Palaeogeography, Palaeoclimatology, Palaeoecology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

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

Paleoecological reconstructions of the Bed I and Bed II lacustrine basins of Olduvai Gorge (Tanzania) and insights into early human behavior

M. Domínguez-Rodrigo [a,b,*], E. Baquedano [a], A. Mabulla [c], J. Mercader [d], C.P. Egeland [e]

[a] *IDEA (Instituto de Evolución en África), University of Alcalá de Henares, Covarrubias 36, 28010 Madrid, Spain*
[b] *Department of Prehistory, Complutense University, Prof. Aranguren s/n, 28040 Madrid, Spain*
[c] *Archaeology Unit, University of Dar es Salaam, Dar es Salaam, P.O. Box 35050, Tanzania*
[d] *Department of Anthropology and Archaeology, University of Calgary, 2500 University Dr., NW Calgary, Alberta T2N 1N4, Canada*
[e] *Department of Anthropology, University of North Carolina at Greensboro, Greensboro, USA*

ARTICLE INFO

Article history:
Received 23 April 2017
Accepted 5 May 2017
Available online xxxx

Keywords:
Human evolution
Paleobotany
Geomorphology
Taphonomy
Archaeology

ABSTRACT

The archaeological record of Olduvai Gorge has played a pivotal role in reconstructions of early human behavior. Classical Oldowan sites (from Middle Bed I), and the extensive archaeological record from Bed II (including the earliest Acheulian at 1.7 Ma), enable the reconstruction of early human behavior throughout its evolution from almost 1.9 Ma to 1.3 Ma. How such behavioral evolution was influenced by ecological factors is still an object of debate. This special issue presents a detailed meso-scale reconstruction of the paleoecology and paleogeography of the environments where some of these sites were formed, including extensive reconstructions of the paleobotany of the sites and the areas surrounding them. This provides, for the first time, a contextual ecological information framed in a scale large enough to understand human behavioral variability as determined by the exceptional ecological conditions of the Olduvai paleo-lake basin for almost one-and-a-half million years. This information is crucial to understand site functionality and the behaviors exhibited by hominins at each of the anthropogenic sites from Olduvai Gorge during the earliest stages of the evolution of the genus *Homo*.

Contents

1. Introduction . . . 0
2. Application of the meso-scale approach to the archaeological record of Olduvai Gorge (Tanzania): modeling the evolution of Oldowan and Acheulian hominin behavior . . . 0
    2.1. In pursuit of hominin behavior during the Oldowan . . . 0
    2.2. In pursuit of hominin behavior during the Acheulian . . . 0
3. Conclusions . . . 0
Acknowledgments . . . 0
References . . . 0

1. Introduction

One of the main objectives of paleoanthropology is the identification of the socio-reproductive organization and subsistence strategies that created human behavior. During the 1970s and 1980s several models emerged to interpret socio-economic behaviors of early hominins through the analysis of the Early Pleistocene archaeological record in Africa. Some models emphasized socio-economic behaviors that resembled those of some modern foraging populations (e.g., Leakey's (1971) “living-floors”; Isaac's (1978) “home base” or “food-sharing” models). Subsequent revisionist models (with a concern for site formation processes) during the 1980s produced ethological models in which hominins had social behaviors that were more similar to those of other non-human primates, such as the marginal or obligate scavenger (Binford, 1981) or the passive scavenger (Blumenschine, 1986) models, the stone-cache model (Potts, 1988), the “chimpanzee-nesting” model (Sept, 1992), or the “refuge” model (Blumenschine, 1991; Blumenschine et al., 1994).

---

[*] Corresponding author.
E-mail address: manueldr@ghis.ucm.es (M. Domínguez-Rodrigo).

http://dx.doi.org/10.1016/j.palaeo.2017.05.009
0031-0182/© 2017 Elsevier B.V. All rights reserved.

Please cite this article as: Domínguez-Rodrigo, M., et al., Paleoecological reconstructions of the Bed I and Bed II lacustrine basins of Olduvai Gorge (Tanzania) and insights into early huma..., Palaeogeogr. Palaeoclimatol. Palaeoecol. (2017), http://dx.doi.org/10.1016/j.palaeo.2017.05.009

The information gap between the reconstruction of site formation (through taphonomic analysis of materials preserved at sites) and the hominin socio-economic organization required to sustain any of the above models led scholars to abandon social and functional interpretations based on modeling of early sites. Isaac's (1983) "central-place foraging" model de-emphasized social aspects of his previous model and Cavallo (1998) even managed to reconcile it with passive scavenging models. Schick's (1987) "favored place" model did not include any significant social components and stressed that sites could simply be created by unintentional re-use of certain spaces, and may have served as secondary sources of raw material (Plummer, 2004). The "near-kill location" model (O'Connell, 1997) or the "male display" (O'Connell et al., 2002) model did not emphasize any specific social organization, despite depicting sites as carcass obtainment *loci* created through confrontational scavenging to increase male mating fitness. Even though some suggested an evolved version of primate behavior to explain early sites (e.g., the "resource-defense" model (Rose and Marshall, 1996), most models produced during the past three decades have approached Early Pleistocene hominin behavior by making it similar to those of other primates in an increasingly dehumanizing trend. One of the last models produced, the "obligate carnivory" model (Ferraro, 2007) intentionally avoided any interpretation of the social behavior of hominins or of the functionality of sites beyond their reconstruction as places where hominins ate substantial amounts of meat. This avoidance of hominin social organization is surprising, since in ethology it is widely known that subsistence (ecological) behavior is strongly dependent on specific types of social behaviors (Brooks and McLenna, 1991).

