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Mid-to-late Marine Isotope Stage 3 mammal faunas of Britain: a new look

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ABSTRACT

Conscious of the difficulty of reliably dating Pleistocene-age bone we re-examine the British record of radiocarbon-dated fauna from mid-to-late Marine Isotope Stage (MIS) 3 and early MIS 2, largely known from carnivore accumulations at cave sites. Although the data does not allow for firm conclusions, some observations can be made. An apparent dearth of remains c. 39 ka cal BP may reflect environmental deterioration during Greenland Stadial 9. A last occurrence of hyaena shortly before 35 ka cal BP is earlier than that proposed previously, and their extirpation probably helps to explain a paucity of dated remains <34 ka cal BP; however, we do not confidently rule out their presence 32–31 ka cal BP. The records of hyaena and wolf raise the possibility that their ranges were partially separate, with wolf thriving when climatic downturns brought greater snow-cover. From 34 ka cal BP a more restricted range of taxa is attested. This change coincides with climatic deterioration observable in ice-core and terrestrial records.

1. MIS 3 Britain: mammal faunas and problems of chronology

Marine Isotope Stage (MIS) 3, c. 59–29 ka cal BP,[1] was the warmer middle part of the Last Glacial period, and encompassed numerous short-term and now well-defined climatic oscillations (Voelker, 2002; Rasmussen et al., 2014). Although the environmental record of MIS 3 Britain is insufficient to observe the impact of these short-term fluctuations, evidence generally points to a landscape dominated by open steppic grasslands, with sedges, woody shrubs, herbaceous plants and dwarf trees. Rich faunal assemblages – particularly cave accumulations thought to largely result from carnivore activity – demonstrate that for at least parts of MIS 3 these environments supported a substantial large-mammal biomass (Aldhouse-Green et al., 1995; Currant and Jacobi, 2001, 2011; Turner, 2009; Pettitt and White, 2012; Scott, 2012; Schreve et al., 2013). Unlike regions farther south, limited MIS 3 human occupation (Jacobi and Higham, 2011; Pettitt and White, 2012; Dinnis, 2015) means that humans played an insignificant role in the accumulation of animal remains in British caves (Turner, 2000; Currant and Jacobi, 2011).

The mammal faunas of MIS 3 Britain have been assigned to the Pin Hole 'Mammal Assemblage-Zone' (MAZ) (Currant and Jacobi, 2001, 2011; Table 1), after the contents of the Lower Cave Earth at Pin Hole, Creswell Crags (Derbyshire). With some variation (see Table 1) similar faunas have been found at MIS 3 sites across Britain, although Currant and Jacobi (2011) were careful to note that Pin Hole's Lower Cave Earth belongs to the earlier part of MIS 3, ≥c. 44 ka cal BP (≥c. 40 ka ^{14}C BP) (Jacobi et al., 1998, 2006; Higham et al., 2006). They and others have also noted the lack of clear stratigraphic patterning within the Pin Hole Lower Cave Earth, as well as more generally at British MIS 3 sites, and that the Pin Hole MAZ represents a long period encompassing numerous stadial and interstadial events (Currant and Jacobi, 2001, 2011; Pettitt and White, 2012: 317–318, 377; Schreve et al., 2013: 124; see also discussions by Stewart et al., 2003; Stewart, 2005). In this regard the British record differs from that of Belgium, which is the most frequent source of comparisons for the British MIS 3 archaeological record (by e.g. Campbell, 1980; Jacobi, 2007; Dinnis, 2012; Pesesse and Flas, 2012). The cave site of Grotte

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[1] All uncalibrated radiocarbon ages (including individual radiocarbon dates) are presented as "^{14}C BP", and all calibrated ranges/dates as "cal BP". Ages have been calibrated against the IntCal13 curve using OxCal version 4.2 (Bronk Ramsey, 2009; Reimer et al., 2013). For dates for Greenland interstadial/stadial events taken from the INTIMATE event stratigraphy the unit b2k is used, indicating years before 2000 AD. Such dates are subject to maximum counting errors due to their basis in the Greenland ice core chronologies (see Blockley et al., 2012; Rasmussen et al., 2014).

