area A'), was analyzed, following the *'chaîne opératoire'* concept (Inizian *et al.* 1999; Tixier *et al.* 1980). Technological categories were studied through qualitative and metrical attributes according to the propositions of several authors (Araújo 1995-1997, 2011; Carvalho 1998, 2008a, 2008b; G.E.E.M. 1969; Inizian *et al.* 1999; Tixier *et al.* 1980; Zilhão 1997). In this text, we will focus on the assemblage of geometric microliths[1].

1 Other aspects of the lithic industry are described in Nukushina 2012.

The variance of the metric data was analyzed using ANOVA tests to detect statistically significant differences between lithic assemblages with distinct attributes. If *F >F critic*, the differences on the dimensions of the assemblages are statistically relevant, and more so for increasing *F*. A level of significance of 5 % was established. Following N. Bicho (1992), it was considered that the *P*-values between 0-0,01 point to significantly different groups, 0,01-0,05 to moderately different groups and >0,05 to not significantly different groups. These results should be interpreted with caution, taking into account the dimension of the samples and the multiple factors that can influence the lithic production.

The lack of contextual information was restrictive for this study, and lead us to approach the materials as a whole, as in previous studies. The conditions in which the remains were collected are relatively unknown, however, the small size of a number of remains recovered (ex: lithic residues) suggests a fairly systematic recovery (Arnaud 1989:615).

3. Results from the lithic analysis of Amoreiras

3.1. Overview of the lithic industry

An assemblage of 1.592 lithic remains was analyzed (Table 2), representing approximately 28 % of the lithic material recovered by Heleno's team and placed in the MNA. Residues compose most of the assemblage (45,67 %), followed by debitage products (31,97 %), predominantly bladelets. However, retouched tools are scarce (16,90 %) and material from core preparation and maintenance operations are residual (1,32 %). A general lithic decrease from the upper to the bottom levels is also patent.

Apparently, the main knapping aim was the production of bladelets to be used directly or transformed by retouch. Flakes were obtained in fewer numbers, and the retouch is occasional (16,88 %) in comparison to the bladelets (38,32 %). Overall, the retouched tools were mostly obtained from bladelets (84,76 %).

3.2. The geometric microliths from Amoreiras

3.2.1. Types and sub-types

Geometric microliths are the most common tools (52,79 %), decreasing in number from the upper to the lowest levels (Table 3, Figure 4). This follows the general decreasing tendency of the distribution of all the lithic materials across the artificial levels, not being significant for the interpretation of this material set.

The segment predominance mentioned by J. Arnaud (1989) can be confirmed on the three artificial levels (66,90 % of the total). The symmetrical sub-type is particularly prominent (76,84 %, Figure 5 and 6). Triangles are less representa-

CATEGORY	L1	L2	L3	TOTAL	
CORES	34	21	11	4,15%	66
PREPARATION/MAINTENANCE PRODUCTS	9	11	1	1,32%	21
DEBITED PRODUCTS	285	178	46	31,97%	509
Blades	5	4	0	0,57%	9
Bladelets	212	120	35	23,05%	367
Flakes	68	24	11	8,35%	133
RETOUCHED TOOLS	133	100	36	16,90%	269
Geometrics	71	53	18	8,92%	142
Retouched bladelets	26	20	10	3,52%	56
«Common fund» tools	14	16	2	2,01%	32
DEBRIS	365	335	27	45,67%	727
Fragments	331	281	24	39,95%	636
Chips	12	33	2	2,95%	47
Microburins	22	21	1	2,76%	44
TOTAL (INCLUDING FRAGMENTS)	826	645	121	100,00%	1592

Table 2. Lithic technological categories present in Amoreiras (ext. of the survey A), by level (L)

TOOLS	L1	L2	L3	TOTAL	
Geometrics	71	53	18	52,79%	142
Retouched bladelets	26	20	10	20,82%	56
«Common fund» tools	14	16	2	11,90%	32
Various	22	11	6	14,50%	39
Total	133	100	36	100,00%	269

Table 3. General categories of retouched tools in Amoreiras, by level (total including fragments)