In sum, although there is a substantial amount of information available about the subsistence of hominins at a small number of Early Pleistocene sites, it is fair to state that we know very little about early site functionality and about hominins' general ecological behavior or social organization. In addition, there is potential confusion among the large diversity of interpretations of hominin subsistence, as observed in the array of behavioral models produced. How can their heuristics be empirically tested? This diversity of interpretations may be due to the controversial nature of an insufficient archaeological record and/or to flawed theoretical framing of these models (see critical discussion in Domínguez-Rodrigo, n.d.).

A site's functionality is tightly linked to the ecology of its surroundings: hominins selected specific spots on the landscape for certain activities because particular ecological characteristics enabled these activities. A better understanding of paleoecological conditions is crucial to uncovering site functionality and hominin behavior. Although some attempts have been made to characterize the surroundings of specific sites according to broad ecosystemic categories, (e.g., open grassland versus wooded habitats) (e.g., Plummer et al., 2009), in only a few cases has the ecological nature of a site been described at the local landscape level (e.g., what geological features, plants and animals existed at the site and how did these vary according to distance from the site?) (e.g., Ashley et al., 2010; Barboni et al., 2010).

With this ecological framework in mind, there is an inferential chain that should be followed prior to framing scientifically testable behavioral models:

A. *A site's functionality cannot be understood without knowing its paleoecological context*. There is virtually no early site where the local ecological characteristics have been accurately reconstructed, beyond general and rather ambiguous interpretations of location (e.g., lacustrine plain or riverine setting). The FLK Zinj site from Olduvai Gorge (Fig. 1) exemplifies how interpretations of site functionality have been linked to interpretations of the paleoecological placement of the site. Initial passive scavenging models situated the site in the middle of a barren lacustrine floodplain (Blumenschine and Masao, 1991). Subsequent research emphasizing the role of the site as a "central-place foraging" spot reconstructed it on a topographic high point within a wooded habitat overlooking a wetland (Ashley et al., 2010; Domínguez-Rodrigo et al., 2010). Recent reconstructions of the site (e.g., Blumenschine et al., 2012) place it in a peninsula surrounded by the water of a braided Okavango-like deltaic system. The hypothesis here is that locus selection by hominins is not random but conditioned by landscape ecology. Traditional archaeology focusing on the micro-scale analysis (the site) gave way to landscape archaeology projects focusing on the macro-scale, in which landscape reconstruction was targeted at kilometric or even regional ecosystems (e.g., Peters and Blumenschine, 1995). However, *we argue that the crucial approach to reconstruct site functionality is the meso-scale*, where efforts should concentrate on reconstructing in as much detail as possible the landscape surrounding a site in an approximately 1–5 km^2 area, integrating this subsequently within a broader and more general ecosystemic reconstruction. Sites must be geologically and topographically studied to analyze their physical setting's morphology and the physical processes operating on them. This type of analysis should start at the site and expand laterally as far as the geological deposit allows. Geochemical (e.g., carbon isotope or organic geochemistry indicators) and paleobotanical (e.g., phytoliths) analyses should also be performed across paleolandscapes to determine former *in situ* local vegetation. Landscape archaeology in the form of systematic test trenches across the landscape will provide information on density and diversity of materials when compared with the dense concentrations documented at sites.
B. *A site's functionality is better understood when compared to other pene-contemporaneous sites*. Diversity or homogeneity of sites, preferably those found on the same paleosurface, can be used to study the relationship between site locations and ecological variables. The testing hypothesis is that functionally different types of sites should be located in ecologically different spots. No archaeological approach exists for the Early Pleistocene in which two or more sites located on the exact same paleosurface are compared according to a detailed reconstruction of the physiognomy of their landscape, let alone of the trophic dynamics inferred from the paleobiocoenoses present in it.
C. *No site can be understood in terms of human behavior without knowing its formation history, and no selective pressures can be heuristically reconstructed from the landscape without knowing the processes and agents operating on that landscape*. Taphonomy is a crucial part of the understanding of site formation. There are abundant taphonomic tools, which, if used in a multivariate format, can be heuristically powerful to discern agents and processes intervening at any given site (see summary in Domínguez-Rodrigo et al., 2007). If the same approach is used at a landscape taphonomic level, successful reconstructions can be made regarding the degree of competition by carnivores in any given habitat within a landscape and their impact on hominin adaptability (see application at the meso-scale in Peninj, Tanzania; Domínguez-Rodrigo et al. (2009a). For example, preliminary landscape taphonomic information derived from the complete sequence of Olduvai Bed I supports the idea that the creation of FLK Zinj coincided with a moment of minimal carnivore impact in the surrounding landscape (Domínguez-Rodrigo et al., 2010).

In sum, micro-scale analysis provides information on how a site was formed and what hominins did in it. Meso-scale analysis provides detailed information regarding why a location was selected and how it enabled or restricted the activities inferred from the micro-scale analysis. Macro-scale analysis (reconstruction of the ecosystem) contextualizes information derived from micro- and meso-scale approaches within a specific framework of trophic dynamics and natural selection. It is only via the combination of three levels of analysis (with special emphasis on the meso-scale) that hypotheses addressing site functionality and hominin behavior can be successfully tested.

Please cite this article as: Domínguez-Rodrigo, M., et al., Paleoecological reconstructions of the Bed I and Bed II lacustrine basins of Olduvai Gorge (Tanzania) and insights into early huma..., Palaeogeogr. Palaeoclimatol. Palaeoecol. (2017), http://dx.doi.org/10.1016/j.palaeo.2017.05.009