MUNIBE (Antropologia-Arkeologia)	nº 62	461-468	SAN SEBASTIÁN	2011	ISSN 1132-2217

Recibido: 2011-07-14
Aceptado: 2011-12-07

The establishment of radiocarbon chronologies for early Medieval sites: a case study from the Upper Mondego Valley (Guarda, Portugal)

El establecimiento de cronologías radiocarbónicas para yacimientos Alto-Medievales: un caso de estudio del Alto Valle del Mondego (Guarda, Portugal)

KEY WORDS: medieval archaeology, radiocarbon dating, settlement system.
PALABRAS CLAVES: arqueología medieval, datación radiocarbónica, sistema de poblamiento.
GAKO-HITZAK: erdi Aroko arkeologia, datazio erradiokarbonikoa, populatze-sistema.

Catarina TENTE[1] and António Faustino CARVALHO[2]

ABSTRACT

Radiocarbon dating of select samples from early medieval sites in the Upper Mondego Valley has enabled the establishment of a precise chronology in relation to archaeological contexts. Such precision has previously been unobtainable for sites lacking type fossils. These results lead to the conclusion that, if similar criteria are used for sample selection, this methodology may be used in other Iberian regions for deposits from the same period which suffer from the same limitations.

RESUMEN

Presentamos los resultados de un proyecto sobre dataciones absolutas de contextos alto-medievales de la región del Alto Valle del Mondego, exponiendo los criterios utilizados en la selección de las muestras fechadas. Asimismo, fue posible obtener una cronología precisa en relación a una realidad arqueológica hasta ahora desconocida, que carecía de fósiles directores. Considerando el balance final de este proyecto, concluimos que la metodología adoptada podrá ser aplicada en otras regiones peninsulares, con yacimientos de este mismo periodo que padecen de las mismas limitaciones.

LABURPENA

Mondegoko Goi Haraneko eskualdean egin diren Goi Erdi Aroko datazioei buruzko proiektu baten emaitzak aurkezten ditugu, datatutako laginen hautaketan erabilitako irizpideak azalduz. Era berean, orain arte ezezaguna zen errealitate arkeologiko baten inguruko kronologia zehatza lortu ahal izan da, izan ere ez baitzegoen fosil zuzentzailerik. Proiektu honen azken balantzea kontuan hartuz, baliatu genuen metodologia penintsulako beste eskualde batzuetan aplikatu ahal izango dela atera genuen ondoriotzat, garai bereko aztarnategiak eta muga berak dituztenetan bereziki.

1.- INTRODUCTION: THE REGION AND THE STATE OF ART

The westernmost tip of the Iberian central ridge is the Estrela Mountain, a granitic geological feature which, with an elevation of 1992 metres asl, is the highest mountain in continental Portuguese territory. Its major drainage system is the upper section of the Mondego River, which describes a curve around the mountain's northern and western flanks. The highly diversified climate conditions that characterise the region are due to the relative proximity of the Atlantic Ocean to the west, and the Spanish *Meseta* to the east. As a result of these factors and of altitude, the vegetation of Estrela Mountain is divided into three distinct sections: the basal (up to 800–900 metres asl), under strong Mediterranean influence and deeply altered by human intervention; the middle (from 800–900 to 1300–1600 metres asl), corresponding to declining oak (*Quercus pyrenaica*) forests due to forest fires and the grazing of sheep and goats; and the upper section (above 1330–1600 metres asl), where the

[1] Universidade Nova de Lisboa / Instituto de Arqueologia e Paleociências das Universidades Nova de Lisboa e do Algarve. Faculdade de Ciências Sociais e Humanas, Av. de Berna, 26C, 1069-061 Lisboa (Portugal)
E-mail: catarina.tente@fcsh.unl.pt
[2] Universidade do Algarve / Instituto de Arqueologia e Paleociências das Universidades Nova de Lisboa e do Algarve.

juniper (*Juniper communis*) cover dominates after human destruction of the post-würmian cover of pine (*Pinus* sp.), and birch (*Betula alba*).

Palynologic research in highland lagoons (Charco da Candeeira and Lagoa Comprida, located at 1400 and 1600 metres respectively) has facilitated the construction of a bioclimatic model from the end of the Pleistocene to the present day. According to this model, there is evidence of increasing deforestation during the Early Middle Ages (VAN DEN BRINK and JANSSEN 1985; VAN DEN KNAAP and VAN LEEUNWEN 1995, 1997), which testifies the systematic economic exploitation of the middle and upper sections of the mountain during this period. Factors underlying such large-scale deforestation – which occurs c. 1000 AD – are clearly identified: forest fires associated with cereal agriculture and clearance for pasture. As the indigenous oak (*Quercus pyrenaica*), birch and willow (*Salix* sp.) forests were eradicated, heathland (*Erica* sp.) developed in its place.

