Quaternary International xxx (2014) 1–9

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Insect tales: Stable isotope evidence of Romano-British socioeconomic activities in northern England

Gary A. King

Department of Archaeology and Wolfson Research Institute for Health and Wellbeing, Durham University, Durham DH1 3LE, United Kingdom

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Coleoptera
Isotopes
Stored products
Palaeodiet
Animal husbandry
Manure

ABSTRACT

Insect remains from archaeological contexts have proven to be valuable indicators of past human activity and have provided unique insight into land-use patterns, palaeodiet, and the role of domestic animals and plants in industry. The present study reports the first application of stable carbon and nitrogen isotopes towards waterlog-preserved beetle and bug remains from Romano-British sites in the north of England. The results of the isotope analyses found the insect chitin signatures to be comparable to previous studies of contemporaneous bone collagen in the area. The marriage of stable isotope analysis to archaeoentomology during this preliminary investigation provided new data for the study of animal husbandry and agricultural practices during the Roman Period. It offers insight into the availability and use of agricultural crops as well as the diet and grazing environments of domesticates.

1. Introduction

Previous studies of Romano-British socioeconomic and agricultural practices have principally relied on historical documents, material culture, and zooarchaeology (e.g. White, 1970; O'Connor and van der Veen, 1998; Albarella et al., 2008). However, insect remains from archaeological deposits have also contributed to this discussion and have been drawn upon to elucidate grain supply, storage, and agricultural production in Roman Britain (e.g. Hall and Kenward, 1976; Buckland, 1978; Smith, 2011; Smith and Kenward, 2011; King et al., 2014). In the absence of charred floral evidence, the disarticulated remains of insects may stand as the sole indicators for the presence of stored plant products in archaeological contexts. Additionally, insect subfossils have been used to differentiate between pastoral and agricultural landscapes (e.g. Robinson, 1983; Schelvis, 1998; Kenward et al., 2002) and to identify the presence and role of domestic vertebrate species (e.g. Hall and Kenward, 1990; Kenward and Allison, 1994; King and Henderson, 2014).

In his 1994 book on Quaternary entomology, Elias called for the development of isotopic studies of fossil insect cuticle, and since then, significant headway has been made. Fossil beetle chitin has been used for radiocarbon dating (e.g. Elias and Nelson, 1989; Walker et al., 2001). Stable hydrogen and oxygen isotope analyses of subfossil chironomids have been employed to reconstruct the stable isotopic composition of lake water as a means of reflecting regional precipitation (e.g. Wooller et al., 2004, 2008; Wang et al., 2008, 2009). In a pilot study, Miller et al. (1988) explored the efficacy of D/H ratios from modern beetle chitin to examine regional environmental temperatures, and Gröcke et al. (2006) studied the D/H ratios from modern Coleoptera (beetles) in relation to regional meteoric water. Moreover, the analysis of $^{13}C/^{12}C$ and $^{15}N/^{14}N$ from insect chitin has proven to be an excellent means of assessing trophic relationships in modern agro-ecosystems (e.g. Wise et al., 2006; Traugott et al., 2008; Birkhofer et al., 2011). Building upon these studies, King (2010, 2012; 2013) examined the stable hydrogen, carbon, and nitrogen isotope ratios of waterlogged preserved archaeological beetles and flies as a means of elucidating past socioeconomic activities such as: land-use, natural resource exploitation, and trade.

The present study explores the application of stable isotope analysis to waterlog-preserved insect assemblages from four archaeological sites dated to the first and fourth centuries and their potential to discern past human activity. In this investigation, the diet and trophic level of beetles and bugs from archaeological deposits are analysed. Nitrogen stable isotope ratios ($^{15}N/^{14}N$) are used to estimate trophic position because organisms exhibit stepwise enrichment relative to their diet (DeNiro and Epstein, 1981; Vander Zanden and Rasmussen, 1999). By contrast, $^{13}C/^{12}C$ ratios vary little between trophic levels; however, stable carbon isotopes ($\delta^{13}C$) have been employed to study compartmentalization in the food webs (DeNiro and Epstein, 1978; Post, 2002). The stable isotope values from insect chitin are compared to non-human

E-mail address: gking500@googlemail.com.

http://dx.doi.org/10.1016/j.quaint.2014.01.051
1040-6182/

vertebrate bone collagen from contemporaneous sites in York. It is hypothesized that, through this comparison, insight into Romano-British diet and animal husbandry in the north of England can be obtained.

2. Materials and methods

Subsamples of raw sediment (250 g) from four Romano-British sites in northern England: first century A.D. contexts from 5 to 7 Spurriergate, York (2000.584 6063), the Roman Warehouse at Coney Street, York (1974.18 2105) and the Ribchester Roman Fort (RB89 124 4174/V), and a fourth century A.D. context from Park View School, Chester-le-Street, Durham (PVC06 114), were processed using the method outlined by Kenward et al. (1980). While new material was analysed for the current study, previous assessments involving insect remains have been conducted at Coney Street (Kenward and Williams, 1979), Park View School (Schmidl et al., 2006; see also; King et al., 2009), Ribchester (Large et al., 1994), and Spurriergate (King, 2010; see also Hall et al., 2000 for medieval contexts). The resulting flots were kept in vials containing industrial methylated spirit (a 90/10 mixture of ethanol/methanol) until they could be sorted using a low-power binocular microscope. Specimens that could be identified to genus or species level were selected for isotopic analysis.

