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MORTUARY ARCHAEOLOGY OF THE MUGE SHELL MIDDENS

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Abstract: We discuss here the radiometric chronology, stable isotopes, site characteristics and burial practices for three of the Mesolithic Muge *concheiros*, Moita do Sebastião, Cabeço da Arruda and Cabeço da Amoreira. We conclude that the sites were initially used as cemeteries in which bodies were normally buried in flexed positions and covered by mounds with little indication of elaboration or differentiation.

Keywords: Mesolithic, Muge, Portugal, burial practices, cemeteries.

1. Introduction

Moita do Sebastião, Cabeço da Arruda and Cabeço da Amoreira (hereafter Moita, Arruda and Amoreira), three *concheiros* (shell middens) on the Muge tributary of the Tagus River in central Portugal (Figure 1), comprise a Mesolithic burial grouping which is among the largest known in Europe—so far much larger than the sites along the Sado, a similar setting further to the south. Around 300 skeletons may have been excavated from the Muge sites since the 1860s, a long period of research that is important to the history of archaeology.[1] Furthermore, a relatively narrow time frame and the circumscribed setting means that the sites provide an excellent sample for bioarchaeological research. We can rightly term the sites a group of cemeteries.

2. Chronology, palaeoenvironment and stable isotopes

The Muge must have been settled because people were drawn to the special characteristics of a sheltered tributary with several higher areas of remnant terrace sands, close to the Tagus valley. By around 8300 calBP (GrA-32654) (see Figure 2 for all dates discussed) brackish marshes and tidal flats appeared just upstream of the Muge mouth, so all the resources of an estuarine environment would have been well established in the region by 8100 calBP (AA-48978) and were maintained until the end of the sea level rise. This is well dated from a core at Vale de Atela, upstream from the Muge, where fluviatile influences overtook the remnant brackish marshes soon after 6900 calBP (UtC-1983).

The oldest bone sample unquestionably[2] excavated from a Muge site, is from Arruda and dated to ~7900 calBP (Beta-152956). It is a canid excavated in 1880 from the main area of human burials (not the area designated in Detry and Cardoso 2010). The next oldest dated bone, at close to 7900 calBP, is human, from a burial in the basal layer of Amoreira (TO-11819R). Nine samples of human bone, seven from Moita and two from Arruda, appear to define the spread of dates for the major period of burials in the lower levels of the sites, ranging from ~7850 calBP to ~7600 calBP (Moita 22, TO-131, to Arruda 42, TO-359). A further five human bone samples from all three sites date from ~~Arruda 6 (7550±100, Beta-127451). Arruda 6 was excavated by Mendes Corrêa (Cardoso and Rolão 1999/2000, 178) with other skeletons at the top of the deepest archaeological layer. The material itself, and its placement, are standard: it would be expected to date to 7600-7700 calBP. The date is at least 500 years too old. The mandible was mistakenly published as Amoreira 6 as an example of typical attrition (Cunha and Cardoso 2001, Figure 2).~~

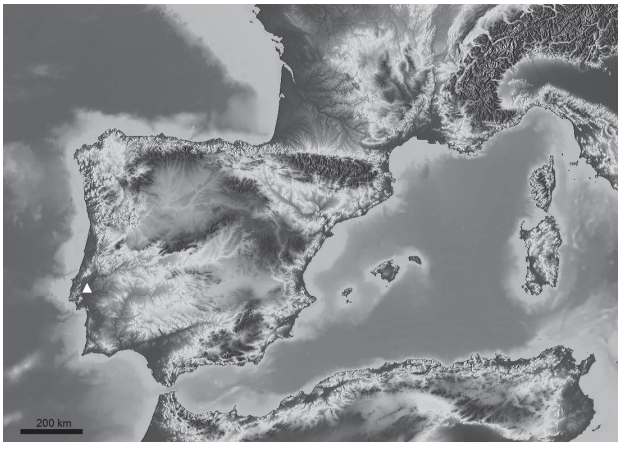

Figure 1. Map showing location of the Muge sites (white triangle).

[1] A paper on such a large and relatively unexplored aspect of Muge archaeology cannot provide detail within the limits on space here. A much longer and more detailed paper, with fuller discussion has been written (Jackes and Lubell in prep.)

[2] Cunha *et al*. 2003, 185 published a very early date for Arruda 6 (7550±100, Beta-127451). Arruda 6 was excavated by Mendes Corrêa (Cardoso and Rolão 1999/2000, 178) with other skeletons at the top of the deepest archaeological layer. The material itself, and its placement, are standard: it would be expected to date to 7600-7700 calBP. The date is at least 500 years too old. The mandible was mistakenly published as Amoreira 6 as an example of typical attrition (Cunha and Cardoso 2001, Figure 2).