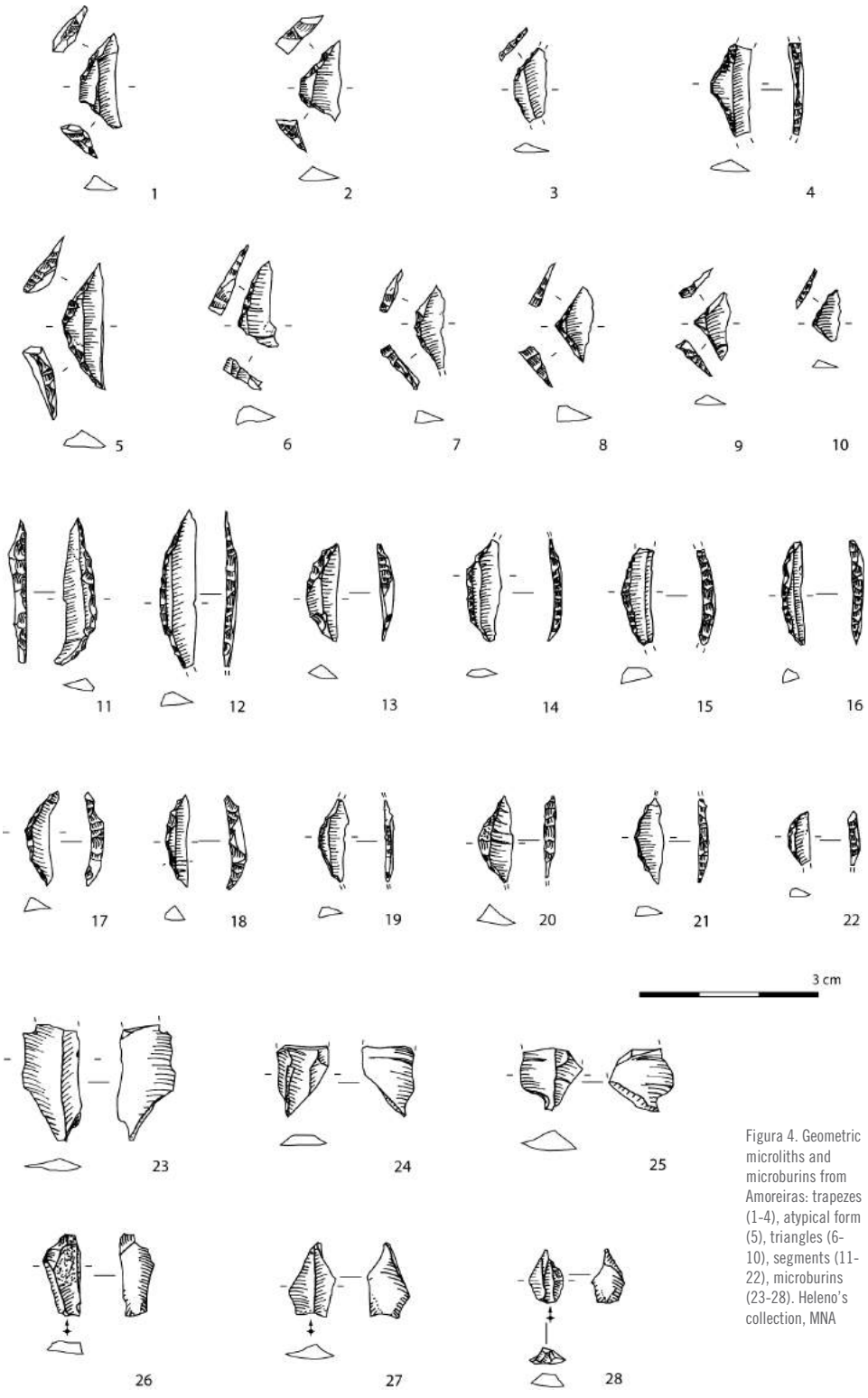

Figura 4. Geometric microliths and microburins from Amoreiras: trapezes (1-4), atypical form (5), triangles (6-10), segments (11-22), microburins (23-28). Heleno's collection, MNA

tive (19,72 %), but their symmetrical forms are also dominant (57,14 %), while trapezes, on the other hand, are rare (9,15 %). From a global point of view, symmetrical types are dominant, showing a high homogeneity of this material set.

Triangles and trapezes often present rectilinear truncations. The microlith retouch is generally direct and abrupt, without significant differences. This uniformity is quite remarkable and can be associated to an absence of changes on the hafting method, possibly done with an adhesive – which could reduce the required time and effort for the production of the projectiles (Yaroshevich 2010:186). Signs of heat treatment (characteristic brightness and homogenous texture, sometimes associated to more aggressive thermal alterations) are visible in some cases (14,79 %), particularly on segments.

Fractures are frequent (59,15 %), but generally small, usually contained to a single extremity (79,76 %), which in some cases (N=10) could probably have

Figure 5. Segments from Amoreiras (Heleno's collection, MNA)

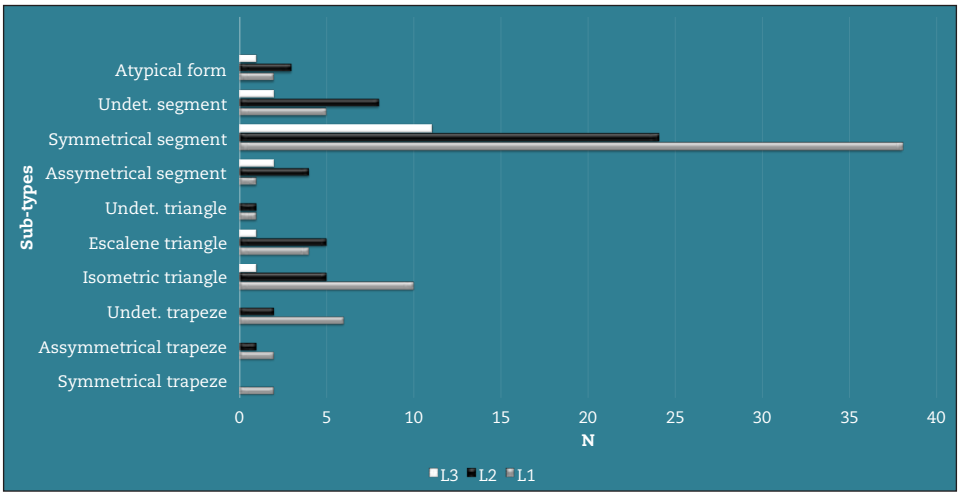

Figure 6. Sub-types of the geometric microliths from Amoreiras, by artificial level (total)

been caused by impact (Nukushina 2012:56). The scarcity of identifiable macro-fractures can be attributed to several factors, namely the hafting mode and the morphology of the geometrics. The experimental study carried out by A. Yaroshevich shows that segments are the geometric type which is more resistant to the impact fracture, when used as points or lateral elements (Yaroshevich 2010:179). On the other hand, the reduced size of the segments also seems to increase the resistance to projectile fracture (Yaroshevich 2010:186). Segments and trapezes from Amoreiras have a higher fracture index (64,21 and 61,54 %, respectively), while triangles are found mainly intact (only 35,71 % are fractured), perhaps due to the lower dimensions of the last type. Some geometrics (8,45 %) also present marks and irregular retouch on the base.

3.2.2. Dimensions

The lengths of the complete geometrics display a clear standardization, with a higher frequency on the 12-14 mm and 14-16 mm classes (Figure 7) (Table 4). Segments are the longest (elongation index=3,42) and triangles the shortest type (EI=2,14), these last ones with a greater variability of length values, between 8-10 mm and 20-22 mm.

Generally, width and thickness present a reduced variation. Segments are the thinnest type, with a reduced deviation (2,12±0,55 mm). This systematic production of thin tools can be interpreted as an efficient strategy for economizing raw-material.

The bladelets produced in Amoreiras appear to be the blanks of the geometrics, since: geometrics are generally narrower than bladelets (mean width for MNI=6,74±1,84 mm); the mean width of the trapezes and some atypical forms (unaffected by retouch) is close to the measurements of the bladelets; the thickness of geometrics and bladelets are similar, in both cases dominant between 1,5-2 mm (Figure 8); concave profiles are prevalent in geometrics, namely in segments (70,59 %), whilst the bladelets are characterized by curved or plunging profiles.

3.2.3. The microburin technique

The microburin fracture technique is attested by its residues in the sample (N=44), which are mostly proximal and are all obtained from siliceous rocks (Figure 9). The number of complete geometrics and microburins is equivalent (1,3:1). Yet, the fragmentation of the majority of the geometrics occurs on the extremities, which means that if we regard the totality of the tools (N=142), the relationship between geometrics and microburins becomes less correspondent (3,2:1). However, as seen by Neeley and Barton (1994:278), the application of these indexes to estimate the intensity of the use of the microburin technique is arguable, as this implies that residues and geometrics are always produced at a similar frequency and that the microburins are never transformed. In fact, this ideal situation might not reflect the reality of the production.

