

THE NEOLITHIC IN NORTHEAST IBERIA: CHRONOCULTURAL PHASES AND ¹⁴C

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ABSTRACT. As in many other regions, the periodization of the Neolithic in the northeastern Iberian Peninsula was based upon relative dating obtained through ceramic typologies. Moreover, this prehistoric period was structured using nomenclature borrowed from the Neolithization of southern France. A total of 37 new radiocarbon dates for NE Iberia have been recently obtained with appropriate sampling criteria. These results have been used in conjunction with other reliable ¹⁴C dates in order to assess the validity of traditional classifications established through the study of ceramic typologies. The gradual improvement in the quality of sample choice and the available archaeological records allowed the selection of 187 dates obtained mostly from short-lived taxa. This has enabled the chronological boundaries to be adjusted as precisely as possible.

KEYWORDS: pottery culture, ¹⁴C, Neolithic, Iberian Peninsula.

INTRODUCTION

The earliest evidence available for the Neolithic in northeast Iberia dates back to the mid-6th millennium cal BC. Until then, this region was occupied by Mesolithic hunter-gatherer communities living in the lowlands and the mountains of the Pyrenees/Pre-Pyrenees, and the Pre-littoral ranges. Examples of Mesolithic sites are Cova del Parco, Cova de Can Sadurní, Cova del Vidre, Font del Ros, Balma Margineda, and Bauma del Serrat del Pont (Guilaine 1976; Guilaine and Martzluft 1995; Pallarés et al. 1997; Bosch 2001; Alcalde et al. 2008; Blasco et al. 2005; Fullola and García-Argüelles 2006).

The first Neolithic societies in southwest Europe were mainly characterized by agriculture and animal husbandry. Neolithic sites show evidence cultivation of wheat, barley (*Triticum aestivum t. compactum*, *Triticum aestivum/durum*, *Triticum dicoccum*, *Hordeum vulgare nudum*, and *Hordeum vulgare*), and legumes (white beans, *Vicia fava*, and peas, *Pisum sativum*) (Zapata et al. 2004; Gassin et al. 2010; Antolin and Buxó 2012). Neolithic groups also kept several domestic animal species (sheep, *Ovis aries*; goats, *Capra hircus*; cattle, *Bos taurus*; and swine, *Sus domesticus*) (Tresset and Vigne 2007; Vigne 2007). In addition, these groups had mastered pottery-making techniques and produced lithic industries consisting both of knapped artifacts (blades and flakes used to make a wide range of tools) and ground stone implements (axes, adzes, and querns).

A large number of radiocarbon determinations are assessed here to examine the validity of the Neolithic phases that have been determined in the northeastern Iberian Peninsula. These have mainly been established on the basis of pottery morphology and decoration, although other elements have also been used to define chronocultural phases, e.g. lithic technologies, patterns observed in the selection of raw materials used in the production of tools and ornaments, peculiarities observed in bone implements, and burial evidence. Based on these parameters, five periods have been defined: Cardial Early Neolithic, Epicardial Early Neolithic, Postcardial Neolithic,

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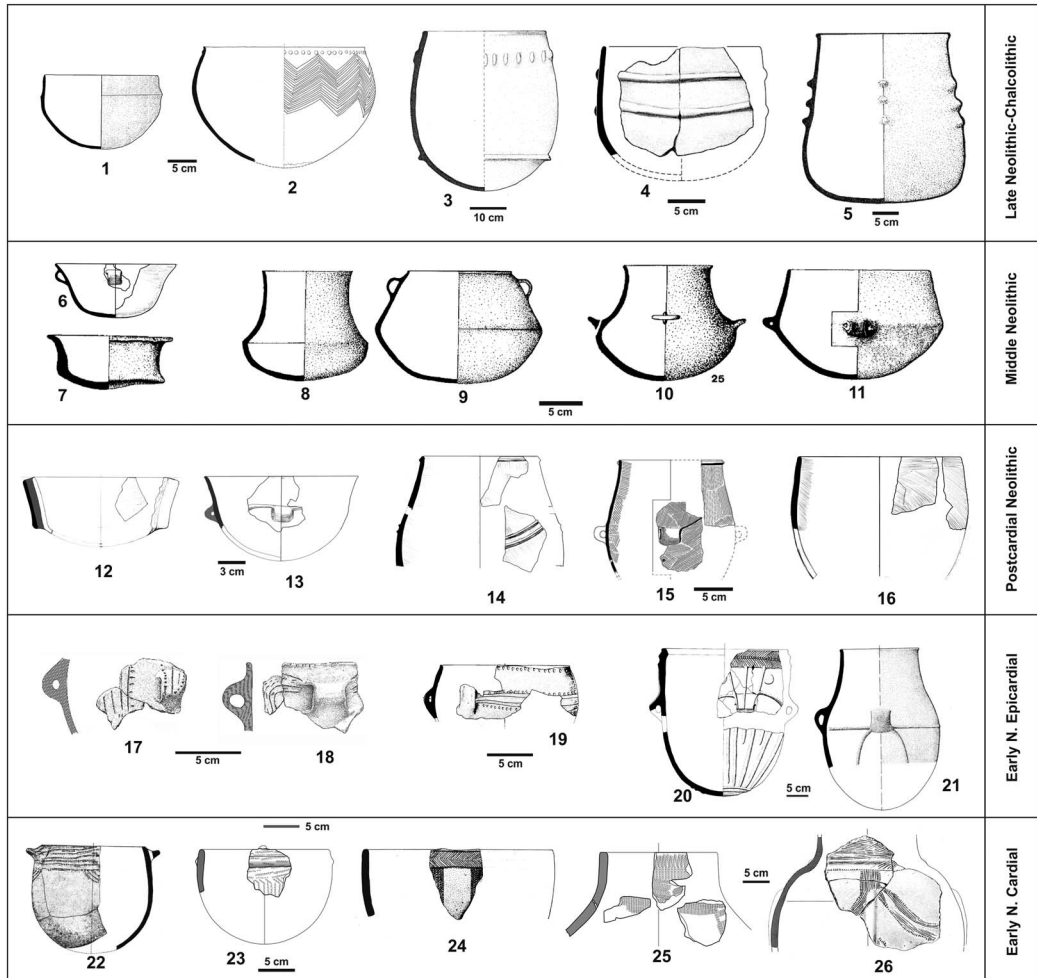


Figure 1 Typical pottery forms and decorations in the different Neolithic phases. **Late Neolithic–Chalcolithic:** 1 Cova de Can Sadurn; 2 Les Roquetes; 3 Bòbila Palazón; 4 Cova Joan d’Os; 5 Cova Verda. **Middle Neolithic:** 6 La Serreta E10; 7 Bòbila Madurell; 8 and 10 Pla del Riu de les Marçetes; 9 Can Tintorer; 11 Garrofers Torrent de Santa Maria. **Postcardial Neolithic,** 12, 13, and 15 La Serreta E32 and E37; 14 Mas d’en Boixos; **Epicardial Early Neolithic:** 17 and 18 Cova del Frare c5; 19 Timba de Barenys; 20 Cova de l’Avellaner; 21 Plansallosa PSL-II. **Cardial Early Neolithic:** 22 Can Sadurn c18; 23 La Serreta E61; 24 Cova del Toll IIb; 25 Guixerens de Vilobi A; 26 La Draga.

