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Cover band Deposit of Cerro dos Castelos de São Brás, Serpa, Portugal. Arsenical copper artefacts. Photo by Rosa Nunes.

Back cover band Porto das Carretas. Phase 2. Wristguard polished on quartzite with a high-tech quality. Macro-photo by Rosa Nunes.

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Contents

The Pleistocene-Holocene transition on the Portuguese southwest coast. A zero stage of social complexity?

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Abstract

The analysis introduced here is based on the results obtained in the archaeological works developed in the shell middens of Pedra do Patacho (Vila Nova de Milfontes) and Medo da Fonte Santa (Aljezur) on the southwest Portuguese coast, radiocarbon dated from the end of the Younger Dryas, transition to the Pre-Boreal. Marine-estuarine invertebrates (no mammals, fish or birds bones were present) constitute exclusively the faunal assemblages of these sites, although they were about 5km far from the coeval seashore in accordance with the bathymetrics of -60/-50m (Vanney and Mougenot, 1981; Dias *et al.*, 2000). Much of the archaeological record of this period might have been submerged and destroyed by sea level rise that brought the shoreline to the current position, creating strong difficulties to the reconstruction of the settlement pattern.

The most striking and innovative aspects of the Epipaleolithic hunter-gatherer social behavior in the context of a supposedly environmental crisis is the very specialized shell-fishing economy, practiced probably by task groups (logistical mobility) in short term camps, presumably articulated with few base-camps like the sites of Vale Boi (layer Z of the 2006/07 fieldworks) (Infantini and Mendonça, 2012) and Palheirões do Alegra (Vierra, 1992). This regional version of the labelled Broad Spectrum Revolution (*sensu* Flannery, 1969, 1986; Zeder, 2012) would open avenues for a new dialogue between culture and nature, moulding the social action for the onward domestication of animals and plants, that would be assimilated in southern Portugal only in the middle of the sixth millennium cal BC (Soares, 1992, 95, 97; Soares and Tavares da Silva, 2003). In comparison with Magdalenian culture, the material culture of the Epipaleolithic period is quite poor and scarce, suggesting a cultural and social regression. However, the ecological challenges successfully faced by the hunter-gatherers in the transition to Early Holocene indicate their ability to adapt social organization, using mechanisms of demographic control to maintain low densities, opting probably for seasonal social fission, and putting in practice a broad spectrum subsistence strategy. The optimal resource zones, even marginal areas, were exploited, with the awareness of the carrying capacity of the environment. Thus the question about social complexity can be addressed.

Keywords

Younger Dryas; Pre-Boreal; Epipaleolithic; marine-estuarine invertebrates; short-term camps; logistical mobility; Broad Spectrum Revolution.

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Locative patterns

Pedra do Patacho

The shell-midden of Pedra do Patacho has been excavated and published by the authors in 1993 (Soares and Tavares da Silva, 1993, 2004; Tavares da Silva and Soares, 1997). It locates on the north bank of the Mira paleo-estuary (Vila Nova de Milfontes), facing a vast plain about 5km wide, currently submerged by the Flandrian transgression. The archaeological layer stretches out about 50m along the seashore and includes a huge amount of faunal remains exclusively from marine-estuarine invertebrates: marine molluscs, mostly *Littorina littorea* followed by *Mytilus* sp. and *Patella* sp., and estuarine molluscs of sandy/mud intertidal environments as *Scrobicularia plana*, *Ostrea edulis*, *Cerastoderma edule* and *Venerupis decussata* (Figs. 1-2; table 1). These species were available all year round, but they would be gathered especially in spring and autumn (avoiding the winters strongest hydrodynamism and the high toxicity of some aquatic plants in the summer).

Figs. 1-2 - Location of Pedra do Patacho in the Mira estuary (Vila Nova de Milfontes). Map (CMP) in the scale - 1:25.000.

Table 1 - Faunal assemblage of the Pedra do Patacho shell-midden, that is constituted exclusively by marine and estuarine invertebrates. After Tavares da Silva and Soares, 1997.

TAXA	Layers			
	2A		2B	
	P. (gr.)	%	P. (gr.)	%
MOLLUSCA				
Patella sp.	144,50	15,20	82,40	7,55
Littorina littorea	554,00	58,26	579,00	53,05
Gastropods undet.	30,00	3,15	13,70	1,26
Mytilus sp	120,90	12,71	302,00	27,67
Ostrea edulis	0,50	0,05	5,00	0,49
Cerastoderma edule	0,80	0,08	0,80	0,07
Venerupis decussata	1,60	0,17	0,00	0,00
Scrobicularia plana	98,60	10,37	108,50	9,94
Total	950,90	100,00	1091,40	100,00