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Table 1
Mammal fauna from the Pin Hole Lower Cave Earth, constituting the Pin Hole MAZ of Currant and Jacobi (2011: 171). Although red deer and Arctic fox are absent from the Pin Hole Lower Cave Earth, the former species occurs at MIS 3 sites in southern Britain and the latter in MIS 3 deposits at Ash Tree Cave (Derbyshire) (Currant and Jacobi, 2011: 172).

Lepus timidus (Linnaeus, 1758)	Arctic hare
Spermophilus major (Pallas, 1779)	Red-cheeked suslik
Canis lupus (Linnaeus, 1758)	Wolf
Vulpes vulpes (Linnaeus, 1758)	Red fox
Ursus arctos (Linnaeus, 1758)	Brown bear
Mustela erminea (Linnaeus, 1758)	Stoat
Mustela putorius (Linnaeus, 1758)	Polecat
Crocuta crocuta (Erxleben, 1777)	Spotted hyaena
Panthera leo (Linnaeus, 1758)	Lion
Mammuthus primigenius (Blumenbach, 1799)	Woolly mammoth
Equus ferus (Boddaert, 1785)	Wild horse
Coelodonta antiquitatis (Blumenbach, 1799)	Woolly rhinoceros
Megaloceros giganteus (Blumenbach, 1799)	Giant deer
Rangifer tarandus (Linnaeus, 1758)	Reindeer
Bison priscus (Bojanus, 1827)	Bison

Walou (Liège Province) contains a comparatively well-stratified and recently studied MIS 3 sequence of palaeontological and archaeological material (Draily, 2011; Draily et al., 2011; Pirson et al., 2011).

Due to the absence of any site equivalent to Grotte Walou, diachronic faunal change in MIS 3 Britain has largely been investigated via radiocarbon-dated remains. The difficulty of radiocarbon dating MIS 3-age bone is now well established (e.g. Damblon et al., 1996; Pettitt et al., 2003; Bronk Ramsey et al., 2004; Higham et al., 2006; Jacobi et al., 2006; Jacobi and Higham, 2008; Higham, 2011; Marom et al., 2012, 2013). The presence of even very small amounts of exogenous modern carbon is a major problem, rendering radiocarbon ages for MIS 3 material artificially young, sometimes by several thousand years (Higham et al., 2006; Jacobi et al., 2006; Higham, 2011). Bones coated in preservatives can be particularly difficult to date accurately (Jacobi and Higham, 2008; Marom et al., 2012, 2013). To address these issues the Oxford Radiocarbon Accelerator Unit (ORAU), which has carried out the majority of dating of British MIS 3 material, updated its pre-treatment protocols from 2000. Most notably this included incorporation of an ultrafiltration step shown to be more effective at removing exogenous carbon (Bronk Ramsey et al., 2004). The result has been an increase in the reliability of dates produced (Higham et al., 2006; Jacobi et al., 2006). The problem of exogenous modern carbon besets the corpus of dates for British MIS 3 fauna. Our searches suggest that at least 60% of currently published dates ≥20 ka ^{14}C BP were produced by the ORAU prior to the implementation of the new methods, and it is now apparent that many are erroneously young. Table 2 details bones ≥20 ka ^{14}C BP (≥c. 23.5 ka cal BP) dated both prior to and following the changes in pre-treatment protocol; when dated again, 63% ($n = 27$ of 43) of these specimens produced radiocarbon ages more than one standard error older. Although some specimens in Table 2 were specifically selected for re-dating due to their surprisingly young radiocarbon ages, the implications for all published MIS 3 bone dates from ORAU are clear. In acknowledgment of these problems, recent considerations of MIS 3 fauna have either relied more heavily on recently produced dates or have been careful to explain the potentially problematic nature of the data from which conclusions are drawn (Jacobi et al., 2009; Currant and Jacobi, 2011: 172; Jacobi and Higham, 2011; Pettitt et al., 2012: 301–303; Pettitt and White, 2012: 8–9; Stuart and Lister, 2012, 2014; Aldhouse-Green et al., 2015: 85–86).

