JOURNAL OF QUATERNARY SCIENCE (2006) **21**(1) 3–8

Published online 10 October 2005 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/jqs.960

New evidence for the occurrence of Eurasian lynx (*Lynx lynx*) in medieval Britain

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Hetherington, D. A., Lord, T. C. and Jacobi, R. M. 2005. New evidence for the occurrence of Eurasian lynx (*Lynx lynx*) in medieval Britain. *J. Quaternary Sci.*, **Vol. 21** pp. 3–8. ISSN 0267–8179.

Received 16 May 2005; Revised 27 June 2005; Accepted 29 June 2005

ABSTRACT: The presence of Eurasian lynx as a former native species in Britain during the Holocene is known from bones recovered from several sites. AMS radiocarbon dating of lynx bone recovered from two sites in the Craven area of northern England gave 1842 ± 35 ^{14}C yr BP and 1550 ± 24 ^{14}C yr BP, together representing the youngest dates for lynx from England, and in the case of the latter, the youngest for Britain as a whole. These dates support the view that the game animal whose occurrence in the nearby Lake District is described in the early 7th century Cumbric text *Pais Dinogad*, and whose translation to date has been problematic, is a lynx. The occurrence of lynx in early medieval Britain shows that earlier periods of climate change, previously blamed for the species' extinction in Britain, were not responsible. Instead, anthropogenic factors such as severe deforestation, declining deer populations, and persecution, are likely to have caused the extirpation of lynx in Britain. Consequently, the lynx qualifies as a candidate for reintroduction. Large-scale reafforestation, the growth of deer populations, and more positive attitudes towards carnivores in modern society, could permit the restoration of lynx to Britain, particularly in Scotland. Copyright © 2005 John Wiley & Sons, Ltd.

KEYWORDS: lynx; extinction; extirpation; deforestation; Cumbric.

Introduction

The past occurrence of Eurasian lynx *Lynx lynx* in Britain is known from their bones found at various cave sites (Table 1 and Fig. 1). However, like the wolf *Canis lupus* and the brown bear *Ursus arctos*, the lynx is no longer part of the wild fauna of Britain. Previous theories on the causes of lynx extinction in Britain have focused on natural processes, such as climate change (Curry-Lindahl, 1951; Guggisberg, 1975; Clutton-Brock, 1991) or fluctuations in mountain hare *Lepus timidus* populations (Perry, 1978). Jenkinson (1983), however, suggested that early deforestation had brought about the extinction of the lynx by the end of the Mesolithic period, around 5000 ^{14}C yr BP.

The Eurasian lynx is the largest of the four extant lynx species and differs from the other three by feeding primarily on small ungulates. Today, the species has a very broad geographical range, occurring from western Europe to the Pacific coast of Siberia, and from the Arctic tundra north of 70° to the mountains of the Middle East and the Himalayas (von Arx *et al.*, 2004). Such a broad range suggests that, in common with many large carnivores, the Eurasian lynx does not appear to be particularly sensitive to climatic variation. Furthermore, throughout much of its range, roe deer *Capreolus* sp. are the principal prey of lynx (Jedrzejewski *et al.*, 1993; Okarma *et al.*, 1997; Jobin *et al.*, 2000). European roe deer *Capreolus capreolus* have been present in Britain since the early Holocene (Yalden, 1999), and so it is unlikely that fluctuations in mountain hare populations would have brought about large perturbations in lynx populations. Unlike cursorial predators such as wolves, lynx rely on cover to get close enough to their prey to launch an ambush attack. Although lynx are known to hunt amongst rocks and scrub on Central Asian mountainsides, a feeding strategy across Europe and Siberia reliant on roe deer and the provision of cover means that woodland is the core habitat for Eurasian lynx there (Jedrzejewski *et al.*, 1993; von Arx *et al.*, 2004). It is likely then that the fate of lynx in Britain was closely tied to that of its forest habitat and the ungulate prey found within that habitat.

