THE PORTUGUESE PALEOLITHIC OCCUPATION AND ENVIRONMENT DURING ISOTOPIC STAGES 2 & 3

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HISTORICAL BACKGROUND

Upper Paleolithic research in Portugal has been important since the 19th Century with the work of Delgado in the caves of Casa da Moura and Furninha (DELGADO 1867, 1884; ZILHÃO 1993). This work, however, only became systematic with the arrival of Henry Breuil and Georges Zbyszewski during the first half of this century. Their work consisted mostly of archaeological and geological surveys of both the coast and major river valleys such as the Tagus (BREUIL and ZBYSZEWSKI 1942, 1946; ZBYSZEWSKI 1958). Rare excavations were carried out, and chronological sequences, as well as the definition of cultural characteristics followed the traditional models published by Breuil in 1912.

In the late 30's, Manuel Heleno, director of the National Museum of Archaeology, focused on two areas of central Portugal. These areas were one on the coast, near Torres Vedras, and the other inland, around the town of Rio Maior. A few sites were found and excavated by local people under Heleno's direction, though very rarely he was present at the sites during the excavation. The work was usually carried out following spits of between 15 and 50 cm thick. The horizontal control was also poor, with divisions by "talhões", long trenches or rectangular units of never less than four sq. meters. Most sites were open air, though Heleno excavated a few caves, following the same methods, but dividing the excavation in smaller units, usually related to the morphology of the cave or rock-shelter (BICHO 1992, In Press; ZILHÃO 1995).

In the 50's, Portugal saw the arrival of Jean Roche. Though this French researcher focused mostly on the local mesolithic, he also excavated a few paleolithic sites, including Suão cave. He also published the only data on Upper Paleolithic of Portugal that was to be published for a couple of decades (ROCHE 1964, 1971, 1979, and 1982).

It was only in the early 80's, that Portugal saw a development in the interest of Late Pleistocene archaeology, with the work of José Arnaud, Vítor Oliveira Jorge, Luis Raposo and João Zilhão, all graduates from the University of Lisbon. While some of these researchers have focused on different periods since then, Zilhão was the only one to become an expert on Upper Paleolithic, finishing his doctoral dissertation in 1995. During this period, a series of contacts with American experts, such as Straus and Marks, made possible an exponential

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increase in the number of projects, as well as in the number of researchers, that, due to their work, have expanded enormously the amount of data on Upper Paleolithic. One of the data sets that were drastically changed was the one resulting from absolute dating. In 1980, there were no dates for the Oxygen Isotope Stages 2 and 3, while we have now more than 100 dates from a diversity of methods.

Research has spread all over the country. Different teams are now working in the north of Portugal (Côa Valley), in Estremadura, and in the south both in Alentejo and Algarve. This work, unlike that of the past, is marked by interdisciplinary research teams, that include experts in geomorphology, geophysics, microfauna and macrofauna, seasonality analysis, and paleobotany. These teams have provided data that presently allow the construction of models for the Upper Paleolithic of Portugal.

ENVIRONMENT

Data on the Portuguese paleoenvironment of Isotopic Stages 3 and 2 is still incomplete, based mostly on geomorphological interpretations and, more rarely, on macrofauna and microfauna, as well as on identification analysis of wood species.

Large and medium sized vertebrates, as well as marine shell have been used to characterize the changes in climate and environment (BICHO 1994; ZILHÃO 1995). As more data as been recovered, however, it seems that these faunal data are not good indicators for climatic changes. It seems that composition of the regional fauna is identical between c. 35,000 and 8,000 bp. These included red deer, roe deer, horse, aurochs, wild boar, ibex and chamois. The last two species have been thought to characterize times of more rigorous and cold temperatures and environments and, thus, related to the Last Glacial Maximum and to Dryas III phase (BICHO 1994; ZILHÃO 1995). The latter cold event was thought also to have been marked by the presence of the marine species Littorina littorea, that was replaced by Monodonta lineata in the Early Holocene (SOARES & SILVA 1993; STRAUS 1995). The hypothesis of species adapted to cold periods, however, do not fit the present data, since Littorina has been reported recently in the southern coast of Portugal (BICHO 1998). Also, the two herbivore species, ibex and chamois, have been found in Picareiro (BICHO et *al.*, n. d. ; BICHO and HAWS 1996) and in Bocas (BICHO 1997, In Press) in levels dated to before and after the Dryas III event. Clearly, these species reflect, during the Portuguese Late Pleistocene, less the climate and more the topography of the area around the site (BICHO 1999), as has been documented in other areas of Europe (PHOCA-COSMETATU 1999).