Sample	Years bp	Years cal BP[a] midpoint of 1 σ range	Years cal BP 1 σ range	Years cal BP 2 σ range	Source
GrA-32654 Borehole 0501.025 (plant remains)	7440±40	8262	8203–8322	8181–8350	Vis and Kasse (2009)
AA-48978 MUG-5 (plant & wood fragments)	7318±44	8114	8050–8177	8014–8277	Van der Schreik *et al.* (2008)
UtC-1983 Alpiarça III peat	6040±50	6874	6798–6949	6600–6320	Vis *et al.* (2008)
Beta-152956 Cabeço da Arruda canid	7070±40	7904	7858–7951	7798–7971	Detry and Cardoso (2010)
TO-11819R Cabeço da Amoreira CAM-00-01	7300±80	7886 [Δδ]	7803–7968	7695–8029	Meiklejohn *et al.* (2009)

Seven dates have been left out of this table as well as three footnotes.

Figure 2. Radiocarbon dates discussed in text in order of mention.

~7500 calBP to ~7300 calBP and represent burials in upper levels. These are followed by an outlier at ~6900 calBP, Arruda N, an individual with severe osteoporosis and matrix characteristic of upper levels (TO-356). Bicho *et al*. (2011, in press) have dated material (WK-26796) close to the modern surface at Amoreira, from within a scatter of bone containing several fragmentary individuals as well as non-human bone, that has a wide range of dates and stable isotope values. We estimate the marine component for the diet of WK-26796 as 43% (based on Martins *et al*. 2008, ~~Figure 3~~ and our broader $\delta^{13}C$ range -21.7 to -10.1), giving a date of ~7000 calBP.

Thus we have something close to the complete range of time for a Muge estuarine environment. While the material to be discussed for the most part dates from the earlier period, beginning about ~7900 calBP, it is important to understand whether the Muge materials discussed here can be called Mesolithic. Amoreira may provide us with the best sample of human material from the later period. Unfortunately, a great deal of it has been lost (Jackes *et al*. in press a, Roksandic and Jackes in press). Nevertheless, what remains indicates that diets were within the Mesolithic regime, based on degree and type of dental attrition: e.g., there is no cupped wear of "milled" posterior teeth as seen in the Neolithic (Lubell *et al*. 1994).

Stable isotopes indicate considerable diversity in the Muge diet (Figure 3), Moita being relatively homogeneous, but Arruda having a wider range. Moita CT is an outlier, heavily marine and the youngest of all Moita dated burials (TO-135, ~7412 calBP). Three Arruda samples fall within the Moita range, but all others are markedly shifted from a marine towards, but not within, a terrestrial diet. The most terrestrial, Arruda D (TO-355, ~7524 calBP), is however firmly within the Mesolithic time range, while the youngest, Arruda N (TO-356, ~6900 calBP) has one of the most extreme of all Muge diets in term of the marine component. Amoreira samples range up to the highest marine component diet, close to 60%, but they form a tight cluster, except for one (TO-10225 for CAM-01-01, 7365 calBP). This is an extreme outlier and comes from within the disturbed scatter of faunal and human material, close to the surface, mentioned above. The stable isotope values are virtually identical to two faunal samples from within the same scatter, one at least 500 years younger and the other about 500 years older than TO-10225 (TO-11861 and TO-11862, respectively, calculated without reservoir offset, unpublished, Roksandic pers. comm.). We assume that WK-26796 (Bicho *et al*. 2011) is from the same scatter and we would suggest that it dates to ~7000 calBP but has a dietary marine component double that of TO-10225. While there is no reason to doubt the provenance of the sample provided for the stable isotope analysis of TO-10225 (Amoreira 2001 #139, Roksandic pers. com.), reanalysis of material from that fragmentary skeleton would confirm that there was no laboratory confusion.

To summarize, the Muge Mesolithic chronology can be tied to the period of estuarine resource availability, ~8100 to ~6800 calBP. Arruda bone dates range from 7900 to 6931 calBP; Moita bone dates cluster around 7800 calBP with an outlier at 7412 calBP; Amoreira dates appear to cover two periods, one starting around 7900 calBP and then another at perhaps 7500 calBP extending to ~6800 calBP.

