

## CARIES AND ORAL PATHOLOGIES AT THE MESOLITHIC SITES OF MUGE: CABEÇO DA ARRUDA AND MOITA DO SEBASTIÃO

BY

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### 1. INTRODUCTION

Dental caries and oral pathologies have long had an impact on the health of humans (Alexandersen, 1967; Brothwell, 1963; Clement, 1958; Emery, 1963; Hardwick, 1960; Larsen, 1982). As Krogman (1938: 70) pointed out nearly 50 years ago, the frequency of caries (dental decay) and alveolar disease have «increased with the progress of civilization, but the disease is not a product of civilization». Rates of caries and incidence of alveolar disease and tooth loss have been reviewed for numerous prehistoric (and living) hunter-gatherer and agricultural groups (e.g. Angel, 1944; Turner, 1979; Wells, 1975) and show a considerable range of variation in the incidence of oral diseases through time and across geographic space.

The following study documents the prevalence of caries, alveolar abscesses, and teeth lost premortem at the two Muge sites of Cabeço da Arruda and Moita do Sebastião. These sites were excavated by different investigators over the past 125 years and are attributed to the late Mesolithic. Recent accelerator <sup>14</sup>Carbon dates on the human bones from Moita do Sebastião place this material between 7240 ± 70 and 6810 ± 70 BP (Meiklejohn, Jackes, & Lubell, 1986). Previously reported dates for Cabeço da Arruda are slightly younger than these new dates for Moita do Sebastião, but archaeological similarities indicate the two sites are roughly contemporaneous (Newell, Constandse-Westermann, & Meiklejohn, 1978).

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## 2. METHODS

Dental and oral pathologies from Cabeço da Arruda and Moita do Sebastião were scored on the original specimens which are housed in the Instituto de Antropologia «Dr. Mendes Corrêa» in Porto and the Serviços Geológicos de Portugal in Lisbon. Material from Cabeço da Amoreira (Newell, Constandse-Westermann, and Meiklejohn, 1979) could not be located in either Porto or Lisbon and is therefore not included in the results.

Three types of pathologies were scored on the original specimens in either Porto or Lisbon. These consisted of caries, abscesses, and premortem tooth loss and were identified following procedures described by Armelagos (1969), Frayer (1984) and Molnar & Molnar (1985). For caries, occlusal and cervical surfaces were inspected by eye and lesions were identified on the basis of destruction of crown enamel or root erosion along the cemento-enamel junction. Since many of the Muge teeth are still located in the jaws, it was often not possible to closely evaluate the interproximal surfaces below the occlusal plane. Consequently, frequencies for these types of caries are probably under-reported. However, at Cabeço da Arruda, Moita do Sebastião or the other Mesolithic sites, interproximal caries along the cemento-enamel border seem to be quite rare.

Abscesses in the alveolar regions were recorded *only* when a distinct cloaca occurred. Because there was considerable alveolar resorption and other evidence of periodontal disease in many specimens, this rigid definition of what constitutes a periapical abscess probably underestimates the number of these types of oral pathologies. However, the procedure has the advantage of allowing a consistent recording technique for comparative purposes. Premortem tooth loss was also often difficult to judge due to the incompleteness of some individuals and questions about how much bone resorption was necessary to qualify a tooth for being scored as lost premortem. The main criterion concerned the integrity of the tooth sockets. When these were remodeled or completely filled in with bone so that the alveoli no longer existed (or just their bases were preserved), the tooth was considered to have been lost before death. This technique lacks the precision of clinical analysis, but without the ability to X-ray the jaws, was deemed the most reliable approach. A similar procedure was used by Molnar and Molnar (1985).

In the following tables, pathologies are presented separately for male, female, and unsexed individuals, with summary data given for the combined sexed samples. In each case sex was determined by a limited number of cranial or postcranial features (such as pelvic morphology, browridge or

mastoid size) according to techniques described by Bass (1971). In addition, only adults are included in the tabulations. Adult status was based on the presence of an erupted (and worn) third molar or evidence that the third molar had been in occlusion in cases where the M3 was missing.