The only species that may suggest colder conditions are the marine mammals, Pusa hispida and Pinguinus impennis, at the Mousterian site of Figueira Brava (ANTUNES 1991). These species may indicate, however, only a low sea surface temperature, and not the general climatic conditions in Portugal. This is suggested here since at other mousterian sites (Caldeirão cave and Foz do

Enxarrique), fauna indicates a temperate forest environment with the presence of wild boar, roe deer and beaver (CARDOSO 1992; ZILHÃO 1995).

Microfauna data, though only from one site, Caldeirão, shows interesting patterns. Five species help to define the climatic patterns during this period. These are *Allocrietus bursae*, *Microtus arvalis* and *Chionomys nivalis* as indicators for cold phases and *Apodemus sylvaticus* and *Eliomys quercinus* for the warmer and temperate times (PÓVOAS *et al.* 1992).

Land snails also from Caldeirão show a diversity of species that point to humid forested to semi-forested environments with the presence of *Rumina decollata*, *Oestophora barbula*, *Portugalla inchata* and *Cepaea nemoralis* (CALLAPEZ 1992).

The amount of paleobotanical data is increasing fast in Portugal, with results from 4 sites with a total of 10 different archaeological occupations dated between 11,000 and 23,000 bp. Again, it seems that there are two major groups, one clearly reflecting the warmer phases with a typical mediterranean and temperate forest, while the other characterizes the colder periods. The first group includes *Pinus pinaster/pinea, Quercus* suber and *ilex, Arbutus unedo, Fraxinus angustifolia,* and *Olea europaea var. sylvestris,* as well as *Erica* and *leguminosae.* The second group includes *Pinus sylvestris* and *pinaster*, and high frequencies of *Erica* and *leguminosae* (BICHO 1997; ZILHÃO 1995).

Based on these data, as well as on local and regional geomorphology, it is possible to construct some patterns for the regional paleoenvironment. It is necessary, however, to state that these data are most likely reflecting only the paleoenvironments around each site. Thus, some sites show conflicting results because of their geographical settings are very diverse. Also, in some cases, the chronological control is not yet detailed enough to allow a perfect understanding of the paleoenvironmental data. Thus, the model presented here is based on the extrapolation from local data to reach the general scenario of the Portuguese paleoenvironment between 35,000 and 9,000 years ago.

During the Late Mousterian, between 35 and 27,000 bp, Portugal was likely to have been characterized by forested areas with pine and oaks. Here, fauna was composed of wild boar, red deer, roe deer, while in the more open areas there were horse and aurochs. At higher altitudes, landscape was likely marked by steppic conditions. Sea surface temperature was probably fairly low, due to the presence of cold sea mammals south of the Tagus River valley. By 26,000 bp, the humidity seems to have increased, due to winds coming from the sea, probably causing a drop in temperature that did not affect the vegetation. During this phase, chamois and ibex communities probably expanded their territory to lower lands. Rare data are available for the period between 25 and 23,000 bp, but it seems not to disagree with the information dated to 26,000 bp.

Between 22,000 and 18,000, during the Proto-Solutrean and Solutrean occupations, the environment became more rigorous, with a clear drop in temperature. Simultaneously, the climate became drier and the vegetation cover of the landscape became more sparce, probably almost completely limited to Erica.

The forests were open, with rare oaks in the inland areas more protected from the cold coastal winds, while pine trees covered sandy areas. Steppic conditions were probably found in coastal as well as unprotected inland flat areas. Fauna was the same as before, but chamois and ibex were likely found in low altitude zones were topography was irregular.

After 16,000 bp, Portugal saw a clear and steady improvement in the climatic conditions. Temperature and humidity rose due to the retreat of the Polar Front further north, decreasing the volume of meltwater and ice, and increasing solar radiation both in the summer and winter (RUDDIMAN and MCINTYRE 1981). By 12,000 bp, Central Portugal was marked by a temperate to Mediterranean forest, with oaks, pine trees, birch, wild strawberry trees as well as wild olive trees. Large and medium fauna were very diverse, from both open and closed environments. Chamois and ibex are present at those sites located in the high altitude mountains as well as low altitude near rough and irregular landscape. This pattern seems to hold until c. 8,000 with the development of the Atlantic phase, when the landscape suffered drastic changes with the appearance of lacustrine like conditions in the major river valleys of central and southern Portugal.

