Archaeology and Human Biology of the Mesolithic–Neolithic Transition in Southern Portugal: a Preliminary Report

Published in:
Clive Bonsall (ed.) 1989
The Mesolithic In Europe: Papers Presented at the Third International Symposium.
John Donald Publishers Ltd.
Edinburgh

David Lubell, Mary Jackes and Christopher Meiklejohn

Abstract

We report here on research begun in June 1984, designed to test whether demographic change was a cause or consequence of the Mesolithic–Neolithic transition. We present data for human skeletons from the site of Moita do Sebastião which show that while dental pathologies were more common amongst older members of the population than is normally the case for Mesolithic Europeans, the population was nonetheless quite healthy. We also present archaeological and palaeoenvironmental data to show that: (i) during the mid-Holocene on the Atlantic coast south of Setúbal, forest cover was heavier than today, and habitats appropriate for *Cervus elaphus* and *Sus scrofa* were present; (ii) most molluscs in coastal sites could have been easily collected from the intertidal zone (e.g. *Mytilus*, *Patella*, *Cardium*), but large marine gastropods (e.g. *Thais haemastoma*) and fish (e.g. *Sparus auratus*) were probably obtained offshore, perhaps with nets; (iii) the Mesolithic economy, as elsewhere in Europe, may have included use of the domestic dog.

INTRODUCTION

What effect does a major change in the economy of a society have upon the health and demography of the people who compose it? What happened when 'Mesolithic' hunter-gatherers changed to being 'Neolithic' farmers and herders? And, why did they change at all?

We began to investigate these questions in Portugal during 1984, with two basic goals. One is to study the palaeopathology and palaeodemography of the larger collections of Mesolithic, Neolithic and post-Neolithic human skeletons that have already been excavated from Portugese sites (especially those near Muge), and thus test hypotheses proposed by others (e.g. Binford 1968; Hassan 1975; Cohen 1977; and see Cohen and Armelagos 1984) as to the effects upon human populations of the shift from foraging to agriculture. A second goal is to excavate and analyze Mesolithic and Neolithic sites from a range of environments (coastal, estuarine, inland, etc.) using an interdisciplinary methodology which while common elsewhere (e.g. in Spain – cf. Guilaine *et al.* 1982; Clark 1983; in the Maghreb – cf. Lubell, Sheppard and Jackes 1984, with references), has yet to be applied extensively in Portugal (see Morais-Arnaud 1982, and contribution to this volume). Eventually, we may request permission to re-excavate some of the sites from which skeletal samples we are studying derive.

In 1984, we inventoried the skeletal collections from Moita do Sebastião and Cabeço da Arruda housed at the Geological Survey in Lisbon, as well as making a preliminary inventory of Muge skeletal collections housed at the Mendes Correa Institute of Anthropology, University of Porto. A partial osteological study of the Lisbon collections from Moita do Sebastião was completed. In addition, we excavated a shell midden known as Medo Tojeiro (Zbyszweski and Penalva 1979) and tested another site called Samouqueira, said to be Mesolithic (Tavares da Silva and Soares 1981, 1982).

ARCHAEOLOGY

Medo Tojeiro

Medo Tojeiro (*Fig. 1*) is located on the Atlantic coast of Portugal, about 2 km south of the modern village of Almograve, which is 10 km south of Vila Nova do Milfontes. The site consists of two areas that are not necessarily closely related in time. One of these is a small remnant (*c.* 12 × 6 m) of a shell midden, overlooking the Atlantic from an elevation of 30 m a.s.l. It is disconformably underlain and overlain by dune sand. The other area is a blow-out within the dunes behind the midden, where there were several piles of apparently fire-cracked rock and about 300 large stone artifacts exposed on a deflated surface. The site was discovered by Carlos Penalva who collected the artifacts consisting primarily of several varieties of large chopper-like tools made of local coarse-grained quartzite or greywacke. They have been assigned to the Languedocian (or Mirensian) industry (Zbyszweski and Penalva 1979). This industry is probably equivalent to the Portuguese Asturian (defined by Maury 1977) and perhaps to the Asturian of Cantabria as well (but see discussion in Clark 1983). The assemblage is being re-studied by Sheppard.