Besides the data for Muge, summary data are presented for other Western and Central European Mesolithic specimens. The specific sites comprising this sample are discussed elsewhere (Frayer, 1988), but the sample includes virtually all known Mesolithic specimens available for study in 1985-87. In all, the Mesolithic sample includes observation on 2016 mandibular and 1878 maxillary teeth, deriving from 105 males, 71 females, and 15 unsexed individuals. Adding the 28 males, 29 females, and 10 unsexed individuals from Cabeço da Arruda and Moita do Sebastião, the entire Mesolithic sample totals 2562 mandibular and 2335 maxillary teeth representing about 260 individuals. Nearly all of these teeth were personally examined by the author on the original specimens. Given inter-observer differences in scoring dental pathologies (Wells, 1975), it is important to note that the data reported here all derive from one perspective and should be internally consistent <sup>(1)</sup>.

### 3. CARIES

Data on a tooth by tooth basis for the mandible and maxilla are given for Cabeço da Arruda and Moita do Sebastião in Table 1. Comparison of the caries rates for the two sites shows some differences on the individual tooth basis, but overall, Cabeço da Arruda and Moita do Sebastião show a close resemblance in the frequency of carious teeth. In fact, none of the «Totals» for either sex in the mandible or maxilla are significantly different as measured by  $2 \times 2$  Chi-square, although a few of the individual tooth comparisons do reach statistical significance ( $p < .05$ ). Since the total rates in the individual jaws for males and females are not significantly different

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<sup>(1)</sup> Since the submission of this paper, I have discovered my dental sample from Moita do Sebastião does not include all the teeth conserved in the Serviços Geológicos de Portugal. Apparently, some specimens were stored in a separate area away from the main collections to which I did not have access (David Lubell, personal communication). Thus, the figures for oral pathologies presented in this paper differ in sample size from results obtained by M. K. Jackes and D. Lubell. However, the pattern of dental pathologies between Moita do Sebastião and Cabeço da Arruda is similar between these two independent studies in that Cabeço da Arruda has lower incidences of oral pathologies than Moita do Sebastião. My results do not indicate these differences reach statistical significance, while Jackes and Lubell find significant differences between the two sites.

TABLE 1 — Caries rates for Cabeço da Arruda and Moita do Sebastião Sample Based on the Total Number of Teeth

(n = number of teeth, % = percent carious)

	I1		I2		C		P3		P4		M1		M2		M3		Totals	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>MANDIBLE</b>																		
<b>Males</b>																		
Cabeço da Arruda	5	0.0	7	0.0	7	0.0	9	0.0	8	0.0	9	0.0	8	12.5	9	33.3	62	6.5
Moita do Sebastião	17	0.0	21	0.0	18	5.6	20	0.0	19	10.5	19	21.1	20	20.0	19	10.5	153	9.2
<b>Females</b>																		
Cabeço da Arruda	19	0.0	23	0.0	26	0.0	27	0.0	25	12.0	27	7.4	21	0.0	15	33.3	183	5.5
Moita do Sebastião	13	0.0	18	0.0	19	0.0	15	0.0	15	6.7	15	13.3	17	5.9	12	33.3	124	6.5
<b>Total Teeth (1)</b>																		
Cabeço da Arruda	25	0.0	32	0.0	37	0.0	40	0.0	37	10.8	40	5.0	33	3.1	25	32.0	269	5.6
Moita do Sebastião	30	0.0	39	0.0	37	2.7	35	0.0	34	8.8	34	17.6	37	16.2	31	19.4	277	7.9
<b>MAXILLA</b>																		
<b>Males</b>																		
Cabeço da Arruda	6	0.0	7	0.0	8	0.0	11	9.1	11	0.0	10	0.0	7	0.0	7	0.0	67	1.5
Moita do Sebastião	14	0.0	14	0.0	25	0.0	19	0.0	17	5.9	22	9.1	19	10.5	14	21.4	144	5.6
<b>Females</b>																		
Cabeço da Arruda	12	0.0	10	0.0	13	7.7	13	7.7	11	0.0	15	6.7	17	11.8	10	50.0	101	9.9
Moita do Sebastião	7	0.0	11	0.0	13	0.0	13	0.0	14	28.6	15	26.7	14	0.0	7	28.6	94	10.6
<b>Total Teeth (1)</b>																		
Cabeço da Arruda	23	0.0	21	0.0	27	3.7	31	6.5	30	3.3	33	6.1	32	6.3	22	22.7	219	5.9
Moita do Sebastião	21	0.0	25	0.0	38	0.0	32	0.0	31	16.1	37	16.2	33	6.1	21	23.8	238	7.6
<b>MANDIBLE AND MAXILLA</b>																		
<b>Total Teeth (1)</b>																		
Cabeço da Arruda	48	0.0	63	0.0	64	1.6	71	2.8	67	7.5	73	5.5	65	4.6	47	27.7	488	5.7
Moita do Sebastião	51	0.0	64	0.0	65	1.5	67	0.0	65	12.3	71	15.5	70	14.4	52	21.2	515	7.8

