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Funerary practices and kinship in an Early Bronze Age society: a Bayesian approach applied to the radiocarbon dating of Argaric double tombs

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ABSTRACT

The main aim of this paper is to test the hypothesis on kinship relations (affinity/marriage *vs* descent/consanguinity, and matrilocality) expressed in the funerary record of the El Argar Bronze Age society (South-east Iberia, 2200–1550 cal BCE), taking into account the absolute chronological dimension of double adult tombs. A set of 23 double tombs having radiocarbon dates for both skeletons were selected, and radiocarbon calibration and Bayesian probability analysis was conducted. The results support the 'descent' hypothesis, since for most of the cases the chronological distance between individuals buried together was larger than two decades. Finally, several guidelines for future research are suggested in order to overcome shortages in current chronological and archaeological data.

1. Introduction

El Argar is one of the main archaeological entities of the Early Bronze Age in Western Europe. Pioneering research by H. and L. Siret (1887) in the late 19th century included excavations in a dozen Argaric sites, setting the foundations for the chronological scheme of later prehistoric times in Iberia and for a wide array of studies on prehistoric technology and social organisation. Twentieth century excavations and current research projects concerning sites such as La Bastida (Lull et al., 2011b), Peñalosa (Contreras, 2000), Fuente Álamo (Schubart et al., 2000), Gatas (Castro et al., 1999), Illeta dels Banyets (Soler, 2006), Lorca (Martínez et al., 1996), El Rincón (Ayala, 1991), Tira del Lienzo (Lull et al., 2011b), Castellón Alto (Contreras et al., 1997), Cuesta del Negro (Molina and Pareja, 1975), Cerro de la Encina (Aranda and Molina, 2006), Cerro de la Virgen (Schüle, 1980) or Cabezo Pardo (López Padilla, 2009) (Fig. 1) have increased our knowledge of the Argaric archaeological record over a territory of *ca.* 33.000 km^2 in a variety of ecological niches in the south-east of Spain, and covering the period between *ca.* 2200 and 1550 cal BCE. A four-level settlement pattern, ranging from up to 6 ha of large hilltop settlements to small hamlets in the lowlands has been observed. Urbanism is characterised by a compact plan of large stone-walled buildings on terraced slopes. Supradomestic buildings, water reservoirs and monumental fortification systems have been reported in some settlements. Standardised pottery, lithic and metallurgical production was carried out by specialists at a local and regional level (Lull, 1983; Lull et al., 2010; 2013). Organic remains have shown that subsistence was increasingly based on the extensive dry farming of barley and diversified husbandry, in the context of wetter than today's semiarid ecological conditions (Castro et al., 1999). Spatial and palaeoeconomic analyses suggest that the Argaric society was politically organised on a State basis (Lull and Risch, 1995; Risch, 2002). Argaric territory was divided into a number of polities sharing elite relationships and funerary rituals.

Apart from research in habitation contexts, the Argaric funerary record has fostered detailed insights on political and social relationships (Lull, 1983, 2000; Lull and Estévez, 1986; Lull et al., 2005). Intramural interments are a particular feature of Argaric burial practices. Tombs were usually located underneath settlement floors and most of them were individual, although sometimes the same grave was used for two and exceptionally three or more corpses. Bodies were placed flexed or seated inside pottery urns (*pithoi*), cists made of stone slabs or masonry, small rock-cut tombs or simple pits. Individuals of both sexes and all ages were represented, although it seems unlikely that all the population deserved this funerary treatment (Chapman, 1990; Lull et al., 2011a). Grave goods included pottery, metal (copper, silver and sometimes gold) tools, weapons and ornaments, and bone, stone and shell items.

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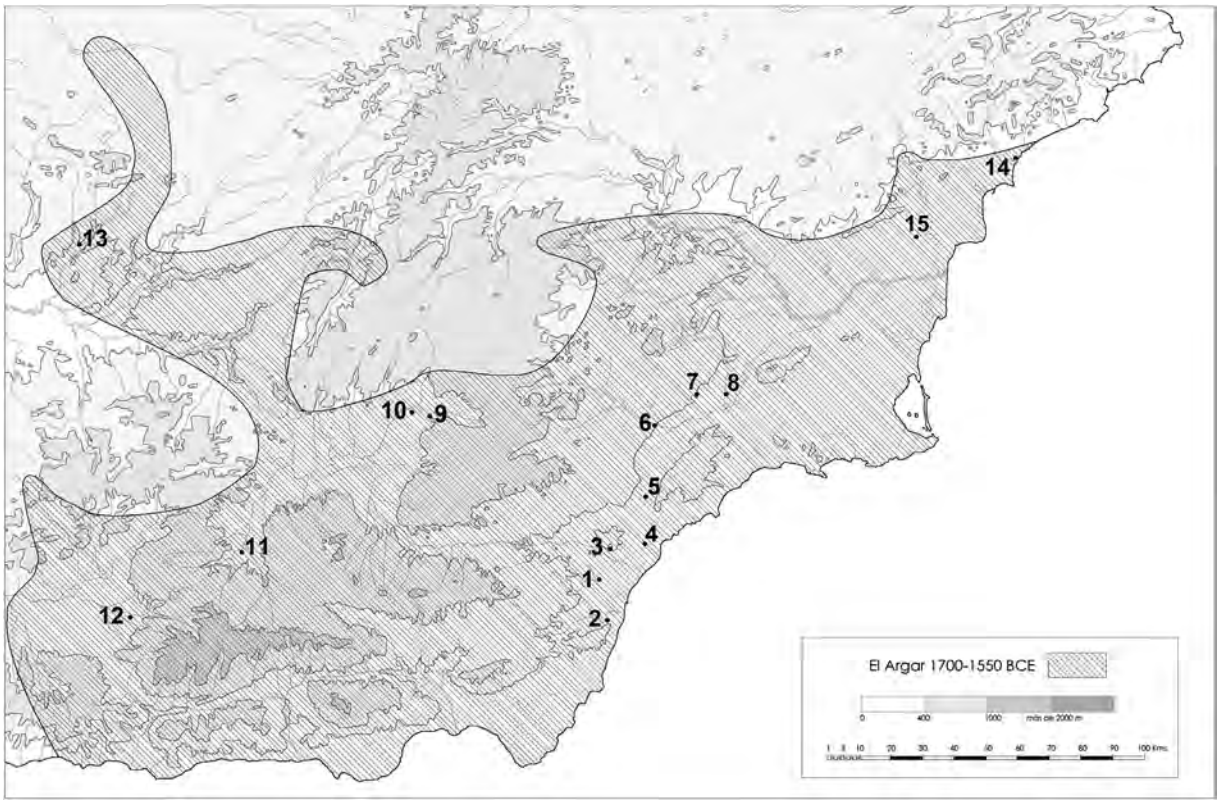