MEASUREMENT	TOTAL	TRIANGLES	TRAPEZES	SEGMENTS	OTHERS
Length					
Mean	14,85	13,99	15,13	15,29	13,95
SD	3,42	3,71	1,43	3,50	-
Conserved width					
Mean	4,92	5,53	-	4,69	5,81
SD	0,83	1,07	-	0,60	0,75
N	128,00	-	-	-	5,00
Original width					
Mean	6,91	-	6,91	-	6,91
SD	0,99	-	1,03	-	-
N	14,00	-	13,00	-	1,00
Thickness					
Mean	2,13	2,14	2,25	2,12	1,94
SD	0,65	0,96	0,60	0,55	0,30
Elongation index					
Mean	3,03	2,54	2,43	3,42	2,48
SD	0,81	0,50	0,26	0,77	-
N (TOTAL)	142,00	28,00	13,00	95,00	6,00
N (COMPLETE)	58,00	18,00	5,00	34,00	1,00

Table 4: Mean dimensions (mm) and standard deviation of geometrics (total). Length and elongation index: complete geometrics. Conserved width: all the geometrics excluding the trapezes and some atypical forms. Original width: trapezes and some atypical forms

In this case, geometrics and unretouched bladelets on siliceous rocks have close length values, suggesting the use of the microburin technique to produce one microlith by bladelet. The mean width of the microburins is 7,15±1,77 mm (Table 5), somewhat greater than the bladelets (6,74±1,84 mm for the MNI), however, there is no statistical evidence for significant differences. The mean thickness is 2,28±0,44 mm, with reduced deviation (0,44 mm). The ANOVA test (Table 6) led us to determine that the thickness differences between microburins, geometrics and unretouched bladelets (MNI) are not statistically significant.

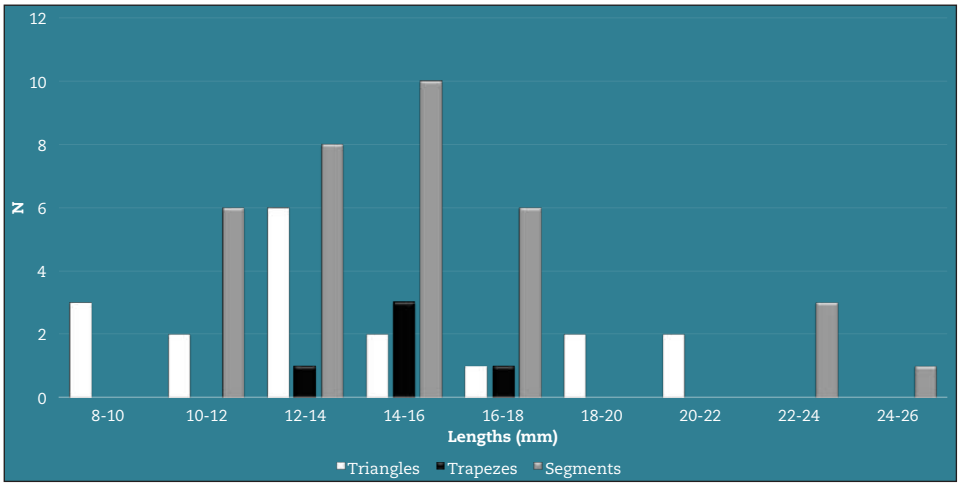

Figure 7. Lengths of the complete geometrics, by classes of 2 mm and types

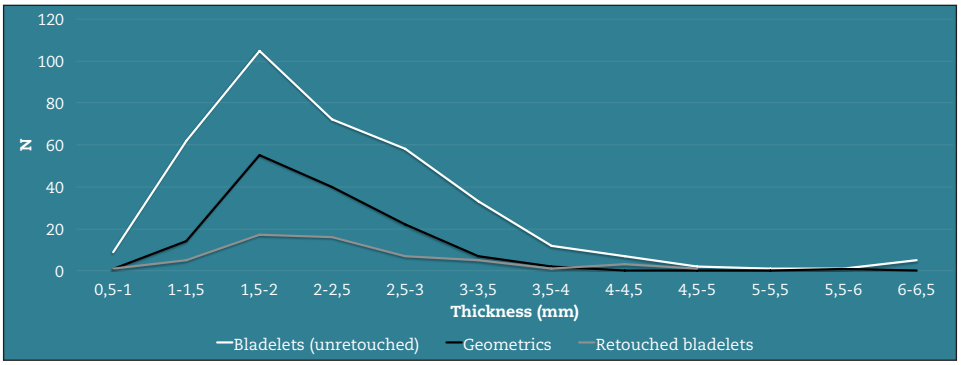

Figure 8. Thickness of unretouched bladelets, geometric microliths and retouched bladelets, by classes of 0,5 mm (total)

3.2.4. General evaluation

The geometric microliths from Amoreiras clearly represent one of the main purposes of the lithic debitage in this site, and also sustain their local production from siliceous rocks. The typological uniformity is evident, not only due to the dominance of segments, but also of symmetrical forms in general. The normalized dimensions of these tools and the respective blanks (bladelets) is another important characteristic to retain, as well as the almost invariable use of abrupt and direct retouch. These elements suggest an intention of a well-standardized production of geometric microliths, which would be more efficient in terms of raw material requirements and production time-effort.

Figure 9. Microburin from Amoreiras (Heleno's collection, MNA)

MEASUREMENT	TOTAL
Length	
Mean	11,86
SD	3,26
Width	
Mean	7,15
SD	1,77
Thickness	
Mean	2,28
SD	0,44
N	44,00

Table 5. Mean dimensions and standard deviation of microburins

4. The geometric microliths from the Sado valley: possible comparisons and interpretations

Currently, systematic comparisons of lithic industries in the Sado valley are only possible for the sites of Amoreiras (Nukushina 2012), Poças de S. Bento (Araújo 1995-1997), Várzea da Mó and Cabeço do Rebolador (Marchand 2001). As different counting, sampling and classification criteria are often employed, it is sometimes impracticable to normalize the values and proceed to rigorous comparisons. Excluding Arapouco (23,87 % according to Diniz and Nukushina 2013) and Cabeço do Rebolador (21,15 %), geometrics are always the dominant tools in the Sado shell middens (Table 7).

