Collecting the dead: temporality and disposal in the Neolithic *hypogée* of Les Mournouards II (Marne, France)

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Introduction: collectivities of the dead in the later fourth millennium cal BC

Several factors may inhibit us from appreciating the specificity of particular mortuary practices. People have a bewildering range of attitudes to death, and practise all manner of disposals of their dead (Ariès 1981; Bloch 1982; Bloch / Parry 1982a; 1982b; Barley 1995; Leach 1961; Metcalf / Huntingdon 1991; Parker Pearson 1999). There is often considerable variety within the same broad horizons (Borić 2015 for eastern Europe; Chambon 2003 for France and surrounding countries).

Collective burials in western Europe are a case in point. In the early Neolithic LBK of the later sixth millennium cal BC and in the continuing 'Danubian' tradition of the fifth millennium, the dead are often grouped, but in a common space – the burial ground or cemetery – rather than in a shared deposit. Subsequently, a long phase in the later fifth and fourth millennia cal BC, and in some regions extending into the third, can be defined in which collective deposits of the dead became commonplace, often, though not always, associated with monuments such as barrows and cairns of various kinds, and also enclosures. In two recent accounts, these have been seen as principally characterising a period from c. 3500 cal BC onwards (Chambon 2003, 316; Harris et al. 2013, 65–70), but the start of such practices is definitely earlier, potentially going back to the fifth millennium cal BC in Brittany (Boujot / Cassen 1992; Scarre et al. 2003; Cassen 2009; Chambon 2003, fig. 9), and to the earlier fourth millennium cal BC in Britain and Ireland, northern Europe and Iberia (Whittle et al. 2011; Müller et al. 2014; Mischka 2014; Ebbesen 2006; Eriksen / Andersen 2014; Balsera Nieto et al. 2015). The massive use of collective burial, however, constitutes one of the striking features of the late Neolithic in western Europe. There appears to have been a broad horizon in the second half of the fourth millennium cal BC in which there was a widespread emphasis on collective burial deposits, many of them in their regional contexts on a larger scale than previously witnessed. These varied practices can be contrasted with a renewed emphasis in many parts of western Europe in the third millennium cal BC on single burials, especially in the orbits of the Globular Amphorae and Corded Ware cultures (Furholt 2014; Salanova / Sohn 2007).

If the principle of collective burial is simple, that is a container that accumulates the deceased, death by death, it does not follow that such mortuary practices were identical

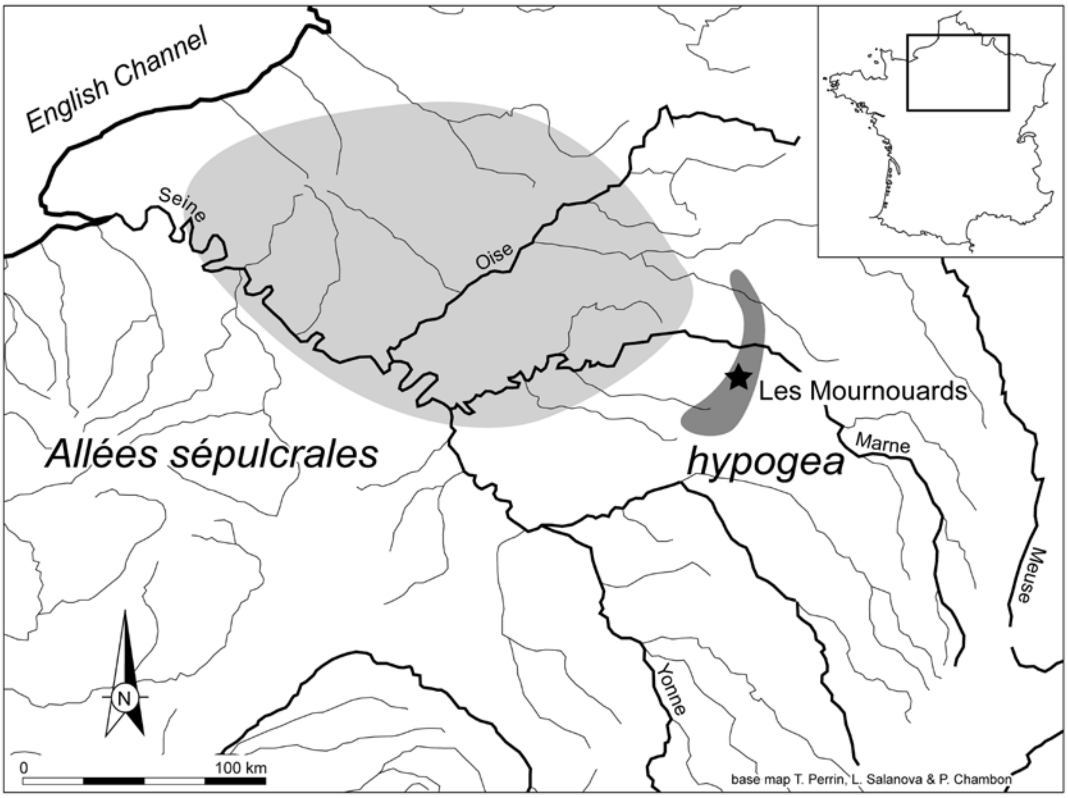

Fig. 1. Map showing the distribution of *allées sépulcrales* and *hypogées* in the Paris basin, and the location of Les Mournouards.

across western Europe. There were very diverse outcomes within the collective mode of disposal. Some containers were monumental but others not; a range of other constructional materials were used as well as the well-known megaliths; and especially the size of burial containers and chambers varied: from 1 m^2 to 100 m^2 or more (Chambon 2003). The location of tombs, the numbers of the deceased, the structure of deposits and the character of grave goods are further variables from region to region. So each set of variations on the general theme of collective burial requires close examination.

In the Paris basin of northern France, the late Neolithic horizon of collective burial is mainly characterised by two distinctive types of funerary monuments, the *allées sépulcrales* and the *hypogées (fig. 1)*. The *allées sépulcrales* are very similar to the so-called gallery graves in Hesse (Germany) and not dissimilar to later TRB monuments including the *Totenhäuser* of the Mittelelbe-Saale region (Germany); there are also passage graves in Denmark to take into account. All these architectures, containing collective deposits, appear to be contemporary (Müller 2001; Schulz Paulsson 2010; Schierhold 2014; Hofmann / Orschiedt 2015, 998–999; Sjögren 2015, 1007; Pape 2016). In the Paris basin, critique of the available radiocarbon dates reduced the construction period of both kinds of tomb to the later fourth millennium cal BC, with some continuation into the early third (Chambon / Salanova 1996), and joint analysis of all types of data has suggested regional groupings and trajectories (Salanova et al. 2011).

The *hypogées* are rock-cut tombs. While some dispersed collective burials, in the Paris basin, may partially or totally correspond to this simple description, one specific area concentrates more than 160 of these tombs: the Côte d'Île-de-France. Dug into the chalk from gentle slopes, they normally include a small corridor, a very short antechamber and a chamber. Passages between each part are usually narrow. The plan of a *hypogée* is quite similar to that of an *allée sépulcrale* but proportions of chambers differ: more square for *hypogées* but rectangular for *allées sépulcrales*. Preventing collapse of the roof may have imposed limitations on *hypogées*. The division of the largest ones into two chambers separated by pillars or a wall of unexcavated chalk speaks for such a hypothesis. That does not exclude using this partition to distinguish groups of dead. Despite convergences in plan between *hypogées* and *allées sépulcrales*, differences are numerous. The most notable one is the usual grouping of *hypogées* in cemeteries; the Razet (Coizard, Marne) example with 37 located tombs remains the biggest. The dead, in each tomb, do not reach the huge number of individuals often counted in *allées sépulcrales*. Moreover, the use of the *hypogées* is shorter, limited to the second half of the fourth millennium BC; very few have provided material of the Final Neolithic of the earlier third millennium cal BC (Langry-François 2004; Renard et al. 2014). The geographical concentration of *hypogées* poses important questions. Should we envisage these necropolises as places of convergence for communities dispersed across wide territories or was there a rapid succession of tombs, each accumulating the dead of the community over a short span of time? Both wide catchments and separate, contemporary social units could also be possible. How then would finer chronological resolution contribute to better understanding of the *hypogées* phenomenon?

The *hypogée* of Les Mournouards II

The distinctive character of *hypogées* relates also to the history of research. It was the excavation of the example at Les Mournouards II that fully established funerary archaeology in France. This artificial burial cave is cut into the side of a chalk hill at Le Mesnil-sur-Oger, Marne, on the eastern side of the Paris basin *(fig. 2)*. Its excavation and publication by André Leroi-Gourhan and colleagues (Leroi-Gourhan et al. 1962) remain a landmark in French archaeology. With Leroi-Gourhan, spatial recording and analysis, methods already current in Germany and the Netherlands, amounted to palaeoethnology, reconstructing the fine details of ancient behaviour. The analysis defined the gamut of funerary behaviour, including the characteristics of the inhumations, their treatment after decomposition, the deployment of grave goods and the treatment of different subgroups of individuals, weaving them into a history of the monument (Chambon / Blin 2011).

More specifically, the publication was a turning point in the understanding of the collective burials which mark the latter part of the Neolithic (*Néolithique récent*) in the Paris Basin. Les Mournouards II is the best excavated and best understood of the 160 *hypogées* known in the area so far, since over 90 % of them were emptied in the late 19th or early 20th century, principally by the Baron de Baye, a local aristocrat (De Baye 1880; Bailloud 1974; Blin 2015). They are often grouped in cemeteries, as at Coizard, noted above. Les Mournouards II was discovered a few metres from Les Mournouards I, another underground tomb excavated in haste a short time before *(fig. 2)*; a third tomb had been destroyed long before (Coutier / Brisson 1959; Bailloud 1974, 272). Other tombs are known 4 km to the north and south, and under 15 km away is the Marais de Saint-Gond, where there is the largest concentration of *hypogées*: more than 100 in less than 80 km^2.

The Les Mournouards II tomb consisted of two successive chambers, entered through a creephole from an antechamber, itself reached by an approach passage which could not be

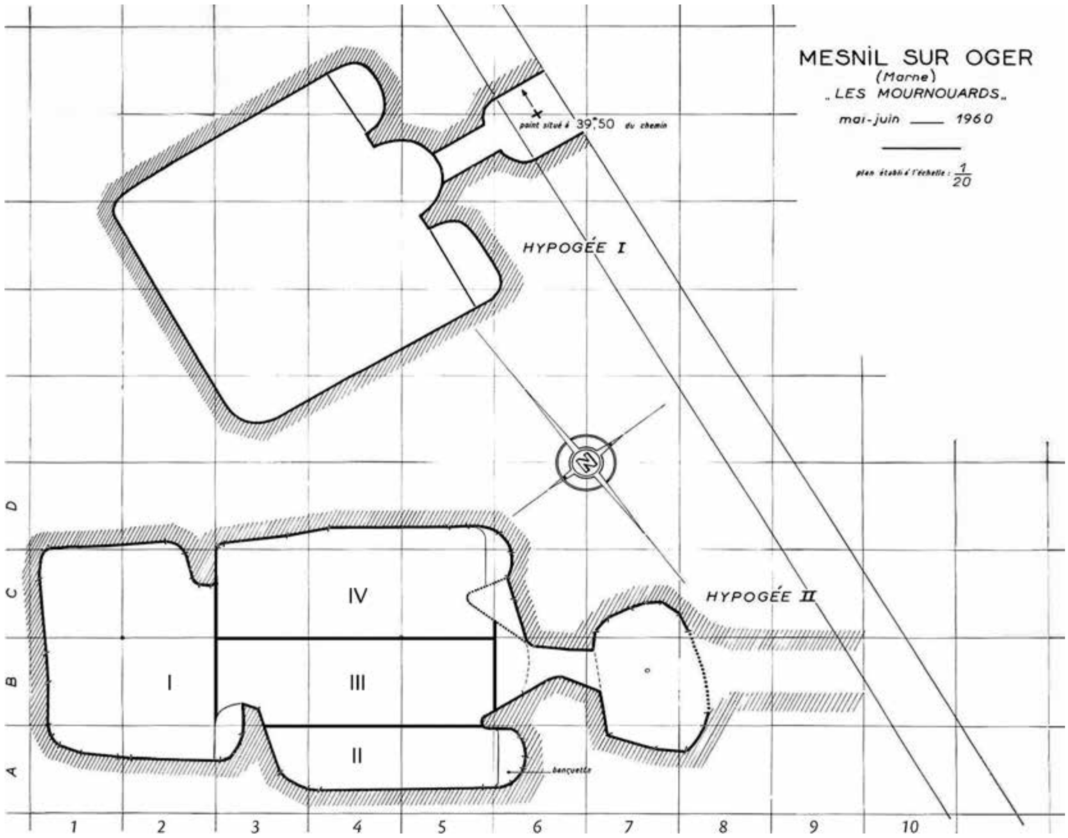

Fig. 2. Les Mournouards (Le Mesnil-sur-Oger, Marne). Plan of Les Mournouards I (above) and Les Mournouards II (below), showing zones I–IV and 1 m grid squares in Les Mournouards II.

excavated. In the course of recording and subsequent analysis it was divided into four zones *(fig. 2)*. Human remains, both articulated and disarticulated, representing a Minimum Number of Individuals (MNI; White 1953; Poplin 1976) of 79 individuals (Blin 2012, 41), were concentrated in zones I (the inner chamber) and II and IV (the two sides of the outer chamber), with relatively few in zone III (the central passage through the outer chamber; *figs 3–4*). A ceiling height of c. 1.15 m would have severely restricted movement within the tomb. A Harris matrix of relationships in zones I, II and IV is given in *figure 5*.

The resumption of analysis of the anthropological collection of Les Mournouards II was intended to be a complement to the research done in 1962. In the original publication, only the material and skeletons found in place were studied in context. A new estimation of the MNI needed an enumeration of all the bones, including loose bones (Blin 2012). Another task was updating our understanding of the structure of the buried population by age and sex. The DSP technique of sex determination, on the coxal bones (Murail et al. 2005), provides more reliable results than those obtained in the 1960s. The chosen threshold was 95 % certainty. Due to lack of time and without access to the skulls and the mandibles, age estimation of the immature individuals was made from levels of bone maturation (Birkner 1980). This choice enabled dividing the individuals into only three age categories: adults, teenagers (15–19 years) and children (under 14 years).

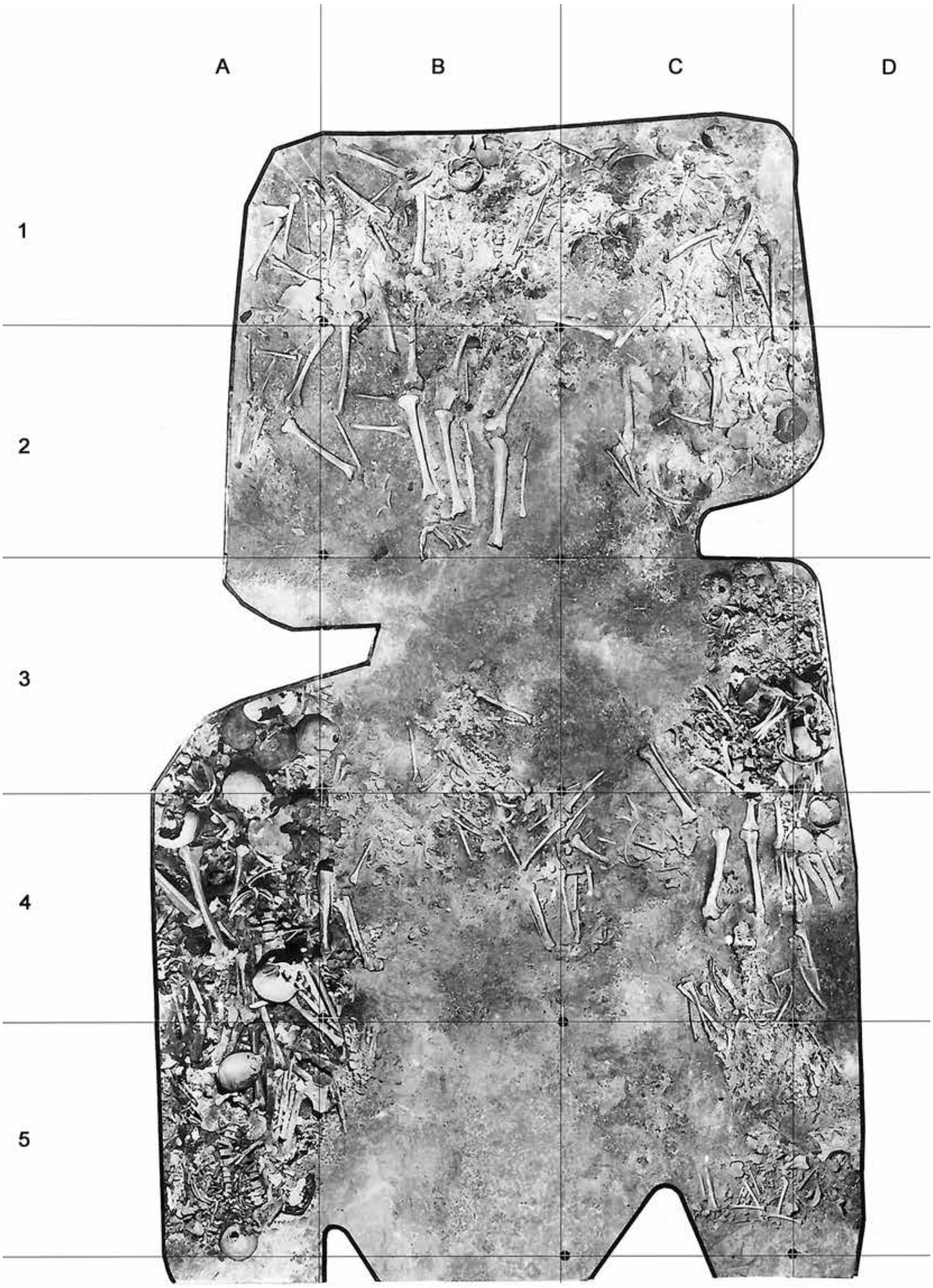

Fig. 3. Les Mournouards II. Photomontage of *in situ* human remains against grid of 1 m squares.

