



Human Palaeontology and Prehistory (Prehistoric Archaeology)

## Chronology of the Neolithic Necropolis at Camí de Can Grau (NE-Iberian Peninsula). Funerary pattern changes and long-distance raw material exchanges



*Chronologie de la nécropole néolithique de Camí de Can Grau (Nord-Est de la péninsule Ibérique). Changements dans les pratiques funéraires et échanges de matières premières sur de longues distances*

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### ABSTRACT

Camí de Can Grau is one of the most important Neolithic necropolises of the “Pit Burials” horizon (North-East of the Iberian Peninsula. Late fifth–early fourth millennia cal BC), because of its large number of graves. However, the number of buried individuals and the type of grave goods of the site have some peculiarities suggesting that could be one of the last manifestations of this horizon. For proving that, a radiocarbon dating programme and some statistical analysis were carried out so as to determine its chronology. The results are discussed regarding the duration of the necropolis, the degree of contemporaneity between graves and grave goods and the number of buried individuals. Moreover, chronological relationships with other similar contexts of the same horizon and located in other regions are presented. This study goes beyond a purely local research, as it proposes a method for addressing the chronology of funerary contexts.

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## R É S U M É

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Camí de Can Grau est l'une des nécropoles néolithiques les plus importantes de l'horizon des « Sépulcres de Fossa » (Nord-Est de la péninsule Ibérique, fin du V<sup>e</sup>–début du IV<sup>e</sup> millénaire cal BC), en raison du nombre élevé de sépultures qui la composent. Cependant, le nombre d'individus enterrés et le type des mobiliers d'accompagnement présentent certaines particularités, qui suggèrent qu'il pourrait s'agir de l'une des dernières manifestations de cet horizon. Pour le démontrer, un programme de datations radiocarbone et d'analyses statistiques a été mis en place afin de déterminer la chronologie du site. Les résultats sont discutés en ce qui concerne la durée d'occupation de la nécropole, le degré de contemporanéité entre les tombes et les mobiliers d'accompagnement et le nombre d'individus inhumés. De plus, des relations chronologiques avec d'autres contextes similaires du même horizon, situés dans d'autres régions, sont présentées. Cette étude va au-delà d'une recherche purement locale, car elle propose une méthode pour aborder la chronologie des contextes funéraires.

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## 1. Introduction and objectives

Camí de Can Grau (La Roca del Vallès, Spain) is one of the best-preserved Neolithic necropolises in the North-East of the Iberian Peninsula. The characteristics of the graves, the form of burial, the type of grave goods and the dates obtained in the late 1990s confirmed that this site belonged to the so-called “Pit Burials” horizon (Muñoz, 1965; Pou and Martí, in press; Ripoll and Llongueras, 1963). This name refers to a particular period in the Neolithic in northeastern Iberia characterised above all by a very large and well-studied funerary record, with over 600 burials currently documented. However, even though it is one of the best-known Neolithic horizon in western Europe, little information was available about its chronology because of the small number of radiocarbon determinations that had been performed.

In order to address this deficiency, one of the main lines of research in the framework of the R+D project “Aproximación a las primeras comunidades neolíticas del NE peninsular a través de sus prácticas funerarias” (in English: “Approach to the first Neolithic communities in the North-East of the Iberian Peninsula through their funerary practices”) has been to initiate a radiocarbon dating programme, which has now obtained as many as 131 dates (additional to the 37 dates that had been obtained and published in the past). This programme has included not only the necropolises with the largest number of burials, but also small cemeteries and even some isolated burials that were interesting because of their type of construction, their grave goods or their geographical location. The results of this research project are providing information about the duration of this funerary practice and about the likelihood of inter-site and intra-site contemporaneity of the burials.

The main objectives of the present study are to determine the overall duration of the use of Camí de Can Grau necropolis, the chronology of the graves and the possible degrees of contemporaneity between them. At the same time, the internal variability of the chronological dates will also be studied in terms of the type of funerary structure, the presence of individual or collective graves (simultaneous or not), their spatial distribution and the presence of

grave goods made from raw materials from other regions or which required a large investment in labour to be obtained or manufactured.

Additionally, by comparing the results with data from other Neolithic burials of the same horizon in the North-East of the Iberian Peninsula, the original hypothesis, that the necropolis of Camí de Can Grau is one of the most recent sites in the “Pit Burials”, will be tested. In this sense, it is known that a few centuries later, this model of normally individual burials in graves disappeared and was replaced by the use of caves, large pits and the construction of dolmens and artificial hypogea in which numerous individuals were buried. It thus seems plausible that the last manifestations of the “Pit Burials” horizon started to break the funerary norm that had existed until then (Gibaja, 2003; Martín et al., 2010; Mestres, 1992; Molist et al., 2003; Miró, 1994; Oms et al., 2016; Roig et al., 2010; Ten, 1980).

Finally, the fact that similar funerary practices have been documented in the South of France and Switzerland during the so-called *Chasséen* Culture (Duday et al., 2000; Moinat and Chambon, 2007; Tarrús, 2002) poses the question of whether this funerary phenomenon had existed simultaneously on both sides of the Pyrenees. This will also be addressed.

The aims of this paper, the methodology used and the processing of the chronometric data can act as a point of reference for other similar case studies of funerary sites, whether they belong to the Neolithic or any other archaeological period.

## 2. Camí de Can Grau and Neolithic funerary sites between the mid-fifth and mid-fourth millennia cal BC

As remarked above, burials in this period generally consist of pits dug in the ground or in cists (stone boxes) in which a single individual (less frequently, two or more individuals), either an adult or a child, was placed. These individuals were usually accompanied by grave goods: flint cores and chipped tools (especially blades and bladelets, geometric microliths and arrow-heads), polished stone axes and adzes, tools made from bones, ceramic recipients,

and adornments made with stones, bones and/or shell beads (Borrell et al., 2015; Carlús et al., 2008; Feliu, in press; Frances, 2007; Gibaja et al., 2010, 2012; González et al., 2011; Martí et al., 1995; Martín et al., 2005; Mestres et al., 1997; Oliva et al., in press; Roig and Coll, in press).

This whole assemblage of grave goods is not found in all the graves by any means. Individuals buried with a large number of artefacts are grouped together with others accompanied by hardly any objects, and in some cases only the human remains are found. However, it should be noted that our analysis is based on well-preserved remains and it is possible that other kind of goods were left in the tombs, but have not survived.

As we mentioned above, some of the artefacts deposited as grave goods were made from exogenous raw materials or required considerable investment in their procurement, manufacture and transport. These are:

- flint: many of the flint artefacts are made from honey flint, which probably came from the South-East of France (Gibaja et al., 2013; Léa, 2005);
- obsidian: the few obsidian artefacts found in the graves came from Lava flow A in the volcano of Mt. Arci in Sardinia, Italy, about 1200 km away (Gibaja et al., 2014; Terradas et al., 2014);
- axes and adzes: a double strategy was in place regarding these artefacts. On one hand, local rocks like hornfels, schist and slate were used to make them (Bosch, 1984; Masclans et al., 2017) and on the other, exogenous rocks such as jadeite and eclogite, probably from the Alps, amphibolite, from the Pyrenees, and fibrolite from the Central Massif in France, were employed (Pétrequin et al., 2012; Vaquer et al., 2012);
- ornaments: these were often made from a green rock called variscite which came from mines at Gavà, near the modern city of Barcelona. A large investment in time and labour was needed to obtain it (Bosch and Borrell, 2009; Villalba et al., 1986).