Area 1, the midden

We excavated an area of *c.* 11 m^2 in the midden, using a combination of artificial (5 cm) and natural levels within one-metre squares. The maximum

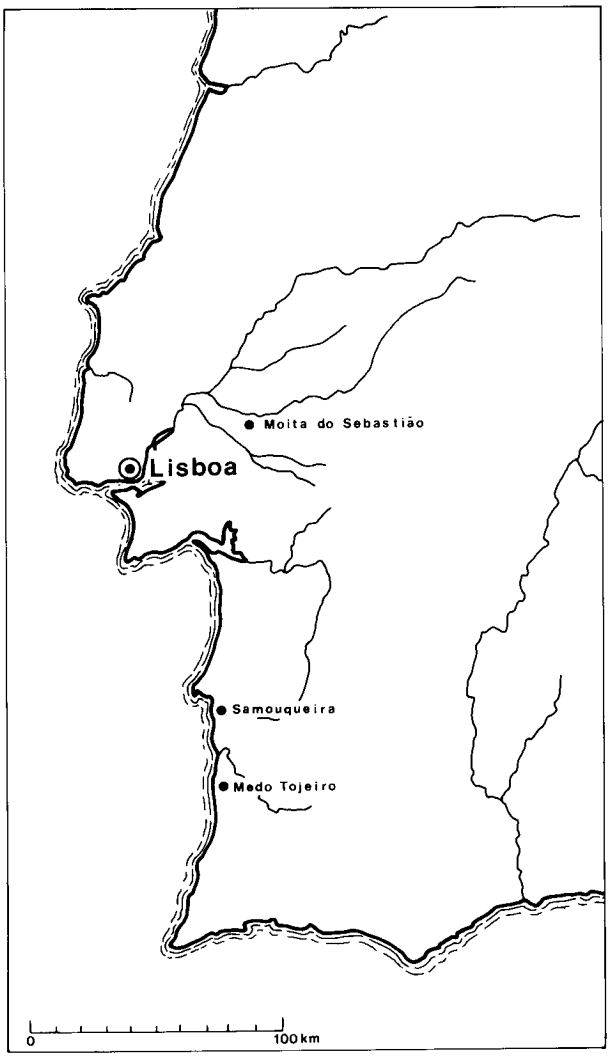

Figure 1 Location of key sites referred to in the text.

thickness of midden deposit was about 75 cm. In some places six levels (couches) could be discerned, but in general only four were observed. Distinctions between levels are based primarily on colour, shell content (both quantity and species observed), and texture. The top of the archaeological levels (couche 1) is a lag deposit composed almost entirely of fire-cracked rock. It grades into a deposit containing more shell which was sometimes called couche 1b. The main shell levels are couches 2 and 4 (*Table 1*).

Table 1: Medo Tojeiro, 1984. Mean percentages, by weight, for shell and rock in the <2 mm and >2 mm fraction of 1 litre bulk samples

	<2 mm		>2 mm		
Couche	*n*	*% shell*	*n*	*% rock*	*%shell*
C.1	12	19.11	8	57.78	42.22
C.2	11	23.30	5	10.95	89.05
C.3	11	10.55	5	21.69	78.31
C.4	10	20.61	4	22.38	77.61
C.5	8	8.14	5	19.56	80.44
C.6	2	4.22	1	44.92	55.08

The only structural features noted during the excavation were several concentrations of fire-cracked rock that we interpret as hearths.

Artifacts were rare, consisting of a few pot sherds, several geometric microliths, one polished celt, one chopper, some chert bladelet fragments and a few greywacke flakes. These, according to Tavares da Silva, are all consistent with an assignment to the Older Neolithic and in accord with the date of 6570±120 BP (BM–2275: calibrated range = 7189 [7108] 6929 BP, cf. Stuiver *et al.* 1986) obtained on a sample of marine shell collected in 1983 during our preliminary inspection of the site.

That sample probably came from couche 4, near the bottom of the midden. However, it was taken from the exposed western face in an area affected by chemical and physical weathering which obscured stratigraphic relationships and may have led to sample contamination. A second sample, of charcoal, was excavated from couche 4 within the midden in 1984. While so small as to require extended counting time, it has yielded an apparently reliable date (corrected for $\delta^{13}C$) of 5450±160 BP (Beta–11723: calibrated range = 6406 [6282, 6222, 6208] 5989 BP, cf. Pearson *et al.* 1986). There is thus a difference of *c.* 900 radiocarbon years between the two samples. We are inclined to place more reliance on the charcoal date but admit that for now the best we can say is that the midden probably dates to between *c.* 7200 and *c.* 6200 BP.

No bone was recovered from our excavations. Fire-cracked rock was very common, forming up to 97% of the >2 mm fraction of the deposit by weight (means are given in *Table 1*). Couche 2 and couche 4 were especially rich in shell, as can be seen from the high values for shell in the <2 mm fraction and the low values for rock in the >2 mm fraction in *Table 1*.