Trapezes and segments are the predominant forms, triangles are less recurrent (Table 8). Segments (mainly symmetrical) dominate at Amoreiras and Várzea da Mó (70,18 %). At the first site, the second main typology is the triangle, but at Várzea da Mó, trapezes are more abundant. In the excavation area 1 of Cabeço

GROUPS	COUNT	SUM	AVERAGE	VARIANCE
Geometrics	142	302,54	2,130563	0,416812
Microburins	44	101,47	2,306136	0,372889
Bladelets (unretouched)	186	440,2	2,366667	1,16166

SOURCE OF VARIATION	SS	df	MS	F	P-VALUE	F CRIT
Between groups	4,556226	2	2,278113	2,901585	0,056191	3,020185
Within groups	289,7119	369	0,785127			
Total	294,2682	371				

Table 6. ANOVA test – thickness of geometrics (total), microburins and unretouched bladelets (MNI)

do Pez (CPZ), segments seem more frequent, followed by triangles (Santos *et al.*, Soares and Silva 1974). Nevertheless, according to the report of J. Roldão (1956), in the areas A, B and C, trapezes (mostly asymmetrical) are the main type. On the other hand, at Cabeço do Rebolador and Poças de S. Bento, trapezes are prevalent (mainly asymmetrical), followed by segments. At Vale de Romeiras, trapezes are also predominant (Arnaud 1989), specifically asymmetrical forms[2]. Conversely, segments are mostly symmetrical at Amoreiras, Poças de S. Bento, Cabeço do Rebolador and Várzea da Mó.

SITE	GEOMETRICS		RETOUCHED BLADELETS		'COMMON FUND'		TOTAL
Cabeço do Rebolador (CR)	21,15%	33	1,92%	3	18,59%	29	156
Poças de S. Bento (PSB)	56,09%	244	19,54%	85	13,10%	57	435
Amoreiras (AM)	52,79%	142	20,82%	56	11,90%	32	269
Várzea da Mó (VM)	46,72%	57	17,21%	21	13,93%	17	122

Table 7. Main types of retouched tools in the Sado shell middens. According to Araújo 1995-1997 (PSB); Marchand 2001 (CR, VM). % relative to the total of retouched tools.

The mean thickness of the geometrics from Amoreiras (2,1 mm) runs parallel to the values from Poças de S. Bento. Specifically, the segments from Cabeço do Rebolador, Amoreiras and Várzea da Mó are, size-wise, highly homogeneous (Table 9).

The microburin technique is attested at all the analyzed sites, including Cabeço do Pez (Santos *et al.* 1974), although the microburins are always less occurring than geometrics (Table 10). These residues are quite common in Amoreiras in comparison with other shell middens. In effect, the ratio geometrics-microburins of 3,2:1 at Amoreiras is lower than the average of the Sado middens.

Although this technique's efficiency for the production of small tools from low-quality raw materials has been questioned (Araújo 1995-1997:137), its use appears to be widespread in the Sado shell middens. In the Alentejo region, the Early Neolithic site of Valada do Mato (Évora) demonstrates its heavy use –the quantity of microburins and geometrics in this site is remarkably similar

2 REIS, Helena (in press). «O lugar dos vivos e o lugar dos mortos: o concheiro de Vale de Romeiras (Alcácer do Sal) revisitado». Paper presented to *4º Encontro de História do Alentejo Litoral* (Sines, 26-27 November 2011).

SITE	TRAPEZES		TRIANGLES		SEGMENTS		TOTAL	COMPLETE
CR	60,61%	20	15,15%	5	24,24%	8	33	17
PSB	63,93%	156	11,89%	29	24,18%	59	244	139
AM	9,15%	13	19,72%	28	66,90%	95	142	58
VM	22,81%	13	7,02%	4	70,18%	40	57	32
CPZ	24,32%	18	29,73%	22	45,95%	34	74	-

Table 8. Main typologies of geometric microliths in the Sado valley. According to Araújo 1995-1997 (PSB); Marchand 2001 (CR, VM); Santos Soares and Silva 1974 (CPZ). Sites: CR (Cabeço do Rebolador), PSB (Poças de S. Bento), AM (Amoreiras), VM (Várzea da Mó), CPZ (Cabeço do Pez)

SITE	L	W	T
CR	16,00	4,90	-
AM	15,29	4,69	2,12
VM	15,10	4,70	2,00

Table 9. Mean dimensions (length, width and thickness) of the segments (mm) from the Sado shell middens. According to Marchand 2001 (CR, VM). Sites: CR (Cabeço do Rebolador), AM (Amoreiras), VM (Várzea da Mó)

SITE	%	N	G/M (TOTAL)	G/M (COMPLETE)
CR	0,95%	20	1,7	0,9
PSB	0,45%	38	6,4	3,6
AM	2,76%	44	3,2	1,3
VM	0,74%	9	6,3	3,6

Table 10. Presence of microburins (% relative to the total lithic assemblage) in the Sado shell middens*. According to Araújo 1995-1997 (PSB); Marchand 2001 (CR, VM). G/M = geometrics/microburins. Sites: CR (Cabeço do Rebolador), PSB (Poças de S. Bento), AM (Amoreiras), VM (Várzea da Mó).

(Diniz 2007:94). Curiously, the metric patterns are very similar to those of the bladelets from Sado middens and the microburins from Amoreiras, with dominant width on the 7-7,9 and 6-6,9 mm classes and thickness between 2-2,9 mm. Despite the controversy related to the use of the microburin quantity as a direct indicator of the intensity of the microburin technique –as mentioned in the point 3.2.3 and explained by Neeley and Barton (1994)–, the systematic application of this typically Mesolithic procedure on Early Neolithic blanks with similar dimensions to those from Sado seems somewhat incongruent. However,

the relatively scarce microburin presence in the Sado valley can be explained by several hypotheses:

- It can be related not only to the reduced size of blanks and desired tools, but also to raw-material limitations. Nevertheless, the direct fracture of the bladelets would not allow a precise control of the truncations, which would be limited by the low quality of the raw materials;
- For rock economization, some microburins could be transformed by retouch, making them non-identifiable (Neeley and Barton 1994:278);
- According to some experiments, even a successful microburin fracture can result in residues which are not characteristic of this technique (Finlay 2003:174; Miolo and Peresani 2005:67);
- This being so, there is the distinct possibility that its use in the Sado valley might have been more frequent than what the archaeological record directly suggests.

Overall, these comparisons point to a high degree of uniformity in the lithic production of the Sado valley - not just in formal, but also in metric terms, particularly visible in the bladelets and microlithic tools. Is this dimensional standardization an expression of cultural unity? Or is it related to other factors, such as the limitations of the local raw-materials (low aptitude for knapping and reduced size of the blocks)?

Differences among sites, however, are also apparent. Várzea da Mó shows a stronger production of bladelets in comparison to Cabeço do Rebolador (Marchand 2001:65), where flakes are more abundant than bladelets and geometrics appear in fewer numbers than in other shell middens. For Arapouco, the situation appears to be identical, with flakes being the dominant support for tools (Diniz and Nukushina 2013). The causes of these dissimilarities in the lithic production of the Sado shell middens are still unclear - differences in site functionality, duration and chronology (Marchand 2001:65, 2005a:180), and possibly in raw-material availability, are important factors to take into consideration.