(1) Includes males, females and unsexed individuals.

TABLE 2—*Caries rates for Muge and the Comparative Mesolithic Samples Based on the Total Number of Teeth*  
(*n* = number of teeth, % = percent carious)

	I1		I2		C		P3		P4		M1		M2		M3		Totals	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>MANDIBLE</b>																		
Males																		
Mesolithic	103	0.0	124	0.0	143	0.0	158	0.0	160	0.0	166	1.8	165	7.2	161	3.1	1180	.8
Muge	22	0.0	28	0.0	25	4.0	29	0.0	27	7.4	28	14.3	28	21.4	28	17.9	215	8.4 <sup>(3)</sup>
Females																		
Mesolithic	76	2.6	88	0.0	104	0.0	107	1.9	105	2.9	107	5.7	110	9.2	94	4.3	791	3.3
Muge	32	0.0	41	0.0	45	0.0	42	0.0	40	10.0	42	9.5	38	2.6	27	33.3	307	5.9 <sup>(2)</sup>
Total Teeth <sup>(1)</sup>																		
Mesolithic	182	1.1	217	0.0	251	.8	271	1.1	270	1.1	281	3.2	284	3.9	260	3.5	2016	1.9
Muge	55	0.0	71	0.0	74	1.4	75	0.0	71	9.9	74	10.8	70	10.0	56	25.0	546	6.8 <sup>(3)</sup>
<b>MAXILLA</b>																		
Males																		
Mesolithic	90	0.0	103	0.0	131	1.5	141	.7	157	1.3	165	1.8	163	1.2	135	.7	1085	1.0
Muge	20	0.0	21	0.0	33	0.0	30	3.3	28	3.6	32	6.3	26	7.7	21	14.3	211	4.3 <sup>(3)</sup>
Females																		
Mesolithic	76	0.0	75	0.0	92	0.0	95	0.0	98	0.0	105	1.9	100	0.0	78	3.8	719	1.0
Muge	19	0.0	21	0.0	26	3.8	26	3.8	25	16.0	30	23.3	31	6.5	17	41.2	195	10.3 <sup>(3)</sup>
Total Teeth <sup>(1)</sup>																		
Mesolithic	173	0.0	181	0.0	228	0.0	244	.8	262	.7	286	2.1	279	.7	225	2.2	1878	1.1
Muge	44	0.0	46	0.0	65	4.6	63	3.6	61	9.8	70	14.3	65	6.2	43	23.3	457	6.8 <sup>(3)</sup>
<b>MANDIBLE AND MAXILLA</b>																		
Total Teeth <sup>(1)</sup>																		
Mesolithic	355	.6	398	0.0	479	.4	515	.4	532	.9	567	2.6	563	2.3	485	2.4	3894	1.5
Muge	99	0.0	117	0.0	139	2.9	138	.7	132	9.8	144	12.5	135	8.2	99	24.2	1300	6.7 <sup>(3)</sup>

(1) Includes males, females and unsexed individuals.

(2) No significant differences (Chi-square:  $p > 0.5$ ) between Muge and the Mesolithic.

(3) Significant difference (Chi-square:  $p < .05$ ) between Muge and the Mesolithic.

between the two sites, I have combined Cabeço da Arruda and Moita do Sebastião in all subsequent tables.