The limited number of radiocarbon dates on lynx bones suggest that lynx were part of the fauna of Britain only when suitable woodland habitat was available (Coard and Chamberlain, 1999). The earliest radiocarbon date in Britain comes from Gough's Cave, Mendip, Somerset. This date of $12\,650 \pm 120$ ^{14}C yr BP (OxA-3411) indicates that lynx inhabited southern Britain during the early part of the Late Glacial Interstadial (Hedges *et al.*, 1994), a warm phase which lasted from around 13 000–11 000 ^{14}C yr BP. The increased temperatures and low sea levels of this period would have permitted the colonisation of southern Britain by both birch woodland and lynx, across a land bridge from continental Europe. The avifauna represented

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Table 1 Sites where lynx bones have been reported in Britain, with radiocarbon dates where available. Lynx bone has also been recovered from Kilgreany Cave, County Waterford, Ireland and has been radiocarbon dated to 8875 ± 70 ^{14}C yr BP (Woodman *et al.*, 1997)

Site	County	Period	Radiocarbon date	Reference
Kinsey Cave	North Yorkshire	Historic	1550 ± 24 BP	This paper
Reindeer Cave	Sutherland	Historic	1770 ± 80 BP	Kitchener & Bonsall (1997)
Moughton Fell Cave	North Yorkshire	Historic	1842 ± 35 BP	This paper
Kitley Shelter Cave	Devon	Flandrian	8930 ± 90 BP	Coard and Chamberlain (1999)
Dog Hole Fissure	Derbyshire	Flandrian	9570 ± 60 BP	Bronk Ramsey *et al.* (2002)
Gough's Cave	Somerset	Late Glacial	12 650 ± 120 BP	Hedges *et al.* (1994)
Aveline's Hole	North Somerset	—	—	Davies (1921)
Beeston Tor	Staffordshire	—	—	Jackson (1926)
Bone Cave	Sutherland	—	—	Horne (1891)
Brown Scar Cave	North Yorkshire	—	—	T. C. Lord (unpublished)
Cales Dale Cave	Derbyshire	—	—	Storrs Fox (1906)
Gop Cave	Denbighshire	—	—	Jackson (1913)
Greater Kelco Cave	North Yorkshire	—	—	Jackson (1938)
Jubilee Cave	North Yorkshire	—	—	T. C. Lord (unpublished)
Langwith Cave	Derbyshire	—	—	Mullins (1913)
Lynx Cave	Denbighshire	—	—	Blore (2002)
Neale's Cave	Devon	—	—	Jenkinson (1983)
Raven Scar Cave	North Yorkshire	—	—	T. C. Lord (unpublished)
Robin Hood Cave	Derbyshire	—	—	Laing (1890)
Sewell's Cave	North Yorkshire	—	—	Raistrick (1936)
Steetley Cave	Derbyshire	—	—	Bramwell *et al.* (1984)
Teesdale Fissure	Durham	—	—	Davies (1880)
Victoria Cave	North Yorkshire	—	—	Jackson (1938)
Yew Tree Cave	Nottinghamshire	—	—	Ransom (1867)
Unknown cave near Grassington	North Yorkshire	—	—	Jackson (1931)

by bones from nearby Soldier's Hole Cave suggests a mosaic of habitats were present at this time, including woodland on the steeper slopes of the Mendip escarpment (Harrison, 1988). Although roe deer have not explicitly been recorded in the Late Glacial Interstadial cave faunas from Mendip, a decorated roe deer metacarpal from the Great Orme area of North Wales, which gave a radiocarbon determination of 11 795 ± 65 ^{14}C yr BP (OxA-6116) (Richards *et al.*, 2005), suggests that roe did occur in Britain during the Late Glacial Interstadial. Had roe been scarce or absent in the Late Glacial Mendips, then lynx could have subsisted instead on mountain hares and red deer *Cervus elaphus* calves and hinds, which are still regularly recorded in lynx diet in parts of Europe today (Gossow and Honsig-Erlenburg, 1986; Jedrzejewski *et al.*, 1993; Červeny and Bufka, 1996). However, with the onset of the cold phase of the Younger Dryas Stadial, running approximately from 11 000 to 10 000 ^{14}C yr BP, it is likely that the re-emergence of tundra and the retreat of woodland would have seen the disappearance of the lynx from Britain (Coard and Chamberlain, 1999).