CHRONOLOGY, CULTURAL STAGES, AND SITE LOCATION

There are 111 absolute published dates for the Portuguese sites dated between 35 and 9,000 bp. The first group of dates corresponds to the Late Mousterian occupation of Portugal. This occupation is dated between 34,000 and 27,000 bp, and the dates are uniformly spread through out those 7 thousand years with 10 sites/levels. All sites are in Central Portugal, and most sites are located in river valleys and on the Atlantic coast. There are both caves and open air sites, though the first type of site seems to have been preferred during this phase.

Zilhão (1995) has argued for the existence of an Aurignacian phase in Portugal. This phase would date between c. 28,000 and 26,000 bp. There are four dates from a single site, Pego do Diabo cave. Three of these dates come from the level attributed to the Aurignacian occupation. This Layer is dated through radiocarbon on bones between 28,000 (base of the layer) and 23,000 bp (top of the layer). This layer has also one date on charcoal with a result of 2,500 bp. The other date, also on bone, comes from the layer underlaying the so-called Aurignacian, and has a result of c. 18,000 bp. The attribution of the materials to the Aurignacian is based on the presence of Lamelle Dufour from a total of 32 lithic pieces, of which 11 are retouched tools. There are one complete and five fragments of Lamelle Dufour, while the other retouched tools are one atypical endscraper, um atypical perfurator, one backed bladelet and a fragment of a retouched piece. Since all these retouched tools are common in other phases of the Portuguese Upper Paleolithic, and it is clear from the radiocarbon results that there has been some vertical disturbance in the cave, the attribution to the Aurignacian is, at best, doubtful in the case of Pego do Diabo. The other four so-called Aurignacian sites have no absolute dates. Salemas cave is a multicomponent site with Mousterian, Gravettian, Proto-Solutrean, and Upper

Solutrean. The so-called Aurignacian artifacts are in a total of three fragments of Lamelle Dufour, removed from a Gravettian level with an assemblage marked by the presence of backed bladelets. Escoural cave is also a multicomponent site with Mousterian and Solutrean occupations. In the collections from the excavation carried out in the 60's, Zilhão found one complete and three fragments of Lamelle Dufour, that where attributed to the Aurignacian, since they were similar to those from Pego do Diabo. Vascas, an open air site excavated in the 50's with very little vertical and horizontal control, was also a multicomponent site with Early and Late Gravettian, Proto-Solutrean, Solutrean and Magdalenian, according to Zilhão (1995). These cultural attributions are based on typological and technological characteristics of the lithic materials, since there was no stratigraphical data. The attribution of the lithic materials to the Aurignacian by Zilhão was based on typology, patina and the presence/absence of iron and manganese concretions on the artifacts. These are a total of a few hundred pieces out of a total close to 4000 artifacts. The typological indicator here was not the Lamelle Dufour, but the carinated pieces, mostly endscrapers. This type of retouched tool, however, is also extremely common in the Magdalenian and Epipaleolithic of the valley where Vascas is located. Finally, the last site, Vale de Porcos, is a single component site with close to 2,500 artifacts coming from two loci. Cultural attribution was again based on typological grounds (high frequency of carinated tools), as well as on dimension of retouched tools and laminar blanks. These show a pattern of length and width/thickness ratio that is very different from any other Upper Paleolithic assemblage in the area, and thus, not comparable to other assemblages. One variable, however, needs to be mentioned. That is, that the site is located on top of the preferred raw material, a red to greenish flint. Though in Gravettian and Solutrean times it was fairly common to have quarry sites, that is not the case for the Magdalenian. In fact, no quarry site has been found for the Magdalenian. Since from the typological point of view, this assemblage is within the variability of the Magdalenian, it is possible to put the hypothesis that Vale de Porcos is Magdalenian.

In conclusion, the attribution to Aurignacian of these five assemblages, at best, needs to be seriously questioned. This is due to the fact that there are no solid absolute dating data, the size of the collections are, in most cases, extremely small, the stratigraphy is unknown or clearly mixed, and the typological data is very weak, since is based on patina and on the idea of type fossils (lamelle Dufour and carinated tools), that themselves are present in abundance in the Magdalenian and in the Epipaleolithic of central Portugal. Also, to acknowledge the existence of Aurignacian between 29-28,000 and 26,000 BP (ZILHÃO 1995), it rises an interesting question. That is the possibility, according to the available absolute dates, that in Portugal the Aurignacian never existed by itself, since the Mousterian lasted until 27,000 bp and was then replaced by the Gravettian. Based on the review put forward here, it seems necessary to argue for the nonexistence of an Aurignacian phase in Portugal.