While at least 20 species of marine invertebrates were found, probably only four (*Mytilus*, *Patella*, *Monodonta* and *Thais*) were major sources of food. Other species (*Cardium*, *Glycimeris*, *Ostrea*) were present but not common, and both barnacles and sea urchins appear to have been collected. *Thais*, a marine gastropod, is more frequent in upper levels than lower ones in some, but not all, excavated squares, while the limpet (*Patella*) tends to be more frequent in lower levels (*Table 2*). In addition, there

Table 2: Medo Tojeiro, 1984. Mean percentage frequencies for major edible molluscs, calculated by weight of shell in the >2 mm fraction of 1 litre bulk samples

Couche	*Patella*	*Monodonta*	*Thais*	*Mytilus*
C.1	14.05	1.94	11.07	73.22
C.2	17.53	0.85	2.46	79.17
C.3	23.78	0.81	5.39	70.02
C.4	16.25	1.05	5.26	77.44
C.5	14.67	1.25	5.37	78.71
C.6	17.73	0.71	3.55	78.01

are quite distinctive frequency differences (shell *vs* stone, species represented) within the same level between adjacent squares (*Table 3*). This suggests

Table 3: Medo Tojeiro, 1984. Horizontal variability in composition of deposits in adjacent squares S3 and S4 as percentage frequencies by weight of 1 litre bulk samples

Couche	*Shell*				*Mytilus*		*Patella*	
	>2 mm		<2 mm					
	S3	S4	S3	S4	S3	S4	S3	S4
C.1	4.8	34.4	0.0	8.6	88.2	72.5	8.8	19.1
C.2	65.7	95.2	24.1	8.0	81.1	70.0	11.8	28.8
C.3	81.4	74.3	13.8	11.0	69.1	72.4	26.5	16.4
C.4	64.8	74.4	25.1	12.5	57.9	87.9	33.3	5.9
C.5	66.8	79.4	4.3	2.2	70.9	86.2	17.7	12.6

rapid accumulation of the deposits, resulting in a record of the collection and discard of individual 'catches' of shellfish, and/or other activities that are reflected in the different frequencies of stone and shell.

Area 2, the blow-out

This area was investigated under the supervision of Tavares da Silva and Soares. Several hearths, which appeared as deflated piles of angular rock fragments, were mapped and sectioned, and Soares discovered and excavated others not yet exposed by deflation. This hearth contained microlithic artifacts. Another, exposed on the surface, contained a greywacke flake amongst the fire-cracked rock (Tavares da Silva *et al.* 1985).

There is no indisputable connection between these hearths and the macrolithic industry found by Penalva on the surrounding deflated surface. Inspection of the surface of the blow-out revealed a mixture of cultural materials ranging in age from quite modern, to Mediaeval, to at least the Bronze Age (a mint condition Palmela point was found on the back slope of the blow-out near the hearths).

Thermoluminescence analyses conducted by Peter Sheppard and Lawrence Pavlish at the University of Toronto confirm that these features were hearths. Samples of greywacke and quartzite collected from modern beaches were compared with samples of the same rock types taken from the features. The results suggest that the rocks from the features were heated to 350–400 °C. The hearths could, of course, date from several widely separated periods.

The relationship between the two areas at Medo Tojeiro has yet to be determined. The radiocarbon dates from the blow-out may help, but stratigraphic continuity between the two areas will be almost impossible to establish. There were too few artifacts in the midden to undertake a comparative study with the materials collected by Penalva on the surface of the blow-out, and the artifacts found by Soares in the hearth are apparently neither sufficiently numerous nor diagnostic to warrant comparison with the scarce material from the midden. The geomorphological setting of Medo Tojeiro is complex and analyses are now underway (including palynology) to try and clarify the picture.

Samouqueira

Samouqueira is a very large site, covering an area of at least 120 × 140 metres. Our work there in 1984 was limited to four one-metre square test pits and an excavation of 7 × 2 m in one-metre squares using 5 cm artificial levels within thicker natural strata – all these in the part of the site thought to contain deposits dating to the Mesolithic. Because the site lies in what is now a ploughed field, there has been an undetermined amount of disturbance. The ground slopes up from the sea edge (a 10 m cliff) to an old beach about 200 m inland. There has been a good deal of overburden which reached >2 m at a distance of 40 m from the cliff edge. There were lithic artifacts scattered throughout the overburden, and there appear to be no remaining *in situ* deposits (Lubell and Jackes 1985).