With the arrival of the present Interglacial around 10 000 ^{14}C yr BP, warmer temperatures allowed the spread of woodland biotopes and roe deer to most parts of Britain. Radiocarbon dates on lynx bones from caves from the period 9570–8930 ^{14}C yr BP demonstrate that lynx were present in Britain well before rising global sea levels eventually separated Britain from continental Europe around 8500 ^{14}C yr BP (Shennan *et al.*, 2000).

Evidence for the early medieval occurrence of lynx in Britain

Skeletal remains of a lynx discovered in 1927 from Reindeer Cave in Sutherland, northwest Scotland (Lawson, 1981), when radiocarbon-dated, gave a surprisingly young age of 1770 ± 80 ^{14}C yr BP (Kitchener and Bonsall, 1997). This date indicated a much more recent extinction of the lynx in Britain than previously thought, and suggested that climate change was not responsible for the species' demise. We report previously unpublished radiocarbon dates for lynx bones from two cave sites in the Craven area of North Yorkshire which confirm this conclusion, and extend the known British distribution of lynx in the historical era.

Craven has the greatest number of lynx records of any of the limestone cave areas of Britain, and 9 of the 25 British cave sites that have yielded lynx bones, are located within the area. The caves are located in Carboniferous limestone at altitudes of 220–440 m. These altitudes are below the Holocene maximum for woodland biotopes in this part of the Pennines (Smith, 1986; Atherden, 1999). Four post-cranial lynx bones were found in Moughton Fell Cave before it was destroyed by quarrying in the late 19th century (Handby, 1899). A proximal right tibia from an adult lynx identified by Jackson (1931) was submitted for AMS radiocarbon dating as part of a cave research project supported by the Yorkshire Dales National Park Authority, and gave the result OxA-11405: 1842 ± 35 ^{14}C yr BP. The calibrated age range with a 95.4% probability is AD80 to AD320, showing that the lynx had lived during the Roman period. Controlled excavations at Kinsey Cave in the 1920s and early 1930s found a mandible and post-cranial limb bones, probably from a single adult lynx (Jackson and Mattinson, 1932). A left femur was submitted for AMS radiocarbon dating, giving the result OxA-12026: 1550 ± 24 ^{14}C yr BP. The calibrated age range with a 95.4% probability is AD425 to AD600. This represents the youngest date yet for lynx in Britain. Together, these two dates show that lynx inhabited the Craven area both during and after the Roman period and most likely continued to do so for some time afterwards. Fossil pollen spectra from across northern England indicate widespread woodland expansion occurring immediately after the Roman period (Atherden, 1999; Dark, 2000), suggesting that upland