5. The geometric microliths and the Mesolithic-Neolithic transition in SW Iberia

5.1. Geometrics as projectiles: their role in the Iberian Mesolithic-Neolithic lithic assemblages

The proliferation of geometric microliths and the general decrease in the typological diversity of tools are well documented in the Western European Mesolithic (Straus 2002:76), namely during the Atlantic (García Puchol and Aura Tortosa 2006:145). These changes have been explained taking into consideration the advantages of the microlithic technology, specifically the minimization of the 'risk' in the less predictable environments of the Holocene (Straus 2002:78; Vierra 1992:80). These small artifacts would be part of composite tools, mostly projectiles (Chesnaux 2009; Clarke 1978). The standardized production would make them more replaceable, and their use would be in accordance to the hafting method (Domingo Martínez 2005:13). Several functional studies of geometrics from Iberian contexts are corroborating their main use as projectiles for hunting (Domingo Martínez 2005, 2009; Fernández *et al*. 2008; García Puchol and Jardón Giner 1999).

Projectiles have been globally regarded as a dynamic element of the material culture, with morphological and/or the technical characteristics which quickly vary through time and space. In this way, and in accordance to several researchers (as Juan-Cabanilles 2008; Pétillon *et al*. 2009), they are well suited for the establishment of chronologies and the definition of archaeological cultures. Indeed, in the Iberian Peninsula, the geometric microliths from the Late Mesolithic and Early Neolithic have been valued, not only because of their substantial weight in the tool class, but also due to their role in the chronological and cultural ascription of the lithic industries (Fernández *et al*. 2008:305). Since the beginning of intensive researches on these contexts, geometric typological variations were stressed as a component of chronological differentiation within and among several sites, as exemplified by the works at Albarracín shelters, Aragón (Almagro 1944), Muge shell middens, Tejo valley (Roche 1972), La Cocina cave, Valencia (Fortea Perez 1971) and Ebro valley (Barandiarán and Cava 1985). This tendency has prevailed until recent times. For example, O. García Puchol and J. Aura Tortosa (2006:151) highlighted the presence of geometrics in the Late Mesolithic Iberian assemblages, stating that some types of material culture would have been relevant in the expression of identity among human groups. Additionally, for J. Juan-Cabanilles (2008), geometric microliths have a huge morphological and technical charge, due to their high degree of conformation that would imply a significant stylistic and cultural containing.

Notwithstanding their value, the proportion of geometrics (and their types) can be affected by elements which are barely noticeable in the archaeological

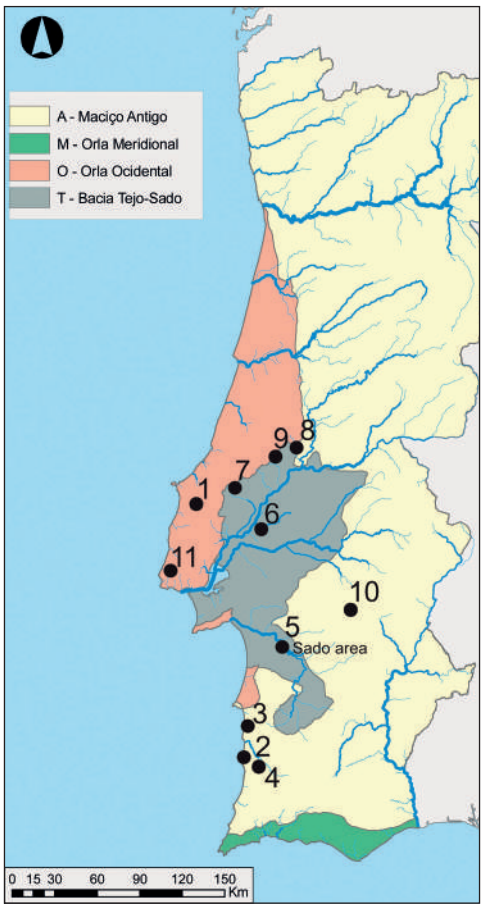

Figure 10. Location of the Mesolithic and Early Neolithic sites in Portugal, mentioned in this text (cartographic base: SNIRH, http://snirh.apambiente.pt). Toledo shell midden (1); Palheirões do Alegra (2); Vidigal (3); Fiais (4); Sado shell middens (5); Tejo (Muge and Magos) shell middens (6); Forno da Telha and Abrigo Grande das Bocas (7); Gruta do Caldeirão (8), Gafanheira, Forno do Terreirinho, Laranjal do Cabeço das Pias, Pena d'Água and Almonda (9); Valada do Mato (10); S. Pedro do Canaferrim (11)

record. For example, a part of the used projectiles would not return to the habitats or to the production areas (Domíngo Martínez 2005:95). Also, the morphological variability of projectiles and the general lithic production can be affected by functional, natural, social or symbolic elements, which restrict a better comprehension of the formal variations.

5.2. Interpreting the geometric microliths in central-southwestern Portugal

In central and southwestern Portugal (Figure 10), geometric microliths were present from the Upper Paleolithic onwards, remaining in use up to the Late Neolithic, with a progressive loss of their microlithic nature during later times. The geometric dominance in tools is particularly evident during the Late Mesolithic (Araújo 1995-1997; Vierra 2004) and highlighted as a break with the previous systems of lithic use, through the microlithization and the standardization of forms (Araújo 2003:592; Bicho *et al.* 2010:91).

During the Early Mesolithic, the use of geometrics is sporadic (Vierra 1992:35), as exemplified by the shell midden of Toledo, Lourinhã (Araújo 2011), in the Estremadura region. On the Southwestern Coast region, through the comparison of the Early Mesolithic site of Palheirões do Alegra (Odemira), and Vidigal and Fiais (Odemira), attributed to the Late Mesolithic, B. Vierra (2004) observed that tools from the Early Mesolithic (endscrapers and microliths) were primarily obtained from flakes or relatively large bladelets; on the other hand, geometric microliths from the Late Mesolithic had small bladelets as blanks. The microburin procedure appears to be associated to an increasing standardization of production.

