[*Journal of Mediterranean Archaeology* 6/1 (1993) 5-63]

The Spread of Agro-Pastoral Economies across Mediterranean Europe: A View from the Far West

João Zilhão
Instituto de Arqueologia, Faculdade de Letras de Lisboa,
1699 Lisboa Codex, Portugal

Abstract

The transition to food production in Portugal begins with the arrival of cardial pottery and domesticates, an event that can be dated to the time period between 6800 and 6200 BP. These items are found in sites located in the northern part of Estremadura. Contemporaneous hunter-gatherer adaptations are known to have continued their development up to c. 6000 BP in areas located further south, centered in the inner part of the estuaries of the rivers Tejo, Sado and Mira. This pattern is interpreted as indicating that the onset of agro-pastoral economies is linked to the arrival of small groups of settlers that, through interaction with local hunters, are at the origins of the subsequent expansion (completed about one thousand years later) of those economies to the rest of the Portuguese territory. The archaeological evidence from southern Spain and southern France commonly invoked by proponents of models of the transition to food production as the result of the domestication of local resources or of the acquisition of novel resources by local hunters through long-distance exchange systems is shown to be flawed. Severe disturbances at the Mesolithic/Neolithic interface of the stratigraphic sequences upon which such models are based—sometimes not recognized by the excavators, but documented either by subsequent work or by critical evaluation of the site reports—can be shown to have occurred. Such disturbances would account well for the radiocarbon dates between 8000 and 7000 BP obtained at some of those sites, as well as for the presence of sheep bones in their pre-Neolithic strata.

Introduction

For the past twenty years, most archaeologists writing about the appearance of farming economies in west Mediterranean Europe have interpreted the available data as suggesting it was the outcome of a long transition process. According to the French evidence, this transition would have begun with the slow and gradual introduction of domesticates in the local Mesolithic subsistence systems, giving rise to a mixed economy where foraging and mobility maintained an important role for more than one thousand years, up to the appearance of stable sedentary villages in the Middle Neolithic (Guilaine 1976; Zvelebil 1986a; Zvelebil 1986b). Recently, however, it has become clear that several taphonomic and chronometric problems may to a certain extent account for the way this evidence is currently perceived.

In Southern France, for instance, at least two types of biases may be affecting the scarcity of village sites in the Early Neolithic of the region: drowning of the littoral plain by the Flandrian transgression (Guilaine *et al.* 1984), and preferential excavation of cave and rock-shelter sites presumably utilized for focalized activities (hunting and herding) that were, however, part of a broader settlement-subsistence system based on agriculture, the latter not being reflected in the remains preserved at those sites (Binder and Courtin 1986). On the other hand, the notion of a long transition is based on the acceptance of ^{14}C dates that would make the Neolithic begin as early as 8000 BP. In France, however, a consensus has recently been reached that there is no Early Neolithic there before c. 6800 BP (Guilaine 1980; Evin 1987), which would make the length of the transition more in line with the patterns from elsewhere in Europe. In southern and eastern Spain, the situation is more complicated, given the fact that several archaeologists have been claiming dates between 7000 and 8000 BP for Early Neolithic levels containing non-cardial impressed wares excavated in a series of cave and rock-shelter sites, such as Cueva de la Dehesilla, Cova Fosca and Cueva de Nerja (Acosta 1987; Acosta and Pellicer 1990; Olaria 1988; Olaria and Gusi 1987; Pellicer 1987). But others (Bernabeu 1989; Fortea and Martí 1984-85; Martí *et al.* 1987) disregard these dates on several grounds, and maintain that in Spain, as well as in France, cardial wares are the earliest Neolithic, and date to c. 6800 BP, as suggested by the evidence from several stratigraphic sequences, particularly that from Cova de l'Or.

Recent research in Portugal has provided new data of relevance to these issues (Zilhão 1990; 1992). In this paper, I will present this evidence, discuss it in the light of the Iberian data, and address its implications for the understanding of the process of neolithization on a continental scale.

The Late Mesolithic in Portugal

The 1980s were a time of considerable development in the study of the Portuguese Late Mesolithic (7500–6000 BP), recently summarized by González Morales and Arnaud (1990): new analyses of the famous Muge skeletal collections have been undertaken (Lubell and Jackes 1985; 1988; Lubell *et al.* 1986); the Sado middens, found and excavated thirty to forty years ago, but essentially unpublished since then, were the object of new studies, including further excavation (Arnaud 1982; 1987; 1989; 1990); and new sites, such as Castelejo (Silva 1989), Fiais (González Morales and Arnaud 1990) and Vidigal (Straus *et al.* 1990), have been investigated along the coasts of the Alentejo and the Algarve.

Central Portugal

As regards central Portugal, the picture that emerges from these studies is that of an essentially estuarine settlement, where aquatic resources played a key role in subsistence. Stable isotope analyses of the Muge skeletons suggest a diet evenly balanced between terrestrial and aquatic resources (Lubell and Jackes 1988). The fauna recovered from the middens is consistent with this, since it includes remains of shellfish, crustaceans, fish, land snails, and small and large mammals (lagomorphs, wild boar, red deer and aurochs). According to Lentacker (quoted in Lubell and Jackes 1988), some seasonal activities are documented in these faunal remains, but the overall impression derived from their study is that of a year-round occupation. The fact that the middens were also used as burial grounds (some 300 skeletons have been excavated there) can also be taken to suggest that the Muge sites were the object of a rather permanent settlement. The size of the mounds (several meters high and about 100m across, making up several thousand cubic meters of deposits) and the habitation features (post holes, pits) found at the basal levels of Moita do Sebastião (Roche 1977), below the midden, also

document a prolonged, if not sedentary, use of these sites.

The Muge sites are distributed north–south along some 30 km of the lower Tejo valley, and all of them are situated on the margins of small tributaries that flow into the Tejo from the east. But the territories exploited by the inhabitants of Muge must have included areas west of the river as well, since flint, the raw material used in the manufacture of their lithic tools, is only available in those areas. More than just the procurement of flint must have been involved, however, as is demonstrated by the site of Forno da Telha, near Rio Maior (Heleno 1956; M.N.A.E. 1989). This site contained a large lithic assemblage, associated with a few faunal remains (mammal bones and mollusk shells). It probably represents a specialized camp, perhaps seasonally occupied, documenting the exploitation of the interior resources (forest foods, flint) by the riverine settlers of Muge. A radiocarbon date of c. 7000 BP was recently obtained for this site (Araújo n.d.), demonstrating its contemporaneity with one of the Muge sites, Cabeço da Amoreira. The latter is in fact dated to 7030 ± 350 BP (Sa-195) (Roche 1977), and it contained large amounts of characteristic spined triangles that are also well represented at Forno da Telha.

No Late Mesolithic coastal sites have so far been found in central Portugal—a marked contrast with the Preboreal and Boreal Mesolithic site distribution patterns (Fig. 1). Since the same site-types (shell-middens) have been found in both areas and in similar topographic locations, it does not seem possible to explain away as the result of biases in the archaeological record the fact that they are all Early Mesolithic on the coast and all Late Mesolithic in the Tejo basin. On the other hand, from the point of view of size, all the earlier sites so far known are on a totally different, much smaller scale, when compared to those dating from the Atlantic. This, in conjunction with the above, suggests that the rise in sea level created a set of ecological conditions, not present before, for the development of a more territorial system centered in the exploitation of the then-enlarged estuary of the Tejo. It cannot be excluded that other poles of Late Mesolithic settlement existed in the littoral region between the Mondego and the Tejo, but after more than one hundred years of research no other Late Mesolithic sites have been found outside the areas immediately surrounding the inner estuary of the latter. For the moment, therefore, the hypothesis of the occurrence in the Late Mesolithic of a global reorientation of settlement-subsistence strategies,

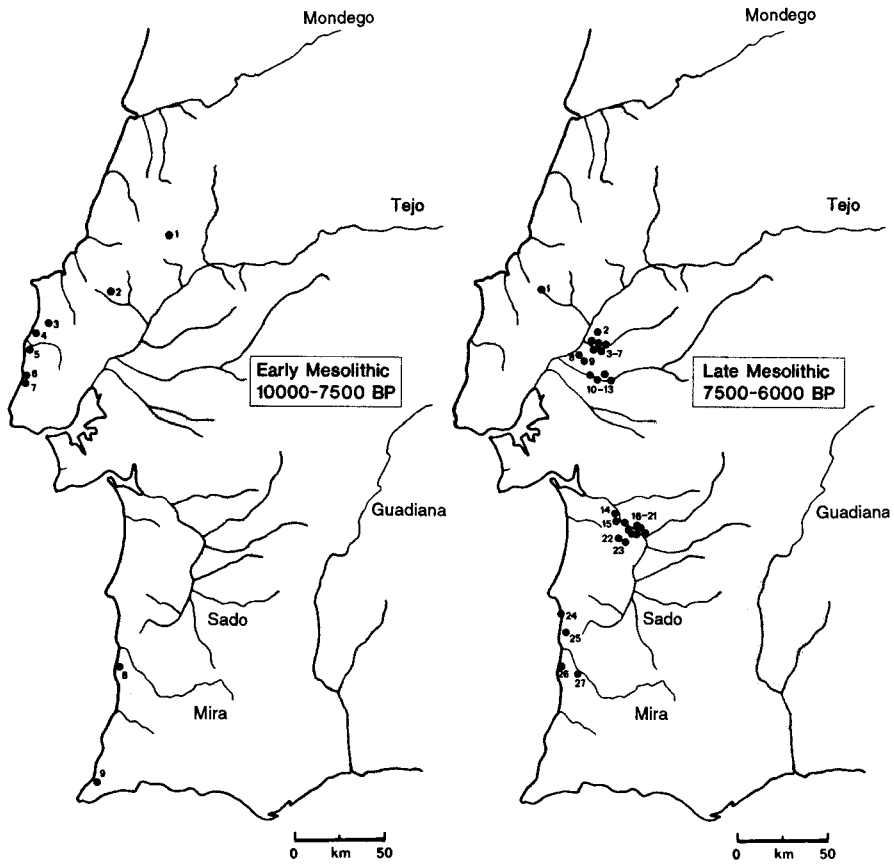


Fig. 1. Spatial distribution of Portuguese Early and Late Mesolithic sites. *Early Mesolithic* (radiocarbon-dated sites only): 1- Gruta do Casal Papagaio; 2 - Areeiro III; 3 - Toledo; 4 - Ponta da Vigia; 5 - Cabeço do Curral Velho; 6 - São Julião; 7 - Magoito; 8 - Palheirões do Alegra; 9 - Castelejo. *Late Mesolithic*: 1 - Forno da Telha; 2 - Fonte da Moça; 3-7 - Muge sites (including Moita do Sebastião, Cabeço da Amoreira and Cabeço da Arruda); 8 - Cabeço dos Ossos/Cova da Onça; 9-13 - Magos sites; 14 - Arapouco; 15 - Cabeço do Rebolador; 16-21 - Várzea da Mó, Vale de Romeiras, Barrada do Grilo, Cabeço do Pez, Barrada das Vieiras, Amoreiras; 22 - Poças de São Bento; 23 - Barranco da Moura; 24 - Samouqueira; 25 - Vidigal; 26 - Medo Tojeiro; 27 - Fiais. (After Arnaud 1982; 1989; 1990).

involving population packing along the lower Tejo valley and a logistical exploitation of territories formerly occupied by smaller social units in the framework of a more foraging-oriented economy, seems to be the explanation that best fits the available evidence.

The oldest date so far obtained for the Muge sites comes from a Moita skeleton: 7240 ± 70 BP (TO-131) (Lubell and Jackes 1988). The most recent one, for a charcoal sample from Cabeço da Arruda, is 5150 ± 300 BP (Sa-196) (Roche 1977), but it should be disregarded on several grounds, mainly the uncertainties concerning the stratigraphic provenience of the sample (see discussion in Soares and Cabral 1984: 208-10). Another charcoal date—6050 ± 300 BP (Sa-194) (Roche 1977)—was obtained for the upper part of Cabeço da Amoreira, but the most recent of the dated skeletons, from Cabeço da Arruda, has an age of 6360 ± 80 BP (Lubell and Jackes 1988). Based on this evidence, the establishment of this estuarine adaptation should be set at around 7300 BP, and its end about one thousand years later, sometime around 6300 BP. However, one should bear in mind that photographs from the 19th-century excavations document that even the burials located higher up in the stratigraphy were still overlain by at least one meter of midden-fill. This suggests that the accumulation of the middens continued well after the most recent skeleton dates. These, in turn, given the stable isotope data for the human bone, are probably partially affected by the reservoir effect: that is, the real radiocarbon age of the skeletons is inferior (probably by at least a hundred years) to that indicated by the raw results (H. Schwarcz, personal communication).

Southern Portugal

A cluster of several shell-middens spread along some 30 km of the inner estuary of the Sado river was found and excavated in the late 1950s and early 1960s. Whereas the different Muge sites seem to resemble each other a lot in terms of the activities carried out there and of the food remains accumulated in the mounds, the Sado sites are highly variable in composition (Arnaud 1987; 1989). Those that are situated closer to the mouth of the river, such as Arapouco, are rich in fish remains and have few mammal bones, but those further inland, such as Cabeço do Pez, are very rich in mammal bones, mostly red deer and wild boar. On the other hand, oxygen isotope analyses of shells from these middens showed autumn and winter collection at all the

sites (Deith, quoted in Arnaud 1990), thus invalidating the possibility of interpreting them as seasonal occupations taking place in the context of a single, highly mobile settlement system. Arnaud (1989) therefore suggests that this pattern can be interpreted as the archaeological image of a collector settlement-subsistence system, with sites like Cabeço do Pez functioning as base-camps, and sites like Arapouco as specialized camps occupied in the framework of the procurement of certain resources. This interpretation is reinforced by the fact that over one hundred burials have been found in the Sado middens, which can be taken to suggest that the same trend towards a more territorial and more sedentary settlement identified in the Muge sites was also in operation in the Sado valley. Comparisons with the pre-Atlantic Mesolithic of the area are not possible at the moment, however, due to the fact that no sites dating to the Preboreal or the Boreal have so far been found there.

Several radiocarbon dates have been obtained for these sites, most of them from shell samples. These dates must be corrected for the apparent age of the shells (a consequence of the reservoir effect), which has been estimated at about 360 years (Soares 1989; Soares and Cabral 1989); after this correction, the dates indicate that the sites were formed between c. 7000 and c. 6000 BP. In some of them, such as Cabeço do Pez, sherds of non-cardial impressed wares have been reported to be part of the recovered artifact assemblages (Santos *et al.* 1974). However, Arnaud's new excavations have shown that these sherds can only be found in the deposits that overlie the midden levels. The only instance where a few were found *in situ* inside the midden was at Amoreiras. Here, however, the corresponding levels were dated to c. 6000 BP.

A third area of important Late Mesolithic settlement is the estuary of the Mira, where a large shell-midden was identified in 1983 at the site of Fiais, some 20 km inland from the mouth of the river, in the inner part of what was its estuary in the Atlantic—a pattern similar to that already seen in the Tejo and the Sado. Excavations carried out here by Arnaud and Lubell (1986), and by Arnaud (1987–89), have established that the site has an area of more than 1000 sqm, and contains several functionally differentiated areas, including a vast butchering zone. The food remains include large mammal bones (red deer, wild boar, aurochs), fish bones and shells of marine and estuarine mollusks. The seasonal indicators present in the fauna, studied by P. Rowley-Conwy, suggest that the site was occupied year-round.

It is interpreted by Arnaud as a base camp, permanently occupied by a social unit that, as in the Sado, also used other sites in a complementary way. Several radiocarbon dates have been obtained for this site, showing that it was used between 7010 ± 70 BP (TO-806; date on charcoal) and 6180 ± 110 BP (ICEN-141; date on bone) (González-Morales and Arnaud 1990).

According to these authors, one of the complementary sites probably connected with the settlement system based at Fiais is the shell-midden of Vidigal (Straus *et al.* 1990), situated some 30 km to the north. The dates so far obtained for this site—6640 ± 90 BP (Ly-4695) and 6030 ± 180 BP (GX-14557), both on bone—do show a broad contemporaneity with Fiais. The range of resources exploited here however was narrower, since, at least in the area that was excavated, mammal bones are fewer and most of the faunal remains are made up of mollusk shells. Another site that might be part of the same system is that of Samouqueira (Lubell and Jackes 1985; 1988), which, in spite of the disturbed character of the deposits, contained a skeleton associated with wild food resources only, for which an accelerator radiocarbon date of 6370 ± 70 BP (TO-130) was obtained.