With respect to these data for the two sites, I have found considerably fewer incidence of caries than the 13.1 % caries rate for Moita do Sebastião reported by Lubell, Jackes, Schwarcz, & Meiklejohn (1986). It is unclear to me how they have arrived at a caries rate nearly double the value I found, since we studied the same collections. Apparently, my determination of caries was more conservative. (I have noted that in some cases they scored a toothpick groove as a caries, but there are not a sufficient number of toothpick grooves at Moita do Sebastião to account for the discrepancy). It is also relevant to note that caries frequencies of about 2 % published by both Ferembach (1974) and Lefèvre (1973) for Moita do Sebastião are considerably lower than the results reported here. Differences in the incidence of caries among four separate studies of the Moita do Sebastião teeth underscore the difficulty in relying on the literature for compiling data on caries rates and point to the importance of personally examining original material.

Data for Cabeço da Arruda and Moita do Sebastião are combined in Table 2 and compared to the Mesolithic sample from other areas of Europe. From these tabulations it is clearly evident that a high number of caries are found at Muge compared to the specimens from other Mesolithic sites. When caries occur, nearly every tooth the Muge sample has a substantially higher incidence of caries than the Mesolithic sample. Carious teeth primarily involve those in the posterior tooth row, although caries afflicting canines also occur (1.4 % in the mandible; 4.6 % in the maxilla). No incisors have caries, but these teeth are ordinarily not affected by caries in any of the Mesolithic specimens. In general, at Muge M3's exhibit the highest frequencies for caries, followed by M1 then M2 (or P4). P3's in both jaws show low caries involvement. It is interesting that M3's which are in the jaws for the shortest period of time with respect to the other teeth have the highest caries rates. This contrasts to the comparative Mesolithic sample which shows about equal frequencies of caries in all the molars.

With respect to total caries incidence for males, females and unsexed individuals, in each case statistically significant differences occur between Muge and the Mesolithic sample (except in the female mandibular teeth) at the .05 level (or better) using  $2 \times 2$  Chi-square tests. In cases where statistically significant differences exist, the caries rate at Muge ranges from 3.6 to 10.5 times the rate in the other Mesolithic samples. When all mandibular and maxillary teeth are considered, caries occur at a 6.7 % rate in Muge, while a rate of 1.5 % exists for the other Mesolithic specimens. Thus, based on the total number of teeth preserved at Cabeço

TABLE 3—*Oral Pathologies Based on the Number of Individuals*  
 (np = number of individuals with the specific pathology)

	MALES			FEMALES			UNSEXED			TOTALS		
	(n)	np	%	(n)	np	%	(n)	np	%	(n)	np	%
<b>CARIES</b>												
Mesolithic	105	9	8.6	71	12	16.9	15	0	0.0	191	21	11.0
Muge	28	11	39.3 <sup>(1)</sup>	29	14	48.3 <sup>(1)</sup>	10	2	20.0	67	27	40.3 <sup>(1)</sup>
<b>ABSCESSSES</b>												
Mesolithic	106	22	20.8	71	25	35.2	15	1	6.7	192	48	25.0
Muge	28	3	10.7	29	8	27.6	10	3	30.0	67	14	20.9
<b>PREMORTEM TOOTH LOSS</b>												
Mesolithic	106	21	19.8	71	17	23.9	15	1	6.7	192	39	20.3
Muge	28	6	21.4	29	8	27.6	10	1	10.0	67	15	22.4

<sup>(1)</sup> Significant difference (Chi-square:  $p \leq 0.02$  or better) with Mesolithic sample.

da Arruda and Moita do Sebastião, these sites show a statistically significant higher incidence of teeth with caries.

Since these data were compiled according to the total number of caries present (and numerous individuals from Muge and other Mesolithic sites have more than one caries per tooth), another compilation was made based on the number of individuals with at least one caries. These data (Table 3) confirm the observations based on the total number of teeth and further demonstrate the high incidence of caries in the Muge sample. Thus, for Muge males 11 of the 28 specimens (39.3 %) have at least one carious tooth, while only 9 of 105 males (8.6 %) in the Mesolithic sample have one or more caries. In females a similar pattern occurs with nearly 50 % of the Muge specimens possessing at least one decayed tooth, while caries rates for the non-Muge Mesolithic females are considerably lower (16.9 %). Overall, approximately 40 % of the total Muge sample has at least one caries, while only 11 % of the comparative Mesolithic sample is pathological. Each of these differences is statistically significant at the .02 level (or better) using a  $2 \times 2$  Chi-square test. Consequently, whether the total number of teeth or the number of pathological individuals is considered, the caries rate at Muge significantly exceeds the rate for non-Muge Mesolithic sample.