Middle Neolithic, and Final Neolithic–Chalcolithic (Tarrús 1985; Mestres 1992; Martín 1993; Miró 1994; Martín et al. 2002, 2010; Molist et al. 2003; Gibaja 2003) (Figure 1).

In the last decade, the number of ^{14}C dates obtained for the Neolithic in northeast Iberia has increased significantly. However, the quality of the data still varies. In many cases, inappropriate samples have been taken from mixed deposits and, in others, the exact location of samples is not specified. Therefore, it can be difficult to make a precise interpretation of the dates. The very nature of ^{14}C determinations, with their statistical and probability aspects and standard deviations (variations smaller than ± 30 yr are still quite rare) means that the chronological periods traditionally established by pottery morphology and decoration overlap

slightly. Indeed, this overlapping requires further reflection and investigation and will be discussed towards the end of this paper.

The aim of this paper is to present the determinations currently available from Neolithic sites of northeast Iberia, analyze their validity according to a number of defined parameters, and compare the results of these determinations with existing relative chronologies.

MATERIALS AND METHODS

The initial phase of this investigation involved gathering all the published dates in addition to those obtained by the authors through their own research projects.¹ This paper presents a total of 37 new dates that are published here for the first time.

The known and new dates total 299 ¹⁴C determinations (Mestres and Martín 1996; Manen and Sabatier 2003; Morales et al. 2010; Martín et al. 2010). An initial critical analysis of these dates led to the elimination of all those results with a standard deviation of over ± 100 yr, which meant that a total of 112 dates were discarded. These dates were disregarded as they were obtained by mixing materials (normally pieces of charcoal), a common practice among archaeologists until quite recently. This practice may have resulted in a mixture from different cultural levels and therefore a lack of archaeological representativeness (Zilhão 2001; Morales et al. 2010).

Secondly, a simple process has been followed to determine the quality and validity of the results. Validity is understood in terms of the reliable archaeological information that can be drawn from them (Van Strydonck et al. 1998; Bernabéu 2006; Rojo et al. 2006:98; Morales et al. 2010; Zilhão 2011). Thus, the nature of the samples has been considered above all: whether they come from reliable archaeological contexts (i.e. from hearths or burial deposits, animal pen levels or *fumiers*, in a primary position or from levels that were sealed rapidly) and whose standard deviation is less than ± 100 BP. This strategy has allowed the classification of chronological determinations into three classes:

- High confidence: Short-life domestic samples (seeds and domestic animals), charcoal identified as coming from short-life taxa or twigs, and human remains from primary burials found in graves dug *ex profeso* or secondary interments in collective deposits.²
- Medium confidence: Short-life samples not identified taxonomically or wild species recovered from well-determined archaeological contexts. Unlike the previous class, these samples were taken from archaeological levels or domestic structures such as storage pits, which are able to define a relative chronology.
- Rejected: This class includes determinations with a standard deviation greater than ± 100 BP and samples from unclear contexts or with dubious associations between radiocarbon results (absolute dates) and contexts (material culture).

¹These dates come from three research projects: *Estudi integral de les recerques arqueològiques al peatge de l'AP-7 (Vilafranca del Penedès)*, funded by the Institut Català d'Arqueologia Clàssica (ICAC); *The Neolithic in the Mediterranean Basin* (SFRH/BD/44089/2008), funded by Fundação para a Ciência e Tecnologia de Portugal; and *Aproximación a las primeras comunidades neolíticas del NE peninsular a través de sus prácticas funerarias* (HAR2011-23149) funded by the Spanish Ministry of Economy and Competitiveness.

²It is widely known that determinations using charcoal samples can result in older dates than short-lived samples because of the "old wood effect" (Zilhão 2001). We have therefore only taken into account samples of charcoal from short-life species or small branches, or those collected from combustion structures or levels of animal pens. It should equally be noted that, as asserted in the discussion, corrections for the "reservoir effect" have not been applied in the case of samples from human remains.

Table 1 Classification of the dating results: A. Cultural phase; B. Number of sites with ^{14}C dates; C. Number of sites with high-confidence dates; D. Total number of dates available; E. Total number of high-confidence dates. F. % of the reliable dates.

A	B	C	D	E	F
Cardial Early Neolithic	25	21	66	46	69.7
Epicardial Neolithic	17	11	27	16	59.2
Postcardial Neolithic	24	16	59	40	67.8
Middle Neolithic	24	20	69	38	55
Final Neolithic-Chalcolithic	41	25	78	47	60.2
TOTAL			299	187	

With these filters, the total number of dates that can be considered reliable was reduced to 187. This is the data set used to obtain the results and conclusions given in the final part of the paper. Table 1 summarizes the results obtained after assessing the dates according to the criteria for their reliability described above. In this paper, only calibrations to 2σ (95% probability) are presented, with cumulative graphs being generated with the software OxCal v 4.2 (Bronk Ramsey 2009) and IntCal13 curve (Reimer et al. 2013). It can be seen that the Cardial Early Neolithic phase is the one with the closest relationship between the total number of dates and the number of accepted dates (~70%). This may be due to the researchers who studied those sites taking greater care in taking the best samples from the clearest deposits. It may also be the result of a wish to minimize issues associated with the transition between Mesolithic hunter-gatherer levels and those of the first Neolithic farming communities. Thus, special care was taken in selecting short-life domestic samples for the first theoretically Neolithic levels and in discarding those that might distort the information obtained with dates older than their real age, if samples of wild fauna or charcoal were selected and dated.

In the other chronological phases, the number of valid dates is around 68–55%. In more recent phases, the number of samples from human remains increases considerably, above all in the phases termed Middle Neolithic and Final Neolithic–Chalcolithic. This is because of the high frequency of funerary sites in those periods.