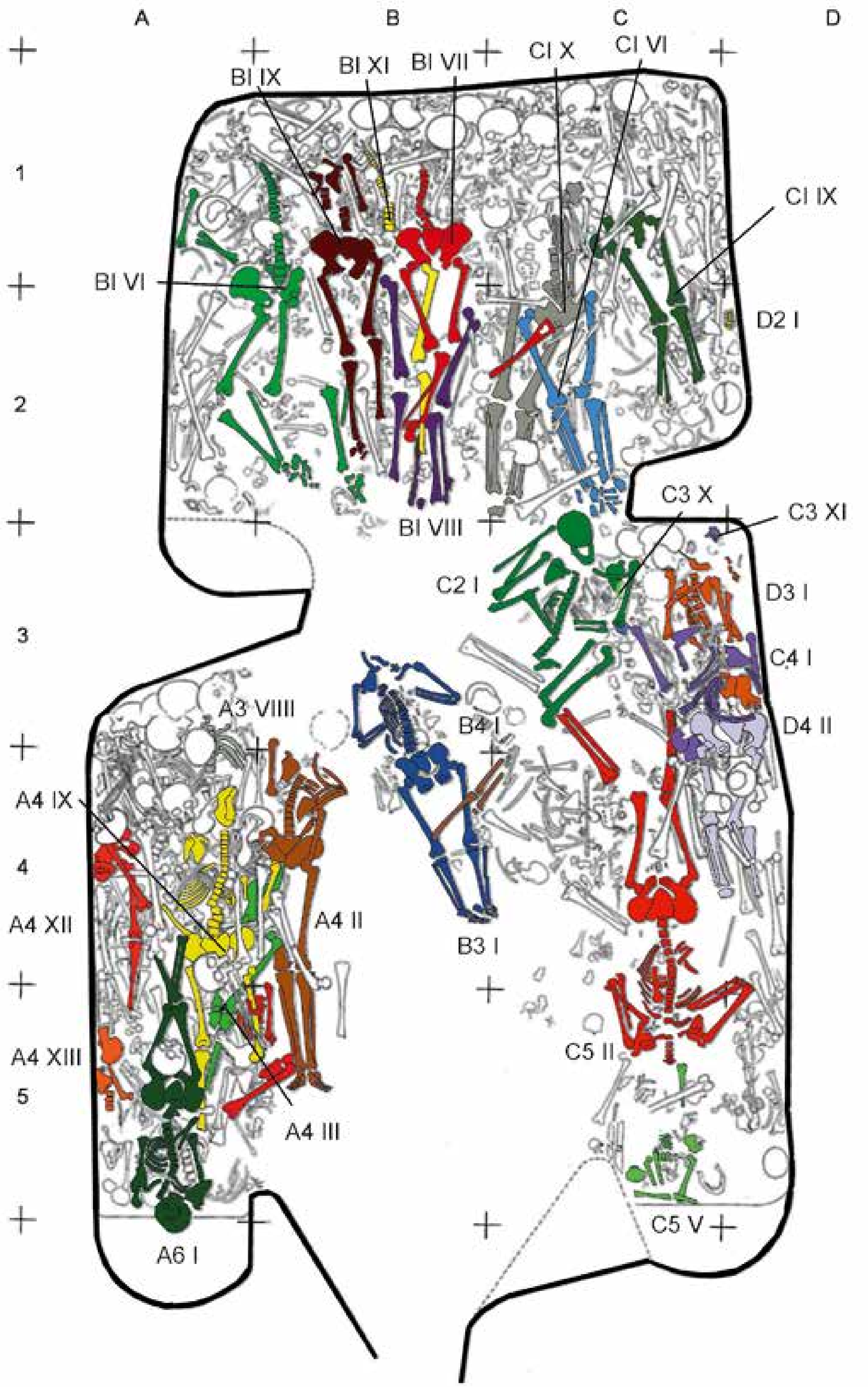

Fig. 4. Les Mournouards II. Articulated individuals identified during the excavation against grid of 1 m squares.

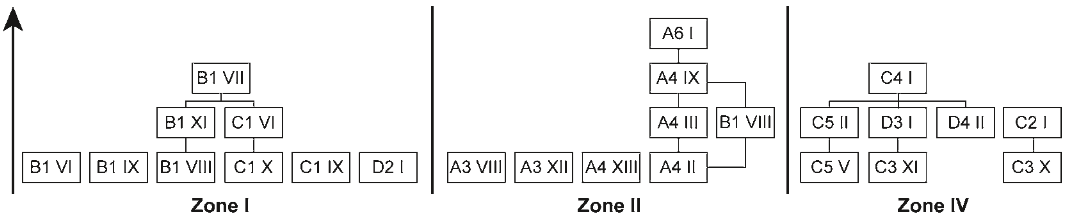

Fig. 5. Simplified Harris matrix of relationships between identified individuals in zones I, II and IV.

Previous dating and interpretation

For the original authors, the artefacts placed the monument in the Seine-Oise-Marne (SOM) culture, perhaps its earlier part, with a date towards the end of the third or the start of the second millennium BC (Leroi-Gourhan et al. 1962, 50; 116; 118). The SOM was then considered as a single, widespread, cultural complex between the middle Neolithic and the Bronze Age. A previous radiocarbon date (2460–1940 cal BC, at 2σ: Reimer et al. 2013; Stuiver / Reimer 1986) was measured on a bulk sample of alder and pine charcoal (3750±150 BP; Gsy-114; Coursaget / Le Run 1966, 128; 132; Leroi-Gourhan et al. 1962, 76; 125; 133). There is, however, no indication of the context or contexts of the sample. Subsequently, Philippe Chambon and Laure Salanova (1996, fig. 9) rejected this date since its context remained unknown. Given these uncertainties, it is not employed in the present models.

Recent revision of cultural and chronological data from the end of Neolithic has led to the splitting of the former Seine-Oise-Marne culture into various entities. In this perspective, according to the reassessment of the grave goods and new dating of *hypogées* and their cultural context, the use of Les Mournouards corresponds only to *Néolithique recent* 2, currently dated to 3350–3000 cal BC (Augereau et al. 2007; Salanova et al. 2011, 82–84; Cottiaux / Salanova 2014).

Leroi-Gourhan's reconstruction of the burial history was painstaking and detailed. He saw all the individuals deposited as fleshed corpses, progressively rearranged inside the tomb in the course of making space for later burials. The first burials would have been placed with their heads to the south-east, resting on chalk-cut ledges in the sides of the chambers; most of the later introductions were laid with the heads to the north-west (Leroi-Gourhan et al. 1962, 82–83 fig. 55). Skulls were moved towards the walls. While the last burials clearly took place in the outer chamber, he was uncertain whether the inner chamber would have been completely filled before burial began in the outer or whether bodies began to be placed in the outer chamber while the inner one was still in use. There were differences between the zones in the composition and disposition of the human remains and in the artefacts accompanying them. The north-east side of the outer chamber (zone IV), for example, saw more disarticulation than elsewhere, with bones left perpendicular or oblique to the chamber axis.

In his re-interpretation of the original publication, Philippe Chambon (2003) saw the funerary processes as involving a greater movement of disarticulated bones rather than of complete corpses and highlighting B3 I, the skeleton of a heavily pregnant woman lying obliquely across the central passage in the outer chamber *(fig. 4)*, as the last interment. He also pointed out that a shortage of skulls in relation to the minimum number of individuals represented meant that skulls had been removed from the tomb.

A wide-ranging reassessment was undertaken by Arnaud Blin (2011; 2012). Most notably, he

- documented which bones were present in each articulated individual, clarifying that none was complete, although some were almost so (id. 2011, 594–595; 2012, 47);
- extended the analysis of the disarticulated bones, establishing that their composition was different in each zone, the bones themselves always being less than would make up the number of individuals represented, and confirming that the bones were unevenly representative of the human skeleton. Zone I, for example, yielded one right scapula and eleven left humeri (id. 2012, 44). These observations pointed to the complete or partial removal of skeletons during the use of the tomb;
- recognised eight articulations and 44 pairings between nearby disarticulated bones, 93 % of them in a single zone and 88 % of the pairings within a single square metre, concluding that the bones had remained close to where they had originally been deposited and that zones I, II and IV functioned almost independently (ibid. 41);
- established more stratigraphic relations between the articulated individuals than those illustrated or described in the original publication, by close examination of the excavation record (ibid. fig. 14);
- and reconstructed the history of the tomb as follows: Leroi-Gourhan's initial placing of skeletons with heads to the south-east against ledges was followed by at least one, and possibly several, emptyings of the tomb, leaving only a few bones from each individual; then, after an interval of perhaps several centuries, the final 29 articulated individuals were introduced, possibly over a fairly short space of time, becoming progressively more displaced the earlier in the sequence they were. He followed Chambon in seeing B3 I as the last of these. The removal of her head, after decomposition, would have been the final act in the use of the monument (ibid. 46–47).

Aims of the dating programme

The analysis presented here has been carried out as part of the project *The Times of Their Lives* (see Acknowledgements). The new chronology for Les Mournouards II complements that for the *allée sépulcrale* at Bury, Oise (Salanova 2007; Salanova et al. 2017).

Previous dating and interpretation left many questions about the chronology of Les Mournouards II, including the following:

- When was the monument built and when did it go out of use?
- Did burial start and end at different times in different zones, in particular did the inner chamber come into use before the outer?
- Did the disarticulated bones include the displaced remains of the earliest burials in the monument?
- What was the duration of burial in the monument, and was there any evidence for one or more hiatus in its use?
- Looking beyond the monument, what could its precise chronology contribute to wider questions (see above) concerning the late Neolithic of the region, especially collective burials (cf. Chambon / Salanova 1996; Salanova et al. 2011)?

These questions serve to define the aims of the dating programme at Les Mournouards II.

Radiocarbon dating and sampling

The new radiocarbon dating programme for Les Mournouards was conceived within the framework of a Bayesian chronological approach (Buck et al. 1996). This allows the combination of calibrated radiocarbon dates with archaeological prior information using a formal statistical methodology.

An analysis of this kind will fail if the samples dated are not contemporary with their contexts. Sample selection must be rigorous and conform to strict criteria (e. g. Bayliss et al. 2011, 38–42). At Les Mournouards, articulated bones are ideal material because they must still have been joined by soft tissue when they reached their final position. This means that the relative order of the dated samples should be the same as that of the parent contexts. Furthermore, the identification of sequences of three or four individuals (Blin 2012, fig. 14) indicated that their stratigraphic relationships could be used to constrain the dates. Unfortunately, the human remains, although excellently preserved, had been extensively consolidated with undocumented substances. This created a problem, because most of the consolidants used during the second half of the 20th century contain extremely old carbons of petrochemical origin, completely depleted in ^{14}C and hence capable of making radiocarbon dates too old. Radiocarbon laboratories have procedures for dissolving these contaminants, but these may not always be totally successful. A preliminary Fournier Transform-Infrared (FT-IR) analysis identified polyvinyl acetate and cellulose acetate in different bones. To avoid any risk of error, only bones which FT-IR analysis showed to be unconsolidated were sampled. All the dated samples then underwent ultrafiltration in the laboratories. One pair of replicate samples subsequently failed at both the Klaus-Tschira-Archäometrie-Zentrum, Mannheim, and the Oxford Radiocarbon Accelerator Unit due to lack of collagen.

This selection process reduced the number of samples eventually dated to 29, although simulations had previously indicated that a higher total was needed to achieve the highest possible precision. The bones sampled from the articulated burials were those which definitely belonged to the individual in question. Those sampled from among the disarticulated bones were all left humeri, the most numerous bone in this part of the collection (Brézillon 1962, 51; Blin 2012, fig. 9). It was hoped that the choice of a bone of which each individual has only one would avoid the risk of biasing the result by dating a single individual more than once. It subsequently transpired that 14 of the 29 articulated individuals, including 5 of the 13 dated ones, lacked their left humeri (id. 2011, tab. 8), so that this eventuality was not totally avoided.

Methods

Sample preparation and measurement

At Mannheim, collagen extracted from bone samples was ultrafiltered and freeze-dried (Brown et al. 1988) before combustion to CO2 and graphitisation prior to measurement by AMS as described by Kromer et al. (2013). At Oxford, all the samples underwent solvent extraction to remove any consolidants, followed by acid-alkali-acid pretreatment, gelatinisation, ultrafiltration and combustion to CO2 (Brock et al. 2010, 106–107: pretreatment AF*). They were then graphitised using methods described by Dee / Bronk Ramsey (2000) and dated by AMS (Bronk Ramsey et al. 2004). δ^{13}C and δ^{15}N values were measured on the target graphite by AMS (the value being used to calculate the conventional radiocarbon age) and also by Isotope Ratio Mass Spectrometry (IRMS) as described by Brock et al. (2010, 110). At Mannheim, δ^{13}C values were only measured

Laboratory No.	Sample	Material	Context	Radiocarbon age (BP)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ ‰	C/N ratio	Calibrated date range BC 2σ	*Highest Posterior Density Interval cal BC (95 % probability). Minimal model*	*Highest Posterior Density Interval cal BC (95 % probability). Preferred model*
Gsy-114		Unidentified bulk charcoal sample (Coursaget/ Le Run 1966, 132)	Unknown	3750 ± 150	-	-	-	-	2580–1750	-	-
Zone I											
MAMS-21794	Ms/O 60 A2	Disarticulated adult left humerus	Zone I, 1 m square A2	4473 ± 22	–28.6 ± 0.2	–20.4 ± 0.2	8.2 ± 0.1	3.1	3340–3025	*3335–3205 (81 %)* *3195–3155 (13 %)* *3125–3110 (1 %)*	*3330–3210 (69 %)* *3195–3155 (26 %)*
MAMS-21801	Ms/O 60 C1a	Disarticulated adult left humerus	Zone I, 1 m square C1	4542 ± 22	–12.1 ± 0.2	–20.3 ± 0.2	8.3 ± 0.1	3.1	3365–3115	*3355–3260 (29 %)* *3245–3130 (66 %)*	*3355–3310 (10 %)* *3300–3260 (8 %)* *3245–3130 (77 %)*
OxA-30839	Ms/O 60 C1c	Disarticulated adult left humerus	Zone I, 1 m square C1	4454 ± 34	-	–20.2 ± 0.2	7.7 ± 0.3	3.2	3340–2970	*3335–3205 (81 %)* *3195–3155 (13 %)* *3125–3110 (1 %)*	*3335–3205 (69 %)* *3195–3150 (26 %)*
MAMS-21802	Ms/O 60 C1d	Disarticulated adult left humerus	Zone I, 1 m square C1	4522 ± 23	–15.7 ± 0.2	–20.5 ± 0.2	8.3 ± 0.1	3.3	3360–3100	*3350–3260 (34 %)* *3250–3135 (60 %)* *3125–3115 (1 %)*	*3350–3260 (22 %)* *3250–3135 (73 %)*
MAMS-21799	Ms/O 60 B1 VII	Thoracic vertebra of articulated adolescent (Leroi-Gourhan et al. 1962, fig. 55; Blin 2011, 149, 595; Blin 2012, fig. 7). No left humerus	Zone I, overlying B1 XI and C1 VI (Leroi-Gourhan et al. 1962, fig 68; Blin 2012, fig. 14).	4491 ± 22	–19.9 ± 0.2	-	-	3.1	3350–3090	*3330–3145 (93 %)* *3125–3110 (2 %)*	*3330–3145 (94 %)* *3125–3115 (1 %)*
OxA-30832	Ms/O 60 C1 X (i)	Lumbar vertebra of articulated adult male (Blin 2011, 149, 595; Blin 2012, fig. 7). No left humerus	Zone I, underlying C1 VI (Leroi-Gourhan et al. 1962, fig. 55; Blin 2012, fig. 14)	4474 ± 36	-	–20.4 ± 0.2	8.7 ± 0.3	3.2	3350–3095	*3345–3155*	*3340–3150*
MAMS-21803	Ms/O 60 C1 X (ii)	Replicate of OxA-30832	As OxA-30832	4513 ± 24	–22.1 ± 0.2	-	-	3.1			

Weighted mean: 4501 ± 20 BP (T‘=0.8; T‘(5 %)=3.8; ν=1)

Laboratory No.	Sample	Material	Context	Radiocarbon age (BP)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ ‰	C/N ratio	Calibrated date range BC 2σ	*Highest Posterior Density Interval cal BC (95 % probability). Minimal model*	*Highest Posterior Density Interval cal BC (95 % probability). Preferred model*
MAMS-21805	Ms/O 60 D2 I	Skull fragment from child < 5, probably < 3 years old, almost complete, numerous articulations. (Leroi-Gourhan et al. 1962, figs 55, 80; Blin 2011, 153, 595; Blin 2012, fig. 7). No left humerus	Zone I, with numerous chalk beads (Leroi-Gourhan et al. 1962, figs 17, 80).	4519 ± 23	–16.4 ± 0.2	–20.1 ± 0.2	9.3 ± 0.1	3.1	3360–3100	*3350–3260* (*35 %*) *3250–3135* (*59 %*) *3125–3115* (*1 %*)	*3340–3260* (*18 %*) *3250–3130* (*77 %*)
Zone II											
OxA-30835	Ms/O 60 A3	Disarticulated adult left humerus	Zone II, 1 m square A3	4450 ± 35	-	–21.2 ± 0.2	8.1 ± 0.3	3.2	3340–2930	*3335–3150* (*87 %*) *3135–3090* (*8 %*)	*3330–3205* (*62 %*) *3195–3145* (*29 %*) *3130–3095* (*4 %*)
MAMS-21795	Ms/O 60 A4a	Disarticulated adult left humerus	Zone II, 1 m square A4	4430 ± 26	–34.9 ± 0.2	-	-	3.3	3320–2930	*3330–3210* (*75 %*) *3185–3155* (*11 %*) *3125–3080* (*9 %*)	*3330–3210* (*66 %*) *3190–3150* (*24 %*) *3120–3085* (*5 %*)
OxA-failed	Ms/O 60 A4b (i)	Disarticulated adult left humerus	Zone II, 1 m square A4	Failed due to very low yield	-	-	-	-	-	-	-
MAMS-failed	Ms/O 60 A4b (ii)	Replicate of Ms/O 60 A4b (i)	As Ms/O 60 A4b (i)	No collagen	-	-	-	-	-	-	-
OxA-30836	Ms/O 60 A4c	Disarticulated left humerus of child < 2 years old	Zone II, 1 m square A4	4423 ± 34	-	–20.2 ± 0.2	10.1 ± 0.3	3.2	3330–2920	*3330–3210* (*73 %*) *3195–3150* (*13 %*) *3130–3075* (*9 %*)	*3330–3210* (*64 %*) *3195–3150* (*26 %*) *3125–3085* (*5 %*)
OxA-32491	Ms/O 60 A4d	Disarticulated adult left humerus, gracile	Zone II, 1 m square A4	4558 ± 32	-	–20.0 ± 0.2	7.9 ± 0.3	3.3	3365–3110	*3355–3310* (*13 %*) *3295–3260* (*5 %*) *3240–3110* (*77 %*)	*3350–3310* (*7 %*) *3295–3265* (*6 %*) *3245–3115* (*82 %*)
OxA-32492	Ms/O 60 A4d	Replicate of OxA-32491	As OxA-32491	4526 ± 32	-	–19.9 ± 0.2	8.1 ± 0.3	3.3			
Weighted means: 4542 ± 23 BP (T'=0.5); $\delta^{13}C$: –19.9 ± 0.14 ‰ (T'=0.1). $\delta^{15}N$: 8.0 ± 0.21 ‰ (T'=0.2) (T'(5 %)=3.8 and ν=1 for all)											
OxA-32493	Ms/O 60 A4e	Disarticulated adult left humerus	Zone II, 1 m square A4	4476 ± 32	-	–20.5 ± 0.2	7.4 ± 0.3	3.3	3350–3020	*3335–3145* (*88 %*) *3135–3100* (*7 %*)	*3330–3145* (*92 %*) *3130–3105* (*3 %*)