The human occupation of the Early Gravettian in Portugal, based on the radiocarbon and TL dates from Vale Comprido-cruzamento and Caldeirão, is likely to have started around 27,000 bp, and lasted to no later than 25,000 years ago. There are a total of six sites, all located in Estremadura. These sites are mostly open air, though two are caves. In general, they are located near high quality raw material. The cave sites are in steep and narrow valleys, while the open air sites are found in high points on open shallow river valleys, between 75 and 150 meters a. s. l.

There are no sites dated between 25,000 and 24,000 bp. This break likely corresponds only to a hiatus in information. The Late Gravettian started sometime after 24,000 bp and ended around 22,000 bp. There are 18 sites/levels spread over the area between the Douro and Tagus river, with a stronger incidence on Estremadura. The sites are mostly open air, though there are a few caves with occupation from this phase. Again, all sites are lower than 150 m a. s. l., located in shallow river valleys. There is one difference, however. That the location of these sites in the valleys is now both in the low and high points. Another difference during this phase is that the present coast line started to be occupied.

The Proto-Solutrean started after 22,000 bp. This cultural phase lasted about a thousand years. There are 13 sites, almost doubling the number of sites per millenium since the earlier cultural phase. This fact suggests, thus, an increase in human population. The sites are found in the same areas as the Late Gravettian, which is between the Douro and Tagus basins. There seems to have been an increase in the use of caves, since only eight out of the 13 sites/levels are open air sites. The sites are located in a diversity of settings, from narrow and steep limestone areas to wide and shallow river valleys. The site altitude varies from 70 m to 350 m a. s. l., indicating a more extensive use of the landscape, and also supporting the idea of an increase in the population pressure in the regional ecology.

The Solutrean started around 21,000 bp. The first phase seems to be the Middle Solutrean as defined by Zilhão (1995). There are 13 sites dated to between 21 and 20,000 b. p., and nine out of these are caves. The area of occupation was expanded to inland Alentejo, in the south. It seems also that there is another site near the coast of Algarve, but it is not published or confirmed yet. Site location was, like with the Proto-Solutrean very diverse, from steep points to shallow valleys, from inland spots to coastal dunes. The altitude of these sites is from 15 to 400 meters a. s. l. Following the Middle Solutrean, after 20,000 b. p. was the Upper Solutrean phase. This phase lasted to around 18,000 b. p. There are only eight sites known dated to this period. Site location and type of site is similar to the Middle Solutrean. It seems that the area of influence during this phase may have decreased, since there no sites known south of the Tagus. This fact, however, may be due to lack of data, since very little work has been carried out in the south.

There are no sites dated to between 18,000 and 16,000 bp in Portugal. This hiatus is, again, likely the consequence of lack of research, as well as data. The lack of data may, however, point to a drop in the human population or a change in settlement system during this period in Portugal.

Early Magdalenian started around 16,000 bp. There are only five levels dated from this period, all of which are from the site of Cabeço do Porto Marinho. This is an open air site, located in Portuguese Estremadura, some 30 km from the present coast line. The site is located in a wide and shallow river valley, near very good raw material sources. Data is still fairly rare, but it seems that after this phase, there is a Middle Magdalenian. The Middle Magdalenian is identical to the Early Magdalenian, except in the use of raw materials, with an increase in the use of quartz and quartzite. This second magdalenian phase may have lasted to 14,000 bp.

There are no data for the period between 14,000 and c. 12,500 bp, except for the presence of a decorated bone in the cave of Buraca Grande dated to 13,000 bp (AUBRY *et al.* 1998). This dated decorated bone, however, was found in a Solutrean level. Also, there are no Magdalenian levels in this cave, though, apparently there are some Magdalenian artifacts mixed with an overlaying Neolithic level (ZILHÃO 1995). Attending to these facts, perhaps this date should be discarded, and the decorated bone should be attributed to the Solutrean.

After 12,000 bp, Portugal saw an important increase in the number of sites with the development of the Late Magdalenian (BICHO 1998). There are 13 occupations dated to between 12,500 and c. 11,000 bp. These occupations are present in a total of six sites, suggesting that during this time existed sites that people tended to reuse frequently, possibly as aggregation sites. The area of influence was again the region between the Douro and the Tagus river valleys. Caves were again used, though not in an important manner.

After 11,000 bp, started the last phase of the Magdalenian. It lasted until around 9,000 bp, with a sharp increase in the number of sites, as well as an increase in the areas of occupation. These seem to have covered all the region between the Douro river and the Algarve coast, with open air, caves and rock-shelters, located in inland river valleys, lakes, and coastal dunes. The altitude of theses sites had an important variation from sea level up to over 500 meters a. s. l. The human ecology clearly became more diverse, with the exploitation of a wide number and type of natural resources, both marine and terrestrial (BICHO 1994, 1999). The data for this phase indicate, thus, an important phase of human demographic pressure, likely to have been suported by a change in technology, settlement system, mobility and land use.