In the main trench we recovered a rich assemblage of microlithic and macrolithic artifacts but no ceramics or ground stone artifacts. Marine shell (mostly *Mytilus* and *Patella* with some *Cardium*) was common (*Table 4*), and there were bones of *Cervus*

Table 4: Samouqueira, 1984. Percentages, by weight, of major species of edible molluscs

Couche	*Patella*	*Mytilus*	*Cardium*	*Thais*
surface	25.17	14.15	25.70	47.84
C.1b	31.90	20.00	+	54.76
C.2a	24.78	20.63	6.42	48.16
C.2b	35.86	16.67	9.83	39.60
C.3a	51.36	15.83	3.03	37.75
C.3b	48.64	11.73	+	44.32
C.3c	52.63	21.05	+	26.32
C.3d	78.36	+	+	18.86
C.3e	55.49	20.45	+	24.05

+ = present but not weighed

elaphus, *Sus scrofa*, *Lepus capensis*, *Vulpes vulpes* as well as birds, fish (*Sparus auratus*), and possibly dog (?*Canis lupus* f. *familiaris*).

Two partial human skeletons were excavated from the main trench, probably both males. Both showed evidence of pathological conditions: a healed fracture of the humerus with osteomyelitis, an infected foot, severe arthritis of one wrist. Both skeletons had been disturbed, probably by ploughing and then

perhaps by subsequent downslope erosion. One may have been buried in full articulation; the other certainly was, probably as a flexed burial (after rigor mortis had relaxed) with the head to the west and the face to the north. In comparison with skeletal populations dated to the Portuguese Mesolithic (to be discussed later) these two Samouqueira individuals indicate rather elevated levels of pathology.

Two AMS radiocarbon dates are available for Samouqueira, and these suggest the deposits are so disturbed that further investigations are not warranted. Collagen from a bovid/cervid long bone fragment from the main excavation area is dated at 5060±130 BP (Beta 11722: calibrated range = 5949 [5887, 5816, 5767] 5652 BP, cf. Pearson *et al.* 1986). Human bone collagen from the same archaeological stratum is dated at 6370±70 BP (TO-130: calibrated range = 7324 [7274, 7200, 7199] 7188 BP, 20-year average of LSB, SKBF, KRBSMSB and LLDF – cf. Stuiver *et al.* 1986). The human remains are therefore certainly Mesolithic in age, but not all the associated archaeological material may be Mesolithic (Meiklejohn *et al.* 1986).

Artifact assemblage

A partial, and possibly not truly representative sample of the artifact assemblage was studied in the field by Sheppard. Additional studies of the entire excavated assemblage are now being undertaken by Soares. Sheppard's results show that the assemblage is predominantly microlithic and made on flint (*Table 5*), which is not locally available today. Analyses of these finer grained materials using instrumental neutron activation analysis suggest that a wide range of raw materials, apparently coming from some distance, were employed in the manufacture of the microlithic component. We will attempt to locate sources during future field seasons and thus try to get some idea of the exploitation territory represented.

It is possible that greywacke débitage is systematically under-represented due to the difficulty of recognizing knapped greywacke. Experimental studies by Sheppard and Lello during the 1984 field season demonstrated that much of the débitage produced lacks any features diagnostic of human knapping.

Sheppard identified two separate technological patterns: one based on greywacke cobbles from the beach below the site, the other on a variety of fine-grained or crystalline rocks with good conchoidal fracture that we are, for now, lumping under the generic term flint.

The greywacke technology produced large primary flakes with minimal secondary retouch. Sheppard recognized only four cores. The greywacke artifacts were all made on fine-grained rock, and it therefore appears that only the finer grained were chosen from amongst the generally coarse-grained cobbles on the beach.

Flint seems to have been used almost exclusively for the manufacture of narrow bladelets with a mean width of 7.9±2.3 mm. These were struck from single platform cores (68%) on which there is only oc-

Table 5: Samouqueira, 1984. Frequencies of major artifact classes and raw materials