Laboratory No.	Sample	Material	Context	Radiocarbon age (BP)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ ‰	C/N ratio	Calibrated date range BC 2σ	*Highest Posterior Density Interval cal BC (95 % probability). Minimal model*	*Highest Posterior Density Interval cal BC (95 % probability). Preferred model*
MAMS-23886	Ms/O 60 A4f	Disarticulated adult left humerus, paired with right	Zone II, 1 m square A4	4439 ± 31	−25.0 ± 0.2	−20.1 ± 0.2	8.3 ± 0.1	3.0	3330–2930	*3330–3210 (72 %)* *3195–3150 (14 %)* *3130–3085 (9 %)*	*3330–3210 (64 %)* *3195–3150 (27 %)* *3125–3090 (4 %)*
OxA-30837	Ms/O 60 A5 (i)	Disarticulated adult left humerus	Zone II, 1 m square A5	4553 ± 33	-	−20.7 ± 0.2	8.0 ± 0.3	3.2	3365–3115	*3355–3310 (13 %)* *3295–3285 (1 %)* *3275–3265 (2 %)* *3240–3110 (79 %)*	*3350–3315 (7 %)* *3295–3285 (1 %)* *3275–3265 (4 %)* *3240–3120 (83 %)*
MAMS-21798	Ms/O 60 A5 (ii)	Replicate of OxA-30837	As OxA-30837	4534 ± 22	−16.6 ± 0.2	−20.6 ± 0.2	8.1 ± 0.1	3.1			
Weighted means: 4540 ± 19 BP (T'=0.2). δ^{13}C: −20.4 ± 0.14 ‰ (T'=5.3). δ^{15}N: 8.1 ± 0.11 ‰ (T'=0.1) (T'(5 %)=3.8 and ν=1 for all)											
OxA-30830	Ms/O 60 A4 II (i)	Rib from almost complete articulated adult male (Blin 2011, 149, 594; Blin 2012, fig. 7).	Zone II, underlying A4 III and B5 1 (Leroi-Gourhan et al. 1962, 87, fig. 55; Blin 2012, 45, fig. 14)	4452 ± 35	-	−19.9 ± 0.2	8.1 ± 0.3	3.3	3350–3095	*3345–3205 (85 %)* *3195–3155 (9 %)* *3125–3115 (1 %)*	*3340–3155*
MAMS-21797	Ms/O 60 A4 II (ii)	Replicate of OxA-30830	As OxA-30830	4523 ± 23	−21.5 ± 0.2	-	-	3.1			
Weighted mean: 4502 ± 20 BP (T'=2.9; T'(5 %)=3.8; ν=1)											
MAMS-23887	Ms/O 60 A4 XVII=A4 IX	Left ulna of articulated adult female, made up of individuals originally identified as A4 XVII and A4 IX (Blin 2011, 149, 594; Blin 2012, 41, fig. 7).	Zone II, overlying A4 III and B5 I; underlying A6 I (Leroi-Gourhan et al. 1962, 87; Blin 2012, fig. 14)	4511 ± 30	−20.8 ± 0.2	−19.9 ± 0.2	8.2 ± 0.1	3.0	3360–3090	*3300–3260 (8 %)* *3255–3095 (87 %)*	*3295–3260 (6 %)* *3250–3095 (89 %)*
MAMS-21800	Ms/O 60 B5 I	Thoracic vertebra of adult female represented by articulated vertebrae and other bones, not all in articulation (Blin 2011, 149, 594; Blin 2012, fig. 7). No left humerus	Zone II, overlying A4 II and underlying A4 XVII=A4 IX (Blin 2012, fig. 14)	4459 ± 22	−20.7 ± 0.2	-	-	3.3	3335–3020	*3330–3210 (75 %)* *3190–3150 (17 %)* *3125–3105 (3 %)*	*3325–3205 (61 %)* *3195–3150 (32 %)* *3125–3105 (2 %)*

Labora-tory No.	Sample	Material	Context	Radiocarbon age (BP)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ ‰	C/N ratio	Calibrated date range BC 2σ	*Highest Posterior Density Interval cal BC (95 % probability). Minimal model*	*Highest Posterior Density Interval cal BC (95 % probability). Preferred model*
Zone IV											
OxA-30840	Ms/O 60 C3	Disarticulated adult left humerus	Zone IV, 1 m square C3	4484 ± 35	-	–20.8 ± 0.2	8.0 ± 0.3	3.2	3360 – 3020	*3335–3145* (*88 %*) *3140–3100* (*7 %*)	*3340–3145* (*94 %*) *3130–3115* (*1 %*)
OxA-30841	Ms/O 60 D5b	Disarticulated left humerus of child c. 5 to 7 years old	Zone IV, 1 m square D5	4477 ± 34	-	–20.3 ± 0.2	8.2 ± 0.3	3.2	3350 – 3020	*3335–3145* (*88 %*) *3140–3100* (*7 %*)	*3340–3145* (*94 %*) *3130–3110* (*1 %*)
MAMS-21804	Ms/O 60 C2 I	Rib of largely articu-lated adolescent, ?male (Leroi-Gourhan et al. 1962, 84; Blin 2011, 149, 595; Blin 2012, fig. 7)	Zone IV, possibly origi-nally buried supine, with legs displaced during introduction of B3 I (Leroi-Gourhan et al. 1962, 87), possibly buried flexed to fit beside rather than on top of C5 II, overlying C3 X (Blin 2012, 50, fig. 14)	4531 ± 23	–10.4 ± 0.2	-	-	3.1	3360 – 3100	*3325–3310* (*2 %*) *3300–3260* (*6 %*) *3245–3100* (*87 %*)	*3295–3280* (*2 %*) *3275–3260* (*4 %*) *3240–3105* (*89 %*)
OxA-30833	Ms/O 60 C3 X	Right ilium of child < 5 years old, possibly < 3 years old, disarticu-lated, represented mainly by longbones (Blin 2011, 153, 595; Blin 2012, 13, fig. 7)	Zone IV, underlying C2 I (Blin 2012, fig. 14)	4462 ± 34	-	–20.1 ± 0.2	7.9 ± 0.3	3.3	3350 – 3010	*3340–3200* (*82 %*) *3195–3150* (*12 %*) *3125–3110* (*1 %*)	*3330–3200* (*68 %*) *3195–3150* (*27 %*)
OxA-failed	Ms/O 60 C3 XI	Left humerus of child. Disarticulated, represented mainly by longbones (Blin 2011, 595; Blin 2012, 13, fig. 7)	Zone IV, underlying D3 I (Blin 2012, fig. 14)	Failed due to very low yield	-	-	-	-	-	-	-
OxA-32495	Ms/O 60 C4 I	Left radius from partly articulated upper body and pelvis of adult (Blin 2011, 149, 595).	Zone IV, overlying C5 I, D3 I, D4 II (Blin 2012, fig. 14)	4474 ± 32		–19.8 ± 0.2	7.9 ± 0.3	3.3	3350 – 3020	*3300–3090*	*3295–3260* (*7 %*) *3255–3090* (*88 %*)

Labora-tory No.	Sample	Material	Context	Radiocarbon age (BP)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ ‰	C/N ratio	Calibrated date range BC 2σ	*Highest Posterior Density Interval cal BC (95 % probability). Minimal model*	*Highest Posterior Density Interval cal BC (95 % probability). Preferred model*
OxA-32496	Ms/O 60 C5 V	Right fibula of fairly complete 3- to 4-year-old child, in anatomical juxtaposition rather than articulation (Blin 2011, 595)	Zone IV, seen as originally seated against chalk-cut ledge (Leroi-Gourhan et al. 1962, 84, 87, fig. 55). Photographs in archive show C5 V partly overlain by disarticulated bones which underlie the shoulders of C5 II, which in turn underlies C4 I (Blin 2012, fig. 14).	4490 ± 32	-	–20.1 ± 0.2	8.0 ± 0.3	3.3	3360–3020	*3340–3150* (*93 %*) *3130–3110* (*2 %*)	*3330–3145* (*94 %*) *3125–3110* (*1 %*)
OxA-30834	Ms/O 60 D4 II (i)	Left talus from articulated lower skeleton of adult female (Blin 2011, 149, 595; Blin 2012, fig. 7). No left humerus	Zone IV, underlying C4 I (Blin 2012, fig. 14)	4486 ± 34		–21.1 ± 0.2	8.3 ± 0.3	3.3	3340–3025	*3335–3210* (*80 %*) *3195–3155* (*12 %*) *3125–3105* (*3 %*)	*3330–3205* (*65 %*) *3195–3150* (*28 %*) *3125–3110* (*2 %*)
MAMS-21806	Ms/O 60 D4 II (ii)	Replicate of OxA-30834	As OxA-30834	4473 ± 23	–19.6 ± 0.2	-	-	1.1			
Weighted mean: 4477 ± 20 BP (T‘=0.1; T‘(5 %)=3.8; ν=1)											
OxA-30838	Ms/O 60 B4	Disarticulated adult left humerus	Zone III, 1 m square B4	4511 ± 35	-	–20.5 ± 0.2	8.1 ± 0.3	3.2	3370–3090	*3300–3260* (*5 %*) *3245–3095* (*90 %*)	*3295–3260* (*6 %*) *3240–3105* (*89 %*)
OxA-30831	Ms/O 60 B3 I	Rib of adult female, pregnant, articulated, complete but for skull. (Blin 2011, 149, 594)	Zone III, prone, lying obliquely across central passage of outer chamber, underlying B4 I (Leroi-Gourhan et al. 1962, 78, 84–85, fig. 44; Blin 2012, 39, 45, 50).	4463 ± 35	-	–20.2 ± 0.2	8.4 ± 0.3	3.3	3355–3090	*3300–3260* (*6 %*) *3245–3100* (*89 %*)	*3295–3280* (*2 %*) *3275–3260* (*3 %*) *3240–3100* (*90 %*)
MAMS-23888	Ms/O 60 B3 I (ii)	Replicate of OxA-30831	As OxA-30831	4534 ± 30	–19.5 ± 0.2	-	-	3.3			
Weighted mean: 4504 ± 23 BP (T‘=2.4; T‘(5 %)=3.8; ν=1)											

Laboratory No.	Sample	Material	Context	Radiocarbon age (BP)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ ‰	C/N ratio	Calibrated date range BC 2σ	*Highest Posterior Density Interval cal BC (95 % probability). Minimal model*	*Highest Posterior Density Interval cal BC (95 % probability). Preferred model*
OxA-32494	Ms/O 60 B4 I (i)	Right tibia of 5.5- to 7-year-old child represented by articulated leg bones (Blin 2011, 149, 594; Blin 2012, fig. 7). No left humerus	Zone III, overlying B3 I, (Leroi-Gourhan et al. 1962, 87, fig. 55; Blin 2012, 45)	4509 ± 32	-	−19.8 ± 0.2	7.8 ± 0.3	3.4	3350–3090	*3295–3260* (4 %) *3240–3090* (91 %)	*3295–3280* (1 %) *3275–3260* (4 %) *3240–3090* (90 %)
MAMS-23889	Ms/O 60 B4 I (ii)	Replicate of MAMS-23889	As OxA-32494	4482 ± 33	−27.8 ± 0.2	−19.7 ± 0.2	7.9 ± 0.1	3.1			
Weighted means: 4496 ± 23 BP (T'=0.3). $\delta^{13}C$: −19.8 ± 0.14 ‰ (T'=0.1). $\delta^{15}N$: 7.9 ± 0.09 ‰ (T'=0.1). (T'(5 %)=3.8 and ν=1 for all)											

Tab. 1. Radiocarbon dates. The calibrations in the 'Calibrated date range 2σ' column are calculated by the maximum intercept method (Stuiver / Reimer 1986) and are cited as recommended by Mook (1986): rounded outwards by 10 if the standard deviation is 25 or more, by 5 if it is less than 25. Those in the *'Highest Posterior Density Interval cal BC'* columns are rounded outwards by 5. All samples are of human bone except that for Gsy-114.

by AMS on the graphite used for dating. These values were again used to calculate the conventional radiocarbon ages, although they can include an element of fractionation introduced during the preparation and measurement of the samples in addition to the natural isotopic composition of the sample. They are thus not suitable for dietary analysis. Sub-samples of the gelatine prepared at MAMS were therefore analysed for $\delta^{13}C$ and $\delta^{15}N$ at the Isotrace facility, University of Otago Chemistry Department, by IRMS using methods outlined by Beavan Athfield et al. (2008, 3). These measurements are used in the dietary analysis of stable isotopes presented below.

Quality control

Both laboratories have continuous internal quality control procedures. They also take part in international intercomparisons (Scott et al. 2007; 2010a; 2010b). For Les Mournouards, consistency in measurement is also confirmed by the results for replicates. The seven pairs of radiocarbon ages measured on the same bone fragments by Oxford and Mannheim are all statistically consistent at 95 % confidence, as are the three replicate pairs of $\delta^{15}N$ values (*tab. 1*; Ward / Wilson 1978). Two of the replicate pairs of IRMS $\delta^{13}C$ values are statistically consistent at 95 % confidence, with the other pair consistent at 99 % confidence. This observed variation is in line with statistical expectation.

Chronological modelling

The new radiocarbon dating programme for Les Mournouards II was designed within the framework of a Bayesian chronological approach (Bayliss et al. 2007; Bayliss 2009). At its most simple, Bayesian statistical modelling allows us to account for the fact that all the radiocarbon dates from Les Mournouards are related. They come from the same tomb and randomly sample the period of use of that tomb. We incorporate into the model the information that the tomb was established, continued to be used for a period of time and was then abandoned (Buck et al. 1992). We also have strong prior beliefs from the excavated stratigraphic sequences of burials that can be incorporated (see again *fig. 5*); all the models for Les Mournouards, for example, incorporate the belief that the articulated leg bones of B4 I overlay the articulated individual B3 I in zone III and were hence placed in the tomb at a later, even if only slightly later, date *(fig. 4)*.

The Bayesian chronological modelling has been undertaken using the program OxCal v4.2 (Bronk Ramsey 2009) and the atmospheric calibration curve for the northern hemisphere published by Reimer et al. (2013). The algorithms used are defined exactly by the brackets and OxCal keywords on the left-hand side of *figs 7–8* and *10–11* (Oxford Radiocarbon Accelerator Unit, http://c14.arch.ox.ac.uk/). The posterior density estimates output by the model are shown in black, with the unconstrained calibrated radiocarbon dates shown in outline. The other distributions correspond to aspects of the model. For example, the distribution *start Zone I articulated (fig. 7)* is the posterior density estimate for the time when articulated burials were first placed in Zone I of the tomb. By taking the differences between such parameters, it is possible to estimate the durations of an episode of activity, i. e. the difference between its start and its end (e. g. *duration Zone I articulated*; *fig. 13*) and the intervals between certain events (e. g. *end zone I / end Les Mournouards*; *fig. 13*). In the latter case, these estimates can be partly negative if the order of the dated events is itself uncertain. In the text and tables, the Highest Posterior Density intervals of the posterior density estimates are given *in italics*. Statistics calculated by OxCal provide guides to the reliability of a model. The individual index of agreement

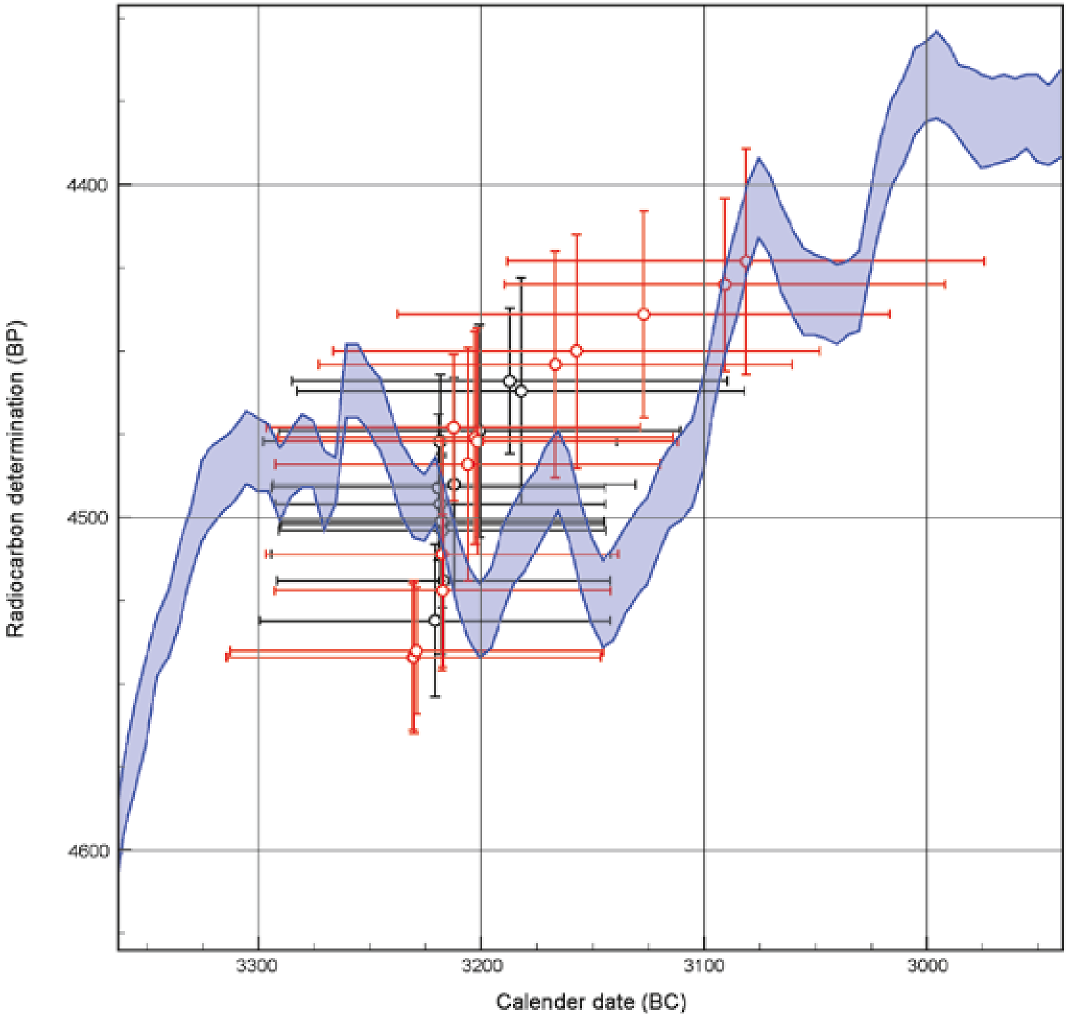

Fig. 6. Radiocarbon dates from Les Mournouards II plotted on the IntCal13 calibration curve (Reimer et al. 2013). Those for disarticulated left humeri are shown in red, those for articulated individuals in black.

(e. g. *'MAMS-21794 (A: 109)'*; *fig. 7*) expresses the consistency of the prior and posterior distributions; if this falls below 60, the radiocarbon date is regarded as inconsistent with the prior information built into the model, probably because of inaccuracy of the information and / or the date. Another index of agreement, Amodel (e. g. 'Amodel: 81'; *fig. 7*), is calculated from the individual agreement indices and indicates whether the model as a whole is likely, given the data. This too has a threshold value of 60.