Fig. 1. Map of South-east Iberia showing the sites mentioned in the text. 1. El Argar, 2. Gatas, 3. Fuente Álamo, 4. El Oficio, 5. El Rincón de Almendricos; 6. Lorca; 7. La Bastida, 8. Tira del Lienzo, 9. Cerro de la Virgen, 10. Castellón Alto 11. Cuesta del Negro, 12. Cerro de la Encina, 13. Peñalosa, 14. Illeta dels Banyets, 15. Cabezo Pardo.

Differences amongst grave goods assemblages have been used to suggest a wide range of hypotheses on the Argaric political and economic organisation (Aranda and Esquivel, 2007; Arribas, 1976; Arteaga, 2000; Cámara, 2001; Cámara and Molina, 2011; Chapman, 1990, 2003; Gilman, 1976; Lull, 1980, 1983, 2000; Lull and Estévez, 1986; Lull et al., 2005, 2011a; Maluquer de Motes, 1972; Micó, 1993; Molina, 1983; Schubart and Arteaga, 1986; Siret and Siret, 1887). There is a general agreement on the unequal character of the Argaric society, although current debates are still held to define whether the socio-political organisation was state level or if it is better characterised by some kind of pre-state political category (chiefdom, stratified society). Apart from class-related differences, age and gender based funerary treatments have also been observed.

Research on kinship is probably the aspect of Argaric society less explored so far. Palaeogenetic data are most needed to address the question when burials come into play. However, different analysis on aDNA conducted since the early 1990s have shown that all South-east Iberia sites tested up to now have an extremely low preservation rate.[1] In spite of this, the Argaric archaeological record offers other possibilities to gain knowledge on kinship relationships. Single burials allow the assessment of how different individuals, male or female, children or elders, were ritually processed according to standardised rules and buried under particular residential units. On the other hand, double burials show specific combinations that could be analysed in terms of sex, age, spatial distribution and chronology. In this paper we will focus on this latter dimension because double burials have mostly contributed to the earliest and ongoing debate on Argaric kinship, always under the assumption of kin relatedness among the people buried in the same grave.

2. Argaric double burials and inferences on prehistoric kinship

About 2.000 Argaric burials have been reported in more or less detail since the pioneering excavations held in the second half of the 19th century. In general terms, double burials account for *ca.* 10% of all Argaric tombs (Micó, 1993).[2] Although variations between sites can be observed, nearly half of these tombs contain the remains of two children or those of one child and one adult/senile. The remaining *ca.* 50% concern only two adult/senile individuals (Fig. 2). Except for a handful of cases, double adult graves were used for burying a man and a woman. We will focus on this set of tombs.

From the very beginning of Argaric archaeology, double adult burials were suggested to be the representation of heterosexual couples (Inchaurrandieta, 1870: 809; Siret and Siret, 1887: 163; Cuadrado, 1947: 62; Schubart et al., 1985: 95; Ayala, 1991: 126; Contreras et al., 1997: 134; Arteaga, 2000: 182; Schubart, 2012: 42). Their relative high frequency among double tombs and symbolic

[1] Samples from Gatas, Fuente Alamo, Lorca town and La Bastida have been processed by Jane E. Buikstra (Arizona State University, USA), Assumpció Malgosa (Universitat Autònoma de Barcelona, Spain), and Christina Roth and Kurt Alt (Johannes Gutenberg-Universität Mainz, Germany) with unsuccessful results.

[2] Even though information from inland sites (Granada) is still fragmentary, double tombs seem to be slightly more frequent here than in the coastal regions. However, differences can also be traced among the latter. In Lorca town, for instance, double tombs account for 31% of the 48 graves excavated in the last three decades (Rihuete et al., 2011, Table 2), whereas in other sites with a much larger sample but collected in the 19th century, such as El Argar and El Oficio, percentages range between 6 and 8% (calculations based on Siret and Siret, 1887; Schubart and Ulreich, 1991; Kunter, 1990).

Fig. 2. Double burial in pottery urn from La Bastida (T16). The remains of a 35–40 year-old male (yellow) were found laying on top of an equally articulated female (red), which was buried first and with the same age-at-death. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

relevance in the funerary realm led to the belief that monogamy was the rule and that marriage was a key political institution. Thus, it was implicitly understood that Argaric society was formed by nuclear families living in domestic units.

In the early 1990s, research conducted in the *Gatas Project* aimed to test these inferences. If couples buried in double tombs were to represent the political roles of husband and wife, it should be expected that both individuals shared the same chronological horizon. At the beginning of the 1990s, only limited data concerning the relative chronology of inhumations were available. For instance, if a pile of bones was observed on one side of the tomb along a fully articulated skeleton, it followed that the remains of a body placed first were disturbed *later*, when a second individual (the one preserved in the articulated condition) was buried. In other cases, the sequence of burials could be defined by taking into account the position of certain bones from one skeleton standing on top or beneath those of another skeleton. In some instances, both skeletons were found articulated and without any clear indication concerning the relative chronology of disposal, thus suggesting a short temporal gap between depositions. Unfortunately, for most double tombs no observations of this kind have ever been made nor published. In any case, relative chronological indicators did not put into question the 'marriage hypothesis'. Simply, one could reasonably explain the chronological gap between inhumations as the result of unpredictable and potentially variable differences in the time of death of the alleged husband and wife.

