World Archaeological Congress 4

University of Cape Town

10th - 14th January 1999

Symposium: Human Developments: Ancient and Modern

Portugal 10,000 years ago: Human Ecology at the End of the Pleistocene

Nuno Ferreira Bicho
UCEH - Universidade do Algarve
Campus de Gambelas
8000 Faro
Portugal
nbicho@mozart.si.ualg.pt

Abstract
During the Late Pleistocene, Western Europe saw important transformations on the ecology of local hunter-gatherers. These transformations are marked by some variability. Portugal, located on the far edge of Southwestern Europe is one of the outliers of this variability. Unlike the traditional core areas of Upper Palaeolithic research, such as Southern France or Northern Spain, Portugal shows evidence for a continuum in human adaptation between c. 13,000 and 8,000 bp. During these 5 millennia, there was a fairly mild and temperate environment in Portugal due to the distance to the polar front, as well as to the proximity to the Mediterranean, North Africa and the Atlantic warm currents coming from the tropical band. Thus, Portugal was marked by a wide diversity of animal and vegetation species, that were fully exploited by the human population. Final Upper Palaeolithic hunter-gatherers in Portugal were then turning to an adaptive strategy that included a subsistence intensification, through both diversification and specialization, based on a highly mobile logistical pattern of settlement and land use.

Introduction
The Pleistocene-Holocene transition was a period of marked and severe changes in most European areas. These changes, both at the environmental and cultural levels, saw important oscillations, related respectively, and among others, to climatic, technological and social transformations. Though this is true in the so called core areas, such as Southwestern France, the events seem to have been rather different in

Central and Southern Portugal. Here climatic fluctuations were, apparently, not nearly as radical as in Central and Northern Europe. While during the Last Glacial Maximum (LGM), Northern Europe was completely abandoned by humans and most animal and vegetation species, Iberia was likely the refugia for a wide diversity of species. During the period of climatic amelioration from 16,000 to 10,000 bp, Southern Iberia saw the development of new technologies, social organization, and, in general, and like the rest or Europe, a demographic expansion, that changed the regional and local human groups. This change, however, and unlike what happened in Northern Europe, took place as a slow process, based on a wide range of variables that will be discussed in this paper. These include not only the paleoenvironment, but also technology, diet, settlement system, land use and human mobility patterns.

Paleoenvironment and Climate

During the LGM, Portugal was clearly influenced by the Polar front, located between 45° and 40° of latitude (Ruddiman and McIntyre 1981), marked by an extreme temperature gradient probably both on the sea and land surface temperatures. Temperatures indicated for the Portuguese coast during the LGM are between 6° and 9° C lower than at present (McIntyre and Kipp 1976; Ruddiman and McIntyre 1981). The sea level was lower than today, with -130 to -140 m below the present sea level in the North of Portugal (Dias 1985; Rodrigues et al. 1991). Geochemical evidence from Caldeirão cave, located in Central Portugal, indicates a continuous drop in the oceanic influence between 25,000 and 19,000 bp, suggesting a decrease in both westerly winds and humidity (Cruz 1990; Zilhão 1995).

