



Stable isotope investigations of charred barley (*Hordeum vulgare*) and wheat (*Triticum spelta*) grains from Danebury Hillfort: implications for palaeodietary reconstructions

Emma Lightfoot*, Rhiannon E. Stevens

McDonald Institute for Archaeological Research, University of Cambridge, Downing Street, Cambridge CB2 3ER, UK

ARTICLE INFO

Article history:

Received 6 December 2010

Received in revised form

13 October 2011

Accepted 25 October 2011

Keywords:

Cereal

Palaeodiet

Carbon

Nitrogen

Iron Age

Collagen

Danebury

ABSTRACT

Palaeodietary studies typically focus on the analysis of bone collagen due to the limited availability of plant remains. Isotopic analysis of plant remains, however, allow for a more extensive consideration of the contribution of plants to the human diet and can potentially provide information about the environment in which the crops were grown. This paper reports the results of carbon and nitrogen isotope analyses performed on charred barley and wheat grains recovered from pits within Danebury Iron Age hillfort. To the best of our knowledge, this is the first Iron Age site in Britain from which charred grains have been isotopically analysed. Our results suggest that cereals found at the hillfort were grown in several different environmental contexts. The isotope data demonstrate that the herbivores were not consuming a diet primarily based on grains as the $\delta^{15}\text{N}$ values of the grains are very similar to those of the herbivores. Palaeodietary investigations typically assume that humans eating plant protein only would have the same $\delta^{15}\text{N}$ value as the local herbivores. This assumption is clearly invalid at Danebury, where the humans and animals appear to have consumed either different parts of the same plants or different plants. Researchers typically interpret high differences between human and animal $\delta^{15}\text{N}$ values as indicative of diets high in animal protein, however where major plant resources have $\delta^{15}\text{N}$ values similar to those of the herbivores our ability to distinguish between plant and animal sources of protein in the diet is limited. Our research has demonstrated that whenever possible it is desirable to measure the isotopic signatures of potential major plant resources in order to understand past subsistence strategies.

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1. Introduction

Danebury, the largest hillfort in southern Britain to have been extensively excavated, formed an important part of the Iron Age landscape. Hillforts have been interpreted as centres where a range of ritual and communal activities took place, and/or as hubs for craft production and exchange. Certain agricultural activities such as the overwintering and birthing stock, and processing, storing and redistributing grain are thought to have taken place within the hillfort (Cunliffe, 1984a,b, 1995; Hill, 1996). Danebury is dated to 550BC to 50AD and the excavations, carried out between 1968 and 1989 by Prof. B. Cunliffe, provided a wealth of dietary information in the form of plant and animal remains (cf. Cunliffe, 1995; Grant, 1984, 1991; Jones, 1984, 1995; Jones and Nye, 1991). Butchery marks on sheep, cattle and pig skeletal remains demonstrate that

these animals were important as sources of food, however husbandry also focussed on the production of wool, milk and manure (Grant, 1984, 1991). Charred cereal grains were recovered from over 2400 pits within the hillfort indicating arable agriculture played an important role in the local community's economy (Cunliffe, 1995, 2003).

This dietary information has been augmented by a recent isotopic study by Stevens et al. (2010), which investigated the contribution of the main domesticated animals to the diets of the population buried at Danebury. The majority of isotopic palaeodietary studies focus on the analysis of bone collagen. This is due to the absence of cereal remains available for isotopic analysis as a result of taphonomic processes. However, carbon and nitrogen isotope analysis of plant remains allows for a more extensive consideration of the contribution of plants to the human diet, and can potentially provide information about the environment in which the crops were grown (e.g. Araus et al., 1999; Heaton et al., 2009; Ogrinc and Budja, 2005; Riehl et al., 2008). Vast quantities

* Corresponding author. Tel.: +44 (0)1223 339326; fax: +44 (0)1223 333536.

E-mail addresses: elfl2@cam.ac.uk (E. Lightfoot), res57@cam.ac.uk (R.E. Stevens).

of charred cereal grain from Danebury makes their analysis viable, desirable and essential for a comprehensive understanding of diet and economy at the site. On the basis of the weed assemblage associated with the cereals, Jones (1984) postulated that cereals found at the hillfort were grown in several different environmental contexts and then brought to the hillfort. The first aim of this study is to measure the isotope signatures of charred wheat and barley from Danebury to determine whether or not the isotopic data from the charred grain grains support Jones' hypothesis. This will allow us to make further comment on the role of arable agricultural production and trade. The second aim of this study is to assess the relative importance of cereal to the human and animal diet through the comparison of the charred grain, human and animal isotopic data. To the best of our knowledge, this is the first Iron site in Britain from which charred grains have been isotopically analysed.