Site	Specimen	Lab. ref.	Years bp	$\delta^{13}C$	-21.7 to -10.1[a]	% marine	Source
Cabeço da Amoreira	Esq. 6			-14.8	6.9	59.5	Umbelino *et al.* (2007)
Cabeço da Amoreira	Esq. 8			-15.6	6.1	52.6	Umbelino *et al.* (2007)
Cabeço da Amoreira	Esq. 4			-15.7	6.0	51.7	Umbelino *et al.* (2007)
Cabeço da Amoreira	CAM-00-01	TO-111819R	7300 ± 80	-16.3	5.4	46.6	Roksandic (2006)
Cabeço da Amoreira	Esq. 7	Beta-127450	6850 ± 40	-16.5	5.2	44.8	Umbelino *et al.* (2007)
Cabeço da Amoreira	CAM-01-01	TO-10225	6550 ± 70	-19.3	2.4	20.7	Roksandic (2006)
Cabeço da Arruda	Ossada N	TO-356	6360 ± 80	-15.3	6.4	55.2	Lubell *et al.* (1994)
Cabeço da Arruda	Esq. 1			-15.7	6.0	51.7	Umbelino *et al.* (2007)
Cabeço da Arruda	Ossada 42	TO-359	6960 ± 70	-17.2	4.5	38.8	Lubell *et al.* (1994)
Cabeço da Arruda	Esq. 10			-17.2	4.5	38.8	Umbelino *et al.* (2007)
Cabeço da Arruda	Ossada III	TO-360	6990 ± 110	-17.7	4.0	34.5	Lubell *et al.* (1994)
Cabeço da Arruda	CA-00-02	TO-10216	7040 ± 60	-17.9	3.8	32.8	Roksandic (2006)
Cabeço da Arruda	CA-00-01	TO-10217	6620 ± 60	-18.1	3.6	31.0	Roksandic (2006)
Cabeço da Arruda	Ossada D	TO-355	6780 ± 80	-18.9	2.8	24.1	Lubell *et al.* (1994)

Figure 3. Radiocarbon chronology and stable isotope values for Muge Mesolithic burials discussed in text.

One Arruda and nine Moita dates have been left out of this table, as well as a footnote.

3. Site characteristics

Amoreira has more evidence of burials spread throughout the depth of the deposits, but the poorer evidence for upper level burials at Moita and Arruda has to be considered in terms of excavation history and site disruption. Arruda was excavated a number of times from 1863 to 2001, while Moita was excavated from 1880 to the 1950s, when much of the midden was removed by bulldozing. Amoreira was not extensively dug in the 19th century because no burials were found.

While all three high middens (*cabeços*) lie above what was a marsh with Holocene alluvium, each is unique in terms of its position along the Muge: Moita and Amoreira lie to the south of the original marsh and Arruda to the north; Amoreira overlooks an embayment, so that floods will act differently upon it than upon Moita; Arruda, on the north bank, is within a deeper and narrower embayment than Amoreira. Figure 4 summarizes some of the differences among the sites (Jackes in press, discusses biological heterogeneity). A major difference among the sites relates to the depth of anthropogenic deposits above the sterile terrace sands: while Moita and Amoreira had/ have a maximum thickness of not much over 3m, Arruda has at least 2m more depth of deposit.

Various types of evidence provide a clear indication that the sites have been disturbed in a number of ways, but flooding has obviously been of importance, especially at Arruda. Roche (1974, 25) described how the excavated profile collapsed as the underlying sand was washed away in 1966, during a flood that was not among the 19 medium to very high hazard floods between 1855 and 1997 (Azevêdo *et al*. 2004). Reconstruction of the excavations at Arruda in the 1860s, 1880s, 1930s and 1960s (Jackes *et al*. nd.b) suggests that midden deposit loss is greater than can be accounted for by archaeological work. Flooding was noted at Amoreira in the 1930s (Gonçalves 1986, 222) and the Roche profiles (Roche 1964-65; 1967) show erosional, as well as other disturbances to the complex stratigraphy at Amoreira. Roche, consistently mentioned disturbances at all sites. While flooding is unlikely to have affected Moita, the surface had clearly been heavily worked; for example, a quarry was recorded there in 1880. Many archaeological prospections, some unrecorded, with poor evidence on the location of back dirt piles, add to the agricultural and aboricultural disruptions.

Disturbances may in part explain the existence of stray bone. Stray material was discovered at Arruda from the time of the very first excavations, and it is recorded that stray bones and those in poor condition were discarded (Oliveira 1889, 71) and reburied (Cardoso and Rolão 1999/2000, 169, 172). These were most likely upper level materials since Roche (1974, 31) stated those were always in poorer shape than skeletons from the lower level. While we can assume that museum collections are incomplete with regard to upper level burials, we have records of some burials very close to the modern surface. At Arruda, CA-00-01 lay at 30cm, Roche's material from level 5 lay just below 45cm from the surface and 19th century archival material records that local men had seen skeletons close to the modern surface at Arruda. At Amoreira, CAM-

Site	Elevations of Quaternary terraces[a]	Muge bed[a] m asl	Deep burials m asl	Distance of closest deep burials when first excavated from Paul do Duque (marsh) m	Height of deep burials above Paul do Duque (marsh) m	Highest point of *cabeço* m asl[b]
Moita	T4 (20-30 m)	~4.2	21	80	16	now 21.5, was 24.5
Amoreira	T4 (20-30 m)	~4.2	16-17	93	14	22.22
Arruda	T5 (12-15 m)	~4.5	~9-10 (1880)	~21 (1880)	~3.25 (1880)	~15.0

[a] Van der Schriek *et al*. (2008) [b] A discussion of sources will be published in Jackes and Lubell (in prep.).