Schimmelman and DeNiro (1986) proposed that glucosamine-HCL was the most reliable compound in chitin for stable isotope studies. Extracting the glucosamine out of chitin is an effective means of eliminating amino acids, which typically comprise 41–55% of chitin mass (Miller et al., 1993). The chitin was prepared in the Department of Archaeology, University of York, UK. The methods for chitin preparation followed Miller et al. (1988; see also Hodgins et al., 2001), as modified by King (2010). The elytral samples were placed in 5 ml glass tubes and were rinsed in a solution of 2:1 dichloromethane: methanol in order to remove waxes. The samples were then fully immersed in 2 ml 10% NaOH, vortexed gently, and incubated for 72 h at 110 °C with gentle agitation to eliminate proteinaceous material. The remaining materials were added to a spin column, spun through a filter at 10,000 g for 1 min to separate the solid and liquid fractions, and the collection tubes emptied. The solid fractions were re-suspended in the distilled water and spun at 6000 g for 1 min, and the collection tubes were subsequently emptied. The last step was repeated three times. The resulting product was transferred to 2 ml Eppendorf Biopur tubes and dried overnight at 60 °C.

The extracted chitin product (0.5 mg) was then collected for carbon and nitrogen isotope analysis using an EA–IRMS (Elemental Analyser – Isotope Ratio Mass Spectrometry) at Iso-Analytical Limited. The natural abundance of ^{13}C and ^{15}N is expressed as per mil (‰) deviation from international standards: $\delta^{13}C$ or $\delta^{15}N = [(R_{sample}/R_{standard}) - 1] \times 1000$, where R is $^{13}C/^{12}C$ or $^{15}N/^{14}N$ for $\delta^{13}C$ or $\delta^{15}N$, respectively. Pee Dee Belemnite and atmospheric nitrogen were employed as the international standards for carbon and nitrogen, respectively. Replicates of samples and inter-comparison material evidenced an external reproducibility better than ±0.10‰ for $\delta^{13}C$ and ±0.23‰ for $\delta^{15}N$ measurements.

3. Results

Isotopic data on all the sampled insect specimens ($n = 26$) are summarized in Table 1 and plotted in Figs. 1–4. In Fig. 5, the insect data from the Spurriergate and Coney Street sites are plotted against the isotopic signatures of vertebrates from Romano-British sites in York, which were originally reported by Müldner and Richards (2007).

Table 1
Insect evidence from Romano-British sites in northeast Britain, including inferred trophic level and stable isotope results.

Species	Site	Trophic level	$\delta^{13}C_{‰}$ PDB	$\delta^{15}N_{‰}$ AIR
Blaps lethifera Marsh.	Coney Street	Omnivore: stored products	−23.0	10.6
Oryzaephilus surinamensis L.	Coney Street	Herbivore: stored products	−23.0	8.1
Sitophilus granarius L.	Coney Street	Herbivore: stored products	−22.4	4.8
Tenebroides mauritanicus L.	Coney Street	Omnivore: stored products	−23.2	7.8
Amara sp.	Park View School	Herbivore	−27.8	–[b]
Heterogaster urticae	Park View School	Herbivore	−24.9	–[b]
Sitophilus granarius L.	Park View School	Herbivore: stored products	−23.2	6.9
Tachinus signatus Grav.	Park View School	Omnivore	−24.1	8.9
Aphodius prodromus Brahm	Ribchester	Dung-associate	−24.2	8.8
Helophorus rufipes Bosc.	Ribchester	Herbivore	−25.9	11.2
Oryzaephilus surinamensis L.	Ribchester	Herbivore: stored products	–[a]	–[b]
Sitophilus granarius L.	Ribchester	Herbivore: stored products	−22.6	–[b]
Trechus obtsus Er. or *quadristriatus* Schr.	Ribchester	Carnivore	–[a]	–[b]
Cercyon analis Payk.	Spurriergate	Dung-associate	−28.9	11.5
Cryptolestes ferrugineus Steph.	Spurriergate	Herbivore: stored products	−22.5	2.9
Cryptophagus scutellatus New.	Spurriergate	Mycetophage	−24.6	6.1
Helophorus grandis Ill. or *aquaticus* L.	Spurriergate	Herbivore	–[a]	–[b]
Hylesinus varius F.	Spurriergate	Herbivore	−27.6	–[b]
Kateretes cf. *pusillus* Thun.	Spurriergate	Herbivore	−23.1	–[b]
Omonadus formicarius Goez.	Spurriergate	Herbivore	−23.4	6.0
Oryzaephilus surinamensis L.	Spurriergate	Herbivore: stored products	−23.3	7.0
Palorus ratzeburgii Wiss.	Spurriergate	Herbivore: stored products	−22.8	7.6
Philonthus politus L.	Spurriergate	Carnivore	−26.9	4.1
Sitophilus granarius L.	Spurriergate	Herbivore: stored products	−21.5	7.8
Sitophilus granarius L.	Spurriergate	Herbivore: stored products	−23.1	6.0

[a] Specimen identified. Insufficient material available for ^{13}C analysis.
[b] Specimen identified. Insufficient material available for ^{15}N analysis.

3.1. Roman Warehouse Coney Street, York

Four species were recovered from the Coney Street sample. The assemblage comprised fauna that are associated with stored products today. The remains of the stored product beetles *Blaps lethifera* (Marsh.), *Oryzaephilus surinamensis* L., *Sitophilus granarius* L., and *Tenebroides mauritanicus* L. were found. The nitrogen isotope

Please cite this article in press as: King, G.A., Insect tales: Stable isotope evidence of Romano-British socioeconomic activities in northern England, Quaternary International (2014), http://dx.doi.org/10.1016/j.quaint.2014.01.051