Artifact class	*Flint*		*Greywacke*		*Quartzite*		*Crystal*		*Total*	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Trapeze concave	3	100.0	–	–	–	–	–	–	3	0.2
Trapeze straight	6	100.0	–	–	–	–	–	–	6	0.4
Trapeze conc./str.	1	50.0	–	–	1	50.0	–	–	2	0.1
Triangle straight	4	80.0	–	–	1	20.0	–	–	5	0.4
Segment	5	100.0	–	–	–	–	–	–	5	0.4
Microburin	8	66.7	–	–	4	33.3	–	–	12	0.9
Backed bladelet	7	100.0	–	–	–	–	–	–	7	0.5
Burin dihedral	1	100.0	–	–	–	–	–	–	1	0.1
Borer/bec	3	100.0	–	–	–	–	–	–	3	0.2
Truncation straight	1	100.0	–	–	–	–	–	–	1	0.1
Truncation oblique	1	100.0	–	–	–	–	–	–	1	0.1
Denticulate	–	–	–	–	1	100.0	–	–	1	0.1
Notch	7	46.7	7	46.7	1	6.7	–	–	15	1.1
Retouched piece	1	16.7	5	83.3	–	–	–	–	6	0.4
Utilized	–	–	1	50.0	1	50.0	–	–	2	0.1
Chopper	–	–	2	100.0	–	–	–	–	2	0.1
Core	21	67.7	4	12.9	5	16.1	1	3.2	31	2.3
Crested blade	1	100.0	–	–	–	–	–	–	1	0.1
Chunk	99	50.0	58	29.3	34	17.2	7	3.5	198	14.8
Flake	125	25.6	298	61.1	63	12.9	2	0.4	488	36.4
Bladelet	273	58.1	46	9.8	134	28.5	17	3.6	470	35.1
Blade	33	41.2	34	42.5	13	16.2	–	–	80	6.0
Total	600	44.8	455	34.0	258	19.3	27	2.0	1340	100.0

casional evidence for platform preparation (20%). Sheppard infers use of either direct percussion or simple indirect percussion. The bladelets were apparently intended primarily as blanks for the manufacture of both geometric and non-geometric microliths.

Discussion of archaeological data

These briefly summarized data raise several points of interest related to palaeoeconomies and settlement patterns.

Large marine gastropods occur at both sites but are more common at Samouqueira. Their presence requires some explanation since today they are apparently collected in nets offshore by fishermen using small boats. The implication that similar methods may have been used by the early and middle Holocene fishermen of this region is obvious.

Sheppard's analysis of artifacts suggests fairly wide-ranging catchment territories which is consistent with one of our working hypotheses – that the coastal sites represent seasonal occupations. Work is now underway on the isotopic composition of shell and bone which we hope will provide data to combine with palynological and palaeobotanical studies for an indication of the season of occupation.

We do not, as yet, have a very clear idea of the palaeoenvironmental conditions which obtained. Results of a preliminary analysis (C.T. Shay, *in litt.*, 15 March 1985) of charcoal recovered in some of the flotation samples from both Medo Tojeiro and Samouqueira are given in *Table 6*. Of 168 pieces so far identified, over 80% are conifer, 71% of them pine. About half are tentatively assigned to stone pine (*Pinus* cf. *pinea*), groves of which are still common in this part of Portugal. The presence of this pine-nut-producing tree is nonetheless potentially important for our interpretation of subsistence and, perhaps, seasonality (since pine nuts would be a seasonal resource). The presence of both Juniper and Pistachio is also of interest.

Table 6: Charcoal from Samouqueira and Medo Tojeiro[a]

Taxa	*Samouqueira (6 samples)*		*Medo Tojeiro (5 samples)*	
	n	%	*n*	%
Conifers				
undifferentiated	13[b]	26.5	8	6.7
Pinus sp.	19[c]	38.8	9[d]	7.6
Pinus cf. *pinea*	10	20.4	81	68.1
Juniperus sp.			2	1.7
Hardwood				
undifferentiated	3	6.1	12	10.1
Pistacia sp.			3[e]	2.5
Unidentifiable	4	8.2	4	3.4
	49		119	

[a] Identifications by Janus Zwiazek; n = number of pieces; unidentifiable = pieces too small or too poorly preserved to identify

[b] Includes 3 uncharred conifer fragments and 2 uncharred cf. conifer fragments

[c] Includes 2 cf. *Pinus* sp.

[d] Includes 1 cf. *Pinus* sp.

[e] Includes 2 cf. *Pistacia*

Finally, marked human skeletal pathologies and the presence of possible domestic dog at Samouqueira may raise the crucial issue of how one defines Mesolithic as opposed to Neolithic. There is as yet no evidence that the inhabitants of either site were engaged in economies dependent upon domesticated plants and animals. For now, unfortunately, this issue must be left without discussion. We hope that future research will provide clarification.