CONCLUSIONS

During the OIS 2 & 3, Portugal saw some important variations, both at the climatic and environmental, as well as at the cultural levels. The Last Glacial Maximum seem to have had a strong influence in northern and central Portugal around 22-21,000 bp, lasting to c. 18,000 bp, roughly the time of the Solutrean occupation.

After this cold pick, Portugal saw a clear and fast improvement. During this phase, the human population increased at a high rate with an important pick at around 11,000 bp, probably related to changes in technology, human mobility and land use, already in Holocene times.

There are three clear hiatus during this period. These are between 26 and 24,000 bp, between 18 and 16,500 bp and between 14 and 12,500 bp. The main reason for these hiatus is likely to be the lack of research in certain areas, though the regional geomorphology may also be an important variable in this scenario.

Finally, an interesting aspect is the presence of a very late Mousterian and the possible nonexistence of the Aurignacian. These aspects, though, are in perfect agreement with the data from southern Spain, indicating, thus, that while the Aurignacian was important (and also very early) in northern Spain, southern Iberia seems to have been the last resort for the Neanderthal population in Europe.

REFERENCES

ANTUNES M.T., 1991,
O homem da Gruta da Figueira Brava (ca 30,000 BP). Contexto ecológico, alimentação, canibalismo. *Memórias da Academia das Ciênciasde Lisboa*. 31 : 487-536.

AUBRY T., ZILHÃO J., ALMEIDA F. and FONTUGNE M., 1998,
Production d'armatures microlithiques pendant le Paléolithique supérieur et le Mésolithique au Portugal. In *II Congreso deArqueología Peninsular*. Vol. 1. Zamora.

BICHO N.F., 1992,
Technological Change in the Final Upper Paleolithic of Rio Maior, Portuguese Estremadura. Ph. D. Dissertation, Southern Methodist University, Dallas. University Microfilms, Ann Arbor.

BICHO N.F., 1994,
The end of the Paleolithic and the Mesolithic in Portugal. *Current Anthropology* 35 : 664-674.

BICHO N.F., 1997,
Spatial, technological and economic organization after the Last Glacial Maximum in Portuguese Prehistory. In *El Món Mediterrani després del Pleniglacial (18,000 - 12,000 BP)*, eds. J. Fullola i Pericot e N. Soler i Masferrer, pp. 213-223. Sèrie Monogràfica, 17. Centre d'Investigaciones Arqueològiques, Girona.

BICHO N.F., 1998,
Caves, Rock Shelters and Open air sites : Land-use during the End of the Palaeolithic in Central Portugal. In *Proceedings of the XIII International Congress of Prehistoric and Protohistoric Sciences, Forlí, Itália*. Vol. 2, pp. 589-597. ABACO.

BICHO N.F., 1999,
Portugal 10,000 years ago : Human Ecology at the End of the Pleistocene. Paper presented at the 4th World Archaeological Congress. Cape Town.

BICHO N.F., In Press,
A Ocupação Epipaleolítica do Abrigo Grande das Bocas, Rio Maior. *O Arqueólogo Português.*

BICHO N.F. and HAWS J., 1996,
What to eat, where to go - subsistence and settlement pattern in the Portuguese Tardiglacial. Paper presented at the 61st Annual Meeting of the Society for American Archaeology. New Orleans.

BICHO NF., HOCKET B., HAWS J. and BELCHER B., n. d.,
Hunter-gatherer Subsistence at the End of the Pleistocene : Preliminary Results from Picareiro Cave, Central Portugal. Paper submitted to *Antiquity.*

BREUIL H., 1912,
Les subdivisions du Paléolithique supérieur et leur signification. *14th Congrés International de Anthropologie at Archéologie Préhistorique,* Geneve vol. I : 165-238.

BREUIL H. and ZBYSZEWSKI G., 1942,
Contribution à l'étude des industries paléolithiques du Portugal et de leurs rapports avec de la geologie du Quaternaire. *Comunicações dos Serviços Geológicos de Portugal* 23.

BREUIL H. and ZBYSZEWSKI G., 1946,
Contribuition á l'étude des industries paléolithiques des plages quaternaires de l'Alentejo litoral. *Comunicações dos Serviços Geologicos de Portugal* 27.

CALLAPEZ P., 1992,
Moluscos terrestres das camadas A/B/C - Eb da Gruta do Caldeirão. In *Gruta do Caldeirão, o Neolític Antigo.* Edited by J. Zilhão, pp. 223-229. IPPAR, Lisbon.