Figure 4. Site situation and characteristics.

01-01 mentioned above, was one of several fragmentary individuals encountered together mixed with faunal bone within 20-60cm depth, and Amoreira 2, 3 and 4 excavated in the 1930s, were also exposed at 20-40cm below the surface.

It seems unlikely that Mesolithic burials would be so shallow but the explanation may be found partly in *cabeço* shape. Deep within a *cabeço*, the burials at the lowest level on the terrace sands will be metres below the modern surface, but at *cabeço* edges, the same sands are exposed, so that some Arruda burials from 1880, although at the same deep level as the majority, close to the terrace surface, were not at great depths.

Erosion will also have removed earlier surface deposits and Roche (1964-65, 199) considered that disconformities showed that *cabeços* were restructured in Mesolithic times. However, there were clearly burials into deposits well above the terrace sands.

Our reconstruction of burials is that they lay in very shallow graves, at best no more than hollows, close to features—hearths, pits and post holes found by Roche at Moita (Roche 1972a) and at Amoreira both by 1930s excavators (e.g. Gonçalves 1986, Document II-b) and Bicho *et al*. (2011). For closely adjacent decomposing cadavers to be tolerable for the living, mounds must have been constructed over graves. There is no indication of disturbance by scavengers: any disturbance must be a consequence of later burials, erosion or digging within historical periods. We can support the hypothesis of grave mounds further by referring to heavy fill packed around some skeletons maintaining bones in place, and sediment weight pushing down on other skeletal elements.

In some cases, there may have been terrace pebbles included in the burial mound and 'grave' fill. Quartz and quartzite pebbles up to 12cm in size were exposed in Facies 1B and 8 in the Tagus lag channels (Vis and Kasse 2009) and they were the raw materials used for some tool making. Pereira da Costa (1865) mentioned a layer containing fire-cracked rocks above the low burial level and Ribeiro (1884, 288) noted that the larger pebbles must have been brought to the Muge sites. While Roche (1951, 1963, 1964-65, 1972b) discussed pebbles in several contexts, there is no mention of rocks specifically associated with graves. However, from Roche's profile (1967) it is probable that pebbles lay within the mound covering his Skeleton 6 at Amoreira. More impressively, unpublished photographs[3] that we have identified as being Amoreira Skeletons 6 and 8 from the 1930s, confirm that up to ten quite large pebbles could be associated with a burial. Amoreira 6 had a pebble lying directly on the left scapular blade, which had collapsed outwards during decomposition. There may be another stone in the neck region.

4. Disposition of cadavers

4.1. Upper body

We have no evidence of grave architecture beyond shallow pits at Moita. At Arruda, natural hollows, sometimes at an angle, were occasionally used. In a few cases, we can see what is called a 'wall effect', meaning that bones are held in position despite the effects of decompositional disarticulation and movement. For example, an ilium may be maintained in an *in vivo* orientation (Jackes *et al*. in press b). Here the evidence is that sediments, heavily charged with shell, ash and charcoal, perhaps very humid because of the season of burial, were packed against a bone, preventing it from falling outwards. We also note cases in which the upper part of the body was kept within a constrained space, the humeri still pressed against the ribs, the ribs themselves slumped down somewhat, rather than outwards, and the clavicles 'verticalized' as seen at Amoreira (Roksandic and Jackes in press). Instead of lying across the shoulders, the clavicles may move, to varying degrees, into a cranio-caudal orientation. The frequency of this at Amoreira suggests that the shallow grave pit was narrower around the shoulders and upper body than around the lower body.

[3] In October 2010, while at the Museu de História Natural da Universidade do Porto, we were able to scan and identify a series of negatives and a few positives from 1930s excavations, mostly at Muge ~~Natural da Universidade do Porto, we were able to scan and identify a series of negatives and a few positives from 1930s excavations, mostly at Muge.~~

Figure 5. Amoreira Skeleton 6, excavated and photographed August 1933. Cropped from the scan of a photographic print incorrectly labelled Muge 1930/16, at the Museu de História Natural da Universidade do Porto. An unnumbered negative exists but has deteriorated. The skeleton lies in dark anthropogenic sediments just above the basal sands. The field notes record that the flexed skeleton was 90cm long.

Of the Amoreira skeletons from the 1960s excavations for which the burial disposition can be ascertained, Skeletons 6, 7, 8 (right side), probably 12 and certainly 13 have such upper constriction. The photographs from the 1930s of those few Amoreira skeletons which were undisturbed give us certain information only for Skeleton 6: this individual was apparently buried without upper body constriction (Figure 5).