According to G. Marchand (2005a:176), the absence of chrono-typologies in Portugal results in a lack of chronological markers which could potentially shed light into technical and social

changes. In fact, the recent Late Mesolithic-Early Neolithic research in Portugal has been characterized by a decline in the relevance of lithic chrono-typology related to the criticism of the typological method, the preference for environment and economy-centered studies and the scarcity of stratigraphic and spatial data associated to reliable radiocarbon dates – particularly for the Tejo and Sado shell middens (Gutiérrez-Zugasti *et al.* 2011:79). In spite of this, geometrics were focus of attention in the Sado shell middens since the early fieldworks directed by M. Heleno, as evidenced by the list of microliths from Cabeço do Pez made by J. Roldão (1956). Later on, regarding the Muge shell middens, J. Roche associated the geometric typological variations to the available chronometric data (Roche 1972). His model argued the antiquity of Moita do Sebastião, where trapezes dominate, relative to Cabeço da Amoreira, characterized by triangles and an increase of segments from the bottom to the top of the occupation sequence. In the 1980s, C. T. da Silva and J. Soares (1987) suggested a sequential model of the Mesolithic and Neolithic sites in southern Portugal, based on the data available from Muge and their own archaeological interventions –even though the lithic typologies and the geometric variance were valued, a chronological significance was not clearly argued. According to them, the lithic industries from the Early Neolithic in southern Portugal would be the end result of an evolution from the lowest level of Moita do Sebastião, the oldest phase of the Muge shell middens (Silva and Soares 1987:664). After some years, the typological differences between Vidigal and Fiais were interpreted by B. Vierra (1992) as a consequence of technological transformations over a long period of time, and segments were considered representative of a more advanced chronological phase than trapezes (Vierra 1995, apud. Marchand 2001:70). The notion of geometric typological differentiation through time was also supported by the analysis of the assemblage of Poças de S. Bento (Araújo 1995-1997:149), as the author could not detect any relation between the typologies and the functionalities of the Sado shell middens addressed by J. Arnaud (1989, 2000). The comparison between Poças de S. Bento, Vidigal and Fiais demonstrated an evolution of the geometric typologies in accordance to the radiocarbon dates - S. Bento was regarded as the oldest site (with a dominating presence of trapezes) in relation to Fiais (where trapezes and segments were both present) and Vidigal (where segments were dominant) (Araújo 1995-1997:148). According to the author, the reasons for this apparent evolution would be stylistic, rather than technical or functional. Concerning the supremacy of different microlith forms in the Sado valley, L. Larsson (1996:136) also stated that chronological differentiation would be the most probable cause.

The geometrics from both the older and the more recent excavations at Muge shell middens have been focus of some attention recently. For the first case, a recent work suggested the possibility of a functional differentiation of the site according to the 'choice' of the geometric-type (Joaquinito 2011), but arguments for the existence of functional differences among the morphologies were not

presented. In respect to the geometrics from recent excavations at Cabeço da Amoreira[3](2008-2010), a sample from the first 15 cm of the shell midden (N=119) showed the dominating presence of triangles, contrasted to the scarcity of segments and trapezes. According to the authors, the functional analysis sustains their use as projectiles for hunting. The dimensions of the triangles are variable, even among the sub-types. Two explanations were proposed – the recycling of the tools and the production of these tools as markers of style of the artisan/user. Furthermore, it was stated that the variation on geometric typologies by each Muge shell midden would result from their use as stylistic, and not chronological markers, as the shell middens are thought to be contemporary[4].

The relationship between typology and chronology was particularly underlined by G. Marchand (2001, 2005a) and collaborators (Manen *et al*. 2007). For the Late Mesolithic and Early Neolithic in central and southern Portugal, a chronological proposal was presented (Manen *et al*. 2007), following a previous model for the Late Mesolithic (Marchand 2001), which conjugates the characters of geometrics with radiocarbon dates from some sites:

- The first phase (MF1), attributed to the beginning of the 6th millennium BC (6100-5900 BC), was characterized by the dominant presence of asymmetrical trapezes, exemplified by J. Roche's excavations at Moita do Sebastião. Arapouco and Vale de Romeiras (Sado valley) were also included in this phase, albeit with some uncertainty.
- The second phase (MF2: 5800-5600 BC) was characterized by the development of the 'Muge triangles', represented by Cabeço da Amoreira and, less emblematically, by Forno da Telha (Rio Maior). The third (MF3) is ascribed to the second half of the 6th millennium b.C. (5600-5000 BC), and is marked by the dominance of segments and asymmetrical trapezes, and a scarcity of triangles. Poças de S. Bento, Cabeço do Rebolador, Várzea da Mó, Fiais and Vidigal were all included in this phase.
- On the other hand, segments were regarded as the main typology of Early Neolithic contexts from the second half of the 6th millennium BC (NA1: 5500-5000 BC), with the example of sites from Estremadura (Gruta do Caldeirão, Almonda and Pena d'Água), and also from the beginning of the 5th millennium BC (NA2: 5000-4800 BC), exemplified by S. Pedro do Canaferrim, Sintra. Pressure and heat treatment were taken as typical technological characters of these phases.

3 JESUS, Luís; MARREIROS, João; CASCALHEIRA, João; GIBAJA, Juan; PEREIRA, Telmo; BICHO, Nuno (in press). «Occupation, functionality and culture. Preliminary results from microliths technology and use-wear analysis of Cabeço da Amoreira (Muge, Portugal)». Paper presented to *The Eighth International Conference on the Mesolithic in Europe, MESO2010, Santander* (13-17 September 2010).

4 MARREIROS, João; CASCALHEIRA, João; PEREIRA, Telmo; GIBAJA, Juan; JESUS, Luís; BICHO, Nuno (in press) «'Shell we move?' Revisiting and expanding new technological approaches to Mesolithic settlement patterns at Muge (Portuguese Estremadura)». Paper presented to *The Eighth International Conference on the Mesolithic in Europe*, MESO2010, Santander (13-17 September 2010).