Evidence for the process of deglaciation is clear in Portugal around 16,000 bp with a rise in sea level to -40 (Dias 1985) and in temperature since the Polar Front was located at around 45° latitude between 16,000 and 13,000 bp with a moderate to reduced outflow of meltwater and sea ice (Duplessy et al. 1992; Ruddiman and McIntyre 1981). It was probably during this phase that the diverse and abundant forests developed in Central and Southern Portugal, stabilizing by 12,000 bp. Charcoal remains dated to between 12,000 and 11,000 bp from different archaeological levels from Cabeço do Porto Marinho (CPM) show the presence of Atlantic and Mediterranean species of pine (Pinus pinea and Pinus pinaster), evergreen and deciduous oaks (Quercus ilex/suber), birch (Fraxinus angustofolia), wild strawberry tree (Arbutus unedo) and olive trees (Olea europaea/sylvestris) (Zilhão et al. 1996). This same scenario is confirmed by the microfauna at Caldeirão cave with the presence in the levels dated to between 16,000 and 10,000 bp of Apodemus sylvaticus, Eliomys quercinus and Terricola duodecimostatus, and the decrease in the cold adapted species (Microtus agrestis) (Póvoas et al. 1992). The land snails from the same level, with the presence of Oestophora barbula, Portugalla inchoata, and Cepaea nemoralis indicate a forested and humid area (Callapez 1992). The later was also confirmed by the geochemical analysis from the same site with a clear change in the ratio of sodium-potassium with the increase of the first (Zilhão 1995). This increase in humidity is likely to be related 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 after 13,000 bp (Ruddiman and McIntyre 1981). This regression of the cold factors to the north, made possible the development of the Mediterranean woods in Central and Southern Portugal. By 9,500 bp, the coastal sand dunes of southern Portugal were covered by pine (Mateus 1985; Mateus and Queiroz 1991), while the highlands of Central Portugal at Lagoa Comprida (1,600 m. a.s.l.) show the presence of pine (Pinus sylvestris), birch, olive and an important

increase in oak (Quercus) and decrease in pine after 9,000 bp (Janssen 1985; Janssen and Woldringh 1981).

The northern Portuguese coastline dropped to a -60 to -70m below modern sea level during the cold pick of the Dryas III (Dias 1985). Apparently, half of the temperature decrease (c. 8°C) of this event, happened within few decades and lasted just over 500 years (Berger 1990), with the Polar Front located again around 45° to 42° degrees of latitude north, around the Bay of Biscay. Dryas III may have, however, not been felt in the Central and Southern Portuguese vegetation, though there are no direct data on the event. After 10,000 bp, the Polar Front retreated far to the north and west, and the warm climatic conditions returned to Western Europe. Portugal saw an important decrease in area on the coastal platform with the sea level rising to -20 m. By 9,000 bp, the climatic and environmental conditions in Central and Southern Portugal were likely identical to those of today.

Faunal data, unlike other regions of Europe and what traditionally has been said for Portugal, does not bring any relevant information on climatic changes during the Pleistocene-Holocene transition. Data point to the boundary between the last Interpleniglacial or Oxygen Isotope Stage 3 and OIS 2 as the last important phase of faunal changes in Portugal. During the last 28,000 bp, the fauna present in both archaeological and paleontological sites is basically identical. The nuances in these assemblages are related to topography and distance from the coast, as well as hunting strategies and techniques rather than to climatic conditions. The main herbivore species were red deer, roe deer, wild boar, aurochs, some horse, ibex and chamois (Bicho 1997 and In Press a). Clearly the later two are related to rougher and higher terrains, as well as colder areas. They seem more important during the Solutrean occupation, though they did not disappear during the Tardiglacial. Traditionally, marine shell has also been used to diagnose cold to warm changes through the presence/absence of the Common Periwinkle (Littorina littorea) and its replacement by Top Shell (Monodonta lineata) (Straus 1995:13). Periwinkle, however, has been reported in different early Holocene archaeological sites in Southern Portugal (Arnaud 1986, 1993; Morales and Arnaud 1990, Soares and Silva 1993), and it is present today in Southern Portugal, in the warm waters of the Ria Formosa, in Atlantic Algarve (Bicho In Press a).

Cultural and Technological Framework

After the Solutrean, Portugal saw the development of the Magdalenian. This can now be divided in 4 phases, Early (16,000-15,000 bp), Middle (15,000-14,000? bp), Late (12,500-11,000 bp) and Terminal (11,000-9,000 bp) (Bicho 1994, 1998a). Magdalenian industries were slowly replaced by new Epipaleolithic assemblages that show some diversity across Portugal, with the increase in the use of macrolithic components added to the microlithic assemblages. Around 8,000 bp, a new technology is in place, based on microburin technique and microlithic geometrics with the full mesolithic economy (Bicho 1998b).