It became clear that testing the 'marriage hypothesis' needed absolute chronological data. This is why a programme aimed at dating both skeletons in a double burial was undertaken (Castro et al. 1993–94; Lull, 2000). Five double tombs from three sites of the Argaric lowlands (Gatas, Fuente Álamo and Lorca) were sampled in the 1990s for Accelerator Mass Spectrometry (AMS) radiocarbon dating. By comparing the central tendencies of 1 *sigma* calibration probability intervals in each pair of dates, a pattern of non-coincidence was observed. The chronological distance between these central tendencies was estimated to be a minimum of two generations (Lull, 2000: 587). As a consequence, an alternative hypothesis to the 'marriage interpretation' was put forward: male and female individuals in Argaric double tombs were not linked by marriage, but by descent.

By combining chronological data and sexual estimation of skeletons, a new pattern seemed to emerge: in four out of the five cases considered, a woman was the first individual to be buried. This trend was interpreted in terms of female priority in descent relationships, a possibility compatible with matrilineal descent rules. In addition to that, Buikstra and Hoshower (1994) analysed the craniometric variability of El Argar following pioneer studies on skeletal remains as a means of assessing post-marital residence practices (Konigsberg, 1987; Lane and Sublett, 1972). The basic assumption in this type of research is that the sex with higher within-group variability is the more mobile sex (Konigsberg, 1988) and the sex with a wider geographic distribution would represent those individuals changing their residence upon marriage. Buikstra and Hoshower's (1994) statistical analysis of El Argar craniometric data showed that males were significantly more variable than females. Therefore, their results were consistent with uxorilocal/matrilocal post-marital residence practices.

A new schema of kinship relationships was then put forward, which can be summarised as follows:

- Argaric society was articulated along matrilineal units on a matrilocal basis.
- Post-marital residence practices relied on male exogamy as a general rule, although perhaps not exclusively.
- Opposite sex double burials reveal descent relationships (i.e., grandmother with grandson). This would mean that the Argaric society paid more symbolic relevance to 'blood' relationships than to political ones based on affinity/alliance (marriage).

Obviously, this new and risky hypothesis required additional empirical support. In the early 2000s, López Padilla et al. (2006) dated the two skeletons found inside grave number 1 of Illeta dels Banyets. In this tomb, the skeleton of a woman was disturbed upon the interment of a man's corpse but, paradoxically, the radiocarbon date obtained for the woman was younger than the man's (Table 1). López Padilla et al. (2006) explained this apparent contradiction as a consequence of a shortage in radiocarbon accuracy; however, given the fact that a certain overlap between both dates was observed, they concluded that the burial sequence (first the woman and later on the man) was after all compatible with the whole probability range of the two radiocarbon dates. Nevertheless, they also warned about the possibility, at least in certain tombs, of a shorter temporal interval between inhumations than previously suggested.

The radiocarbon database of double burials has increased significantly in recent years, mainly thanks to skeletal remains from excavations carried out since the 1960s at inland sites such as Cerro

Table 1
Results of the probability analysis after Bayesian calibration of radiocarbon datings for Argaric double tombs.

Tomb id.	C14 dates (uncal. BP) (sex)	Group prior	Sex of 1st burial	Age at death (years)	Probability difference (%)	Elapsed time (years) (68%)	Elapsed time (years) (95%)	Lower limit HPD region = 0.05% (years)	Bibliography
CA-7	Ua-37879: 3490 ± 40 (?) Ua-37880: 3455 ± 40 (?)	No relationship	Unknown	Unknown	64.68	−38 to 110	−119 to 184	−100	Cámara and Molina 2009: Tab. 1
CA-75	Ua-37882: 3630 ± 50 (?) Ua-37881: 3510 ± 40 (?)	No relationship	Unknown	Unknown	97.12	83 to 245	3 to 348	36	Cámara and Molina 2009: Tab. 1
CA-85	Ua-37883: 3665 ± 45 (?) Ua-37884: 3570 ± 40 (?)	No relationship	Unknown	Unknown	92.58	39 to 214	−29 to 318	−9	Cámara and Molina 2009: Tab. 1
CA-91	Ua-37885: 3475 ± 40 (?) Ua-37886: 3445 ± 40 (?)	No relationship	Unknown	Unknown	64.88	−31 to 121	−122 to 187	−103	Cámara and Molina 2009: Tab. 1
CA-110	Ua-37890: 3565 ± 40 (?) Ua-37891: 3530 ± 45 (?)	No relationship	Unknown	Unknown	71.99	−17 to 143	−128 to 217	−95	Cámara and Molina 2009: Tab. 1
CE-21	Beta-230006: 3330 ± 40 (F) Beta-230005: 3280 ± 40 (M)	No relationship	Unknown	F: 16−17 M: 22−24	74.26	−22 to 119	−87 to 190	−70	Aranda et al., 2008: Tab. 1
CP-1	Beta-237765: 3460 ± 40 (M) Beta-237766: 3390 ± 40 (F)	M earlier than F	M	M: Unknown F: 25−30	100.00	111 to 229	59 to 301	67	López Padilla 2009: p. 257; pers. comm.
CV-6	Ua-39402: 3500 ± 35 (F) Ua-39401: 3488 ± 34 (M)	F earlier than M	F	F: 50−55 M: 25−35	100.00	54 to 140	23 to 192	34	Cámara and Molina 2009: Tab. 2, Fig. 4, pp. 178−179
CV-22	Ua-39412: 3525 ± 33 (J) Ua-39413: 3433 ± 30 (J)	No relationship	Unknown	J: 17.5−18 J: 14−15	88.74	38 to 174	−41 to 230	−10	Cámara and Molina 2009: Tab. 2
CV-30	Ua-39419: 3802 ± 30 (M) Ua-39420: 3780 ± 32 (F)	M earlier than F	M	M: 21 F: 22−24	100.00	60 to 159	28 to 269	40	Cámara and Molina 2009: Tab. 2, p. 179
FA-69	KIA-22261: 3760 ± 25 (M) KIA-22256: 3580 ± 30 (F)	M earlier than F	M	M: 20−50 F: 20−50	99.90	170 to 299	110 to 380	128	Van Strydonck et al., 2005: p. 143
FA-75	OxA-4973: 3635 ± 50 (F) OxA-4972: 3545 ± 65 (M)	F earlier than M	F	F: 20−30 M: 55−65	100.00	152 to 321	73 to 395	96	Hedges et al., 1995b: p. 425
GT-33	OxA-3970: 3630 ± 60 (F) OxA-3969: 3530 ± 60 (M)	F earlier than M	F	F: 50−60 M: 50	100.00	156 to 326	82 to 416	97	Hedges et al., 1993: p. 320
GT-37	OxA-4473: 3665 ± 65 (M) OxA-4472: 3520 ± 80 (F)	M earlier than F	M	M: >50 F: >50	100.00	195 to 391	98 to 511	133	Hedges et al., 1995a: p. 207
IL-1	Beta-188925: 3410 ± 60 (F) Beta-188926: 3470 ± 50 (M)	F earlier than M	F	F: 24−30 M: >451	100.00	65 to 175	25 to 234	32	López Padilla et al., 2006: pp. 126−130 Soler et al., 2006: Tab. 3.2, p. 91
LMI-11	OxA-7672: 3510 ± 40 (F) OxA-7671: 3435 ± 35 (M)	F earlier than M	F	F: 28−35 M: 30−35	100.00	99 to 209	46 to 270	62	Martínez and Ponce, 2002b: pp. 122−124
LTI-2	OxA-7668: 3690 ± 40 (F) OxA-7667: 3560 ± 35 (M)	F earlier than M	F	F: 35−40 M: 35−45	100.00	157 to 305	94 to 373	112	Martínez and Ponce, 2002a: pp. 155−156
NE-2	Ua-39464:3508 ± 30 (?) Ua-39463: 3505 ± 30 (?)	No relationship	Unknown	Unknown	50.91	−57 to 60	−113 to 120	−101	Cámara and Molina, 2009: Tab. 3, p. 180
NE-4	Ua-39467: 3375 ± 32 (M?) Ua-39466: 3281 ± 30 (F?)	M earlier than F	M	Unknown	95.87	106 to 200	51 to 242	71	Cámara and Molina, 2009: Tab. 3
NE-9	Ua39474: 3414 ± 30 (?) Ua-39473: 3413 ± 30 (?)	No relationship	Unknown	Unknown	50.73	−57 to 54	−135 to 135	−108	Cámara and Molina, 2009: Tab. 3
NE-19	Ua-39480: 3589 ± 31 (M) Ua-39481: 3511 ± 30 (F)	M earlier than F	M	Unknown	100.00	109 to 211	57 to 264	77	Cámara and Molina, 2009: Tab. 3, Fig. 5, p. 180
NE-29	Ua-39488: 3413 ± 31 (?) Ua-39489: 3288 ± 34 (?)	No relationship	Unknown	Unknown	99.10	85 to 200	20 to 283	43	Cámara and Molina, 2009: Tab. 3
NE-31	Ua-39492: 3287 ± 32 (F?) Ua-39491: 3254 ± 33 (M?)	F earlier than M	F	Unknown	100.00	61 to 139	27 to 187	37	Cámara and Molina, 2009: Tab. 3, p. 180