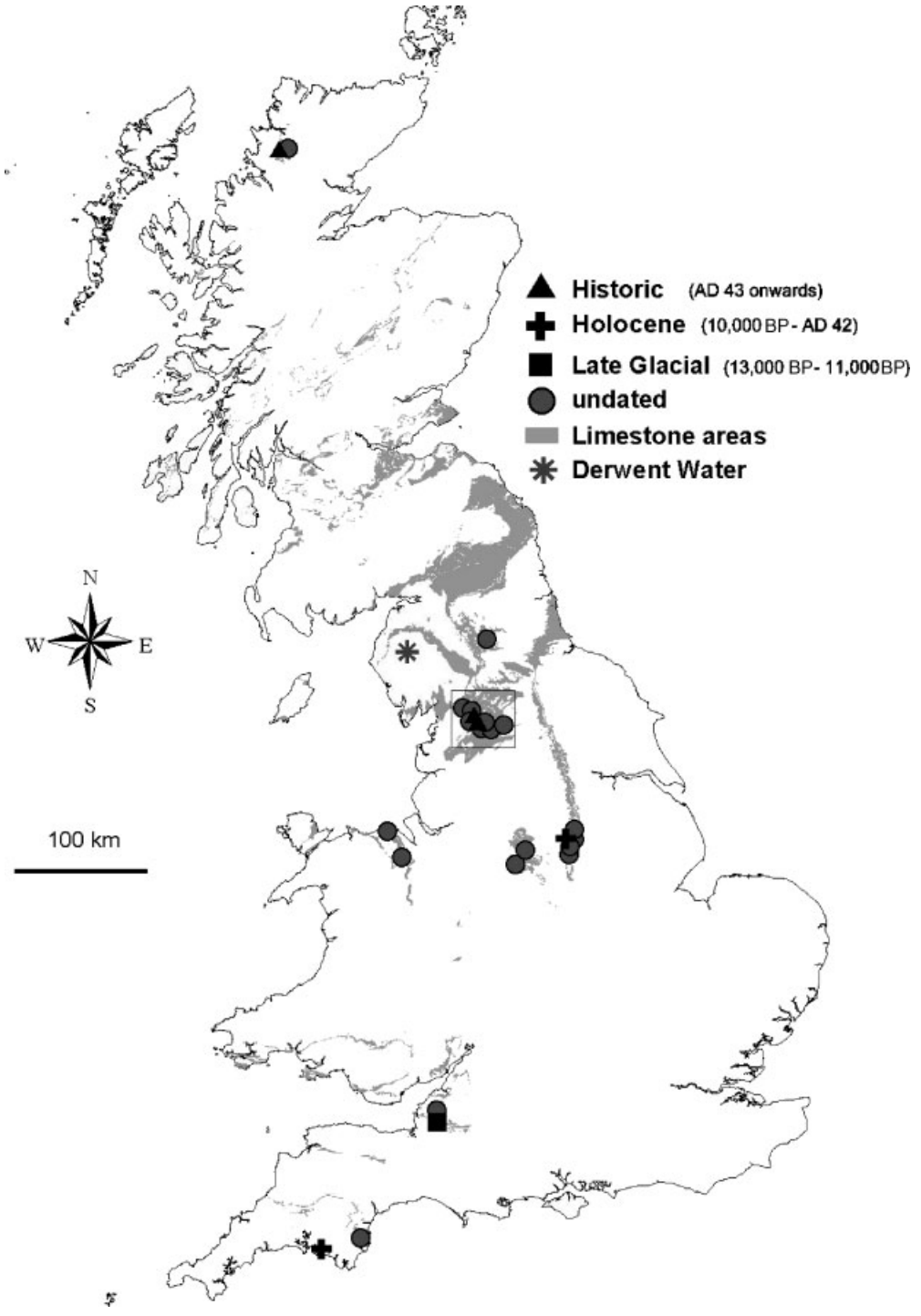

Figure 1 *Distribution of cave sites in Britain where lynx bones have been recovered.* The Craven area is highlighted in the box. Three further sites in north and west Scotland have recently yielded lynx bones but the locations have not yet been disclosed, and so are not marked. The location of Derwent Water is also marked. Limestone information from 625K Bedrock Data by permission of the British Geological Survey (IPR/54-18C British Geological Survey. NERC. All rights reserved)

habitats in northern England may even have improved for lynx at this time.