At the same time, it should be noted that the calibration curve (Figure 2) indicates certain times that are unfavorable for calibration. These moments are seen as a steep fall in the curve followed by an artificial plateau or even a peak, called wiggles (Reimer et al. 2013). The most important of these times, in connection with the chronological phases established by pottery types, are

- 5300–5000 cal BC, at the end of the Cardial Early Neolithic.
- 4300–4000 cal BC, in the transition from the Postcardial Neolithic to the start of the Middle Neolithic.
- 3600–3200 cal BC, a time traditionally regarded as falling between the Middle Neolithic and Final Neolithic.
- 3000–2400 cal BC, during the Late Neolithic–Chalcolithic phase.

RESULTS

The ^{14}C determinations obtained from different kinds of samples will be presented in connection with the relative chronology of the sites and their position in the different phases traditionally accepted for the Neolithic in the northeastern Iberian Peninsula.

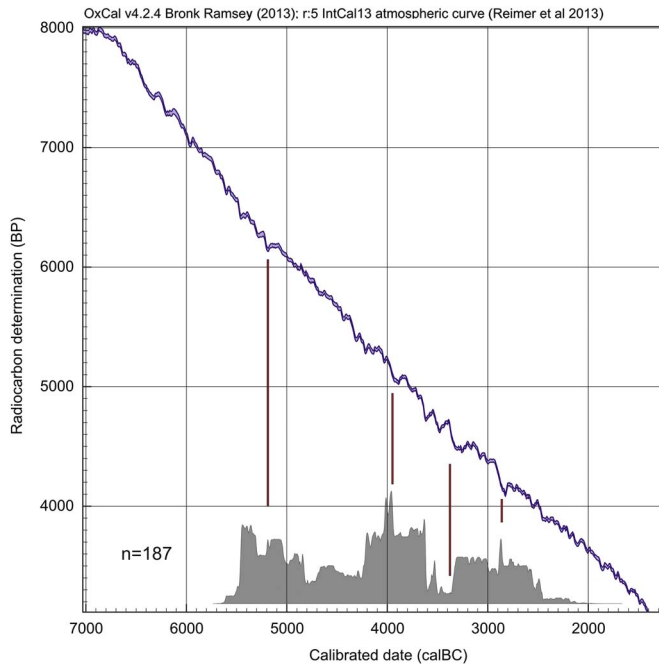


Figure 2 Radiocarbon diagram for the Neolithic of northeast Iberia with the dates accepted for this study. The steep slopes (vertical red) are highlighted in the calibration curve (OxCal v 4.2 and IntCal13).

Cardial Early Neolithic

The first Neolithic phase has been traditionally characterized by Cardial Ware, a particular type of pottery decorated with impressions of *Cerastoderma edule* and *Cerastoderma glaucum*. However, current research has demonstrated that other sites belonging to the same phase yielded decoration based on impressions made with other techniques and implements such punches and combs (Oms et al. 2012; Oms 2014).

Most of the samples dated belonging to this period come from open-air and cave habitation sites located near the Mediterranean coast, and in precoastal and inland territories (Figure 3). This follows a pattern already observed at the first Neolithic settlements in the western Mediterranean: these early settlements are located near the shore. A number of scholars believe that this is because the first Neolithic societies traveled by sea, following the coast (Zilhão 2001). In contrast, few samples were taken from human remains, as little is known about the funerary practices of these first Neolithic populations.

After critically assessing the known determinations for this phase, a total of 46 dates have been considered valid. Most of them (44) were analyzed by the accelerator mass spectrometry (AMS) method and only two of the dates were obtained by beta-counting ^{14}C dating.

Most of the samples were taken from carbonized domestic cereal grains (*Triticum aestivum*/*durum*, *Triticum dicoccum*, and *Triticum* sp.) and domestic fauna (*Ovis aries*, *Bos taurus*), with 19 and 14 determinations, respectively. These two types of short-life samples are the best for dating, according to the quality criteria proposed by many researchers (e.g. Bernabéu 2006; Zilhão 2011) (Figure 3). In addition, at two sites, dates were obtained for human remains (Plaza Vila de Madrid and

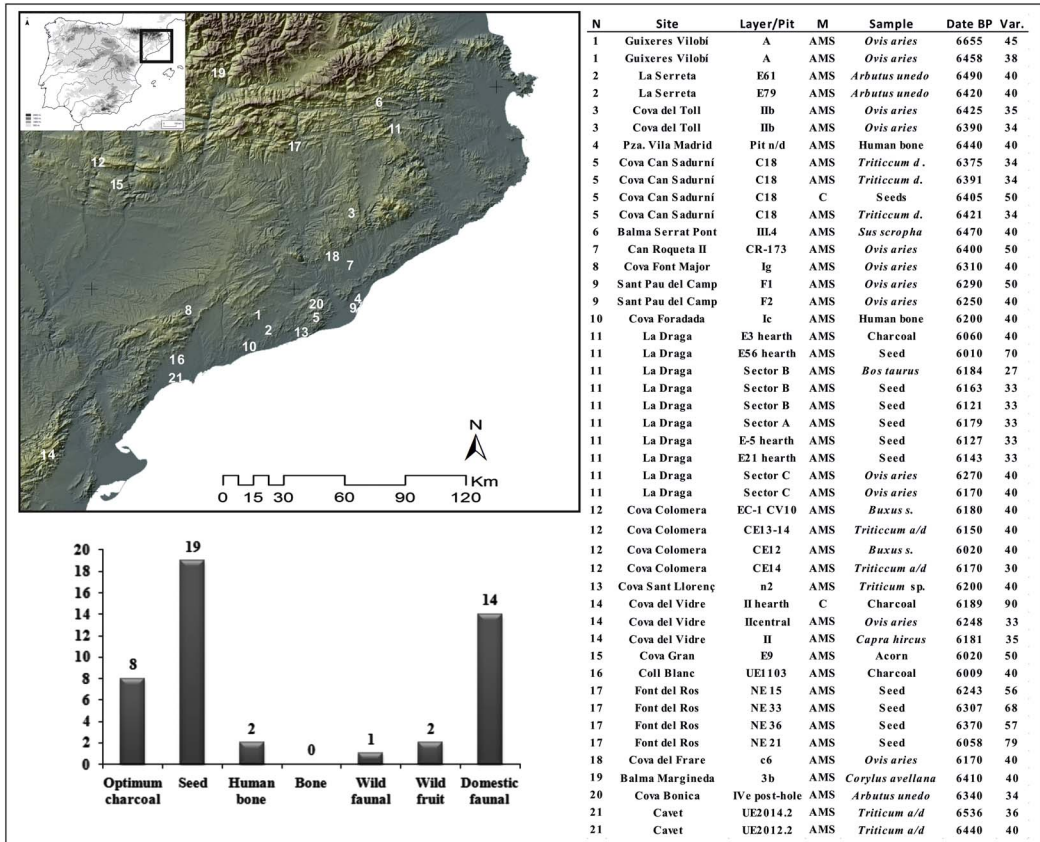


Figure 3 Location of the Cardial Early Neolithic sites with high-confidence dates and the type of material sampled (the complete reference of the determinations is in the online Appendix).