Little was known, however, about medieval settlement and associated strategies of natural resource exploitation in the Upper Mondego until the start of a research project entitled "The Upper Mondego valley: land of frontier". Previously, a number of rock-cut tombs constituted the only archaeological sites potentially of early medieval date. For the most part these are not associated with artefactual or osteological remains and therefore it is impossible to determine their exact chronology or to study the communities that used them. The few cases where a spatial association to pottery scatters exists are unfortunately irrelevant due to the lack of ceramic typologies.

The Upper Mondego project was funded by the Portuguese *Fundação para a Ciência e a Tecnologia* (2007–2010) and was specifically designed to evaluate human occupation of the region between the 6th and 12th centuries AD. Excavation and/or study of six archaeological sites (Fig. 1) has provided insights into aspects such as defensive, domestic and funerary architectures, artefactual productions (mainly pottery), landscape use, and historical integration. The main results have been synthesised by Tente (2010).

2. OBJECTIVES AND METHODOLOGICAL OPTIONS

One of the most significant challenges for the project was the chronological attribution of the sites under excavation. Lacking well-established artefact

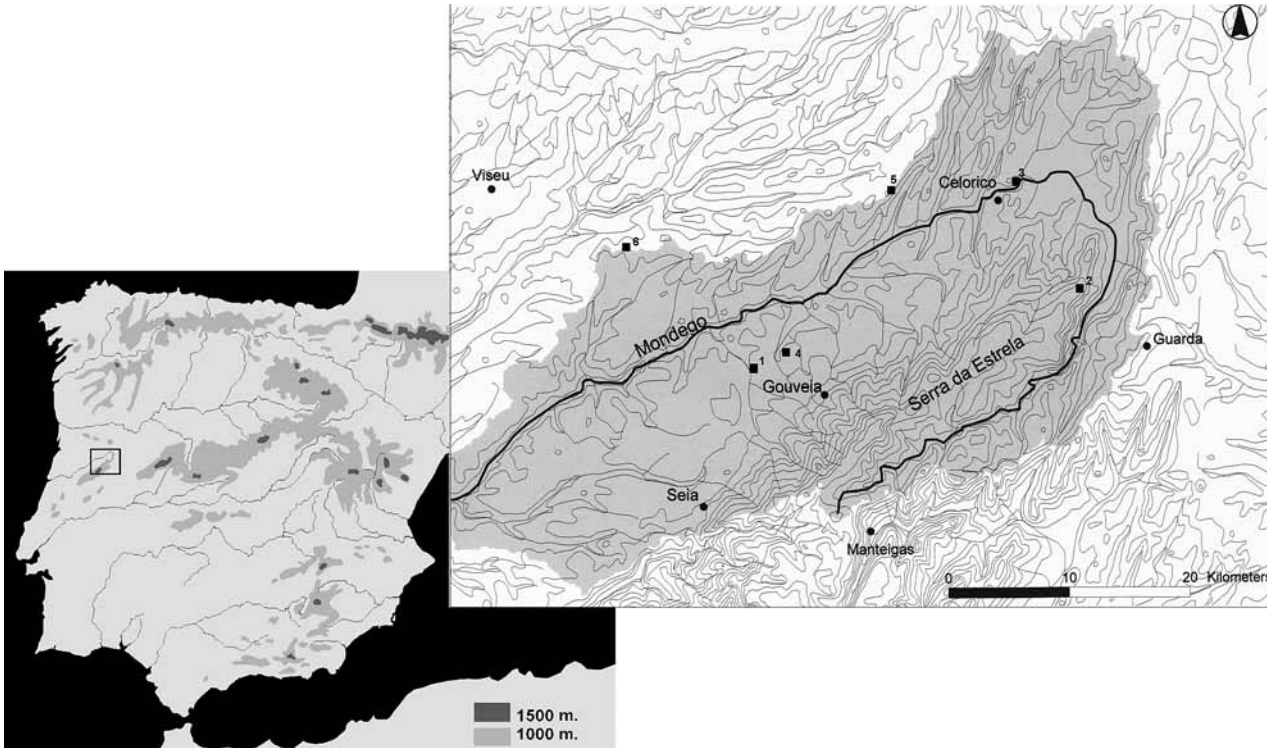

Fig. 1. The Upper Mondego Valley region and sites mentioned in text. 1. Aljão; 2. Soida; 3. São Gens; 4. Penedo dos Mouros; 5. Algodres; 6. Alto da Quintinha.

type-fossils or other relevant archaeological evidence (such as coinage, specific architectural styles or building techniques, imported artefacts, etc.), the determination of detailed chronologies has had to rely on systematic radiocarbon dating of organic remains.