Other smaller sites are also known along the southern part of the Portuguese western coast, such as Vale Marim (Silva and Soares 1981), Medo Tojeiro (Silva *et al.* 1985) and Castelejo (Silva 1989). Of these, the only one with a secure chronology is Castelejo. A first result obtained on shells collected from the midden before excavation indicated an age of 8220 ± 120 BP (BM-2276R) (Bowman *et al.* 1990) which, after accounting for the reservoir effect, translates into c. 7850 BP. The middle levels of the midden (described as Mesolithic, and said to be overlain by Early Neolithic deposits) are dated on charcoal collected during excavation to 7450 ± 90 BP (Beta-2908), at the Boreal/Atlantic interface. It is not yet known whether this site was also occupied during the 7500–6000 BP time period, in which case it might represent the only instance known of a fourth, southernmost, cluster of sites along the western coast of Iberia. However, the composition of the midden (limpets and mussels), its location, and the available radiocarbon dates, all suggest that this site is more likely related to the above-mentioned pre-Atlantic pattern of coastal sites produced in the framework of a highly mobile settlement system already identified in central Portugal. That such a system may have been in operation in the Alentejo as well is also indicated by

the distribution of the sites attributed to the Mirian, a technocomplex that has recently been dated to c. 8500 BP at Palheirões do Alegra (Raposo *et al.* n.d.).

Summary and Pattern

Fig. 1 shows very clearly that all the Late Mesolithic sites so far known in Portugal are clustered in three evenly-spaced nuclei situated along the inner estuaries of the Tejo, the Sado and the Mira, separated by empty areas where no sites are known. Judging from the raw materials utilized in the manufacture of stone tools in these three areas, they represent separate settlement systems exploiting only the locally available geological resources. One can therefore hypothesize that we are dealing here with three distinct social or ethnic units that nonetheless shared a common adaptation, based on the exploitation of estuarine resources through similar logistically-organized procurement strategies, possibly based on permanent camps. This represented a marked shift from the earlier pattern of more mobile settlement and smaller group size inferred from the much smaller size and lower density of finds that characterize the Boreal and Preboreal sites of central and southern Portugal.

Nothing is known of the Mesolithic settlement of the northern part of the country, or of the interior lands, if it existed at all. Although biases in the evidence cannot be excluded, these areas have been the object of archaeological survey, and the possibility therefore exists that the negative evidence so far collected is a true reflection of the non-occupation of those parts of Portugal during the Late Mesolithic.

From the chronological point of view, the contemporaneity between the estuarine adaptations of these three areas seems to be well established. It would seem, however, that, south of the Tejo, the Mesolithic way of life lasted for a few hundred years more, up to c. 6000 BP, while further north it probably had already come to an end by c. 6200 or 6300 BP (see below, Table 2 and Fig. 10). Yet when it comes to defining the absolute temporal limits of these adaptations, one should bear in mind that the vast majority of the available radiocarbon evidence is based on bone and shell samples, and that their comparability with charcoal dates must therefore be the object of careful discussion before both kinds of dates are used to derive patterns of change through time and or between regions.

The Early Neolithic in Portugal: Research History and Models for the Transition to Farming

Until twenty years ago, the Early Neolithic of Portugal was known only through the identification of diagnostic pottery sherds in assemblages coming from surface collections or from cave excavations that had failed to recognize and isolate the appropriate stratigraphic contexts. Based on this poor evidence, Guilaine and Ferreira (1970) were nonetheless able to conclude that in Portugal, as also in the rest of west Mediterranean Europe, it was possible to discriminate the existence of two archaeological stages in the development of Early Neolithic material culture: an earlier one, characterized by cardial wares, and a later one, the *horizonte da Furninha*, characterized by different kinds of non-cardial impressed and incised wares.

During the 1970s, several open-air sites were identified and excavated in the Sines area by Silva and Soares, namely Vale Pincel, Vale Vistoso and Salema (Silva and Soares 1981; 1987). Stratigraphic observations made at Vale Pincel suggested to these authors that the Early Neolithic in the Sines area could also be divided into two stages, as in Guilaine and Ferreira's model. Here, however, the initial stage (represented only by what the authors considered to be a 'lower level' of the single archaeological layer excavated at Vale Pincel), seemed to contain very little cardial pottery, setting this region apart from the patterns identified in central Portugal, southern France and eastern Spain. Therefore, Silva and Soares sought an integration of the Sines settlers in a different cultural tradition, contemporaneous with the cardial, and also characterized by impressed wares, but of a different nature. The existence of such a tradition was by then being put forward by several Spanish researchers (see above), for whom it represented the archaeological manifestation of an entirely local transition to the Neolithic. No absolute dates for the Sines sites have so far been published, but according to Silva (personal communication), a recently obtained date on charcoal would support the suggestion that the first occupation of Vale Pincel was contemporaneous with the earliest cardial sites of the west Mediterranean.

The discovery of these sites, located very close to the Sado cluster of Mesolithic middens, led Arnaud (1982) to discuss their possible relations. In his *Model A*, the Sines sites were related to colonization by small groups of

seafaring settlers, which would have established an agricultural economy in a territory that was not exploited by the aboriginal contemporary Mesolithic groups of the Sado. These would have been absorbed into the new economic system at a later stage, after demographic growth had led the farmers into a process of territorial expansion, the presence of pottery in the levels overlying the middens being the archaeological correlate of such an absorption. In *Model B*, the Sines area was considered to be part of the territory of the same Mesolithic group that exploited the estuary of the Sado. At a certain point this group would have acquired pottery and agriculture through exchange, and settled more permanently in the Sines area, exploiting the Sado valley only in a more specialized, seasonal, way, archaeologically manifested in the sherds abandoned on top of the middens accumulated during the previous phase. Evaluation and testing of these models has proven to be a difficult task, however, given the absence of good chronological control for the Sines sites, the non-preservation there of faunal or plant remains, and the fact that the few other sites also attributed to the Neolithic side of the transition known in southern Portugal suffer from similar problems (see below).

Fortunately, this is not the case in central Portugal, where excavations carried out between 1979 and 1988 at Gruta do Caldeirão (Tomar) exposed a c. 6 m deep stratigraphic sequence, spanning the last 50,000 years and including Early Neolithic levels that contained artifactual, faunal and human osteological evidence in a securely dated context (Zilhão 1990; 1992). Given the key role that, in the above-mentioned circumstances, this site necessarily plays in the discussion of the Mesolithic to Neolithic transition in Portugal, it will now be presented in more detail.

The Cave Site of Gruta do Caldeirão

The site is situated at about 120 m above sea level, dominating a small valley at the bottom of which a temporary stream flows into the Nabão, the subtributary of the Tejo which cuts the small limestone plateau where the cave is located. It consists of a narrow meandering gallery where excavations were undertaken in three different areas: outside the entrance; squares K/O-13/15 (the corridor); and squares N/S-8/15 (the back chamber). It was only in the

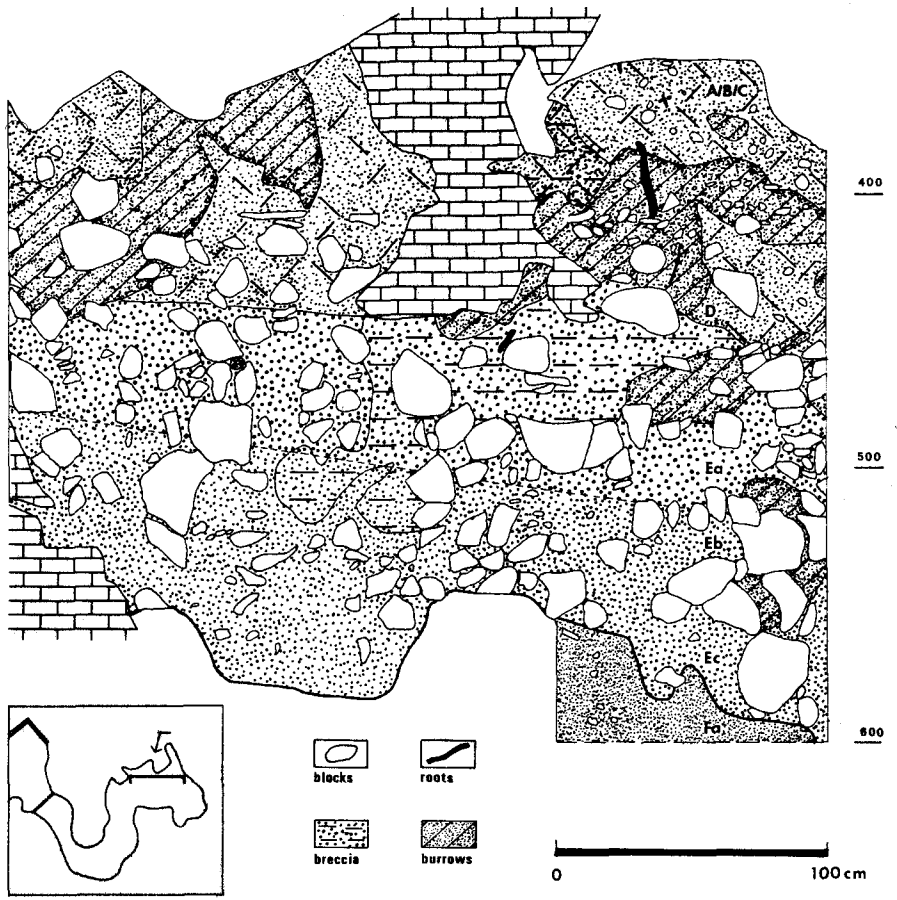
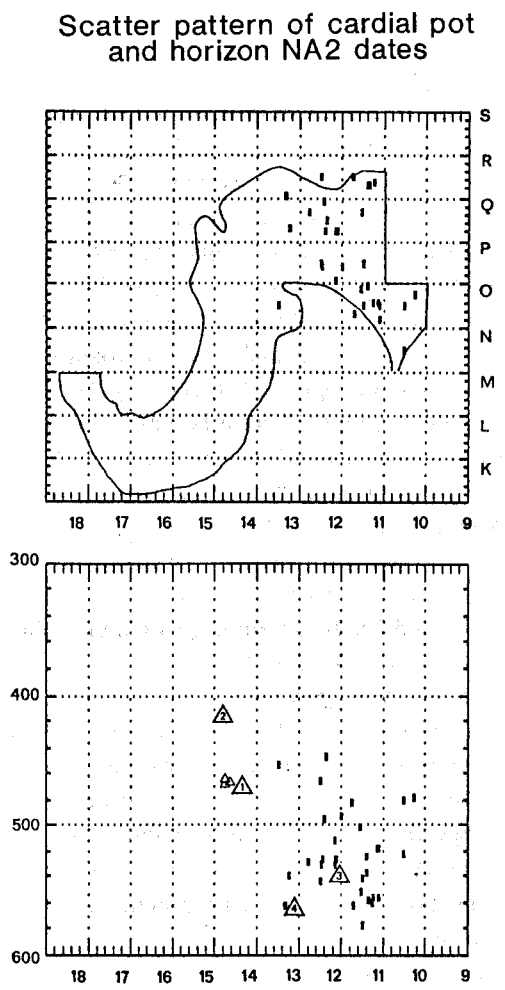


Fig. 2. Gruta do Caldeirão: stratigraphic profile in squares R11-13. Note the marked discontinuity at the top of layer Fa, which dates to the Upper Solutrean. Early Neolithic materials were found in layers Eb and Ea.

latter two that remains from the Early Neolithic occupations of the cave were present.

The Early Neolithic remains were contained in the upper part of the sequence (Figs. 2 and 3), deposited during the last 16,000 years and separated from the underlying levels by a marked discontinuity (Fig. 2). Several stratigraphic units were discriminated inside this first block of deposits: layers A/B/C, D, Ea, Eb and Ec. At the top, layers A/B/C and D—two loose dark brown units, highly disturbed by roots and large burrowing animals—contained archaeological remains from the Copper, Bronze and Iron Ages, as well as from Roman and medieval times. Below layers A/B/C-D there was, in the back chamber, a layer of *éboulis*, which contained human remains associated with non-cardial impressed wares (Fig. 4): layer Ea. This unit thinned out towards the corridor, where it became impossible to differentiate from the unit that underlay it (layer Eb) in the back chamber. As a result, there was, in the corridor, a direct contact between layers A/B/C-D and Eb. Blocks were also present in Eb and Ec, packed in a brown-red sandy matrix that contained artifactual and faunal materials of Upper Paleolithic (Magdalenian) appearance (see below), mixed up with an Early Neolithic funerary context defined by an assemblage of human bones and several sherds of a cardial decorated pot (Fig. 5).

This stratigraphic pattern suggests that there was a hiatus in deposition at the end of the last glacial period. Since no Mesolithic-type artifacts were found in the cave deposits, it follows that the first post-glacial occupation was that of the cardial burials. Therefore, these took place over a surface formed by the sediments deposited in Late Upper Paleolithic times (layer Eb), which explains (through human activities and natural bioturbation, namely by burrowing animals) the presence in this stratigraphic unit of the above-mentioned intrusive Neolithic items. Subsequently, roof collapses connected with the development of the chimneys that exist in the back chamber produced the accumulation of the large boulders that make up the bulk of layer Ea. Deposition of fine exogenous sediments, resulting in the formation of layer A/B/C, therefore does not seem to have resumed until post-Neolithic times. This inference is supported by the geochemical study of the sediments (Cruz 1992a) and by the analysis of the malacofaunas they contain (Callapez 1992). These data suggest that massive forest clearance, resulting in the erosion of



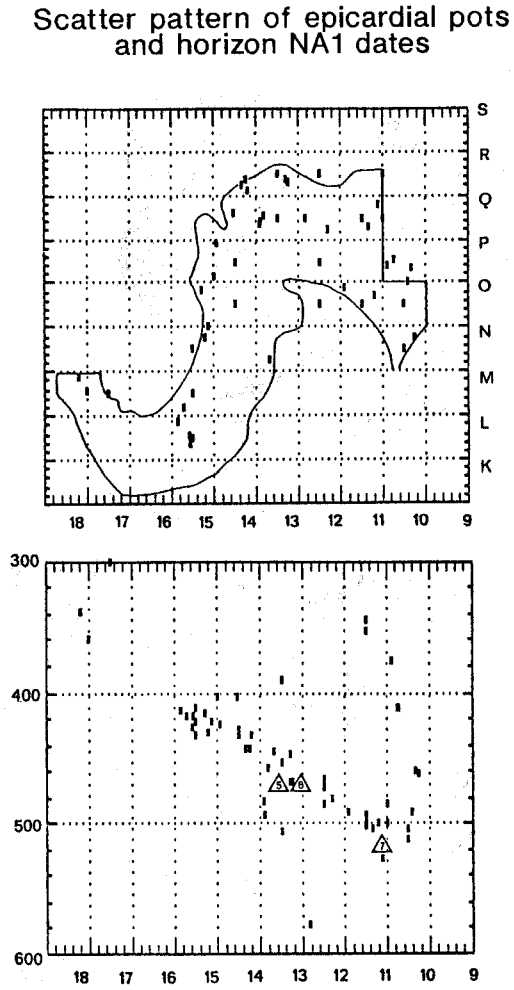


Fig. 3. Gruta do Caldeirão: horizontal and vertical scatter plots of the cardial pot from horizon NA2 and of the decorated epicardial pots of horizon NA1. Note that in spite of post-depositional vertical and horizontal spread, sherds belonging to the former are clearly clustered below those belonging to the latter. The numbered triangles in the vertical scatter plots represent the position of radiocarbon samples: 1 - ICEN-296; 2 - OxA-1035; 3 - OxA-1033; 4 - OxA-1034; 5 - OxA-1036; 6 - OxA-1037; 7 - TO-350. The small triangles in the vertical scatter pattern of the cardial pot represent the three sherds associated with the ICEN-296 date.

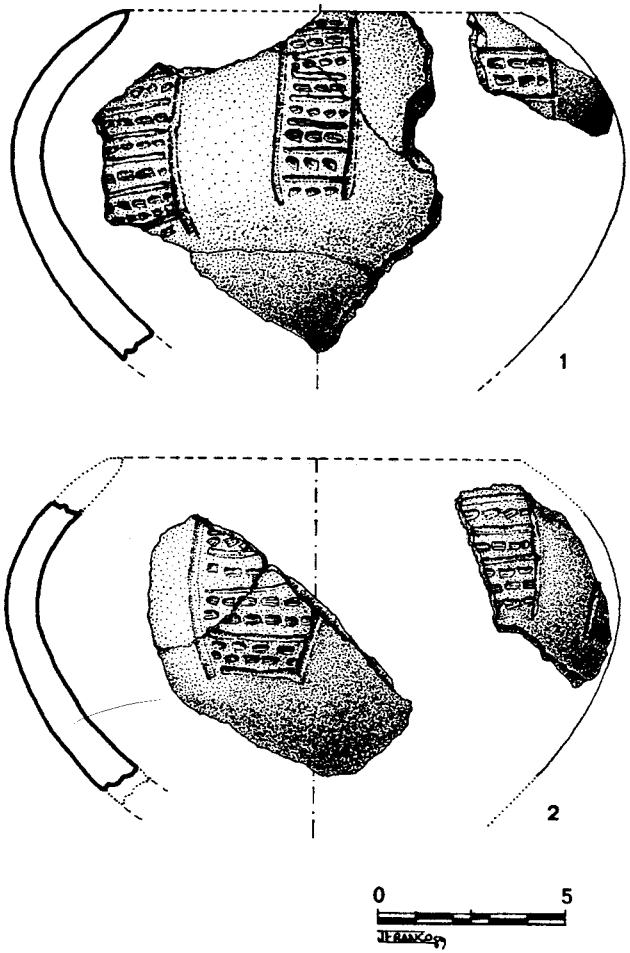


Fig. 4. Epicardial pot from Gruta do Caldeirão, horizon NA1. (Drawing by J. Franco.)