Cova Foradada). Finally, three dates were obtained from wild taxa: an acorn in Structure E-9 at Cova Gran de Santa Linya, a seed coat of *Corylus avellana* from Level 3b at Balma Margineda, and a *Sus scropha* bone from Level III.4 at La Balma del Serrat del Pont. These determinations are perfectly valid bearing in mind the level in which the samples were located and their relationship with the archaeological record with which they are associated.

A further 11 determinations were based on charcoal samples (Figure 3). In this case, they were regarded as acceptable as they came from species with a potential short life or were taken in certain structures, like a hearth, *fumier*, or silo. Some examples are the charcoal from the *fumier* and the combustion structure EC1 at Cova Colomera, the hearth in Level II at Cova del Vidre, the hearth E3 at the settlement of La Draga, and the silos E61 and E79 at La Serreta.

The calibration of the 46 dates and the graphs produced show that they correspond to the period between ~5500–4850 cal BC (2σ , 95% probability). The graph (Figure 9) reveals other aspects requiring explanation. Above all, two clear groupings can be seen, one around 5400 cal BC and the other around 5150 cal BC. This may be because of a taphonomic problem with the conservation of sites dated between 5350 and 5250 cal BC (Berger 2005) or due of the existence of a wiggle-match in the calibration curve (as suggested above and in Figure 2).

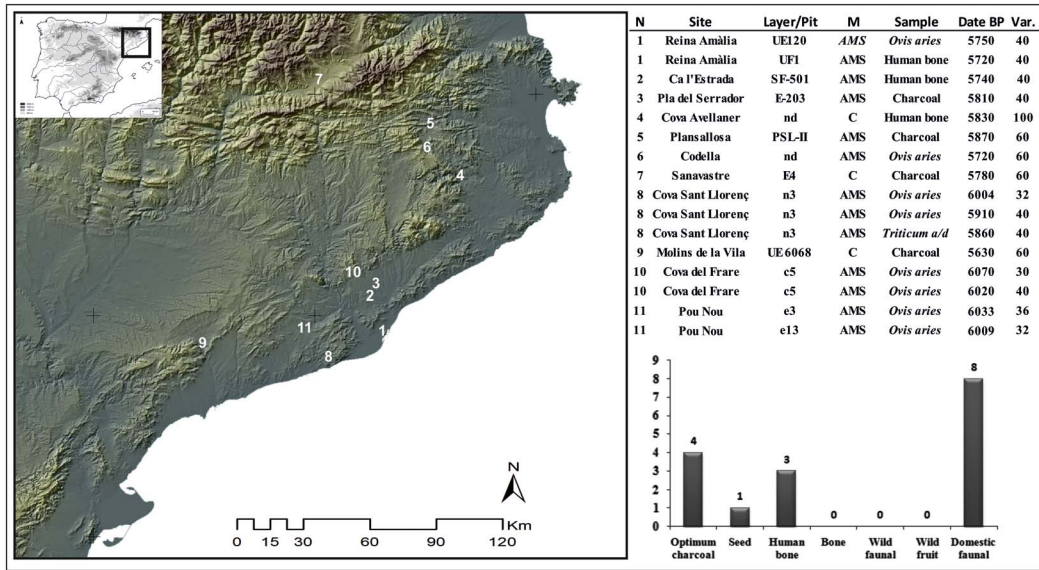


Figure 4 Location of the Epicardial Early Neolithic sites with high-confidence dates and the type of material sampled (the complete reference of the determinations is in the online Appendix).

Epicardial Early Neolithic

In this phase, Neolithic populations continued to occupy sites both in caves and in the open air (Martín et al. 2010). Two different decorative traditions appear to exist. Whereas in the eastern sector of the northern area the diagnostic decorative element is a smooth orthogonal cordon, in the rest of the area the decorations include motifs combining incisions and impressions (Miró 1994; Oms et al. 2012). Although burials are still scarce, they are more common than in the previous phase. Both individual interments and collective burials in caves have been documented.

The number of available dates decreases noticeably, as there are fewer sites corresponding to the phase (Martín and Vaquer 1995). Only 16 ¹⁴C determinations (Figure 4) meet the quality parameters outlined above. Of these, 13 were dated by the AMS method and the other three by beta-counting ¹⁴C dating.

Eight of the dates were obtained from bone remains of *Ovis aries* (Structure UE120 at Reina Amàlia, La Codella, Level 3 at Cova de Sant Llorenç, Level c5 at Cova del Frare, and the silos E3 and E13 at Pou Nou). A further three determinations dated human remains (grave UF1 at Reina Amàlia, an individual in the collective burial at Cova de l'Avallaner, and grave SF501 at Ca l'Estrada). The other dates come from charcoal samples. One of these was for an accumulation of charcoal found in the habitat at Plansallosa II, and three samples came from silos (Pla del Serrador, Sanavastre, and Molins de la Vila) with a close relationship between the ¹⁴C result and the material culture. We must be wary of the latter samples as examples from similar structures have given a dissonant relationship (Rojo et al. 2006)

The calibrations of these 16 dates fall in the period between 4930 and 4420 cal BC. Although the small number of results available does not allow a more precise interpretation, concentrations of dates around 4800 and 4560 cal BC can be perceived.