Key: CA: Castellón Alto, CE: Cerro de la Encina, CP: Cabezo Pardo, CV: Cerro de la Virgen, FA: Fuente Álamo, GT: Gatas, IL: Illeta dels Banyets, LMI: Madres Mercedarias (Lorca), LTI: Calle Los Tintes (Lorca), NE: Cuesta del Negro. (F) Female; (M) Male; (J) Juvenile.

de la Virgen, Cuesta del Negro, Cerro de la Encina and Castellón Alto (Granada). Several researchers from the University of Granada have conducted an extensive ^{14}C dating programme on eighteen double graves, most of them containing two adults (Cámara and Molina, 2009). Cámara and Molina compared the 1 and 2 sigma calibration probability ranges for each pair of radiocarbon dates. They noticed some cases in which these ranges did not overlap or in which overlapping was minimal. Nevertheless, for most of the cases they concluded that the degree of overlapping was enough to discard the hypothesis of a substantial chronological distance between deaths. Cámara and Molina (2009) did not use this conclusion in order to support the 'marriage hypothesis', but to suggest that the relationship between a woman and a man in Argaric double tombs still remains uncertain or problematic. They also pointed out that the anteriority of women in double tombs was not positively tested in all cases, thus putting into question the matrilocal inference and concluding that the debate on Argaric kinship is still open.

The units for comparison chosen by Cámara and Molina (2009) are the 1*s* and 2*s* ranges of calibrated radiocarbon dates, assuming in some way that they represent continuous intervals. Nevertheless, this is a mistaken premise because radiocarbon calibration produces an unequal distribution of probabilities all along the 1*s* or 2*s* ranges. This implies that a basic visual or proximate percentage comparison considering the extreme values of these ranges does not take into account the complexity of their internal probability distributions. A different approach is thus called for. It seems clear that the calibration ranges of most pairs of dates in double tombs overlap to some extent, but *how much 'overlapping' is needed for a reliable choice between synchrony and temporal spacing?* Furthermore, if any distance between individual dates is observed, *is it possible to measure this temporal gap in terms of how many human generations (if any) have elapsed?*

3. Material and methods

The approach developed here includes two dimensions neglected in previous research: (1) a mathematical analysis suitable for the full probabilistic distribution of the radiocarbon calibration ranges; and (2) the available archaeological information concerning relative chronology, sex and age at the death of each individual. Bayesian statistics have the virtue of covering both aspects and therefore seem most suitable for the topic under discussion.

A set of 23 Argaric tombs with remains of two adults[3] and absolute dates available for both provide the sample for the following analysis (Table 1). The 46 radiocarbon dates involved cover the full time span of the El Argar period, from *ca.* 2200 to 1550 cal BCE[4] (Fig. 3). Standard deviations of the overall series average ±40 years. It should be noticed here that lower values would be desirable given the fact that accuracy of individual dates is a key factor in assessing the degree of proximity between any pair of radiocarbon dates. The graves correspond to nine sites: five are located in the lowlands of Almería, Murcia and Alicante (Gatas, Fuente Álamo, Lorca town – sectors of Madres Mercedarias and Los Tintes –, Illeta dels Banyets and Cabezo Pardo), and provide one third of the sample (eight tombs)[5]; the remaining four are spread throughout the inner highlands of Granada (Cerro de la Virgen,[6] Castellón Alto, Cuesta del Negro[7] and Cerro de la Encina), contributing 15 graves. No chronological differences can be observed in relation to geographical variables. Information about the relative order of inhumation, sexual identification and age at death is available for the lowland sites, but is lacking for most of the Granada tombs due to incomplete publication.