Table I lists all of the radiocarbon determinations obtained so far, according to archaeological sites. Due to the acidity of the granitic derived soils, which have prevented the preservation of bone remains, the dated samples consist almost exclusively of charcoal. Only in a couple of cemeteries was it possible to obtain determinations from human collagen. However, these dates were obtained according to previously defined criteria related to the inconsistent reliability of the sampled material and its relationship to archaeological context—and, therefore, historical events—which are intended to be dated. This is a methodology first developed in Iberia to approach the neolithization process, and was successfully used in the interpretation of multistratified cave sequences (e. g. ZILHÃO 2001; BERNABEU AUBAN *et alii* 2001). It has been clearly demonstrated that sound chronologies can only be obtained when systematic dating of short-lived diagnostic elements directly associated with strata becomes a common procedure.

Radiocarbon samples from Early Medieval sites in the Upper Mondego region were selected and categorized according to four levels of quality and reliability, depending on their nature and provenance context:

1. Samples of individual short-lived species (bones and seeds). In many circumstances these samples may be clearly attributed to human presence in the sites under analysis, such as when human bones are recovered in individual burials or seeds from cultivated plants are recovered. Bulk samples were avoided, because elements of disparate chronologies may be present that affect the radiocarbon result.

2. Samples from fireplaces. These can only be used to date archaeological levels by contextual association, an exercise requiring a degree of subjective reasoning. If the dated sample is charcoal, it is assumed not to be the result of the burning of tree trunks (indicative of the so-called "old wood effect") but instead of branches or shrub species. To avoid the "old wood effect", only shrub species were dated, after anthracological determination.

3. Samples of short-lived shrub species. Although avoiding the "old wood effect", materials such as these may originate and be incorporated in the sediments by natural causes (e.g., forest fires, slope-washing processes, etc.). In addition, they are easily transported by the remobilizing or the mixing of sediments, or through migration processes, and thus can become intrusive in contiguous layers.

4. Samples from negative structures. The option of dating negative structures should also be dependent on the evaluation of the site formation processes, since these are very often reused or refilled with sediments which may contain datable material resulting from completely independent events, either human or natural. These events may have taken place in the area surrounding the structure under analysis, after or before its opening and first use, and should therefore be critically evaluated.

In sum, the dating of charcoal dispersed in sediments, or aggregated in concentrations but without direct association to any structure, usually

Site	Provenance	Lab Number	Type of Sample	Date BP	cal BC/AD *(1 sigma)*	cal BC/AD *(2 sigma)*
Monte Aljão	Sector II, Test 10, SU13 (inside sink)	Wk-25176	*Quercus* sp. (cork)	1699 ± 30	260-400	250-420
	Sector II, Test 10, SU29	Wk-27458	*Erica* sp.	2016 ± 30	50BC-25AD	100BC-70AD
	Sector II, Test 10, SU47	Wk-27457	*Erica* sp.	1750 ± 30	240-335	210-390
	Sector III, Test 6, grave II	Wk-27459	*Cistus* sp.	1100 ± 30	895-985	880-1020
São Gens	Sector 9, room VII, collapsed roof	Wk-27456	*Erica arborea*	1920 ± 30	55-125	1-140
	Sector 10, SU9 (collapsed palisade)	Wk-25175	*Quercus* sp. (cork)	1161 ± 30	780-950	770-970
	Sector 10, SU8 (hearth)	Wk-27455	*Quercus pyrenaica*	1136 ± 30	880-970	780-990
Soida	Sector III, SU2	Wk-20462	*Genista florida*	789 ± 33	1220-1265	1180-1280
	Sector II, SU6 (plank)	Wk-25174	*Quercus pyrenaica*	1337 ± 37	640-770	640-780
	Sector II, SU5 (hearth)	Wk-27454	*Sorbus aucuparia*	1098 ± 30	895-985	880-1020
Penedo dos Mouros	Sector I, SU22	Sac-1947	*Vicia faba* L. var. *minuta*	1070 ± 45	890-1020	870-1040
	Sector I, SU22	Sac-1950	*Vicia faba* L. var. *minuta*	1060 ± 40	900-1020	890-1030
	Sector II, Test 1, SU9	Wk-25818	*Erica arborea*	1147 ± 30	820-970	770-980
Alto da Quintinha	Burial	Sac-2333	*Homo*	1080 ± 50	880-1020	810-1040
Algodres	Burial 23	Sac-2207	*Homo*	710 ± 40	1260-1380	1220-1390