Moita skeletons from the 1950s (Jackes *et al*. in press b) provide rather contradictory evidence. There is partial constriction in Skeletons 30, 32, 5 and 12 but apparently none for Skeletons 31, and 15. On the other hand, full upper constriction is suggested for Skeletons 33, 3, 9, 17 and 19. Skulls at Moita often lay on slight mounds of sediment, but less often at Arruda (Roche 1974, 32). It is unfortunate that Arruda provides us with less evidence overall and lacks detailed analysis of burial disposition. However, we can say that upper body constriction is not obvious from photographs of the 1930s Arruda excavations and did not occur in the one group of skeletons excavated in 1880 for which we have a reasonable photograph. Published photographs of the 1960s Arruda excavations (Roche 1974, Plate 2; Cardoso and Rolão 1999/2000, 235, Figure 61) are not very clear, but certainly show some verticalized clavicles (Arruda 4) and evidence of bilateral constriction (Skeleton 7). Roche (1974, 33) stated that there were no hollows dug to receive Arruda cadavers, a marked difference from Moita: thus we must assume that there was tightly packed anthropogenic sediment around some bodies.

Evidence on the position of hands, in those few cases where we can specify—34 right and 36 left hands across all three sites—provides us with no pattern of age, sex or site. There are five cases in which both hands are placed on the hips and five cases in which both hands extend beside the body. In one case (Arruda 1930s Skeleton 5) both hands are folded across the body. In 17 cases, the two hands are placed in different positions, most often on the body rather than beside it. In roughly equal numbers 1. the upper hand is on the chest, opposite shoulder or upper arm, while the lower is on the abdomen, iliac blade or beside the body; 2. both hands are placed somewhere on the upper body, from the waist up; 3. both hands are placed low, on or beside the body. There is no consistency with regard to which hand is placed higher or lower – in all cases, when both hands can be observed and in the overall sample, the likelihood of left or right hand being placed higher is equal.

4.2. Lower body

Posture differences for the lower limbs were suggested in our original 1984-5 study of Muge skeletons (which did not focus on burial disposition): '...—based on our reconstructions—many of the Arruda skeletons were in extreme flexion of thigh on hip. However, for the Moita materials, we have found flexion only at the knees, suggesting that the bodies were buried fully extended, sometimes with raised knees' (Lubell and Jackes 1988, 245). While limited in scope, because many skeletons had been mixed and in most cases articulations maintained by breccia had been separated, our conclusion with regard to Moita may have been correct based on the later finding of archival material (Jackes and Alvim 2006) which showed that a number of Moita skeletons had been laid one against another, with crania leaning against the flexed-up knees of the individual behind. In comparison, a photograph of Arruda in 1880 (Ribeiro 1884, Plates 1 and 2, parts of the same image) shows burials illustrating why 19th century researchers spoke of the skeletons as being in 'the most bizarre positions imaginable' (Costa 1865, 15—our translation). In this photograph of one of three groupings of burials discovered in 1880, and the only photograph for which we have a clear image, there is no evidence of lateral constriction: ribs have slumped outwards, humeri have rolled out, ilia have fallen flat and clavicles have not shifted vertically. Yet the legs, both at hips and knees, are in extreme flexion indicating cranio-caudal, not lateral, constriction. In some cases, the legs might have fallen to the sides from an original position on the trunk, in others a leg seems to have been initially placed firmly beside the body, keeping the ilium upright. In one burial, the sediment curved up under the pelvis and kept the legs on the trunk. Even in this one photographed Arruda 1880 group we see another burial disposition—lateral decubitus: this individual must have been laid with the legs folded to the left side.

Unpublished 1930s photographs allow us to examine ten Arruda burials: some individuals were buried extended with knees semi-flexed, one was buried with feet set on the ground by the pelvis so that the knees must have been

tightly flexed up at the time of burial. Two subadults had the femora hyperflexed onto the trunk. Arruda 9, from deep in the 1930s excavation, seems to be a bundle of long bones with a fragment of mandible, while for Arruda 5, a juvenile, the bundle of hyperflexed lower limb bones was maintained in place by folded forearms. Since the left talus is retained attached to the left posterior femoral neck and the ischial ramus, we know that the ankle was held above the hip. Extreme cranio-caudal constriction and tight hyperflexion of the thighs on the trunk is the only explanation here, and indeed the 1884-85 Arruda excavator noted that the knees were held close to the face (Oliviera 1889, 73). All hips retaining an articulation in the Arruda collection at the Museu Geológico in Lisbon when we studied them in 1985 had strong flexion of femora at the hip. Some feet were also flexed up towards the tibiae. It is not possible to know whether the feet were set on the ground under flexed knees and pushed up by cranio-caudal curvature of the underlying sediments, or whether the thighs lay on the trunk, with the feet pushed against mounded sediment. In this position, the feet could not have been placed on the ground at burial (Roksandic and Jackes in press).