The reappraisal of the palaeontological evidence prompted by the radiocarbon dating of the two Craven lynx specimens, has implications beyond the recognised boundaries of Quaternary science. Scholars of ancient British language and history have long recognised the cultural significance of the epic poem *Y Gododdin*, which was written in Cumbric, a British language similar to Welsh, and included in the Book of Aneirin (Williams, 1938; Koch, 1997). Also contained within the book, however, is a Cumbric lullaby known as *Pais Dinogad*, thought to date to the first half of the 7th century AD (Williams, 1938). This lullaby celebrates Dinogad's father's hunting prowess and refers to him killing roe deer, red deer, wild boar *Sus scrofa*, grouse, and fish from the Waterfall of Derwent. Interestingly, the second last line of the lullaby lists one of the game that Dinogad's father killed with his spear, as *llewyn*. There has been some disagreement among scholars on the translation of this word, with some interpreting it as a reference to fox *Vulpes vulpes* (Williams, 1938; Koch, 1997), and others to wildcat *Felis sylvestris* (Williams, 1959; Conran, 1992). However, the suffix *-yn* is merely a singular ending in Cumbric, while *llew-* is considered to be entirely cognate with *lugh*, the word in the Old Gaelic language of Scotland and Ireland for 'lynx' (*Dictionary of the Irish Language*, 1913–1976: L: 235. 33–56; A. Price, pers. comm.). Welsh *Llew* and Old

Gaelic *Lugh* were also the names given to the Celtic god of light (A. Price, pers. comm.). There appears to be a connection running through much of the Indo-European group of languages between 'light' and 'lynx', probably due to a widespread perception of the powerful sight and shining eyes of lynx (Partridge, 1966; Onions, 1966). Loth (1930) and Jarman (1988) argue that *llewyn* should be translated as 'lynx', while *llwynein* represents 'fox'. According to Jarman (1988: 68) therefore, the last few lines of the lullaby should translate as:

Of all those that thy father reached with his lance,
Wild boar and lynx and fox,
None escaped which was not winged.

Many other linguists may not have considered 'lynx' as a translation for *llewyn*, because until very recently, lynx were considered to have become extinct in Britain several thousand years ago, and therefore would not have been perceived as a potential game animal of 7th century Britain. The Waterfall of Derwent is a probable reference to the Falls of Lodore, an impressive cataract which flows into the Derwent Water in the Lake District, northwest England (Gruffydd, 1990). It is this area, which, during the 7th century, formed part of the Cumbric-speaking kingdom of Rheged and which is likely to have been the geographical setting for *Pais Dinogad* (Gruffydd, 1990). With lynx bone dated to around the 6th century AD coming from Kinsey Cave, located just 80 km to the southeast of Derwent Water (Fig. 1), it seems entirely feasible that the animal *llewyn* described in the early 7th century AD, was a lynx.

Discussion

The available evidence shows that lynx still occurred in the North West Highlands of Scotland, the Lake District and the Yorkshire Dales during the early historical era. Other than an obscure reference by Holinshed (1805; but originally written in 1577) to there having been an abundance of 'lions' in northern Scotland, which at his time of writing appeared to be extinct, there is a lack of documented references to wild lynx in Britain. This suggests that lynx may have become extinct by the late medieval period. This is considerably later than was previously thought. However, in comparison to other areas of continental Europe, this is an early local extinction. In 1800, lynx were still thought to exist right across the Alps, in the Pyrenees, Massif Central and Jura, and in the mountainous areas of Germany and the Czech Republic (Kratochvil, 1968). Why did upland areas of Britain, which have acted as refuges for several other carnivorous species on the island of Britain, lose their lynx populations, while other, similarly mountainous and thinly populated parts of continental Europe, continued to support lynx up until the 19th century? Breitenmoser (1998) noted that the Eurasian lynx had become extinct in southern European areas where the wolf continued to exist, while in Scandinavia the lynx clung on. He concluded that this disparity was due to the lynx's requirements for the cover provided by woodland, in which to stalk its prey of small ungulates. Southern Europe experienced greater deforestation than did Scandinavia with consequent declines in populations of forest-dwelling ungulates such as roe deer. High densities of domestic livestock grazing in the remaining forests would have placed more pressure on already diminishing deer populations, and the residual lynx population would have turned to killing the sheep and goats of peasant farmers. This would in turn, have led to increased persecution of the lynx by humans and ultimately its extinction over most of southern Europe.