These studies have generally fallen into two categories: those primarily concerned with extirpation/extinction of individual taxa at the national/international scale (e.g. Stuart and Lister, 2007, 2011, 2012, 2014; Jacobi et al., 2009; Jacobi and Higham, 2011: 187) and those examining changes to regional/national faunal communities through time (e.g. Pettitt, 2000; Pettitt and White, 2012: 317–324, 376–381; Pettitt et al., 2012; Aldhouse-Green et al., 2015: 86–88). With their comparatively rich assemblages and multiple radiocarbon dates, Welsh cave sites have featured heavily, particularly Paviland and Pontnewydd (Upper Breccia unit). Overall, from a reading of these studies, a lack of consensus is apparent. The reader is referred to the sources for details of their conclusions, but the main observations in recent publications can be summarised as:

- the extirpation of woolly rhino c. 35 ka cal BP (Jacobi et al., 2009; Stuart and Lister, 2012);
- the extirpation of hyaena from c. 31 ka cal BP (Jacobi and Higham, 2011: 182; Stuart and Lister, 2014; see also Turner, 2009: 1002; Pettitt and White, 2012: 379);
- an increase in taxa/diversity and the appearance of a “mammoth steppe community” at c. 41 ka cal BP and again at c. 33 ka cal BP, based in the main on evidence from Paviland and Pontnewydd caves (Pettitt et al., 2012: 318–319; Pettitt and White, 2012: 378–379);
- the co-existence of wolves and hyaenas at Paviland Cave c. 32 ka cal BP (Pettitt and White, 2012: 379; see also Aldhouse-Green et al., 2015: 88; Turner, 2009: 1002);
- a faunal restructuring around 30 ka cal BP as environments deteriorated into the Last Glacial Maximum (LGM), with the appearance of Currant and Jacobi's (2011: 173) taxonomically restricted Dimlington Stadial MAZ (Table 3), and a dearth of fauna after 30 ka cal BP at Pontnewydd and Paviland caves (Pettitt and White, 2012: 379).

2. Materials and methods

In order to reconsider the mid-to-late MIS 3 British faunal record we compiled a dataset of radiocarbon-dated remains from 45–20 ka ^{14}C BP (c. 49–23.5 ka cal BP), all produced at ORAU and all from published sources. Despite universal acceptance of the difficulty of dating MIS 3 bone, there is still no agreement over how dates should be selected and screened (see references above). We took a stricter approach than previous studies, our rationale being that we would prefer to lose three valid dates than risk including one potentially erroneous date.

Although it is likely that many are accurate, all dates produced prior to the implementation of ORAU's new pre-treatment protocols were excluded, as were dates post-dating the new protocols but produced on filtered (rather than ultrafiltered) gelatin. We also excluded specific ultrafiltered dates over which concerns had been expressed in print regarding the presence of preservatives. Details of these exclusions are given in the Supplementary Information (SI Table).

Unlike others (e.g. Jacobi and Higham, 2011; Stuart and Lister, 2014) we have excluded dates from sites on Caldey Island (Potter's Cave, Ogof-yr-Ychen, Nanna's Cave, Eel Point Cave), as we have concerns over the curation of bones from these sites. A note by Nédervelde and Davies (1975: 3) indicates that faunal collections from Caldey's sites were heavily conserved:

> Bones in stalagmite are usually very hard and in such good condition that they need only be air-dried and varnished before storage... The best varnish seems to be the woodworkers (*sic*) “Ronseal” as it soaks into the bone, strengthens it, and gives a pleasing shiny finish from which dust is later easily removed. Bones from air spaces such as those under boulders, or from cavities under stalagmite floors, are usually soft and friable.