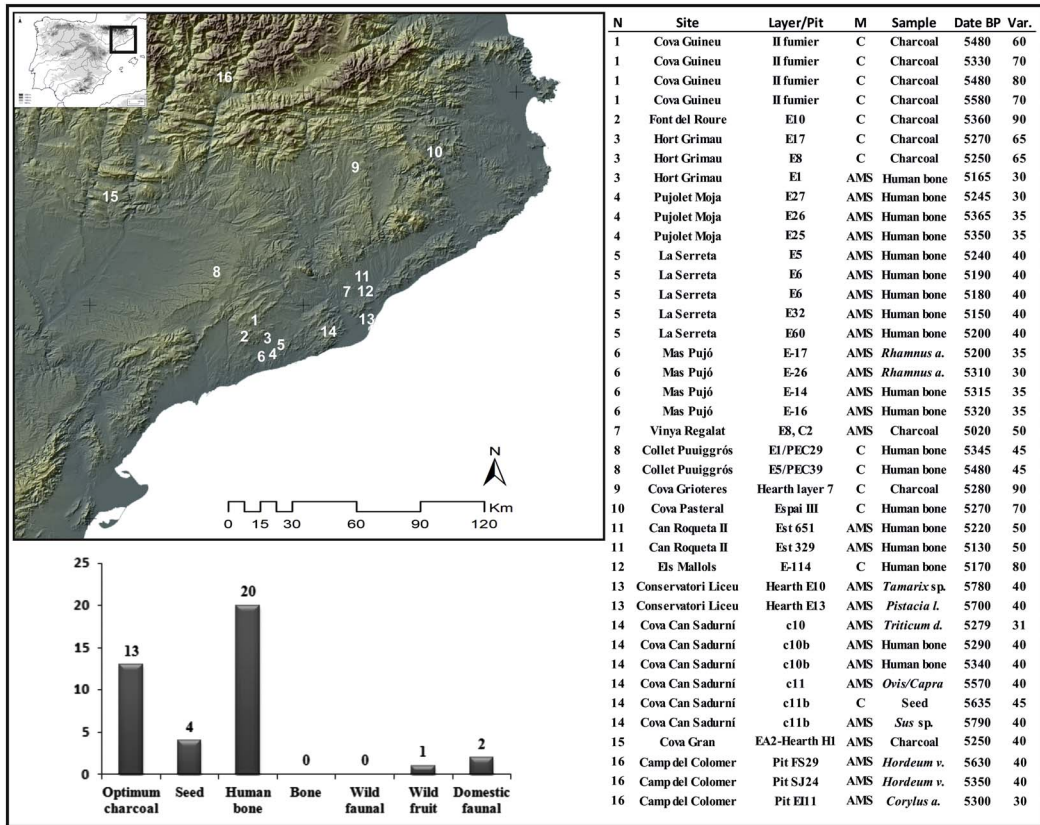


Figure 5 Location of the Postcardial Neolithic sites with high-confidence dates and the type of material sampled (the complete reference of the determinations is in the online Appendix).

Postcardial Neolithic: Molinot and Montboló Groups

Neolithic populations are seen to occupy the valleys and lowlands more intensely during this phase. At the same time, the number of burials located near the sites or inside them gradually increases. These no longer tend to be collective, but contain one or occasionally two individuals. The deceased are accompanied by various kinds of grave goods, such as lithic or osseous implements, pottery, and ornaments. The pottery found at the archaeological sites belonging to the so-called Molinot Group display combed surfaces with triangular cross-section cordons. In contrast, the Montboló Group is characterized by burnished finishes, carenated profiles, and vertical tubular handles (Mestres 1992; Molist et al. 1996).

A total of 40 dates are available for reliable archaeological sites and with a standard deviation less than ±100 yr BP. The larger number of burials results in a large proportion of the samples for this phase coming from human remains: 20 in total. The others include four determinations for seeds and domestic fauna in Levels 10 and 11 at Can Sadurní and 13 for charcoal samples (some of which were identified taxonomically as *Rhamnus alaternus*, like the samples in Silos E17 and E26 at Mas Pujó). The others were deemed valid because of the place where the charcoal was collected: the *fumier* in Level II at Cova de la Guineu and the combustion structures in Level 7 at Cova de les Grioterres and the Liceu Conservatory (E10, *Tamarix sp.*, and

E14, *Pistacia lentiscus*) and H1 at Cova Gran. Owing to the correct association between the ¹⁴C results and the material culture, the dates for Silos E17 and E8 at Hort d'en Grimau and E10 at Font del Roure have also been accepted as probably valid (Figure 5). In addition, the silos at Camp del Colomer have yielded two determinations for seeds (*Hordeum vulgare*) and one for a *Corylus avellana* seed coat.

After calibrating the results and generating the graphs (Figure 9), it has been seen that the dates are clustered between 4690 and 3800 cal BC. When the domestic and funerary sites are analyzed separately, it can be appreciated that the former are dated between 4690 and 3790 cal BC while the latter are relatively younger, between 4320 and 3850 cal BC (Figure 9). Indeed, the results show that whereas the dates for human remains are in the later part of the phase (as at the sites of La Serreta and Can Roqueta II), those for domestic sites are in the earliest part (as at Cova Can Sadurní, Liceu Conservatory, and Cova de la Guineu). It is therefore necessary to obtain more high-quality ¹⁴C dates for domestic sites to confirm or discard this situation. It is equally necessary to obtain further dates for the first part of the phase (~4800–4400 cal BC) as only nine dates are currently available for that time (Figures 5 and 9).

Middle Neolithic

During this phase, the funerary practices initiated in the previous phases become fully consolidated. The importance of the number of burials discovered since the early 20th century is such that this phase is known as the Pit Burial culture (Llongueras et al. 1986; Martín and Villalba 1999; Martín 2009). Although the communities who carried out those burials lived mainly in plains and valleys, very little is known about their dwellings, of which very few have been discovered (Mestres and Tarrús 2009; Esteve et al. 2012). One of the factors explaining this absence is that they were made mostly with perishable materials, lowering the ground level very little or not at all. The repeated disturbance of these areas by later human occupations throughout history, as well as by farm work and the recent proliferation of various kinds of buildings and industries, have caused the disappearance of any trace of those dwellings. This explains why the only evidence of this phase consists basically of structures dug more deeply in the ground, such as the burials and silos.

During this phase, the pottery is generally smooth, with careful finishes and composite profiles, usually carenated. The few decorations that have been documented (scratched geometric-linear motifs) are associated with the Chasséen types in southern France (Martín and Villalba 1999).

The frequency of the funerary structures is the reason for the large number of human bone samples that have been dated. Until recently, very few dates had been obtained for domestic structures, like hearths, huts, silos, or waste pits. However, this problem is slowly being solved.

A total of 38 ¹⁴C dates are known for the phase, 20 of them analyzed by the AMS method. Of particular interest are the 28 dates for human remains documented in the necropolises of Camí de Can Grau, Mines de Gavà, Plà del Riu de les Marcetes, Bòbila Madurell, and Can Gambús (14 by AMS). The other 10 were obtained from samples of charcoal, seeds, and fauna from domestic structures like the silos and pits at La Serreta (E10, E12, and E46), Bòbila Madurell (Habitat 1), and Can Roqueta/Torre Romeu (E145 and E195); and the combustion structure E2 at the site of Ca n'Isach and H6 at Cova Gran (Figure 6).