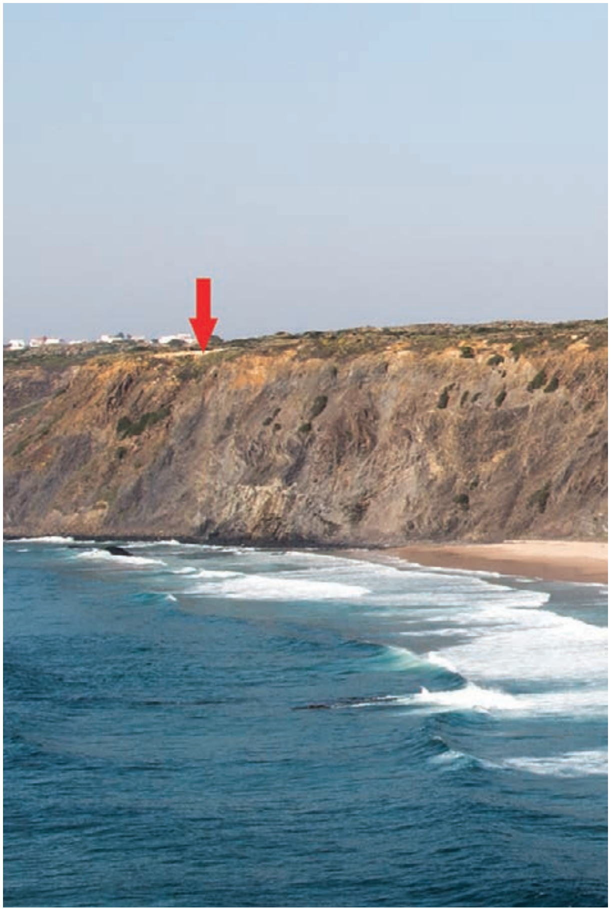
Medo da Fonte Santa

The shell-midden of Medo da Fonte Santa (Aljezur) was discovered in a field survey by Manuel Marreiros, Carlos Tavares da Silva and Luis Barros, and it is being studied by the authors in the context of a research project about neolithization of the Portuguese southwest coast, supported by the Archaeological Centre of the Museum of Archaeology and Ethnography of the District of Setúbal (MAEDS). The site (37º 19’ 37,8”N; 8º 51’ 55,8” W), about 60m above the modern sea level, was installed on aeolian sands deposited over the Plio-Pleistocene formations, which are overlapping the schist from the Palaeozoic basement (Oliveira, 1979, 1984, 1999). The site locates in the geomorphological unity of Arrifana (Pereira, 1990, 1995, 1997) that integrates the littoral platform. The name of Medo da Fonte Santa originates from the Holocene dunefield (Medo) that covers the shell-midden layer and from the existence of water springs in the littoral cliff (Fonte Santa) accumulated between clays from the Carboniferous schist alteration and Plio-Pleistocene sediments. The drinking water shortage in this coast stretch gives much value to the accessible aquifer in the Fonte Santa cliff. Nowadays Medo da Fonte Santa overlooks a very narrow beach (Figs. 3-6), but at the transition to Pre-Boreal there was a large littoral plain with 5-4 km extension in accordance with the bathimetrics of -60/-50m (Vanney and Mougenot, 1981; Dias *et al.*, 2000)[1].

The archaeological layer (L.2), with the average of 0,30m thickness, was exposed by aeolian deflation in an area of c. $80m^2$ and it is a shell midden formed by a huge amount of invertebrate fauna cemented by means of the carbonate calcium dissolution from thousands of mollusc shells (Figs. 7-10). In the base of the shell midden layer (L. 2B; 0,15m thickness) the aeolian sands were not concretionated. Marine invertebrates exclusively consti-

Figs. 3-4 - Location of Medo da Fonte Santa (Aljezur) in Google maps.

1 - The Aljezur stream Basal Unit I deposited over Paleozoic basement before 8220 BP "corresponds to a high energy fluvial deposit composed of azoic muddy sandy gravel containing clasts of schist, greywacke, quartzite and quartz". Fluvial and incipient estuarine conditions (Unit II) only appeared between 8220 and 7800 BP (Freitas *et al.*, 2011).



Figs. 5-6 - Medo da Fonte Santa view from Pedra da Atalaia.

tute the faunal remains (Table 2): mostly molluscs like *Patella* sp., *Littorina littorea*, *Nucella lapillus*, *Mytilus* sp. whose habitat is a rocky intertidal zone, and a few decapod crustaceans of the Brachyura infraorder.

In spite of their low caloric content, the shellfish provides essential protein, carbohydrates and mineral salts. Edible plants (unfortunately not preserved in the empirical record) would complete the diet. Totally absent at Pedra do Patacho, the *Nucella lapillus* (dog-whelks) is abundant at the

Fig. 7 - View from Medo da Fonte Santa to southwards till Pedra da Atalaia; 1 - dunefield, 2 - shell-midden, 3 - Plio-Pleistocene formations.

Table 2 - Faunal assemblage of the Medo da Fonte Santa shell-midden, that is constituted exclusively by marine and estuarine invertebrates (sample of 5l of sediments).

TAXA	Layers									
	2A						2B			
	NR	%NR	NMI	%NMI	P	%P	NR	%NR	NMI	%NMI
CRUSTACEA										
Decapoda	-	-	-	-	-	-	1	0,4	1	0,6
MOLLUSCA										
Patella sp.	204	52,3	107	73,3	190	60,9	182	63,9	139	80,3
Littorina littorea	24	6,2	10	6,8	32,4	10,4	17	6,0	5	2,9
Nucella lapillus	127	32,6	27	18,5	78,2	25,1	55	19,3	23	13,3
Mytilus sp	35	9,0	2	1,4	11,2	3,6	30	10,5	5	2,9
Total	390	100	146	100	312	100	285	100	173	100

NR - Number of remains

NMI - Minimum number of individuals

P - Weight (gr.)

Table 3 - Medo da Fonte Santa. Shells fragmentation patterns obtained through the ratio: number of remains/complet shells/100 (Álvarez Fernández, 2007; Gutiérrez Zugasti, 2009).

TAXA	Layers					
	2A			2B		
	NR	ICOM	IF	NR	ICOM	IF
Patella sp.	204	36	0,06	182	69	0,03
Littorina littorea	24	4	0,06	17	3	0,06
Nucella lapillus	127	3	0,42	56	3	0,19
Mytilus sp	35	0	0,00	-	-	-

NR - Number of remains

ICOM - complet shells

IF - Shells fragmentation pattern

Figs. 8-9 - Aeolian deflation surface with the concretionated shell-midden layer exposed.