Tabla 1: Radiocarbon determinations for Medieval archaeological sites of the Upper Mondego Valley.

provide random results and should therefore be rejected. It should be stressed that in reality these can be associated with the human use of individual sites, but only in well-defined contexts detailed taphonomic analyses may, in some cases, help to identify more secure samples.

Calibrations, as well as the corresponding graph (Fig. 2), were obtained using *Version 3.10* of the *OxCal Program* (BRONK-RAMSEY 2005), and based on the IntCal09 curve (REIMER *et alii* 2009).

3. PRESENTATION AND DISCUSSION OF RESULTS

3.1. Monte Aljão (Gouveia)

Monte Aljão is an archaeological complex located in a wide platform on the left bank of the Mondego River. Although severely affected by deep ploughing in the 1980s, when this plot of land was converted into a vineyard, limited salvage excavations in 1985 and systematic testing of the area in the framework of the above-mentioned project (field campaigns in 2008 and 2009) enabled the recognition of rural Roman structures partially reused in medieval times. A necropolis was also in use during the later occupation of the site, although skeletons recorded during the 1985 excavations could not be used for radiocarbon dating since they have been lost in the meantime.

Despite these limitations, four radiocarbon dates have been obtained. All samples were composed of charcoal from short-lived botanic species:

• Wk-25176: 1699 ± 30 BP (250–420 cal AD) corresponds to a piece of burnt cork found inside a stone sink attributed to the latest occupation of the Roman building.

• Wk-27457: 1750 ± 30 BP (210–390 cal AD) was obtained from charcoal of heath (*Erica* sp.) recovered in a stratigraphically well-defined level, which formed during a fire that took place after the Roman site had been abandoned. Its result, virtually identical to Wk-25176, supports a conclusion pointing to a first abandonment phase of Monte Aljão around the transition from the 3rd to the 4th century AD.

• Wk-27458: 2016 ± 30 BP (100 cal BC–70 cal AD) is anomalous. This burnt heath (*Erica* sp.) sample was recovered from the upper layers of the strati-