Results and calibration

The radiocarbon results and associated measurements are listed in *table 1*. All are conventional radiocarbon ages that have been corrected for fractionation (Stuiver / Polach 1977). The calibrated radiocarbon dates given in *table 1* (at 2σ) have been calibrated by the maximum intercept method (Stuiver / Reimer 1986); in the Bayesian modelling, calibration has been undertaken using the probability method (Stuiver / Reimer 1993). Highest posterior density intervals have been rounded outwards to five years. The dates fall on a plateau in the calibration curve in the 33rd to 31st centuries cal BC *(fig. 6)*, so that their distributions, even when constrained by the models, are extended and sometimes bimodal. The resulting chronology is thus less precise than it would have been had the dates fallen elsewhere on the curve. A further consequence is that the dataset is flexible when it comes to accommodating various interpretations.

The models

Another significant limitation is that disarticulated bones were recorded only by 1 m square, so that there is no record of their stratigraphic relationships. Photographs make it clear that, while some underlay the articulated individuals, not all did (e. g. *fig. 3*), and there is also the consideration that the left humeri missing from 14 of the articulated individuals may be among the disarticulated bones, if they were not removed from the tomb. Before any constraint is put on the dates, it should be noted that all the measurements from zone I and all the measurements from zone IV, whether for articulated or disarticulated samples, are statistically consistent (zone I: T'=8.5; T'(5 %)=12.6; ν=6; zone IV: T'=4.7; T'(5 %)=12.6; ν=6). Those from zone II are not (T'=28.6; T'(5 %)=18.3; ν=10; Ward / Wilson 1978).

A minimal model

It seemed best to start with a minimal model which incorporated only the least contestable relationships and then to modify it to explore some of the interpretations proposed over the years. This model is presented first and in detail *(figs 7–8)*. It treats the use of the tomb as a single, more-or-less continuous phase of activity, within which the start, end and duration of each zone (and the articulated and disarticulated burials within each zone) are estimated. The only relationship between zones included is that burial in zone I must have ceased before burial B3 I and the overlying articulated limb B4 I were placed in the central passage of the outer chamber, since the introduction of a corpse into the inner chamber would have entailed disturbance to B3 I, and there is no trace of this; the skeleton was fully articulated and complete but for the head. At least the outer parts of zones II and IV would have remained accessible after B3 I and B4 I were in place *(fig. 4)*. Within individual zones, the stratigraphic relations between articulated individuals identified by Blin (2012, fig. 14; *fig. 5*) are incorporated where it was possible to date the individuals concerned. Weighted means have been taken of replicate measurements before their incorporation in the model.

According to the minimal model, burial in zone I – the inner chamber – would have started in *3360–3215 cal BC (90 % probability)* or *3195–3160 cal BC (5 % probability; start Zone I; fig. 7)* on the basis of dates for four disarticulated left humeri and for three articulated individuals. The radiocarbon dates are in good agreement with the stratigraphic sequence between C1 X and B1 VII *(fig. 7)*. Burial here would have ended in *3320–3310 cal BC (1 % probability)* or *3305–3260 cal BC (8 % probability)* or *3255–3105 cal BC (86 % probability; end Zone I; fig. 7)*. It would have extended over *1–165 years (95 % probability; use Zone I; fig. 13 [upper])*. Within this period, there was little difference between the chronology of disarticulated and articulated bone; it is only *60 % probable* that the individuals from whom the disarticulated bones came began to be placed in the chamber before those who remained more or less intact *(tab. 2)*. Similarly, both seem to have continued to the end of burial in the inner chamber; it is only *40 % probable* that the

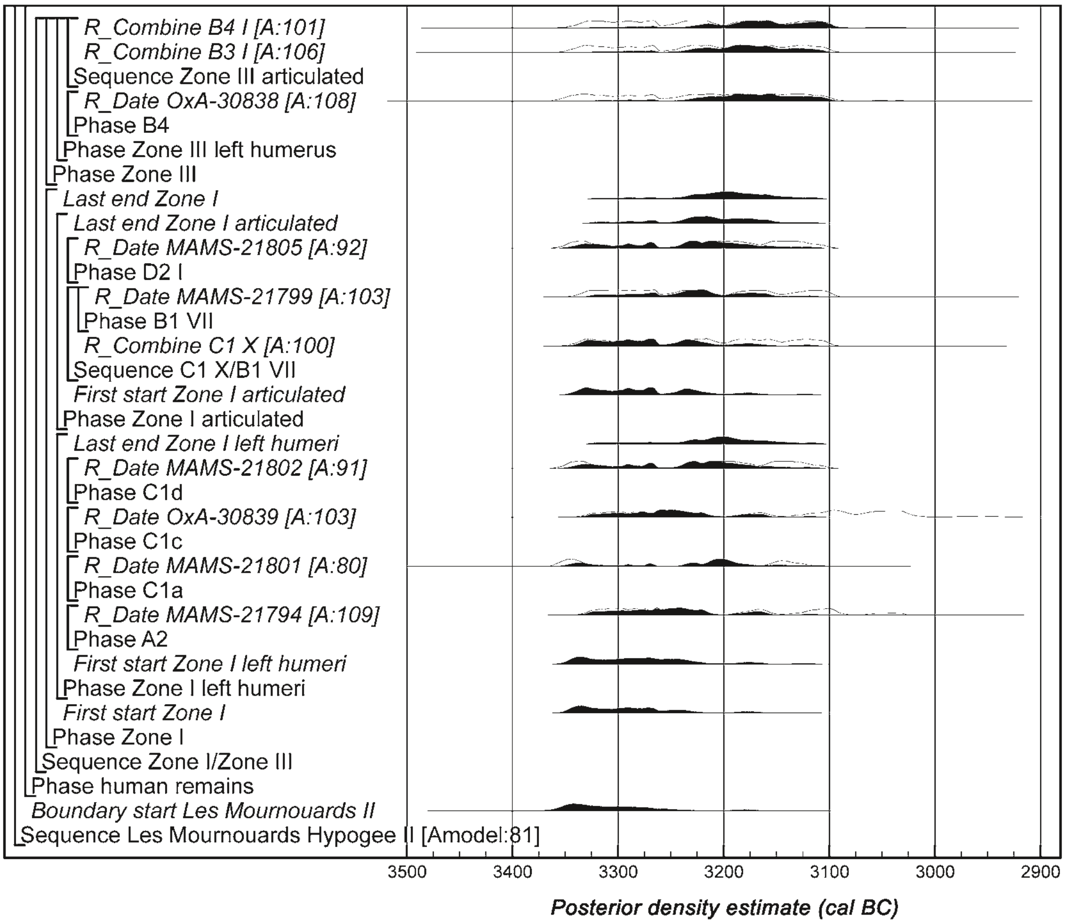

Fig. 7. Probability distributions of radiocarbon dates from zones I and III at Les Mournouards II (minimal model). Each distribution represents the relative probability that an event occurs at a particular time. For each of the dates two distributions have been plotted: one in outline, which is the result of simple radiocarbon calibration, and a solid one, based on the chronological model used. Distributions other than those relating to particular samples correspond to aspects of the model. For example, the distribution *'start Les Mournouards II'* is the estimated date when burial on the site began. The OxCal keywords and the large square brackets down the left-hand sides of *figures 7* and *8* define the overall model exactly.

most recent disarticulated humeri in the chamber were older than the most recent articulated individual *(tab. 2)*.

In the central passage of the outer chamber, statistically consistent weighted means for B3 I and the overlying limb B4 I accord with the sequence between the two individuals and with the premise built into the model that they post-date the last insertion into the inner chamber *(fig. 7)*.

In zone II of the outer chamber, burial would have started in *3355–3220 cal BC (90 % probability)* or *3195–3160 cal BC (5 % probability; start Zone II; fig. 8)*. This is based on dates for seven disarticulated left humeri and on a sequence of three articulated individuals. The radiocarbon dates from these skeletons are in good agreement with this stratigraphic sequence. More humeri were dated from here than from zone I because more

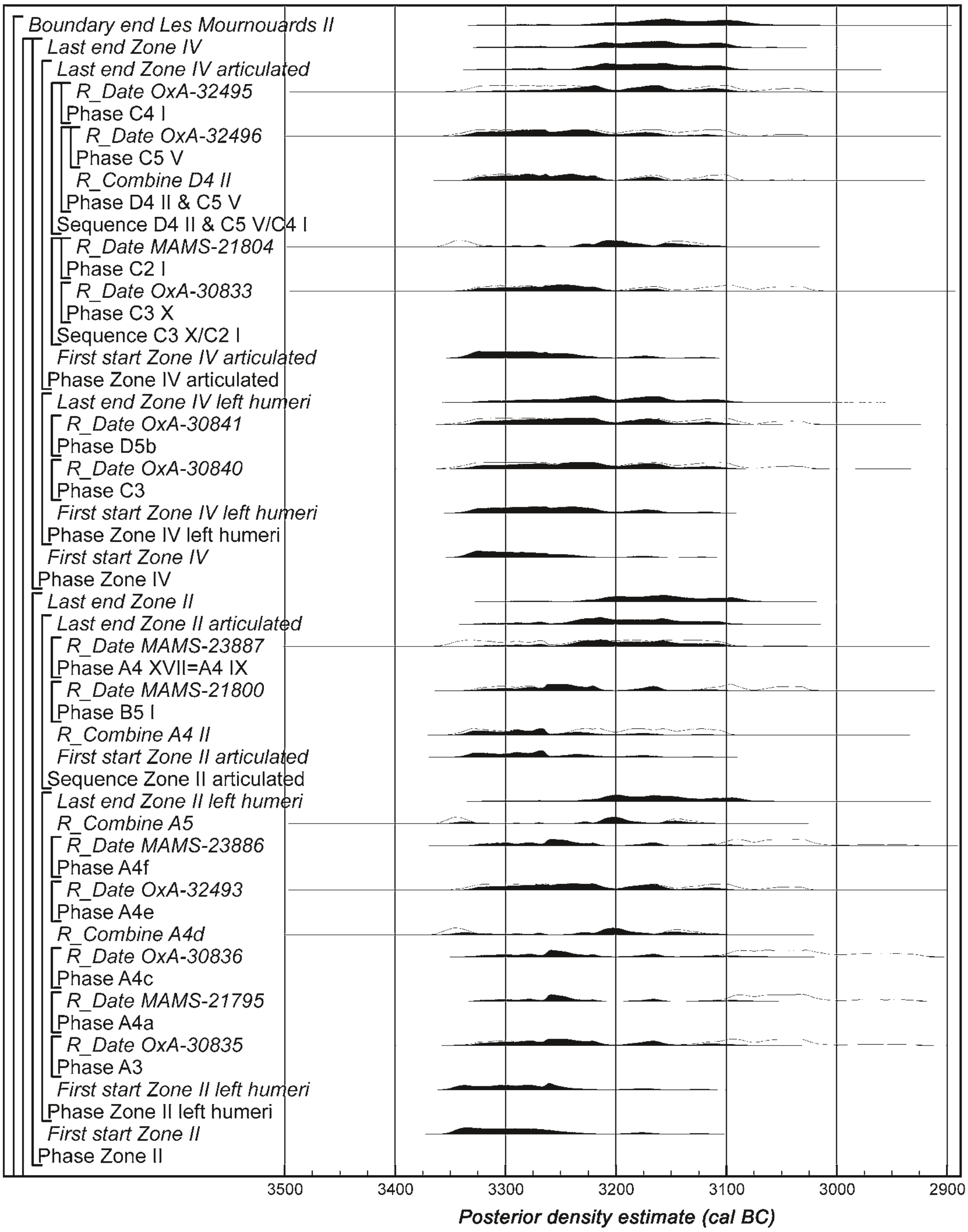

Fig. 8. Probability distributions of radiocarbon dates from zones II and IV at Les Mournouards II (minimal model). The format is identical to that of *figure 7*. The OxCal keywords and the large square brackets down the left-hand sides of *figures 7* and *8* define the overall model exactly.

	start Zone II left humeri	*start Zone I left humeri*	*start Zone IV articulated*	*start Zone I articulated*	*start Zone II articulated*	*start Zone IV left humeri*	*end Zone IV left humeri*	*end Zone I articulated*	*end Zone II articulated*	*end Zone I left humeri*	*end Zone IV articulated*	*B3 I*	*B4 I*	*end Zone II left humeri*
start Zone II left humeri	-	56	61	64	67	78	97	98	99	99	100	100	100	100
start Zone I left humeri		-	56	60	63	74	96	98	99	100	100	100	100	100
start Zone IV articulated			-	53	58	71	95	96	98	98	100	100	100	100
start Zone I articulated				-	55	67	93	100	97	98	99	100	100	100
start Zone II articulated					-	63	91	90	100	93	99	98	99	99
start Zone IV left humeri						-	100	81	90	85	96	94	98	98
end Zone IV left humeri							-	39	59	44	73	64	80	81
end Zone I articulated								-	73	60	89	100	100	94
end Zone II articulated									-	32	66	55	75	75
end Zone I left humeri										-	86	100	100	92
end Zone IV articulated											-	35	60	61
B3 I												-	100	75
B4 I													-	52
end Zone II left humeri														-

Tab. 2. An ordering of key parameters from the minimal model. Each cell expresses the per cent probability that the event in the first column is earlier than the event in the subsequent columns. It is, for example, 64 % probable that *start Zone II left humeri* was earlier than *start Zone I articulated.*

untreated examples could be found and because, after the first round of dating had delivered two slightly surprisingly late results for disarticulated samples *(MAMS-21795, OxA-30836; fig. 8)*, it was decided to check whether there were other similar ones. Here, it is *67 % probable* that some of the disarticulated bones were earlier than the articulated individuals, and *75 % probable* that disarticulated bones were also the latest in this zone *(tab. 2)*. Burial in zone II would have ended in *3300–3255 cal BC (5 % probability)* or *3245–3065 cal BC (90 % probability; end Zone II; fig. 8)*, after *1–230 years (95 % probability; use Zone II; fig. 13 [upper])*.

In zone IV of the outer chamber only two unconsolidated left humeri could be found. Five dated articulated individuals, however, provided two stratigraphic sequences. In the north-east, a young child, C3 X, underlay an adolescent, C2 I, who seemed to have been crammed flexed into the space between C5 I and the end of the chamber (Blin 2012, 50). Immediately north-west of this pair, the lower body of an adult male, D4 II, underlay the pelvis and upper body of another adult, C4 I, also underlain by the undated adult C5 II *(figs 4–5)*; archival evidence indicates that the bones of a young child, C5 V at the south-east end of the zone, underlay C5 II, and hence C4 I. These relationships are incorporated into the model. All the radiocarbon dates are in good agreement with this stratigraphic sequence. On this basis, burial in zone IV would have begun in *3350–3215 cal BC (89 % probability)* or *3190–3160 cal BC (6 % probability; start Zone IV; fig. 8)* and continued until *3300–3260 cal BC (5 % probability)* or *3240–3085 cal BC (90 % probability; end Zone IV; fig. 8)*. Burials would have been made for *1–205 years (95 % probability; use Zone IV; fig. 13 [upper])*. With only two dates for disarticulated bones, it is not realistic to consider their chronological relationship with the articulated individuals.

Overall, the monument would have been initiated in *3375–3225 cal BC (89 % probability)* or *3200–3165 cal BC (5 % probability)* or *3130–3120 cal BC (1 % probability; start Les Mournouards II; fig. 7)* and the last burial would have been made in *3295–3250 cal BC (4 % probability)* or *3235–3045 cal BC (91 % probability; end Les Mournouards II; fig. 8)*. The total period of burial was *1–265 years (95 % probability; duration Les Mournouards II; fig. 13 [upper])*.

Salient points include these:

- There was almost no perceptible difference between the times at which burials began to be made in zones I, II and IV *(fig. 12 [upper]; tab. 4)*.
- Zone I (the inner chamber), however, probably went out of use before the outer chamber *(figs 12–13 [upper]; tab. 4)*.
- There were minimal differences between the dates of disarticulated bones and articulated individuals in zone I. In zone II, however, the picture is different. Here, disarticulated bones may have covered a greater span of time than the articulated individuals *(fig. 13 [upper]; tab. 5)*.
- Nowhere is there any hint of an interval between the end of the deposition of disarticulated bone and the start of burial of articulated individuals.
- The last human remains to have been deposited in the tomb seem to have been either B4 I, the articulated leg overlying B3 I in the central passage, or the latest disarticulated bones in zone II (*fig. 12 [upper])*.

Modelling other interpretations

Going beyond the relationships incorporated in the minimal model, it is possible to explore different interpretations which have been suggested over the years. The alternative

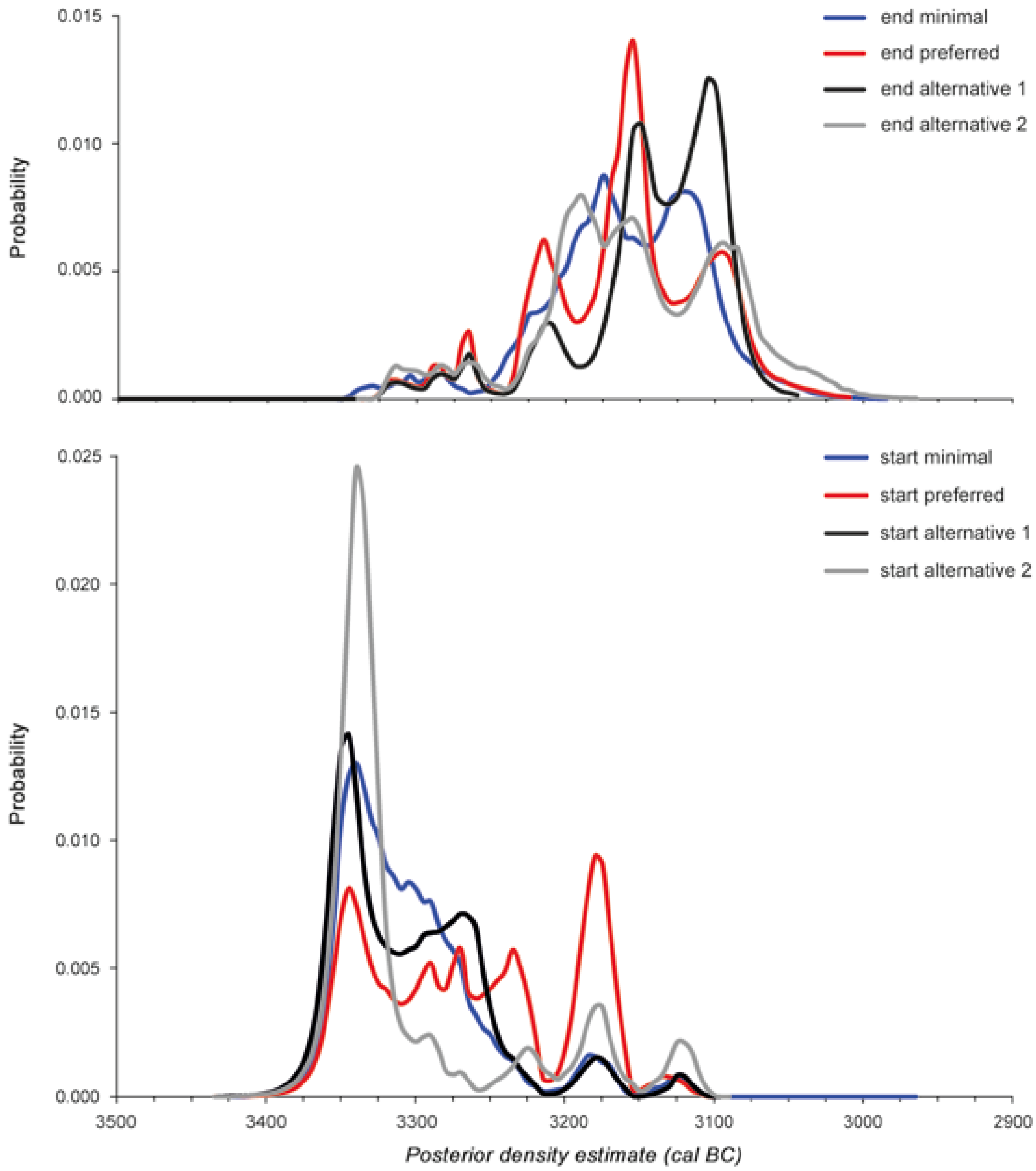

Fig. 9. Posterior density estimates for (below) *'start Les Mournouards II'* and (above) *'end Les Mournouards II'* from the minimal, preferred, and alternative models discussed in the text.

models described below retain the original prior information: that burial in zone I ceased before B3 *I and B4* I were placed in the central passage (zone III); that each zone had a separate history, on the evidence of the virtual restriction to each of the pairings and articulations; and that there were stratigraphic relationships between some of the articulated individuals. Each then adds a further constraint which affects the model outputs. The posterior density estimates for the start and end of burial at Les Mournouards II from the alternative models are shown in *figure 9*. They differ not so much in the overall date ranges covered, as in the balances of probability within them.