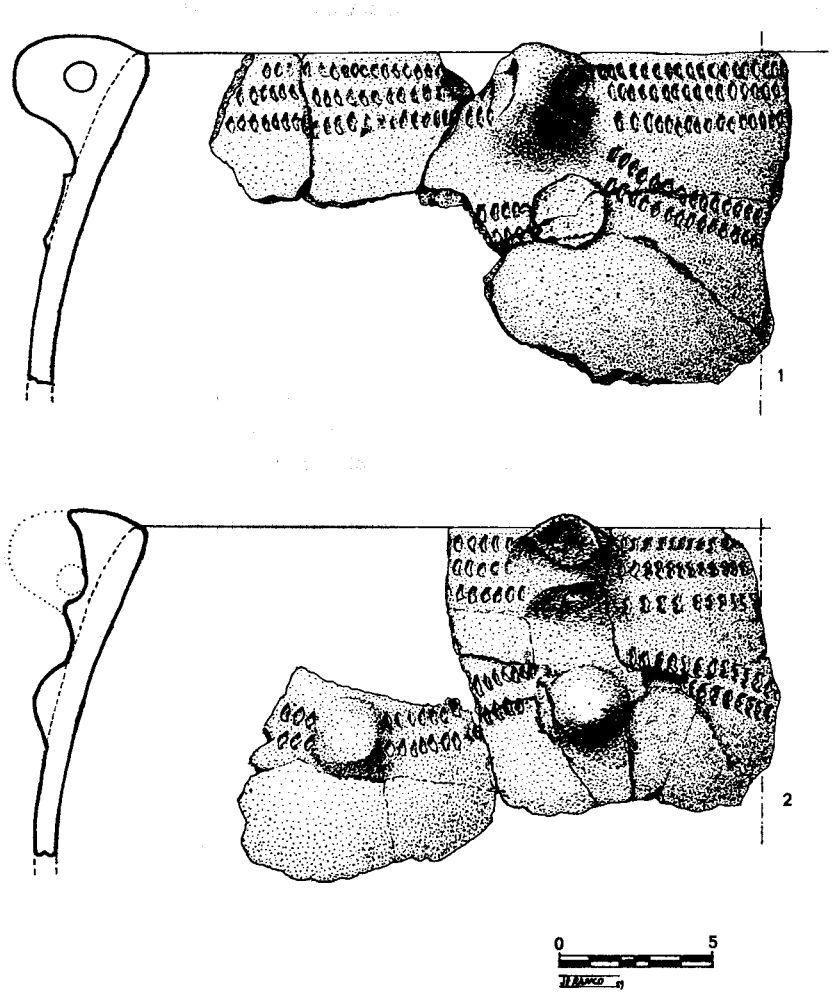


Fig. 5. Two reconstructed portions of a single cardial pot from Gruta do Caldeirão, horizon NA2. (Drawing by J. Franco.)

soil covers that made possible the accumulation of the A/B/C-D matrix, did not begin until the Chalcolithic.

The occurrence of post-depositional disturbance made it necessary to approach the study of the archaeological contents of the deposits from the perspective of taphonomic site-formation (Zilhão 1992). As a result, the materials recovered in the natural layers Ea and Eb were organized in four different assemblages pertaining to four different *horizons*. These were defined as site-specific occupation units, representing a theoretical reconstruction (through spatial analysis, refitting of sherds and bones, and techno-typological considerations) of the way the contents of the deposits were arranged prior to post-depositional disturbance:

1. *Upper Paleolithic occupation horizon (Magdalenian).* Its remains (lithics and fauna) were contained in layer Eb; due to post-depositional disturbance, a few items also turned up in layers Ea and A/B/C.
2. *NA2 (Neolítico Antigo 2) occupation horizon (Cardial).* Its remains (pottery, lithics, human and animal bones) were found only in the back chamber, at the interface between layers Eb and Ea, but sometimes penetrating deeply into the former; a few sherds also made their way up to layers A/B/C-D. The marked differences in surface appearance, weight and degree of mineralization made it easy to separate the bone component of this assemblage from the Upper Paleolithic fauna with which it was mixed. After sorting was performed, the correctness of the operation was successfully tested in several ways. Paleontological classification showed that the group considered to be of Neolithic age was almost entirely made up of human bones and also included some fauna (mainly wild boar, but also a few domesticates), while the group considered to be of Magdalenian age contained neither human bones nor domesticates, and was dominated by red deer and rabbits (Rowley-Conwy 1992). Fluorine content analysis (Cruz 1992b) of randomly-selected samples showed that those attributed to the first group were indeed of a younger age: their radiocarbon dating provided Neolithic ages, whereas radiocarbon dating of bones from the second group provided Paleolithic ages.

3. *NA1 (Neolítico Antigo 1) occupation horizon (Epicardial).* Its remains were mainly found in layer Ea, although a few items also turned up in underlying (Eb) and overlying (A/B/C-D) stratigraphic units.
4. *NM (Neolítico Médio) occupation horizon (Middle Neolithic).* Its remains (a few undecorated sherds associated with human bone fragments) were mostly found at the top of layer Ea, clustered in the area around square O14. Given its small size and the impossibility of separating it securely from that of horizon NA1 using either spatial analysis or surface appearance, the NM bone assemblage was subsumed within the former for analytical purposes.

Horizon NA2 contained the remains of at least four adult individuals (one of them probably a woman) and a child, although estimates based on the dental material suggest that a fifth adult is also present in this assemblage (Jackes and Lubell 1992). The spatial distribution of these human bones revealed a pattern of two concentrations, one against the north wall, in squares O/11-12, the other against the south wall, in squares R/11-13. Sexing of the individuals represented in these clusters and their association with the artifactual material suggest that the cardial pot may originally have been deposited with a female buried in O/11-12, the microliths (one trapeze and two segments) with a male buried in R/12-13, and a cluster of 120 shell beads (*Theodoxus fluviatilis*, *Hinia pfeifferi*, and *Glycymeris glycymeris*) with another male buried in R11 (Fig. 6). The post-depositional scattering of these hypothesized original associations also suggests that the bodies were not placed inside protective burial features but simply laid down on the floor, while the location of the clusters of cranial material suggests that the heads were probably placed against the walls of the cave. The human bone material ascribed to horizon NA1 represented a minimum of thirteen individuals. Eight of these were young people (six less than fifteen years old and two aged between fifteen and twenty), and five were adults; of the latter, two (one male and one female) were still young (twenty to twenty-five), while the other three (two males and one female) were somewhat older. However, the extent of the post-depositional disturbance suffered by the two later Neolithic occupations of the cave did not allow the identification of any spatial patterning in the distribution of the different individuals.

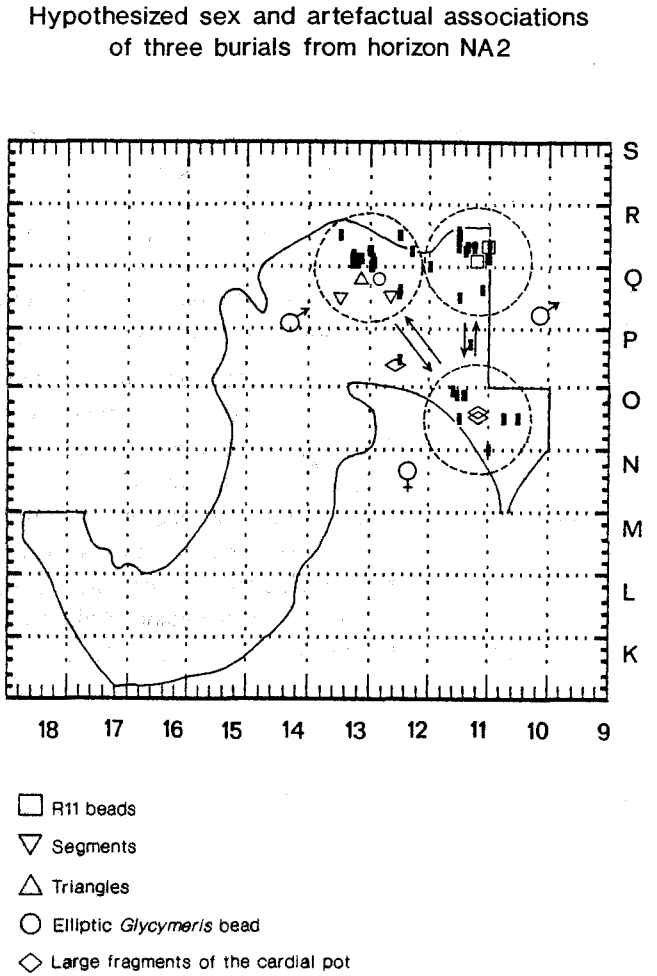


Fig. 6. Reconstructed location of three individual burials (and associated artifactual material) from Gruta do Caldeirão, horizon NA2. The dots indicate the location of the human cranial material; the arrows indicate the hypothesized post-depositional movement of bone material responsible for the scattering of the three individuals.

Radiocarbon dating (Fig. 3; Table 1) showed that the burials of horizon NA2 took place around 6200 BP (5231 Cal BC). An earlier, very poorly preserved, burial episode, may have taken place at around 6800 BP (5732 Cal BC), given the spatial association of a dated charcoal sample (ICEN-296) with three sherds from a single vessel and a few human bones found in square P14. However, these sherds, although undecorated, are very similar in fabric to the cardial pot (but significantly thicker, thus suggesting that they belong to a different vessel). This earlier date might therefore also be related to the burials of Horizon NA2, the fact that it is statistically older than the others perhaps being explicable by an 'old wood effect'. Contamination by mixture with Paleolithic charcoal is not a serious possibility, since the sample was made up of a single large piece of carbonized wood. Horizon NA1 burials took place at around 5900 BP (4776 Cal BC), and those from horizon NM at around 5000 BP (3751 Cal BC).

Provenience	Lab Number	Composition	Date BP	Cal BC (1 sigma)	Cal BC (2 sigma)
P14 - Eb base	ICEN-296	Charcoal (single piece)	6870±210	5970-5570	6120-5370
Horizon NA2					
P14 - Ea	OxA - 1035	*Ovis* metapodial	6330±80	5348-5231	5480-5079
Q13 - Eb	OxA - 1034	*Ovis* phalange	6230±80	5302-5072	5340-4940
O12 - Eb	OxA - 1033	*Homo* rib	6130±90	5226-4941	5296-4843
	Weighted average			5240-5148	5324-5060
Horizon NA1					
Q13 - Ea	OxA - 1037	*Bos* phalange	5970±120	5048-4770	5220-4583
Q13 - Ea	OxA - 1036	*Bos* phalange	5870±80	4894-4685	4941-4540
Q11 - Ea	TO - 350	*Homo* rib	5810±70	4782-4588	4895-4510
	Weighted average			4789-4718	4896-4603
Horizon NM					
O14 - Ea	TO - 349	*Homo* rib	4940±70	3787-3689	3950-3541

Table 1. Gruta do Caldeirão: Absolute Chronology of the Neolithic Occupations

In Early Neolithic times Gruta do Caldeirão seems to have been used mainly as a burial site. However, the presence of some animal bones suggests an episodic use also as a spring/summer shelter for the hunting of wild boar and the pasturing of sheep (Rowley-Conwy 1992). The settlement site inhabited by the people that used Gruta do Caldeirão in this way is still unknown to us, but was probably located further south, near the good soils in the alluvial plain of the Nabão. The absence of cereal grains or other direct proof of the existence of domesticated plants in the cave deposits thus cannot be taken as indicating that agriculture was not part of the economic system of these people, and should rather be attributed to the nature of this specialized use of the cave. Stable isotope analysis of the human bone showed a diet where aquatic resources were absent, in sharp contrast with what is known for the Mesolithic of the region (Fig. 7). As discussed above, the aboriginal hunter-gatherer populations do not seem to have settled permanently in inland areas that had no direct access to aquatic resources. The fact that such a settlement was achieved by Early Neolithic people strongly suggests that, as in southern France and eastern Spain, cereal agriculture, although archaeologically less visible, was introduced alongside ovicaprids as the mainstay of the new economic system. Cardial pottery thus seems to have appeared as a part of the Neolithic package, not isolated from it, as a prestige item acquired by hunter-gatherers, as might also be conceivable. Anthropological analysis of the human remains did not show any signs of stress (Jackes and Lubell 1992). The new adaptive system therefore seems to have been successful right from the beginning. Sourcing of the raw materials showed that the earliest occupation (horizon NA2) took place in the framework of an exchange system oriented towards the sea-shore, given the presence of the littoral and estuarine shells used as adornments. The clays used in the cardial pot, being non-local, were also probably of estuarine origin (Barnett 1992). By later Early Neolithic times, the exchange system (or the specialized exploitation territory) already encompassed the inland areas of Paleozoic age from which came the amphibolite, the variscite and the muscovite used in the manufacture of the polished hand-axes and the mineral beads included in horizon NA1 (Real 1992).

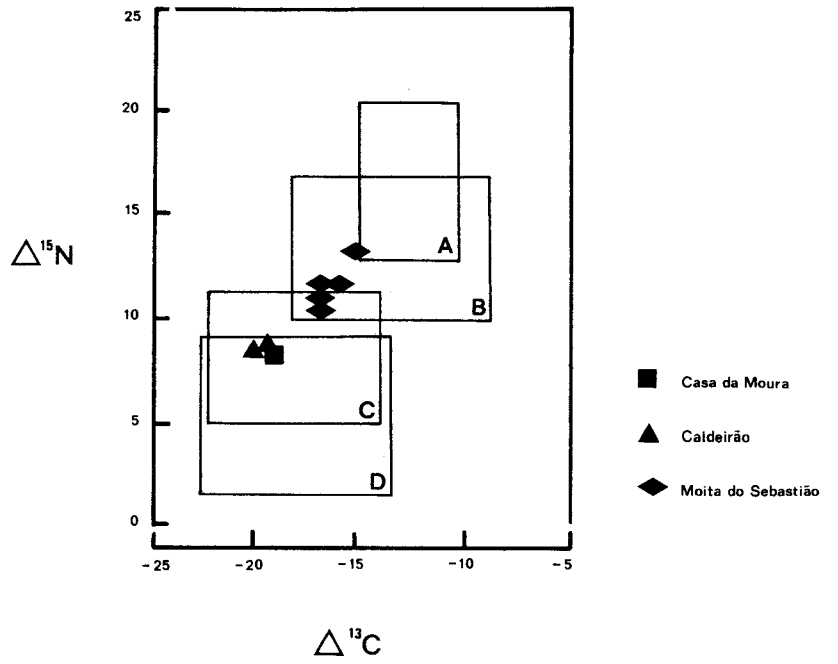


Fig. 7. Stable isotope data for the Early Neolithic cave burial sites of Casa da Moura and Caldeirão (from the human rib dated at Toronto, horizon NA1), and for the Mesolithic shell-midden of Moita do Sebastião. A - sea carnivores feeding on vertebrates; B - sea carnivores feeding on invertebrates; C - terrestrial carnivores; D - terrestrial herbivores. (After De Niro 1986: fig. 6).

The Neolithic Enclave of Central Portugal

The data from Gruta do Caldeirão, combined with those from Gruta do Almonda (Zilhão 1990) and from the sites mentioned by Guilaine and Ferreira (1970) (particularly the open air settlements near Figueira da Foz), therefore seem to suggest that the earliest Neolithic of central Portugal is indeed archaeologically characterized by the presence of 'classic' cardial

In Early Neolithic times Gruta do Caldeirão seems to have been used mainly as a burial site. However, the presence of some animal bones suggests an episodic use also as a spring/summer shelter for the hunting of wild boar and the pasturing of sheep (Rowley-Conwy 1992). The settlement site inhabited by the people that used Gruta do Caldeirão in this way is still unknown to us, but was probably located further south, near the good soils in the alluvial plain of the Nabão. The absence of cereal grains or other direct proof of the existence of domesticated plants in the cave deposits thus cannot be taken as indicating that agriculture was not part of the economic system of these people, and should rather be attributed to the nature of this specialized use of the cave. Stable isotope analysis of the human bone showed a diet where aquatic resources were absent, in sharp contrast with what is known for the Mesolithic of the region (Fig. 7). As discussed above, the aboriginal hunter-gatherer populations do not seem to have settled permanently in inland areas that had no direct access to aquatic resources. The fact that such a settlement was achieved by Early Neolithic people strongly suggests that, as in southern France and eastern Spain, cereal agriculture, although archaeologically less visible, was introduced alongside ovicaprids as the mainstay of the new economic system. Cardial pottery thus seems to have appeared as a part of the Neolithic package, not isolated from it, as a prestige item acquired by hunter-gatherers, as might also be conceivable. Anthropological analysis of the human remains did not show any signs of stress (Jackes and Lubell 1992). The new adaptive system therefore seems to have been successful right from the beginning. Sourcing of the raw materials showed that the earliest occupation (horizon NA2) took place in the framework of an exchange system oriented towards the sea-shore, given the presence of the littoral and estuarine shells used as adornments. The clays used in the cardial pot, being non-local, were also probably of estuarine origin (Barnett 1992). By later Early Neolithic times, the exchange system (or the specialized exploitation territory) already encompassed the inland areas of Paleozoic age from which came the amphibolite, the variscite and the muscovite used in the manufacture of the polished hand-axes and the mineral beads included in horizon NA1 (Real 1992).