Besides the incidence of caries, the severity of carious lesions was determined. These data, calculated on individual cases, represent the average number of caries per specimen (Table 4) and the degree of the carious involvement (Table 5). The latter is based on the size and severity of the caries, as described by Hillson (1979). However, only two categories were defined: occlusal (non-penetrant) and pulpal (penetrant) as others have done (Borgognini Tarli & Repetto, 1985; Lefèvre, 1973). These categories depend on whether the dental lesion is confined to the occlusal surface (non-penetrant caries) or whether it extends into the dentin and pulp (penetrant caries). Occlusal caries tend to be small, shallow pits on the crown surface, while pulpal involvement ranged from a moderate amount of coronal destruction to the complete loss of the crown, so that only the root stub remained.

With respect to the number of caries per individual (Table 4), the males from Muge average 2.5 caries (range = 1 – 7) and females 2.6 caries (range = 1 – 6). These frequencies indicate when caries occur, they commonly involve more than one tooth in the two jaws, while some teeth show polycaries. It is interesting to note the incidences per individual at Muge do *not* differ significantly from those for the other Mesolithic specimens, where both sexes together average 2.4 caries per individual (2.1 for males; 2.7 for females). Thus, based on the above data it is clear that caries per individual is not the reason for the high dental decay rate at Muge.



Rather the high incidence of caries is simply a reflection of the greater number of individuals from Muge with carious teeth compared to the Mesolithic sample.

Severity of the caries is summarized in Table 5. These data show that a high number of caries at Muge (44.6 %) penetrate through the enamel and involve the dentin and pulp. Males have a greater frequency of this type of caries compared to females, although incidences between the sexes are not significantly different. Compared to the other Mesolithic specimens, the rates for the Muge males and females are higher, indicating that the caries are more severe, although again there are no statistically significant differences between Muge and the other Mesolithic specimens.

TABLE 5 — *Types of Caries at Muge and in the Comparative Mesolithic Sample*

	MALES		FEMALES		UNSEXED		TOTALS		PERCENT	
	Occlusal	Pulpal								
Mesolithic	12	7	21	12	0	0	33	19	63.5	36.5
Muge	14	13	21	14	1	2	36	29	55.4	44.6

In summary, these different quantifications for caries involvement in the individuals from Cabeço da Arruda and Moita do Sebastião consistently show a high incidence of caries in the two Portuguese sites compared to Mesolithic specimens from other parts of Europe. Where significant differences occur between Muge and the rest of the Mesolithic, caries rates at Cabeço da Arruda and Moita do Sebastião are always higher.

#### 4. ABSCESSSES AND PREMORTEM TOOTH LOSS

Rates for the occurrence of abscesses and teeth lost before death were calculated only with respect to the percentage of individuals afflicted by one or both of these pathological conditions. In general, unlike the incidence of caries, the males and females from Muge do not show significant differences in the occurrence of these two indicators of oral health.

For abscesses (Table 3), Cabeço da Arruda and Moita do Sebastião males and females show lower frequencies compared to the other Mesolithic specimens, although neither of these comparisons represent statistically significant differences. Overall, about 21 % of the individuals from the

two sites possess at least one abscess, while 25 % of the Mesolithic samples have one (or more) periapical abscesses. Although not given in the table, there is no correlation between the location of periapical abscesses and the type of tooth most commonly afflicted by caries. For example, at Cabeço da Arruda and Moita do Sebastião third molars have the highest caries rate, but the first molars are associated with the highest number of abscesses (40.9 %), followed by M3 (22.7 %), P4 (13.6 %), and M2 (9.1 %). From these data it is clear that abscess formation is not highly correlated with caries.

Teeth lost before death are also not significantly more frequent in the two sites compared to the other Mesolithic sites (Table 3). Males, females and unsexed categories from Cabeço da Arruda and Moita do Sebastião have a slightly higher number of individuals with at least one tooth which was lost premortem compared to the Mesolithic sample, but overall the rates for this pathological condition are virtually identical for both samples. Thus, about 22 % of the specimens from Muge show the loss of one or more teeth before death, while 20 % of the comparative Mesolithic sample exhibits premortem tooth loss. As with the occurrence of abscesses, the posterior teeth show the highest frequency of missing teeth, with no differences occurring among M1, M2, and M3.