Fig. 10 - Detail of the shell-midden layer (concheiro) with emphasis on the species *Patella* sp. and *Littorina littorea*. Scale in cms.

shell-midden of Medo da Fonte Santa. Its small size and high degree of intentional fragmentation (Fig. 14; Table 3) indicate a probable use for extraction of red-purple and violet dyes, colours that could be used for adornments (Biggam, 2006; Fechter and Falkner, 1993, p. 54) and for objects dyeing.

Chronology

An abrupt and brief cold event has long been recognized in the transition from the Late Glacial to the Holocene interglacial in the northern Atlantic basin (Broecker *et al.*, 1988), in the time span of 12.900 to 11.700 cal BP, but its regional expressions in our latitudes needs much more study.

Only in June 2009 the Quaternary System/ /Period that encompasses the most recent 2.58 million years had been ratified by the Executive Committee of the International Union of Geological Sciences (IUGS EC), as proposed by the International Commission on Stratigraphy (ICS). Thus, the Quaternary System/Period is officially subdivided into the Pleistocene and Holocene series/epochs, with the beginning of the Holocene assigned at 11,700 calendar years before AD 2000 (Gibbard, Head and Walker, 2010; Head, Gibbard and Kolfschoten, 2013). This date has been obtained through a GSSP at the NorthGRIP ice core from Greenland (Walker *et al*., 2009) and it corresponds to a sharp change "in deuterium excess values that reflect the start of climatic warming following the Younger Dryas/ Greenland Stadial 1 cold phase" (Head, Gibbard and Kolfschoten, 2013, p. 78).

AMS radiocarbon dates from the first human occupation phase of Medo da Fonte Santa confirm its integration in the transition to the Holocene, partially contemporaneous of the "concheiro" of Pedra do Patacho -Vila Nova de Milfontes (Soares and Tavares da Silva, 1993; Tavares da Silva and Soares, 1997) (Table 4; Fig. 11). The shell-midden of Medo da Fonte Santa had been dated by two AMS ^{14}C

Table 4 - Radiocarbon dates of Pedra do Patacho and Medo da Fonte Santa. Program Calib 6.1.0 (Stuiver and Reimer, 1993) and calibration courb marine 09, ΔR=0 (Reimer *et al*., 2009).

SITE	LAB. CODE	SAMPLE	14C BP	CAL BP 1σ	%	CAL BP 2 σ	%	REF.
Pedra do Patacho	ICEN-748	Marine shells	10760 ± 80	12041-12339	100	11909-12407 12444-12541	93 7	Soares and Tavares da Silva, 2004
Pedra do Patacho	ICEN-207	Marine shells	10740± 60	12028-12270	100	11925-12372 12506-12511	99,8 0,2	Soares and Tavares da Silva, 2004
Pedra do Patacho	ICEN-267	Marine shells	10450± 60	11380-11688	100	11283-11770 11775-11859	94	Soares and Tavares da Silva, 2004
Pedra do Patacho	ICEN-266	Marine shells	10380± 100	11244-11444 11461-11632	57 43	11191-11770 11775-11859		Soares and Tavares da Silva, 2004
Medo da Fonte Santa	Beta-191458	Marine shells	10510±70P	11419-11502 11599-11894	20 80	11331-11958	100	This article
Medo da Fonte Santa	Beta-433478	Marine shells	10490±30P	11414-11509 11577-11738	33 67	11389-11770 11775-11860	90 10	This article

determinations on marine shells (Table 4, Fig. 11): a sample of *Littorina littorea* (Beta-191458) gave a result of 10510±70 BP (11331-11958 cal BP at 2 sigma-95% probability, with ΔR=0±0); a sample of limpets (P*atella* sp.), Beta-433478, gave a statistically similar result, 10490±30BP (11389–11860 cal BP, at 2 sigma, with ΔR=0±0). The evaluation of the ocean reservoir effect in the Pre-Boreal shell-midden of Magoito, for now the nearest analysed site in chronological and geographical terms, gave the result of 160± 60 ^{14}C yr (Soares and Dias, 2006, p. 56). In general, the upwelling intensity has been very variable (Abrantes, 1988, 1991, 2000; Soares, 2005), and in the transition to the Holocene it decreased; in the Holocene, after the 8.2 kyr event "it dropped below current levels" (Haws and Bicho, 2007, p. 40). Thus, we decided for now not to apply the correction of the local ocean reservoir.