Were cadavers buried with feet above the pelves, but knees parted, rather than on the trunk? An argument against this is that there are cases where knees actually lay on the thorax when excavated, but these are often subadults whose lesser muscle mass would have been a factor in maintaining the position. While it is possible that a ligature, or wrapping with hides, could have kept the body in this hyperflexed position, Roche, summarizing his Arruda burial findings, dismissed the idea of a ligature keeping the femora flexed against the trunk (1974, 32, 34). There is no clear evidence of bundles requiring a hide wrapping, although the limb bones, especially of juveniles, may appear bundled. In the most likely case, from the 1880s Arruda excavations, a child with the mandible attached to the posterior left femoral shaft, in fact lies on the bones of a small female with her femur flexed on her hip and her right hand under her crossed feet. This cannot be a multiple secondary burial bundle; it must be an earlier burial disturbed by a later one. While one group of 1880 Arruda skeletons suggests alignment of separate individuals, so that each must have been well-marked for a sufficient length of time that later burials did not disturb earlier interments, this cannot have been true for other groupings, and certainly not for some of the 1930s skeletons. Furthermore, Arruda skeletal elements have most often fallen laterally, outwards, arguing against wrapping.

Jackes *et al*. (in press b) considered the evidence on wrapping for the 1950s Moita burials and concluded that 'The best, and most parsimonious, argument…. seems to be that no coverings were placed over the bodies, and that the grave fill and subsiding mounds filled the voids slowly and at intervals, depending on particular circumstances, the season of the year, drainage and slight variations in the fill and mound construction'. In fact, the Moita burial disposition, as evidenced by the 1950s excavations, is that all but one of the dorsal decubitus burials had the knees flexed. The exception was an extended burial, although one other skeleton had the knees very slightly raised. Most skeletons had the knees flexed upright and only one is likely to have had hyperflexion onto the trunk, a case where the knees apparently collapsed to the right. So at Moita, in most cases, the feet were placed flat on the ground close to the pelvis. We postulate that this is the modal burial posture for Moita.

What can be gleaned of the Amoreira mortuary practices found in the 1960s has been summarized (Roksandic and Jackes in press). Only five burials can be discussed with any certainty, and of these, four suggest constricted but shallow burial pits. Three adult females were buried with knees flexed, and a fourth was an extended burial. The flexed burials were not homogeneous since only two involved hyperflexion: Skeleton 6 had the knees side by side and the feet apparently raised and side by side, and Skeleton 12 must have had the feet raised and crossed, with the knees perhaps parted prior to decomposition.

An Amoreira child, CAM-00-01, for which the suggestion is no wrapping and immediate covering with sediment (Roksandic 2006, 44 and Figure 1a), is a good example of asymmetry of the lower limbs. The feet are now in different positions, the left having fallen straight down, while the right lies on the sacrum. The right side of the body makes it extremely unlikely that there was wrapping, even though the right leg lay folded in such a way as to maintain the ilium in the *in vivo* position, generally the same asymmetrical posture as in a subadult in Ribeiro's Arruda photograph (1884, Plate 2). Our most interesting image (Figure 5) is of Amoreira 6 from the 1930s, a male skeleton, which gives a faulty impression of symmetry in the lower limbs. The right iliac blade, but not the left, is flat; the right femur has moved, but not the left, perhaps because the left elbow stabilized the leg (as with CAM-00-01). In this rare case of observable feet, we can see that ankles fell onto the sacrum, with each foot pointing away from the sacrum: it appears that the left foot lies with the plantar surface up, on the left proximal femur. The posture of the feet suggests that the earth must have been firmly packed against them in order to keep them from falling caudally, as they moved from their initial flexed position above the body. The feet must have fallen laterally into empty space provided by decomposition of the lower body tissues.

Three more Amoreira skeletons from the 1930s can be discussed from information in the field note books (Cardoso and Rolão 1999/2000) and on the basis of unpublished photographs. Two (Skeleton 7, an adult female and 8, an older male)[4] lie on their sides, their

[4] This information comes from Roksandic (pers. comm. January 2010) who examined the skeletons at the Department of Anthropology, Universidad de Coimbra. The material as it is now, in Porto, is too fragmentary and mixed to discuss in detail.

tightly flexed legs beside the thorax, to the right and left, respectively. The final skeleton that can be discussed is Amoreira 1930s Skeleton 9 (illustrated by Cunha and Cardoso 2001 as 9/A). This is an interesting child burial, dorsal decubitus, with the left and right hyperflexed legs both fallen to the right side of the thorax. The phalanges of the child are resting upon its left parietal, i.e., the body lay with the right arm wrapped behind the head, the only such case seen.