Britain seems to follow the southern European model of losing the lynx early, and before the wolf. This is very likely to be tied in to Britain's forest history, which is not typical for northern Europe. Mather (1990) contended that the pattern of deforestation of the British Isles, where the forest almost disappeared before a 20th-century reafforestation commenced, resembles that of the Mediterranean Basin, and not that of most central and northern European countries. As in southern Europe, Britain is likely to have seen an early lynx extinction driven by anthropogenic and landscape-scale forest clearance, which commenced in the Neolithic and continued into the early decades of the 20th century (Birks, 1988; Mather, 1990; Rackham, 1993). Consequent upon this deforestation would have been declines in the populations of forest-dwelling deer. British roe and red deer populations almost became extinct, existing only in remote woods of the Scottish Highlands by the end of the 18th century (Ritchie, 1920). Wolves were not threatened by the severe deforestation to the same extent, as they do not require cover for hunting, and their favoured prey, the red deer, had adapted to the deforestation of the Scottish Highlands by inhabiting the open moors. Instead, a sustained campaign of persecution encouraged by a system of laws and bounties forced the wolf into extinction in the 18th century, at a time when Britain had already been largely disafforested for some centuries (Ritchie, 1920).

Conclusion

To date, three of the six radiocarbon dated lynx specimens from Britain have yielded Roman or post-Roman dates, and it is highly unlikely that the Kinsey Cave specimen represents the last lynx to have inhabited Britain. It is hoped that further radiocarbon dating of lynx specimens may serve to improve our understanding of the occurrence of lynx in Britain, and indeed may yield a still younger date. With climatic processes ruled out as a cause of the extinction of lynx in Britain, and anthropogenic processes such as forest clearance and persecution implicated by the carbon dates instead, the Eurasian lynx qualifies ethically as a candidate for reintroduction. The potential for reintroduction of the lynx in Britain has been discussed in the literature over the years (Yalden, 1986; Dennis, 1995; Kitchener, 1998; Wilson, 2004). Indeed, the Eurasian lynx is listed on Annex IV of Article 22 of the EU Habitats and Species Directive (92/43/EEC) (EEC, 1992), which obliges member states, including the UK, to study the desirability of its reintroduction. Eurasian lynx have been restored to several upland areas of western and central Europe in recent decades, including the Swiss Alps, Jura Mountains, Harz Mountains, Bavarian Forest, Vosges and Dinaric Alps. The IUCN guidelines on reintroductions state that the factors responsible for a species' extinction must be identified and eliminated before a reintroduction can be considered (IUCN, 1998). A better understanding of the history of the Eurasian lynx in Britain may strengthen arguments for the reintroduction of the species. Areas such as the Scottish Highlands, which, throughout the 20th century have witnessed continuing large-scale reafforestation, albeit with exotic conifers, as well as the rapid and problematic growth of deer populations, both native and exotic, may have created suitable conditions for a lynx population once more. There is greater human tolerance of, and interest in, large carnivores today than in previous societies. Furthermore, the continued restructuring of agricultural subsidies to reward farmers for enhancing wildlife and landscapes, could allow lynx to be restored to the human-modified landscapes of

Britain, just as they have been elsewhere in Europe. The return of a top predator may restore natural ecological processes to the forests of Britain, which have been missing since lynx, bears and wolves were driven to extinction several centuries ago.

Acknowledgements We are very grateful to Dr John Nudds, formerly Keeper of Geology at the Manchester Museum, for making available the specimen from Moughton Fell Cave for dating. Funding for the AMS radiocarbon dates was provided by the Yorkshire Dales National Park Authority. The involvement of DAH was as part of a PhD at the University of Aberdeen funded by the Highland Foundation for Wildlife. Research by RMJ is part of the Leverhulme Trust funded project 'The Ancient Human Occupation of Britain'. Our thanks go to Dr Adrian Price, Cardiff University, for his invaluable contribution to discussion of *Pais Dinogad*. We would also like to thank Dr Derek Yalden and an anonymous reviewer for their constructive comments.

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