Bayesian probability analysis has been undertaken using the online tool provided by BCal (http://bcal.sheffield.ac.uk, Buck et al., 1999). Twenty-three separate projects (one for each tomb) were created according to the following procedure:

- Each project corresponds to one tomb and has two groups (one for each inhumation) formed by one element (one radiocarbon date).
- Radiocarbon dates were ordered in each project, entering in the first place the date of the earliest inhumation according to archaeological observations retrieved during excavation. When this kind of data was unavailable, the first radiocarbon date to be entered was the oldest one.

The uncalibrated BP date and its associated error were typed in the menu for each group. Delta *R* correction value for the human bone collagen offset (Barta and Štolc, 2007; Geyh, 2001) was not applied because many of the skeletons in the sample lacked the information required on age-at-death. Nevertheless, it should be stressed that in those cases where this information is available, Delta *R* only reports very minor differences when compared to standard calibrations calculated without this correction factor.

Relative chronological information was entered when the order of inhumations was known. In these cases ($n = 13$), the 'Earlier than' option was selected in order to define the sequential relationship between the first and the second burial. This means that BCal calibrates both samples, trying to minimise, if possible,

[3] The database includes three osteologically determined juveniles because, as it has been suggested for El Argar after a multivariate analysis on age, gender and class categories, the social consideration of adulthood for males seems to have started after 15 years of skeletal age, and even earlier for females (Lull et al., 2005: 261).

[4] Sum of probabilities after calibration using Calib 6.1.0 and the atmospheric curve 2009 (Stuiver & Reimer 1986–2011). One Sigma Ranges: [start: end] relative area [cal BC 2015: cal BC 1997] 0.030288 [cal BC 1979: cal BC 1665] 0.959049 [cal BC 1647: cal BC 1645] 0.003064 [cal BC 1599: cal BC 1594] 0.007598 Two Sigma Ranges: [start: end] relative area [cal BC 2205: cal BC 2138] 0.03904 [cal BC 2135: cal BC 2077] 0.036245 [cal BC 2074: cal BC 1500] 0.924716 The scarcity of graves during the first two centuries of El Argar has already been stressed (Castro et al. 1993–94). It is also worth mentioning the rather high chronology of tomb 30 from Cerro de la Virgen, slightly above the upper range of El Argar ^{14}C series (Lull et al., 2010, 2011a). This data, along with other possible cases from inner Murcia and Ciudad Real provinces in south-east Iberia, opens the possibility that double burial was a practice issued in the context of transitional societies at the beginning of the Early Bronze Age. At the lower end of the Argaric period, a decrease in the number of radiocarbon data is observed from *ca.* 1700 cal BCE, probably as a consequence of changing burial practices (Lull et al., 2011a).

[5] Readers acquainted with the prehistoric archaeology of Iberia might wonder why we have not considered the new archaeological evidence provided by systematic excavations carried out since 2009 in the hilltop site of La Bastida (Murcia) (Lull et al., 2011b), where a new set of adult double undisturbed tombs have been discovered. At the beginning of the La Bastida project, an extensive ^{14}C dating program was established with the Leibniz-Labor für Altersbestimmung und Isotopenforschung of Kiel University (Germany), which included the analysis of human remains from double burials. Unfortunately, since June 2009 it was noticed that a series of radiocarbon results provided by this laboratory were not consistent with the stratigraphic position, the specific archaeological context and/or the associated pottery and metal types. Some technical anomalies in dating procedures have been detected, and a redatation programme is now under way.

[6] Tomb 21 of Cerro de la Virgen has been excluded from the database because it probably represents two distinct graves instead of a double burial in the same funerary structure (Cámara and Molina, 2009: 178 and plate I). Tomb 30 is included here as a double tomb because according to Delgado-Raack (2003: 227; 2013), individuals 30a and 30b were recorded as coming from a double tomb, whereas individual 30c came from a nearby single grave.

[7] Tomb 6 from Cuesta del Negro has been excluded due to the unusually recent conventional date (Ua-39469: 3132 ± 30 BP), perhaps due to contamination, which falls out of the Argaric temporality. Since different publications on the burials of Cuesta del Negro provide somewhat contradictory details, we have decided to rely exclusively on the information supplied by Cámara and Molina (2009).

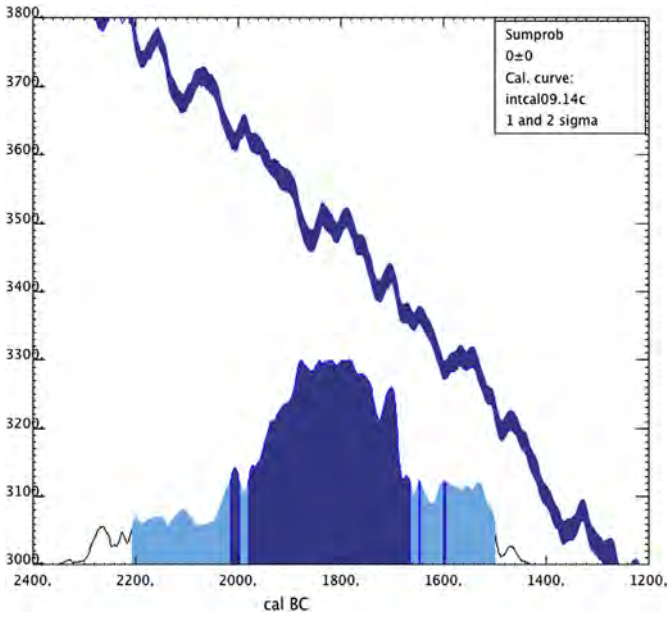

Fig. 3. Probability sum of the 46 radiocarbon dates from Argaric adult double tombs (Calib 6.1.0, ©Stuiver & Reimer 1986–2011).

overlapping results. When information about the order in funerary deposition was lacking, the 'No relationship' option between groups was selected. Here the calibration process considers that both dates are independent from each other. The calibration parameters were those established by default by BCal.[8]

After calibration, different probability analyses were undertaken. First, a comparison between individual calibrated ranges for each pair of dates was made in order to assess their chronological distance. The query was as follows: which is the probability that the older date and/or the first burial is *earlier* than the second one? The range of possible results lies between 50 and 100%. If the dates tend to be contemporary or if a substantial part of the probability calibration range of the later date overlaps with the earlier one, then the result will be close to 50%. On the contrary, the result will be 100% or very close to this figure.