CARDOSO J. L., 1992,
Contribuição para o conhecimento dos grandes mamíferos do Plistocénico Superior de Portugal. Unpublished Ph. D. Dissertation, Universidade Nova de Lisboa, Lisbon.

DELGADO J.F.N., 1867,
Da existência do homen em tempos mui remotos provada pelo estudo das cavernas. I - Notícia àcerca das grutas da Cesareda. Lisboa, Comissão Geológica de Portugal.

DELGADO J.F.N., 1884,
La Grotte de Furninha à Peniche. In *Congrès International d'Anthropologie et d'Archéologie préhistoriques. Compte-rendu de la neuviéme session à Lisbonne (1880)*, pp. 241-247. Lisboa.

MARKS A.E., ZILHÃO J., BICHO N. and FERRING R., 1994,
Upper Paleolithic Prehistory in Portuguese Estremadura : preliminary results. *Journal of Field Archaeology.* 21 : 53-68.

PHOCA-COSMETATOU N., 1999,
Wild caprid econimies and use of the hinterland during the Upper Paleolithic in southern Europe. *Paper presented at the 4th World Archaeological Congress.* Cape Town.

PÓVOAS L., ZILHÃO J., CHALINE J. and BRUNET-LECOMTE P., 1992,
La Faune de Rongeurs du Pleistocene Superieur de la Grotte de Caldeirão (Tomar, Portugal). *Quaternaire* 3 (1) : 40-47.

ROCHE J., 1964,
Le Paléolithique supérieur portugais. Bilan de nos connaissances et problemes. *Bulletin de la Société Préhistorique Française* 31 : 41-47.

ROCHE J., 1971,
Le climat et les faunes du Paléolithique moyen et supérieur de la provinve d'Estremadura. In *Actas do II Congresso Nacional de Arqueologia*, pp. 39-48. Instituto nacional de cultura, Lisboa.

ROCHE J., 1979,
Le Magdalénien Portugais. In *La Fin des Temps Glaciaires en Europe*, edited by D. Sonneville-Bordes, pp. 753-758. Editons du CNRS, Paris.

ROCHE J., 1982,
A gruta chamada Lapa do Suão (Bombarral). *Arqueologia* 5 : 5-18.

RUDDIMAN W. and MCINTYRE A., 1981,
The north Atlantic Ocean during the Last Deglaciation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 35 : 145-214.

SOARES J. and SILVA C.T., 1993,
Marisqueio na Pedra do Patacho. *Almadan serie* II 2 : 21-29.

STRAUS L.G., 1995,
Diversity in the face of adversity : human adaptations to the environmental changes of the Pleistocene-Holocene transition in the Atlantic regions of Aquitaine, Vasco-Cantabria and Portugal. In *Los últimos Cazadores de los Tiempos Glaciares*. Edited by V. Villaverde, pp. 9-22. Ediciones de la Fundación Gil-Albert, Alicante.

ZBYSZEWSKI G., 1958,
Le Quaternaire du Portugal. *Boletim da Sociedade Geológica de Portugal*, 13.

ZILHÃO J., 1993,
As origens da Arqueologia Paleolítica em Portugal e a obra metodologicamente precursora de J. F. Nery Delgado. *Arqueologia e História* Série 10, 3 : 111-125.

ZILHÃO J., 1995,
O Paleolítico Superior da Estremadura Portuguesa. Ph. D. Dissertation, Faculdade de Letras, Universidade Clássica de Lisboa.

Table 1.
Absolute Dates From the Mousterian, Aurignacian and Gravettian Sites from Central and Southern Portugal