PHYSICAL ANTHROPOLOGY

The major effort of this portion of the project, so far, has been the thorough study of the Moita do Sebastião collection housed at the Geological Survey in Lisbon. This entailed detailed examination and measurement of crania, dentition and post-cranial materials (including X-rays), as well as the removal of 9 mm diameter cores from all left femora. These cores are now being analyzed for osteon counts and several rib samples for stable isotopic ratios. Much of this research is still in progress.

Analyses of metrical data on femora and humeri demonstrate that the Moita population was smaller and less robust than modern Portuguese (the Coimbra sample: cf. Themido 1926; Tamagnini and Vieira de Campos 1949), but it is not yet clear whether Mesolithic Portuguese differed in size or robusticity from their contemporaries in other European sites. Bianchi *et al.* (1980) have compared early and middle Holocene Portuguese, Maghreb and Italian postcranials. It is evident that the Italian materials were more gracile than either the Portuguese or North Africans.

Studies now in progress, using vault measurements from Moita do Sebastião and other western Europe Mesolithic samples (as defined by Newell *et al.* 1979), suggest a north–south clinal distribution and the possibility that Moita male skulls are narrower and female skulls are shorter than those from other Mesolithic sites, especially those in Brittany and Scandinavia for which there are larger samples. Moita dentitions, on the other hand, may be larger than those of their northern contemporaries, but the significances have not yet been evaluated. Lefèvre (1973; see also Fléchier *et al.* 1976) has shown that while Muge teeth are larger than northern European Neolithic teeth, there are no clear differences between the Portuguese and Bretons of the Mesolithic. Only the premolars show fairly consistent differences but, in the absence of

published sample sizes, the significance of the differences cannot be evaluated.

The Portuguese skeletal size seems, on the slight evidence available, to have been unchanged into the Portuguese Neolithic and/or Chalcolithic. This is said on the basis of the robusticity of the female femur (Riquet 1972), and of pooled data on the humeral distal breadth (Spindler 1972).

Sexual dimorphism – expressed as (Male stature ÷ Female stature) × 100 – during the Mesolithic of Portugal was about 11.2%, little different from that of the modern Coimbra sample (11%) or the Visigothic dimorphism of 10.9% (Serra *et al.* 1952). There is no evidence on which to base a discussion of Neolithic sexual dimorphism.

Of 648 permanent teeth examined, 85 (13%) were carious, a level higher than any other reported for a Mesolithic European sample and higher than many Neolithic samples. The incidence of caries is clearly age-dependent. There are no deciduous teeth with caries, and the most carious teeth are, in general, from dentitions which show greater degrees of attrition. It is interesting that previous analyses of Moita dentition did not report such high caries rates (Ferembach 1972; Lefèvre 1973; Meiklejohn *et al.* 1984).

Linear enamel hypoplasia, which may be a marker of periodic nutritional or disease stress during childhood, is uncommon in deciduous teeth (3 of 46), but it is present in almost half the permanent teeth (148 of 515). It occurs with equivalent frequencies amongst males and females, but is more common in maxillary than mandibular teeth (χ^2:P = 0.0002). As yet, we have no explanation for this anomaly.

Palaeodemographic investigations are being pursued from a number of directions using all available methods, so as to have a basis to compare their relative accuracy. Thus, we are counting osteons, using dental attrition (in the absence of a sufficient sample of pubic symphyses) and femoral X-rays to estimate adult ages of death. Dental attrition has been studied – using a modification of the Smith (1984) method for mandibular molars – by a seriation of mandibles. This indicates a very wide spread of adult ages but exact ages cannot yet be estimated and, in the demographic analysis, age class membership was assigned by grouping individuals at similar attrition levels.

The validity of our attrition stages (*Table 7*) is supported by the correlation (0.8) found between the stages and the height of the cemento-enamel

Table 7: Moita do Sebastião. Preliminary age breakdown of adults on the basis of mandibular attrition

M_1	M_2	M_3	*Attrition stage*	*n*	*Guessed 'age'*	*Lost and carious molars*	
						Observable molar sockets	
						n	%
			1	2	15–20	1/4	25
			2	7	20–25	4/25	16
			3	7	25–30	5/28	18
			4	9	30–35	12/43	28
			5	9	35–40	±7/32	22
			6	3	40–45	4/14	29
			7	2	45–50	±4/8	50
			8	3	50–55	5/10	50
			9	3	55–60	±8/17	47
			10	2	60–65	±8/12	67
			11	3	65–70	±12/14	86