BCal offers further useful calculation options for our current purposes. In particular, the option 'Elapsed time intervals' calculates posterior probability distributions for the length of time elapsed between pairs of parameters. Results are given in two formats: posterior probability density plot and highest posterior density (HPD) regions. In this latter option, results at 95% are given by default, but users can modify percentage values in order to obtain other elapsed time intervals. HPD regions were run for all pairs of radiocarbon dates with levels of 95% and 68%.

4. Results and discussion

Results of the probability difference calculations and elapsed time intervals are shown in Table 1. From the 23 pairs, 15 pairs show a probability difference higher than 95%. This means that, for two thirds of the tombs, the two radiocarbon dates are significantly different from each other. The remaining third, below 95%, shows a diversity of values, but it is worth stressing that only two (NE-2 and NE-9) fall very close to 50%, suggesting close temporal distance.

[8] MCMC sampling long run size: 1000; MCMC sampling interval: 50; minimum sample size: 50,000; convergence checking sensitivity level: 5 (very strict).

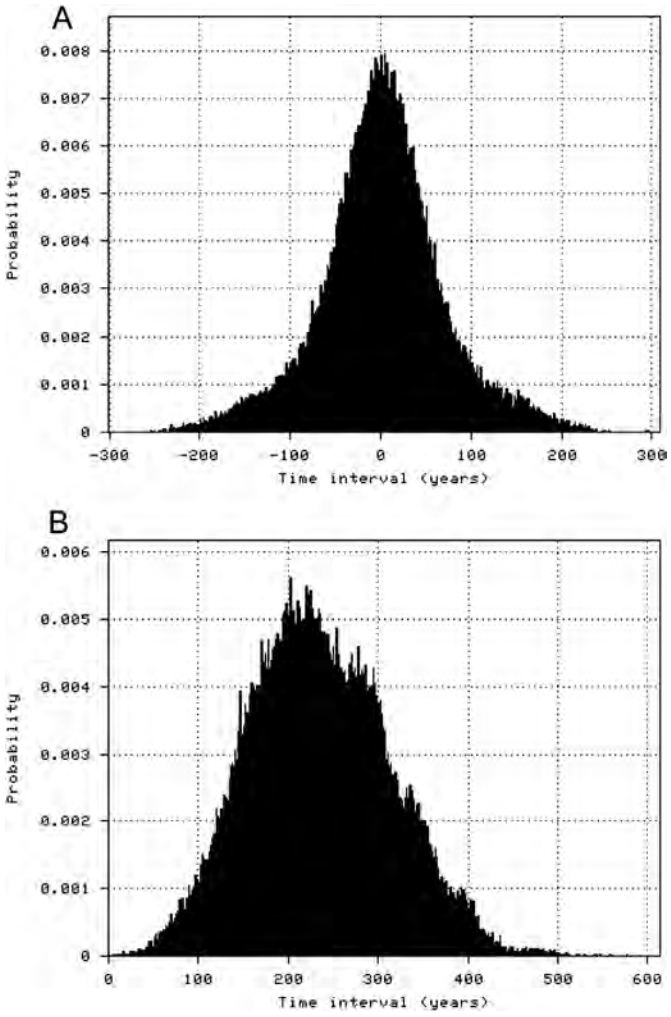

Fig. 4. A. Example of posterior probability density distributions. Plot for radiocarbon dates of tomb 9 from Cuesta del Negro. Note that the median is about zero value. This kind of result would indicate a small temporal difference between deaths. B. Example of posterior probability density distributions. Plot for radiocarbon dates of tomb 1 from Los Tintes-Lorca. Note that the whole distribution is positive. This kind of result would indicate a difference between deaths in terms of several generations.

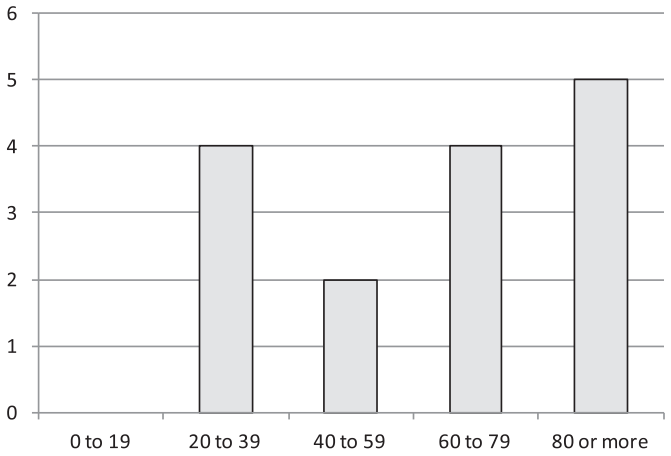

Fig. 5. Frequency distribution of positive lower HPD interval (95%) values (BCal probability analysis with 'Earlier than' as a prior condition in group definition) by time intervals of 20 years ($n = 15$).

Table 2
Results of the probability analysis after calibration of radiocarbon datings for Argaric double tombs (no prior Bayesian conditions were applied: "No relationship" option).