Site	Level	Method	Date bp	Lab. N°	Material	Evaluation
Late Mousterian (35-27,000)						
Lapa dos Furos	4	C14	34,580+1,010			
			-1,160	ICEN-473	land snail shells	A
Foz do Enxarrique	C	U-Th	34,093±920	SMU-224	tooth enamel	A
		U-Th	34,088±800	SMU-226	tooth enamel	A
		U-Th	32,938±1,055	SMU-225	tooth enamel	A
Figueira Brava	2	C14	30,930±700	ICEN-387	*Patella*	A
	?	C14	30,050±550	ICEN-386	*Patella*	?
Pedreira Salemas	Lower	C14	29,890+1,130			
			-980	ICEN-366	bone	A
		C14	>29,200	ICEN-371	bone	?
		C14	27,170+1,000			
			-900	ICEN-361	bone	?
Columbeira	20	C14	28,900±950	Gif-2704	sediment	A
Caldeirão	K base	14C	23,040±340	OxA-5521	*Capra.*	R
Caldeirão	K top	14C	27,600±600	OxA-1941	*Cervus*	A
	K top	14C	18,060±140	OxA-5541	*Cervus*	R
Columbeira	16	C14	26,400±700	Gif-2703	sediment	A
Conceição	C	OSL	27,200±2500		sediment	A
Salemas	T.V.b	C14	24,8720±550	ICEN-379	bone	R
		C14	23,830±580	ICEN-383	bone	R
		C14	20,740±470	ICEN-384	bone	R
Aurignacian (28-26,000?)						
Pego do Diabo	3	14C	18,630±640	ICEN-491	bones	R
	2b	14C	28,120+860			
			-780	ICEN-732	bones	?
		14C	2,400±80	ICEN-306	charcoal	R
	2a	14C	23,080±490	ICEN-490	bones	?
Early Gravettian (28-26,000)						
Vale Comprido C	North Prof.	TL	30,300±3,900		flint	A
	L. (-40cm)	TL	26,700±2,700		flint	A
	L. (-35 cm)	TL	12,400±2,100		flint	R
Caldeirão	Jb	14C	26,020±320	OxA-5542	bone	A
Casada Moura	1b	14C	25,090±220	TO-1102	*Canis lupus*	?
Late Gravettian (24?-22,000)						
Fonte Santa	3	TL	40,400±4,600		flint	?
		TL	39,300±4,700		flint	?
		TL	35,300±3,600		flint	?
CPM	1	C14	34,730±1,890	SMU-2667	charcoal	R
		C14	19,220±280	ICEN-691	charcoal	R
Buraca grande	9b	C14	23,920±300	GiA-93048	charcoal	A
CPM	2	C14	23,050±750	ICEN-428	charcoal	A
		C14	22,710±350	SMU-2475	charcoal	A
		C14	21,080±850	ICEN-692	charcoal	A
CPM	3	C14	23,490±280	ICEN-280	charcoal	A
		C14	19,030±440	ICEN-692	charcoal	R
		C14	16,080±350	ICEN-821	charcoal	R
Buraca Escura	2e	C14	22,700±240	OxA-5523	bone	A
Terra do Manuel	2s	14C	21,770±210	ETH-6038	charcoal	A
Picos		C14	7,720±70	OxA-5525	charcoal	R

* TL Dates obtained by the Laboratory of the British Museum.

Table 3.
Absolute Dates From the LGM Sites from Central and Southern Portugal

Site	Level	Method	Date bp	Lab. N°	Material	Evaluation
Proto-Solutrean (22-21,000)						
Caldeirão	I	14C	22,900±380	OxA-1940	*Cercus e.*	?
Buraca Escura	2b	C14	21.820±200	OxA-5524	bone	A
Anecrial	1b-2a	14C	23,450+1,470 -1,240	ICEN-963	charcoal	A
	2b	14C	21,560±680	ICEN-964	charcoal	A
	2b	14C	21.560±220	OxA-5526	*Erica*	A
Gato Preto	C	TL	40,700±5,600		flint	R
		TL	36,500±5,600		flint	R
		TL	5,100±600		flint	R
		TL	4,940±640		flint	R
Terra do Manuel	2	TL	16,400±1,800		flint	R
		TL	15,700±1,700		flint	R
		TL	7,300±700		flint	R
Solutrean (21-18,000?)						
Lapa da Rainha	4	14C	25,580+1.820 -1,800	ICEN-789	bones	R
Middle Solutrean (21-20,000)						
Caldeirão	H	14C	20,530±270	OxA-2511	bone	A
		14C	19,900±260	OxA-1939	*Capra P.*	A
Upper Solutrean (20-18,000)						
Salemas	V.S.	14C	20,250±320	ICEN-376	bones	?
		14C	19,220±300	ICEN-385	bones	?
		14C	17,770±420	ICEN-367	bones	?
Caldeirão	Fc	14C	18,840±200	OxA-2510	*Cervus e.*	A
	Fa-top	14C	20,400±270	OxA-1938	*Cervus e.*	R
		14C	21,200+1840 -1490	ICEN-295	charcoal	?
Buraca Grande	9a	14C	17,850±200	Gif-9502	charcoal	A

TL Dates obtained by the Laboratory of the British Museum.