Alternative 1. Do the disarticulated bones include the remains of the earliest burials, most of whose remains were cleared out of the tomb?

This is what would be expected from the progressive displacement and reworking of the burials envisaged by both Leroi-Gourhan and Blin. The latter (Blin 2012), indeed, has suggested that all the disarticulated bones, regardless of their final stratigraphic positions, pre-date the more or less complete burials. The incompleteness of some of the articulated individuals is an argument against this, unless the bones in question were removed. If, however, the minimal model is modified to place the start of articulated individuals in each zone after the end of disarticulated left humeri in the same zone, overall agreement is good (Amodel: 74; model not shown). This constraint makes the estimates more precise than in the minimal model because the two groups of dates in each zone are made sequential. The overall duration, however, is similar to that estimated by the minimal model. Even in this reading there could have been continuity between the end of disarticulated remains and the start of articulated ones.

Alternative 2. What was the chronological relationship between the inner and outer chambers?

Leroi-Gourhan was uncertain whether the inner chamber was filled before the outer came into use or whether both chambers were used simultaneously, although the inner would have been full before the outer. In this second case, differences in body position and grave goods between the two would have reflected two different social groups (Leroi-Gourhan et al. 1962, 86). The minimal model indicates that burial started in all three zones at more or less the same time, but ceased earlier in zone I, the inner chamber, corresponding to the second of these interpretations *(fig. 12)*. If, however, that model is modified to place the start of burial in zones II and IV after the end of burial in zone I, corresponding to the first interpretation, overall agreement is good (Amodel: 76; model not shown). Any interval between the end of burial in zone I and the start of burial in the outer chamber would in this case have amounted to a decade or two. The overall timescale is the same as that of the minimal model, although the durations of the individual chambers are shorter because they are made successive.

The minimal model is safe and uncontentious. The alternatives are both statistically feasible because the shape of the calibration curve for this period *(fig. 6)* gives the data the flexibility of a contortionist. The minimal model and the alternatives cannot all be correct. Indeed, if the first and second alternatives are combined (with both the sequences in different zones between disarticulated and articulated remains and the primacy of zone I invoked), the model falls into poor overall agreement (Amodel: 33; model not shown).

A preferred model?

In these circumstances, archaeological judgement must be the decider. On any of the proposed interpretations of the burial process, some of the disarticulated humeri should derive from the oldest burials. We suggest a model incorporating the prior information that *some* disarticulated humeri are older than all the articulated individuals in each zone,

	start Zone II left humeri	*start Zone I left humeri*	*start Zone IV articulated*	*start Zone I articulated*	*start Zone II articulated*	*start Zone IV left humeri*	*end Zone IV left humeri*	*end Zone II articulated*	*end Zone I left humeri*	*end Zone I articulated*	*end Zone IV articulated*	*B3 I*	*B4 I*	*end Zone II left humeri*
start Zone II left humeri	-	54	88	87	100	62	97	100	100	100	100	100	100	100
start Zone I left humeri		-	84	100	86	57	95	100	100	100	100	100	100	100
start Zone IV articulated			-	52	55	0	84	97	93	92	100	100	100	100
start Zone I articulated				-	54	22	80	97	96	100	99	100	100	100
start Zone II articulated					-	19	77	100	88	87	98	98	100	99
start Zone IV left humeri						-	100	100	99	98	100	100	100	100
end Zone IV left humeri							-	74	56	55	84	81	90	87
end Zone II articulated								-	25	24	66	59	78	71
end Zone I left humeri									-	47	89	100	100	92
end Zone I articulated										-	90	100	100	93
end Zone IV articulated											-	41	64	56
B3 I												-	100	65
B4 I													-	42
end Zone II left humeri														-

Tab. 3. An ordering of key parameters from the preferred model. Each cell expresses the per cent probability that the event in the first column is earlier than the event in the subsequent columns. It is, for example, 87 % probable that *start Zone II left humeri* was earlier than *start Zone I articulated.*

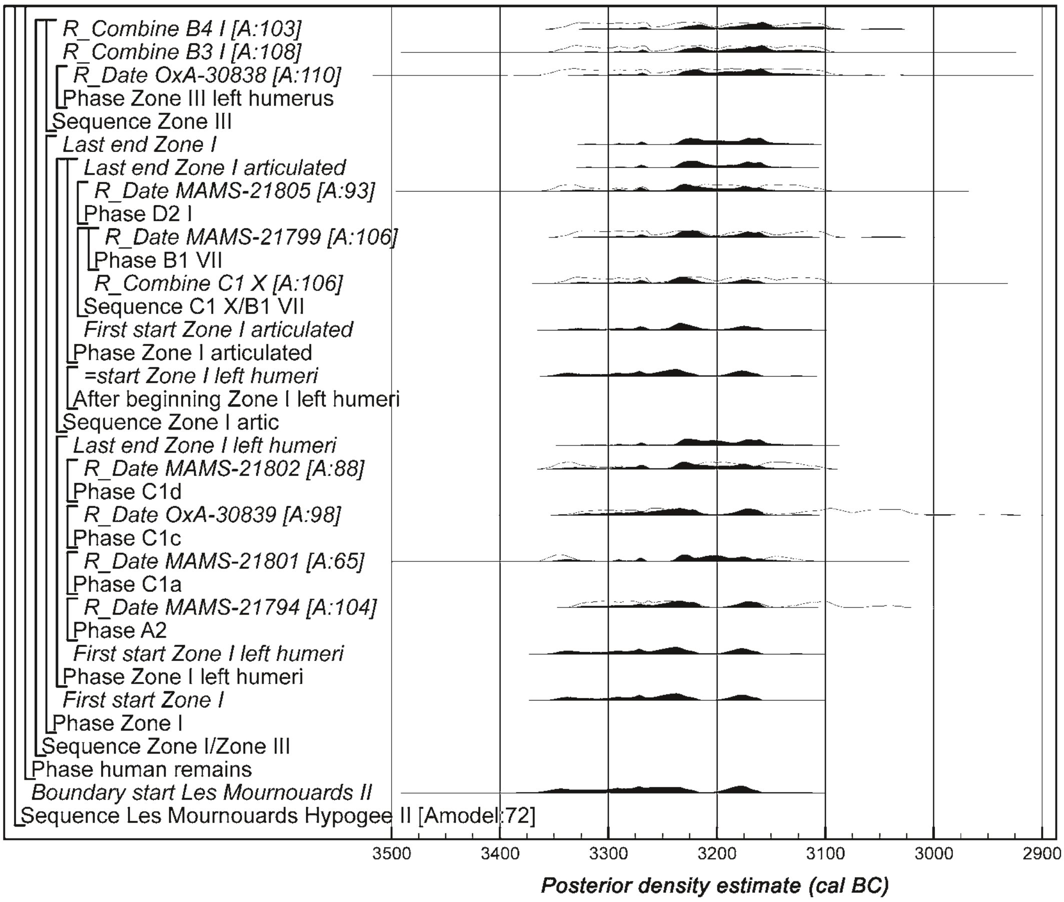

Fig. 10. Probability distributions of radiocarbon dates from zones I and III at Les Mournouards II (preferred model). The format is identical to that of *figure 7*. The OxCal keywords and the large square brackets down the left-hand sides of *figures 10* and *11* define the overall model exactly.

although others may have been contemporary or later, with the burials in zone III (the central passage) still later than those in zone I (the inner chamber). The model has good overall agreement (Amodel: 72; *figs 10–11*). *Figures 12–13* show key parameters from both the minimal model (upper) and the preferred model (lower).

Following this preferred model, the monument would have been initiated in *3365–3215 cal BC (74 % probability)* or *3200–3160 cal BC (21 % probability; start Les Mournouards II; fig. 10)*. The oldest bones eventually found disarticulated in zone I would have been deposited in *3350–3215 cal BC (74 % probability)* or *3200–3155 cal BC (21 % probability; start Zone I left humeri; fig. 10)*. The first burial to have survived in articulation would have been inserted in *3340–3260 cal BC (29 % probability)* or *3255–3155 cal BC (66 % probability; start Zone I articulated; fig. 10)*. Burial in zone I would have continued for *1–140 years (95 % probability; use Zone* I*; fig. 13 [lower])*, until *3325–3310 cal BC (1 % probability)* or *3295–3260 cal BC (7 % probability)* or *3245–3110 cal BC (87 % probability; end Zone I; fig. 10)*. As in the minimal model, the deposition of disarticulated

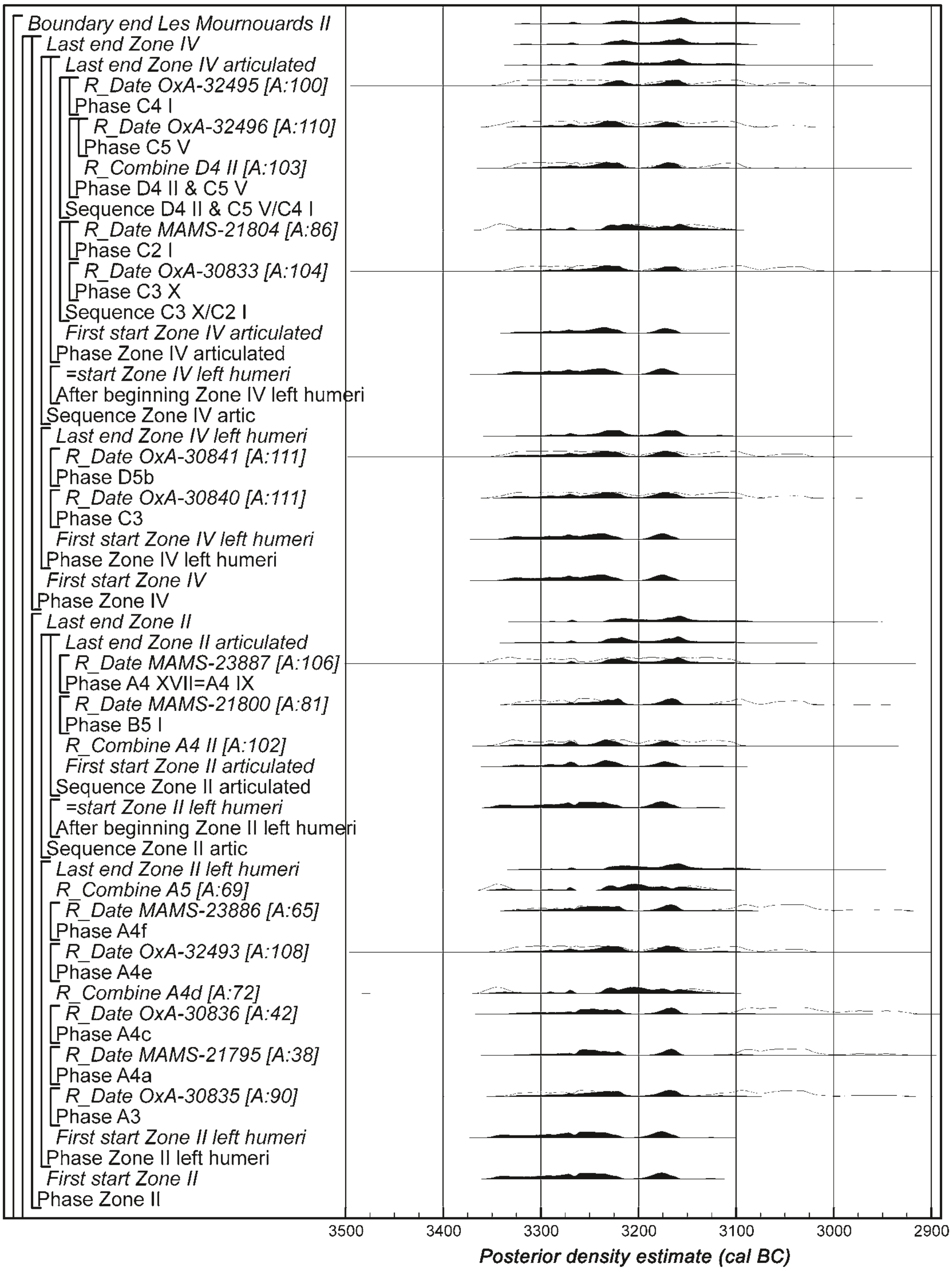

Fig. 11. Probability distributions of radiocarbon dates from zones II and IV at Les Mournouards II (preferred model). The format is identical to that of *figure 7*. The OxCal keywords and the large square brackets down the left-hand sides of *figures 10* and *11* define the overall model exactly.

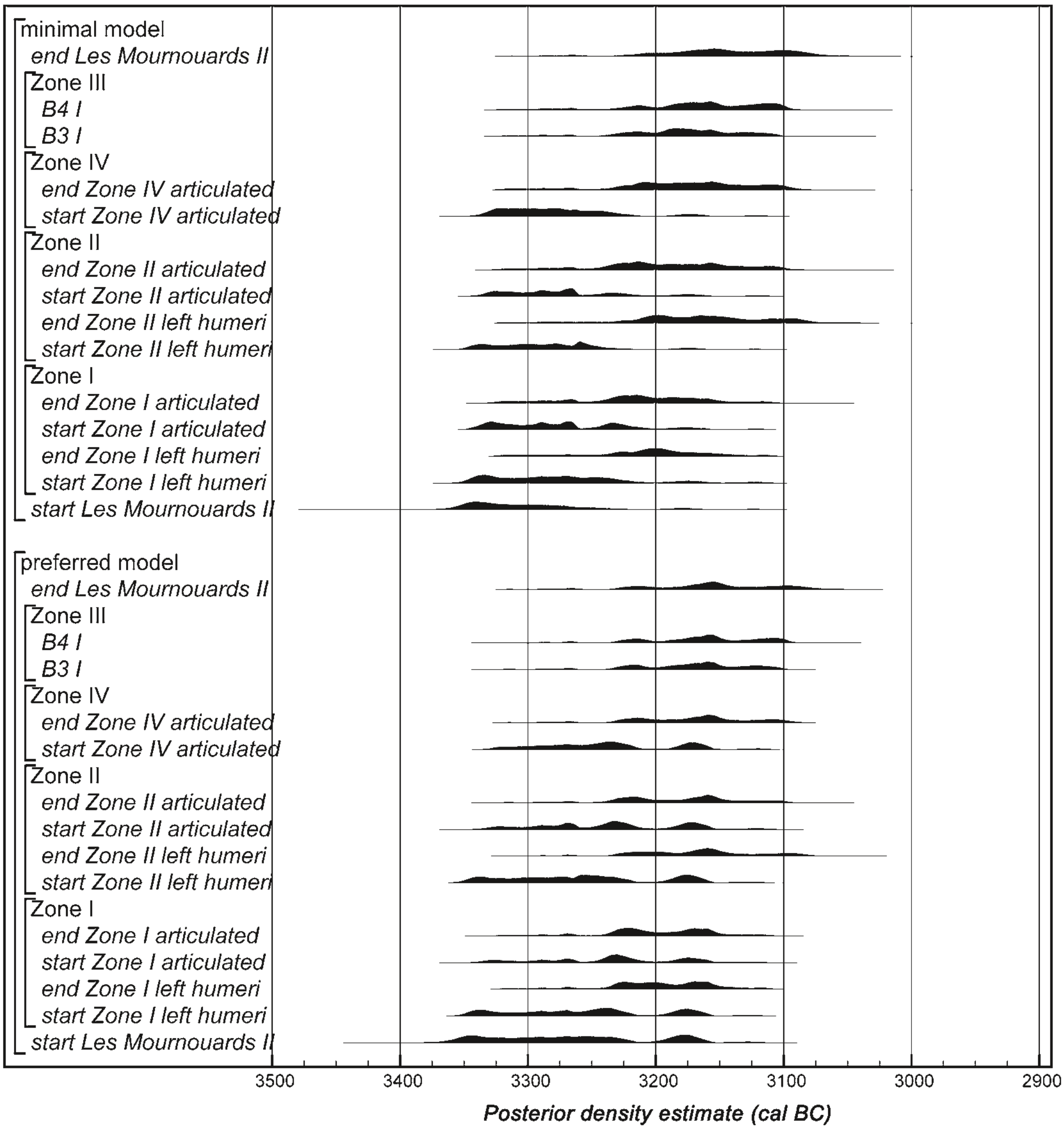

Fig. 12. Key parameters for Les Mournouards II, derived from the minimal model *(figs 7–8)* and the preferred model *(figs 10–11*; *tab. 4)*.

and articulated bone seems coterminous; it is only *47 % probable* that left humeri ended earlier than articulated individuals *(tab. 3)*.

Burial in zone II would have begun in *3350–3215 cal BC (74 % probability)* or *3200–3155 cal BC (21 % probability; start Zone II; fig. 11)*; burial in zone IV in *3340–3215 cal BC (73 % probability)* or *3195–3155 cal BC (22 % probability; start Zone IV; fig. 11)*. There was no appreciable difference between the start dates of the two zones. In zone II, disarticulated humeri may have ended slightly after articulated individuals.