## 5. SUMMARY AND CONCLUSIONS

Based on these results, it is apparent caries occur in high frequencies at Cabeço da Arruda and Moita do Sebastião compared to the European Mesolithic sample. This is true whether dental caries are measured by the total number of teeth preserved or when based on the number of individuals with at least one carious tooth. In another publication, caries rates for different Mesolithic sites are reviewed for 10 sites in which 4 or more individuals are present (Frayer, 1988). Of these, the caries prevalence at Muge is only exceeded by Tévéc in NW France and Uzzo in SW Italy, but the differences are not great. Although it is not completely clear if the data are truly comparable, it is interesting to note that caries at Muge exceeds rates typical of most other hunter-gatherer samples. Thus, the Muge caries frequencies are substantially greater than the 1.0 % rate published by Armelagos (1966) for the Sudanese «Mesolithic.» Turner (1979: Table 3) has published a mean caries rate of 1.3 % for 19 hunter-gatherer samples and 4.8 % for a group of 13 «mixed economy (agriculture + hunting, gathering, or fishing)» samples. Total rates at Muge exceed the mean and range of the hunter-gatherer samples and are above the mean for the mixed

economy samples. Thus, whether based on the European Mesolithic or on world-wide samples, the caries rate at Muge is high, particularly in reference to data published for other hunter-gatherer groups. In contrast to the high prevalence of caries, the two Muge samples show no consistent differences with the comparative Mesolithic sample for the frequency of abscessed jaws or teeth lost premortem. This is not inconsistent with other studies, since tooth loss and abscesses are closely associated with alveolar disease due to plaque, heavy attrition and other «non-carious» factors (Wells, 1975).

The cause of the high caries involvement at Muge is difficult to pinpoint. Reviews of the etiology and epidemiology of caries have demonstrated a bacterial component to their development (Jordan, 1965) and have shown a strong correlation between caries and sugar/carbohydrate consumption (Mandel, 1979; Newbrun, 1982). Other factors such as protein ingestion (Hillson, 1979); Rugg-Gunn, 1983), fluoride, phosphate, and other mineral intake (Lukacs, Retief & Jarrige, 1985; Molnar & Molnar, 1985; Rugg-Gunn, 1983), saliva composition (Johansson, Ericson, Bowen, & Cole, 1984), malnutrition (Kreitzman, 1976; Sweeney, 1966) and tooth morphology (Paynter & Grainger, 1961) influence the onset, incidence and severity of caries in humans and experimental animals (Navia, 1977). There is also evidence for a genetic component in dental caries (Murray, 1983) and a general anthropological consensus that heavy occlusal wear tends to reduce the probability of developing caries (Armelagos, 1969). These and other factors lead to differential caries susceptibility in living people and presumably account for differences occurring in and among prehistoric populations.

Given the multiple factors responsible for caries and the lack of specific dietary data for Cabeço da Arruda and Moita do Sebastião, it is not possible to confidently identify the cause(s) for high caries frequency at Muge. From my survey of the skeletal material, there is no greater incidence of nutritional deficiencies (based on the occurrence of enamel hypoplasias) in comparison to the other European Mesolithic skeletal material. Dietary information is sparse and limited to faunal remains. Yet, besides abundant evidence for shellfish collection at Muge, the archaeological data indicates land mammals were hunted (Roche, 1957; 1967). Thus, it is reasonable to assume the Muge people were consuming some amount of marine and terrestrial protein (Meiklejohn, Jackes, & Lubell, 1986) and were not suffering from abnormal nutritional stress. However, more thorough testing of these observations would be an interesting and useful project for future research, as would analysis of ground water supplies for concentrations of mineral content.