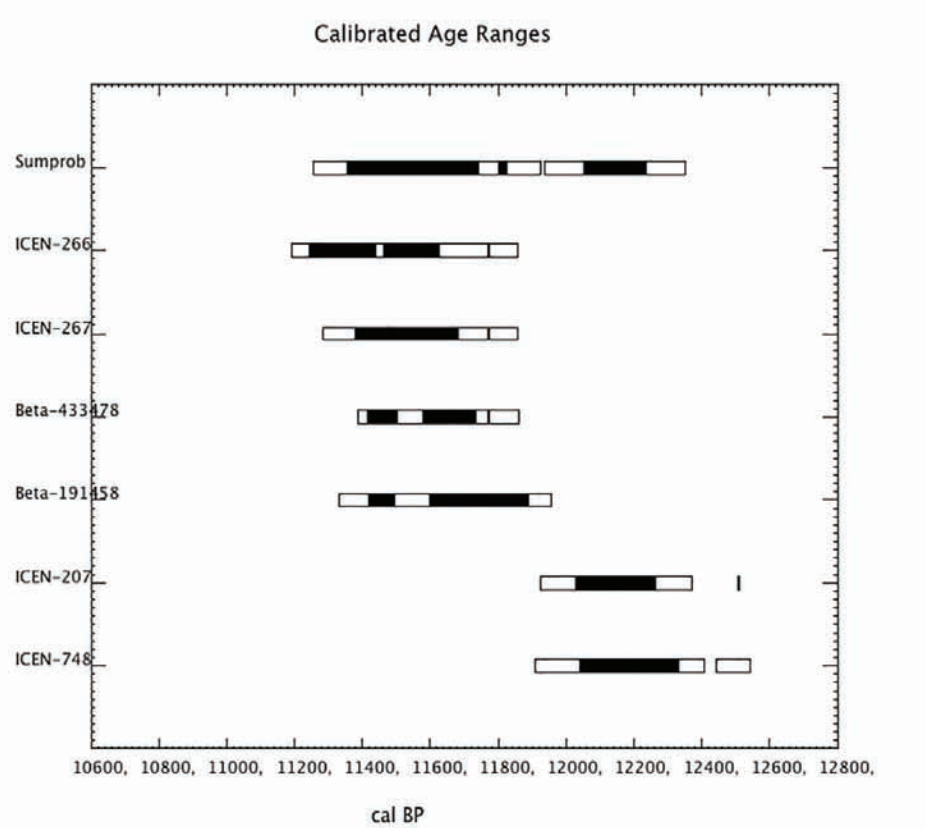


Fig. 11 - Radiocarbon chronology of Pedra do Patacho and Medo da Fonte Santa. Calibration at 1 and 2 sigma BP.

The radiocarbon determinations (Soares and Tavares da Silva, 2004) obtained for the shell midden of Pedra do Patacho, statistically similar to those of Medo da Fonte Santa, also support our statement about the cold invertebrate faunal association that characterizes the end of the Younger Dryas in the southwest coast (Tavares da Silva and Soares, 1997).

Paleoenvironment

As already referred, changes in the coastline associated to the Flandrian transgression have triggered the configuration of the new Holocene landscapes and seascapes (Dias *et. al.*, 2000; Haws and Bicho, 2007; Vanney and Mougenot, 1981). Both sites of Medo da Fonte Santa and Pedra do Patacho, at the Pleistocene/Holocene transition, gave evidence of an intense marine shellfish exploitation strategy, exclusively based on invertebrate fauna, mainly molluscs, inhabitants of the intertidal zone, that indicates colder ocean temperatures than nowadays by the relevant presence of *Littorina littorea*. The available information shows an increasing trend of the regional exploitation of the marine and estuarine resources, mainly in the Atlantic chronozone (Soares, 1996; Soares and Tavares da Silva, 2004). The upwelling off the Portuguese coast would create conditions for a rich marine ecosystem: shellfish, fish, shorebirds and marine mammals. Meanwhile terrestrial faunal resources (large preys) seem to decline (Davis and Detry, 2013). This would be more patent on the outer coast, especially during cold events, taking in consideration that the upwelling intensity correlates positively with terrestrial aridity (Shi *et al*. 2000).

The Epipaleolithic shell midden of Magoito in the littoral of Estremadura, estuary of the Mata River, dated to the Preboreal (GrN-11229: 9580±100 BP, cal BC, 2 sigma = 9250-8630; ICEN-52: 9490±60 BP, cal BC, 2 sigma = 9140-8610) is another site with a narrow spectrum economy almost exclusively constituted by *Mytilus* sp., *Tapes decussata*, *Cardium edule*, *Scrobicularia plana*, *Patela* sp., and *Littorina littorea* (Daveau, Pereira and Zbyszewski, 1982; Soares, 2003). This evidence highlights a general trend to specialization and intensification of the exploitation of marine resources articulated with a component of diet diversification among post-Pleistocene hunter-gatherers. Three species of molluscs consumed by hunter-gatherers on the Southwest Coast and Estremadura seem to be good climatic indicators: *Littorina littorea*, *Phorcus lineatus* and *Thais haemastoma*. The former, more adapted to cold waters, is abundant in the Younger Dryas and Pre-Boreal (Pedra do Patacho; Medo da Fonte Santa; Magoito), the remnants species are absent in these periods. In the Boreal shell-middens of S. Julião (Miranda, 2004) and Toledo (Araújo, 1998), in Estremadura, *Littorina littorea* drops to a very residual presence, being replaced by *Phorcus lineatus*; at the Boreal shell-middens of Castelejo and Montes de Baixo (Tavares da Silva and Soares, 1997), on the southwest coast, *Littorina littorea* is absent and *Phorcus lineatus* is well represented. The *Thais haemastoma*, adapted to warmer conditions, is present with residual values, at the Boreal sites of S. Julião and Montes de Baixo but it will increase onwards in the Atlantic period, e. g. in Samouqueira, Montes de Baixo, Armação Nova (Soares, Tavares da Silva and Canilho, 2005-07).

The Younger Dryas event had been in southern Portugal an abrupt return to cold conditions, with a marked decline in arboreal species, documented by the results of the pollen analysis of a sediment sequence from Lateglacial and Holocene in the Guadiana estuary. William Fletcher *et al.* (2007) describe the vegetation dynamics of Younger Dryas as a "[...] forest decline (*Quercus*) and expansion of pinewoods, xeric scrub and open ground habitats with *Juniperus*, *Artemisia*, *Ephedra distachya* type, *Centaurea scabiosa* type under arid and cold conditions [...]". The CM5 Guadiana core, for sub-zone CM5-II, that corresponds to Early Holocene vegetation, c. 11.860–8960 cal BP, shows that a "mixed woodland and scrub landscape continues into the Early Holocene, with relative high frequencies for a number of open ground herbaceous types (Centaurea, Erodium, Serratula type) and shrub taxa (Coronilla type, Cistaceae and Ericaceae)" (Fletcher, 2005, p. 216-17). Paleoenvironmental information obtained by the SU81-18 core of the

Alentejo coast covers a period of c. 25.000 to 1.000 BP (Turón, Lézinel and Denèfle, 2003). Species adapted to cold conditions decrease between 15.000 and 12.000 BP, but at the end of the Pleistocene a climatic deterioration and cold adapted species increased (Dryas III event). After this cold fluctuation, the cooling conditions disappeared and gave space to a mild-warm and humid climate. At the regional scale, the impact of climatic amelioration at the transition to Holocene can be observed in the Mediterranean taxa, more adapted to warmer conditions after c. 10.000 cal BP. In the Guadiana estuary, a forested landscape (with *Pinus* sp., *Quercus* sp., *Olea* sp., *Phillyrea* and *Pistacia* sp.) emerged only at 9800--8960 cal BP (Fletcher, 2005, p. 260).

