

# RADIOCARBON DATING OF EUROPEAN BEAVER (*CASTOR FIBER* L. 1958) FROM GOUGH'S CAVE PROVIDES EVIDENCE OF POPULATION PERSISTENCE OVER THE YOUNGER DRYAS IN BRITAIN.

by

MELISSA MARR

## ABSTRACT

Rapid changes in climate have been shown to be strong drivers of biological evolution and the abrupt fluctuations between warm and cold periods observed over the Pleistocene-Holocene boundary are hypothesised to have had profound effects on mammal populations. In order to investigate the persistence of a typical warm-stage taxon, the Eurasian beaver (*Castor fiber*), in Britain over the Younger Dryas cold phase two specimens from the University of Bristol Speleological Society Museum (UBSSM) were radiocarbon dated. Age estimates of 12,386-11,836 cal BP and 11,989-11,405 cal BP suggest that beavers did indeed survive this brief cold phase in south-west England. These results suggest that Gough's Cave functioned as a micro-refugia for this species and represent the oldest directly dated beaver remains from Britain.

## INTRODUCTION

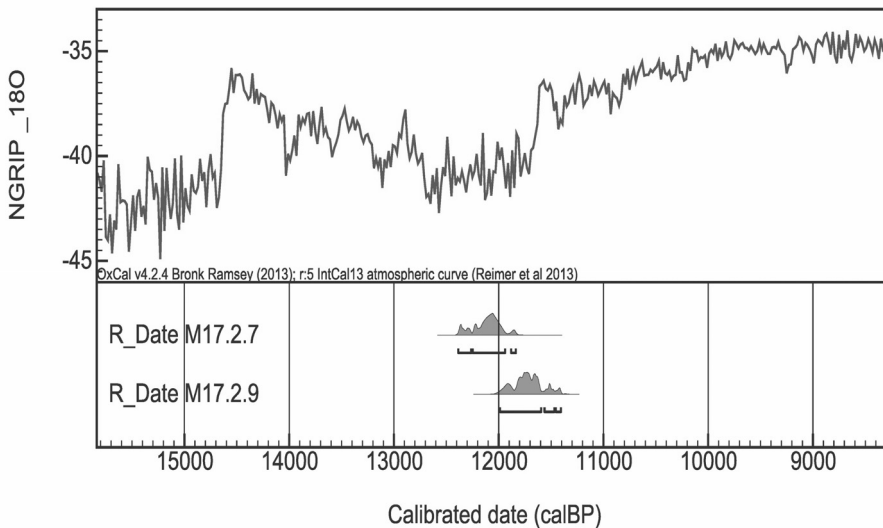
Abrupt fluctuations in climate are known to be drivers of profound ecosystem change which is strongly associated with range shifts, local extirpations and adaptive evolution in mammal populations (Hewitt, 2004). In particular the Pleistocene-Holocene boundary is characterised by a series of rapid, millennial-scale climatic fluctuations that had profound effects on biota, as observed in the vegetation, invertebrate and vertebrate records for this period. Britain is well-placed to examine questions of timing, patterns and process of post ice-age recolonisation over the Pleistocene-Holocene boundary due to *i*) its sensitivity to climate on account of its proximity to the North Atlantic, *ii*) its exceptional fossil record and *iii*) its geography, being formerly connected to the European mainland via a large contiguous landbridge, Doggerland. The locality of Gough's Cave, in the south-west of England, makes it a particularly interesting site with which to investigate recolonisation routes from mainland Europe prior to the drowning of Doggerland.