As mentioned above, the necropolis of Camí de Can Grau is interesting because of the hypothesis that it may have been one of the last sites within the “Pit Burials” horizon. This hypothesis is based on several traits documented at this necropolis which are not common at other sites belonging to this horizon. Specifically these are:

- unlike the usual funerary structures of this horizon, a large number of the burials (22 = 91.6%) of Camí de Can Grau were performed in very complex structures that would have required considerable effort in their construction;
- as many as ten of the graves (41.66%) held more than one individual (seven are double graves, two had three individuals and one of them contained four bodies);
- there is a total absence of some objects that are common in other necropolises of this period, such as honey flint cores and polished axes and adzes, and a scarcity of other materials, such as variscite adornments (three tombs with six beads in total).

It seems that, unlike other communities, the population buried at Camí de Can Grau did not enjoy easy access to exogenous raw materials, like honey flint, obsidian and Alpine or Pyrenean rocks. In contrast, these materials are common in burials at necropolises in the same area, such as Bòbila Madurell–Can Gambús, Bòbila d'en Joca, Bòbila Padró and the Gavà variscite mines (Bosch and Borrell, 2009).

These differences suggested that this might be one of the last funerary sites within the “Pit Burials” horizon. In later periods, not only funerary practices changed to collective (simultaneous or not) inhumations in structures like dolmens, large pits, burial caves and artificial hypogea, but also the raw material exchange networks that had functioned in the late fifth and early fourth millennia cal BC broke down. Honey flint, obsidian, variscite ornaments, and practically all the Alpine and Pyrenean rocks used to make axes and adzes disappeared from sites, whether these were funerary or not. These materials were replaced by other types of stones, such as flint from various sources in southern France and the North of the Iberian Peninsula (Castany, 2008; Gibaja et al., 2008; Terradas et al., 2012).

Therefore, in addition to the general goal of situating the necropolis of Camí de Can Grau chronologically within the framework of funerary practices in the “Pit Burials” horizon, more specific aspects have also been assessed. These refer to chronological differences between the two types of funerary structures, the number of buried individuals, the presence or absence of some types of grave goods and the position of the graves in the area of the necropolis. Based on the results, a comparative chronological analysis with other funerary contexts from the North-East of the Iberian Peninsula and the South of France and Switzerland has been carried out.

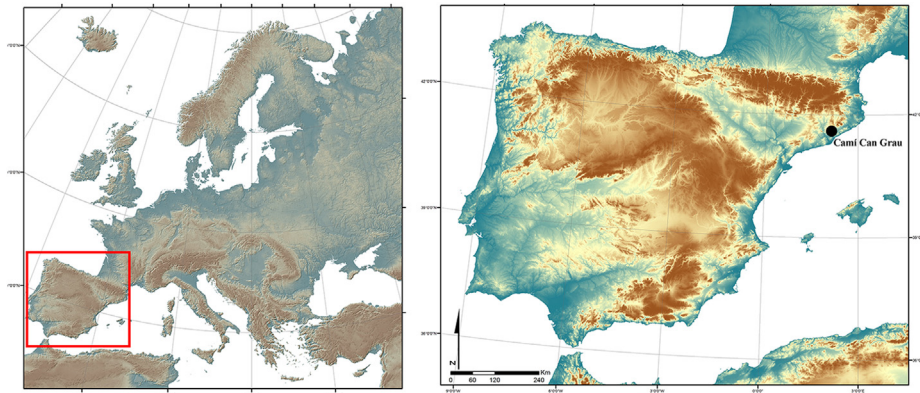
### 3. The site of Camí de Can Grau

Camí de Can Grau is located in the town of La Roca del Vallès in Barcelona (UTM 31T X:441600 Y:4605100). At 160 m a.s.l., it must have been in an excellent location for Neolithic communities, since it is situated on potentially suitable land for arable farming and livestock, thanks to the type of clay soils and perennial water-courses. In addition, the proximity of the Pre-Littoral Mountain Range would have signified access to wild resources obtained by hunting and gathering (Fig. 1).

Camí de Can Grau is one of the most interesting and best-preserved Neolithic necropolises found in the twentieth century in the North-East of the Iberian Peninsula. The depth of the graves and limited impact of farming on them in previous centuries meant that the funerary structures were preserved practically in their original form.

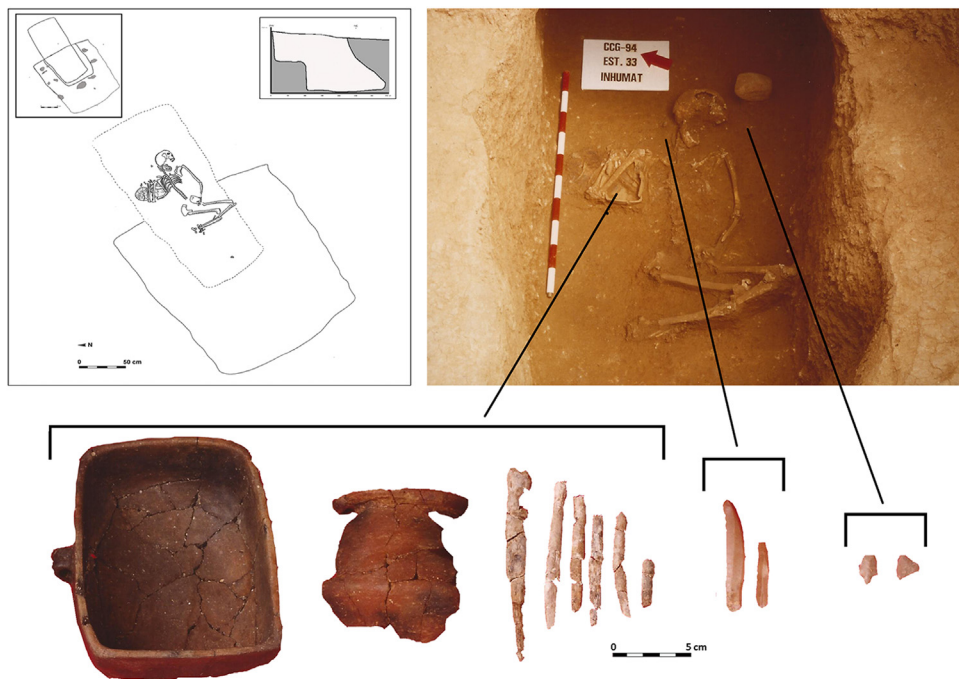
The necropolis consists of 24 graves, most of which practically maintain their original morphology, allowing the documentation of their construction techniques and different typologies. Two types of construction techniques were identified, classified as Type 4 and Type 5b according to the typology of Martí et al. (1997), some of the first archaeologists who worked at the site.