Table 8: Moita do Sebastião. Life table for collections at Lisbon and Porto, with male:female ratio adjusted to 1:1 by addition of 22.35 individuals, and with minimum infant adjustment assuming low mortality level

x	*Dx*	*dx*	*lx*	*qx*	*Lx*	*Tx*	*ex*	*Cx*	*Mx*
0	23.60	214.7	1000.0	0.215	4463.2	29712.5	29.7	150.2	0.0481
5	9.00	81.9	785.3	0.104	3721.8	25249.3	32.2	125.3	0.0220
10	1.00	9.1	703.4	0.013	3494.4	21527.5	30.6	117.6	0.0026
15	4.24	38.6	694.3	0.056	3375.2	18033.1	26.0	113.6	0.0114
20	8.48	77.1	655.7	0.118	3085.9	14657.9	22.4	103.9	0.0250
25-65	63.60	578.6	578.6	1.000	11572.1	11572.1	20.0	389.5	0.0500
	109.92								

Population size given 500 years = 56.5 (see Acsádi and Nemeskéri 1970: 65)
Crude death rate = 33.7
Juvenile:adult ratio = 0.139
Mean childhood mortality = 0.058 (mean of q5, q10, q15)

junction (CEJ) above the healthy, unbroken alveolar margin. Originally, we took six measurements per tooth for all teeth, but this soon became too time-consuming and the usefulness of so many measurements was dubious. Tests on the molars showed that midpoint measurements on M_1 gave the highest correlation with wear (0.86); so this tooth was chosen for the midpoint measurements. The second premolar (P_4) was measured as a control. While the results are still inconclusive, preliminary examination of the data seems to show that molar wear and M_1 CEJ height may, in combination, allow quite reasonable distributions of adults over postulated age categories.

Study of the Singh Index (Singh *et al.* 1972) with regard to age-related modifications of the trabecular patterns in all left femora, has suggested that the adult age spread is greater than indicated by the mandibular molar attrition seriation. The method, however, does not provide exact adult age estimates.

There are several major, and perhaps irresolvable, problems with the Moita sample, viz. underrepresentation of infants, juveniles and females. To date, we have been able only to estimate mortality, primarily on the basis of juvenile dentitions, a method which is complicated by the apparent loss of much of the juvenile material that had been housed in Porto. Our method of demographic analysis is based on life tables calculated for juveniles using age intervals of five years from birth to age 25, and pooling all individuals over age 25. This allows analysis in the absence of detailed age assessment. Our results must be considered very tentative. They show that life expectancy at birth was about 30 years and that almost one-third of the population died by age 20. If we assume Moita was used for a span of 500 years, we can use the palaeodemographic data to estimate the size of the group inhabiting the site as 57, with two deaths per year (*Table 8*). This is within the upper range of studied modern foraging populations (e.g. the !Kung San) living in less favoured environments than those which presumably existed in Portugal during the early and middle Holocene.

The Moita level of mortality, which we derive by studying ratios of juvenile (5–14 years) to adult (25+ years) deaths, is low by comparison with 30 other prehistoric samples from both the New and Old Worlds (Jackes and Lubell, n.d.). Thus, the high rate of enamel hypoplasia and the relatively high frequency of dental caries may be due to the fact that people of this population survived childhood stresses and lived longer than other Mesolithic populations. On the other hand, the abscessing and periodontal disease rates are not comparatively high, perhaps indicating good general health and nutrition.

Support for this comes from Nordin's femoral index (cf. Pfeiffer and King 1983) by which one estimates cortex thickness from radiographs of the mid-shaft of the femur. This is not necessarily a measure of great accuracy, but we used two analysts working over a period of several months so that we could average across three tests for a final result. The cortical thickness at the mid-shaft of the femur, the shape of the shaft and the form of the proximal trabecular structure as seen on radiographs (Singh's Index) are all related to a complex interplay of factors of which nutrition and individual age are probably the most important. We have not been able to demonstrate any correlations amongst the three sets of data, but we can say that the Moita distribution of the Nordin Index is very interesting and unusual in comparison with other published distributions (Pfeiffer and King 1983).

The Moita bone has great cortical thickness. The mean values for adult males and females at Moita are both high: males = 60.46 ($n = 16$, $s = 4.2$, $CV = 7.0$); females = 60.73 ($n = 11$, of which one is probably osteoporotic, $s = 7.0$, $CV = 11.6$); males and females pooled = 60.5 ($n = 32$, $s = 5.3$, $CV = 8.7$). This suggests that good nutrition did indeed underlie

the postulated low mortality. Even the juvenile dead have high scores in general, though the dead of ages 5–7 seem all to have had reduced cortex.

