5

DIET RECONSTRUCTION OF A NEOLITHIC POPULATION FROM HYPOGEA BURIALS OF VALE DE BARRANCAS 1 USING BONE COLLAGEN STABLE ISOTOPIC SIGNATURES

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5.1 - INTRODUCTION

The archaeological site of Vale de Barrancas 1, situated in the Alentejo region, South Portugal, was discovered in the context of the construction of a motorway and excavated by Era Arqueologia between 2011 and 2012. An abundance of negative structures was discovered, dated to the Bronze Age and Late Roman period, alongside nine underground rock-cut tombs (hypogea) dated to the late Middle Neolithic (see Chapters 2 and 3).

Paleoanthropological analysis of the large quantities of manly disarticulated human bones recovered from these funerary structures has provided basic information on the buried populations with a minimum number of individuals estimated of 57 (see Chapter 4).

Given the relatively well preservation of the human bones, a study was conducted to reconstruct the diets and subsistence strategies of this population using isotopic signatures, comparing it with available isotopic information of humans and animals from the Neolithic period in the region of Alentejo hinterland.

Stable isotope analysis is an established technique used for reconstruction of past human diets by measuring ratios of stable carbon ($^{13}C/^{12}C = \delta^{13}C$), nitrogen ($^{15}N/^{14}N = \delta^{15}N$) and sulphur ($^{34}S/^{32}S = \delta^{34}S$) isotopes preserved in the organic component of bones and extracted as collagen. These bulk isotopic results enable differentiation between trophic levels within terrestrial and marine food chains and dietary input plants with different photosynthetic pathways (C_3 vs. C_4). Multi-isotopic analysis also provides additional information on subsistence strategies in cases where studies are limited by poor preservation or the lack of archaeozoological and archaeobotanical remains.

5.2 – METHODOLOGY AND SAMPLES

Seven hypogea were sampled (H1, H2. H3. H4, H5, H7 and H8), selecting right tibias from excavated osteological remains to reliably distinguish between individuals. Most of the bones come from ossuary deposits, with a minority coming from anatomical connections and dispersed deposits (Table 5.1).

Prior to the removal of approximately 1-2 g of bone, its surface was cleaned with a diamond drill bit, in other to remove any modern contaminants and soil. Collagen was extracted using a modified Longin method (Login, 1971), which includes bone demineralization in 0.5 M HCI, followed by removal of fulvic and humic acids with 0.125 M NaOH and gelatinization in 0.01 M HCI.

Lyophilized collagen was then analysed using EA-IRMS to obtain elemental composition (C%, N%) of the samples, as well as the $\delta^{13}C$ and $\delta^{15}N$ isotopic ratios.

5.3 – RESULTS AND CONTEXTUALIZATION

Collagen was successfully extracted from 54% of the bone samples from Vale Barrancas 1, with an average collagen yield of 1.21% (van Klinken, 1999) (Table 5.1).

Table 5.1 – Samples and $\delta^{13}C$ and $\delta^{15}N$ isotopic ratios from Vale de Barrancas 1.