The results again reveal a certain difference between the dates for domestic sites and those for funerary contexts (Figure 7). After calibration (Figure 9), the dates obtained at domestic sites

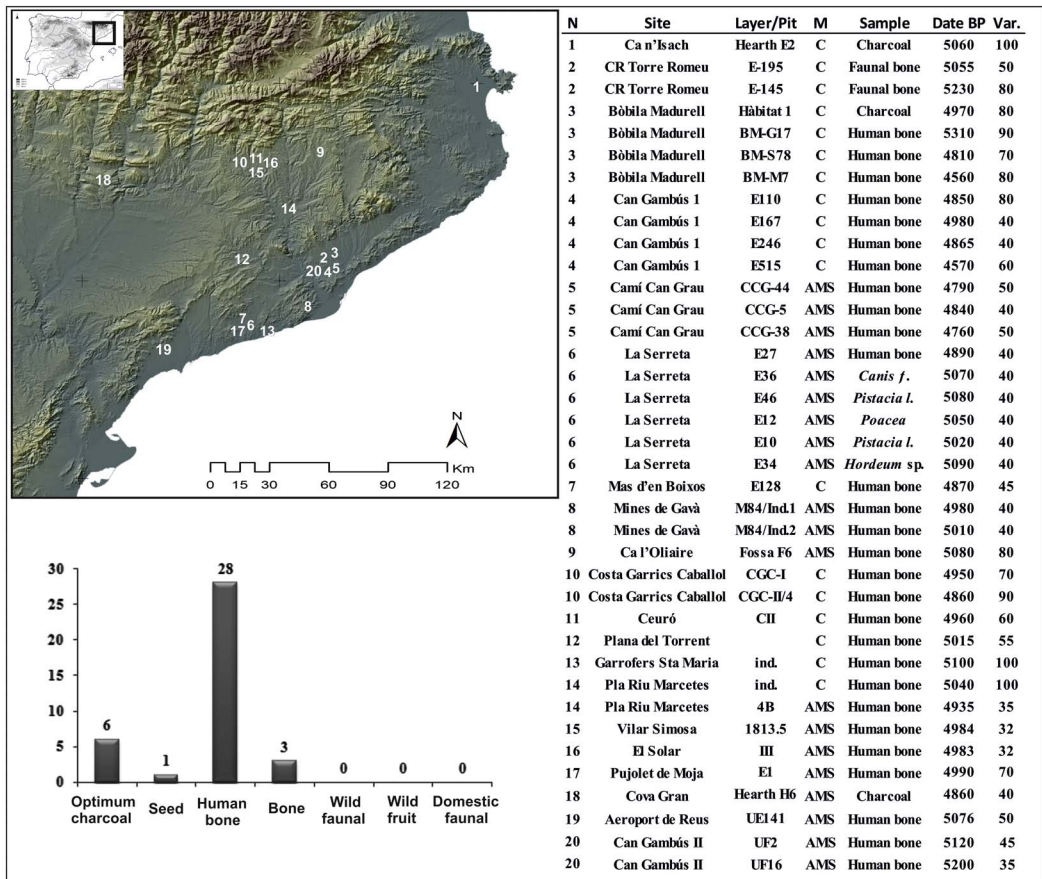


Figure 6 Location of the Middle Neolithic sites with high-confidence dates and the type of material sampled (the complete reference of the determinations is in the online Appendix).

are grouped in the time from 4150 to 3680 cal BC, with a tight clustering around 3900 cal BC, except for the determination for Structure E145 at Can Roqueta/Mas Romeu (dated to 4100 cal BC). In turn, the dates for burials are grouped between 4170 and 3150 cal BC, especially around 3600 cal BC (Figure 9). This implies that although the dates for domestic and funerary sites start at a statistically similar time, the latter continue over a longer span of time. This may be due to a sampling problem.

Late Neolithic–Chalcolithic

In this phase, the exchange networks established between groups in the western Mediterranean in the Middle Neolithic (reflected by the presence of raw materials from the Alps, Italy, and southern France) disappear almost completely. At the same time, the burials are collective and generally in small caves. Many caves that had been abandoned after the Postcardial Neolithic are reused in this phase (Martín et al. 2002).

The pottery types associated with this period are characterized by large sack-shaped recipients with lugs added to the outer surface and smooth parallel cordons. These vessels, typical of the Veraza group in southern France, are complemented by other recipients decorated with

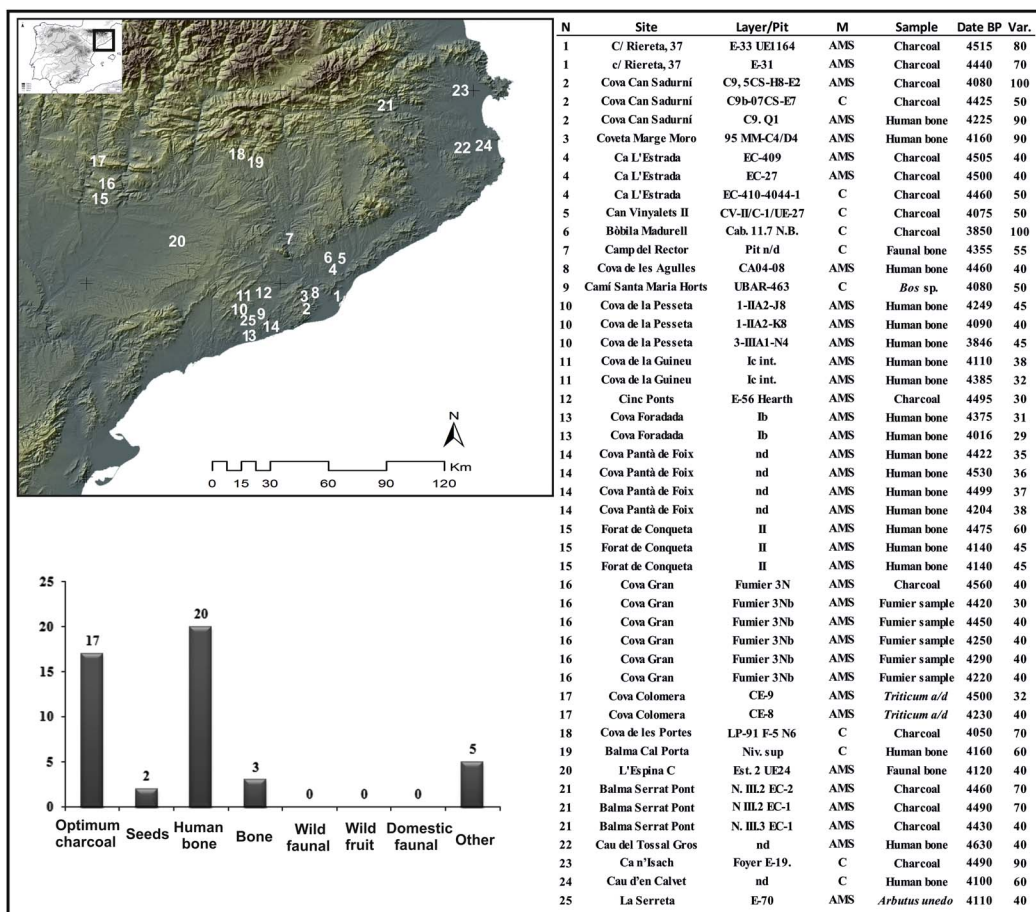


Figure 7 Location of the Late Neolithic-Chalcolithic sites with high-confidence dates and the type of material sampled (the complete reference of the determinations is in the online Appendix).

triangles, belonging to the Ferrières and Treilles groups, typical of southern France (Martín 2003). The pottery associated with burials is not usually decorated until the arrival of Bell Beaker influences.