Lithic industry

The relatively small lithic assemblage sample of the temporary campsite of Medo da Fonte Santa cannot be considered to statistically test for significant differences. It allowed a first glance to a very general characterization of the lithic productive system. It consists of:

- an expediently organized knapping component, on dolerite, greywacke and quartz (Table 5, Fig. 12), raw materials locally available in the form of cobbles, whose reduction trajectory is cores >heavy core-tools (mainly carinated scrapers)> flakes. The lithic artefacts of this subsystem are constituted by cores, cobble tools and flakes used without previous retouch, probably for cutting and scraping activities.

- a curated technological subsystem on flint (Tables 5-13, Fig. 13), that indicates an improvement of techno-environmental efficiency, with two main varieties of flint, from Cape S. Vincent, with about 18% (white, pinkish white, light gray, light yellowish brown), and mostly (c. 54%) from the mountain of Alte (e.g. yellowish red, dark yel-

Table 5 - Medo da Fonte Santa. Raw materials of the lithic assemblage.

Raw materials	N	%
Dolerite	2	3,0
Greywacke	5	7,6
Quartz	1	1,5
Chert	1	1,5
Flint undetermined	9	13,6
Flint from Cape S. Vincent	12	18,2
Flint from Alte	36	54,5
Total	66	100

Table 6 - Medo da Fonte Santa. Flint colour.

Flint colour		N	%
N 9	white	1	1,7
10 R 4 / 6	red	1	1,7
10 R 5 / 2	weak red	1	1,7
10 R 6 / 2	pale red	1	1,7
10 R 8 / 2	pinkish white	1	1,7
10 Y 8 / 2	pale greenish yellow	1	1,7
10 YR 5 / 4	moderate yellowish brown	7	12,1
10 YR 6 / 2	pale yellowish brown	1	1,7
10 YR 6 / 4	light yellowish brown	3	5,2
10 YR 6 / 6	dark yellowish orange	7	12,1
10 YR 7 / 2	light gray	2	3,4
10 YR 7 / 4	grayish orange	2	3,4
10 YR 8 / 2	very pale orange	2	3,4
5 R 6 / 2	pale red	1	1,7
5 YR 4 / 4	reddish brown	4	6,9
5 YR 5 / 4	reddish brown	9	15,5
5 YR 5 / 6	yellowish red	10	17,2
5 YR 6 / 2	pinkish gray	1	1,7
5 YR 6 / 6	reddish yellow	1	1,7
5 YR 7 / 1	light gray	1	1,7
5 YR 7 / 2	pinkish gray	1	1,7
Total		58	100,0

Table 7 - Medo da Fonte Santa. Lithic assemblage on flint. Platform type.

Platform type	N	%
Cortical	6	13,0
Unfaceted	9	19,6
Faceted	10	21,7
Punctiform	15	32,6
Absent	6	13,0
Total	46	100,0

lowish orange, reddish brown) (identification by Paulo Fonseca, Professor of Geology from the University of Lisbon). There is also a residual variety of chert generally associated with green schist.

It is possible to reconstruct two hypothesis of flint procurement:

1) raw materials procurement embedded in the scheduled foraging and hunting expeditions;

2) inter-groups exchange.

For the first hypothesis, flint would arrive by two quite different pathways: littoral, about 48km far, that takes about 10 hours of walking; inland-littoral, about 85 km far, that takes about 18 hours of walking.

Flint is available in the Meso-Cenozoic sedimentary rocks of the Algarve basin, but it is almost absent in the remaining southwest littoral platform, an extension about 120Km, until the Cape of Sines.

Table 8 - Medo da Fonte Santa. Lithic assemblage on flint. Bulb of percussion.

Bulb of percussion	N	%
Prominent	11	23,9
Double bulb	1	2,2
Moderate	14	30,4
Partially eliminated	4	8,7
Diffuse	11	23,9
Absent	5	10,9
Total	46	100,0

Table 9 - Medo da Fonte Santa. Lithic assemblage on flint. Debitage strategy.

Debitage	N	%
Direct percussion	12	25,5
Indirect percussion	31	66,0
Undetermined	4	8,5
Total	47	100

Table 10 - Medo da Fonte Santa. Lithic assemblage on flint. Cortex.

Cortex	N	%
0%	35	60,3
Residual	12	20,7
<=25%	3	5,2
>25 <=50%	6	10,3
>50 <=75%	1	1,7
>75 <=100%	1	1,7
Total	58	100

Table 11 - Medo da Fonte Santa. Lithic assemblage on flint. Cross section of blade and bladelets.

Cross section	Bladelet	Blade	Total
Trapezoidal	1		1
Triangular	9		9
Undetermined		1	1
Total	10	1	11

The rare cores discovered at Medo da Fonte Santa are exhausted by extractions of flakes and bladelets. Probably the Epipaleolithic group brought already formatted flint cores that were "overexploited" in *situ*. Not only an emphasis on the latter stages of core reduction, but also the low overall presence of

Table 12 - Medo da Fonte Santa. Lithic assemblage. Curated technological subsystem on flint. Measurements (mm). Means of the maximum dimensions and weight of the techno-typological categories of the analysed sample.