Lab N.	Structure	Est. Unit	Bone N.	Sample type	Context	ollagen yeld	%N	%C	C:N	δ^{15}N ‰	δ^{13}C ‰
VdB 01	H1	4510	653	Right Tibia	Ossuary	0.59					
VdB 02		4510	4	Right Tibia	Ossuary	0.91					
VdB 03		4510	6	Right Tibia	Ossuary	0.71					
VdB 04		4510	7	Right Tibia	Ossuary	1.19	14,7	42,8	3.39	9,8	-18,9
VdB 05	H2	7215	28	Right Tibia	Ossuary	1.12	14,6	41,7	3.34	10,1	-19,8
VdB 06		7215	199	Right Tibia	Ossuary	0.49					
VdB 07		7215	77	Right Tibia	Ossuary	2.19	14,5	41,2	3.32	10,1	-18,9
VdB 08		7215	116	Right Tibia	Ossuary	0.66					
VdB 09	H3	6328	3	Right Tibia	Connection	1.36	14,1	40,9	3.39	8,3	-19,3
VdB 10		6325	73	Right Tibia	Connection	0.40					
VdB 11		6329	2	Right Tibia	Connection	1.20					
VdB 12		6333	7	Right Tibia	Connection	3.52	15,0	42,6	3.31	9,1	-18,3
VdB 13	4	6135	9	Right Tibia	Ossuary	0.95	14,5	42,5	3.41	9,0	-18,8
VdB 14		6137	4	Right Tibia	Connection	0.78	14,0	40,9	3.40	9,5	-19,5
VdB 15	5	8304	75	Right Tibia	Dispersed	0.56					
VdB 16		8304	76	Right Tibia	Dispersed	1.12	13,5	38,3	3,31	9,2	-19,9
VdB 17		8305	7	Right Tibia	Connection	0.93	12,9	37,2	3.36	9,0	-19,2
VdB 18	7	11209	2	Right Tibia	Ossuary	0.50					
VdB 19		11211	1	Right Tibia	Connection	0.49					
VdB 20		11210	8	Right Tibia	Connection	3.17	14,7	41,4	3.29	9,5	-19,4
VdB 21	8	11507	151	Right Tibia	Ossuary	2.32	14,6	40,6	3.25	9,1	-18,1
VdB 22		11507	55	Right Tibia	Ossuary	2.16	14,6	41,0	3.28	9,6	-18,6
VdB 23		11507	192	Right Tibia	Ossuary	1.20	13,0	37,1	3.32	9,8	-19,2
VdB 24		11507	3	Right Tibia	Ossuary	0.42					
Average						1.21	14,2	40,6		9,4	-19,1

Table 5.2 – δ13C and δ15N isotopic ratios for human and animals from other Neolithic contexts of Alentejo region.

Isotopic values for Neolithic humans						
Site	%N	%C	δ^{15}N %	δ^{13}C %	C:N	Bib. Ref.
Sobreira de Cima	?	?	8,98	-19,64	3,27	Carvalho, 2013
	?	?	9,43	-19,45	3,33**	Carvalho, 2013
	?	?	9,39	-19,1	3,36	Carvalho, 2013
	?	?	8,78	-19,46	3,35*	Carvalho, 2013
	?	?	10,26	-20,15	3,63*	Emslie *et al.*, 2015
	?	?	10,13	-20,58	3,34**	Emslie et *al.*, 2015
Anta da Cabeceira 4	?	?	10,1	-19,38	3,32	Carvalho, Rocha, 2015
	?	?	10,06	-19,11	?	Carvalho, Rocha, 2015
	?	?	10,89	-19,42	3,59	Carvalho, Rocha, 2015
* Valores para um mesmo indivíduo						
** Valores para um mesmo indivíduo						

Isotopic values for animals of the Neolithic phase of Perdigões						
Amostra	%N	%C	δ^{15}N %	δ^{13}C %	C:N	Bib. Ref.
Bos taurus	14,4	40,4	6,9	-20,6	3,3	Zalaite *et al.*, 2018
Bos taurus	14,1	41,5	6,2	-20,2	3,4	Zalaite *et al.*, 2018
Bos taurus	13,9	41,2	5,8	-20,5	3,5	Zalaite *et al.*, 2018
Bos primigenius	13,6	40,2	6,4	-20,1	3,4	Zalaite *et al.*, 2018
Bos primigenius	14,3	42,1	6,6	-20,3	3,4	Zalaite *et al.*, 2018
Equus caballus	13,1	39,4	5,6	-20,8	3,5	Zalaite *et al.*, 2018
Equus caballus	13,9	40,7	4,2	-20,5	3,4	Zalaite *et al.*, 2018
Cervus elaphus	12,9	38,6	5,8	-20,5	3,5	Zalaite *et al.*, 2018
Cervus elaphus	14,1	41,7	7,7	-19,0	3,4	Zalaite *et al.*, 2018
Cervus elaphus	14.2	40.2	5,3	-20,3	3,4	Zalaite *et al.*, 2018
Ovis/Capra	14,9	41,7	4,8	-20,1	3,3	Zalaite *et al.*, 2018
Ovis/Capra	14,3	41,7	5,1	-19,9	3,4	Zalaite *et al.*, 2018
Ovis/Capra	14,4	42,1	3,3	-19,9	3,4	Zalaite *et al.*, 2018
Ovis/Capra	14,2	41,8	5,7	-20,8	3,4	Zalaite *et al.*, 2018
Sus sp.	13,5	40,1	5,6	-19,4	3,5	Zalaite *et al.*, 2018
Sus sp.	14,5	42,6	6,3	-19,8	3,4	Zalaite *et al.*, 2018
Sus sp.	14,2	41,7	4,7	-20,0	3,4	Zalaite *et al.*, 2018
Sus sp.	12,3	42,7	5,5	-21,1	4,1	Zalaite *et al.*, 2018
Canis familiaris	12,1	33,4	9,8	-19,3	3,2	Zalaite *et al.*, 2018

