Editorial

Bioarchaeological research on animal dung – possibilities and limitations

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Animal dung is a potential source of information on various palaeoeconomical and palaeoecological topics, which can often not be obtained through other bioarchaeological find categories. Moreover, from the Neolithic onwards, dung preserved in archaeological deposits is usually the result of the interaction of agricultural and animal husbandry activities and is therefore especially useful for the investigation of past agro-pastoral economies. Thus, the recognition of dung in archaeological, but also natural deposits, and its careful analysis deserves special attention. The importance of herbivore dung has long been recognised in modern bioarchaeological research. From the archaeobotanical point of view, one of the key issues that has been addressed is the taphonomy of animal dung and the extent of its contribution to archaeobotanical assemblages (see Miller and Smart 1984; Neef and Bottema 1991). The first issue of *Environmental Archaeology* was also dedicated to a great extent to the topic as it dealt with fodder. Several of its papers focussed on the recognition and interpretation of plant remains derived from dung, in relation to studies of fodder (Anderson and Ertug-Yaras 1998; Charles 1998; Hall and Kenward 1998; Karg 1998). After those first steps subsequent research focused on the animal dung itself, and provided further insights of the potential of this material for solving diverse environmental archaeological research questions (e.g. Akeret *et al*. 1999; Carrion *et al*. 2000; Shahack-Gross *et al*. 2004; Leroy and Simms 2006). The accumulated experience and increasing understanding of the taphonomy of animal dung in archaeological layers as well as the refining of methodologies led to increasing complexity and precision of the outcome of environmental archaeological studies on animal dung (e.g. Shahack-Gross 2011; Baeten *et al*. 2012; Lancelotti and Madella 2012; Portillo *et al*. 2012)

The complex character of this find category has led also to a variety of approaches and research strategies in relation to animal dung from archaeological deposits. In order to establish more common methodological approaches among environmental archaeologists working on animal dung, the European research network 'BIOARCH', funded by the CNRS, initiated a workshop held at the Royal Belgian Institute of Natural Sciences, in Brussels, June 2010. This meeting brought together various specialists: archaeobotanists, archaeozoologists, micromorphologists, entomologists, biochemists, specialists in aDNA, etc. It focused on methodological aspects such as (1) the identification of the animal species that produced archaeological dung; (2) the variety of bioarchaeological information that can be recovered from dung and methods applied for its analysis, in particular, in arid environments and waterlogged deposits; (3) the interpretive value of archaeological dung remains with an emphasis on the variety of plant remains that can be recovered from it and questions related to animal husbandry; (4) experimental research helping to understand the contribution of dung to the general bioarchaeological record in a better manner. The results of the papers and discussions of the workshop are collected in the contributions for this special issue of *Environmental Archaeology*. They cover various geographic regions, including both arid and waterlogged preservation conditions, as well as

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different methodological approaches starting from classical ones dealing with recovery and description to state-of-the-art biomolecular analyses.

An important question and main precondition enabling bioarchaeological studies by animal dung is the recognition of dung remains and identification of the defecating animal species. The current issue therefore starts with the paper by Linseele *et al.*, which gives a critical overview of potential methods for identifying the animal species that produced archaeological dung. This first contribution already shows the multidisciplinarity of dung research, integrating approaches from *inter alia* archaeozoology, archaeobotany, palaeogenetics and biochemistry.

Further contributions deal with the interpretation of botanical remains in archaeological dung using experimental approaches. Wallace and Charles apply archaeobotanical methods to the analysis of dung from sheep fed a known diet of cereal and wild plant material. The main findings of this study are that cereal material (grain or chaff) survives digestion poorly. In contrast, small and/or hard-coated seeds survive well and offer scope for investigating animal diets, grazing environments and foddering practices. Valamoti's paper represents an attempt to distinguish between digested and undigested glume wheat chaff in the archaeobotanical record. The experiment described in this paper (Valamoti 2013), using einkorn chaff digested by goats, showed that in certain conditions dung can contribute glume bases to the archaeobotanical assemblages and that these glume bases may be distinguishable from those derived from glume wheat dehusking by-products used as fuel.

The other contributions represent case studies dealing with different preservation conditions and evaluate the most suitable approaches, mainly botanical, for bioarchaeological analyses of animal dung, as well as the possibilities, limitations and potential to combine those methods with other lines of evidence. Kühn *et al.* explore the capacities of analyses of plant macro- and micro-remains, micromorphology, palaeoparasitology for the study of waterlogged dung and potential dung remains. Using two case studies from Alpine lake shore settlements the authors show the variety of information which could be obtained from those remains concerning feeding and animal husbandry as well as further palaeoeconomic aspects. Marinova *et al.* focus on dung remains preserved in a desiccated state and, like the previous paper, discuss the optimal application and combination of methodologies for study of such remains. The methods applied on animal gut content from the elite predynastic cementery (HK6) of Hierakonpolis in Upper Egypt (plant macrofossil, pollen and phytolith analyses), proved to be complementary to each other. In combination, they allowed a detailed reconstruction of plant diet of the animals in question, providing further information on the feeding practices, available pasture and land use and taphonomy. The last paper (Kuzmicheva *et al.*) presents results of pollen analysis and radiocarbon dating of two hyrax dung deposits from rock shelters found in the Afroalpine zone of the Bale Mountains (South-Central Ethiopia). It shows the potential of natural dung deposits for inferring the palaeoclimate history of a region with poor preservation of other palaeoclimate and palaeovegetation proxies, but also shows the usefulness of the approach for tracing the human impact of the vegetation in the study area.

Through the six contributions to the paper, it was possible to highlight a selection of key aspects of research applied to archaeological dung. With this volume, we hope to have provided a base for increasing the awareness of dung as an important archaeological find category and for standardisation of its study.

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