Techno-typological categories	N	%	Length max. (mm) N'	X̄	S	Width max. (mm) N'	X̄	S	Thickness max. (mm) N'	X̄	S	Thickness / Width N'	X̄	S	Weight (gr.)
Cores	5	8,6	5	23,0	± 9,9	4	18,3	± 4,3	4	11,8	± 4,3	4	0,66	± 0,27	26,6
By-products (of knapping)	11	19,0	11	19,7	± 6,3	11	15,8	± 5,5	11	7,4	± 2,3	11	0,54	± 0,26	18,8
Debitage products	11	19,0	9	17,7	± 4,3	10	17,6	± 4,0	10	6,3	± 2,8	10	0,39	± 0,27	16,8
Retouched tools	21	36,2	17	21,1	± 6,6	19	14,5	± 6,5	19	5,4	± 2,3	19	0,40	± 0,2	46,4
Unretouched tools (with macro use-wear traces)	10	17,2	6	23,3	± 3,9	10	11,9	± 3,7	10	4,2	± 1,4	10	0,36	± 0,1	11,8

N' - Number of artefacts whose measurements were considered. The weight has been obtained for all artefacts (N).

Typology	N	%
Cores	**5**	**8,6**
Discoidal	1	1,7
Exhausted	4	6,9
By-products (of knapping)	**11**	**19,0**
Debris	5	8,6
Flake	6	10,3
Debitage products	**11**	**19,0**
Flake	9	15,5
Blade	1	1,7
Bladelet	1	1,7
Retouched tools	**21**	**36,2**
Endscrapers	3	5,2
Carenated	1	1,7
Simple on flake	1	1,7
Unguiform	1	1,7
Perforators	1	1,7
Perforator on flake	1	1,7
Burins	2	3,4
Burin simple on breaks	2	3,4
Truncations	3	5,2
Flake with truncation	1	1,7
Bladelet with truncation	2	3,4
Notches and denticulates	9	15,5
Notches on flake	2	3,4
Flake denticulated	6	10,3
Blade denticulated	1	1,7
Various	3	5,2
Pointed flake	1	1,7
Pointed bladelet	2	3,4
Unretouched tools (with macro use-wear traces)	**10**	**17,2**
Flake	6	10,3
Bladelet	4	6,9
Total	58	100

Table 13 - Medo da Fonte Santa. Lithic assemblage. Curated tecnological subsystem on flint.

cortex (Table 10) and the low percentage of by-products of knapping activity (Tables 12-13) indicate that most of the initial core reduction would be done in a different space, probably another campsite.

A total of 58 lithic artefacts were analysed from the collection of Medo da Fonte Santa (Tables 12-13). This includes 5 cores, 11 by-products of knapping, 11 pieces of debitage, 21 retouched tools and 10 unretouched tools, with macro use-wear traces. The debitage products (where bladelets are well represented) are in general mainly microlithic artefacts (Table 12).

The retouched pieces belong mostly to the group of common and non-specialized tools like notches and denticulates; in the scrapers, it worth referring the presence of unguiform type; several flakes and bladelets were slightly retouched or show macro-use-wear traces (edge-damage); few bladelets have a truncation on the distal edge. These lithic artefacts have been recovered directly inside the shell-midden that is in *situ* and in fragments of the shell-midden scattered and disaggregated by erosion (lithics with calcium carbonate deposit conserved on its surfaces).