Zone II remained in use until *3295–3260 cal BC (6 % probability)* or *3240–3075 cal BC (89 % probability; end Zone II; fig. 11)*, over *1–195 years (95 % probability; use*

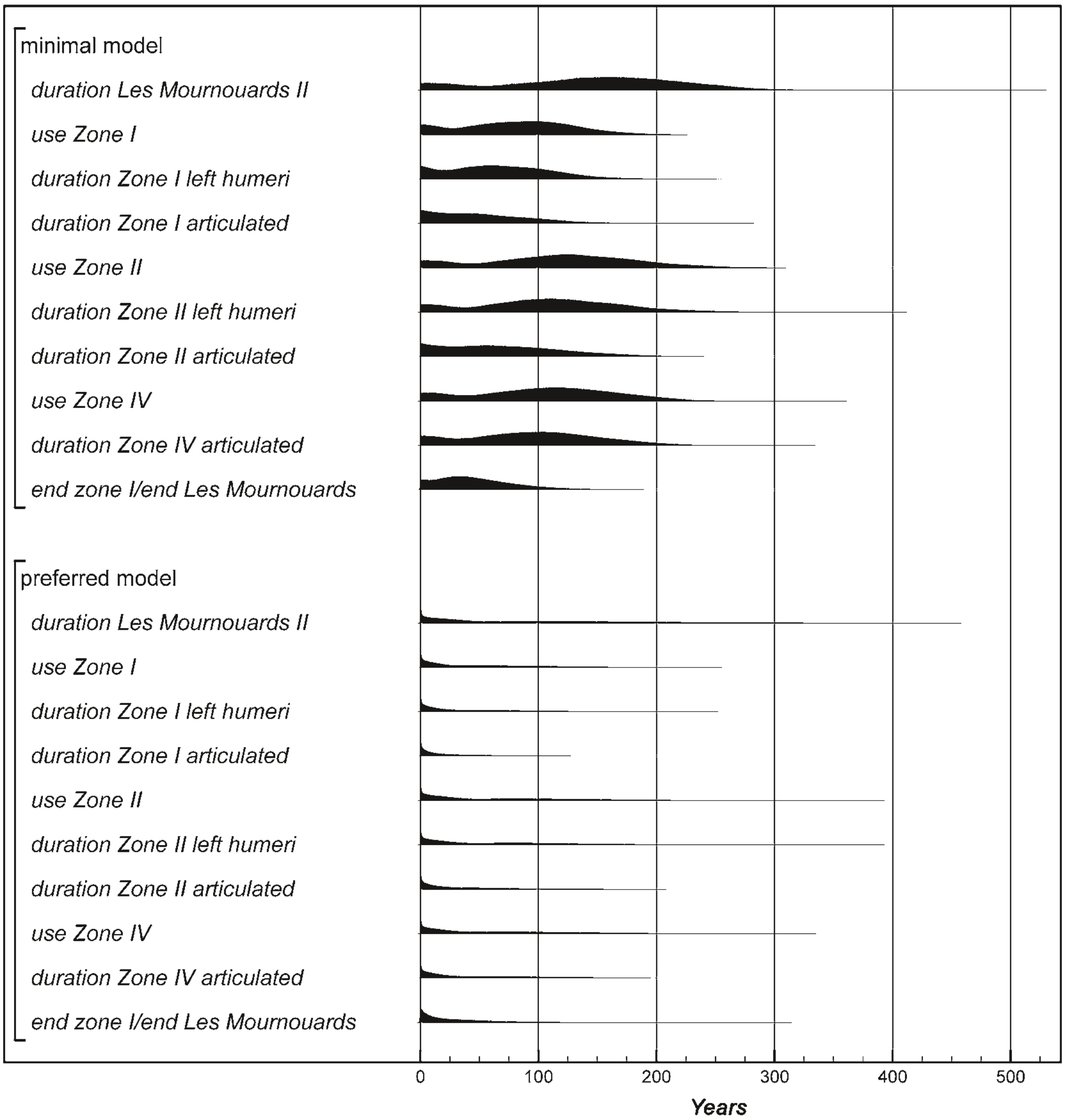

Fig. 13. Key durations and intervals from Les Mournouards II, derived from the minimal model *(figs 7–8)* and the preferred model *(figs 10–11*; *tab. 5)*.

zone II; fig. 13 [lower]). Zone IV remained in use until *3295–3280 cal BC (2 % probability)* or *3275–3260 cal BC (3 % probability)* or *3240–3085 cal BC (90 % probability; end Zone IV; fig. 11)*, over *1–180 years (95 % probability; use Zone IV; fig. 13 [lower])*. There is no appreciable difference between the start and end dates for the two zones. The use of the tomb as a whole ended in *3295–3255 cal BC (6 % probability)* or *3240–3065 cal BC (89 % probability; end Les Mournouards II; fig. 11)*, *1–100 years (95 % probability)* after burial had ceased in the inner chamber *(end zone I / end Les Mournouards; fig. 13 [lower])*. The overall span of burial was *1–235 years (95 % probability; duration les Mournouards II; fig. 13 [lower])*, with much of the probability concentrated at the shorter end of the distribution, making a duration of 50 years or so feasible, although one of 200 years or more is

	Minimal model (*figs 7–8*)		**Preferred model (*figs 10–11*)**	
	Highest Posterior Density interval (cal BC)		*Highest Posterior Density interval (cal BC)*	
Parameter	*95 % probability*	*68 % probability*	*95 % probability*	*68 % probability*
start *Les Mournouards II*	*3375–3225 (89 %)* *3200–3165 (5 %)* *3130–3120 (1 %)*	*3360–3275*	*3365–3215 (74 %)* *3200–3160 (21 %)*	*3350–3335 (5 %)* *3300–3225 (46 %)* *3195–3165 (17 %)*
start Zone I	*3360–3215 (90 %)* *3195–3160 (5 %)*	*3350–3260*	*3350–3215 (74 %)* *3200–3155 (21 %)*	*3345–3330 (5 %)* *3295–3265 (14 %)* *3260–3220 (32 %)* *3190–3160 (17 %)*
start Zone I *left humeri*	*3355–3210 (89 %)* *3195–3160 (6 %)*	*3350–3315 (21 %)* *3305–3235 (47 %)*	*3350–3215 (74 %)* *3200–3155 (21 %)*	*3345–3330 (5 %)* *3295–3265 (14 %)* *3260–3220 (32 %)* *3190–3160 (17 %)*
end Zone I *left humeri*	*3320–3130 (94 %)* *3125–3110 (1 %)*	*3240–3150*	*3325–3310 (2 %)* *3300–3260 (8 %)* *3255–3110 (85 %)*	*3240–3155*
start Zone I *articulated*	*3350–3160*	*3340–3260 (55 %)* *3245–3220 (13 %)*	*3340–3260 (29 %)* *3255–3155 (66 %)*	*3295–3285 (3 %)* *3280–3260 (8 %)* *3250–3210 (36 %)* *3190–3155 (21 %)*
end Zone I *articulated*	*3325–3260 (18 %)* *3255–3130 (75 %)* *3325–3310 (2 %)*	*3125–3110 (2 %)* *3245–3155 (66 %)*	*3275–3265 (2 %)* *3300–3260 (9 %)* *3245–3115 (84 %)*	*3275–3265 (1 %)* *3240–3200 (36 %)* *3190–3150 (31 %)*
end Zone I	*3320–3310 (1 %)* *3305–3260 (8 %)* *3255–3105 (86 %)*	*3235–3150*	*3325–3310 (1 %)* *3295–3260 (7 %)* *3245–3110 (87 %)*	*3235–3150*
start Zone II	*3355–3220 (90 %)* *3195–3160 (5 %)*	*3345–3265*	*3350–3215 (74 %)* *3200–3155 (21 %)*	*3340–3335 (1 %)* *3300–3220 (50 %)* *3190–3165 (17 %)*
start Zone II *left humeri*	*3355–3215 (89 %)* *3195–3160 (5 %)* *3130–3115 (1 %)*	*3345–3270 (55 %)* *3265–3250 (13 %)*	*3350–3215 (74 %)* *3200–3155 (21 %)*	*3340–3335 (1 %)* *3300–3220 (50 %)* *3190–3165 (17 %)*
end Zone II *left humeri*	*3300–3070*	*3215–3130 (57 %)* *3115–3085 (11 %)*	*3295–3260 (6 %)* *3240–3075 (89 %)*	*3235–3140*
start Zone II *articulated*	*3345–3205 (85 %)* *3195–3155 (9 %)* *3125–3115 (1 %)*	*3335–3260 (62 %)* *3240–3225 (6 %)*	*3340–3155*	*3295–3285 (4 %)* *3280–3260 (11 %)* *3250–3215 (31 %)* *3190–3155 (22 %)*
end Zone II *articulated*	*3300–3260 (8 %)* *3255–3095 (87 %)*	*3240–3140*	*3295–3260 (6 %)* *3250–3095 (89 %)*	*3275–3265 (1 %)* *3240–3195 (33 %)* *3190–3145 (34 %)*
end Zone II	*3300–3255 (5 %)* *3245–3065 (90 %)*	*3215–3130 (56 %)* *3115–3090 (12 %)*	*3295–3260 (6 %)* *3240–3075 (89 %)*	*3235–3140*
start Zone IV	*3350–3215 (89 %)* *3190–3160 (6 %)*	*3335–3260*	*3340–3215 (73 %)* *3195–3155 (22 %)*	*3330–3325 (1 %)* *3295–3220 (50 %)* *3190–3165 (17 %)*

Parameter	Minimal model (*figs 7–8*) *Highest Posterior Density interval (cal BC)* *95 % probability*	*68 % probability*	Preferred model (*figs 10–11*) *Highest Posterior Density interval (cal BC)* *95 % probability*	*68 % probability*
start Zone IV left humeri	*3340–3155* (*93 %*) *3125–3110* (*2 %*)	*3325–3220*	*3340–3215* (*73 %*) *3195–3155* (*22 %*)	*3330–3325* (*1 %*) *3295–3220* (*50 %*) *3190–3165* (*17 %*)
end Zone IV left humeri	*3310–3095*	*3275–3200* (*36 %*) *3195–3150* (*27 %*) *3125–3105* (*5 %*)	*3325–3145* (*90 %*) *3135–3105* (*5 %*)	*3275–3260* (*4 %*) *3255–3205* (*35 %*) *3190–3150* (*29 %*)
start Zone IV articulated	*3345–3215* (*89 %*) *3190–3160* (*6 %*)	*3335–3245*	*3335–3210* (*72 %*) *3195–3155* (*23 %*)	*3280–3215* (*48 %*) *3185–3160* (*20 %*)
end Zone IV articulated	*3300–3260* (*5 %*) *3245–3085* (*90 %*)	*3220–3135* (*61 %*) *3120–3105* (*7 %*)	*3295–3280* (*2 %*) *3275–3260* (*3 %*) *3240–3090* (*90 %*)	*3235–3145*
end Zone IV	*3300–3260* (*5 %*) *3240–3085* (*90 %*)	*3220–3140* (*55 %*) *3125–3100* (*13 %*)	*3295–3280* (*2 %*) *3275–3260* (*3 %*) *3240–3085* (*90 %*)	*3270–3265* (*1 %*) *3235–3145* (*67 %*)
B3 I	*3300–3260* (*6 %*) *3245–3100* (*89 %*)	*3230–3145* (*60 %*) *3140–3120* (*8 %*)	*3295–3280* (*2 %*) *3275–3260* (*3 %*) *3240–3100* (*90 %*)	*3270–3265* (*1 %*) *3235–3205* (*21 %*) *3200–3145* (*43 %*) *3130–3120* (*3 %*)
B4 I	*3295–3260* (*4 %*) *3240–3090* (*91 %*)	*3220–3210* (*3 %*) *3195–3145* (*39 %*) *3140–3100* (*26 %*)	*3295–3280* (*1 %*) *3275–3260* (*4 %*) *3240–3090* (*90 %*)	*3230–3205* (*18 %*) *3190–3145* (*39 %*) *3125–3100* (*11 %*)
end Les Mournouards II	*3295–3250* (*4 %*) *3235–3045* (*91 %*)	*3185–3080*	*3295–3255* (*6 %*) *3240–3065* (*89 %*)	*3230–3195* (*18 %*) *3190–3135* (*41 %*) *3115–3090* (*9 %*)

Tab. 4. Highest Posterior Density intervals for key parameters from the minimal model (*figs 7–8*) and the preferred model (*figs 10–11*). See also *figure 12*.

not excluded. As in the minimal model, it is impossible to judge whether the final deposits in zone II or B4 I in the central passage were the latest to be placed in the tomb.

Use may have continued rather longer: bones, including the skull of B3 I, one of the latest burials, may have been removed at a later date; the placement of artefacts in the antechamber is undated; and there may have been later activity in the unexcavated entrance area. It is noteworthy that, except in the model where disarticulated humeri were constrained to finish before the start of articulated individuals, they continue from the start to the end of burial in the monument. This suggests that, rather than a universal intermittent progress from articulation to disarticulation as further burials were made in the tomb, some individuals, regardless of date, may have undergone more radical manipulation than others.

The possibility of dietary offsets

Diet-induced radiocarbon offsets can occur if a dated individual has taken up carbon from a reservoir not in equilibrium with the terrestrial biosphere (Lanting / van der Plicht

Parameter	Minimal model (*figs 7–8*) *Highest Posterior Density interval (years)* *95 % probability*	*68 % probability*	Preferred model (*figs 10–11*) *Highest Posterior Density interval (years)* *95 % probability*	*68 % probability*
duration Zone I left humeri	*1–145*	*1–15* (*9 %*) *25–105* (*59 %*)	*1–130*	*1–65*
duration Zone I articulated	*1–135*	*1–75*	*1–100*	*1–40*
use Zone I	*1–165*	*1–15* (*6 %*) *45–130* (*62 %*)	*1–140*	*1–70*
duration Zone II left humeri	*1–215*	*1–10* (*3 %*) *55–175* (*65 %*)	*1–195*	*1–45* (*44 %*) *50–110* (*24 %*)
duration Zone II articulated	*1–170*	*1–95*	*1–130*	*1–55*
use Zone II	*1–230*	*1–10* (*3 %*) *65–190* (*65 %*)	*1–195*	*1–45* (*44 %*) *55–115* (*24 %*)
duration Zone IV articulated	*1–190*	*1–15* (*7 %*) *50–150* (*61 %*)	*1–150*	*1–75*
use Zone IV	*1–205*	*1–15* (*5 %*) *60–170* (*63 %*)	*1–180*	*1–45* (*46 %*) *50–100* (*22 %*)
duration Les Mournouards II	*1–265*	*1–15* (*2 %*) *85–235* (*66 %*)	*1–235*	*1–55* (*43 %*) *70–145* (*25 %*)
end zone I/ *end Les Mournouards*	*0–120*	*0–65*	*0–100*	*0–40*

Tab. 5. Highest Posterior Density intervals for durations and an interval calculated from the minimal model *(figs 7–8)* and the preferred model *(figs 10–11)*. See *figure 13*.

1998). If one of the reservoir sources has an inherent radiocarbon offset – for example, if the dated individual consumed marine fish or freshwater fish from a depleted source –, then the bone will take on some proportion of radiocarbon that is not in equilibrium with the atmosphere. This makes the radiocarbon age older than it would be if the individual had consumed a diet consisting of purely terrestrial resources. Such ages, if erroneously calibrated using a purely terrestrial calibration curve, will produce anomalously early radiocarbon dates (Bayliss et al. 2004).

Given the nature of the monument, there is no direct dietary evidence from Les Mournouards; the scant fauna consisting almost entirely of wild taxa that could have found their own way into the tomb (fox, polecat, dormouse, field mouse, bat and birds of the sparrow family; Leroi-Gourhan et al. 1962, 123–124). The site lies on free-draining chalk and so surface water is comparatively rare. Those buried in Les Mournouards, however, could have consumed freshwater fish which would be depleted in ^{14}C because some of their carbon would have derived from chalk dissolved in the water of rivers and lakes. This possibility is examined by means of a quantitative reconstruction of the diet of the dated individuals.

Food Sources	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)
Cereals	–24.6 ± 0.3	5.0 ± 0.4
Terrestrial animals	–21.7 ± 0.1	6.1 ± 0.2
Fish (freshwater and anadromous)	–20.5 ± 0.2	9.6 ± 0.3

Tab. 6. Mean $\delta^{13}C$ and $\delta^{15}N$ for food sources used in the FRUITS proportional diet modelling (from Ogrinc / Budja [2005], Bogaard et al. [2013] and Bocherens et al. [2007]).

FRUITS source proportional diet modelling

Diet reconstruction for the Les Mournouards burial population was determined by the Bayesian mixing model FRUITS v2.0β (Food Reconstruction Using Isotopic Transferred Signals; Fernandes et al. 2014). FRUITS employs the isotopic averages of possible food sources and allows the user to define isotopic offsets between diet and consumer, as well as the expected weighting and concentration of food sources. Prior information to constrain the calculations of the stable isotope mixing model can also be added. FRUITS then produces estimates of the mean percentage (and standard deviation) for each of the possible food sources making up the diet for each given consumer.

Weighted means of replicate isotopic values were used in the dietary modelling *(tab. 1)*. The FRUITS results were produced from two diet proxies ($\delta^{13}C$ and $\delta^{15}N$) and used the following food source data and assumptions in the model.

The averages and the standard deviation of analytical error from $\delta^{13}C$ and $\delta^{15}N$ analyses of three possible food sources were used, with the weight and concentration of each of the three diet sources set at 100 %. Cereal values come from analyses of archaeobotanical cereals: wheat and barley (n = 18; average values: Ogrinc / Budja 2005) and emmer wheat and naked barley from Ecsegfalva, Hungary (Bogaard et al. 2013). Data for terrestrial herbivores are from Neolithic herbivore faunal values from the Meuse Basin, Belgium (n = 19; Bocherens et al. 2007, tab. 5A). Data for fish (freshwater and anadromous) are from collated European archaeological fish data from previous studies (n = 9; ibid. tab. 2). The mean values used in the FRUITS diet proportion modelling and their errors are given in *table 6*[1].

Mean isotope values and the mean of analytical errors for each food source in *table 6* were then used to run a simple FRUITS model where the whole diet is considered. The isotopic offsets were 4.8±0.2 ‰ for $\delta^{13}C$ (Fernandes et al. 2014) and 6.0±0.5 ‰ for $\delta^{15}N$ (O'Connell et al. 2012).

The FRUITS modelling at Les Mournouards included prior information that terrestrial herbivores probably provided a higher proportion of dietary protein than freshwater fish (Bocherens et al. 2007; Meiklejohn et al. 2014). Work by Arbogast / Clavel (2007) on early Neolithic sites in the Oise, Aisne and Marne valleys revealed that a range of freshwater fish could be found among local bone assemblages. Further evidence of diets which included local fish can be provided by the stable isotope values of human popula-

[1] For the future, specifically regional dietary baselines would greatly improve analysis of the effects of diet on radiocarbon age.