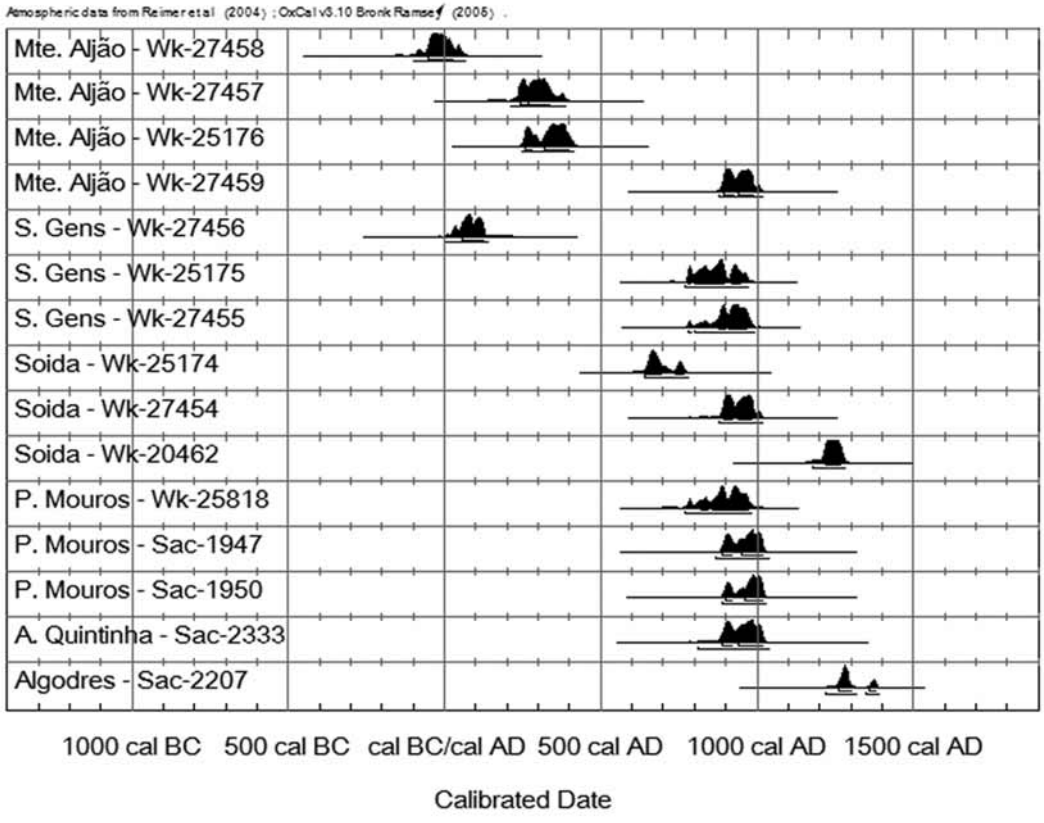

Fig. 2. Radiocarbon chronology for Roman and Medieval archaeological sites of the Upper Mondego Valley.

graphy at the site, overlaying the above-mentioned fire level; it was therefore supposed to be later than Wk-27457. However, it is 300 to 400 years older, a fact that may be explained by deep ploughing and other events of ground disturbance due to agriculture.

• Wk-27459: 1100 ± 30 BP (880–1020 cal AD) was obtained from a *Cistus* sample collected inside Grave II, where no human remains were found. Despite being in close agreement with the expected age of the tomb, the context and nature of the sampled material raise obvious questions concerning the correspondence between the result and the use of this funerary structure. As happens with most—if not all—charcoal derived from local vegetation found inside negative structures, it is impossible to determine the origin of the dated charcoal.

3.2. São Gens (Celorico da Beira)

São Gens is on the right bank of the Mondego River, in one of its most fertile sections. The site's location is not prominent in the landscape and it does not present natural defensive conditions or visual control over the surrounding territory. The archaeological complex includes a rock-cut tomb cemetery occupying a large area (totalling more than 50 tombs), a rural Roman building on a platform overlooking the slight slope of the river bank, and an Early Medieval settlement located in the mid-slope, close to a concentration of massive boulders. The latter was detected due to the remains of defensive structures, with an oval plan, which are still visible on the ground and in aerial photography. Tombs are scattered in the vicinity of the fortified site, but none are found inside its perimeter, an observation that strongly suggests the contemporaneity of both.

Excavations took place in the Roman and Medieval sites in 2008–09 and 2008, respectively (MARQUES and TENTE in press). In the Medieval settlement it was possible to record a short section of the fortification, as well as associated domestic structures. As in the case of the Soida huts, these are evident in the form of stone fireplaces. The fortification wall wouldn't have been higher than 1 or 1.5 meters. The upper part would have been completed with a palisade, of which some burnt remains were found during the excavation.

This site yielded three radiocarbon determinations, two for the medieval fortified site and one for the Roman building:

• Wk-25175: 1161 ± 30 BP (770–970 cal AD) is from a piece of cork found in the layer of the collapsed palisade at the Medieval site. Presumably its collapse was due to a fire that occurred when the site was abandoned and destroyed. Despite being from a long-lived species, cork is always more recent than the tree itself and can be considered a short-lived material. This sample therefore dates the end of the medieval occupation at the site.

• Wk-27455: 1136 ± 30 BP (780–990 cal AD) is from a sample of oak (*Quercus pyrenaica*) charcoal collected from a fireplace located next to the inner side of the fortification. Although oak is a long-lived species, the result accords with Wk-25175; thus, logic allows us to assume that tree branches may have been used in the fireplace instead of tree trunks. If this is the case, the "old wood effect" is absent, a strong possibility reinforced by the result mentioned above.

• Wk-27456: 1920 ± 30 BP (1–140 cal AD) is the only sample obtained from the Roman site at this time. It is a burnt heath (*Erica arborea*) sample found inside a room, under the collapsed roof. The artefactual assemblage found in upper levels and other rooms at the site, however, points to the 3rd and 4th centuries AD (MARQUES and TENTE in print). A logical explanation for this apparent contradiction—which needs to be tested in further excavations—is the possibility that this particular room had been subject to architectural remodelling around the 1st century AD, after a (short?) period of abandonment during which heath and other spontaneous plants may have grown inside.