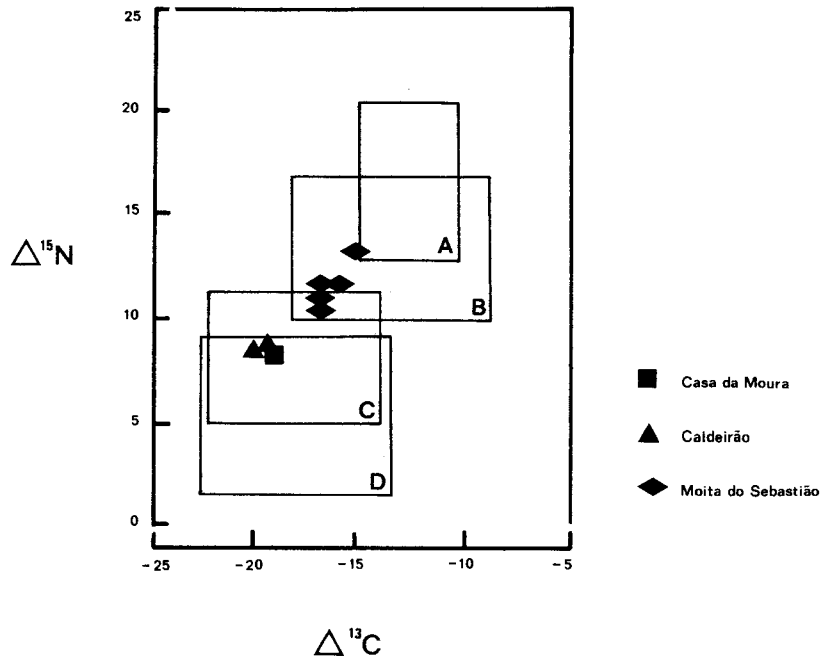


Fig. 7. Stable isotope data for the Early Neolithic cave burial sites of Casa da Moura and Caldeirão (from the human rib dated at Toronto, horizon NA1), and for the Mesolithic shell-midden of Moita do Sebastião. A - sea carnivores feeding on vertebrates; B - sea carnivores feeding on invertebrates; C - terrestrial carnivores; D - terrestrial herbivores. (After De Niro 1986: fig. 6).

The Neolithic Enclave of Central Portugal

The data from Gruta do Caldeirão, combined with those from Gruta do Almonda (Zilhão 1990) and from the sites mentioned by Guilaine and Ferreira (1970) (particularly the open air settlements near Figueira da Foz), therefore seem to suggest that the earliest Neolithic of central Portugal is indeed archaeologically characterized by the presence of 'classic' cardial

wares, and that this pottery is associated right from the beginning with a full agro-pastoral economic system. Such a beginning may date to c. 6800 BP, if the charcoal date for Caldeirão is accepted; but it is certainly older than the average age (based on bone samples) of 6200 BP for the NA2 burials of this site, since the style of the cardial pot found in this horizon would qualify it as a late product of the cardial tradition, whereas the more baroque decoration of some cardial pots from Almonda and Figueira da Foz suggests that the first Neolithic use of these sites took place at an earlier time than at Caldeirão. Another stylistically early cardial pot is the vessel found near Santarém whose exact provenience is currently unknown (Ferreira and Guilaine 1979). Thus, the available evidence indicates that the initial Neolithic settlement of Portugal probably took place in the northern part of Estremadura, in the limestone areas surrounding Figueira da Foz, Tomar and Torres Novas (Fig. 8). This would have been marginal territory for the Mesolithic groups living in the estuary of the Tejo, with which this earliest Neolithic seems to have been (at least in part) contemporaneous, a contemporaneity that is beyond doubt when the Late Mesolithic of southern Portugal is considered (Table 2; Fig. 9). This earliest Neolithic therefore represented a kind of agricultural enclave, sandwiched between the successful hunter-gatherer adaptations of the Tejo, Sado and Mira estuaries, to the south, and the well-known Asturian settlement of Cantabria, where the introduction of domesticates only occurred well after 6000 BP (González-Sainz and González-Morales 1986).

If this pattern is confirmed by future research, it would imply an understanding of the transition to agriculture in southern Portugal as related to an expansion from north to south of groups descended from the first Neolithic settlers of northern Estremadura. It seems logical to admit that such an expansion process would only have begun after several generations, and that by that time the material culture would already have changed: when close contacts ending in what may have been the absorption of the southern hunter-gatherers into the new economic system began, the production of cardial pottery could have been a phenomenon that was already past. The occurrence of such an expansion at the beginning of the *horizonte da Furninha* stage might thus explain why cardial pottery is not common in the Early Neolithic sites of the Alentejo. On the other hand, the stratigraphic evidence from the Sado middens also concurs in suggesting that, south of the

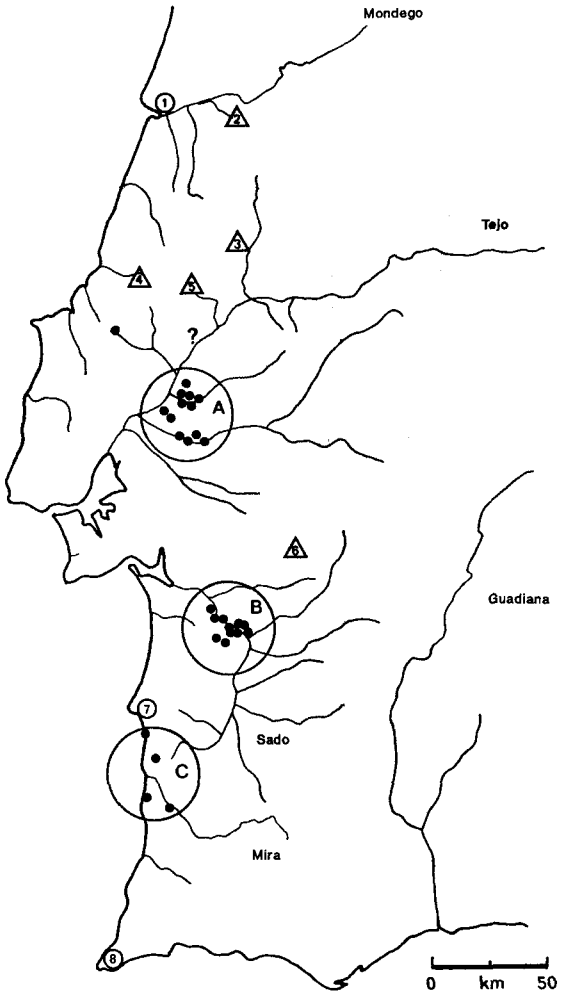


Fig. 8. Portuguese Early Neolithic sites with cardial pottery. 1 - Várzea do Lírio and Junqueira (Figueira da Foz); 2 - Gruta da Eira Pedrinha; 3 - Gruta do Caldeirão; 4 - Gruta III de Cabeço da Ministra; 5 - Gruta do Almonda; 6 - Gruta do Escoural; 7 - Vale Pincel; 8 - Cabranosa. The question mark refers to the city of Santarém, in whose neighbourhood a 'classic' cardial vessel was found. Note how all the known instances are located outside the areas exploited by the Late Mesolithic groups (A - Muge middens, B - Sado middens, C - Mira middens; for specific site names see caption to Fig. 1).

Period	Site	Provenience	Sample[2]	Lab. Nº	Date BP	Cal BC 1 sigma	Cal BC 2 sigma
Late	Forno da Telha[3]	Layer 2	Es	ICEN-416	7320± 60	5960-5734	5980-5640
Mesolithic		Layer 2	Es	ICEN-417	7360± 90	5980-5740	6080-5640
				FT1(average)		5960-5742	5980-5657
	Moita do Sebastião	Skeleton 22	Hbc	TO-131	7240± 70	6129-5993	6219-5970
		Skeleton 29	Hbc	TO-133	7200± 70	6108-5886	6180-5886
		Skeleton 24	Hbc	TO-132	7180± 70	6097-5974	6170-5848
		Skeleton 41	Hbc	TO-134	7160± 80	6091-5966	6170-5830
				MT1(average)		6093-5988	6120-5970
		Skeleton CT	Hbc	TO-135	6810± 70	5739-5629	5830-5540
	Cabeço da Arruda	Skeleton III	Hbc	TO-360	6990± 110	5980-5730	6090-5640
		Skeleton A	Hbc	TO-354	6970± 60	5960-5740	5980-5650
		Skeleton 42	Hbc	TO-359a	6960± 60	5960-5734	5980-5640
				ARR1(average)		5956-5744	5970-5720
		Skeleton D	Hbc	TO-355	6780± 80	5732-5573	5810-5490
		Skeleton N	Hbc	TO-356	6360± 80	5380-5235	5480-5210
	Arapouco[4]	Middle level.	Es	Q-2492	7420± 65	6033-5822	6090-5740
	Poças de São Bento[4]	Lower level	Es	Q-2493	7040± 70	5638-5489	5720-5428
		Middle level	Ch	Q-2494	6780± 65	5726-5584	5770-5530
		Middle level	Es	Q-2495	6850± 70	5487-5339	5560-5242
	Cabeço do Pez[4]	Middle level	Es	Q-2497	6730± 75	5414-5236	5480-5210
		Middle level	Es	Q-2496	6430± 65	5199-4902	5230-4792
		Upper level	Abc	Q-2499	5535± 130	4510-4247	4720-4043
	Vidigal[5]	Level 3	Abc	Ly-4695	6640± 90	5630-5480	
		Level 2	Abc	GX-14557	6030± 180	5220-4770	5330-4510
	Samouqueira		Hbc	TO-130	6370± 70	5382-5238	5480-5220
	Medo Tojeiro[4]		Shells	BM-2275R	6820± 140	5500-5241	5640-5087
	Fiais		Abc	TO-806	7010± 70	5973-5750	6075-5668
			Abc	ICEN-141	6180± 110	5240-4947	5340-4848
Early	Caldeirão	Layer Eb	Ch	ICEN-296	6870± 210	5970-5570	6120-5370
Neolithic		Layers Ea/Eb		NA2(average)		5240-5148	5324-5060
		Layer Ea		NA1(average)		4789-4718	4896-4603
	Casa da Moura		Hbc	TO-953	5990± 60	4944-4800	5192-4780
	Cabeço de Porto Marinho III S	Neolithic hearth	Ch	SMU-2477	5710± 155	4780-4366	4938-4245
	Medo Tojeiro	Layer 4	Ch	Beta-11723	5420± 160	4460-4046	4675-3970

Table 2: Absolute Chronology of the Mesolithic–Neolithic Transition in Portugal[1]

Notes to Table 2

1. References: Forno da Telha - Araújo (n.d.); Moita and Arruda - Lubell *et al.* (1986); Arapouco, Poças de São Bento and Cabeço do Pez - Arnaud (1989); Vidigal - Straus and Vierra (1989); Samouqueira and Medo Tojeiro - Lubell and Jackes (1985; 1988), Bowman *et al.* (1990); Casa da Moura - Straus (1988); Cabeço de Porto Marinho III S - Marks *et al.* (n.d.)

2. Es - estuarine shells; Hbc - human bone collagen; Ch - charcoal; Abc - animal bone collagen.

3. The date ICEN-416 was obtained from the intermediate fraction of *Cerastoderma edule* and *Cerastoderma glaucum* shells. The date ICEN-417 was obtained from the inner fraction of the same shells. They were both calibrated with the curve for continental samples after subtraction of 360±35 years, apparent age of the estuarine shells accumulated in the Sado middens (Soares 1989; Soares and Cabral 1989).

4. The dates for the Sado middens and for Medo Tojeiro that were obtained from shells were calibrated with the curve for continental samples after subtraction of 360 ± 35 years, apparent age of the estuarine shells accumulated in the Sado middens (Soares 1989; Soares and Cabral 1989).

5. The date GX-14557 is referred to as from the 'midden fill above pavement' (Straus and Vierra 1989). According to Vierra (personal communication), it is a bone sample, and was therefore calibrated with the continental curve.

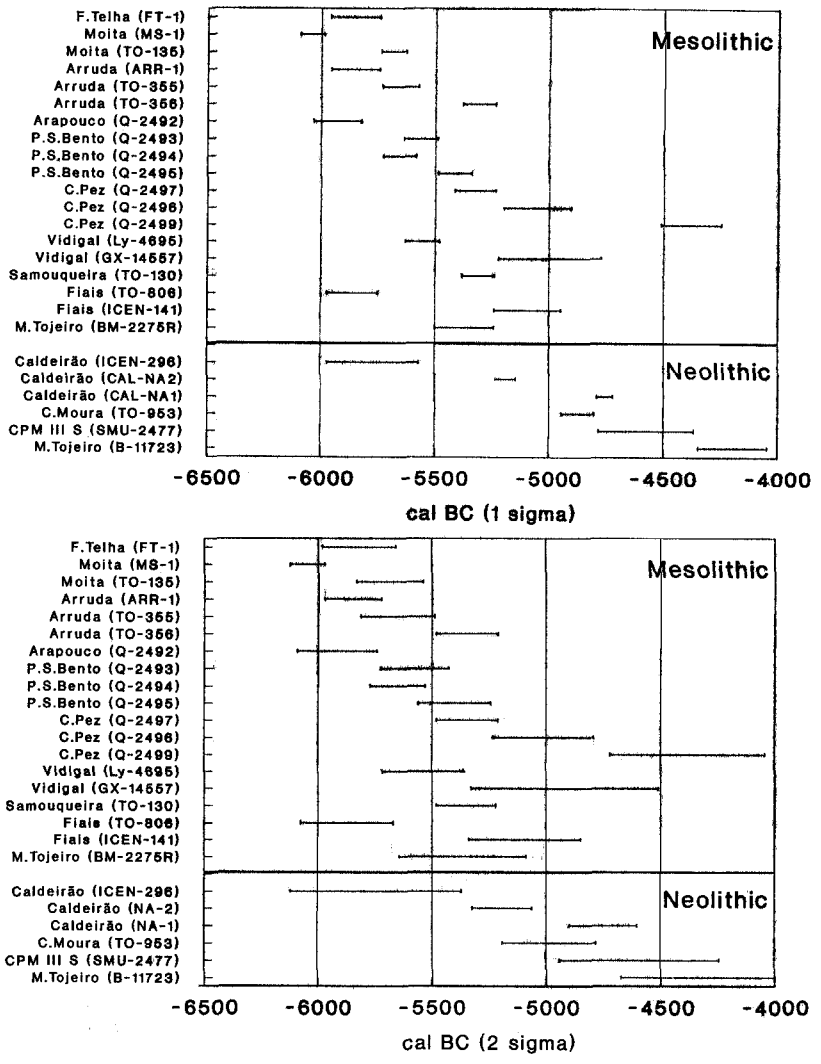


Fig. 9. Radiocarbon dates relevant for the Mesolithic/Neolithic transition in Portugal. FT-1, MS-1, ARR-1, NA-2 and NA-1 designate the averages reported in Table 2. Note the contemporaneity of the cardial occupation of Caldeirão (NA-2) with the Mesolithic middens in the estuaries of the Sado and the Mira (Cabeço do Pez, Samouqueira, Vidigal, Fiais and Medo Tojeiro).