Type 4 graves are characterised by a quadrangular access and a rectangular or oval chamber displaced from the centre towards one of the ends, where an apse was



**Fig. 1.** Location of the necropolis of Camí de Can Grau in the North-East of the Iberian Peninsula.

**Fig. 1.** Emplacement de la nécropole de Camí de Can Grau, dans le Nord-Est de la péninsule Ibérique.



**Fig. 2.** Grave CCG33, belonging to Type 4.

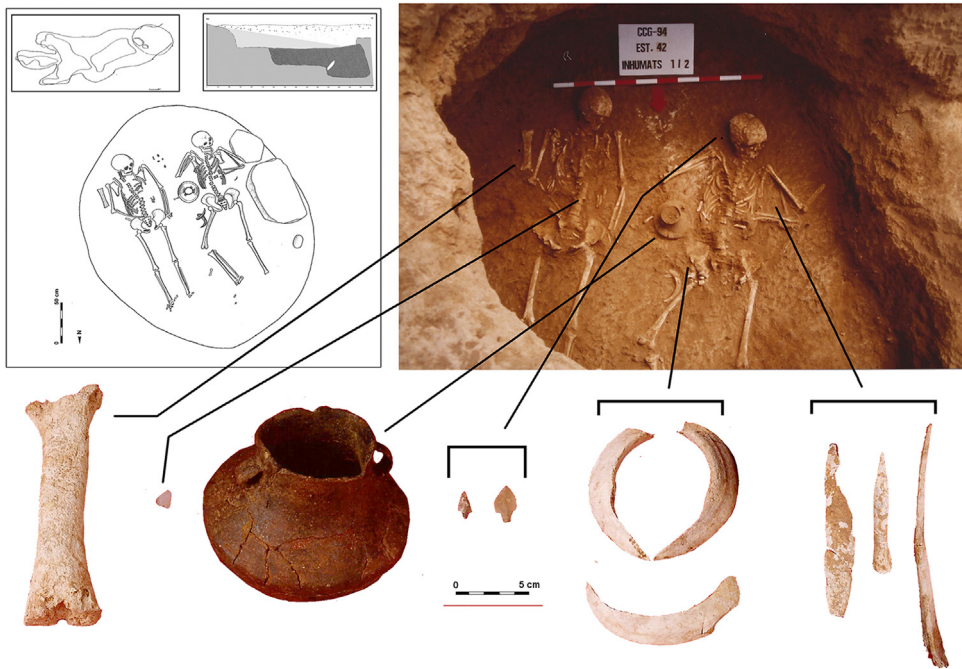
**Fig. 2.** Tombe CCG33, appartenant au type 4.

built. In contrast, in Type 5b graves the access was through a vertical pit that reached a chamber with a lateral apse excavated underneath the base of the pit entrance (Figs. 2 and 3).

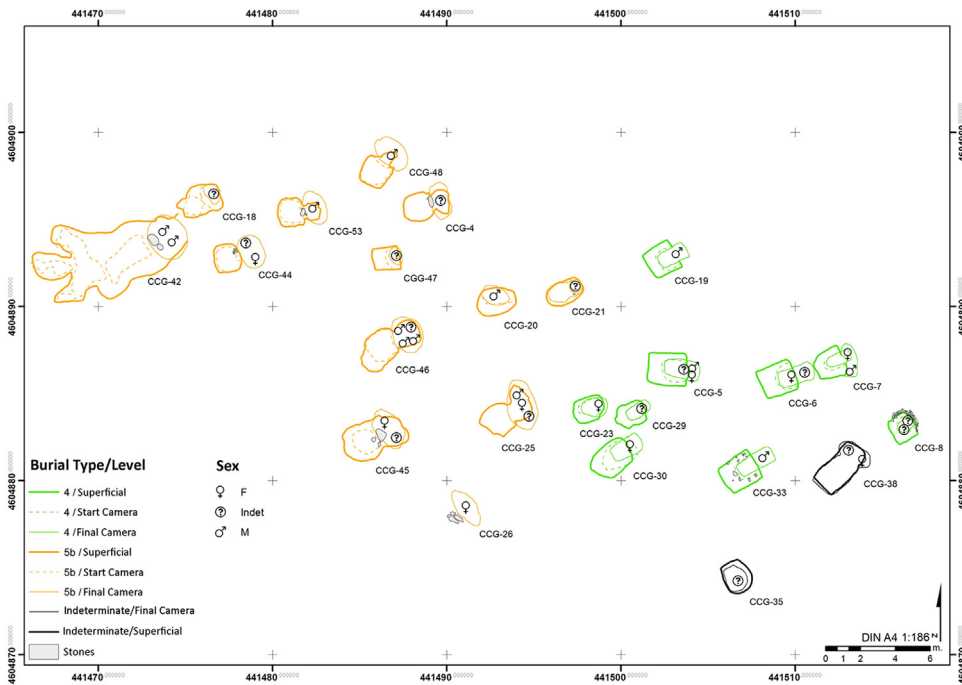
Funerary structure CCG38 deserves a special mention. It is different from the other structures because, although it was originally a Type 4 structure, the same grave was reused later to bury a second individual (a female with outstretched lower limbs) within a Type 5b structure. The arrangement of the two types, which was clearly differentiated during the excavation of the grave, suggested that the Type 4 burial must be older than the 5b type.

Additionally, although all graves are oriented on the same NE-SW line, the Type 4 burial chambers are oriented NE-SW, whereas in the Type 5b graves they are oriented NW-SE. Moreover, the distribution of the two types in the area of the necropolis is clearly different. Whereas Type 4 graves are located on the eastern side, the Type 5b ones are on the western side. It is unusual to find superimposition of burials in the “Pit Burials” horizon, so it is thought that some method must have been used to mark the position of the graves. In Camí de Can Grau this was achieved, for example, by covering the entrance with large stones that stood above ground level (Fig. 4).





**Fig. 3.** Grave CCG42, belonging to Type 5b.  
**Fig. 3.** Tombe CCG42, appartenant au type 5b.



**Fig. 4.** Distribution of the graves at Camí de Can Grau. The type of funerary structure (Type 4 or 5b) and number, sex and age of the buried individuals are given.  
**Fig. 4.** Distribution des sépultures de Camí de Can Grau. Le type de structure funéraire (type 4 ou 5b) et le nombre, le sexe et l'âge des individus inhumés sont renseignés.

A total of nine graves with 14 individuals belong to Type 4 and thirteen graves with 21 individuals correspond to

Type 5b (see Table 1) (Martí et al., 1997). Only two structures could not be assigned to one of the types: CCG24 and

**Table 1**

The number of the grave, the type, the number of individuals and their sex (M= male, F= female, Indet= indeterminate) and age are specified. The age groups are based on Duday et al., 2000: Infantile I (1–6 years), Infantile II (7–12 years), Infantile (unknown exact age), Juvenile (13–18/20 years), Young Adult (20–29 years), Mature (30–49 years), Adult (unknown exact age) and Indet (Indeterminate age).

**Tableau 1**

Le numéro de la tombe, le type, le nombre d'individus, leur sexe (M= masculin, F= féminin, Indet= indéterminé) et leur âge sont précisés. Les groupes d'âges sont basés sur Duday et al., 2000 : *Infantile I* (1–6 ans), *Infantile II* (7–12 ans), *Infantile* (âge exact indéterminé), *Juvenile* (13–18/20 ans), *Young Adult* (20–29 ans), *Mature* (30–49 ans), *Adult* (âge exact indéterminé) et *Indet* (âge indéterminé).