The solutrean foliate points were replaced by a much lighter and efficient set of weaponry types. These were the small pointed bladelets, marked by both backing and/or marginal retouch, such as Microgravettes, Malaurie, Istres, Sauveterre and Dufour bladelets (Bicho 1992, 1993, 1994; Marks et al. 1994). After 12,000 bp, there was a clear increase in the production of bladelets, as well as in the production of

points. These show a distinct pattern of size reduction, that changes only with the introduction of the mesolithic technology sometime after 8,500 bp (Bicho In Press b). These patterns (size reduction and increase in the production of bladelets and microlithic points) suggest not only a change in hunting techniques and strategies, but also in technology, reflecting the introduction of the bow and arrow, and the expansion of the use of composite tools, that were used instead of the bone harpoons, non-existent in Portugal.

Lithic reduction strategies were fairly standardized. The final product was flakes and bladelets. Sometimes different reduction sequences were used for each type of blank, while in some other cases, both types were extracted during core reduction. Change in flaking direction was very common, with the use of both opposed and multiplatform techniques. Though there were different reduction sequences for different raw materials (i.e., a reduction using a chopper and producing simple flakes was very common in quartzite, less common in quartz and extremely rare in flint), in most cases, the reduction sequence was identical for all raw materials. There was a change in the frequency in the use of quartz and quartzite through time, with a marked decrease in the use of these raw materials after 14,000 bp, from a 30% to a almost complete absence (Bicho 1998b). This change seems to be related to the change in technology mentioned above.

It seems that there was a preferred size and blank type used for different tools. While the largest flakes, marked by the presence of cortex on the dorsal surface were frequently used for the production of denticulates and notches, smaller but thicker flakes were used for bulky endscrapers and burins. These were then used as cores for the production of the marginally retouched Dufour bladelets. The smallest and thinnest flakes were used for thin endscrapers and burins, making most of the tool kit. Each one of these groups of blanks seem to be related to the 3 main phases of the reduction sequence - cortex removal, core shaping and flake production.

An expedient technology was used for quartz and quartzite, with very few retouched tools, unlike the flint that had a serious time investment in tool production with a very high ratio tool-core (Bicho In Press b). There is no evidence of serious curation procedures during this period in Portugal.

Subsistence Strategies and Land Use

Portuguese data on subsistence strategies are improving every year, with recent projects, excavations and publication of the results. Between 12,000 and 11,000 bp, the most important protein and fat source were the large herbivore species such as red deer, roe deer and wild boar. Aurochs, horse, ibex and chamois were also hunted, mostly in some areas and seasons, but likely they were never the main prey of the human population. In addition, and possibly in replacement in certain times of the year, small game was intensively used. The most important species was the rabbit, extensively hunted at Caldeirão and Picareiro caves. Also, birds and large amounts of fish were brought to Picareiro cave during this period (Bicho In Press a). After 10,000 bp, a series of shellmiddens were formed both in Central and Southern Portugal. These have large numbers of marine shell, including a variety of rocky and sandy areas, such as limpets, mussels, cockles, clams, oysters, scallops, brown venus, peppery furrow shell, razor shells, top shells, periwinkles, and whelks. Unlikely what one would expect, these large and packed shellmiddens, were formed not only on the

coastal areas, but also inland, where they appear in a cave (Papagaio - Arnaud and Bento 1989) and in 2 rock-shelters (Bocas and Pena de Mira - Bicho 1997).
Diet, most likely, also included some fruits, nuts and berries that were available near the sites. Though no direct evidence has been found so far, wood charcoal from oaks, pines, olive trees and wild strawberry trees were found in different levels at the archaeological site of CPM and pine at Picareiro. Confirming this idea is the presence of grinding stones as well as anvils as early as 16,000 bp at CPM.

In summary, 10,000 years ago the diet in Central and Southern Portugal was marked by a general pattern of subsistence intensification, similar to that of Northern Spain (Bicho 1994; Straus 1991 and 1996). This intensification was marked by both a diversification, that can be seen in the use of a wide variety of animal species from both terrestrial and marine environments, and a specialization (Bicho In Press b). The later is seen at the site of Bocas with aurochs and at Picareiro cave with rabbit and fish (Clupeidae).

