Journal of Archaeological Science 41 (2014) 868–878

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

'SmartFauna': a microscale GIS-based multi-dimensional approach to faunal deposition at the Ness of Brodgar, Orkney

Ingrid Mainland [a,*], Nick Card [a], Mary K. Saunders [b], Cecily Webster [a], Leif Isaksen [c], Jane Downes [a], Mark Littlewood [a]

[a] Dept. of Archaeology, University of the Highlands and Islands, Orkney College, Kirkwall, Orkney KW 15 1LX, United Kingdom
[b] Dept. of Archaeological Sciences, University of Bradford, Richmond Road, Bradford BD7 1DP, United Kingdom
[c] Dept. of Archaeology, Faculty of Humanities, University of Southampton, Avenue Campus, Highfield, Southampton SO17 1BF, United Kingdom

ARTICLE INFO

Article history:
Received 30 June 2013
Received in revised form
3 October 2013
Accepted 6 October 2013

Keywords:
Archaeozoology
Taphonomy
GIS
Neolithic
Orkney

ABSTRACT

Recent technological advances in survey and computing are opening up new opportunities for the accurate spatial recovery and recording of archaeological materials during excavation. These have the potential to revolutionise understanding of depositional practices and (other such) taphonomic processes which create the deposits and sites that archaeologists explore. This article summarises a new methodological approach to the recovery and analysis of faunal remains which enables a highly accurate 3D spatial analysis of any patterning in bone deposited within archaeological layers using a combination of high resolution survey techniques for the recovery of animal bones, 'bridging' software and a high end GIS package. Application of this methodology to archaeological deposits from the Ness of Brodgar in Orkney has provided evidence for deliberate placement of selected cattle and red deer remains, suggesting that these species were of central importance in Late Neolithic society.

1. Introduction

Taphonomy, the pathway of activities and behaviour that lead from once living animals to assemblages of bone recovered from an archaeological site, is a major focus for research within zooarchaeology, allowing insight into human attitudes to and utilisation of fauna in the past, as well as the pre- and post-depositional histories of a site (Lyman, 1994; Charles and Halstead, 2000; Orton, 2012; Madgwick and Mulville, 2012). A limitation for taphonomic studies, however, is the prevalence of bulk retrieval strategies for faunal material under which spatial co-ordinates of individual skeletal elements are not routinely recorded but are taken only in specific situations (e.g. animal burials and articulations, floors or working surfaces), often at the discretion of the on-site archaeologist. This has implications for the understanding of depositional processes involving faunal material and is particularly problematic where the aim is to address non-economic attitudes to animals though identification of the deliberate placement or 'structuring' of biological remains and material culture within archaeological features (e.g. Thomas, 1999; Pollard, 2001). Recognition of such practices requires an understanding of spatial variation within a bone deposit, which is impossible when animal bones are normally excavated in bulk; this limits analytical resolution and has engendered some scepticism regarding identification of 'structured' depositional events, particularly where incorporated in larger bone dumps (Wilson, 1992; Rowley-Conwy and Owen, 2011; Orton, 2012).

Recent technological advances in survey and computing are opening up new opportunities for the accurate spatial recovery and recording of archaeological materials, including bone, during excavation. High resolution metric survey (i.e. sub 2 cm accuracy) and the use of integrated GIS and database systems have been common place in archaeology for at least 10 years, pioneered by projects such as the work in advance of Heathrow T5 (Framework Archaeology, 2010), while the potential of GIS to address spatial variation of material remains is becoming increasingly evident (Arroyo, 2009; Katsianisa et al., 2008; Smith and Levy, 2012). More recently, application of laser scanning is facilitating rapid 3D recording of sites, structures and deposits (Lambers et al., 2007; McPherron et al., 2009). As part of a wider research project into Late Neolithic faunas at the Ness of Brodgar in Orkney, and in specific response to an unusual bone deposit recovered from this site, the Structure 10 'bone layer', a methodology for the multi-dimensional recovery and analysis of faunal remains was developed. This combines high resolution survey techniques for the recovery of animal bones, 'bridging' software and a high end GIS

* Corresponding author.
E-mail address: ingrid.mainland@uhi.ac.uk (I. Mainland).

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http://dx.doi.org/10.1016/j.jas.2013.10.019

package to enable a highly accurate 3D spatial analysis of any patterning in bone deposited within archaeological layers. This article presents the methodology and reviews the potential of this approach for identifying selectively in the deposition of particular categories of faunal remains (species, element, body-side, sex) within dense accumulations of bone, i.e. midden-type deposits.

1.1. The Ness of Brodgar

Excavation at the Ness of Brodgar in Orkney is revealing a remarkable multi-phase complex of late Neolithic structures contained within a large walled enclosure (Card, 2010, 2013) (Fig. 1). Radiocarbon dates imply that the site was the focus of activity for at least a millennium (circa 3300–2300 cal BC) and exclusively associated with Grooved Ware ceramics. In its later phases so far revealed, the site is dominated by several large buildings, whose scale, complexity, architectural details, decoration and associated finds assemblage indicate that their function is out with the domestic sphere, and is presently being interpreted as a communal ceremonial centre associated with the nearby stone circles at the Ring of Brodgar and the Stones of Stenness.