The vertical distribution of geometrics was considered highly important in the Sado shell middens, even though it was stated that typological variations could be the result from fairly unidentifiable factors, and it was also recognized that the almost complete absence of stratigraphic concerns in the excavations of M. Heleno is a significant hindrance (Marchand 2001:72). For Cabeço do Rebolador, it was specified that there are no relevant differences in the stratigraphic organization, with the exception of the concentration of all the segments (only 8) in the first level – according to the author, that would correspond to the typological evolution registered at Cabeço da Amoreira, where the proportion of segments increases from the base to the top (Marchand 2005a:178). Nevertheless, attempting a chronological interpretation based on the altimetry to such a scarce assemblage seems quite risky - in addition to the badly known stratigraphy and recovering criteria, we should take into account the reduced size of the geometrics that makes them susceptible to movements across the stratigraphy. In the phase MF3 of this model (Manen *et al.* 2007; Marchand 2001), in Poças de S. Bento, Cabeço do Rebolador and Várzea da Mó, the percentage of segments and asymmetrical trapezes, seen as its main characteristics, is not proportional. The trapezes are dominant at Poças de S. Bento and Cabeço do Rebolador, and the segments at Várzea da Mó. Contrarily, for the Early Neolithic phases (NA1 and NA2), in which the segments were viewed as the defining type (Manen *et al.* 2007), these sites –Gruta do Caldeirão, Almonda, Pena d'Água and S. Pedro de Canaferrim– provided a relatively small amount, although segments are, in fact, the dominant type and are quite often the only one present, as is shown in the published analyses (Carvalho 2008a; Simões 1999; Zilhão 1992). In S. Pedro do Canaferrim, for example, only two segments were recovered, both from *locus* 2 (Simões 1999:47). On the other hand, in Valada do Mato (Diniz 2007), a site this model makes no mention of, the geometric tools are more common (28 %), and segments appear to be the dominant type (N=173), in a much more significant way than in the other sites. On the chronological aspects, this model was originally established using radiocarbon dates calibrated at 1σ for the Sado middens (Marchand 2001:98) and dates without referencing the calibration mode for the Muge shell middens. In our opinion, the intervals of each phase should be better grounded, moreover, each site used encompasses a single cultural phase – with the exception of Cabeço da Amoreira, Muge, whose later deposits are attributed to the third phase of the Late Mesolithic (Marchand 2005b:544). In relation to the Muge shell middens, Martins *et al.* (2008:81) underlined the restrictions of establishing phases for the Mesolithic using each shell midden as a homogenous chronological entity. In effect, despite the relatively abundant set of dates from human bones, all the middens with more than one date have statistically different results, suggesting a long occupation in time or a succession of different occupational phases. Recently published radiocarbon dates from Cabeço da Amoreira increased the available arguments for the existence of different occupational phases within the site, and possibly by distinct

social groups (Bicho *et al.* 2013). In the Sado shell middens, the scarcity of radiocarbon dates and the misinterpretation of the occupation dynamics seriously challenge any chronological and cultural interpretations of the material culture, including those of the geometric microliths.

5.3. The case of the segments

Segments have been extensively addressed as a common feature of lithic industries from the Late Mesolithic and the Early Neolithic of central and southern Portugal (Diniz 2007; Manen *et al.* 2007; Marchand 2001, 2005a, 2005b; Marchand and Manen 2010).

As shown, the profusion of segments at Amoreiras is not unique in the Sado valley. They are also the major type in Várzea da Mó (Marchand 2001), and even in Poças de S. Bento they are the second most representative group (Araújo 1995-1997). In these three sites, segments are manufactured using an abrupt and direct retouch, and are primarily symmetrical. On the other hand, segments seem to be scarce in the Muge shell middens:

- According to J. Rolão (1999) and confirmed by Joaquinito (2011), segments are only the main type in the assemblage uncovered at Vale Fonte da Moça 1 in the 1982-1986 campaigns. At Vale Fonte da Moça 2, segments and triangles are the most common geometric shapes of the collection recovered in 1987-1988. In these sites, only two radiocarbon dates based on out of context animal remains were obtained peaking at 6650±60 BP (TO-11863) and 6890±140 BP (TO-11864), which points to occupations in the 6th millennium cal BC (Martins *et al.* 2008:92);
- At Cabeço da Amoreira, segments are scarce, in spite of the increasing number present in the last phase (Roche 1972). This was viewed as a remarkable occurrence by Manen *et al.* (2007:136) who considered it as a clear example of the 'appearance' of this tool-type. Notwithstanding, in the more recent interventions (2008-2010), segments appear to be uncommon in the first 15 cm (Jesus *et al.* in press).

Nearby, in some sites of Estremadura with Late Mesolithic occupations - for instance, Abrigo das Bocas and Forno da Telha (Rio Maior) - segments are present, but again are not the dominant tool (Carvalho 2008a). At Bocas, the chronological and cultural definition of this type is hard, due to the scarcity of contextual data and also the probable migration of the remains and intrusions (Zilhão 1992:136, 1997:847).

Along the Southwestern Coast, the situation continues to be unclear: the data obtained in the 1986 excavation of Fiais (Lubell *et al.* 2007:216) revealed a significant dearth of tools and an even greater rarity of segments opposed to the greater relevance of triangles and trapezes. Nevertheless, according to the analysis performed by B. Vierra, trapezes and segments are fairly equivalent

numbers (42 % and 33 %, respectively); in Vidigal, on the other hand, segments are the dominant type, accounting for 62% of the analyzed geometrics (Vierra 1995 *apud*. Carvalho 2009:63).

In Early Neolithic sites from central and southern Portugal, the dominance of segments among geometric-types is more visible, however there are certain aspects that have to be taken into consideration. At Valada do Mato (Diniz 2007), where there is a particularly significant geometric component among tools, the importance of segments is evident (84 % of the geometrics), and like the cases of Amoreiras and Várzea da Mó, symmetrical forms with abrupt and direct retouch are dominant. In Valada do Mato, the most frequent width of the segments is around the 5-5,9 mm mark, which makes them only slightly larger than those from the Sado middens (Table 9). In contrast, geometrics are rarer in Estremadura, even though segments are the most frequent (and often only) type present, a situation that occurs in Gafanheira, Forno do Terreirinho, Laranjal do Cabeço das Pias and Pena d'Água, Torres Novas (Carvalho 2008).

For J. Soares (1995), segments are a Late Mesolithic innovation that points to shifting internal dynamics of the hunter-gatherers who were in the process of incorporating Neolithic technological innovations like pottery. According to the author, this type appears at Cabeço do Pez in a traditional context showing no significant ruptures with the previous material culture. In addition to this, Amoreiras held, from the base of its sequence, pottery in association to a geometric based lithic industry with a significant segment presence - a situation confirmed, according to the same author, in the excavations of the 1980s (Soares 1995:28). It is also mentioned that segments would have evolved from trapezes which had a retouched minor base. Nevertheless, the presently available data and our analysis of the lithic component of Amoreiras do not support an exclusive association of segments to Neolithic pottery, not even a single cultural attribution. Furthermore, the evolutionary perspective of segments from trapezes needs to be carefully justified, as the evidence can also support the progression from triangles which are shape-wise more similar to segments. This proximity, previously addressed, is quite possibly a consequence of an analogous use (Marchand 2001: 71), and could justify the scarcity of triangles in the Sado valley.