Land use seems to have been fairly complex during the Pleistocene-Holocene transition in Portugal. This was probably a phase of great demographic expansion, marked by the introduction and consolidation of new technologies. In this context, Portugal was the stage for a dynamic process of adaptation, with the exploitation of all the available resources. Thus, after 12,000 bp, the human groups living in two areas of Central Portugal, quickly expanded to a variety of regions, that included Central and Southern Portugal. They intensified the exploitation of the highlands of the interior in Estremadura, while simultaneously used the flat plains of the coast, and the inland river valleys. Different types of shore were exploited, with the use of open and shallow estuaries as well as the open Atlantic sandy and rocky shores. These areas where chosen not only because of their protein and fat potential, but also, and possibly more important, the presence of lithic raw materials of great quality - flints, cherts, jaspers and chalcedony. The presence of these raw materials seem to be the main condition for site location, since all sites are within very few kilometers, always less than 10km, from these raw material sources.

The mobility pattern during this phase was a logistical one. Fairly large residential sites were located near important raw material sources, while small task sites were used both inland or on the coast, possibly seasonally, to take advantage of the diversity of resources. At these smaller sites, food resources were gathered, hunted or fished, and then brought to the larger residential sites. These hunter-gatherers, most likely had a perfect time and space map of the resources, including the raw material sources. This knowledge and the new bow and arrow technology, made possible a much lighter tool kit, that would allow to these small expeditionary task groups a higher degree of mobility, as well as a better capability of transportation of the exploited resources. Possibly, it was this high degree of mobility that made feasible the use of new regions during this phase of human cultural development.

Site Location and Settlement Pattern
During the Pleistocene-Holocene boundary, site location becomes more diverse than before. It seems that site location during the Terminal Magdalenian and Epipaleolithic (11,000-8,000 bp) followed the same general pattern of that of the Late Magdalenian. A significant change in settlement pattern happened only during the Atlantic phase already with a well established Mesolithic economy.

Different geo-ecological units were used during the Pleistocene-Holocene boundary. In Central Portugal, caves, rock-shelters and open air were use as sites in all areas. The most common site location was the low sandy flat plains, near or around small to medium inland and coastal river valleys. These sites are found at less than 100 m a.s.l., always near water lines and within a few kilometers from flint sources. These areas were likely to have been characterized by moderately to thick forest of pines, oaks, and birch, among others species.

A second group of sites in Central Portugal can be found in the low altitude limestone country, where steep river valleys are located between 80 and 150 meters a.s.l. Vegetation and animal communities were probably similar to those in the flat plains, except for the presence of chamois and ibex. Again, these sites are all within few kilometers from flint sources.

The third site location found in Central Portugal is the limestone highlands, where sites are rare and found above 400m a.s.l. The landscape was likely to have been fairly open, marked by concentrations of pine, birch and few oaks, while fauna was composed of red deer, caprids and wild boar. Flint sources have not been found in these areas. The sites located in this area seem to have been used only for specialized tasks, and corresponding to a short term occupations.

Data is still scarce for the southern region since only in 1997 a systematic research project has started. Sites have been found on the edge of high limestone cliffs overlooking the Atlantic sea. These cliffs are cut by steep river valleys, where sites have not been found, except in their open, flat areas. The coastal dunes where also chosen for site location, while no occupation has been found in caves. Finally, another site location seems to have been near fresh water lakes, located at c. 140 meters above sea level. These lakes are within 2 kilometers of the Atlantic coast, and at less than 10 km from flint sources.

The number of sites is extremely high during the Pleistocene-Holocene transition. In fact, there are only 7 sites dated between 12,500 and 11,000 bp, while there are 24 sites dated between 11,000 and 9,000 bp. This number seems not to have increased much during the Atlantic period, although site location becomes completely different. With the Mesolithic, the preferred site location in Central Portugal was the wide estuaries of major river valleys, such as the Tagus and Sado. In the south, however, site location was mostly the bottom of steep river valleys that run to the Atlantic on the west coast of Alentejo and Algarve.