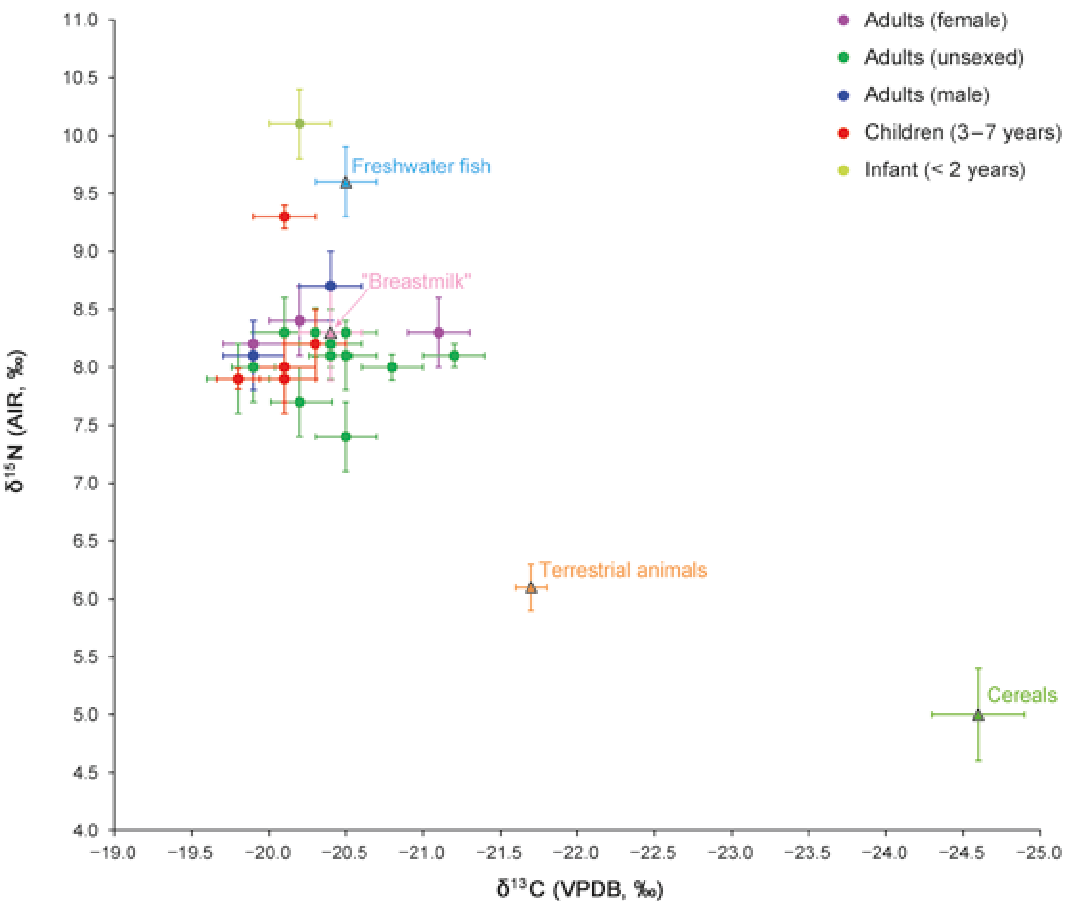

Fig. 14. Plot of the $\delta^{13}C$ and $\delta^{15}N$ values for human samples from Les Mournouards II and the mean isotopic values of food sources used in the FRUITS modelling of their diets. The positions of the adults and sub-adults are offset from the isotopic positions of food sources by isotopic offsets from metabolic enrichment of these foods by the consumer ($\delta^{13}C$ by 4.8±0.2 ‰: Fernandes et al. 2014; and $\delta^{15}N$ by 6.0±0.5 ‰: O'Connell et al. 2012). For "breastmilk", the isotopic value sits amongst the population cluster, as this proxy was generated from three adult females; the breastfeeding infant is enriched by 1.0±0.5 ‰ for $\delta^{13}C$ and 3.0±0.5 ‰ for $\delta^{15}N$. A 3–5-year-old child (MAMS-21805) plots as an outlier, but had low estimates of fish in the FRUITS results.

tions, such as the enriched $\delta^{15}N$ values found in Middle Neolithic populations of the Meuse Basin by Bocherens et al. (2007, 18).

In the Les Mournouards population, stable isotope values are not indicative of an isotopically enriched dietary protein component such as fish *(fig. 14)*. Average adult values ($\delta^{13}C$ = –20.4±0.4 ‰; $\delta^{15}N$ = 8.1±0.3 ‰; n = 17) differ little from the average values of the 3–7-year-old children ($\delta^{13}C$ = –20.1±0.2 ‰; $\delta^{15}N$ = 8.3±0.1 ‰; n = 5). These stable isotope profiles have therefore returned FRUITS estimations of negligible percentages of fish (1±1 % to 2±2 %), with a greater proportion of cereals in the overall diet *(tab. 7)*. One child (MAMS-21805; $\delta^{15}N$ 9.3±0.1 ‰), which plotted as an outlier in *figure 14*, also returns a negligible percentage of fish in its FRUITS estimates *(tab. 7)*.

A different model was used to estimate the diet for the disarticulated femur of a child of under 2 years (A4c; OxA-30836; $\delta^{13}C$ = –20.2±0.2 ‰, $\delta^{15}N$ = 10.1±0.3 ‰). This very young child's $\delta^{15}N$ is enriched by +2 ‰ over adults and enriched by 1.8 ‰ over children of 3–7 years. Considering the age of the infant subject, we assume that the $\delta^{15}N$ enrichment is associated with breastfeeding (Jay et al. 2008; Fuller et al. 2006) rather than with fish or other higher protein foods. A second food source for this individual is likely to have been cereal gruels which are associated with the gradual introduction of solid foods during the weaning transition (Fildes 1986). For this FRUITS model, the stable isotope values for archaeological cereals outlined above was used *(tab. 6)*, and a "breastmilk" isotopic signature was calculated using the average $\delta^{13}C$ and $\delta^{15}N$ value of the four adult women in the Les Mournouards population ($\delta^{13}C$ = –20.4±0.2 ‰, $\delta^{15}N$ = 8.3±0.3 ‰). The FRUITS isotopic offsets (the consumer's trophic enrichment of the metabolised food) was set at 1.0±0.5 ‰ for $\delta^{13}C$ and 3.0±0.5 ‰ for $\delta^{15}N$, following the enrichment factors noted between mothers and nursing infants in other studies (Fuller et al. 2006; Katzenberg et al. 1996). This FRUITS model returned a diet estimate for OxA-30836 of 75.0±11 % breastmilk and 25.0±11 % cereals.

Two alternative models for the chronology of Les Mournouards which account for the possibility of a freshwater reservoir effect in the samples of human bone were constructed. These were identical in form to the models defined in *figures 7–8* and *10–11*, except that an individual calibration curve that accounts for the proportion of fish in their diet has been constructed for each dated individual.

Unfortunately, no measurements of the freshwater reservoir in the waters of the Marne or surrounding area are currently available, and so we have used a generic offset of 500±100 BP. On the basis of the evidence that is currently available, this is probably a reasonable average of the marine offset in the North Atlantic (from which any migratory species are likely to derive) and the local freshwater offset in the Marne and its tributaries (cf. Keaveney / Reimer 2012; Bonsall et al. 2015). This reservoir is used, offset from the atmospheric calibration data-set (Reimer et al. 2013) and the Mix_Curves function of OxCal v4.2 (Bronk Ramsey 2001, amended following Jones / Nicholls 2001).

The individual mixed-source calibration curve for each dated individual incorporates the aquatic reservoir in the proportion suggested by the dietary estimates provided by the FRUITS model for that particular person *(tab. 7)*. So, for example, MAMS-21794 (A2) has been calibrated using a calibration curve including a component of 2±2 % aquatic resources (note that the proportion of any curve is constrained to be 0–100 %). The remainder of diet sources will be in equilibrium with the contemporary atmosphere and these have been calibrated using IntCal13 (Reimer et al. 2013). For OxA-30836, the proportion of breastmilk in this individual (75.0±11.0 %) has been multiplied by the average proportion of fish in the diets of adult females from Les Mournouards (2.0±2.0 %). For the two adult and two adolescent individuals for whom stable isotopic values by IRMS could not be obtained (MAMS-21795, -21799, -21800, -21804), the average proportion of fish in the diets of adult and sub-adult individuals from Les Mournouards (also 2.0±2.0 %) has been employed.

The posterior density estimates for the start and end of burial at Les Mournouards II from the minimal and preferred models and their alternative variants which allow for the possibility of a small component of fish in the diet of the dated human individuals are shown in *figure 15*. Again, these estimates differ not so much in the overall date range covered, as in the balances of probability within them. The estimated dates for when burial began in Les Mournouards II vary only slightly, with the medians of the distribution varying by only a decade or two. The estimated dates for when burial ended in Les

Zone	Sample	Laboratory number(s)	Age	Sex	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰	Cereals	Terrestrial animals	Freshwater fish	'Breast milk'
I	Ms/O 60 A2	MAMS-21794	Adult	-	−20.4 ± 0.20	8.2 ± 0.10	91 ± 7 %	7 ± 6 %	2 ± 2 %	-
I	Ms/O 60 C1a	MAMS-21801	Adult	-	−20.3 ± 0.20	8.3 ± 0.10	90 ± 7 %	8 ± 6 %	2 ± 2 %	-
I	Ms/O 60 C1c	OxA-30839	Adult	-	−20.2 ± 0.20	7.7 ± 0.30	91 ± 6 %	8 ± 6 %	2 ± 2 %	-
I	Ms/O 60 C1d	MAMS-21802	Adult	-	−20.5 ± 0.20	8.3 ± 0.10	91 ± 7 %	8 ± 6 %	2 ± 2 %	-
I	Ms/O 60 C1 X	OxA-30832	Adult	Male	−20.4 ± 0.20	8.7 ± 0.30	86 ± 10 %	12 ± 9 %	2 ± 2 %	-
I	Ms/O 60 D2 I	MAMS-21805	<5, probably <3 years	-	−20.1 ± 0.20	9.3 ± 0.10	85 ± 10 %	13 ± 9 %	2 ± 2 %	-
II	Ms/O 60 A3	OxA-30835	Adult	-	−21.2 ± 0.20	8.1 ± 0.30	90 ± 7 %	8 ± 6 %	2 ± 2 %	-
II	Ms/O 60 A4c	OxA-30836	<2 years	-	−20.2 ± 0.20	10.1 ± 0.30	25 ± 11 %	-	-	75 ± 11 %
II	Ms/O 60 A4d	OxA-32491 / OxA-32492	Adult	-	−19.9 ± 0.14	8.0 ± 0.21	90 ± 7 %	8 ± 6 %	2 ± 2 %	-
II	Ms/O 60 A4e	OxA-32493	Adult	-	−20.5 ± 0.20	7.4 ± 0.30	92 ± 6 %	7 ± 5 %	1 ± 1 %	-
II	Ms/O 60 A4f	MAMS-23886	Adult	-	−20.1 ± 0.20	8.3 ± 0.10	90 ± 7 %	8 ± 7 %	2 ± 2 %	-
II	Ms/O 60 A5	OxA-30837 / MAMS-21798	Adult	-	−20.4 ± 0.14	8.1 ± 0.11	91 ± 6 %	7 ± 5 %	2 ± 2 %	-
II	Ms/O 60 A4 II	OxA-30830	Adult	Male	−19.9 ± 0.20	8.1 ± 0.30	89 ± 7 %	9 ± 7 %	2 ± 2 %	-
II	Ms/O 60 A4 XVII=A4 IX	MAMS-23887	Adult	Female	−19.9 ± 0.20	8.2 ± 0.10	91 ± 6 %	7 ± 6 %	2 ± 1 %	-
IV	Ms/O 60 C3	OxA-30840	Adult	-	−20.8 ± 0.20	8.0 ± 0.30	90 ± 7 %	8 ± 7 %	2 ± 2 %	-
IV	Ms/O 60 D5b	OxA-30841	5–7 years	-	−20.3 ± 0.20	8.2 ± 0.30	89 ± 7 %	9 ± 7 %	2 ± 2 %	-
IV	Ms/O 60 C3 X	OxA-30833	<5, possibly <3 years	-	−20.1 ± 0.20	7.9 ± 0.30	90 ± 7 %	8 ± 7 %	2 ± 2 %	-
IV	Ms/O 60 C4 I	OxA-32495	Adult	-	−19.8 ± 0.20	7.9 ± 0.30	89 ± 8 %	9 ± 7 %	2 ± 2 %	-
IV	Ms/O 60 C5 V	OxA-32496	3–4 years	-	−20.1 ± 0.20	8.0 ± 0.30	90 ± 8 %	9 ± 7 %	2 ± 2 %	-
IV	Ms/O 60 D4 II	OxA-30834	Adult	Female	−21.1 ± 0.20	8.3 ± 0.30	89 ± 8 %	9 ± 7 %	2 ± 2 %	-
III	Ms/O 60 B4	OxA-30838	Adult	-	−20.5 ± 0.20	8.1 ± 0.30	90 ± 7 %	9 ± 6 %	2 ± 2 %	-
III	Ms/O 60 B3 I	OxA-30831	Adult	Female, pregnant	−20.2 ± 0.20	8.4 ± 0.30	87 ± 9 %	11 ± 8 %	2 ± 2 %	-
III	Ms/O 60 B4 I	OxA-32494 / MAMS-23889	5.5–7 years	-	−19.8 ± 0.14	7.9 ± 0.09	92 ± 6 %	7 ± 5 %	1 ± 1 %	-

Tab. 7. δ13C and δ15N values and the results of FRUITS proportional diet modelling. Duplicate analyses of single samples, indicated by multiple laboratory numbers, were combined in a weighted mean for the final isotopic values used in the diet modelling.

Mournouards II are more sensitive to the presence of even small amounts of fish in the diet, with medians of the distributions varying by 50 or 60 years towards earlier endings (and consequently shorter durations)[2].

All the models presented broadly agree in placing the use of Les Mournouards II somewhere between c. 3350 cal BC and c. 3100 cal BC (the probability that it was in use before or after these dates is relatively low in all readings; *figs 9* and *15*). It is improbable that the tomb was used for burial throughout this period *(fig. 13)*, with the balance of probability in the preferred model favouring a shorter duration of a century or less. Our understanding of which generations within this period used the tomb is, however, dependent on the model selected.

Other hypogées in the Paris basin

There are so few radiocarbon dates available for other *hypog*ées in the Paris basin that any interpretation must be tentative. They are listed in *table 8* and shown in *figure 16* together with estimates for the start and end of Les Mournouards from the preferred model *(figs 10–11)*. Four were measured on bulk samples: bone for Les Gouttes d'Or (Gif-2619; *fig. 16*) and for a sample dated soon after the excavation at Mont Aimé II (Ly-5345; *fig. 16*); and charcoal for Saran 7 (Ly-5244; *fig. 16*) and L'Homme Mort (Gif-360; *fig. 16*). All these samples could thus have included material of mixed ages.

Three are recently measured dates on single-entity samples, two for humeri from the base of the burial deposit in each chamber of Mont Aimé II (GrN-28995, -28996; *fig. 16*; Donat et al. 2014) and one for carbonised residue on the interior of a *Néolithique récent* vessel from one of the tombs excavated by the Baron de Baye in the Marais de Saint Gond (Ly-5345; *fig. 16*; Renard et al. 2014). Pending new modern excavations, these are at the moment the best dated contexts for *hypogées* apart from Les Mournouards II. Sepulchral behaviours in Mont-Aimé II remain unpublished but grave goods indicate short use; even if the context of the de Baye excavations is poorly documented, the remains correspond more or less to the date of the associated pot which has to be regarded as contemporary with grave use.

These three, taken together with the estimates for Les Mournouards, point to a currency in the mid to late fourth millennium cal BC, the two dates from Mont Aimé II falling in the second quarter of that millennium (GrN-28995, -29996; *fig. 16*). The four later dates extend to the end of the third millennium cal BC. They are suspect because they were measured on bulk samples. The sample from Saran 7 (Ly-5244; *fig. 16*) came from the access passage and may thus relate to activity at or after the end of the use of the tomb. That from L'Homme-Mort came from between two burial layers which might suggest two episodes of use. The precise context of Ly-5345 from Mont Aimé II is unclear; the artefacts from the tomb belong entirely to the *Néolithique récent* (Donat et al. 2014, 410). The context of Gif-2169 from Les Gouttes d'Or is unknown. It is noteworthy, however, that the excavators envisaged two phases of burial at this tomb, the blocked antechamber being opened up and used for burial after the main chamber had been sealed for some time (Chertier et al. 1994, 38). If this was the case, all or

[2] This is counter-intuitive since accounting for the presence of freshwater reservoir effects in calibration should make the resultant dates *later*. The shape of the calibration curve in this case, however, counteracts this effect as the revised calibrated dates are more compatible with a shorter history for the monument.

Site	Laboratory No.	Material	Context	Radiocarbon age BP	$\delta^{13}C_{AMS}$ (‰)	$\delta^{13}C_{IRMS}$ (‰)	Calibrated date range BC 2σ
Loisy-en-Brie, Les Gouttes d'Or (Marne)	Gif-2169	Unidentified human bones (Delibrias et al. 1982)	Unknown (Chertier et al. 1994; Blin 2011, 162–203)	3690 ± 100	-	-	2460–1770
Marais de Sant Gond, Vase de Baye (Marne)	GrA-30006	Carbonised residue from the interior of a pot of type 2 as defined by Renard et al. (2014, 318, fig. 11: De Baye 9)	Unknown hypogeum excavated by the Baron de Baye in the 19th century	4425 ± 40	?	?	3340–2910
Saran 7 (Loiret)	Ly-5244	Unidentified charcoal	The base of the access passage, at the entrance to the antechamber (Crubézy / Mazière 1991, 134)	3745 ± 115	?	?	2480–1880
Tinqueux, L'Homme-Mort (Marne)	Gif-360	Unidentified bulk charcoal sample (Delibrias et al. 1970)	Layer 6, between two bone deposits (Bailloud / Brézillon 1968, 494, fig. 8)	3910 ± 200	-	-	2920–1880
Val-des-Marais, Mont-Aimé II (Marne)	GrN-28996	Femur of a different individual from that dated by GrN-28995	From the base of the bone deposit, in chamber 1 (1m square B4) (Donat et al. 2014, 409). In this square, some long bones seemed to belong to the same individual (Crubézy / Mazière 1991, 125)	4760 ± 30	?	?	3640–3380
Val-des-Marais, Mont-Aimé II (Marne)	GrN-28995	Femur of a different individual from that dated by GrN-28996	From the base of the bone deposit in chamber 2 (1m squares B10 / C10) (Donat et al. 2014, 409)	4790 ± 30	?	?	3650–3520
Val-des-Marais, Mont-Aimé II (Marne)	Ly-5345	Unidentified human bones (Crubézy / Mazière 1991, 134)	Chambers 1 and 2 (Crubézy / Mazière 1991, 134)	4160 ± 55	?	?	2900–2570

Tab. 8. Radiocarbon dates for *hypogeés* in the Paris basin.

part of the sample for Gif-2169 may have derived from this second use. There are so few radiocarbon dates from *hypogées* that grave goods provide the best indication of chronology for most of them. All the *hypogées* contain material from *Néolithique recent 2*, and none, or hardly any, continue to be used into the *Néolithique final 1* (Blin 2011, 223–225).

Discussion

The results of chronological modelling expand and modify existing hypotheses concerning the functioning of the tomb. The concurrent use of all parts, together with their relative autonomy, evidenced by the virtual absence of anatomical links between them, reinforce the notion of different social groups of some kind as proposed by Leroi-Gourhan et al. (1962, 86) and developed by Blin (2012, 52).