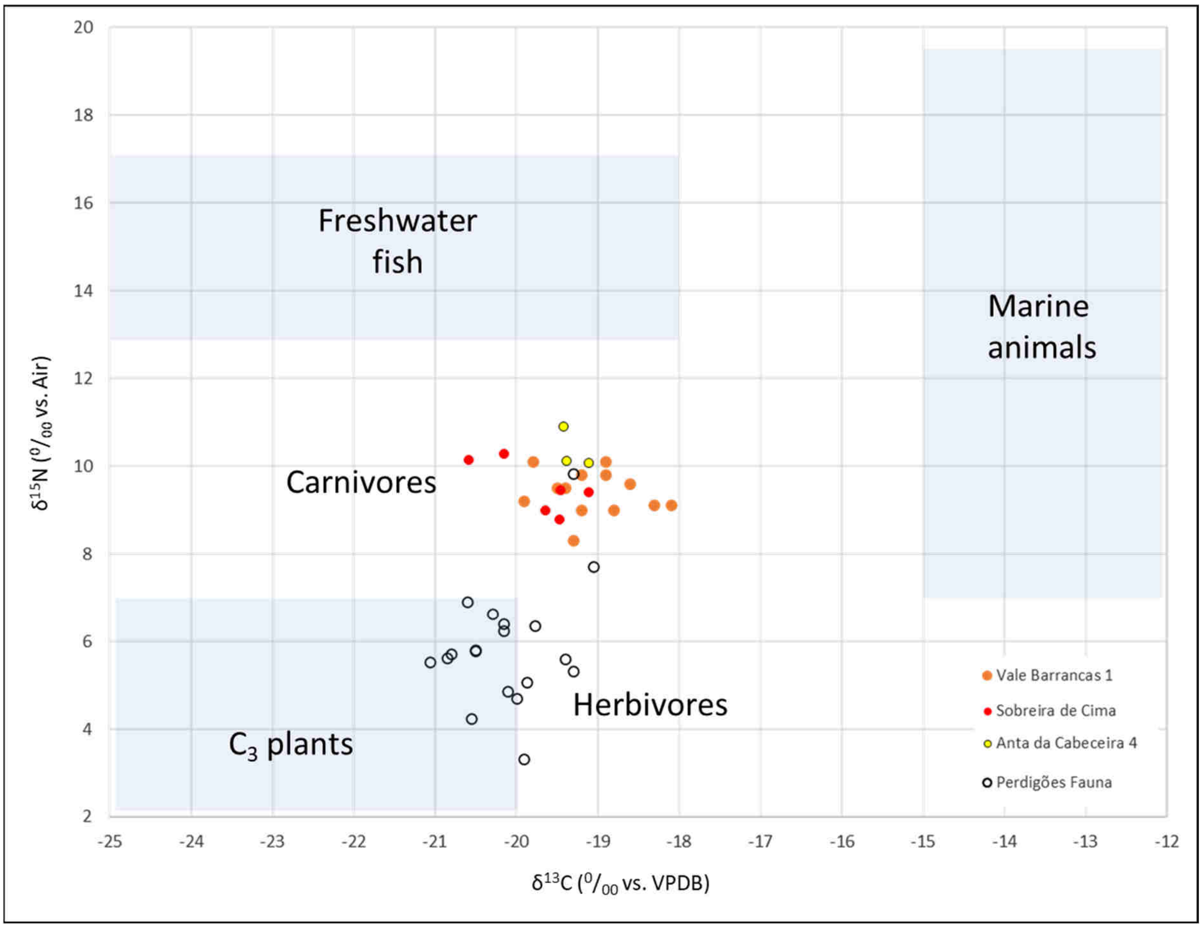

Figure 5.1 – Plot of δ13C and δ15N isotopic ratios for human and animals from Neolithic contexts of Alentejo region.