3.3. Soida (Celorico da Beira)

This site is located on top of a vast promontory, around 1000 metres asl. The steep, irregular topography allowed the building of only a few huts. Field-work in 2006 and 2007 focused on the fortification and the domestic structures. The fortification is a thick stone wall, complemented by a palisade of indeterminate height. In Sectors II and III the remains of two huts were identified and excavated; although their superstructures were probably built with light, perishable materials, stone fireplaces are their most obvious archaeological remnants.

At Soida, three radiocarbon determinations were obtained:

• Wk-20462: 789 ± 33 BP (1180–1280 cal AD) is the result of a charcoal sample of *Genista florida*

recovered in a stratum immediately above the archaeological level and thus corresponding to the abandonment of the site in Sector III. This sample is not associated to any human occupation of site, suggesting therefore that this short-lived spontaneous species might have been burnt during a natural forest fire around the 13th century. The hut found in this sector was not radiocarbon dated.

• Wk-27454: 1098 ± 30 BP (880–1020 cal AD) was obtained from a wild sorb (*Sorbus aucuparia*) sample collected in a fireplace associated with a wooden long bench (which was also dated, see below), in the Sector II hut. This is a highly reliable date: the dated sample is a short-lived species corresponding to a very precise moment in time of use of the hut.

• WK-25174: 1337 ± 37 BP (640–780 cal AD), as mentioned above, refers to a long bench made of a single oak (*Quercus pyrenaica*) plank associated with the dated fireplace. The difference between these two results is two to three centuries, amply illustrating the variation of results that may come up when dating short-lived versus long-lived species. This date was made with the intended purpose of testing this assumption, and to demonstrate why the dating of unknown charcoal or long-lived species should be avoided.

3.4. Penedo dos Mouros (Gouveia)

A large granitic tor located on top of a platform overlooking the Boco stream valley (one of the Mondego's tributaries in the region) supported a complex wooden superstructure on its northern side. This superstructure had at least two floors and dominated the whole settlement, which, in turn, was delineated by a stone wall. Only a small section of the Boco stream is visually connected to the site; taken as a whole it has a reduced visual control over the surrounding landscape (ANGELUCCI *et alii* 2004).

Three field campaigns took place on the northern side of the tor between 1999 and 2009, focusing on the area that linked the summit and the wooden structure (TENTE 2007). Destruction levels—including remains of burnt planks and poles, as well as associated artefacts (mostly pottery) and ecofacts (wood and seeds)—were identified during the excavations. No huts were found, but the recovered material culture is in all aspects comparable to Soida and São Gens, a fact that attests to the residential character of this medieval occupation.

Three radiocarbon determinations obtained for the Early Medieval occupation of Penedo dos Mouros confirmed the above deduction:

• Sac-1947: 1070 ± 45 BP (870–1040 cal AD) was obtained from a sample of burnt broad beans (*Vicia faba*) recovered from destruction levels among the burnt planks and poles of the superstructure. Most probably, these seeds are the remains of storage facilities that existed at the time of the site's destruction by fire around the 10th century AD. Since the broad bean is a short-lived species, this reliably dates the end of the medieval occupation.

• Sac-1950: 1060 ± 40 BP (890–1030 cal AD) was also obtained from broad beans recovered in the same context as Sac-1947. Both coherently point to the same century as the moment of the site's destruction.

• Wk-25818: 1147 ± 30 BP (770–980 cal AD) is from a sample of heath (*Erica arborea*) charcoal recovered from a layer immediately below the medieval occupation. It is not associated with pre-Medieval occupation, with the calibration result according with the sample's stratigraphic position.

Fragments of a wolf mandible probably related to the post-Medieval occupation of Penedo dos Mouros were not successfully dated due to lack of preserved collagen. Parts of its skull were found in what seemed to be a burrow opened through the sediments in the western side of the site. Here the tor's topography forms a natural rock shelter, which was used as a temporary camp during the Neolithic and to keep animals (probably a flock of sheep and/or goats) in medieval times. Its supposed medieval use is supported by scattered artefacts, which do not form a coherent level of occupation, and by the large amount of phytoliths still present in the sediments (IPHES 2009).

3.5. Alto da Quintinha (Mangualde)

A rock-cut tomb was found during the construction of electricity power lines in the highland surrounding the modern town of Mangualde. This site was excavated in 2005 and subsequently published (NÓBREGA *et alii* in print). Bone was preserved, despite the acidity of the granite substrata. Bioanthropological analysis allowed the recognition of two adult individuals, one of which is represented only by a left humerus and some cranial vault fragments.