A total of 46 ¹⁴C dates have been deemed valid (37 analyzed with the AMS method). Of these, 20 were obtained from human bones found in burial sites in caves and rockshelters. Two dates were obtained from cereal grains (*Triticum aestivum durum* in the *fumier* levels CE8 and CE9 at Cova Colomera) and three from domestic faunal remains at the sites of Camp del Rector, Espina C, and Santa Maria dels Horts. The remaining 21 dates come from charcoal samples collected in combustion structures (E33 and E31 at Riereta, E27 and E409 at Ca l'Estrada, EC1 and EC2 at Serrat del Pont, and E19 at Ca n'Isach), from a *fumier* (Cova Gran), and from a furnace (E56 at Cinc Ponts).

As in the previous two phases, the dates obtained at domestic and funerary sites are slightly different. Whereas the former are situated between 3560 and 2590 cal BC, with a main grouping from 3300 to 3100 cal BC, the dates of burials are situated between 3370 and 2310 cal BC, with a grouping in the period 3000–2700 cal BC (Figure 9).

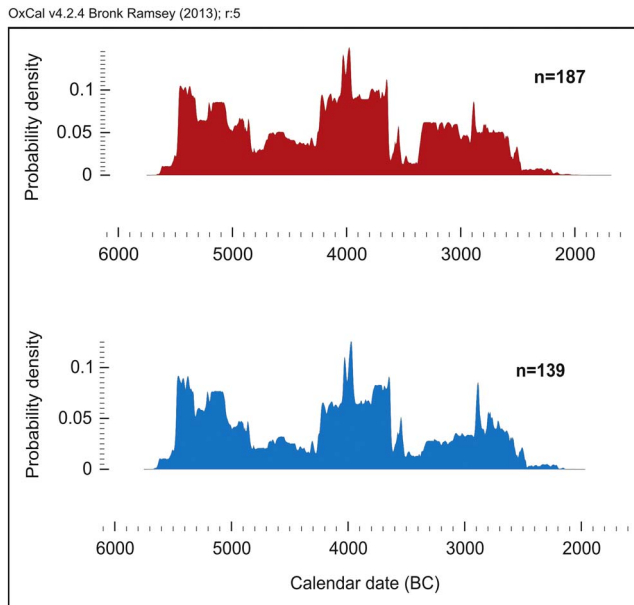


Figure 8 Graph with all dates versus only short-lived dates (generated with OxCal v 4.2 and calibrations with the IntCal13 curve).

DISCUSSION

The critical appraisal of the 187 ^{14}C dates considered valid after applying the filter described in the Methods section has been able to define with a certain exactness the different Neolithic phases established mainly through pottery decoration typologies. The number of dates is larger than 30 in all the phases, except for the Epicardial Early Neolithic, for which only 16 dates are available (compared with 46 for the Cardial Early Neolithic, 40 for the Postcardial Neolithic, 38 for the Middle Neolithic, and 46 for the Late Neolithic–Chalcolithic).

The best documented times in these phases are 5500–5100 cal BC in the Cardial phase, 4200–3850 cal BC in the later part of the Postcardial, ~3700–3600 cal BC at the end of the Middle Neolithic, and ~2800–2600 cal BC at the start of the Final Neolithic. At other times, not only is there a low density of dates, but occasional gaps. Clear examples are the Epicardial (because of a lack of dates), the start of the Postcardial, around 4690–4300 cal BC, the end of the Middle Neolithic around 3500–3200 cal BC, and the end of the Final Neolithic, which is very vague owing to the low density of dates. When analyzing the dates from a technical point of view, at least three issues must be addressed:

1. Do charcoal samples produce older dates?

It is noticeable that 49 of the dates from domestic sites belonging to different phases come from charcoal samples. These have been identified taxonomically in only 12 cases and can be defined as coming from “short-lived” species (*Pistacia lentiscus* and *Arbutus unedo* at La Serreta, *Rhamnus alaternus* at Mas Pujó, *Tamarix* sp. and *Pistacia lentiscus* at the Liceu Conservatory, and *Buxus sempervirens* at Cova Colomera). However, in most cases the charcoal has not been identified (Guineu, Grioterres, Ca n’Isach, and Bòbila Madurell, among others), and the material selected for dating is unknown. However, the graph generated with the charcoal samples excluded (Figure 8) shows that the information does not vary substantially