In the site's penultimate phase earlier 'stalled' structures are superseded by an even larger building whose architecture is a departure from these earlier buildings: Structure 10 is monumental in scale with walls 4 m thick that initially defined a sub-square central chamber later modified into a cruciform plan (Fig. 1). Surrounding this building was a paved pathway defined by its external wall face and an external revetment. Apart from its scale (over 20 m long by 19 m wide) many aspects of Structure 10 sets it apart: the incorporation of several standing stones in its build, its alignment with Maeshowe, and the extensive use of dressed and decorated stone (Card and Thomas, 2012, 117).

At the end of Structure 10's life, the building was 'decommissioned', with an elaborately pecked stone being placed next to an upturned cattle skull in the central hearth, whilst the surrounding pathway was backfilled. The upper most fill of the pathway was a thick deposit of animal bone C14 dated to c. 2300 cal BC. The interior of Structure 10 was then filled with a sequence of dumps of midden-enhanced soils and rubble, and the walls systematically robbed. This not only signifies the end of the use of this building but also marks the cessation of the Ness as a major Neolithic centre.

From when it was initially encountered, the unusual nature of the bone layer and its potential structured deposition was recognised. Occurring at a crucial stage in the history of the Ness, a closer examination and recording of the bone was considered essential to clarify the interpretation and meaning of the deposit. Rather than excavating it in its entirety a staged approach was taken, with a series of sondages through the deposit, initially with bone recovered in 'bulk' and subsequently, in 2011 and 2012, using the high resolution survey techniques outlined in this paper (Fig. 1). To date approximately 20% of the bone deposit has been excavated representing over 30% ($n = 19{,}850$) of the animal bone recovered from the Ness excavations.

2. Materials and methods

2.1. Developing a methodology for the 3D recording of faunal assemblages: X-bones and Crossbones

The methodology presented here for the 3D recording of faunal assemblages is an adaptation of 'X-bones', a survey and analytical software package developed for the 3D visualisation of commingled human remains in, e.g. mass graves (Isaksen et al., 2007). 'X-bones' comprises two elements: on-site protocols for the excavation and 3D recording of human remains ('Crossbones') and analytical software for manipulation of the resulting survey data to render accurate 3D visualisations ('X-bones'). The X-Bones software is fully Open Source and is designed to work with GIS packages such as ArcGIS, gvSIG, GRASS/Paraview and qGIS. It takes a simple text file of survey data (Point ID, x, y, z) coded according to the X-bones schema, and generates a series of schematic 3D bone representations (polygons, darts, horizontal and vertical planes or darts) (Isaksen et al., 2007). The skeletal information inherent in the survey data is retained within the 3D polygons allowing them to be linked to more extensive analytical data, such as for example, an

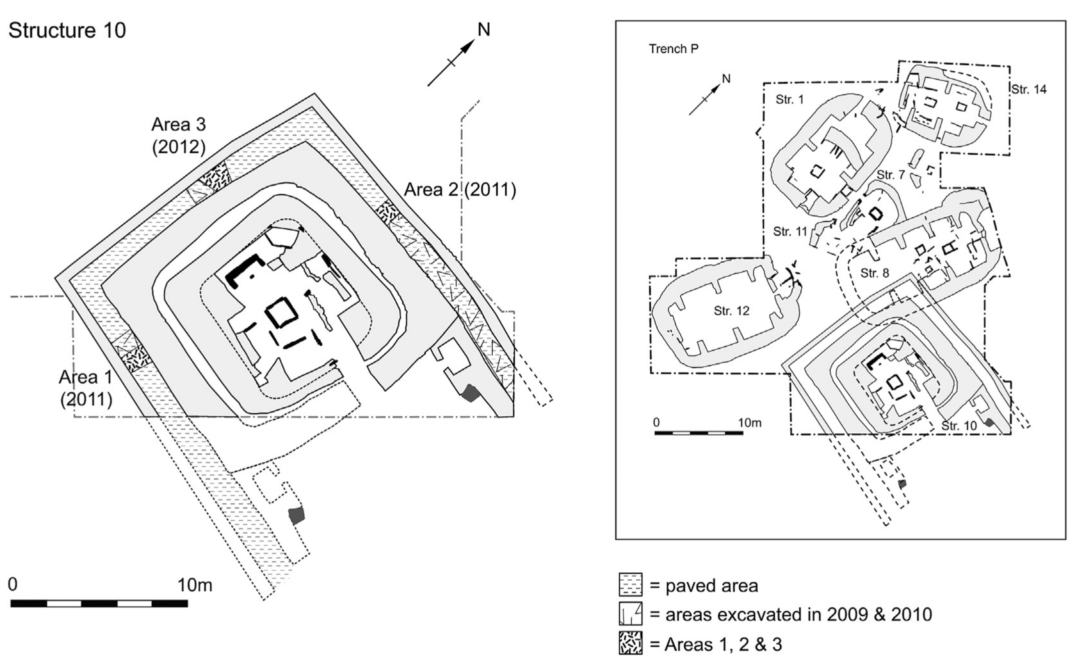

Fig. 1. The structural evidence at the Ness of Brodgar, Orkney.