Typically, the collagen quality and presence of contaminants can be assessed with the C:N ratio falling between 2.9 and 3.6 (DeNiro, 1985). The range of C:N ratios calculated for the Vale Barrancas 1 samples was between 3.2 and 3.4 ±0.05. The low collagen yield values suggest a high degree of degradation, most likely as the result of diagenetic post-depositional processes and depositional age.

Most of the $\delta^{13}C$ and $\delta^{15}N$ isotopic values for the analysed human remains are clustered closely together, suggesting a uniform population without any evident differentiation based on dietary preferences (Figure 5.1). Bulk isotopic ratios of carbon and nitrogen suggest that C_3 plants were the dietary basis of the analysed individuals, complemented with protein deriving from terrestrial herbivores and eventually their secondary products.

Comparison with other available isotopic data from other Neolithic burials of the region, such as the hypogea necropolis of Sobreira de Cima (Carvalho, 2013; Emslie *et al.,* 2015) and the megalithic monument of Anta da Cabeceira 4 (Carvalho, Rocha, 2015), displays very similar dietary patterns. When the available isotopic ratios for humans are compared with the isotopic data of the Neolithic fauna for Perdigões ditched enclosures (Zalaite *et al.,* 2018), it shows that $\delta^{15}N$ is in average $3{,}5^0/_{00}$ higher in humans, suggesting the preserved trophic level effect of $2\text{-}4^0/_{00}$, as reported in the literature, while the trophic level increments for $\delta^{13}C$ ratios are smaller (approximately of $1^0/_{00}$). The exceptions are the isotopic ratios of one dog, that plots right in the middle of the humans, indicating the proximity and integration of dogs in human communities, probably fed with remains of human food.

5.4 - CONCLUSIONS

The number of sites with available $\delta^{13}C$ and $\delta^{15}N$ isotopic ratios for the Neolithic in Alentejo hinterland is still scarce. Nevertheless, the present data draws a coherent and homogeneous picture, indicating a general dietary mixed pattern, with an important contribution of C_3 plants complemented by proteins obtained from herbivores animals and their secondary products. This, though, does not clarify the balance between produced subsistence items and gathered ones.

In fact, the study of the Neolithic sequence of Perdigões (Valera, 2018), covering the end of the Middle Neolithic and the Late Neolithic, showed the presence of cereals at the site in these phases, but with few empirical evidence (a seed and some pollen of cereals and legumes in the bottom of ditches). In the Late Neolithic phase of Moinho de Valadares 1 the indirect presence of barley was established (Queiroz, Ruas, 2013). But these records are sparse, and the indirect evidence of agriculture is also limited for the great majority of settlements of the period in the region (Valera, 2018). So, it is hard to value the contribution of agriculture *vs*. gathering, but the isotopic data indicates that agriculture is already central in the subsistence strategies of these communities. The same problem exists regarding the protein contribution. At Perdigões, the faunal record for the end of the Middle Neolithic, which is coincident with the chronological span of Vale Barrancas 1 necropolis, shows an equivalence of wild and domestic species, and only in the Late Neolithic the domestic animals clearly overcome the hunted ones (Almeida, Valera, in press), indicating that hunting still was an important source of protein during the late Middle Neolithic.

What the current data suggests, for the subsistence strategies of these population of Alentejo hinterland at the end of the Middle Neolithic, is a clear terrestrial dietary pattern based on the production of C_3 plants and animal husbandry, but where the contribution of gathering and hunting is still quite relevant. This relevance of gathering and hunting would decay during the Late Neolithic and Chalcolithic in favour of agriculture and pastoralism. By the late 3rd millennium BC, thought, hunting seems to grow again at a cost of pastoralism (Almeida, Valera, in press), which can be interpreted as another symptom of the crises of the end of the millennium.

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