As for other factors, crown morphology and degree of occlusal wear do not vary significantly between Muge and the other Mesolithic samples. Furthermore, there is no evidence for greater longevity in the Cabeço da Arruda and Moita do Sebastião samples which, although not a cause of caries, will affect the caries rate per individual (Larsen, 1982). Of all the possible factors, it seems probable that dietary components may be an important contributor to the high caries rate. Since fermentable carbohydrates are the single-most important cause of caries in living populations, it is reasonable to suspect consumption of these may account for the caries incidence at Muge. One possible dietary sugar is honey. There are numerous examples from the Iberian Peninsula of cave art depicting honey gathering which are dated to the Mesolithic (Crane, 1983; Dams & Dams, 1977). Rugg-Gunn (1983: 62) reports «it is unlikely honey is any less cariogenic than refined sugar» and, although there is no evidence for the use of honey at Muge, it is possible this food source may have contributed to the high caries rate. Another factor could be the incorporation of sweet, sticky fruits (such as dates, figs, or similar types of subtropical fruits) into the diet of the Muge inhabitants. No botanical evidence for these food sources has been discovered at Muge, although figs and dates are present today in the region (Condit, 1947) and, according to Crane (1983), dates may have been depicted in Mesolithic art. Both dates and figs have a substantial amount of sucrose and are considered moderately to highly cariogenic (Stephan, 1966). If they (or similar wild foods) were part of the diet at Muge, they would have had an important effect on the incidence of caries <sup>(2)</sup>.

In the absence of any confirmatory evidence for either honey or sweet fruits (or any botanical evidence of the diet), it is presumptuous to argue these food sources were the specific cause of high dental caries at Muge. However, it seems likely exposure to sugary foods is related to the incidence of caries at Muge, particularly since high caries frequencies are related to sugar/carbohydrate consumption in other prehistoric (and historic) populations (for example, see Angel, 1944; Owsley, Miles, & Gill, 1985; and Wells, 1975). Whatever the cause of caries at Cabeço da Arruda and Moita do Sebastião, individuals from these two sites show distinct tendencies to develop dental caries, which distinguishes them from most of the other European Mesolithic specimens.

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<sup>(2)</sup> The occurrence of fig in Mesolithic/Neolithic contexts has recently been reported by Lubell and Jackes (personal communication) from charcoal found at the coastal sites of Samouqueira and Medo Tojeiro in Alentejo. Although there is no evidence the fruits were eaten, it seems likely these were available as food sources.

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## RESUMO

Este trabalho revela evidências de patologias dentárias e bucais em restos humanos provenientes de duas estações do Mesolítico Português: Cabeço da Arruda e Moita do Sebastião, em Muge. Os dados obtidos nestas estações são comparados com a incidência de doenças bucais noutros espécimes do Mesolítico europeu. Os dentes provenientes de Cabeço da Arruda e Moita do Sebastião mostram uma elevada percentagem de cáries, relativamente a amostras comparativas de outros espécimes do Mesolítico europeu. A maior parte destas diferenças são estatisticamente significativas, quer sejam baseadas no número total de dentes, quer no número total de indivíduos analisados. Pelo contrário, para a percentagem destas cáries, a frequência de abscessos alveolares e a perda de dentes antes da morte, não difere significativamente dos outros espécimes mesolíticos.

Dado que estudos experimentais e epidemiológicos mostram que as cáries estão relacionadas, em primeiro lugar, com uma alimentação à base de açúcares e hidratos de carbono, podemos deduzir que os alimentos ingeridos pelos habitantes pré-históricos de Muge, envolviam uma alta quantidade de produtos susceptíveis de provocar cáries.

## SUMMARY

This paper presents evidence for dental and oral pathologies in the human remains deriving from the two Portuguese Mesolithic sites at Muge: Cabeço da Arruda and Moita do Sebastião. Data for these sites are compared to incidence of oral disease in other European Mesolithic specimens. The teeth from Cabeço da Arruda and Moita do Sebastião show high rates of caries with respect to a comparative sample of other European Mesolithic specimens. Most of these differences are statistically significant, whether based on the total number of teeth or the total number of individuals in the samples. In contrast to these rates of caries involvement, the frequency of alveolar abscesses and teeth lost before death do not differ significantly from other Mesolithic specimens. Since experimental and epidemiological studies show that caries is primarily related to dietary items involving sugars and carbohydrates, it is postulated the diet of the prehistoric inhabitants of Muge was high in these cariogenic foods.

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