Burial Reference	Type of Burial	Number of individuals	Individual Reference	Sex	Age	Groups of Age
CCG4	5b	1	I	Indet	15–20	Juvenile
CCG5	4	3	I	Indet	8	Infantile II
			II	M		Adult
			III	F		Mature
CCG6	4	2	I	Indet	6–7	Infantile
			II	F		Adult
CCG7	4	2	I	F		Adult
CCG8	4	2	II	M	40	Mature
			I	Indet		Juvenile
CCG18	5b	1	II	Indet	8	Indet
			I	Indet		Infantile II
CCG19	4	1	I	M	20–25	Young Adult
CCG20	5b	1	I	M		Adult
CCG21	5b	1	I	Indet	3	Infantile I
CCG23	4	1	I	F		Adult
CCG25	5b	3	I	M		Adult
			II	F	Adult	
			III	Indet	Adult	
CCG26	5b	1	I	F		Mature
CCG29	4	1	I	Indet	9	Infantile II
CCG30	4	1	I	F		Adult
CCG33	4	1	I	M		Mature
CCG35	Indet	1	I	Indet		Indet
CCG38	4 and 5b	2	I	Indet	20	Young Adult
			II	F		Adult
CCG42	5b	2	I	M	30	Mature
			II	M		Adult
CCG44	5b	2	I	Indet	11–13	Infantile II
			II	F		Juvenile
CCG45	5b	2	I	F		Adult
			II	Indet	Indet	
CCG46	5b	4	I	M		Adult
			II	Indet	Juvenile	
			III	M	Adult	
			IV	M	Adult	
CCG47	5b	1	I	Indet	3	Infantile I
CCG48	5b	1	I	M		Adult
CCG53	5b	1	I	M		Mature

CCG35. The first of these, CCG24, because it was so badly damaged that it is not sure if the few documented human remains were associated directly with the structure. In the case of CCG35, only a small part of the base of the structure was preserved, so it is not possible to classify it in either type (Table 1).

However, the differences between Type 4 and 5b graves are not only seen in their construction characteristics, but also in the way individuals were buried. In Type 4 graves, the individuals are on a NE-SW line with their head towards the north-east.

They are lying in a supine position with their upper and lower limbs flexed. Some of the graves were reused, because the remains of the first individual or individuals were moved towards the bottom of the structure, while the last individual to be buried is in perfect anatomical connection in the centre of the chamber. In contrast, in Type 5b graves the individuals are on a NW-SE line with their head towards the south-east. The bodies are in a totally outstretched supine position, although in some

cases the limbs are slightly flexed. These graves were also occasionally reused, as in graves CCG38 and CCG46, but with a different conception; the first individual was left in his or her original position, in the chamber of the grave, and the later individuals were buried in the access pit to the chamber. Unlike in the Type 4 graves, all the individuals were found in anatomical connection.

In both burial types the grave goods are generally located near the upper part of the body and might include ceramic recipients, bone implements (awls and spatulas), lithic tools (blades, points and geometric microliths), and adornments made with variscite beads and wild boar tusks. Unmodified animal offerings have been also found occasionally, such as *Bos taurus* radii and even a whole fox in grave CCG45.

In order to assess the relationship between the grave type and the grave goods, the  $\chi^2$  statistical test was performed (see results in Table 2). The results of the test reveal significant associations:

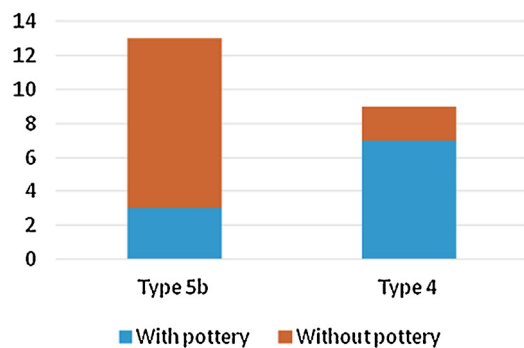


Fig. 5. Graves with ceramics (whole recipients or potsherds).

Fig. 5. Tombes avec de la céramique (récipients complets ou tessons).

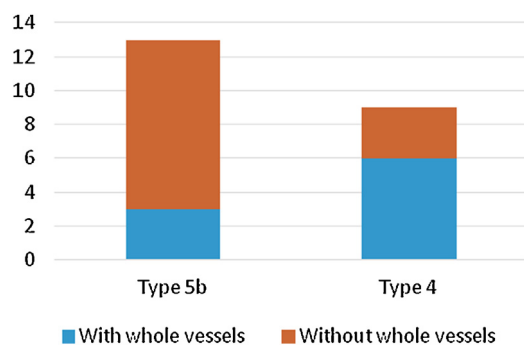


Fig. 6. Graves with or without whole recipients.

Fig. 6. Tombes avec ou sans récipients complets.

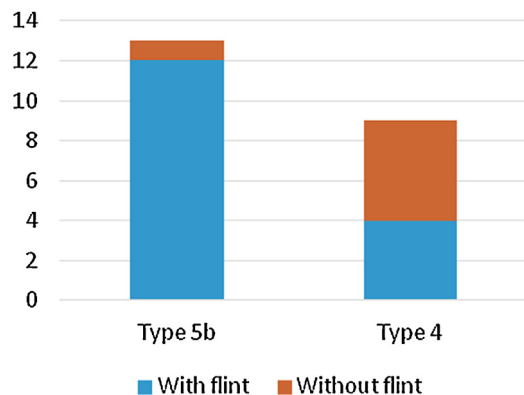


Fig. 7. Graves with or without flint tools in the grave goods.

Fig. 7. Tombes avec ou sans silex parmi le mobilier funéraire.

- pottery in general and whole vessels in particular are much more common in Type-4 graves than in Type-5b ones (Figs. 5 and 6);
- flint tools in general are more frequent in Type-5b graves than in Type-4 ones. However, honey flint, with a probable provenance in south-east France, is proportionally more usual in Type-4 graves (Figs. 7 and 8);
- bone implements appear more assiduously in Type-4 graves (Fig. 9);
- variscite only appears in Type-4 graves (Table 2).

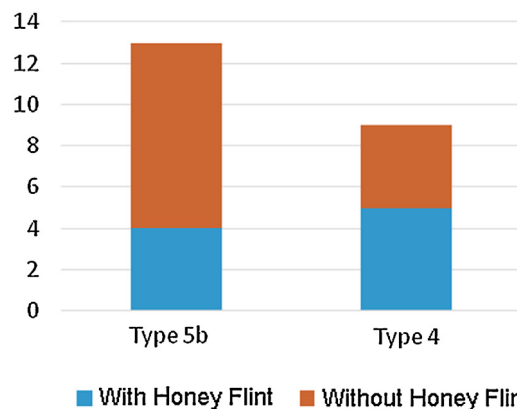


Fig. 8. Graves with or without honey flint tools in the grave goods.

Fig. 8. Tombes avec ou sans silex blond parmi le mobilier funéraire.