Tomb id.	C14 dates (uncal. BP) (sex)	1st burial sex	Probability difference (%)	Elapsed time (years) (68%)	Elapsed time (years) (95%)	Lower limit HPD region = 0.05% (years)	Bibliography
CA-7	Ua-37879: 3490 ± 40 (?) Ua-37880: 3455 ± 40 (?)	Unknown	64.68	−38 to 110	−119 to 184	−100	Cámara and Molina, 2009: Tab. 1
CA-75	Ua-37882: 3630 ± 50 (?) Ua-37881: 3510 ± 40 (?)	Unknown	97.12	83 to 245	3 to 348	36	Cámara and Molina, 2009: Tab. 1
CA-85	Ua-37883: 3665 ± 45 (?) Ua-37884: 3570 ± 40 (?)	Unknown	92.58	39 to 214	−29 to 318	−9	Cámara and Molina, 2009: Tab. 1
CA-91	Ua-37885: 3475 ± 40 (?) Ua-37886: 3445 ± 40 (?)	Unknown	64.88	−31 to 121	−122 to 187	−103	Cámara and Molina, 2009: Tab. 1
CA-110	Ua-37890: 3565 ± 40 (?) Ua-37891: 3530 ± 45 (?)	Unknown	71.99	−17 to 143	−128 to 217	−95	Cámara and Molina, 2009: Tab. 1
CE-21	Beta-230006: 3330 ± 40 (F) Beta-230005: 3280 ± 40 (M)	M?	74.26	−22 to 119	−87 to 190	−70	Aranda et al., 2008: Tab. 1
CP-1	Beta-237765: 3460 ± 40 (M) Beta-237766: 3390 ± 40 (F)	M	88.37	28 to 180	−57 to 254	−27	López Padilla 2009: p. 257; pers. comm.
CV-6	Ua-39402: 3500 ± 35 (F) Ua-39401: 3488 ± 34 (M)	F	54.27	−54 to 72	−122 to 136	−97	Cámara and Molina, 2009: Tab. 2, Fig. 4, pp. 178–179
CV-22	Ua-39412: 3525 ± 33 (J) Ua-39413: 3433 ± 30 (J)	Unknown	88.74	38 to 174	−41 to 230	−10	Cámara and Molina, 2009: Tab. 2
CV-30	Ua-39419: 3802 ± 30 (M) Ua-39420: 3780 ± 32 (F)	M	65.30	−39 to 94	−124 to 188	−86	Cámara and Molina, 2009: Tab. 2, p. 179
FA-69	KIA-22261: 3760 ± 25 (M) KIA-22256: 3580 ± 30 (F)	M	99.90	170 to 299	110 to 380	128	Van Strydonck et al., 2005: p. 143
FA-75	OxA-4973: 3635 ± 50 (F) OxA-4972: 3545 ± 65 (M)	F	86.30	27 to 229	−87 to 352	−50	Hedges et al., 1995b: p. 425
GT-33	OxA-3970: 3630 ± 60 (F) OxA-3969: 3530 ± 60 (M)	F	88.32	40 to 252	−91 to 359	−31	Hedges et al., 1993: p. 320
GT-37	OxA-4473: 3665 ± 65 (M) OxA-4472: 3520 ± 80 (F)	M	91.78	80 to 313	−63 to 453	−26	Hedges et al., 1995a: p. 207
IL-1[a]	Beta-188925: 3410 ± 60 (F) Beta-188926: 3470 ± 50 (M)	F	100.00	65 to 175	25 to 234	32	López Padilla et al., 2006: pp. 126–130 Soler et al., 2006: Tab. 3.2, p. 91
LMI-11	OxA-7672: 3510 ± 40 (F) OxA-7671: 3435 ± 35 (M)	F	82.52	6 to 166	−79 to 227	−48	Martínez and Ponce, 2002b: pp. 122–124
LTI-2	OxA-7668: 3690 ± 40 (F) OxA-7667: 3560 ± 35 (M)	F	98.48	157 to 305	21 to 339	41	Martínez and Ponce, 2002a: pp. 155–156
NE-2	Ua-39464:3508 ± 30 (?) Ua-39463: 3505 ± 30 (?)	Unknown	50.91	−57 to 60	−113 to 120	−101	Cámara and Molina, 2009: Tab. 3, p. 180
NE-4	Ua-39467: 3375 ± 32 (M?) Ua-39466: 3281 ± 30 (F?)	M	95.75	54 to 163	−3 to 225	14	Cámara and Molina, 2009: Tab. 3
NE-9	Ua39474: 3414 ± 30 (?) Ua-39473: 3413 ± 30 (?)	Unknown	50.73	−57 to 54	−135 to 135	−108	Cámara and Molina, 2009: Tab. 3
NE-19	Ua-39480: 3589 ± 31 (M) Ua-39481: 3511 ± 30 (F)	M	96.16	55 to 177	−3 to 243	16	Cámara and Molina, 2009: Tab. 3, Fig. 5, p. 180
NE-29	Ua-39488: 3413 ± 31 (?) Ua-39489: 3288 ± 34 (?)	Unknown	99.10	85 to 200	20 to 283	43	Cámara and Molina, 2009: Tab. 3
NE-31	Ua-39492: 3287 ± 32 (F?) Ua-39491: 3254 ± 33 (M?)	F	70.84	−19 to 101	−84 to 147	−70	Cámara and Molina, 2009: Tab. 3, p. 180

Key: CA: Castellón Alto, CE: Cerro de la Encina, CP: Cabezo Pardo, CV: Cerro de la Virgen, FA: Fuente Álamo, GT: Gatas, IL: Illeta dels Banyets, LMI: Madres Mercedarias (Lorca), LTI: Calle Los Tintes (Lorca), NE: Cuesta del Negro.
(F) Female; (M) Male; (J) Juvenile.
[a] Illeta dels Banyets 1 calculations not were run under the "No relationship" option, as radiocarbon uncalibrated result clearly were against the archaeological observation about the relative order of burials.

Most of the elapsed time intervals indicate a substantial distance of at least some decades between the events represented in paired radiocarbon dates. If we focus on the elapsed time intervals at a probability level of 95%, 14 out of 23 cases show a *minimum* distance of 20 years between deaths. Since posterior probability density plots look very much like normal distributions (Fig. 4), the lower values of HPD regions' intervals at 95% indicate, properly, that there is a 97.5% of probabilities for the real value of the chronological distance to be higher. In order to fit these values to 95%, the lower limit of HPD regions was calculated (Table 1). This increases to 15 the number of cases for which temporal distance between dates was larger than two decades. In fact, the lowest value is 32 years, allowing for a minimum of one generation to have passed between deaths. Usually the time span covers more than two generations (Fig. 5).