Tejo, the replacement of hunter-gatherer adaptations was, by comparison with central Portugal, a late phenomenon, taking place after the process of midden accumulation had come to an end. This end, in turn, seems to be a well-dated event, occurring more or less simultaneously in the Sado valley, in the Sines area (for instance at Vidigal), and in the estuary of the Mira—that is, around c. 6000 BP. And, by that time, the pottery present in the dated Neolithic sites of Estremadura, Caldeirão—horizon NA1 (see above), and Casa da Moura (Straus 1989; Straus *et al.* 1988), is indeed no longer cardial in style, and can be easily attributed to the *horizonte da Furninha.*

This view of the facts therefore seems to fit the available evidence better than the proposition put forward by Silva and Soares (1981; 1987) that an Early Neolithic, contemporaneous with the cardial, but culturally different from it, existed in coastal Alentejo, being represented by the lower part of the Vale Pincel archaeological level. This does not mean that one should exclude the possibility, *a priori*, that other Neolithic enclaves, similar to that in northern Estremadura, may have existed along the Mesolithic littoral of the Alentejo, for instance in the Sines area (Fig. 8). If so, the differences with the northern Estremadura pattern, instead of having a chronological basis, could be related to some other cause, such as a different ethnic origin of the first farmers of southern Portugal. That cultural traditions different from the 'classic' cardial may indeed have been involved in the spread of agro-pastoral economies in western Mediterranean Europe is actually indicated by the site of Portiragnes, in the Languedoc (Roudil 1990). Roudil even suggests that the presence of pottery with the characteristic *sillons à impressions* in some Portuguese sites could be interpreted as indicating that both cardial and ligurian traditions played a role in the introduction of agro-pastoral economies in Portugal. Regardless of what one thinks of this author's ethnic interpretation of these two pottery styles, the fact remains, however, that the Portuguese sites he mentions (the caves of Calatras and Almonda) are the same where the 'classic' cardial was also found, and they are located in Estremadura. This pottery is not present in the Sines sites.

On the other hand, although qualified as rare, cardial decorations are after all present at Vale Pincel, as well as at other sites south of the Tejo, such as the cave site of Escoural (Montemor-o-Novo), and the open air site of Cabranosa (Sagres) (Fig. 8). Silva (1989) argues that cardial decorated pots only represent a small percentage of these assemblages, and therefore these,

when considered as a whole, cannot be included in the cardial tradition. However, in the only instance where concrete figures are supplied (the site of Cabranosa), cardial decorated pots represent two out of the six vessels reported (Silva 1989): 33% can hardly be considered a small percentage. As for Vale Pincel, although cardial decorated sherds are illustrated by Silva and Soares (1981), we are not told what actual percentage of the impressed pots they represent. It may well be, therefore, that the whole argument about the affinities of the Sines sites is affected by a definitional problem—the fact that cardial pots are 'rare' (although whatever Silva and Soares mean by rare remains to be clarified) at Vale Pincel does not necessarily mean that the pottery assemblages as a whole cannot be considered as part of the cardial tradition.

To accept the hypothesis of an early age for the Neolithic of Vale Pincel (regardless of which would have been its cultural affinities), however, would make it necessary to face the fact that those putative early agricultural communities of the coastal Alentejo would not seem to have engaged in archaeologically visible interaction with their Mesolithic neighbours for several hundred years, something that seems to contradict the available ethnographic evidence for hunter-gatherer/agriculturalist contact (Moore 1985). Alternatively, if proven early, the Sines sites could also be interpreted as showing that the transition had been, there, an essentially local phenomenon, as Silva and Soares have postulated: i.e., that we might be dealing here with an essentially hunter-gatherer adaptation with some agriculture and some new items of material culture—a 'pottery Mesolithic'. This latter hypothesis does not seem very likely, however, since it would imply that those local hunter-gatherers who had somehow acquired pottery used and discarded it differentially across the landscape, thus forming midden sites with molluskan and wild faunal remains, but no pottery, on the one hand; and settlement sites with pottery, but no evidence for the exploitation of wild resources, on the other. This would also be a unique pattern, since in the known 'pottery Mesolithic' cultures, such as the Danish Ertebølle, the ceramics are associated with the midden sites.

A close analysis of the published information from Vale Pincel also shows that the idea of an earlier level is far from having a sound archaeological basis. This site was first tested in 1975, and, subsequently (in 1986), an area of about 200 × 500 m was excavated (Silva 1989); but only very preliminary

reports have been published so far, and these are not exempt from contradictions. For instance, the 1975 tests exposed features that were interpreted as 'hut floors'. The artifacts inside these features were contained in a 15 cm thick level. The different percentages in which the two main kinds of pottery fabric occurred in the upper and lower parts of the level supplied the basis for identifying two periods in the occupation of the site, an early 'Full Early Neolithic' and a late 'Evolved Early Neolithic'. But the 'huts' inside which such a prolonged occupation would have taken place were in turn described as built of light and very perishable material, a context in which one would expect chronological variation to be expressed horizontally across the site, rather than vertically. Furthermore, the archaeological features interpreted as huts were elongated (c. 10 m long) pockets differentiated by the darker colour of the sands; but these pockets had an east–west axis that coincided with the slope of the terrain and, judging from the published photographs and plans, the 'burnt stones' found inside them did not form any clear patterns. The possibility cannot be ruled out, therefore, that these features are post-depositional—i.e., that some degree of slope washing and scattering may have been involved in the site formation process, which would account for the low densities of finds reported by the excavators. On the other hand, the lithic component of the 'Full Early Neolithic' occupation was defined by an assemblage that mixed all the pieces recovered in the excavation, regardless of level, and also included the surface finds. Incidentally, the lithics of Vale Vistoso, a site whose pottery was identical to that from Salema, the 'type-site' of the local 'Evolved Early Neolithic', were however considered to be identical to those from Vale Pincel, that is of 'Full Early Neolithic' appearance. The explanation of the Vale Pincel features as 'hut floors' has since been partially abandoned (Silva 1989), but so far no taphonomic analysis of the sherds and their spatial distribution (refitting studies, for instance) has been produced to support the claim for the existence of two stratigraphically differentiated occupation horizons within this thin sandy deposit. One is therefore forced to conclude that the existence, as a separate stratigraphic entity, of a very early Neolithic occupation at Vale Pincel remains to be demonstrated, and that the nature (cardial, non-cardial, epicardial, or any combination of these) of the occupations that indeed took place there has yet to be clarified. In any case, the hypothesis seems worthy of future examination that the site is a palimpsest of several occupations, and that several components

may be represented in the archaeological assemblages collected in the extensive area that was excavated, including possibly a Mesolithic one as well. Such was at least the case at the nearby site of Samouqueira (Silva and Soares 1981: 218-19), where both Early Neolithic and Mesolithic occupations were present in an area much smaller than that reported to have been excavated at Vale Pincel.

The only dated site of the Alentejo coast that has been attributed to the Early Neolithic is the shell-midden of Medo Tojeiro. A date of 6820 ± 140 BP (BM-2275R) (Bowman *et al.* 1990) was obtained for this site, which translates into 6460 ± 145 BP after correction for the apparent age of the shells. However, this date refers to a sample obtained from an exposed part of the midden, before its excavation by Lubell and Silva. Lubell (personal communication) thinks that the sample cannot be securely provenanced, but that it probably can be attributed to what was later (during the excavation) called layer 4. The only item considered diagnostic of the Neolithic recovered in the site for which the provenience has been published (one trapeze, no specific stratigraphic provenience having been given for a decorated potsherd and a polished handaxe) came from the uppermost layer 1 of the midden (Silva *et al.* 1985), something that brings to mind the stratigraphic patterns of the Sado and Tejo sites, where the Mesolithic middens were sometimes overlain by Neolithic deposits, or contained intrusive Neolithic materials in the upper part of the sequences. And the fact that a charcoal date (B-11723) of 5420 ± 160 BP was also obtained for Medo Tojeiro (Table 2; Fig. 9) does seem to strengthen its interpretation as a multi-component (Mesolithic and Neolithic) site. Such an interpretation is also reinforced by the fact that Silva *et al.* acknowledge that the site went through at least three phases of deposition, and that, according to their data, lithic materials change radically across the sequence (dominated by greywacke in layers 3, 4 and 5, and by flint in uppermost layer 1).

Consequently, until (1) a sound dating of the Sines sites is obtained, (2) adequate publication of the finds is supplied by the investigators working there, and (3) information on the economy of these communities is acquired, the possible contemporaneity of agricultural and hunter-gatherer communities in the Alentejo will remain an unresolved issue. But, insofar as the earliest agricultural settlement of Estremadura is concerned, its contemporaneity with the southern Mesolithic (and possibly with the later part of the Muge

sites as well) seems beyond question. So, regardless of whether the Sines sites are proven to be early or late, the earliest agricultural groups of Iberia will still be characterized by a discontinuous settlement pattern in the framework of a clearly littoral distribution. This suggests that the hypothesis of a leap-frog colonization by small seafaring communities initially put forward by Arnaud (1982) in the context of his *Model A* (see above) should, for the moment, be retained as the best explanation for the appearance of agro-pastoral economies along the western shores of Iberia.

Spanish and North African Evidence

The excavators of the Sines sites base their point of view on the stylistic parallels they establish with the non-cardial pottery of the Cimetière des Escargots site, in Oran (Algeria), for which a date of 6680 ± 300 BP (Gif-463) was obtained, and with the non-cardial pottery of some Andalucian cave sites, where such pottery has been reported to be associated with dates ranging from 8000 to 7000 BP (Acosta 1987; Pellicer 1987). Accordingly, the discussion of the Portuguese data would not be complete without also considering the evidence from these two other areas.

With respect to the *Maghreb*, Gilman (1975) discussed the Cimetière des Escargots date and concluded that the association between the dated charcoal sample and the ceramic assemblage is not clear. Furthermore, at the site of Columnata, the same characteristic channeled ware found at the Cimetière des Escargots was dated to 5850 ± 100 BP (MC-156) and to 5250 ± 250 BP (Gif-307). The underlying aceramic levels were dated to between 6340 ± 300 (Gif-309) and 6800 ± 150 BP (MC-154). And, although channeled and cardial decorations are often associated, in the same sites and even in the same pots, stratigraphic evidence from the cave sites of El Khril, in northern Morocco (Jodin 1958-59), would suggest that, in the Maghreb, cardial wares are older than channeled wares. Recent dating of cardial sites is reported by Daugas *et al.* (1989). At Kaf Taht el Ghar (Tetuan province), a charcoal sample provided the date of 6050 ± 120 BP (Ly-3821) for a cardial context with domesticates (sheep, goat and bovine). A statistically identical date—5980 ± 210 BP (Ly-2149)—was obtained from bone collagen extracted from human skeletons excavated at the El Harhoura II cave (Temara province), in

a disturbed context that also included cardial decorated sherds.

The fact that no dates older than 6000 BP have so far been obtained for the Neolithic of the Maghreb should not be surprising, since the local Epipaleolithic tradition, the Capsian, is reported by all authors who have worked on the subject to last precisely up to c. 6000 BP (Sheppard 1987). All the available chronological evidence therefore indicates that 'Oran type' wares are later than the cardial wares, and therefore later than 6000 BP. If the pottery from Vale Pincel is paralleled to that from Oran, then that would imply its attribution to a late, epicardial or post-cardial, phase of the Early Neolithic, beginning after 6000 BP, not to the hypothetical non-cardial (but contemporaneous) Early Neolithic cultural tradition postulated by Silva and Soares.

In *Andalucia*, the long stratigraphy excavated at the cave of La Carigüela de Piñar suggests that the Neolithic sequence begins there, as well as in Valencia, Catalonya and southern France, with cardial wares, followed by a phase characterized by other non-cardial impressed wares (Navarrete 1976; Navarrete and Molina 1987). As a matter of fact, the sequence of La Carigüela is in this regard identical to that found in all the other major stratigraphic sequences of eastern Spain: Cova de l'Or (Valencia), Cueva de Cendres (Valencia) and Cueva de Chaves (Huesca). The several radiocarbon dates obtained for these sites place the cardial phase between c. 6800 and 6300 BP, and the next, epicardial, phase, between c. 6300 and 5700 BP (Bernabeu 1989). The marked differences that exist between the common items of material culture (stone and bone industries) found in the cardial settlements, on one hand, and in the local Mesolithic substratum, on the other, are interpreted as indicating an allochthonous origin for the domesticates that are associated with the ceramics and the other material culture finds made at those cardial sites. As a matter of fact, at Cova de l'Or, for instance, sheep/goat represented 56 per cent of the animal remains, and cereal remains were abundant (Martí *et al.* 1987).

This scheme is, however, questioned by the authors of the excavations at such sites as Cueva de Nerja (Malaga) and Cueva de la Dehesilla (Cadiz), which, together with Cova Fosca (Castellón), in the northern part of the Pais Valenciano, constitute the archaeological basis of the theory upon which the Sines sites have been interpreted by their excavators. In outline, this theory

suggests that pottery assemblages which on stylistical grounds are attributable to the epicardial phase of Bernabeu (1989) and Martí *et al.* (1987), are in reality—given the radiocarbon dates obtained for them—contemporaneous with, or even earlier than, the known cardial settlements; and that these assemblages constitute the archaeological manifestation of a local transition to food production based on the domestication of the traditional resources, particularly ibex, as argued, for instance, in the Cova Fosca site report (see below).

Cueva de la Dehesilla

This site is located in the mountainous interior of Cadiz province. It was the object of two field seasons (1977 and 1981), during which two contiguous areas of the cave were excavated, revealing a similar stratigraphy, with a depth of c. 3.3 m. The results of this work have recently been published as a monograph (Acosta and Pellicer 1990), to the pages of which I refer in the following presentation of the relevant data.

Six natural strata were differentiated in the stratigraphic profiles. The top two were attributed to the Chalcolithic, stratum III to the Late Neolithic, stratum IV to the Middle Neolithic, and strata V and VI to the Early Neolithic. The latter two contained a large ceramic assemblage (some 4000 fragments in the area opened in 1981 alone), associated with stone artifacts and animal bones. The stone débitage was not studied, but the retouched tools recovered in all layers amounted to about 350 pieces, of which some 60 were recovered in the Early Neolithic levels. These comprised mostly *varia* (some 50 pieces), two endscrapers, two burins and three backed bladelets. Two hundred and four animal bone fragments were recovered in the Early Neolithic levels, of which 30 per cent were said to be unclassified. However, the percentages supplied by the authors (p. 62) add up to only 80 per cent, so 60 (30% of 204) is just a minimum number for those unclassified fragments. The remaining pieces belonged (in decreasing order) to rabbit, ovicaprids (of which two pieces were definitely *Ovis*, and one definitely *Capra*), pigs, bovines, red deer, aurochs, wild boar and lynx. The authors characterize this assemblage as dominated by domesticated species. The Early Neolithic levels also contained some intact burials. Those found in stratum VI (at least two) were considered to be related to the stratum V occupations, that in stratum V to the stratum IV occupations.

Several radiocarbon dates were obtained for the lower part of this sequence. Stratum IV was dated to 5920 ± 170 BP (Gak-8956), a result that is in good accord with the expectations for what in southern Spain is termed the Middle Neolithic (post-cardial or epicardial impressed wares, often with *almagra*). However, five other dates (one for stratum VI, one for stratum V, and three for stratum IV), range from 8200 ± 160 BP (Gak-8957, stratum IV) to 7120 ± 200 BP (Gak-8954, also stratum IV). Although the text (pp. 87-89) is not absolutely clear, all these dates seem to have been obtained from charcoal samples. The important point here, however, is that the authors use these results to sustain the idea of a very early neolithization of the area. But a close analysis of the information supplied by them reveals that the association between these dates and the archaeological materials they are supposed to date is highly questionable.

As a matter of fact, there is another date, disregarded by the authors, for the intact burial of an adult female found in stratum V and considered to be related with the occupations represented in stratum IV; this date, obtained from the human bones themselves, gave a result of 3120 ± 180 BP (Gak-8958). There were no burial gifts associated with this skeleton, but there is no *a priori* reason to exclude the possibility that this is indeed a late prehistoric burial, which would suggest that the degree of post-depositional disturbance of the sequence is much higher than acknowledged by the authors. On the other hand, it should be stressed that the animal bones present in the Early Neolithic levels can only be considered by the authors as predominantly those of domestic animals because the rabbits are considered to have been domesticated! Furthermore, strangely enough, there would be no wild rabbits alongside the domestic ones and, even more interesting, these domestic rabbits would decrease markedly between the Early Neolithic and the later prehistoric periods—from 24 per cent of the bones in the basal strata, to 8 per cent in the Middle and Late Neolithic strata, and only 4 per cent in the Chalcolithic ones (pp. 62-64). This characterization of the rabbits as domestic is even more incomprehensible, since it is a well-established fact that, in Europe, their domestication only occurred in late medieval times. If rabbits are counted (as they should be) as wild, than the only remains of domesticates identified in the Early Neolithic levels would be the above-mentioned *Ovis* bones, plus the 9 (4% of 204 fragments) bones classified as pig.

If so, the Early Neolithic strata would be characterized by the combination of a very large (thousands of pieces) ceramic assemblage with a faunal assemblage almost entirely made up of non-domestic species. It might of course be argued that such a combination is the archaeological correlate of an economy where hunting still maintained an important role. But what it really means is revealed by a fact reported by the authors, a fact from which, however, they do not extract the obvious consequence:

> the bones from strata VI and V of the Early Neolithic are very frequently extremely fragmented and with abundant calcareous incrustations; therefore, a high percentage of these bones are not recognizable, and have to be included in the unclassified group; on the other hand, those same incrustations cannot be cleaned without bone breakage, and influence the calculations based on the weight of the material (p. 61, my translation).