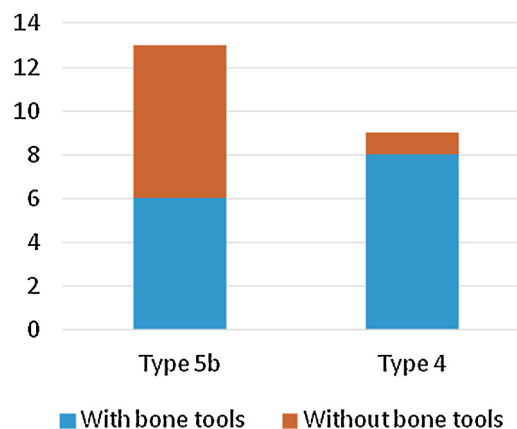


Fig. 9. Graves with or without bone tools in the grave goods.

Fig. 9. Tombes avec ou sans industrie osseuse parmi le mobilier funéraire.

In short, with the initial statistical assessment of the data, it can be said that Type 4 graves contained a larger amount of grave goods. However, aspects associated with the contents and the forms of the graves (i.e. their morphology, position, the number of buried individuals and the type of the grave goods) must also be approached by taking into account their chronology. It is essential to determine whether the differences appear synchronically or reflect diachronic changes.

#### 4. Materials and methods

The radiocarbon dating programme at Camí de Can Grau began some years ago with a group of five samples that the directors of the excavation (Miquel Martí and Roser Pou) sent to several laboratories. Later, within the present project, a total of 19 human bone samples have been analysed in the *Centro Nacional de Aceleradores* (in English: National Accelerator Center) in Seville (Spain). Unfortunately, the state of conservation of the samples was relatively deficient, and while nine yielded positive results, in three cases the results were dubious, due to the small amount of collagen. Furthermore, seven results

**Table 2**Variables assessed with the  $\chi^2$  test and the results.**Tableau 2**Variables évaluées à l'aide du test  $\chi^2$  et résultats.

Artefacts or raw materials	Presence in Type-4 graves (a total of 9)	Presence in Type-5b graves (a total of 13)	$\chi^2$ Test P-value
Grave goods	9	13	1
Pottery (vessels and fragments)	7	3	0.02
Whole pottery vessels	6	3	0.04
Flint	4	12	0.013
Honey flint	5	4	0.03
Variscite	3	0	0.02
Bone implements	8	6	0.04

**Table 3**

Radiocarbon determinations at the necropolis of Camí de Can Grau. Bold indicates the dates whose results have not been considered because the amount of collagen and their quality were inadequate. All the radiocarbon dates have been calibrated to  $2\sigma$  with the OxCal v.4.2 software (Bronk Ramsey, 2009) using the IntCal13 curve (Reimer et al., 2013).

**Tableau 3**

Déterminations radiocarbones de la nécropole de Camí de Can Grau. Les caractères gras indiquent les datations dont les résultats n'ont pas été considérés, car les quantités de collagène ainsi que leur qualité n'étaient pas adéquates. Toutes les datations radiocarbones ont été calibrées à  $2\sigma$  avec le logiciel OxCal v.4.2 (Bronk Ramsey, 2009), en utilisant la courbe IntCal13 (Reimer et al., 2013).

Locus	Lab.Code	Method	BP	SD	CAL.BC ( $2\sigma$ )	%C	%N	C/N	References
CCG46.Ind.1	CNA3046.1.1	AMS	4643	34	3520–3360	39.0	14.3	3.2	Unpublished
CCG46.Ind.3	CNA3047.1.1	AMS	4694	33	3630–3370	38.2	14.1	3.2	Unpublished
CCG46.Ind.4	CNA2665.1.1	AMS	4798	31	3650–3520	30.2	10.5	3.4	Unpublished
CCG33	AA19183	AMS	4800	110	3915–3350	–	–	–	Pou and Martí, in press
CCG38.Ind.1	UBAR576	Conventional	4950	80	3955–3545	–	–	–	Pou and Martí
CCG38.Ind.2	BETA120561	AMS	4850	50	3760–3520	–	–	–	Pou and Martí
CCG44.Ind.2	BETA120559	AMS	4870	50	3770–3530	–	–	–	Pou and Martí
CCG4	CNA2653.1.1	AMS	4880	35	3760–3540	38.7	14.1	3.2	Unpublished
CCG5.Ind.3	BETA120560	AMS	4920	40	3780–3640	–	–	–	Pou and Martí, in press
CCG7.Ind.1	CNA2655.1.1	AMS	4945	35	3790–3650	33.3	12.7	3.1	Unpublished
CCG42.Ind.1	CNA3044.1.1	AMS	4973	33	3910–3660	37.5	13.9	3.1	Unpublished
CCG42.Ind.2	CNA3045.2.1	AMS	4977	39	3935–3660	29.5	11.1	3.1	Unpublished
CCG20	CNA3042.1.1	AMS	5058	33	3955–3780	39.2	14.5	3.2	Unpublished
CCG45.Ind.1	CNA2664.1.1	AMS	5148	33	4040–3805	27.2	9.5	3.3	Unpublished
<b>CCG23</b>	<b>CNA2657.1.1</b>	<b>AMS</b>	<b>4030</b>	<b>35</b>	<b>2830–2470</b>	<b>17.3</b>	<b>3.9</b>	<b>5.2</b>	<b>Unpublished</b>
<b>CCG26</b>	<b>CNA2659.1.1</b>	<b>AMS</b>	<b>4572</b>	<b>55</b>	<b>3510–3095</b>	<b>25.0</b>	<b>8.8</b>	<b>3.3</b>	<b>Unpublished</b>
<b>CCG33</b>	<b>CNA3043.1.1</b>	<b>AMS</b>	<b>5367</b>	<b>37</b>	<b>4330–4055</b>	<b>29.5</b>	<b>10.2</b>	<b>3.4</b>	<b>Unpublished</b>
<b>CCG6</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–
<b>CCG19</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–
<b>CCG25</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–
<b>CCG29</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–
<b>CCG30</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–
<b>CCG48</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–
<b>CCG53</b>	–	–	<b>Without collagen</b>	–	–	–	–	–	–

were negative as the samples did not contain collagen. All this information is given in Table 3, which identifies the graves that were sampled and the problems encountered. All dates have been calibrated to  $2\sigma$  using OxCal v 4.2 software (Bronk Ramsey, 2009) with the IntCal13 curve (Reimer et al., 2013).

Except for one result (AA19183), all the standard deviations are below  $\pm 100$  years and, also with the exception of one sample (UBAR576), all were dated with the AMS method and all of the samples come from human bones. Dating fauna bones or charcoal samples was excluded. In the first case, because we would not be dating the time of burial, but some of the bone implements or unmodified animal bones left as grave goods. In the latter case, because we do not know the origin of the charcoal, which might not be contemporaneous with the burial, and also because this type of sample tends to give older results due to the “old wood” effect (Ashmore, 1999; Dean, 1978; Schiffer, 1986).

All in all, although the preservation conditions were not ideal, the availability of fourteen dates from eleven of the 24 graves was an exceptional situation to extract significant information about the chronology of the site and the Neolithic community buried there. No Neolithic funerary sites with such a large number of radiocarbon dates as Camí de Can Grau is known in the Iberian Peninsula (Table 3).