As part of a larger PhD project looking at mammalian recolonisation of Britain after the Last Glacial Maximum (LGM; *c.* 26,500-19,000 cal BP) Eurasian beaver (*Castor fiber*) remains from the collection at the University of Bristol Speleological Society Museum (UBSSM) were sampled for both ancient DNA and radiocarbon dating. The Eurasian beaver is a woodland specialist and typical warm-stage taxon which was widespread and ubiquitous during warm phases of the Pleistocene and into the Holocene (Coles, 2006). Its strong association with temperate woodland habitat suggest that beaver populations may have suffered declines, changes in distribution and/or local extinctions during cold phases. Beavers likely recolonised Britain at the commencement of the Lateglacial Interstadial (*c.* 14,500 cal BP) but it is unknown whether they survived the subsequent Younger Dryas cold phase (*c.* 12,900 cal BP) and also what the geographic origins of the British Holocene populations were. To investigate the alternative scenarios of population continuity or population replacement over the Younger

Dryas in Britain, radiocarbon evidence from these key Gough's Cave specimens was used to help reconstruct the history of the beaver in Britain.

## METHODS AND RESULTS

Around 0.5g of bone was sampled from specimen M17.2.7 (right maxilla) and M17.2.9 (right hemi-mandible). These were part of the 1958 excavation of Gough's Cave which explored the portion of the cave "under the arch of the entrance and inwards past the Cave Man Rift" ([http://www.ubss.org.uk/resources/catalogues/M23\\_catalogue.pdf](http://www.ubss.org.uk/resources/catalogues/M23_catalogue.pdf)) and may represent skeletal elements of the same individual. Specimen M17.2.9 was previously dated by Roger Jacobi in 1987 (Hedges, *et al.* 1987) returning an Early Holocene date of 11,068-10,957 cal BP (OxA 1,119). It was decided to re-date this specimen due to subsequent improvements in chemical pre-treatment and the introduction of ultrafiltration. Results returned a date range for M17.2.7 of 12,386-11836 cal BP (OxA 33,526) and 11,989-11405 cal BP for M17.2.9 (OxA 33,526; Figure 1) placing these specimens in the Younger Dryas cold phase with a probability limit extending into the Early Holocene.



**Figure 1.** Radiocarbon age estimates for samples M17.2.7 and M17.2.9.

These findings are extremely significant for several reasons. Firstly, the dates strongly suggest that a population of beavers persisted in south-west England well into the Younger Dryas cold phase and possibly into the Holocene. This supports a hypothesis of population continuity over the Younger Dryas and indicates that the Gough's Cave area functioned as a 'micro-refugia' for this species and possibly other species of temperate-adapted mammals. Extant beavers have been observed surviving in the far north of Scandinavia in areas where ice-cover persists for up to 7 months of the year (Rosell and Pederson, 1999) so the species presumably has a high tolerance for sub-optimal conditions. Secondly, if the Gough's Cave

population survived into the Holocene it is likely that it expanded and dispersed throughout the UK as the climate ameliorated. Therefore, this population may have made a significant contribution to the Early Holocene recolonisation of the UK. Beavers suffered catastrophic population declines throughout Eurasia in the Late Holocene due to human persecution and became extinct in Britain by the 1500's (Manning, *et al.* 2014). Current conservation efforts to reintroduce the species seek to determine the most genetically similar extant source population to the original British population in order to comply with the guidelines set by the International Union for the Conservation of Nature (IUCN). Determining the Early Holocene source population for Britain could make a significant contribution to this. Finally, the discrepancy between the original 1987 radiocarbon date for specimen M17.2.9 (11,068-10,957 cal BP; Hedges, *et al.* 1987) and the older one obtained in this project (11,989-11405 cal BP) highlight the possibility of modern contamination producing erroneously young age estimates in samples dated before the introduction of ultrafiltration.

### FUTURE WORK

Both of the specimens sampled here have also generated ancient mitochondrial DNA for the Control Region locus. They will be combined in a database with aDNA from other ancient British Holocene beavers from a range of sites. This data will be used to reconstruct the Late Pleistocene – Holocene phylogeny of this species in Britain and provide insights into how the species responded to rapid climatic fluctuations over this period as well as informing conservation planning.

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Melissa Marr  
Dept. of Earth Sciences  
Natural History Museum, London  
SW7 5BD  
melissa.marr@nhm.ac.uk