But the ceramics are not reported to suffer from the same problem! This clearly suggests that these strata contain a mixture of two different things: (a) a relatively low density Paleolithic or Epipaleolithic context (comprising the rabbit and red deer bones, and some, if not all, of the lithics, namely the backed bladelets), originally associated with concreted deposits, and (b) a high density Neolithic ceramic assemblage with a few bones of domesticated animals. No wonder, therefore, that such old charcoal dates were obtained from these mixed contexts.

The fact that intact burials were found in the basal levels, implying that the bodies were deposited inside excavated features that protected them from subsequent scattering, also contributes to the interpretation of this sequence as having been the object of important post-depositional disturbance. Why the excavators failed to recognize this is not clear, but it may have something to do with the impressive pace at which the excavations were carried out: in 1977 an area of 3 × 3 m was excavated down to 3.35 m (which amounts to c. 30 m^3) in less than one month; much the same thing happened in 1981, when an area of 4 × 4 m was excavated down to 3.3 m (which amounts to c. 53 m^3), in only two months! That serious stratigraphic problems exist with these excavations is also indicated by the fact that, according to the authors (p. 24), stratum VI had an inclination of 25° to the south (i.e., towards the bottom of the cave, according to the plan) in the 1977 excavation, while in the area opened in 1981 (p. 26), only 2.5 m away, its inclination was of 14° to the north (i.e., towards the exterior)! Until these problems

are clarified by the excavators, it is obvious that the evidence from Cueva de la Dehesilla cannot be the object of serious scientific consideration.

Cova Fosca

This site is located in the interior of the Castellón province, in the El Maestrazgo limestone massif, and was excavated between 1975 and 1979. A monograph on the site has recently been published (Olaria 1988), and it is to this work that the page citations in the following discussion refer.

The archaeological excavations were carried out after clandestine diggers had destroyed most of the upper 2 m of deposits. The remaining sediments were dug in four areas (Cuadros I-IV), where a similar stratigraphy, comprising four levels (S [surficial], I, II and III), with a total depth of c. 1.8 m, was identified. Level III contained no ceramics, and yielded a charcoal date of 9460 ± 160 BP (I-11313). The lower part of level II (IIB) was also aceramic and yielded another charcoal date of 8880 ± 200 BP (I-9868). The upper part of level II (IIA) already contained ceramics, but was not dated. Level I yielded three charcoal dates: 7100 ± 70 BP (CSIC-356); 7210 ± 70 BP (CSIC-357); and 7210 ± 110 BP (CSIC-353). The surficial level, dated to 5715 ± 80 BP (I-9867), was suspected of having been disturbed by the clandestine digs.

The ceramics found in levels I and II are described as very similar: the shapes are predominantly ovoid, and the decoration is impressed, incised and plastic, with only two fragments (of the 1271 found in level I and the 360 in level II) bearing cardial motifs. This fact, in association with the radiocarbon dates quoted above, provides the basis for the identification of the pottery-bearing settlers of this site as members of a pre-cardial Early Neolithic developed from the local Mesolithic groups. However, as pointed out by Martí *et al.* (1987), the ceramics from Fosca are identical to those found in the epicardial and post-cardial levels of the other cave sites of eastern Spain. An important piece of Olaria's argument is supplied by the faunal study of J. Estevez (1988), according to which the faunal assemblage is dominated in all levels (cf. counts on p. 286) by rabbits (86% of the remains in level III, 80% in level II, and 46% in level I). If these are excluded, the bone samples are relatively small (172 pieces in level III, 268 in level II, and 885 in level I), and overwhelmingly made up of ibex (74% in level III, 60% in levels II and III), followed by red deer (6% in level III, 22% in level II, and 20% in

level I). Taken together, these two species therefore account for 80% of the non-rabbit bones of all levels. Therefore, as at Cueva de la Dehesilla, we are again faced with an assemblage of hundreds of pot sherds associated with very few bones of domesticates. As a matter of fact, according to Estevez (1988: 291), there were only three clear *Ovis* bones in level II, and nine in level I, while not one of the more diagnostic anatomical parts (none of the many recovered horns, for instance) could be attributed to domestic sheep/goats. Conscious of the problem, Estevez tried to bring the faunal and ceramic data into closer agreement with the ceramics by conducting some metrical analyses (1988: 292-306) of the ovicaprids in order to check for the possibility that some of the smaller ibex material might actually belong to goats locally domesticated by the Mesolithic groups.

His conclusion is that 'the issue is not clarified by the consideration of measurements alone' (1988: 301, my translation). Despite this acknowledgment, Estevez speculates that the smaller animals that form one of the three clusters obtained by graphing the measurements for the different bones analysed 'seem to correspond, already in level III, to animals morphometrically equivalent to *Ovis aries* (slightly smaller than the *Ovis aries palustris* described by Ducos) and to *Capra hircus*' (*ib.*). The other clusters are formed by: (1) animals the size of Late Pleistocene ibex from the Basque country; and (2) animals intermediate in size between female ibexes and domestic male goats. From this he jumps to the conclusion that 'it is possible to maintain that, beginning in level III, there are ovicaprids of a size compatible with that of domestic animals, that is, that we are dealing with the initial stage of a domestic economy' (1988: 302, my translation). If the cluster of smaller animals had only been present in the uppermost levels with a presumed Neolithic occupation, this interpretation of the meaning of such a cluster might be acceptable. But the fact that the cluster already appeared in the analysis of the material from level III indicates that something else is going on, particularly in the light of the widespread opinion among specialists that the ancestor of the domestic goat is the middle eastern species *Capra hircus aegagrus*, and that European ibex are morphologically too different from goats to be related to their origin (Poplin *et al.* 1986; Vigne 1989). Estevez's conclusion is all the more unwarranted since he does not take into consideration the possibility that a second caprid, chamois, could be represented in the assemblage and be responsible for the smaller size ranges.

Chamois bones are very similar to sheep, and any faunal analyst, no matter how competent, might easily mistake the former for the latter (Uerpmann 1987; Rowley-Conwy, personal communication), particularly if operating in the framework of a theoretical bias towards early domesticates. On the other hand, it should be borne in mind that the site is located in high mountainous terrain, more than 1000 m above sea level, in what could, in the ecological conditions of early post-glacial times, have been the territory of chamois as well as ibex.

If these unwarranted speculations are discarded, the evidence for food production in layer II of Cova Fosca is restricted to the three *Ovis* bones found there and, in an indirect way, to the pottery that occurred in its upper part (the lower part, IIB, was aceramic, as mentioned above), since the lithics it contains are considered by Olaria to be identical to those from level III. According to her, it is only in level I that a change occurs in the lithic assemblages, which then acquire a Neolithic character, specifically by the presence of geometrics such as the segments, trapeze and transverse arrowheads illustrated on p. 215. The idea that levels II and III are in continuity and that a real stratigraphic break only occurs at the interface with level I is also apparent in the sedimentological study of the site by X. Ballbé and E. Villate (1988). According to them, 'there was no clear-cut stratification' (1988: 89) in the site, and the deposits could only be divided into two main groups: at the base, levels II and III, mainly made up of slabs and blocks accumulated through processes of gelifraction; at the top, level I, an anthropic deposit, made up of fine sediments and ash, and containing only a few scattered blocks. In this context, it is possible to suggest an interpretation of the Fosca stratigraphy different from that proposed by the excavator—namely, that level II is also of Epipaleolithic age, as indicated by the sediments, the lithics and the date obtained for its lower portion, and that the ceramics (which, let it be remembered, are considered by Olaria to be identical to those from level I), and the *Ovis* bones are therefore intrusive from the overlying Neolithic level I. If so, the disturbances responsible for such an intrusion might have brought up into level I charcoal from the underlying level II, and the dated samples would therefore be contaminated by older material. It is interesting to note, incidentally, that the three dates for level I are good averages of the age of the base of level II and the age of the surficial level, the latter (c. 5700 BP) being considered by Martí *et al.*

(1987) and Bernabeu (1989) as in good accord with the style of the ceramics found at Cova Fosca.

This explanation would require that the sequence, as at Dehesilla, were the object of post-depositional disturbance the excavator failed to recognize; and, unfortunately, several clues in the site report do tend to suggest that such is the case. For instance, the faunal analyst clearly acknowledges that badger bones (and possibly some of the rabbit, too) were naturally accumulated in the deposits. Badger is particularly important here, since it was represented in all levels (19 bones in level I, 6 in level II, 3 in level III); yet even though these bones unmistakably document an occupation of the cave by this carnivore, no animal burrows were identified in the excavation. Alleged 'habitation' features, by contrast, were numerous: for instance, Olaria presents two plans for level I (1988: 359 and 361) in which there is not a single stone not interpreted as belonging to a 'hearth' (none of them very convincing)—something that is hard to accept in face of the conclusion of the sedimentological report that the limestone blocks are a natural component of the deposits. Interestingly enough, these 'occupation floors' in which no badger burrows were recognized contained what the excavator calls 'post-holes': for instance, in the plan for Cuadro IV, level I (p. 363), there are no less than five so-called 'post-holes' of irregular shape and different sizes within an area of less than half a square meter, and they are contiguous to a 'storage pit' separated from an outcrop of the rocky cave floor by only some 30 cm of space occupied by—a 'hearth'!

In my opinion, based on prolonged experience of excavation in several cave sites located in similar Mediterranean environments, the majority of the so-called features reported by Olaria are in fact animal burrows. In any case, I should stress that I do not know of a single Holocene cave site in Portugal where burrowing by foxes and badgers has *not* produced significant disturbances of the deposits. Particularly relevant in this regard are the instances where Upper Paleolithic sequences are overlain by Neolithic occupations. In all such cases—Casa da Moura (Delgado 1867), Salemas (Roche *et al.* 1962), and, as discussed above, Caldeirão—the Upper Paleolithic layers were always affected by Neolithic intrusions, producing mixed deposits that, if not sorted, would have produced situations identical to those suggested here as an alternative interpretation for both La Dehesilla and Fosca. The validity of this alternative interpretation should therefore be tested and, if necessary,

rejected, for instance by individually dating the clearly Neolithic elements (such as the sheep bones, after confirmation that they are indeed those of sheep!), before the chronology attributed to these sites, based on samples of questionable association with the Neolithic material, can be accepted.

Cueva de Nerja

No monograph is available for this site, so its discussion cannot be as detailed as that for the other two sites considered above. According to Pellicer (1987), cardial sherds are present at Nerja, but they are very rare. One, however, was found at the interface between the Epipaleolithic and the Neolithic strata, which leads him to conclude that cardial pots were present from the very beginning of the Neolithic onwards.They would, however, have been a very minor and allochthonous element, related to influences from the east (Valencia), the characteristic ceramics of the earliest Neolithic at Nerja being the non-cardial impressed and *almagra* wares that, in all the known complete stratigraphic sequences of southern Spain, are epicardial or post-cardial. The dates obtained for this horizon at Nerja were 6480 ± 180 BP (GaK-8959), 7130 ± 150 BP (GaK-8975) and 7160 ± 180 BP (GaK-8973).

As acknowledged by Pellicer (1987) himself, however, the cave deposits suffered severely from mixing, particularly at the Epipaleolithic/Neolithic interface, which undoubtedly contributed to the fact that one third of the dates obtained for the Nerja sequence were not considered as acceptable. Among these were dates of c. 8000 BP for a 'Full Neolithic', of c. 6800 BP for a 'Late Neolithic', and of c. 6300 BP for an 'Upper Paleolithic'. In this regard, why those dates cited above are given credence, in face of the contradictory stratigraphic evidence from all the other sites, can only be explained in the context of the theoretical bias towards a very early non-cardial, locally evolved, Neolithic. One is thus forced to recognize that, if such an argument cannot be supported by the evidence from Cova Fosca and Cueva de la Dehesilla, there is even less likelihood of it being sustained by the yet weaker evidence from Nerja.

The Taphonomic Filter

As I hope to have demonstrated by this survey of the relevant empirical data, the hypothesis of a locally evolved Neolithic in Iberia is based on seriously flawed archaeological evidence. All the sites in question suffer from what can be called, after a well-known instance of the disease (see Fortea and Martí 1984–85), *the Verdelpino syndrome*: problematic stratigraphies (as, to a greater or lesser extent, all stratigraphies are, particularly in cave deposits) that went unrecognized, giving rise to questionable associations of sediments, dates and finds.

Another good example of it comes from France, at the Abri du Martinet, in Aquitaine. Here, the original excavations, undertaken by L. Coulonges in the 1930s, had uncovered what was described as a fine Holocene stratigraphy made up of several hearth levels, with a clear Sauveterrian level at the base, followed by three levels of Tardenoisian, the uppermost of which was considered to be already into the Neolithic. This sequence later played a major role in a model of local neolithization of southwestern France, where, based on the evolution of the lithics throughout the sequence, its late Tardenoisian or 'Pre-Roucadourian' levels were considered to be the Mesolithic substrate of a continental Early Neolithic, contemporaneous with the cardial but constituting an independent cultural tradition (Roussot-Laroque 1977). Recent work carried out at the site (Kervazo and Mazière 1989), however, revealed that this supposedly 'fine' stratigraphy was in fact highly disturbed, with numerous animal burrows and with medieval silos excavated through the deposits to a depth of over two meters below the surface. Furthermore, both the geological and the malacological data agreed in suggesting that this Holocene sequence was not even *in situ*, that it had accumulated through slope wash of sediments originally present in the platform above the shelter, and that the black colour of the sediment was not due to the 'hearths' identified by the original excavator, but to the fact that these deposits were an organic soil.

The fact that this syndrome turns out to be more pervasive than is currently acknowledged in the literature prompts a further question: might it not also be affecting the pattern of a long Mesolithic/Neolithic transition, with a slow and gradual introduction of the several elements of the Neolithic package, that has been derived from the French evidence, particularly in

relation to the existence of 'Mesolithic sheep'? Could the objections raised above against their existence at Cova Fosca be valid for the French sites as well? For Châteauneuf-les-Martigues, at least, this would indeed seem to be the case: in fact no Mesolithic sheep bones were found there when salvage work was carried out at the site by Courtin in 1979, suggesting that unidentified disturbances at the Mesolithic/Neolithic interface might be responsible for their presence in the Castelnovien levels of Escalon de Fonton's 1947 excavations (Courtin *et al.* 1985).

The other two sites that are reported to contain Mesolithic sheep are Grotte Gazel and the Abri de Dourgne. Grotte Gazel is located in the Aude valley, and contains a stratigraphic sequence that includes Magdalenian, Epipaleolithic and Early Neolithic occupations. The upper part of this sequence was excavated by J. Guilaine, the lower by D. Sacchi (1976), with analysis of the fauna from Guilaine's excavations undertaken by Geddes (1981; 1983). These excavations examined four areas of the site: the porch, the *eboulis*, and two areas of a central chamber. In the former two, the excavations included Late Mesolithic deposits, while in the chamber they stopped at the base of the cardial deposits. Ovicaprids are reported to be present in both the Late Mesolithic and the Early Neolithic levels, and in similar percentages: in the porch, they represent 21 to 62% of the fauna in the Mesolithic, and 36 to 80% in the Neolithic, while in the *eboulis*, they represent 39 to 42% in the Mesolithic, and 42 to 52% in the Neolithic.

A close analysis of the stratigraphic profiles supplied by Sacchi indicates that these data should be used very cautiously. He presents a profile (Sacchi 1976: fig. 2.2) of one of the areas of the central chamber, starting at the base of Guilaine's excavations (which, here, were the early cardial levels). The first level below these excavations (Level 3) is described as *Epimagdalénien évolué remanié par le cardial*—i.e., a Mesolithic level disturbed by the subsequent Neolithic occupations. If the first Neolithic occupation was so intense as to cause such a significant post-depositional disturbance of the underlying stratigraphy, there is no reason to suppose that the other areas of the cave were not equally subject to the same process. The Mesolithic levels underlying the cardial excavated by Guilaine in the porch and the *eboulis*, however, are not reported to have suffered from the problem identified by Sacchi in the equivalent levels of the central chamber—unless, of course, the presence of ovicaprids is taken precisely as a symptom of such a disturbance.

The magnitude of such processes in this site is also apparent from the data supplied by Sacchi: more than 50% of the area shown in his profile is occupied by the disturbed Level 3 and by animal burrows, some reaching all the way down to the top of the Magdalenian surface.