A series of statistical tests have been performed with the radiocarbon dates, in order to assess the chronometric results and to answer the questions posed. First of all, a “Sum of Probability Distributions” of the whole set of dates was performed. It evaluates the probability of whether independent events (i.e. radiocarbon dates) occurred in a given time. It combines the set of dates with the mean sum of their probability distributions without taking into account their margins of error (Barceló, 2008; Caracuta et al., 2012; Gamble et al., 2005; Steel, 2010; Wicks et al., 2014; Williams, 2012).



The peaks in the graphic representation of the “Sum of Probability Distributions” are usually interpreted as the greatest probability of the concentration of date intervals in one or several times. However, these peaks may also be due to the form of the calibration curve inside those time boundaries, so considering them markers of greater probability may lead to errors (Bayliss and Bronk Ramsey, 2004; Contreras and Meadows, 2014; Weninger et al., 2011; Williams, 2012). To overcome this issue and determine whether the particular section of the calibration curve has conditioned the distribution of the dates, we have carried out a simulation of the “Sum of Probability Distributions”.

This simulation consists of constructing a consecutive series of uncalibrated dates, considering the oldest and most recent ones as the boundaries of the time interval (i.e. one date per year). The standard deviation given to the simulated dates has been the smallest possible,  $\pm 10$ , so that a uniform process has been modelled in order to observe whether or not the peaks in the graph of the archaeological dates coincide with those in the simulated series. This analysis has been performed with CalPal 2016 software (Jöris and Weninger, 1998) with the IntCal13 curve, since it allows the superimposition of the graphs obtained with the calibration curve, facilitating their observation and interpretation.

At the same time, the degree of contemporaneity between the different burials has been calculated with the “Combine” function in the OxCal v4.2 software with the IntCal13 curve. This function calculates the degree of probability of the overlapping of the intervals of each date after their calibration. The internal consistency of the degree of overlapping is assessed with the  $\chi^2$  statistical test (Long and Rippeteau, 1974; Ward and Wilson, 1978).

When more than one date was available for the same burial, as in Structure CCG38, they were combined previously with the same function. The aim was to avoid redundancies that would increase the intervals of uncertainty in the dated contexts. Additionally, the degree of contemporaneity of the dates has also been assessed with the same test, differentiating the following variables: the type of the structure, the number of individuals and the presence or absence of some grave goods (especially the artefacts made with exogenous raw materials, like honey flint or the adornments, or that required a large investment in time and labour in their manufacture, such as the variscite beads used to make necklaces and bracelets).

Once the degree of contemporaneity between the funerary structures and the variables was determined, their temporal distribution was represented with different “Sum of Probability Distributions” performed with CalPal 2016 software (Jöris and Weninger, 1998) with the IntCal13 Curve. The aim was to determine whether chronological differences existed in connection with the presence or absence of the variables being assessed. In this case the software used was CalPal, because it is the only one that superimposes different graphs in a single picture on the same scale, which favours their comparison and interpretation. Moreover, this software projects where the probability distributions of each of the dates (the small black bars) are within the framework of the full

distribution, so it allows us to observe which radiocarbon dates delimit the boundaries of the general distribution.

Finally, to calculate and compare the time boundaries of the Camí de Can Grau necropolis with other funerary sites considered from the same horizon located in the same region and the South of France and Switzerland, the sum of the probability distributions of all radiocarbon dates (see Appendix 1) were compared and “Overlapping Phases Bayesian Modelling” (Bronk Ramsey, 2009) through the OxCal v4.2 with the IntCal13 curve was carried out. This Model is based on the hypothesis that all the events (radiocarbon dates) have the same probability of occurring at any time between the start and end of the phase. The model takes the oldest and most recent dates as the boundaries of the time sequence in each phase, taking into account that the end of the first phase overlaps with the beginning of the second. The model also estimates the duration of each phase.

All the results of the statistical analysis are presented in  $2\sigma$  (95.4%).

## 5. Questions and results

Taking into account the suggested goals at the beginning of the paper, several questions were posed:

- what is the chronological distribution of the necropolis of Camí de Can Grau? Are all the burials contemporary?
- are there any chronological differences between the different grave types, 4 and 5b, at Camí de Can Grau?
- are the individual and collective inhumations coetaneous?
- is there any relationship between the age of the graves and the presence of raw materials from outside areas or that were the outcome of considerable investment in labour?
- is there a differential spatial distribution of the graves within the necropolis according to their chronology?
- how long was the necropolis in use? Are there any chronological differences between Camí de Can Grau and the other funerary sites in the “Pit Burials” horizon in the North-East of the Iberian Peninsula?
- what kind of chronological relationship can be established between Camí de Can Grau and other similar funerary sites in the south of France and Switzerland?

### 5.1. What is the chronological distribution of the necropolis of Camí de Can Grau? Are all the burials contemporary?

The “Sum of Probability Distributions” indicates that the chronological distribution of the burials in the necropolis of Camí de Can Grau is situated between 4000 and 3400 cal BC. However, within this time, a greater probability of its use between about 3800 and 3650 cal BC can be appreciated (SM1). The simulation of the sum of the probability distributions has assessed the reliability of these results. In the graph of the simulated series (SM2), the inclined section of the calibration curve that could affect the distribution starts from 3500 cal BC (highlighted in red), so it does not

seem to condition the interval of greater probability of concentration of the burials between the 3800–3650 cal BC.

CalPal projects the vertical black bars on the chronological axis by default. These indicate where the probability distributions of each of the dates are located within the framework of the sum. Each of the bars are located approximately in the mean of each of the calibrated dates. Although we should not take the mean as a chronological value (Barceló, 2008; Contreras and Meadows, 2014; Weninger et al., 2011; Williams, 2012), they could allow us to visualize which of the radiocarbon dates delimit the boundaries of the general distribution.

As regards the hypothesis of the contemporaneity of the burials, the  $\chi^2$  test shows that there is sufficient statistical consistence in the overlapping of the intervals of the dates of Structures CCG33, CCG38, CCG44, CCG4, CCG5 and CCG7, between 3710 and 3650 cal BC (with a value of 127.7% – Acomb). Two dates from Structure CCG38 (UBAR76 and BETA120561) were combined previously and gave a distribution between 3765 and 3540 cal BC (Acomb. 108.4%).

This function has also been used to verify the degree of contemporaneity in other dates obtained from different individuals in the same structure (to be exact, in graves CCG46 and CCG42). In this way, as remarked above, redundancies in the different tests can be avoided. In the case of grave CCG42, the test shows sufficient statistical reliability (Acomb. 127%) to confirm the contemporaneity of Individuals 1 and 2, between 3890 and 3695 cal BC. For the three individuals dated in Structure CCG46, it can only be reliably claimed that Individuals 1 and 3 are contemporaneous between 3520 and 3370 cal BC (Acomb. 92%). Individual 4 would have been buried in about 3650–3520 cal BC.

Thus, we can conclude that, according to our data, although the chronological distribution of the burials at Camí de Can Grau was around 4000–3400 cal BC, with a greater probability of a concentration between about 3800–3700 cal BC, we can only confirm that the burials in Structures CCG33, CCG38, CCG44, CCG4, CCG5 and CCG7 were contemporary around 3710–3650 cal BC.