Conclusions

Central and Southern Portugal was marked by important changes 10,000 years ago. These changes occurred at different levels of the hunter-gatherer lifeways, starting after the Last Glacial Maximum. While rapid and dramatic changes seem to have characterized the Solutrean (Zilhão 1995), the cultural adaptations during the Tardiglacial and Early Holocene were marked by a slow process. This was likely to have been the result of both climatic and paleoenvironmental characteristics of Southwestern Iberia, as much as the introduction of new technologies. The most important new technology was the use of the bow and arrow, likely related to the increase in the use of flint-like raw materials, in bladelet production and in microlithic

point production. This new technological complex, allowed a change in mobility patterns, with a diversified and probably seasonally use of the food resources. The subsistence trend was then one of intensification through specialization and diversification. The later was certainly related to the high degree of mobility of the hunter-gatherer groups that started to spread in Central and Southern Portugal. With this mobility pattern and the exploitation of wide diversity of animal and plant resources, Portugal saw a demographic expansion. This expansion was probably the cause for the use of a wide diversity of areas and regions, both inland and coastal. From the economic point of view, this process seems very different from the Mesolithic economy that was established in Portugal during the Atlantic phase. Apparently, the Portuguese Mesolithic developed from the local Epipaleolithic communities, with the local development of the microburin technique and the increase in the use of standardized microlithic geometrics between 8,500 and 8,000 bp (Bicho In Press), but with a radical change in settlement system and land use. This change was certainly a consequence of the climatic and paleoenvironmental changes that occurred in Portugal with the Postglacial Optimum after 8,000 bp.

Acknowledgements: I wish to thank Fundação para a Ciência e Tecnologia (Grant PCSH/HAR/H/70/96) , Fundação Calouste Gulbenkian (travel grant) and Instituto Português de Arqueologia for the work at Picareiro Cave.

Bibliography

Arnaud, J.
1986. Post-Glacial Adaptations in Southern Portugal. World Archaeological Congress, Southampton, 1986. (preprint).
1993. O Mesolítico e a neolitização. Balanço e perspectivas, in O Quaternário em Portugal: balanços e perspectivas. Edited by G.S. Carvalho, A.B. Ferreira, and J.C. Senna-Martinez, pp. 173-184. Edições Colibri, Lisboa.
Arnaud, J. and J.D.B. Bento.
1988. Caracterização da Ocupação Pré-Histórica da Gruta do Casal Papagaio (Fátima, Vila Nova de Ourém). Boletim da Sociedade Portuguesa de Espeleologia 2:27-34.
Berger, W.
1990. The Younger Dryas Cold Spell - A Quest for Causes. Palaeogeography, Palaeoclimatology, Palaeoecology, 89:219-237.
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.
1993. Late Glacial prehistory of central and southern Portugal. Antiquity 67:761-775.
1994. The end of the Paleolithic and the Mesolithic in Portugal. Current Anthropology 35:664-674.
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 d¹Investigaciones Arqueològiques, Girona.
1998a. Paleolithic Occupation and Environment of Central and Southern Portugal during Isotopic Stages 2 and 3. Paper presented at INQUA Workshop on European Late Pleistocene Isotopic Stages 2& 3, Leuven, Belgium.
1998b. Pleistocene-Holocene Transition in Portuguese Prehistory: a technological perspective. In The Organization of Lithic Technology in Late Glacial and Early Postglacial Europe, ed. Sarah Milliken, pp.39-62. BAR 700.