According to G. Marchand (2005a), the importance of segments in the Late Mesolithic and Early Neolithic could be explained not only by an independent evolution of the Iberian Late Mesolithic transmitted to the technological systems of the Early Neolithic, but also through a transference from the Early Neolithic to the systems of the Mesolithic, or even by a North-African influence on the Mesolithic and Neolithic systems of the second half of the 6th millennium BC. According to Manen *et al.* (2007:146), in spite of the presence of this type during the beginning of the Mesolithic in the Iberian Peninsula, the development of trapezes and triangle based industries both in the Late Mesolithic of

Levantine area (Cocina), in Eastern Spain, and in central and southern Portugal, would have resulted in a disconnected 'reappearance' of segments, during the middle of the 6th millennium BC. In Portugal, segments from the Late Mesolithic and Early Neolithic are characterized almost exclusively by abrupt retouch. In eastern Iberia, segments are known in Late Mesolithic and Early Neolithic contexts. Nevertheless, these tools are rare during the Cardial ware phase (Marchand and Manen 2010:174), and are mainly identified in later contexts and characterized by bifacial retouch.

Taking into account their seeming absence in France and northeastern Iberia, the origin of the segments in Northern Africa and its transmission along with other elements to southwestern Iberia (like the heat treatment and the pressure technique) is, according to some authors, a distinct possibility (Manen *et al.* 2007; Marchand and Manen 2010). These authors state that the recurrent association of segments and backed bladelets in the Early Neolithic of Iberia allows for some, however conservative, analogies with the North African sites. In northern Morocco and Algeria, segments and backed bladelets have been found in Early Neolithic contexts (Marchand and Manen 2010:175). Nevertheless, some cases of this association seem to have somewhat more recent chronologies, as Zafrín (Chafarinas Islands), where the available dates point to an occupation centered around the middle of the 5th millennium cal BC (Gibaja *et al.* 2012), and as few as two segments (in three geometrics) and one backed bladelet are referred. In respect to the shelter of Hassi Ouenzga, in the Eastern Rif, Morocco, the presence of long segments and backed bladelets in the Neolithic levels has been underlined (Manen and Marchand 2010:175). However, according to Lindstäder (2003:103-105), only one segment, one trapeze and one triangle were uncovered, along with a larger amount of backed bladelets. Concerning the lithic industries attributed to the Epipaleolithic of northern Morocco, the majority presence of backed bladelets is mentioned (Lindstädter 2010:93), but it can be contrasted to the residual weight of geometrics. References to the presence of any substantial quantity of segments are absent (Lindstädter 2010:90).

Furthermore, on the Iberian side, the lithic industries from Andaluzia region do not have a clear association of segments to backed bladelets, due to the lack of geometric types (Carvalho *et al.* 2012; Gavilán *et al.* 2010). In central and southern Portugal, backed bladelets seem scarce, both in Late Mesolithic and Early Neolithic contexts. In opposition to what A. Carvalho (2008:33) states, the association of segments and backed bladelets does not appear to be significant in the Late Mesolithic in the Sado and Mira valleys, due to the rarity of backed bladelets. In the analyzed assemblage of Amoreiras, in the Sado valley (Nukushina 2012), these tools are rare (N=5) comparing to other armatures. The presence of this type is not referred at Poças de S. Bento (Araújo 1995-1997), and at Várzea da Mó, only two tools are mentioned (Marchand 2001:105). Among the archaeological remains of Fiais analyzed by Lubell *et al.* (2007), there are

only three backed bladelets. The available data points to a relatively frequent occurrence of this association between segments and backed bladelets in the Estremadura (Carvalho 2008a), however, in western Algarve, these armatures are uncommon (Carvalho 2008a:265). In the Alentejo, Valada do Mato has few backed bladelets, which contrast with afore-mentioned importance of segments (Diniz 2007:97).

Summing up, the 'reappearance' of segments in SW Iberia, specifically during the middle of the 6th millennium BC, should be approached with greater care, since in our opinion, the chronological and stratigraphical data which is necessary to run against the temporal and cultural origin of this type is greatly lacking. In fact, the predominance of segments in Early Neolithic contexts of central and southern Portugal does not imply their uniqueness in the more recent contexts of the Late Mesolithic. The contextual and chronometric data from the Sado shell middens does not completely confirm the late character of segments relative to other armatures, as their development from the beginning of the Late Mesolithic also appears to be a reasonable hypothesis. Moreover, the scarcity of segments at Muge and their presence in the Sado valley, where triangles are uncommon, can be related to factors which are not chronological or cultural, but which can instead be connected, for example, to the morphological proximity between triangles and segments, as verified in the Sado valley site of Amoreiras.

6. Geometric microliths as markers in SW Iberia? Perspectives about the Mesolithic-Neolithic transition from the Sado valley

Even though the presence of geometric microliths in southwestern Iberia is significant in the lithic assemblages of the Late Mesolithic, the attribution of a more precise chronocultural value to them is compromised by a serious absence of chronological background. Reliable stratigraphic and chronometric data are still scarce, despite the recent developments on the Mesolithic research. More radiocarbon dates from recently excavated contexts and more systematic lithic analyses of the recovered materials are vital. Functional analyses are also lacking for the geometric sets. In the case of the Sado shell middens, a pattern of 'sites with trapezes *versus* segments' is identifiable, but it is difficult to support a diachronic view, as the contextual data is absent from the excavations carried on the 1950s and 1960s. The heterogeneous chronometric and material data from Amoreiras goes against a cultural uniformity perspective in this site and in the Sado shell middens in general, where a human burial dated from the final of the 7th millennium cal BC, two radiocarbon dates indicating occupations during the second half of the 6th and the beginning of the 5th millennium

cal BC, the presence of cardial ware and typical recipients from different phases of the Neolithic and a microlithic industry with a clear dominance of segments do not confirm this hypothesis. In spite of the absence of domestic fauna, the post-Mesolithic occupations cannot be ignored in the cultural integration and in the discussion of this site. This being so, the restriction of Amoreiras to the final phase of the Late Mesolithic (Marchand 2005a) or even its broad consideration as one of the most recent shell middens (Arnaud 2000, 2002; Marchand 2001) are notions which are currently hard to sustain. The questions remain: is there a strict chronological or cultural significance for the importance of segments and the almost complete absence of trapezes at Amoreiras? Or is this a result from the successive accumulation of deposits, dating from the end of the 7th millennium cal BC onwards?

In addition, it is still complex to support the existence of different groups and styles in the Sado valley during the Late Mesolithic and Early Neolithic, based solely on the geometric tool forms and their variations. Actually, it appears that there is a great standardization of the dimensions and other formal aspects of the production. Moreover, the importance of these tools needs to be carefully analyzed for the Early Neolithic contexts and in the discussion of the transition process in SW Iberia, as they often tend to be overvalued, in spite of their scarceness in many Neolithic sites.

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