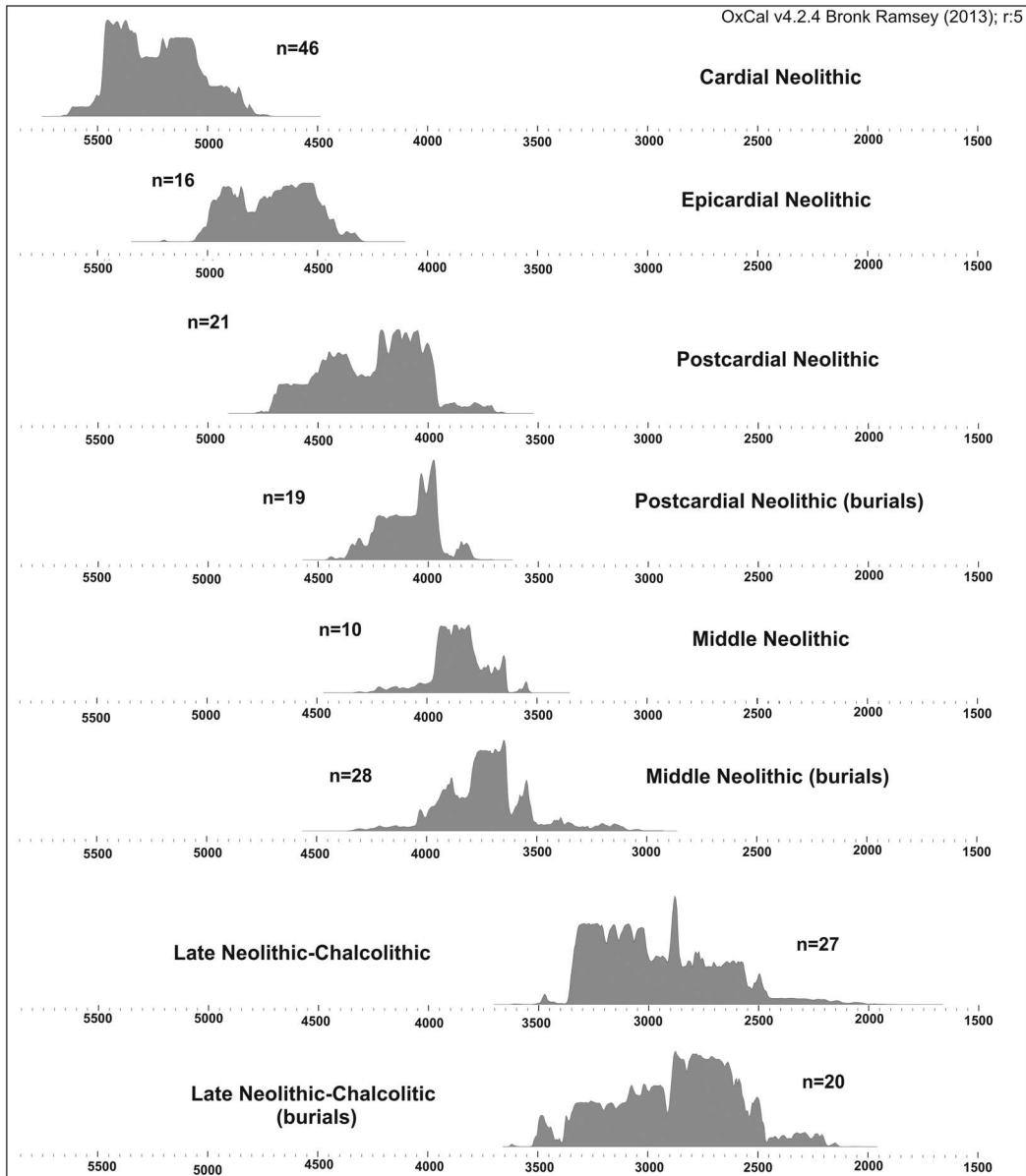


Figure 9 Cumulative curve for the whole Neolithic in the northeastern Iberian Peninsula (calibration using OxCal v 4.2 and IntCal13).

and only the density of dates per phase is altered and not the chronological length of the phases. Selecting only those ^{14}C samples recovered from well-defined anthropic structures (quickly sealed), the old-wood effect has been minimized.

2. Are the human remains affected by the reservoir effect?

Another issue, mentioned in the Introduction, is the high number of dates obtained from human remains, 73 in total. If these individuals' diet had been rich in marine resources, this might alter

the date of the osseous remains and corrections for the reservoir effect would have to be applied. However, the research being carried out within the framework of the project “Approach to the first Neolithic communities in north-east Iberia through their funerary practices” suggests that this effect is insignificant (Fontanals-Coll et al. 2015). Therefore, no reservoir effect corrections have been applied. Although the dating of human bones has provided more recent data (Figure 9), the problem is thought to lie in the imbalance caused by favoring funerary clusters to date horizons.

3. Do the unfavorable periods for calibration alter the “cultural phases”?

The existence of times that are unfavorable for calibration creates the problem of accumulations of data in certain parts of the curve (Figure 2), for example, at the start and end of the Cardial Neolithic, the time of 4300–4100 cal BC in the transition from the Postcardial Neolithic to the Middle Neolithic, the end of the Middle Neolithic and the start of the Late Neolithic ~3600–3400 cal BC, and during the second half of the Late Neolithic.

These phenomena, coupled with the development of the different prehistoric cultural phases, trace a continuous cumulative curve, with few areas of low density, always associated with times when few dates are available (see Figure 2). Nonetheless, if the data are analyzed from the cultural point of view, at least two issues need to be addressed:

- (a) The statistical nature of the dates means that certain chronological overlapping occurs between the historical phases represented by certain types of pottery forms and decorations. It is clear that the relative chronologies traditionally based on the pottery types do not possess such clear chronological boundaries. The dates studied here show that the chronologies of different phases overlap as a consequence of several possible factors: continuance of certain pottery traditions, the type of samples dated, the quality of the samples in relation to the place where they were taken, etc. In Figure 9, some of these overlaps can be seen, between the end of the Cardial Early Neolithic and the Epicardial, and between the Epicardial and the start of the Postcardial Neolithic.
- (b) Another point to be considered is the rather later age of the funerary dates within each phase. This cannot be investigated only by studying the ^{14}C dates, but by analyzing the archaeological record in each phase. However, it seems that certain funerary practices continued over a slightly different length of time to the domestic sites classified according to the pottery record. The new determinations now being carried out at other burial sites will be able to shed light on this issue and define more clearly the chronological framework in which they are situated.

CONCLUSIONS

Recent years have undoubtedly been very productive in the selection and analysis of ^{14}C determinations at Neolithic sites in northeast Iberia. This is the result of the scientific community’s interest in understanding more exactly the age of the sites they were excavating. Indeed, a large part of the excavations’ funding has been used to carry out a wide series of ^{14}C determinations. It is because of this attitude that many of the sites listed in the tables and figures in this paper are not represented by just one or two dates, but by several (e.g. La Draga, Cova de Can Sadurní, Cova Colomera, Bòbila Madurell, Minas de Gavà, and Can Gambús 1).

The importance of dating for researchers working at Neolithic sites in northeast Iberia has made it currently one of the areas in the European Mediterranean basin with the largest number of dates and therefore where the chronological framework is most accurately defined.

However, much remains to be done, and dated, but the prospects for the coming years are extremely promising because of all the research projects currently being undertaken and for which ¹⁴C dating is an essential part.

This paper undoubtedly reflects this interest in dating archaeological sites and in considering chronology as one of the fundamental approaches with which to study the sites and the historical conclusions reached through their study. We shall soon not only understand much better when the sites were occupied and when the individuals were buried, but also be able to define more accurately the chronology of the phases traditionally established in the archaeological record. This will allow us to determine whether any correspondence exists between the absolute and relative dates and assess whether it is appropriate to continue using the traditional terminologies based on pottery types.

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SUPPLEMENTARY MATERIAL

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