Low mortality did not, apparently, equate with a life totally devoid of stress but the evidence is as yet ambiguous. The presence of linear enamel hypoplasia, suggesting some dietary stress, is in contrast to the apparent richness of the resources available. Moita do Sebastião was located on a tributary of the Muge estuary, and the published faunal materials (as well as unpublished collections from neighbouring sites) suggest a diet based upon a mixture of aquatic and terrestrial animals. We presume that plants were also an important element. Initial results of stable isotopic analyses of five human bone samples from Moita do Sebastião by Dr. H.P. Schwarcz (*in litt.*, 22 March 1985) show values for $\delta^{13}C$ (per mil with respect to PDB: −15.3 to −16.1, $\bar{x} = -16.4$, $s = 0.67$) and $\delta^{15}N$ (per mil with respect to atmosphere: 10.4 to 12.2, $\bar{x} = 11.8$, $s = 1.12$) which suggest that the human diet was equally divided between marine and terrestrial foods, since these values fall midway between terrestrial herbivores and marine carnivores.

It is, therefore, of some interest that social stress is also reflected in this sample. Amongst a relatively small collection of adults, there are two females with parry fractures and one male who had been shot in the foot. From this indication, slight though it is, pressures of increasing population or population density could be suggested – as was done, for example, with reference to the terminal Pleistocene Jebel Sahaba cemetery in the Nile valley (Wendorf 1968). The sample of the population buried at Moita may, however, be incomplete, so that at the moment it would be foolhardy to make guesses about the social structure. On the basis of the innominates, the group consisted of 41 individuals over 15 years of age; of these 29 were males and only 12 females. The study of the Mesolithic human biology requires information derived from our archaeological studies on the possibility of seasonal movement of groups and short-term occupations of particular sites. We need information on the representativeness of the buried sample.

We suspect that the Portuguese data may show little or no demographic change as a result of the shift to a Neolithic economy (whenever that occurred – the chronology is still uncertain). Mortality amongst the Mesolithic population at Moita do Sebastião was extremely low, due in large part to the very productive subsistence regime. Rather than a dramatic shift to the Neolithic, all indications are of continuity and a gradual transition. This has already been mentioned with reference to Samouqueira. Similarly, if we accept the Medo Tojeiro midden as Neolithic, we support the hypothesis that the Neolithic came in as a slow introduction of new elements into a basically strong and continuous Mesolithic economy. We reached similar conclusions, though not with reference to demographic data, for the Maghreb Epi-Palaeolithic, which has certain parallels to the Portuguese Mesolithic (Lubell 1984; Lubell, Sheppard and Jackes 1984). However, these interpretations of the Portuguese materials must not be seen as final. Far more, and more reliable, data need to be collected and analyzed.

Acknowledgements: Our research is funded by a grant from the Social Sciences and Humanities Research Council of Canada (Operating Grant 410–84–0030) to the authors who are principal co-investigators for archaeology and palaeoenvironments (DL) and human osteology (MJ, CJM). We thank the Director, Geological Survey of Portugal, Lisbon, for permission to study human skeletal collections in his care. The archaeological research done in 1984 and described here was undertaken in collaboration with C. Tavares da Silva and J. Soares (Museu de Arqueologia e Etnologia, Setúbal) and C. Penalva (Serviço Regional Arqueologia da Zona Zul, Evora) who have published a preliminary report (Tavares da Silva *et al.* 1985) on certain aspects of this research which utilizes earlier results of some of the work reported here. Additional archaeological fieldwork took place in 1986 at other sites, and osteological research in 1985–1986 continued on Mesolithic and Neolithic skeletal collections. Project personnel to date have included: Dr Peter Sheppard (Toronto, lithic technology and analysis), Dr Achilles Gautier (Gent, archaeozoology), Mr R. De Ceunynck (Gent, palynology), Dr C. Devereux (London, geomorphology), Dr C.T. Shay, Mr M. Kelly and Mr J. Zwiazek (Winnipeg, palaeobotany), Dr G. Weih (Victoria, osteology), and Dr H.P. Schwarcz (Hamilton, stable isotope studies). Student assistants have been Mr R. Lello and Mr J. Woollett (Edmonton, archaeology), Ms C. Hooey (Edmonton, geoarchaeology), Ms A. Lentacker (Gent, archaeozoology), Mrs E. Palmer (Edmonton, osteology) and Ms C. Schentag (Winnipeg, osteology).

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