A further potential source of problems is the chamois/sheep similarity in bone morphology. Gazel is situated on the southern foothills of the Montagne Noire, with highly irregular relief rising to above 800 m within less than 10 km of the site (Geddes 1983). That this territory was exploited by the Mesolithic inhabitants of the cave is indicated by the ibex bones in Level F5 (the uppermost Mesolithic level) of the porch area; and, given the presence of ibex, there is no reason to suppose that the other alpine caprid, chamois, would have been absent from the environment. Could some of the *Ovis/Capra* bones of the Mesolithic levels actually be ibex and chamois? The doubt seems reasonable, and even more so in the case of the Abri de Dourgne, whose site catchment includes areas above 1200 m (Geddes 1983). As suggested above in the case of the Cova Fosca, the data from both sites therefore need clarification, specifically by investigating the possible confusion of sheep with chamois, and by the individual accelerator radiocarbon dating of bones that can be identified with certainty as those of sheep. Only then could we accept the concept of an early introduction of domesticates in the Late Mesolithic.

Implications for the Neolithization of Europe

When the very early, and unacceptable, radiocarbon dates are excluded, and the concept of Mesolithic sheep is submitted to detailed evaluation—that is, when the evidence is looked at through the appropriate taphonomic filters—the archaeology of the Mesolithic/Neolithic transition in west Mediterranean Europe exhibits a very clear pattern. This is the rather sudden and simultaneous appearance at around 6800 BP of several things that were not present before: pottery, polished stone axes, domesticated animals—in short, the so-called 'Neolithic package'. Once this pattern is recognized, the spread of cardial pottery archaeological cultures does not seem to be a process very different from that represented by the *Linearbandkeramik* [LBK] expansion across the northern European plain, the explanation of which has tradition-

ally been rooted in several variants of demic diffusion models (Childe 1929; Childe 1958; Dennell 1984; Dennell 1985a; Moore 1985). This is particularly so when one considers the rates of spread in each case (more or less instantaneous, at the available degree of resolution). In the case of Central Europe, however, it must be borne in mind that the pattern may be biased by the impact of 'old charcoal' on the dates currently available. As a matter of fact, recent AMS ^{14}C dating of short-lived samples (bone and seeds) has suggested that the chronology of the LBK in Germany may be somewhat later than hitherto thought (Whittle 1990), thus opening the possibility that the expansion was slow and gradual—along the lines of Ammerman and Cavalli-Sforza's (1973; 1984) and Renfrew's (1989) wave of advance—rather than the punctuated process it currently seems to have been.

But, insofar as the western Mediterranean areas are concerned, the chronometric evidence discussed above does suggest that in Mediterranean Spain and central Portugal the transition did not occur significantly later than in southern France. Such a broad contemporaneity between sites located more than 1500 km apart (as the crow flies) does not seem compatible with wave of advance models for the spread of agriculture. Indeed, according to Ammerman and Cavalli-Sforza's prediction, the Neolithic should have arrived in the Pyrenees between 6000 and 5000 BP. However, pottery, ovicaprids and agriculture are already present at c. 6800 BP in the Pyrenees themselves (Cueva de Chaves, Huesca), in Catalonya, in Valencia, in Andalucia, and, very likely, in Portugal as well (where the Caldeirão AMS ^{14}C dates on sheep bones demonstrate their presence at least from 6200 BP onwards). This, in combination with the 'enclave' settlement pattern that, at least in Portugal, characterizes the earliest Neolithic, instead suggests a process of initial settlement by small Neolithic seafaring groups in areas that were not exploited (or were only marginally exploited) by local hunter-gatherers, followed by a more or less delayed assimilation of the latter into the new economic system. Such a process, rapidly producing small widely -spread 'colonies', which were subsequently isolated from each other and thus drifted apart culturally, could, on the other hand, explain the interesting pattern noted by Guilaine (1976) in the ceramic styles of this vast region: initial broad similarity during the cardial stage, followed by marked regionalism in the epicardial or post-cardial stage. The evidence for exchange reported by Barnett (1990) for cardial wares from southern

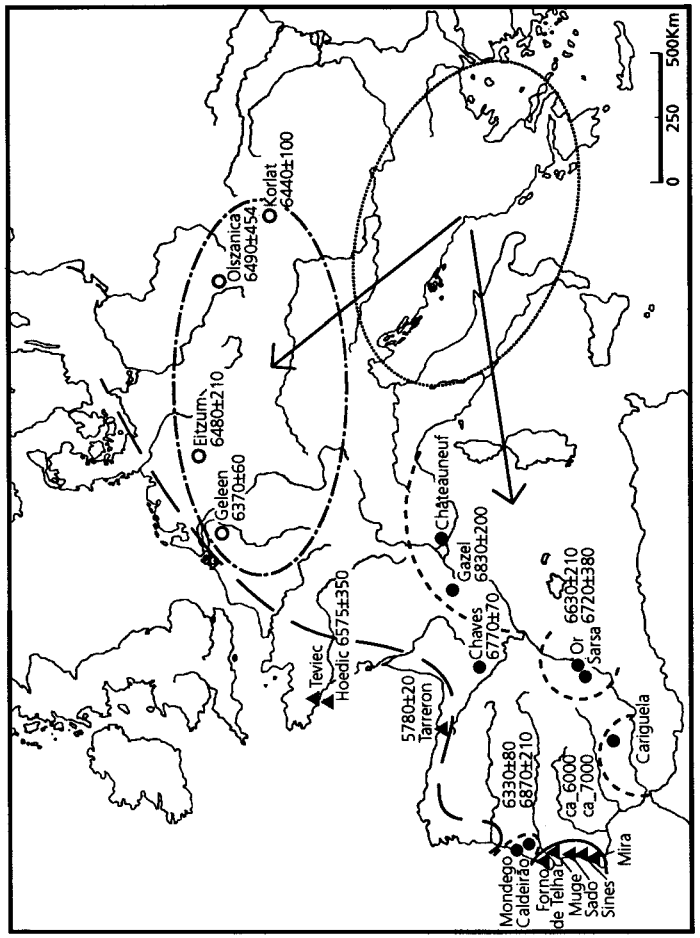


Fig. 10. The neolithization of Central and Western Europe as a punctuated phenomenon. A first pulse took settler groups ultimately originating in southern Italy and the Balkans up to the Atlantic littoral (Mesolithic sites—black triangles), following two main routes: the Danube (LBK sites—open circles) and the west Mediterranean shores (Cardial sites—black circles). A second pulse, after 6000-5500 BP, took agro-pastoral economies to northern Iberia, western France, the Low Countries, the British Isles and Scandinavia, probably through adoption of the new system by the local hunter-gatherer groups.

France, and his interpretation of these wares as 'affiliatory items in inter-group interaction', also contribute to the hypothesis of a common genealogy for the different west Mediterranean agricultural groups for which this pottery is the archaeological signature.

In this context, and with all the appropriate reservations in mind, it nonetheless seems that the neolithization of central and western Europe can still be seen as a punctuated process, with two main pulses (Fig. 10). The first, beginning around 6800–6400 BP, is characterized by the spread of the new economic system, following two main paths: (1) the *Danubian route*, along which the local Mesolithic populations would have been rapidly absorbed, given the immediate advantages that agriculture presented in these environments for solving the problems of over-wintering (Zvelebil 1986a); and (2) the *Mediterranean route*, where hunting and gathering and a more mobile settlement system were retained, given the particular ecological conditions and, perhaps, the more active role played by local hunter-gatherers in the transition. In the case of the Valencia area, for instance, several authors interpret the neolithization of the geometric Mesolithic Cocina facies as a process of acquisition by local hunters of the innovations (pottery, ovicaprids) brought by the settlers who occupied Cova de l'Or and other sites (Fortea and Martí 1984–85). This first phase of rapid expansion is followed by a period of stabilization, with a well-defined Neolithic/Mesolithic boundary, beyond which the littoral adaptations that had solved the problem of over-wintering through the exploitation of stable (mollusk banks) or migratory (salmon, seals, wild fowl, etc.) aquatic resources continued their development (Rowley-Conwy 1986; Zvelebil and Rowley-Conwy 1986). Although stable, this would not have been an impermeable boundary, since Neolithic objects and techniques (pottery, for instance) sometimes occur across the border, the disappearance of which would only take place during a second phase, after 6000–5500 BP. It is then that the Mesolithic groups living beyond the agricultural frontier stabilized at the end of the first pulse in the Atlantic fringe of Europe—the coasts of northern Portugal, Cantabrian Spain, western France, Belgium, the Netherlands and Great Britain—are finally assimilated.

If the scenario sketched above is indeed realistic, then the interpretation of the spread of agro-pastoral economies cannot be limited to its consideration simply as the inevitable result of these economies coming into being, as

implied by wave of advance models. And even if the onset of the second phase can be interpreted as linked to a catastrophic decline in the availability of aquatic resources, prompting local hunter-gatherers to adopt an economic system that already existed in their immediate neighbourhood, as argued by Zvelebil and Rowley-Conwy (1986) for the Scandinavian case, concrete historical explanations have still to be supplied for the question of why agricultural expansion happened in the first place. As a matter of fact, some of the processes of interaction between Mesolithic and Neolithic groups through which the new economic system finally spread across all of Europe are now beginning to be understood in a more satisfactory way (e.g., Dennell 1984; Dennell 1985a; Dennell 1985b; Moore 1985). But more effort should be put into modeling the process of initial expansion of the Neolithic groups—i.e., in *understanding the transition not only from the point of view of the locals, but also from that of the newcomers*. Demographic variables probably played a crucial role in the process, and models that take into consideration the differential demography of agriculturalists and hunters in close contact and competing for the same space would need to be developed in order to test the implications of this scenario.

The ideas put forward by Lewthwaite (1986a; 1986b) for the west Mediterranean area are a welcome first attempt to look at the problem from such a supra-regional perspective, and one that considers the social dynamics of the groups involved in the events. However, they suffer from the problem of trying to explain processes that in all likelihood never actually happened—a problem stemming from Lewthwaite's somewhat uncritical acceptance of two sets of crucial data, namely, the very early radiocarbon dates and the Mesolithic sheep. It is the acceptance of these data that drives him to try to explain the early diffusion of individual elements of the Neolithic package (sheep), selected through the operation of what he describes as an island filter (Corsica and Sardinia), and their introduction in the hunter-gatherer economies of southern France as prestige items acquired in the framework of long-distance exchange systems.

We will not insist further on the fact that neither the Spanish nor the French Neolithic dates older than 6800 BP should be accepted. On the other hand, the existence in western Mediterranean Europe, during Late Mesolithic times, of the long-distance exchange systems required by the model also

remains to be proven. Barnett (1990) has shown that cardial vessels circulated and might be involved in processes of exchange; Ricq-de Bouard (1983) has signaled important movements of raw-materials for the production of polished stone axes; extra-regional obsidian was present at Portiragnes (Roudil 1990). However, all this movement of artifacts and/or raw materials dates to a time *after* the introduction of pottery and domesticated animals. Furthermore, long distance east–west movement of objects or raw materials (such as the Portiragnes obsidian) is not enough to document the operation of an exchange system, since it can also be explained as the archaeological signature of a population movement following that same direction. West-to-east movements would have to be documented as well, namely through the discovery in Italy or in France of objects with a clear Iberian or North African origin, which, to the best of my knowledge, is something that has never been reported. Actually, in the case of Iberia at least, such two-way movement of objects or raw materials is not documented before the Chalcolithic, when beaker pots, Palmela points and other metal objects are found in sites of the Atlantic Maghreb, while ivory and ostrich-eggshell beads turn up in Portuguese and Spanish tombs of the same time period (Gilman 1975).

The fact that, according to the model, not only pottery but also domesticates would have been involved in the postulated exchange system represents a supplementary difficulty. The idea of domesticates as prestige items is in fact hardly acceptable in light of the fact that, as Rowley-Conwy (1986: 27) has shown for the case of pigs, it might be difficult for hunter-gatherers to reconcile the possession of domestic animals with their traditional economy, given the incompatibilities in terms of mobility and timing of resource acquisition that such a possession might imply (even if only owned for prestige, sheep and cattle would still have to be taken care of, fed and protected). It is interesting to note in this regard that when items of the 'Neolithic package' are reported across a hunter/farmer frontier and were arguably introduced through exchange systems, such items are invariably *artifacts*—for instance the pottery (or pottery technology), the amphibolite axes and the bone rings and combs that appear in the latest Mesolithic of Denmark and southern Sweden (Price 1991). By comparison with the northern European pattern, the fact that sheep and cereals are involved in the west

Mediterranean process seems to strengthen rather than weaken the hypothesis that the movement of people, not just the exchange of objects, is what actually took place.

Conclusion

Throughout this article, stratigraphic and taphonomic issues have been instrumental in rejecting variant models of the neolithization of west Mediterranean Europe put forward by different authors. The emphasis put on these issues may seem exaggerated to some, but in my opinion their impact on the way the Mesolithic/Neolithic transition has been interpreted is much stronger than is currently apparent in the literature. Nineteenth-century prehistorians (e.g., Delgado 1867) were well aware of the importance of submitting their data to a critique based on the 'site formation' perspective and, in the last twenty years, Paleolithic archaeologists have also become increasingly aware of this issue (e.g., Binford 1983). Pioneer work along these lines has already been reported from major Neolithic sites, such as that undertaken at the Baume de Fontbrégoua by Villa and Courtin (1982), which largely inspired my own work at Gruta do Caldeirão. It is with the same perspective that the Mesolithic/Neolithic transition should be analyzed in the first place, if we want to be sure that we are really dealing with the neolithization of *people*, not the neolithization of *deposits*.

Acknowledgments

This paper was written while the author was benefiting from a scholarship granted by the Calouste Gulbenkian Foundation (Lisbon). The excavations at Gruta do Caldeirão, and the ICEN dates obtained for this site, were mainly funded by the Instituto Português do Património Cultural. The Municipality of Tomar and the landowners (CELBI) also contributed in many different ways. Toronto AMS radiocarbon dates for Gruta do Caldeirão were obtained with the collaboration of David Lubell, Mary Jackes and Henry Schwarcz (who extracted the collagen and made the stable isotope analyses); those from Oxford were obtained with the collaboration of Peter Rowley-Conwy and

John Gowlett. José Arnaud, Nuno Carvalho Santos, William K. Barnett and Peter Rowley-Conwy read a preliminary version of the paper and contributed valuable comments, as did the three anonymous referees appointed by the editors. This author is deeply grateful to them and to all the researchers who contributed to the monographic study of the Neolithic levels of Caldeirão.

Author's Biography

Born in 1957, João Zilhão graduated from the Department of History of the University of Lisbon in 1982, where he has been a lecturer since 1984, teaching courses in World Prehistory, Prehistoric Archaeology of Iberia, and Archaeological Theory and Method. He is a member of the Permanent Council of the UISPP and of its Commission 8 (Problems of the Upper Paleolithic). His main research interests have been focused on the archaeology of the Late Pleistocene and the Early Holocene, particularly as regards the study of Upper Paleolithic societies, and on methodological issues in the investigation of cave deposits. He has recently published the first monographic volume reporting the excavations carried out at Gruta do Caldeirão, which deals with the Early Neolithic levels of the site; a second volume, on its Middle and Upper Paleolithic occupations, is in preparation.

References

Acosta, P.
1987 El Neolítico antiguo en el Suroeste español. La Cueva de la Dehesilla. In J. Guilaine, J-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 653-59. Paris: Centre National de la Recherche Scientifique.

Acosta, P., & M. Pellicer
1990 *La cueva de la Dehesilla (Jerez de la Fontera)*. Jerez: Consejo Superior de Investigaciones Científicas.

Ammerman, A.J., & L.L. Cavalli-Sforza
1973 A population model for the diffusion of early farming in Europe. In C. Renfrew (ed.), *The Explanation of Culture Change*, 343-57. London: Duckworth.
1984 *The Neolithic Transition and the Genetics of Population in Europe*. Princeton: Princeton University Press.

Araújo, A. C.
n.d. A estação epipaleolítica do Forno da Telha (Rio Maior). *O Arqueólogo Português* (in press).

Arnaud, J. M.
1982 Néolithique ancien et processus de néolithisation dans le sud du Portugal. *Archéologie en Languedoc*, no. spécial (Actes du Colloque International de Préhistoire), 29-48.
1987 Os concheiros mesolíticos dos vales do Tejo e do Sado: semelhanças e diferenças. *Arqueologia* 15: 53-64.
1989 The Mesolithic communities of the Sado Valley, Portugal, in their ecological setting. In C. Bonsall (ed.), *The Mesolithic in Europe*, 614-31. Edinburgh: John Donald.
1990 Le substrat mésolithique et le processus de néolithisation dans le sud du Portugal. In D. Cahen & M. Otte (eds.), *Rubané et Cardial*, 437-46. ERAUL 39. Liège: Études et Recherches Archéologiques de l'Université de Liège.

Ballbé, X., & E. Villate
1988 Estudio preliminar de la sedimentologia de la cavidad. In C. Olaria, *Cova Fosca. Un asentamiento meso-neolítico de cazadores y pastores en la serranía del Alto Maestrazgo*, 89-95. Castellón: Servicio de Publicaciones Diputación de Castellón.