4.3. Summary on body posture

All these details indicate that the slender bodies were placed in very compacted postures, after rigor mortis but before the development of gas in the trunk. The position of the corpse was maintained by the immediate construction of a mound rather than placement in anything more than a very shallow pit or natural hollow. Sometimes the sediment could be built up under the skull or under the pelvis, at other times it was not shaped. We have no firm evidence of wrapping of the body, rather the opposite, with sediment mounded up to support the feet, although the weight of the limbs would no doubt have helped to keep the inert limbs, now very flaccid, in place until the heavy sediment was layered up around the body.

In summary, the disposition of the bodies suggested is:

1. extended, more often with knees slightly flexed (very rare);
2. knees tightly flexed with feet placed next to the pelvis (more common, especially at Moita);
   3. legs hyperflexed at the hip (quite common at Arruda and Amoreira);
4. lateral rather than dorsal decubitus, with legs flexed (rare);
5. apparent bundle burials in rare cases, interpreted as a reorganization of bones disturbed by a later inhumation (very rare).

Differences among sites can only be that of an impression, although the 1880 photographs tend to support Roche's opinion (1974, 33) that at Arruda there were no hollows to receive the bodies such as he had seen at Moita, and there is very limited evidence for hyperflexion at Moita. It is not possible to specify differences between the basal and upper level burials at either Amoreira or Arruda.

4.4. Orientation

Most authors have noted orientation of bodies, starting with Pereira da Costa (1865, 13) who maintained that Arruda skulls were in general to the NW of the postcrania. A group of nine skeletons excavated in 1880 also apparently had skulls oriented to the NW, but the two other groups of skeletons found that year were not clearly aligned or oriented, one group being of tightly packed skeletons seemingly oriented at random (Jackes *et al*. nd.b). In the skeleton group found at Moita in 1880, bodies generally lay with heads to the S (Jackes and Alvim 2006, Figure 1). The 20th century excavations often provided exact information, so that we know that at Moita (Roche 1972a, 130) 14 of the skeletons had their heads between the N and the W, with the majority (9/14) directly to the NW. However, even within the main grouping, orientations differed, so we cannot say that each group had a specific orientation. At Arruda, the deep burials (Roche 1974, 26) had their heads generally to the N, while the three upper level skeletons were NW, W and SW. Only four of the 1930s Arruda skeletons can be listed here with full certainty, and the directions were N, W, E and NE. It is possible to determine that the four upper level 1960s Amoreira skeletons were mostly laid with their skulls to the SE, just one of them heading NW. The twelve lower level 1960s skeletons for which we have information were highly variable, none to the NW and only five to the N or NE. The recorded orientation of upper level skeletons from Amoreira, five 1930s and four from the 1960s, is also variable, with four to the N or NW, and the rest of this sample of nine with the skulls to the E, S or, in three cases, SE.

5. Grave goods

Just as we see no evidence for any complexity to the grave structure at any of the three sites, there is little evidence of grave goods, but a mediating factor is how 'grave goods' were identified or recognized. Paula e Oliveira (1889, 73) noted that stone tools were to be found in greater numbers close to skeletons, but a lack of grave goods at Moita and Arruda was emphasized in the 19th century (Carthailhac 1886, Ribeiro 1884, 286), and Corrêa (1933, 367) mentions only a few stone tools as examples of grave goods discovered at Amoreira in the first campaign. On the other hand, Roche (1956, 160) noted that Moita burials were accompanied by ochre and occasionally by the addition of shell fish beside the body. The situation at Moita was described in much greater detail in Roche's 1972 monograph: for example, Skeleton 14 has a great quantity of *Scrobicularia* associated with it. Most notably, small pierced *Neritina fluviatilis* were also found beside or over the bodies in six cases at Moita (Roche 1972a, 132). Roche (1974, 33) stated that Arruda was different from Moita in that no ochre and no food provisions were found in Arruda graves, and noted only that a scraper was found with 1960s Arruda Skeleton 2 and a bone point under the left hand of Skeleton 7 (Roche 1972a, 28, 29). However, Mendes Corrêa's team had found perforated shells close to the skull of an unnumbered Arruda child (Cardoso and Rolão 1999/2000, 178). The most impressive collection of pierced shells is with the Moita 25 child from the 1950s, still retained in the collections at the Museu de História Natural da Universidade do Porto but wrongly labelled 27 and listed by Ferembach (1974) as Moita 27. The legs were hyperflexed on the trunk and it was laid on what seems to have been a string of *Neritina* which extends from the left lower ribs around the left hip and under the sacrum.