Table 4.
Absolute Dates From Portuguese Tardiglacial Sites

Site	Level	Method	Date bp	Lab. Nº	Material	Cal BP*	Evaluation
Early Magdalenian (16-15,000)							
CPM	5	14C	16,180±290	Wk-3126	charcoal	19,410-18,750	A
	7	14C	16,340±420	SMU-2015	charcoal	19,790-18,790	A
		14C	15,820±400	ICEN-542	charcoal	19,130-18,310	A
		TL	20,400±2300		flint	22,700-18,100	A***
	8	14C	15,410±195	SMU-2476	charcoal	18,530-18,120	A
	9	14C	17,515±270	SMU-2633	charcoal		R
		14C	15,420±180	SMU-2634	charcoal	18,520-18,140	A
		14C	15,040±210	Wk-3127	charcoal	18,180-17,720	A
Middle Magdalenian (15?-14,000)							
CPM	10	14C	14,050±850	SMU-2668	charcoal	17,830-15,740	A
Caldeirão	Fa pocket	14C	15,170±740	ICEN-69	bone	18,840-17,230	A
	Eb base	14C	14,450±890	ICEN-70	bone	18,290-16,200	A
	top	14C	10,700±380	ICEN-72	bone	13,080-12,010	A
Buraca Grande	9	14C	13,050±100	OxA-5522	bone	15,703-15310	?
Late Magdalenian (12,5-11,000)							
Lapa do Picareiro	G	14C	12,310±90	OxA-5527	*Pinus*	14,570-14210	A
CPM	12	14C	11,810±110	ICEN-689	charcoal	13,930-13,610	A
	13	14C	12,220±110	ICEN-687	charcoal	14,470-14,080	A
		14C	11,680±60	SMU-2011	charcoal	13,730-13,500	A
		TL	14,110±1100		flint	15,210-13,010	A***
Lapa do Picareiro	F (hearth)	14C	12,210±100	Wk-6677	charcoal	14,322-13,971	A
	F	14C	11,780±90	Wk-4219	charcoal	13,880-13590	A
	E Lower	14C	11,550±120	Wk-4218	charcoal	13,630-13,220	A
	E Middle	14C	11,700±120	Wk-5431	charcoal	13.810-13,480	A
CPM	14	14C	11,160±280	ICEN-545	charcoal	13,370-12,790	A
	15	14C	11,110±130	SMU-2637	charcoal	13,160-12,890	A
	16	14C	10,940±210	ICEN-690	charcoal	13,080-12,650	A
Final Magdalenian (11-9,000)							
Cameira	Pinhal	14C	10,880±90	SMU-2635	charcoal	12,910-12,700	A
Pedra do Patacho		14C	10,400±90	ICEN-748	*Littorina l.*	12,430-12,130	A**
		14C	10,380±60	ICEN-207	*Patella*	12,380-12,140	A**
		14C	10,090±60	ICEN-267	*Littorina l.*	11,910-11,210	A**
		14C	10,020±100	ICEN-266	*Littorina l.*	11,800-11,010	A**
CPM	17	14C	10,160±80	SMU-2636	charcoal	12,090-11,510	A
Bocas I	Fundo	14C	10,110±90	ICEN-901	bone	11,910-11,420	A
Lapa do Picareiro	E top	14C	10,070±80	Wk-4217	charcoal	11,750-11,320	A
Bocas I	0	14C	9,880±220	ICEN-900	*Bos*	11,800-10,890	A
	1/2	14C	9,900±70	ICEN-903	shell	11,430-11,400	A**
Casal Papagaio	base	14C	9,710±70	ICEN-369	charcoal	10,280-10,260	A
		14C	9,270±90	ICEN-372	shell	10,350-10,320	A
		14C	8,870±105	Hv-1351	shell	9,980-9,830	A
Magoito		14C	9,970±70	ICEN-80	shell	11,490-11,360	A
		14C	9,790±120	ICEN-81	shell	11,250-10,180	A
		14C	9,580±100	GrN-11229	charcoal	10,900-10,780	A
		14C	9,490±60	ICEN-52	charcoal	10,800-10,750	A
CPM	18	14C	9,270±170	SMU-2666	charcoal	10,440-10,030	A
CPM	19	14C	9,100±160	ICEN-688	charcoal	10,290-10,250	A
Cameira	II (-60-70cm)	TL	10,500±700		flint	11,200-10,800	A***
		14C	4,280±100	ICEN-420	charcoal		R
Cameira	Olival	14C	5,290±170	ICEN-820	charcoal		R

* Calibrated dates by CALIB 3.0.3a (Bard *et al.* 1993; Stuiver e Reimer 1993).
**Dates corrected by the subtraction of 360±35 years, apparent age of estuarine shells accumulated in the Sado shellmiddens, acording to Soares (1989).
*** Average of the TL dates obtained by the Laboratory of the British Museum.