Lacking precise dates for the use of rock-cut tombs in Portugal, the potential of Alto da Quintinha immediately became evident. One radiocarbon determination was thus obtained:

• Sac-2333: 1080 ± 50 BP (810–1040 cal AD) is the result obtained from the femur belonging to the most complete individual. Its better preservation perhaps suggests that this individual is related to the last moment of use of the tomb, which took place around the 10th century AD. However, it is impossible to determine the time depth between the two, or whether there were previous inhumations, of which no record exists.

3.6. Algodres

The modern village of Algodres is located on a vast platform above the Cortiço stream, a tributary of the left bank of the Mondego River. Successive salvage excavation in 1999 and 2000–01 by different teams around the modern church resulted in the identification of residential structures dated to the 4th century, overlaid by an extensive cemetery (SOARES and CARDOSO 2004; FARIA and COSTA 2007; PINTO 2008). Rock-cut tombs, shallow graves, and stone-built tombs constitute the main types of burial recognized among 161 individual interments and 35 ossuaries.

Written evidence indicates that the cemetery was still in use in the 19th century. Presumably the church was built in the 12th century, when the parish network was established in the region, but the cemetery's foundation is of unknown date. After stratigraphic analysis, two bone samples attributed to its foundation were selected for radiocarbon dating. However, due to the acid granite substrate only one sample—a femur—contained sufficient collagen:

• Sac-2207: 710 ± 40 BP (1220–1390 cal AD), obtained from a female internment (designated as Burial 23), points to the 13–14th centuries, immediately after the presumed foundation date of the church. It is possible that previous burials may have taken place, but only further attempts at direct dating of bone remains from lower levels can clarify this issue.

4. CONCLUSIONS

An uncritical acceptance of the radiocarbon results obtained, and/or an absence of solid criteria when selecting samples, would lead us to build a rather different chronological framework for the medieval settlement in Estrela Mountain. Soida probably constitutes the best example of the erroneous interpretations that can be drawn from uncritical use of radiocarbon determinations. In effect, if all available dates were accepted, the apparently obvious conclusion would be a continuous five hundred-year occupation, ranging between the 7th and 13th centuries (Fig. 2). However, if acceptance were limited to Wk-27454—the only date obtained from a short-lived species clearly associated with the archaeological context under study—then the only plausible conclusion is a short occupation period around the 10th century.

The same is true at a regional scale of analysis (Fig. 2). If we except from discussion unreliable dated samples, a clear pattern emerges: after the late Roman period recorded at Monte Aljão, which ended at the site around the transition from the 3rd to the 4th centuries AD, the occupation of S. Gens, Soida, Penedo dos Mouros and Alto da Quintinha are all dated to the 10th century AD. Even the date Wk-27459 from Monte Aljão's Grave II falls within this short time period, although this result requires independent confirmation. The later date (c. 13th century AD), from Algodres corresponds to a settlement reorganization during which cemeteries are relocated and founded next to parishes.

We have long considered that a discussion on the use and evaluation of radiocarbon dates from medieval archaeological sites has been necessary, not only in Portugal, but also in Iberia. Quirós Castillo's (2009) theoretical paper on the problems and experiments related to the use of radiocarbon chronologies in historical periods—published in the pages of this journal—constituted a decisive step forward in this regard. This author presents a strong case for the use of the radiocarbon method in contexts without chronologically valid type fossils, and in particular for two aspects that become essential: the criteria for sample selection, and a critical interpretation of the archaeological contexts under study.

Therefore, the aim of this paper has been to test, on recently acquired field data (TENTE 2010), the requisites specified by the previously mentioned prehistorians (BERNABEU AUBAN *et alii* 2001; ZILHÃO 2001) in the framework of these considerations (QUIRÓS CASTILLO 2009).

Discussion presented in the previous sections clearly demonstrates how the use of radiocarbon

dates is useful for overcoming difficulties raised by archaeological contexts with few chronologically diagnostic indicators. Well-established criteria for sample selection—namely, avoiding the use of bulk samples or wood from long-lived species, as shown in the case of Soida—and calibration of results systematically obtained using the more recent curve, has allowed the building of a coherent corpus of results.

5. ACKNOWLEDGMENTS

The authors wish to thank Carol L. DeLancey for editing a first draft of the paper and Juan F. Gibaja for the Spanish translation of the title and abstract. We also thank the suggestions and comments of an anonymous reviewer that helped clarifying some aspects of our text.

6. BIBLIOGRAFÍA

ANGELUCCI, D.; TENTE, C. ; MARTINS, A. R.