Since Roche did not publish a monograph on Amoreira, all we have is his list of grave goods at Moita and Arruda, mentioning small fires lit around three bodies at Moita, but making no reference at all to Amoreira (Roche 1972b, 100). Apart from Amoreira 1930s Skeleton 6, apparently underlain by much shell and charcoal, the Mendes Corrêa field notes do not mention materials associated with the graves except for intrusive later artifacts. Nevertheless, Amoreira Skeleton 7 from the 1930s had a quite large burnt log lying close beside the left shoulder, but no other skeleton has a record of associated materials. In 2011, a skeleton was excavated by Bicho at Amoreira with lithics, shell fish and bones, interpreted as grave goods (Anonymous 2011). A deep burial excavated by Rolão at Amoreira in 2000 was not accompanied by such items (Roksandic pers. comm. 7/10/2011).

6. Discussion and Conclusion

We have looked briefly at the available evidence from three Muge Mesolithic sites. The sites survived because they were established on remnant terraces above the Muge River. Their choice as burial places must relate to the fact that they stood proud of the Muge valley, in Mesolithic times as today. Two other lower sites were identified and destroyed long ago, and two further sites have recently been recognized (Gonçalves 2009), but it is the *cabeços* that stand out as burial places, arguing against mere preservation bias as an explanation. We imagine that the sites discussed here were, at the very least, the most important burial sites for the small Mesolithic groups that inhabited the Muge valley on a near-permanent basis.[5] We have argued for the Muge as a base camp location because of the identity of the dead, males and females, neonates to the very elderly, the unhealthy as well as the healthy (Jackes and Lubell 1999). We add here the argument that we see no sign of secondary burials. While we could suggest, based on demographic parameters, that some adults were buried where they died at a distance, those buried on the *cabeços* were buried in-flesh, very soon after death. Burials were marked by mounds, built over cadavers that were generally folded to various degrees, to ensure that a mound was roughly circular or oval in shape. In some cases, the locations of prior burials were known, in other cases burials disturbed previous inhumations. Burials may be grouped, but there is no evidence that the grouping was by age or sex, except in one case of childrens' burials at Moita (Roche 1972a, 131, but other children lay elsewhere) found to one side of what was evidently an arrangement of postholes, perhaps a windbreak, opening onto what seemed to be a U- shaped arrangement of burials (Jackes and Alvim 2006). It is not yet possible to have a similar understanding of the horizontal layout of burials at Amoreira or Arruda. The mounds over the dead were constructed of the materials that lay around – ash, charcoal, shell, sometimes fire-cracked rocks. It is this material that has built the *cabeço* middens up over what seems, for Moita and Arruda at least, to have been initially sites devoted to burials with, quite clearly, a great deal of debris from fires and meals. Many Moita burials were placed in the sterile terrace sands, but Arruda burials seem more often to have lain slightly above the sands.

Are the supposed differences between the purposeful hollows at Moita and the apparent lack of any at Arruda related to the sediments in which people were buried? Our evidence on Moita comes from Roche's 1950s excavations, in which the burials were all in the basal sands, many underlying a very hard breccia which only occurred in isolated nodules at other sites. Roche (1974, 27) attributed the breccias to the higher clay content of the Moita terrace sands. Arruda burials were initially found only in a narrow band lying just above the basal sands (Costa 1865). This is confirmed by archival material from the extensive 1880 excavation showing that skeletons in one group were found within a level about a metre thick, just above the sands. The 1930s excavations found nine skeletons lying from 30cm to 1.4m above the basal sands (Cardoso and Rolão 1999/2000). Our limited understanding of the Muge sites might lead us to over-emphasize this difference between Moita and Arruda, especially since Roche (1974, 27) states that his Arruda burials were on terrace sands, with anthropogenic sediments piled over the dead. However, there are comparisons we can make. At Moita, where bodies were more extended, they were buried in hollows in the sand and covered by more elongate burial mounds which included more sand. At Arruda and Amoreira, where lower level cadavers were tightly folded, the mounds were more compact and constructed from anthropogenic sediments that were firmly packed over the bodies. Such factors would help to explain differences in preservation and colouration, as well as the nature of adherent breccias, between Moita and the other sites.

It seems unlikely that people would have actually have been living at the focal points of the *cabeços*, surrounded by multiple shallow graves, each marked by an eroding mound. It is possible that after the initial use of the *cabeços* as burial places there were periods during which they became places to which pebbles were brought to construct hearths and there was a rapid deposition of ash, charcoal, bone and shell, layers which could be shaped by erosion and were later disturbed by further burials, perhaps especially at Amoreira, where the upper layer contains many pebbles, as noticed by Roche, by Rolão's team, and now by Bicho's team in their new controlled excavations.

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[5] Year-round availability of food resources has been noted by Lentacker (1986) and Detry (pers. comm. 26/10/2011).

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