### 5.2. Are there any chronological differences between the different grave types, 4 and 5b, at Camí de Can Grau?

Another aspect to be assessed was whether or not the architectonic differences and forms of Type-4 and 5b graves were contemporaneous. In the case of Type 5b graves, the  $\chi^2$  test only indicates contemporaneity between two of the six structures, CCG44 and CCG4, in a time between 3700 and 3685 cal BC (Acomb. 134.9%). Therefore, it cannot be claimed that all the graves of this type are strictly contemporaneous.

In contrast, the test indicates sufficient statistical consistence regarding the contemporaneity of Type-4 graves, in 3765–3650 cal BC, with a value of 96.8% (Acomb.) Although these results suggest the structures are contemporaneous, as only three dates of this grave type were analysed, the results should be taken with caution, while awaiting new radiocarbon dates in the future.

In any case, if the temporal distributions of the dates obtained from Type-4 and 5b graves are compared (SM3), it can be seen that the Type-4 graves are distributed

between 3800 and 3380 cal BC, and the 5b type around 3970–3360 cal BC. This suggests that, although the Type-5b graves began to be constructed earlier, both finished at the same time and are practically contemporaneous in their use. However, there is a certain decompensation between the number of dates available from one type and the other (a total of 9 from the Type-5b graves and just 3 from the Type-4 ones), so these interpretations should be taken with caution pending new data.

On the other hand, one special case that deserves specific comments and treatment is Grave CCG38, which was not included in the previous analysis because of its peculiarities. According to the archaeological study, it seems that a Type-4 grave was constructed first and a second funerary structure corresponding to the parameters of the 5b type later. Two burials in this structure were dated, one from Type 4 and the other from Type 5b. The Combine function showed that the time interval of these burials overlaps in 3765–3540 cal BC, so there is no statistical chronological criterion indicating a significant difference in time between them.

### 5.3. Are the individual and collective inhumations coetaneous?

Above all, one of the most characteristic traits of the necropolis of Camí de Can Grau, which differentiates it from most of the “Pit Burials” horizon sites, is the high proportion of graves containing more than one individual (41.66%). This is an aspect to be assessed in order to determine if the collective burials (simultaneous or not) were the result of a change in the funerary conception after a certain moment in time, as regards the other graves in the same necropolis and other funerary sites belonging to this period. In SM4, it can be seen that whereas the individual burials are distributed from 3950 to 3380 cal BC, the graves with more than one individual are dated between 3960 and 3370 cal BC. However, the tests show that four of the graves with more than one individual (CCG44, CCG5, CCG7 and CCG42) are dated around 3765–3660 cal BC (Acomb. 73.3%). This period closely matches the time of individual graves, like CCG33 and CCG4, whose time interval lies from 3710 to 3540 cal BC (Acomb. 106.2%).

These results show that there is no chronological difference between the use of individual and collective burials in the necropolis of Camí de Can Grau. However, this aspect needs further investigation, since unfortunately there is again an imbalance between the number of dates from individual (3) and collective (8) graves.

### 5.4. Is there any relationship between the age of the graves and the presence of raw materials from outside areas or that were the outcome of considerable investment in labour?

Another question refers to the raw materials deposited in the grave goods and whether exogenous materials, like the honey flint probably from South-East France, and materials that involved considerable effort in their procurement, such as variscite from the mining complex at

Gavà (Barcelona), are present in the burials at a particular moment of time.

The results, however, should be interpreted with some reserve, as only a small number of graves contain honey flint and variscite. The honey flint only appeared in eleven of the total of twenty-four graves (45.83%) and variscite in three (12.55%). Similarly, honey flint was found in ten (41.66%) of the dated graves (14) and variscite in just one (20.83%).

In any case, the first tests do not seem to show that the appearance of honey flint corresponds to any particular time. Of the ten graves with this type of flint that were dated, only two overlap chronologically with statistical significance (CCG33 and CCG38), between 3760 and 3535 cal BC (Acomb. 107.9%). This test could not be performed for variscite as it was only dated in grave CCG5. In any case, with its calibration of 3780–3640 cal BC, this grave is chronologically situated in an intermediate time at the necropolis.

Comparing the dates of the graves that contained honey flint or variscite with the others (SM5), it can be seen that their presence (especially honey flint because of the larger number of dated graves) was a constant throughout the time the necropolis was in use.

### 5.5. Is there a differential spatial distribution of the graves within the necropolis according to their chronology?

The aim of the geo-statistical analysis performed at the necropolis of Camí de Can Grau was to detect possible patterns of spatial organisation. In other words, to determine whether the graves displayed any particular distribution regarding their typology or the number of individuals or if they were simply mixed with no significant spatial pattern. Two tests were applied: Moran's I spatial autocorrelation and the nearest neighbour test.

Moran's I spatial autocorrelation suggested that graves are distributed according to their typological structure (Types 4 and 5b). This was confirmed by applying the test in 21 of the 24 funerary structures (CCG35 and CCG24 were discarded because their typology was not clear and CCG38 since it involved both types). The obtained result is very close to 1, the P-value is statistically significant and the Z score is positive. Therefore, it can be affirmed that Type-4 and Type-5b graves were intentionally distributed spatially in two groups (see Fig. 4 and Table 4).

The same spatial autocorrelation test gives a negative result if the number of individuals is included. The value of Moran's I index is close to 0 while the P-value is not statistically significant. Both values indicate that there is no specific spatial distribution of the graves according to the number of bodies. The results in both tests should be regarded as descriptive, since the sample is too small ( $n < 30$ ) to be considered reliable.

Regarding the nearest neighbour analysis, it has been adapted to the polygonal surface area that contains the graves. The resulting index gives a value higher than 1. This indicates a clearly disperse pattern which, together with the statistically significant P-value and the positive Z score, shows that the graves are located in a

**Table 4**

Results of Moran's I spatial autocorrelation test, assessing the typology of the grave (Types 4 and 5b) and the number of buried individuals.

**Tableau 4**

Résultats du test d'auto-corrélation spatiale I de Moran, évaluant la typologie des sépultures (Types 4 et 5b) et le nombre d'individus inhumés.

	Typology of the grave	Number of buried individuals
Moran Index	0.822874	-0.077603
Expected Index	-0.047619	-0.043478
Variance	0.029771	0.022445
Score Z	5.045094	-0.227779
P-value	0.000000	0.819818

**Table 5**

Index values of the Nearest Neighbour test.

**Tableau 5**

Valeurs d'indices du test *Nearest Neighbour*.

	Total graves	Type-5 burial	Type-4 burial
Average observed distance, m	4.2309	4.6200	3.8585
Average expected distance, m	2.8808	2.5698	2.2902
Index Nearest Neighbour	1.468666	1.797777	1.684843
Score Z	4.392383	5.502806	3.930460
P-value	0.000011	0.000000	0.000085

regular geographic arrangement and that the area was intentionally structured (Table 5).

Finally, according to the values and taking into account the typology of the graves (again excluding Structures CCG24, CCG35 and CCG38), the probability that the grave types would have been distributed randomly is less than 1%. Thus, according to these results, we can conclude that the community at Camí de Can Grau distributed the graves deliberately according to their morphology.