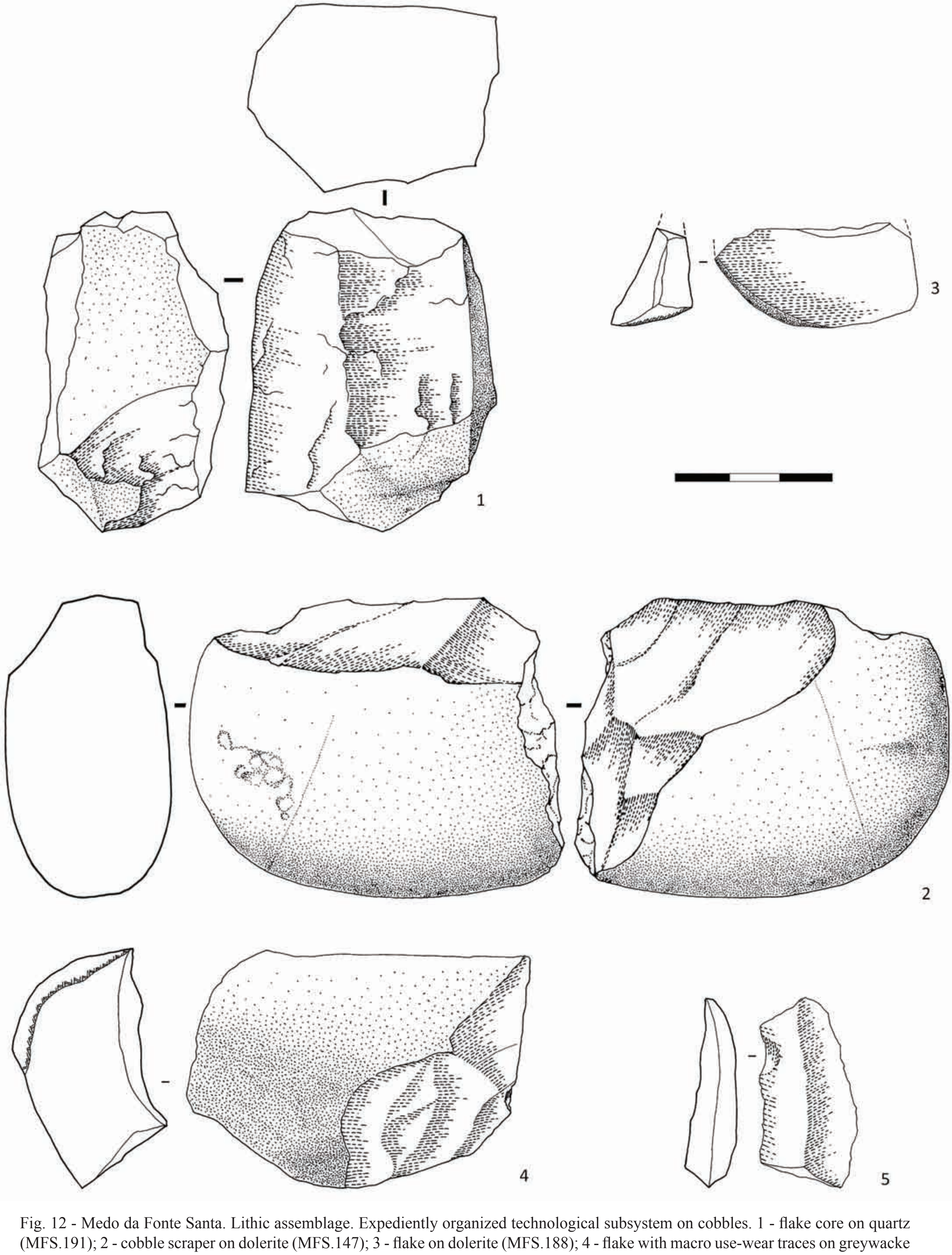


Fig. 12 - Medo da Fonte Santa. Lithic assemblage. Expediently organized technological subsystem on cobbles. 1 - flake core on quartz (MFS.191); 2 - cobble scraper on dolerite (MFS.147); 3 - flake on dolerite (MFS.188); 4 - flake with macro use-wear traces on greywacke (MFS.189); 5 - flake with notch on greywacke (MFS.187). Drawings by Fernanda Sousa.