In short, *there is only a probability of 0.05% of being incorrect when making the statement that the chronological gap between deaths in 65.2% of the double graves considered was equal or higher than two generations*. For the remaining 34.8%, this probability is higher, but a short chronological distance could only be suggested in a few cases.

These results strongly support the hypothesis of a genealogical relationship between two adults buried in the same grave. On the other hand, there is not a clear trend for females to be the ones buried first, since only 7[9] out of 13 dated couples with sexual determinations report this pattern of relative chronology.

A closer look at the values obtained so far reveals that all comparisons made with the 'Earlier than' option before calibration show high temporal distances. Hence, it may seem that this prior condition had a major influence on the results. In order to assess its

[9] NE-31, CV-6, FA-75, GT-33, IL-1, LMI-11 and LTI-2. On the other hand, in NE-4, NE-19, CV-30, FA-69, CP-1 and GT-37, the first burial is that of a male.

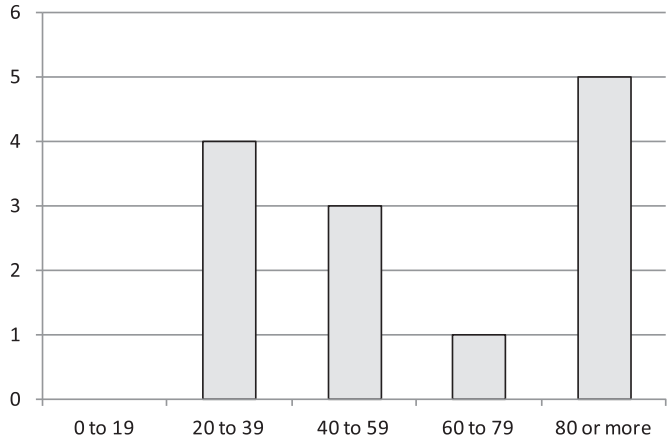

Fig. 6. Frequency distribution of positive lower HPD interval (68%) values (BCal probability analysis with 'No relation' as a condition in group definition) by time intervals of 20 years ($n = 13$).

weight and given the fact that BCal allows working in different scenarios, we reanalysed all projects, setting the option 'No relationship' between each pair of dates. No Bayesian analysis was performed in its proper sense, since we omitted here any prior knowledge arising from archaeological observations. By doing calculations under 'No relationship' conditions, independent calibration was undertaken.

Results of the probability difference and HPD calculations are shown in Table 2. Now, only 7 out of 23 pairs of radiocarbon dates show probability differences higher than 95%. Looking at the 95% HPD ranges, again in 7 cases, the lower limit of the elapsed time probability range between dates is positive.

How could we assess this new set of calculations? As it would be readily seen, the genealogical hypothesis receives lesser support. Nevertheless, it should be taken into account that the three pairs of dates with standard deviations equal to or higher than ±50 years (FA-75, GT-33 and GT-37) now show a substantial overlap, despite the fact that uncalibrated central values are *ca.* 100 radiocarbon years apart. These samples were processed in the early 1990s, when AMS was generally not able to provide more accurate measurements. With current standard deviation values closer to ±30, these three pairs would belong to the group of higher HPD positive values, thus equalising the overall percent values. Moreover, even with a very restrictive criterion such as the 95% probability level, the couples in nearly one third of the tombs hardly would have ever met. If we set the lower value of the HPD interval at 68%, then in most cases (13 pairs of dates out of 23), there is a probability of 84% that the elapsed time between deaths was higher than 27 years, that is, at least one generation (Fig. 6).

5. Concluding remarks

The main aim of this paper was to test different hypotheses on possible kinship relations (affinity/marriage *vs* descent/consanguinity, and matrilocality) expressed in the Argaric funerary record, taking into account the absolute chronological dimension of double adult tombs. Two different scenarios concerning the comparison of a set of 23 paired radiocarbon dates from Argaric adult double burials have been explored. Overall, some conclusions arise from calculations made on probability calibration distributions.

1. In general, results fit with the expectations according the 'descent hypothesis'. By applying previous archaeological knowledge to probability calculations, up to two thirds of all dated double burials show a significant spacing concerning the time of death of each individual. Even in the most restrictive scenario, a minimum gap of several decades between deaths might be suggested by high levels of probability for most of the tombs.
2. The minimum temporal distance between deaths usually points to at least two generations. This would mean that some combination of elders and their descent was represented in these tombs. It should also be kept in mind that the 'descent hypothesis' fits better to other types of double burials (adult and child or two children) than the one based on marriage.
3. A much shorter interval between the two deaths finds support in a few cases while, in others, it cannot be ruled out. However, even in these cases, the available probability results do not openly discard the 'descent hypothesis'.
4. Burying a woman in the first place remains the most frequent practice, but the number of reverse examples (the man being the one buried first) has increased since our initial observations. A combined pattern of matrilocality with the acknowledgement of the social relevance of the mother's brother (the *avunculus*) can still be maintained as a working hypothesis.

In view of the conclusions presented here, the researchers supporting both the 'marriage hypothesis' or, in general, a very short chronological distance between deaths, should be required to provide evidence and arguments: now, 'the ball is on their court'. Even though we are aware that the 'descent hypothesis' needs further support due to the probabilistic nature of the analysis conducted here, as well as a consequence of some relevant gaps and failures of current research. In the first place, radiocarbon dating of human collagen is still a complex issue, and there are factors not fully understood which could seriously affect the conventional results. For instance, much is still to be known about differences in ^{14}C isotope fractionation according to different types of tissues and bones, and also about the ageing effect in radiocarbon assimilation in the human body. Also, most of the available radiocarbon dates lack published information on indicators concerning the quality of the sample (% of collagen content, % C in collagen), and isotopic assessments of possible sources of bias arising from specific diets (aquatic food) and climate (aridity). More detailed reports including proper observations on the position of skeletal remains, sex and age estimations and general contextual information are also needed. Finally, improving accuracy in radiocarbon measurements and subsequently reduced standard deviations will also be crucial for a better assessment of the temporal distance between inhumations in Argaric double tombs.

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