Barnett, W.K.
1990 Production and distribution of early pottery in the West Mediterranean. In W.D. Kingery (ed.), *Ceramics and Civilization*. V. *The Changing Roles of Ceramics in Society: 26,000 BP to the Present*, 137-57. Westerville: The American Ceramic Society.
1992 The physical analyses of Early Neolithic impressed pottery from Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 297-312. Trabalhos de Arqueologia 6. Lisboa: Instituto Português do Património Arquitectónico e Arqueológico.

Bernabeu, J.
1989 *La tradición cultural de las cerámicas impresas en la zona oriental de la Península Ibérica*. Serie de Trabajos Varios 86. Valencia: Servicio de Investigación Prehistórica.

Binder, D., & J. Courtin
1986 Les styles céramiques du Néolithique ancien provençal. In J.-P. Demoule & J. Guilaine (eds.), *Le Néolithique de la France*, 83-93. Paris: Picard.

Binford, L.
1983 *In Pursuit of the Past*. London: Thames and Hudson.

Bowman, S.G.E., J.C. Ambers & M.N. Leese
1990 Re-evaluation of British Museum radiocarbon dates issued between 1980 and 1984. *Radiocarbon* 32(1): 59-79.

Callapez, P
1992 Moluscos terrestres das camadas A/B/C-Eb da Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 223-29. Trabalhos de Arqueologia 6. Lisboa, Instituto Português do Património Arquitectónico e Arqueológico.

Childe, V.G.
1929 *The Danube in Prehistory.* Oxford: Clarendon Press.
1958 *The Prehistory of European Society.* London: Penguin.
Courtin, J., J. Évin & Y. Thommeret
1985 Révision de la stratigraphie et de la chronologie absolue du site de Châteauneuf-les-Martigues (Bouches-du-Rhône). *L'Anthropologie* 89(4): 543-46.
Cruz, A.J.C.
1992a Análise geoquímica da coluna de amostragem D (camadas A/B/C-Eb) da Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 203-15. Trabalhos de Arqueologia 6. Lisboa: Instituto Português do Património Arquitectónico e Arqueológico.
1992b O teor em flúor nos ossos da Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 217-22. Trabalhos de Arqueologia 6. Lisboa, Instituto Português do Património Arquitectónico e Arqueológico.
Daugas, J.-P., J.-P. Raynal, A. Ballouche, S. Ochietti, P. Pichet, J. Evin, J.-P. Texier & A. Débénath
1989 Le Néolithique nord-atlantique du Maroc: premier essai de chronologie par le radiocarbone. *Compte-Rendus de l'Académie des Sciences de Paris* 308 (series II): 681-87.
Delgado, J.F.N.
1867 *Estudos geológicos. Da existência do homem no nosso solo em tempos mui remotos provada pelo estudo das cavernas. Primeiro opúsculo: Notícia acerca das grutas da Cesareda.* Lisboa: Memórias da Comissão Geológica de Portugal.
De Niro, M.J.
1986 Stable isotopy and archaeology. *American Scientist* 75: 182-91.
Dennell, R.
1984 The expansion of exogenous-based economies across Europe: the Balkans and Central Europe. In S.P. De Atley & F.J. Findlow (eds.), *Exploring the Limits. Frontiers and Boundaries in Prehistory*, 93-115. BAR International Series 223. Oxford: British Archaeological Reports.
1985a The hunter-gatherer/agricultural frontier in prehistoric temperate Europe. In S.W. Green & S.J. Perlman (eds.), *The Archaeology of Frontiers and Boundaries*, 113-39. New York: Academic Press.
1985b *European Economic Prehistory.* London: Academic Press.
Estevez, J.
1988 Estudio de los restos faunisticos. In C. Olaria, *Cova Fosca. Un asentamiento mesoneolítico de cazadores y pastores en la serranía del Alto Maestrazgo*, 281-337. Castellón: Servicio de Publicaciones Diputación de Castellón.
Evin, J.
1987 Révision de la chronologie absolue des débuts du Néolithique en Provence et Languedoc. In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 27-36. Paris: Centre National de la Recherche Scientifique.
Fortea, J., & B. Martí
1984–85 Consideraciones sobre los inicios del Neolítico en el Mediterráneo español. *Zephyrus* 37-38: 167-99.

Geddes, D.
1981 Les débuts de l'élevage dans la vallée de l'Aude. *Bulletin de la Société Préhistorique Française* 78(10-12): 370-78.
1983 Neolithic transhumance in the Mediterranean Pyrenees. *World Archaeology* 15: 51-66.
Gilman, A.
1975 *A Later Prehistory of Tangier (Morocco).* Cambridge (MA): Peabody Museum of Archaeology and Ethnology.
González Morales, M., & J. Arnaud
1990 Recent research on the Mesolithic of the Iberian Peninsula. In P.M. Vermeersch & Ph. Van Peer (eds.), *Contributions to the Mesolithic in Europe*, 451-61. Leuven: Leuven University Press.
González Sainz, C., & M. González Morales
1986 *La Prehistoria en Cantabria.* Santander: Tantin.
Guilaine, J.
1976 *Premiers bergers et paysans de l'Occident méditerranéen.* Paris: Mouton.
1980 Problèmes actuels de la néolithisation et du Néolithique ancien en Mediterranée occidentale. In J.G.P. Best & N.M.W. de Vries (eds.), *Interaction and Acculturation in the Mediterranean*, 3-22. Amsterdam: BR Grüner.
Guilaine, J., J. Coularou, A. Freises & R. Montjardin (eds.)
1984 *Leucate-Corrège. Habitat noyé du Néolithique cardial.* Toulouse/Sète: Centre d'Anthropologie des Sociétés Rurales/Musée Paul Valéry.
Guilaine, J., & O.V. Ferreira
1970 Le Néolithique ancien au Portugal. *Bulletin de la Société Préhistorique Française* 67 (Études et Travaux 1): 304-22.
Heleno, M.
1956 Um quarto de século de investigação arqueológica. *O Arqueólogo Português* III (2nd series): 221-37.
Jackes, M., & D. Lubell
1992 The Early Neolithic human remains from Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 259-95. Trabalhos de Arqueologia 6. Lisboa: Instituto Português do Património Arquitectónico e Arqueológico.
Jodin, A.
1958–59 Les grottes d'El Khril à Achakar. *Bulletin d'Archéologie Marocaine* 3: 249-313.
Jorge, S.O.
1979 Contributo para o estudo de materiais provenientes de estações neolíticas dos arredores da Figueira da Foz. In *Actas da 1ª Mesa-Redonda sobre o Neolítico e o Calcolítico em Portugal (Porto, Abril de 1978)*, 53-82. Porto: Grupo de Estudos Arqueológicos do Porto.
Kervazo, B., & G. Mazière
1989 Le gisement du Martinet à Sauveterre-la-Lémance (Lot-et-Garonne): nouvelles données et implications. *Bulletin de la Société Préhistorique Française* 86(9): 263-65.
Lewthwaite, J.
1986a From Menton to the Mondego in three steps: application of the availability model to the transition to food production in Occitania, Mediterranean Spain and Southern Portugal. *Arqueologia* 13: 95-112.

1986b The transition to food production: a Mediterranean perspective. In M. Zvelebil (ed.), *Hunters in Transition: Mesolithic Societies of Temperate Eurasia and their Transition to Farming*, 53-66. Cambridge: Cambridge University Press.

Lubell, D., & M. Jackes
1985 Mesolithic-Neolithic continuity: evidence from chronology and human biology. *Actas da I Reunião do Quaternário Ibérico*, 2:113-33. Lisboa: Grupo de Trabalho Português para o Estudo do Quaternário.
1988 Portuguese Mesolithic-Neolithic subsistence and settlement. *Rivista di Antropologia* 66 (Supplementary volume): 231-48.

Lubell, D., M. Jackes, H. Schwarcz & C. Meiklejohn
1986 New radiocarbon dates for Moita do Sebastião. *Arqueologia* 14: 34-36.

Marks, A., N. Bicho, J. Zilhão & C.R. Ferring
n.d. Upper Pleistocene prehistory in Portuguese Estremadura: preliminary results. *Journal of Field Archaeology* (in press).

Martí, B., J. Fortea, J. Bernabeu, M. Perez, J.D. Acuna, F. Robles & M.-D. Gallart
1987 El Neolitico antiguo en la zona oriental de la Peninsula Iberica. In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 607-19. Paris: Centre National de la Recherche Scientifique.

Moore, J.A.
1985 Forager/farmer interactions: information, social organization, and the frontier. In S.W. Green & S.J. Perlman (eds.), *The Archaeology of Frontiers and Boundaries*, 93-112. New York: Academic Press.

M.N.A.E. [Museu Nacional de Arqueologia e Etnologia]
1989 *Portugal. Das Origens à Época Romana.* Lisboa: Instituto Português do Património Cultural.

Navarrete, M.-S.
1976 *La cultura de las cuevas con cerámica decorada en Andalucía oriental.* Granada: Universidad de Granada.

Navarrete, M.-S., & F. Molina
1987 Le processus de néolithisation et les débuts de la sédentarisation en Haute-Andalousie. In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 645-51. Paris: Centre National de la Recherche Scientifique.

Olaria, C.
1988 *Cova Fosca. Un asentamiento meso-neolítico de cazadores y pastores en la serranía del Alto Maestrazgo.* Castellón: Servicio de Publicaciones Diputación de Castellón.

Olaria, C., & F. Gusi
1987 Nouveaux aspects dans la problématique du Néolithique ancien dans la Méditerrannée occidentale: Cova Fosca (Castellón, Espagne). In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 633-37. Paris: Centre National de la Recherche Scientifique.

Pellicer, M.
1987 El Neolitico de la Cueva de Nerja (Malaga). In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 639-43. Paris: Centre National de la Recherche Scientifique.

Poplin, F., Th. Poulain, P. Méniel, J.-D. Vigne, D. Geddes & D. Helmer
1986 Les débuts de l'élevage en France. In J.-P. Demoule & J. Guilaine (eds.), *Le Néolithique de la France*, 37-51. Paris: Picard.

Price, T.D.
1991 The Mesolithic of Northern Europe. *Annual Review of Anthropology* 20: 211-13.

Raposo, L., C. Penalva & J.P. Pereira
n.d. Notícia da descoberta da estação mirense de Palheirões do Alegra, Cabo Sardão (Odemira, Portugal). Paper presented to the II Reunião do Quaternário Ibérico, Madrid, September 1989.

Real, F.C.S.
1992 Estudo mineralógico de adornos de cor verde do Neolítico Antigo da Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 315-319. Trabalhos de Arqueologia 6. Lisboa: Instituto Português do Património Arquitectónico e Arqueológico.

Renfrew, C.
1989 The origins of Indo-European languages. *Scientific American* 261(4): 82-90.

Ricq-de Bouard, M.
1983 L'outillage de pierre polie des Alpes aux Pyrénées au Néolithique ancien: la naissance d'une industrie. In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 305-15. Paris: Centre National de la Recherche Scientifique.

Roche, J.
1977 Les amas coquilliers mésolithiques de Muge (Portugal). Chronologie, milieu naturel et leurs incidences sur le peuplement humain. *Approche écologique de l'homme fossile. Supplément au Bulletin de l'Association Française pour l'Étude du Quaternaire* 47: 353-59.

Roche, J., J.C. França, O.V Ferreira & G. Zbyszewski
1962 Le Paléolithique supérieur de la grotte de Salemas (Ponte de Lousa). *Comunicações dos Serviços Geológicos de Portugal* XLVI: 197-207.

Roudil, J.-L.
1990 Cardial et Néolithique ancien ligure dans le sud-est de la France. In D. Cahen & M. Otte (eds.), *Rubané et Cardial*, 383-91. ERAUL 39. Liège: Etudes et Recherches Archéologiques de l'Université de Liège.

Roussot-Larroque, J.
1977 Néolithisation et Néolithique ancien d'Aquitaine. *Bulletin de la Société Préhistorique Française* 74 (Etudes et Travaux 2): 559-82.

Rowley-Conwy, P.
1986 Between cave painters and crop planters: aspects of the temperate European Mesolithic. In M. Zvelebil (ed.), *Hunters in Transition: Mesolithic Societies of Temperate Eurasia and their Transition to Farming*, 17-32. Cambridge: Cambridge University Press.

1992 The Early Neolithic animal bones from Gruta do Caldeirão. In J. Zilhão, *Gruta do Caldeirão. O Neolítico Antigo*, 231-57. Trabalhos de Arqueologia 6. Lisboa: Instituto Português do Património Arquitectónico e Arqueológico.

Sacchi, D.
1976 Les civilisations de l'Epipaléolithique et du Mésolithique en Languedoc occidental (Bassin de l'Aude) et en Roussillon. In H. de Lumley (ed.), *La Préhistoire Française, I-II*, 1390-97. Paris: Centre National de la Recherche Scientifique.

Santos, M.F., J. Soares & C.T. Silva
1974 O concheiro epipaleolítico do Cabeço do Pez (Vale do Sado - Torrão) - primeira notícia. *Actas do III Congresso Nacional de Arqueologia*, 173-89. Porto: Junta Nacional de Educação.

Sheppard, P.
1987 *The Capsian of North Africa*. BAR International Series 353. Oxford: British Archaeological Reports.

Silva, C.T.
1989 Novos dados sobre o Neolítico antigo do sul de Portugal. *Arqueologia* 20: 24-32.

Silva, C.T., & J. Soares
1981 *Pré-história da área de Sines*. Lisboa: Gabinete da área de Sines.
1987 Les communautés du Néolithique ancien dans le sud du Portugal. In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 663-671. Paris: Centre National de la Recherche Scientifique.

Silva, C.T., J. Soares & C. Penalva
1985 Para o estudo das comunidades neolíticas do Alentejo litoral: o concheiro do Medo Tojeiro. *Arqueologia* 11: 5-15.

Soares, A.M.
1989 *O efeito de reservatório oceânico nas águas costeiras de Portugal continental*: Lisboa: Instituto de Ciências e Engenharia Nucleares.

Soares, A.M., & J.M.P. Cabral
1984 Datas convencionais de radiocarbono para estações arqueológicas portuguesas e a sua calibração: revisão crítica. *O Arqueólogo Português* 2 (IVth series): 167-214.
1989 Idades aparentes das conchas marinhas provenientes da costa portuguesa e a sua variação ao longo do Holoceno. Paper presented to the II Reunião do Quaternário Ibérico, Madrid, September 1989.

Straus, L.G.
1989 New chronometric dates for the prehistory of Portugal. *Arqueologia* 20: 73-76.

Straus, L.G., J. Altuna, E. Carvalho, M. Jackes & M. Kunst
1988 New excavations in Casa da Moura (Serra d'El Rei, Peniche) and at the Abrigos de Bocas (Rio Maior), Portugal. *Arqueologia* 18: 65-95.

Straus, L., J. Altuna & B. Vierra
1990 The Concheiro at Vidigal: a contribution to the Late Mesolithic of Southern Portugal. In P.M. Vermeersch & Ph. Van Peer (eds.), *Contributions to the Mesolithic in Europe*, 463-74. Leuven: Leuven University Press.

Uerpmann, H.-P.
1987 The origins and relations of Neolithic sheep and goats in the Western Mediterranean. In J. Guilaine, J.-L. Roudil & J.-L. Vernet (eds.), *Premières communautés paysannes en Méditerranée Occidentale*, 175-79. Paris: Centre National de la Recherche Scientifique.

Vigne, J.-D.
1989 Origine des principaux mammifères domestiques de l'Ancien Monde. *Ethnozootechnie* 42: 1-5.

Villa, P., & J. Courtin
1982 Une expérience de piétinement. *Bulletin de la Société Préhistorique Française* 79(4): 117-23.

Whittle, A.
1990 Radiocarbon dating of the Linear Pottery culture: the contribution of cereal and bone samples. *Antiquity* 64: 297-302.

Zilhão, J.
1990 Le processus de néolithisation dans le centre du Portugal. In D. Cahen & M. Otte (eds.), *Rubané et Cardial*, 447-59. ERAUL 39. Liège: Études et Recherches Archéologiques de l'Université de Liège.
1992 *Gruta do Caldeirão. O Neolítico Antigo*. Trabalhos de Arqueologia 6. Lisboa: Instituto Português do Património Arquitectónico e Arqueológico.

Zvelebil, M.
1986a Mesolithic societies and the transition to farming. In M. Zvelebil (ed.), *Hunters in Transition: Mesolithic Societies of Temperate Eurasia and their Transition to Farming*, 167-88. Cambridge: Cambridge University Press.
1986ab (ed.) *Hunters in Transition: Mesolithic Societies of Temperate Eurasia and their Transition to Farming*. Cambridge: Cambridge University Press.

Zvelebil, M., & P. Rowley-Conwy
1986 Foragers and farmers in Atlantic Europe. In M. Zvelebil (ed.), *Hunters in Transition: Mesolithic Societies of Temperate Eurasia and their Transition to Farming*, 67-94. Cambridge: Cambridge University Press.