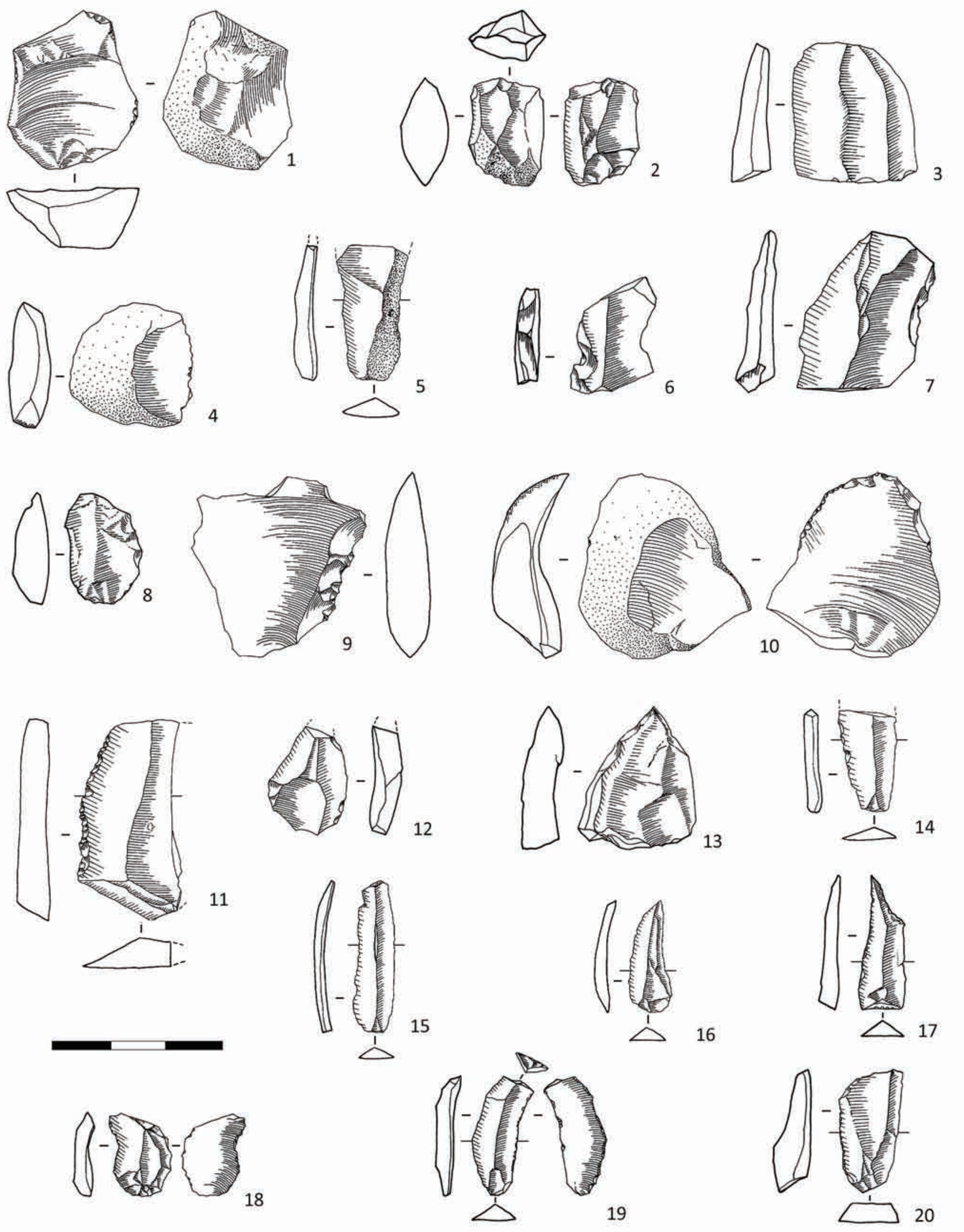


Fig. 13 - Medo da Fonte Santa. Lithic assemblage. Curated technological subsystem on flint. 1 - exhausted core (MFS.206); 2 - exhausted core (MFS.100); 3 - flake (MFS.210); 4 - flake (MFS.9); 5 - blade (MFS.199); 6 - flake with multiple notches (MFS.103); 7 - denticulated flake (MFS.33); 8 - denticulated flake (MFS.137); 9 - denticulated flake (MFS.204); 10 - denticulated flake (MFS.207); 11 - denticulated blade (MFS.209); 12 - flake with macro use-wear traces (MFS.96); 13 - pointed flake (MFS.14); 14 - bladelet with macro use-wear traces (MFS.201); 15 - bladelet with macro use-wear traces (MFS.200); 16 - Pointed bladelet with macro use-wear traces (MFS.203); 17 - retouched pointed bladelet (MFS.104); 18 - flake with truncation (MFS.149); 19 - bladelet with truncation (MFS.86); 20 - bladelet with truncation (MFS.151). Drawings by Fernanda Sousa.

Social complexity (?)

An increasing valuation of marine resources in human subsistence and a greater focus on the littoral settlement had been proposed for postglacial hunter--gatherers not only at a regional scale (Soares and Tavares da Silva, 2004; Vierra, 1992) but also at the remnant European Atlantic coast (Schulting, 2015).

The shell middens of Medo da Fonte Santa and Pedra do Patacho, containing only concentrations of marine invertebrate fauna, seem to reveal a new regional pattern of coastal adaptations, by hypothesis under the stress of a demographic-ecological imbalance (Soares and Tavares da Silva, 1993, 2004; Tavares da Silva and Soares, 1997). This subsistence strategy is quite different from the cultural pattern of the Pleistocene simple bands, with low population density, highly mobile and focused on the hunting of large herbivores. Evidence of marine exploitation, probably in occasional occurrences, has been documented in the Portuguese coast at the Middle and Upper Palaeolithic, but not in a specialized gathering mode and dissociated from hunting activities; on the contrary, it was characterized by

Fig. 14 – Fragmentation pattern of *Nucella lapillus* shells (dog-whelks).

the exploitation of a great diversity of species of marine mammals, fish, shellfish, shorebirds, consumed, for example, at the cave of Figueira Brava in Arrábida by Neanderthals (Antunes, 2000a, b) or at the site of Vale Boi in Algarve from the Gravettian to the Magdalenian (Stiner 2003).

The proposed scenario of resources depletion can explain the broadening of the subsistence base (broad dietary patterns) of hunter-gatherers in the transition to Early Holocene. The food diversification strategy was complemented by foraging/hunting intensification and specialization on particularly available and abundant food items, like shellfish or red deer, to maximize the exploitation of food resources in all the accessible biotopes (see the Broad Spectrum Revolution theory in Flannery, 1969; Zeder, 2012).

In spite of the regional differences, the analysis of the final phases of Tardiglacial adaptations in the Vasco-Cantabrian and Pyrenean regions done by Lawrence G. Straus (1990/91; Strauss *et al*., 1980) arrived to similar results to those of the southwest coast: evidence of specialization on a particular species (red deer), decline of large ungulates, and exploitation of a wider range of species, including aquatic resources (molluscs and crustaceans); situations of overexploitation of deer and limpets were observed suggesting a demographic-ecological imbalance (Straus, 1990/91, p. 15-16).

The economic specialization of Medo da Fonte Santa and Pedra do Patacho supposes:

1) A diet enriched in vegetarian components that unfortunately were not preserved in the studied archaeological contexts;

2) A logistical mobility strategy (*sensu* L. R. Binford, 1980), in which task groups of the band could move for abundant and reliable seafood probably embedded in scheduled pathways of raw materials procurement (Soares, 1996). This economic strategy supposes increasing social differentiation, associated with division of labour inside the bands, in probable accordance with age and gender. Kuhn and Stiner (2006) attributed to Upper Palaeolithic diet diversification the origin of gendered division of labour, and this would provide advantage over Neanderthal populations;

3) Marine resources could support exchange networks, not only for food consumption purposes but also for ornaments. *Nucella lapillus*, for example, could be used for extraction of red-purple and violet dyes. The small size of the shells and the fragmentation pattern observed in Medo da Fonte Santa fits well with this hypothesis (Table 3 Fig. 14). It was probably a very valuable item as colour source. “Colours act as important means of constructing difference in the form of adornments and body paints” (Jones and MacGregor, 2002, p. 12). As Alfred Gell (1992) stated in his concept of “technology of enchantment”, colour is “a powerful way to objectify and differentiate people and actions so it has capacity to create solidarities and tensions”. Goods exchange networks and social tensions could stimulate social complexity, as defended by Sahlins (1972).

4) Thus, in a long term perspective, these economic and cultural changes and the more territorialized control of ecological transformations among the hunter-gatherer societies, possibly still egalitarians, put them in the way of a progressive economic intensification, precondition for growing cultural and social complexity, which is very well expressed by Íñigo García-Martínez de Lagrán (2008, p. 54), when he argues that the economic intensification in the Mesolithic hunter-gatherers “es uno de los elementos fundamentales y primigenios para el desarrollo de la complejidad en todos sus ámbitos”.

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