2004 O Penedo dos Mouros e a sua integração paisagística. *Revista Portuguesa de Arqueologia*. 7:1, p. 467-481.

BERNABEU AUBAN, J.; BARTON, C.M.; PEREZ RIPOLL, M.

2001 A taphonomic perspective on Neolithic beginnings: theory, interpretation, and empirical data in the Western Mediterranean. *Journal of Archaeological Science*. 28, p. 597-612.

BRONK-RAMSEY, C.B.

2005 *OxCal program v.3.10*. Oxford: University of Oxford, Radiocarbon Accelerator Unit [http://www.rlaha.ox.ac.uk/oxcal/oxcal.htm].

FARIA, F.; COSTA, C.

2007 *Igreja matriz de Algodres. Relatório antropológico de campo*. Évora: Universidade de Évora (unpublished report).

IPHES [INSTITUT CATALÀ DE PALEOECOLOGIA HUMANA I EVOLUCIÓ SOCIAL]

2009 *Análisis de fitolitos*. Tarragona: Universitat Rovira i Virgili (unpublished report).

MARQUES, A.C.; TENTE, C.

(in print) A estação arqueológica de S. Gens (Santa Maria, Celorico da Beira). Resultados e perspectivas de investigação. *IV Congresso de Arqueologia da Beira Interior.* Vila Nova de Foz Côa.

NÓBREGA, P.P.; NETO. F.; TENTE, C.

(in print) A sepultura medieval do Alto da Quintinha (Mangualde). *Arqueologia Medieval. 12.*

PINTO, M.

2008 *Intervenção arqueológica no âmbito da empreitada de melhoramentos no Centro Histórico de Algodres. (Fornos de Algodres, Guarda).* Lisboa: ERA-Arqueologia (unpublished report).

QUIRÓS CASTILLO, J.A.

2009 Las dataciones radiocarbónicas de yacimientos de época histórica. Problemas y experiencias de análisis en contextos de época medival. *Munibe*. 60, p. 313-324.

REIMER, P.J.; BAILLIE, M.G.L.; BARD, E.; BAYLISS, A.; BECK, J.W.; BLACKWELL, P.G.; BRONK-RAMSEY, C.; BUCK, C.E.; BURR, G.S.; EDWARDS, R.L.; FRIEDRICH, M.; GROOTES, P.M.; GUILDERSON, T.P.; HAJDAS, I.; HEATON, T.J.; HOGG, A.G.; HUGHEN, K.A.; KAISER, K.F.; KROMER, B.; MCCORMAC, F.G.; MANNING, S.W.; REIMER, R.W.; RICHARDS. D.A.; SOUTHON, J.R.; TALAMO, S.; TURNEY, C.S.M.; VAN DER PLICHT, J.; WEYHENMEYER, C.E.

2009 IntCal09 and Marine09 radiocarbon age calibration curves, 0-50,000 years cal BP. *Radiocarbon*. 51:4, p. 1111-1150.

SOARES, A.; CARDOSO, H.

2004 *Algodres, intervenção arqueológica de emergência.* Relatório final entregue ao Instituto Português de Arqueologia (unpublished report).

TENTE, C.

2007 *A ocupação alto-medieval da Encosta Noroeste da Serra da Estrela*. Lisboa: Instituto Português de Arqueologia (Trabalhos de Arqueologia; 47).

2010 *Arqueologia Medieval Cristã no Alto Mondego, Ocupação e exploração do território nos séculos V a XI*. Lisboa: Universidade Nova de Lisboa (unpublished PhD dissertation).

VAN DEN BRINK, L.M.; JANSSEN, C.R.

1985 The effect of human activities during cultural phases on the development of montane vegetation in the Serra da Estrela, Portugal. *Review of Palaeobotany and Palynology*. 44, p. 193-215.

VAN DER KNAAP, W.O.; VAN LEEUWEN, J.F.N.

1995 Holocene vegetation succession and degradation as responses to climatic change and human activity in the Serra de Estrela, Portugal. *Review of Palaeobotany and Palynology.* 89, p. 153-211.

1997 Late Glacial and early Holocene vegetation succession, altitudinal vegetation zonation, and climatic change in the Serra da Estrela, Portugal. *Review of Palaeobotany and Palynology.* 97, p. 239-285.

ZILHÃO, J.

2001 Radiocarbon evidence for maritime pioneer colonization at the origins of farming in West Mediterranean Europe. *Proceedings of the National Academy of Sciences*. 98, p. 14180-14185.