Following the dating programme, we may conclude that:

- The use of the tomb was continuous and relatively brief (up to 265 years and perhaps less than 100 years);
- the unbalanced composition of the disarticulated bones (Blin 2012, fig. 9) shows that large parts of some skeletons were removed;
- the disarticulated bones cannot all derive from an earlier stage than the articulated individuals. The limitations of the record, despite the excellence of the excavation, make it impossible to distinguish between disarticulated bones left behind during the substantial removal of some skeletons and those displaced during the later manipulation of burials from those skeletons which remained articulated, although incomplete, at the time of excavation;
- all the bones of the more recently buried individuals probably remained in the tomb after decomposition, except, probably, for some skulls.

Can the history of Les Mournouards II be applied to all the *hypogées* in the Marne? Here, the very standardised character of *hypogées*, especially their dimensions, prompts the thought that a double *hypog*ée is indeed the equivalent of two *hypogées*; two groups, related in some way, shared the same space without mingling their dead. The short use-life of *hypogées* has often been emphasised; unlike *allées sépulcrales*, they were only rarely used in the *Néolithique final*. The minimum number of 79 individuals represented at Les Mournouards II is at the upper end of the (inexact) estimates for the other *hypogées*. This suggests very short durations in practically all cases. Such a hypothesis leaves open the possibility that small clusters of *hypogées* may correspond to the successive tombs of a single social group or community.

The duration of the *hypogée* phenomenon remains confined to the *Néolithique recent 2* (Salanova et al. 2011), but there is no indication that it occupies the whole of that period; it is rather a matter of a few centuries, as suggested also by the typology of the material culture found in the tombs. Even if they were used successively, the concentration of *hypogées* in the Côte d'Île-de-France seems too important simply to correspond to the communities in the immediate area of the monuments. This concentration could be linked to a catchment extending beyond the local area, with the Côte d'Île-de-France thus appearing as a place with special funerary associations.

How then do these results contribute to a better understanding of both the wider and site-specific questions already raised? At one level, Les Mournouards II is just another collective burial which collects deceased people in line with local mortality, within the wider

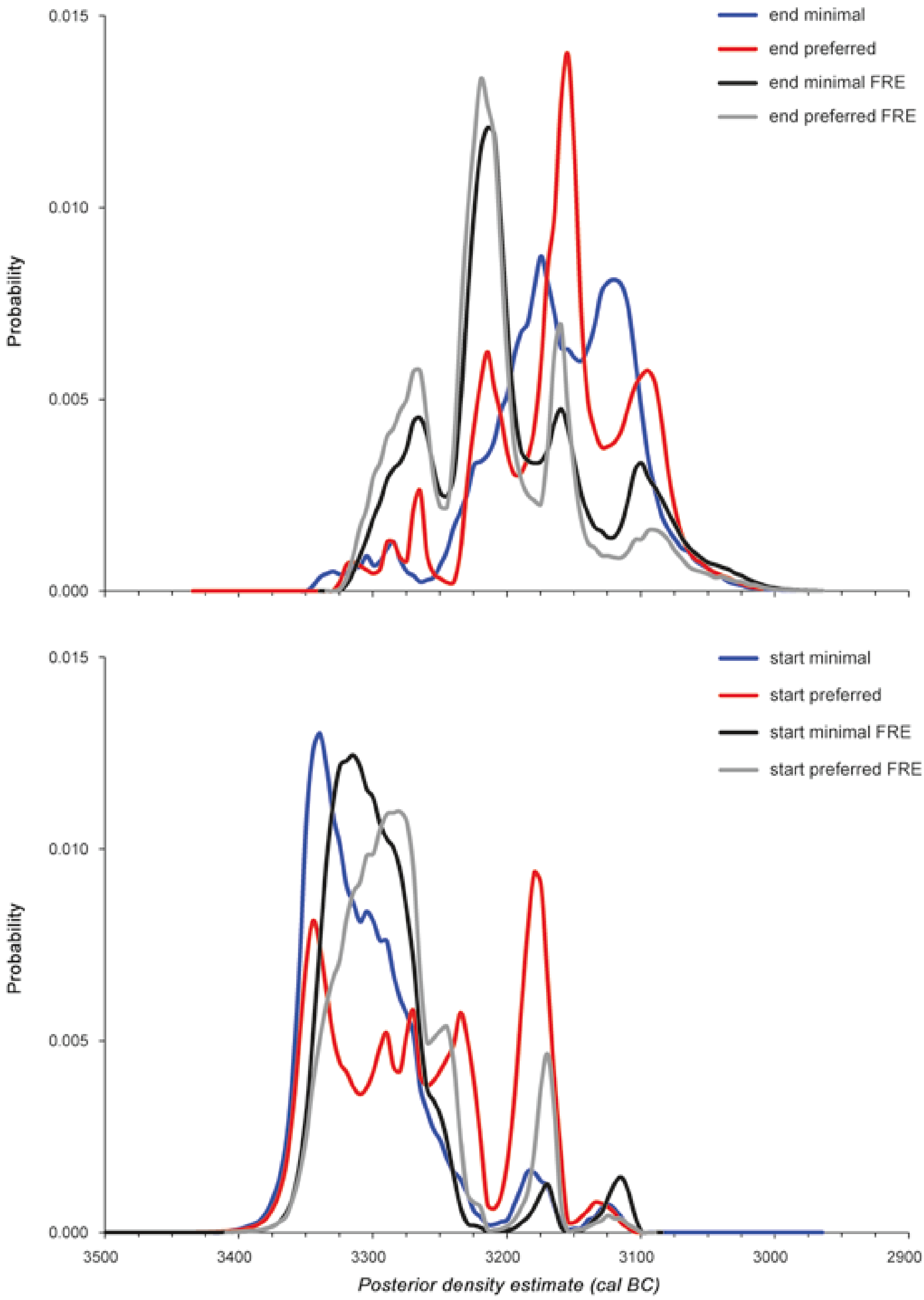

Fig. 15. Posterior density estimates for (below) *'start Les Mournouards II'* and (above) *'end Les Mournouards II'* from the minimal, preferred and freshwater reservoir models discussed in the text.

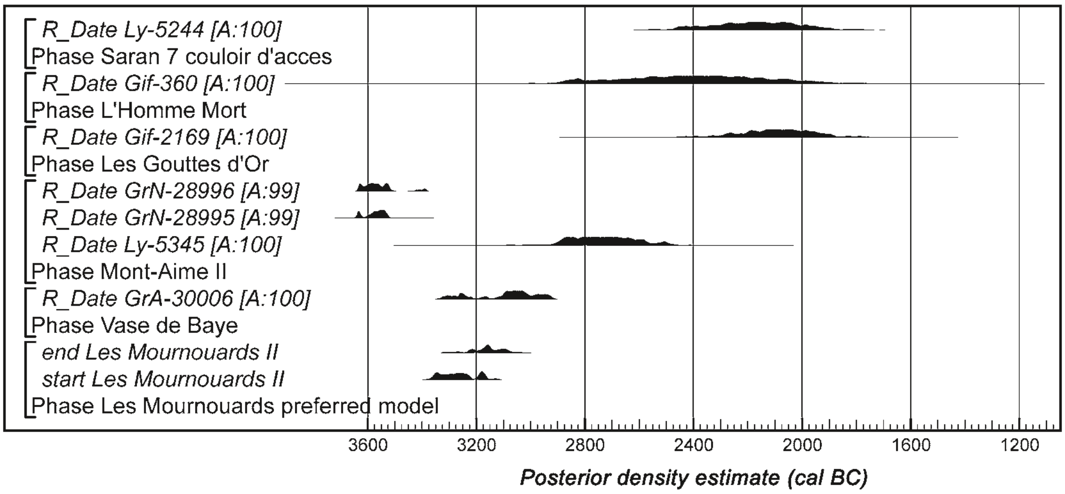

Fig. 16. Probability distributions of radiocarbon dates from *hypogées* in the Paris basin, calibrated using the probability method (Stuiver / Reimer 1993) and IntCal13 (Reimer et al. 2013). Posterior density estimates for Les Mournouards II are derived from the preferred model defined in *figures 10–11*.

phenomenon characteristic of western Europe after c. 3500 cal BC. But literally at another level, one major dimension of the *hypogée* of Les Mournouards II, and of all its comparable neighbours, is that it was underground. This serves to fracture any simple overall categorisation of a single collective burial practice. Divided into different funerary spaces and marked by differences in grave goods (Leroi-Gourhan et al. 1962; Blin 2012), the tomb accommodated several social groups who chose to differentiate themselves in death; collectivity here does not signify uniformity.

There is also the question of the relative brevity of the use of the tomb, in immediate proximity to comparable structures, and in a region with a striking density of similar constructions. A number of factors may be relevant. First, it seems significant to try to relate these mortuary practices to their wider settlement and landscape context. It is fair to say that the settlement record of the *Néolithique récent* is patchy at best (Bostyn et al. 2011; Cottiaux / Salanova 2014); but despite a very imperfect record, we could risk the generalisation that settlement was probably dispersed. Writing on the Lugbara of Uganda and Zaire, John Middleton (1982, 134) commented that "it is reported for many peoples living in small settlements at a low density that one is hardly aware of death", but that seems unlikely to apply here, given the numbers of *hypogées* and *allées sépulcrales*, and perhaps there were increasing concerns in the Paris basin and widely elsewhere in the later fourth millennium cal BC about land and numbers of people. Drawing on a better documented region, though some distance to the north, it has been argued, on the basis of pollen diagrams and monument trajectories, that the second half of the fourth millennium cal BC in northern Germany was a time of agricultural intensification (Hinz et al. 2012; Hinz 2014, fig. 1), and perhaps something of the same applied in the Paris basin and elsewhere at this time. Now it was commonplace in processual archaeology to apply generalised ideas, such as the Saxe-Goldstein Hypothesis 8, about the links between formal disposal areas, scarce or vital resources and the existence of corporate descent groups (reviewed in Morris 1991), or the notion of territorial markers (Renfrew 1979). It could be that something of both ideas could be applied to the situation of the *hypogées* in the later fourth millennium cal BC. On the basis of that rather universal logic, such numbers of tombs with varying but probably in some sense corporate groups buried in them could speak strongly to concern over resources and land.

But here we should emphasise differences between the circumstances of the generally dispersed *allées sépulcrales* and the concentrated *hypogées*, since the character and placing of tombs may relate to how the land round about was perceived. In the case of the *hypogées*, there is a strong sense of connectivity at multiple levels: within a tomb like Les Mournouards II, within local cemeteries and within the Côte d'Île-de-France concentration of tombs as a whole. Apart from the shorter use of *hypogées* compared to *allées sépulcrales*, differences remain in the concentration in cemeteries and in the underground nature of the *hypogées*. How far that reflects real difference is a difficult question, since the chalk of Champagne makes it possible to carve out elaborate underground spaces, in a way impracticable in the subsoils elsewhere in the Paris basin. On the other hand, the plans of *allées sépulcrales* are not categorically different; they always have an access ramp to the partially dug-in structure, an antechamber and an elongated main funerary chamber. Differences in architecture are to some extent a matter of degree. By contrast, the differences in location and concentration are absolute.

It is obvious that the chalk of the Côte d'Île-de-France gave a good opportunity for this kind of construction. However, such a concentration implies that communities moved outside their daily surroundings to set up a tomb and then to bury the dead. That means another perception of territory, if compared to the more dispersed pattern of *allées sépulcrales*. Mobility has also to be questioned. Even without a large-scale organisation, groups that shared the same location for their dead – the same cemetery but also the same natural barrier that is the Côte d'Île-de-France – must have had a strong consciousness of belonging to the same community.

Further grasping the origins, life histories and relationships of individuals, chamber by chamber and tomb by tomb, would require an ambitious programme of isotopic, discrete trait and aDNA analyses in the future. It is not a given that the mortuary population within Les Mournouards II was entirely local, and the possible groupings within it could be read in several ways. They are presumably intimately linked, but whether through lineage segments, local alliances or some kind of bilateral descent group is obviously hard to call. It can be noted, however, that bilateral groups often appear to dissipate more quickly than in other descent systems, over only three to four generations (Foxhall 1995; Forbes 2007, 136–141), and that at least would be compatible with a shorter rather than longer chronology for the uses of Les Mournouards II and other *hypogées* in the Paris basin.

Further, but at a general level of speculative interpretation that could apply to both *hypogées* and *allées sépulcrales*, the numbers of dead assembled over a potentially short span of generations could also be seen as a celebration of the unity and the cohesion of the community, essential for the tenure of place, and conversely as a counter to the fear of dispersal of the assets of the community which are recurrent features of funerary rites in many cultures observed by anthropologists (Bloch / Parry 1982b, 18–21; Bloch 1982, 212–213; 218–219; Metcalf / Huntingdon 1991, 108). If the relative uniformity in death emphasises that the destiny of the dead is mainly equal, the *hypogées* bring out some slight differences between both kinds of tombs. In Les Mournouards II specifically, there is clear evidence for differentiation between males and females, with dead women placed mainly on the left side of the tomb and associated with what are considered to be less individual grave goods (Blin 2015, 590–592). Is it just coincidence that the last near-complete corpse in the central passage, B3 I, was that of a heavily pregnant woman? A triangle of women, birth and death marked and perhaps determined the end of the use of the tomb. It must be correlated, in some way, with what is pure or impure regarding the afterlife and its part in the maintenance of community in the 34th and 33rd centuries cal BC.

Future possibilities

The short use-life of the Marne *hypogées* has often been asserted; unlike *allées sépulcrales*, they are only exceptionally used in the *Néolithique final* (Vander Linden / Salanova 2004). The number of individuals buried at Les Mournouards is among the largest of the estimates (which do not exceed a few dozen people) for other *hypogées* which could indicate short use-lives in practically all cases. Such a hypothesis leaves open the possibility that small clusters of these monuments at places like Les Mournouards may consist of the successive tombs of the same group, whereas real cemeteries like Razet at Coizard could mix this kind of continuity with the convergence of separate communities in the same place. The overall duration of the *hypogée* phenomenon remains unknown. It is confined to the *Néolithique récent*, but there is no evidence that it spans this whole period; that this was a particular historical episode or horizon seems to us likely, but it will be for future research to establish that more firmly. To define who is involved it appears essential to compare populations within a cluster or cemetery in terms of age and sex composition, activities, genetic links and kinship rules. Continuity and discontinuity in the use of the tombs and of the cemeteries are key points for future investigations. The dating of a whole cemetery should be a priority, but the nature of the archives and modern realities (the distribution of *hypogées* in the Côte d'Île-de-France coincides with the cultivation of vines for the production of champagne) make this unlikely in the short term. It will also be for future research to refine and calibrate but also differentiate with much greater precision the claim made here that large collectivities of the dead were a widespread and significant feature of the later fourth millennium cal BC.

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Abstract: Collecting the dead: temporality and disposal in the Neolithic hypogée of Les Mournouards II (Marne, France)

Why were large collectivities of the dead a widespread feature of the later fourth millennium cal BC in western Europe? The *hypogée* or artificial cave of Les Mournouards II in the Marne region, northern France, where remains of 79 people were deposited in two chambers, is used to address this and related questions. Bayesian modelling of 29 newly obtained radiocarbon dates places the construction of the tomb in the 34th or 33rd centuries cal BC, with a use-life which could be as little as 100 years. The results indicate that the two chambers were used concurrently, distinctions between them being attributable to their use by different social groupings, as hypothesised by the excavator, André Leroi-Gourhan. The probably short life of this tomb suggests that clusters of *hypogées* in general could reflect the use of successive tombs by the same groups. The character of the tomb is discussed in general terms of anxieties about territory and numbers of people, threats of dispersal and the maintenance of community. Diversity within collective burial practices in the Paris basin is examined, and a series of specific differences between *hypogées* and *allées sépulcrales* are explored.

Zusammenfassung: Die Toten vereinen: Temporalität und Organisation des neolithischen Hypogäums von Les Mournouards II (Marne, France)

Warum waren große Kollektivitäten von Toten ein weitverbreitetes Merkmal im Westeuropa des späten 4. Jahrtausends cal BC? Anhand des Felskammergrabs von Les Mournouards II in der Marneregion im nördlichen Frankreich, in dem die Überreste von 79 Menschen in zwei künstlichen Kammern niedergelegt wurden, wird auf diese und weitere Fragen eingegangen. Mittels Bayes'scher Statistik von 29 neu gewonnenen Radiokarbondaten kann die Erbauung des Grabes ins 34. oder 33. Jahrhundert cal BC datiert werden, wobei seine Belegungszeit vielleicht nur 100 Jahre umfasste. Die Ergebnisse deuten an, dass die beiden Kammern zeitgleich benutzt wurden und dass erkennbare Unterschiede zwischen beiden das Resultat ihrer Nutzung durch unterschiedliche soziale Gruppierungen sein können, wie es bereits der Ausgräber André Leroi-Gourhan annahm. Die wahrscheinlich kurze Lebensdauer dieses Grabes legt die Annahme nahe, dass Gruppen von Hypogäen grundsätzlich die zeitlich aufeinanderfolgende Nutzung von Gräbern durch die gleiche soziale Gruppe reflektieren. Die Bedeutung des Kollektivgrabes wird verknüpft mit territorialen Fragen und mit der Aufrechterhaltung der Gemeinschaft und der Festigung der Gruppenkohäsion angesichts der Gefahr der Zersplitterung. Die Diversität von Praktiken kollektiver Bestattungen im Pariser Becken wird untersucht und eine Reihe von spezifischen Unterschieden zwischen Hypogäen und Galeriegräbern (*allées sépulcrales*) wird herausgestellt.

Résumé: La gestion des morts: temporalité et organisation de l'hypogée néolithique des Mournouards II (Marne, France)

Pourquoi les communautés d'Europe de l'ouest à la fin du IVe millénaire rassemblent-elles leurs morts au sein de sépultures collectives? Cette question est analysée sous le prisme de l'hypogée (ou grotte artificielle) des Mournouards II (Marne, France) où 79 individus ont été inhumés dans deux chambres. La modélisation bayésienne de 29 nouvelles dates place la construction de la tombe durant le 34e ou le 33e siècle avant J.-C., avec une durée d'utilisation qui n'excède peut-être pas 100 ans. Les deux chambres ont été utilisées conjointement, l'utilisation par deux groupes sociaux expliquant les différences, comme l'avait déjà envisagé le fouilleur, André Leroi-Gourhan. La probable courte durée de la tombe suggère que les petits groupes d'hypogées peuvent correspondre à des usages successifs par les mêmes groupes. Par l'affirmation de la cohésion du groupe dans la mort, la tombe collective peut apparaître comme une réponse à la crainte d'une dispersion liée à un accroissement de la taille de la communauté. Enfin la diversité des pratiques funéraires dans le Bassin parisien est examinée, et les spécificités des hypogées en regard des allées sépulcrales sont soulignées.

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Fig. 1, 5–16: Authors. – *Fig. 2:* Leroi-Gourhan et al. 1962, fig. 6. – *Fig. 3:* Leroi-Gourhan et al. 1962, fig. 54. – *Fig. 4:* Blin 2011, fig. 46; 2012, fig. 7.