In Press a. 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.
In Press b. Lithic raw material and hunter-gatherer mobility in the late Glacial and Early Postglacial in Portuguese Prehistory, in Lithic Raw Material Economy in late Glacial and Early Postglacial Western Europe. Edited by L. Fischer and B Eriksen.
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.
Cruz, A.J.
1990. A Influência Atlântica mo Clima da Estremadura Portuguesa Durante o Paleolítico Superior: os resultados geoquímicos da Gruta do Caldeirão. Finisterra, 25 (49):156-168.
Dias, J.M.A.
1985. "Registos de migração da linha de costa nos últimos 18000 anos na plataforma continental portuguesa setentrional," in Actas da I Reunião do Quaternário Ibérico. Vol. I, pp.281-295. Lisboa.
Duplessy, J.C., L. Labeyrie, M. Arnold, M. Paterne, J. Duprat, and T.C.E. Van Weering
1992. Changes in surface salinity of North Atlantic Ocean during the Last deglaciation. Nature 358:485-488.
Janssen, C.
1985. "História da vegetação," in Glaciação da Serra da Estrela: aspectos do Quaternário da Orla Atlântica. Livro Guia da pré-reunião do I Congresso do Quaternário Ibérico. Edited by S. Daveau, pp. 66-72. Lisbon.
Janssen, C. and R. Woldringh.
1981. A preliminary radiocarbon dated pollen sequence from the Serra da Estrela, Portugal. Finisterra 16:299-309.
McIntyre, A. and N. Kipp
1976. Glacial North Atlantic 18,000 years ago: a CLIMAP Reconstruction," in Investigation of Late Quaternary paleooceanography and paleoclimatology. Edited by R. Cline and J. Hays, pp. 43-76. Geological Society of America, Memoir 145.
Marks, A.E., J. Zilhão, N. Bicho, and R. Ferring.
1994. Upper Paleolithic Prehistory in Portuguese Estremadura: preliminary results. Journal of Field Archaeology.21:53-68.
Mateus, J. E.
1985. The coastal lagoon region near Carvalhal during the Holocene; some geomorphological aspects derived from a palaecological study at Lagoa Travessa, in Actas da I Reunião do Quaternário Ibérico, Vol. 2, pp. 237-249. Lisbon.
Mateus J.E. and P. Queiroz.
1991. Holocene Paleoecology of the north-littoral of Alentejo. International Paleoecological Excursion. Lisbon
Morales, M.G. and J. Arnaud. 1990. Recent Research on the Mesolithic in the Iberian Peninsula: Problems and Perpectives, in Contributions to the Mesolithic in Europe. Edited by P.M. Vermeersch and P. Van Peer, pp. 451-462. Leuven University Press, Leuven.
Póvoas, L., J. Zilhão, J. Chaline, and P. Brunet-Lecomte.
1992. La Faune de Rongeurs du Pleistocene Superieur de la Grotte de Caldeirão (Tomar, Portugal). Quaternaire 3 (1):40-47.

Rodrigues, A., F. Magalhães and J.A. Dias
1991 Evolution of the Portuguese Coast in the Last 18,000 Years. Quaternary International, 9:67-74.
Ruddiman, W. and A. McIntyre
1981. The north Atlantic Ocean during the Last Deglaciation. Palaeogeography, Palaeoclimatology, Palaeoecology 35:145-214.
Soares, J. and C.T. Silva.
1993. Marisqueio na Pedra do Patacho. Almadan serie II 2:21-29.
Straus, L.G.
1991. Southwestern Europe at the Last Glacial Maximum. Current Anthropology 32 (2):189-199.
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.
1996. The Arhcaeology of the Pleistocene-Holocene Transition in Southwest Europe. In Humans at the End of the Ice Age. Editors L. Straus, B. Eriksen, J. Erlandson and D. Yesner, pp. 83-99. Plenum Press.
Zilhão, J.
1995. O Paleolítico Superior da Estremadura Portuguesa. Ph.D. Dissertation, Faculdade de Letras, Universidade Clássica de Lisboa.
Zilhão. L., A. Marks, C.R. Ferring, N.F. Bicho and I. Figueiral
1996. The Upper Paleolithic of the Rio Maior basin (Portugal) Preliminary results of a 1987-1993 Portuguese-American research project. Trabalhos de Antropologia e Etnologia, 35(4):69-88.