### 5.6. How long was the necropolis in use? Are there any chronological differences between Camí de Can Grau and the other funerary sites in the "Pit Burials" horizon in the North-East of the Iberian Peninsula?

Finally, the chronological distribution of all the radiocarbon dates obtained at Camí de Can Grau has been compared with published radiocarbon dates for other funerary sites of the "Pit Burials" horizon (see the data in the Appendix file). This was principally to determine in which period of the general chronological distribution of the "Pit Burials" horizon Camí de Can Grau could be assigned. As SM6 shows, whereas the graves of Camí de Can Grau are chronologically situated between 3960 and 3370 cal BB; the other "Pit Burials" horizon sites are dated from 4550 to 3580 cal BC.

In addition, "Two Overlapping Phases Bayesian Modelling" (Appendix 1) indicates that, whereas the Pit Burials Cultural phase lasted from 4600–4460 to 3650–3510 cal BC, the necropolis of Camí de Can Grau started about 4030–3805 and ended about 3615–3340 cal BC. The model suggests the span of use of the necropolis between 195–530 calendar years. The model is statistically reliable (Amodel 84.7% and Aoverall 82.5%), although it considered the CNA2664.1.1 date as an outlier (Agreement index: 41.7%), being statistically different from the other ones. This does

**Table 6**

Result of Three Overlapping Phases Bayesian Modelling of the funerary structures of south of France and Switzerland (Phase 1), “Pit Burials” from the north-east of the Iberian Peninsula (Phase 2) and the necropolis of the Camí de Can Grau (Phase 3).

**Tableau 6**

Résultat de trois phases se chevauchant de la modélisation bayésienne des structures funéraires du Sud de la France et de Suisse (Phase 1), des “sepulcres de fossa” du Nord-Est de la péninsule Ibérique (Phase 2) et de la nécropole de Camí de Can Grau (Phase 3).

	START	END	SPAN
Funerary structures from the South of France and Switzerland	4790–4665 cal BC	3635–3530 cal BC	1035–1190 calendar years
Pit Burials from the North-East of the Iberian Peninsula	4615–4405 cal BC	3660–3530 cal BC	760–995 calendar years
Burials of the Camí de Can Grau	4030–3805	3620–3340	195–530 calendar years

not mean that the model is incorrect, but it alerts us that either there was a problem during the realization of the radiocarbon dating or this burial is simply relatively posterior to the other ones. It would be interesting to re-date this burial in order to rule out one of these two hypotheses (SM7).

These results confirm the hypothesis formulated at the beginning of this paper: the necropolis at Camí de Can Grau was in use towards the end of the so-called “Pit Burials” horizon.

### 5.7. What kind of chronological relationship can be established between Camí de Can Grau and other similar funerary sites in the South of France and Switzerland?

As in the previous cases, in the first place a sum of the probability distributions of the radiocarbon dating of the three groups has been carried out (see the data in the [Appendix file](#)). As the graphic illustrates, the radiocarbon datings of the funerary structures from the South of France and Switzerland (upper part of the graph) are distributed between 4720–3480 cal BC, while those belonging to the funerary sites of the “Pit Burials” horizon (middle part of the graph) and the necropolis of Camí de Can Grau (bottom part of the graph) are distributed between 4550–3580 cal BC and 3960–3370 cal BC respectively (SM8).

A Three Overlapping Phases Bayesian Modelling (see [Appendix 2](#)) has tested the statistical consistency of the chronological distribution hypothesis previously suggested by the sum of probabilities distribution (Amodell index: 78.5 Overall index: 78.8) (Table 6).

Thus, although the chronological distribution of the three groups would overlap over time, the funerary structures from the South of France and Switzerland (Phase 1) would be the oldest ones, followed by the “Pit Burials” from the North-East of the Iberian Peninsula (Phase 2). Finally, according to this model, the graves of Camí de Can Grau would be the earliest phase, which would overlap with the most recent structures of the “Pit Burials” horizon.

## 6. Discussion

The necropolis of Camí de Can Grau is one of the best-preserved Neolithic funerary sites to be studied in recent decades in the North-East of the Iberian Peninsula. Since it was excavated with modern archaeological techniques, the available data regarding the funerary structures, their location, the types of inhumation, the grave goods and their position inside the graves were documented in great detail.

Although both grave types are clearly linked to the funerary practices of the “Pit Burials” horizon, several elements differentiate them. Above all, the large number of graves with more than one individual, and the scarce presence of exogenous raw materials or objects that required a large investment in labour, are unusual. These differences suggested the initial hypothesis that the Camí de Can Grau necropolis represented a site in which the funerary practices of the “Pit Burials” horizon were beginning to change and, therefore, it might be later than most of the other sites ascribed to this funerary phenomenon.

The chronological comparison between the necropolis of Camí de Can Grau and other funerary sites in the “Pit Burials” horizon shows they coincide with the time when the number of radiocarbon dates for other sites of the “Pit Burials” begins to decrease, when it seems that mortuary traditions are changing. Added to the fact that the deceased at Camí de Can Grau are not accompanied by as many grave goods and a large proportion of graves were collective and even reused, this could mean that Camí de Can Grau represents one of the last necropolises in this funerary phenomenon.

On the other hand, the similar funerary horizons from the South of France and Switzerland seem to have an older chronological distribution than the Iberian ones. This suggests that, although the three horizons coincided in time, the French and Swiss contexts would have begun earlier than those of the near-east of the Iberian Peninsula, which, at the same time, would have disappeared later. In the future it would be interesting to analyse whether a similar chronological pattern between these three regions is documented or not regarding the raw material exchange networks.

These changes, which must have taken place slowly, could be related to the mortuary practices that appeared shortly afterwards, during the Late Neolithic-Chalcolithic periods, when collective burials in dolmens, artificial hypogea, pits and caves, with few grave goods, became the recurrent funerary pattern. In this period (Late Neolithic-Early Chalcolithic), the provenance of the raw materials used for lithic tools deposited as grave goods is different. The exchange networks operating from the late fifth millennium to the mid-fourth millennium cal BC broke down and during the late fourth millennium cal BC they were replaced by connections bringing flint from the South-East of France (Roussillon-Languedoc-Provence regions) and the Ebro valley in Spain ([Gibaja et al., 2008](#); [Terradas et al., 2012](#)).

Regarding future expectations of this research project, it would be interesting to date similar funerary sites to



Camí de Can Grau, since it could help to clarify this time of change in mortuary practices in the second half of the fourth millennium cal BC. Some collective burials associated with scarce grave goods have been identified in the same geographical area and a new radiocarbon dating programme will be carried out. They include the burials at Can Filuà, Can Vinyals and Can Pallàs (Costa et al., 1982; Martí et al., 1995; Ten, 1980). If these sites coincide in time with Camí de Can Grau, there will be more solid criteria to propose that in the second half of the fourth millennium cal BC, ideological conceptions related to death and funerary practices began to change. These conceptions would have also been related in some way with changes in the raw materials exchange networks linking northeastern Iberia to other communities in the western Mediterranean. However, this is ground to make up in the near future.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.crpv.2017.10.002>.

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