2. The site

The following summary of the Danebury landscape is based on Cunliffe (1984a, 1993, 1995). Danebury hillfort is situated near Stockbridge in Hampshire, England (Fig. 1). Positioned 145 metres above sea level, the hillfort dominates the landscape as the surrounding terrain rarely exceeds 100 metres altitude. The hillfort is situated within chalk land, which is intersected by the River Enborne some 24 km to the north and the River Test 3 km to the east. Wallop Brook, Pillhill Brook and the River Anton, all tributaries of the Test, are located 2 km to the west, 6 km to the north and 6 km to the east of the hillfort respectively. The river valleys in the surrounding area contain varying depths of colluvial and alluvial deposits. Thin light soils typically 200–300 mm thick cover the chalk land, however in places patches of clay-with-flints cap the hilltops. The Danebury region would have been a preferred landscape for settlement because the light soils and gradual slopes could have been easily ploughed with a prehistoric ard. The landscape around the fort may be divided into five ecological zones: 1. flood plains; 2. watered downland (within 1 km of the nearest permanent water supply); 3. dry downland (away from permanent water supply); 4. isolated woodlands; and 5. clay lands (which are likely to have been forested in the Iron Age) (Cunliffe, 1984b).



Fig. 1. Location of Danebury hillfort.

Ecological zones 1 to 3 are thought to have been suitable for growing cereals and other economic crops.

3. The zooarchaeological and archaeobotanical record of subsistence

The following summary of the Danebury archaeobotanical record is based on Jones (1984, 1995) and Jones and Nye (1991). The majority of the archaeobotanical remains recovered from Danebury were preserved as carbonised assemblages in pits. Spelt wheat (*Triticum spelta*) was dominant, although significant amounts of hulled six-row barley (*Hordeum polystichum*) were also present. These two species are the focus of the isotopic investigations carried out in this study. Although more limited in number, other crops recovered included bread wheat (*Triticum aestivo-compactum*), emmer (*Triticum dicoccum*) and hazelnut (*Corylus avellana*). Wild carrot (*Daucus carota*), along with a number of other taxa, may have been grown as crops or alternatively may have grown as weeds. The general composition of the crop species represented does not appear to have fluctuated during the 500 year occupation of the hillfort. Grain was brought to the site either fully processed or in the ear ready for dehusking.

A large number of other plant taxa were recovered from the same assemblages as the economic crops, the majority of which are considered to be weeds associated with arable land. Many of the weed taxa present are ecologically consistent with the types of well-drained cultivated land which dominates the chalk land catchment of Danebury. A few taxa do not, however, share the same ecological requirements. Buttercup (*Ranunculus* sp.) and mint (*Mentha* sp.) are typically associated with moist conditions, and spike rush (*Eleocharis palustris*) and sedges (*Carex* sp.) would definitely not have occupied the same ecological zone as the weeds that require free-draining land. Sheep sorrel (*Rumex acetosella*) and corn marigold (*Chrysanthemum segetum*), flourish on acidic soils rather than the very alkaline chalk-derived sediments. As these taxa are found in the same assemblages as the carbonised cereal grains they are thought to represent weeds growing in the cereal fields. It is therefore likely that the cereals found at Danebury were grown both on the well-drained alkaline soils close to the hillfort and on low-lying valley loams and gravel soils slightly further away.

The quantity and abundance of carbonised cereal and arable weeds indicate that extensive cereal processing (threshing, winnowing and storage) was taking place within the hillfort (Cunliffe, 1995). There is evidence of the waste material from cleaning and threshing, and it has been suggested that this part may have been mixed with barley as the basis of animal feed. Processed cereal grains were then stored in pits and granaries. The site's storage capacity was greatly in excess of the needs of the resident population, supporting the argument for Danebury's role as a redistribution centre (Cunliffe, 1995).

Zooarchaeological analysis undertaken at Danebury indicated that a range of species were utilised including cattle, sheep, horse, pig, dog, goat, cat, red deer, roe deer, fox, badger, fish and birds. However, only a few of these species (cattle and sheep in particular), were regularly consumed by the human population (Grant, 1984, 1991). Palaeodietary investigations at Danebury have been carried out through carbon and nitrogen isotope analysis of human and associated animal remains (Stevens et al., 2010). Further details of this previous study and comparison its isotopic results with those from our isotopic analyses of charred grains are given in section 6, below.

4. Isotope analysis of charred grains

Stable isotope analysis is now routinely used to provide quantitative dietary information that supplements the evidence

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