Senior Honors Project

Taphonomic analysis of the excavated faunal assemblage from BK East at Olduvai Gorge, Tanzania

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ABSTRACT

Since 2014, excavations of BK East (Bed II, Olduvai Gorge, Tanzania) have found the site to produce well-preserved lithic materials and faunal assemblages bearing clear butchery marks. By analyzing the excavated assemblage from BK East for such factors as taxon and body size, skeletal element, and surface modifications, this study looks to answer the question of what taphonomic agents contributed to the creation of this assemblage. While the results are thus far preliminary, the assemblage consists of a high percentage of surface modifications (tooth marks (TM), percussion marks (PM), and cut marks (CM)) and shows clear signs of butchery by hominins at the site.

INTRODUCTION

Mary Leaky conducted much of her work in the main gorge in the Bed I levels (dated between 2.1-1.7mya) at sites such as FLK Zinj, FLK N, FLK NN, and DK. She also excavated at sites in the Bed II levels (dated between 1.7-1.15mya), such as TK and BK in the side gorge. A promoter of the Home Base Model for hominin site use, she interpreted many of these sites as hominin living floors based on the assumption that bones found in association with stone tools indicated active hunting by hominins (Leakey 1971). This broad assumption has since been disproved at many sites. Fossil assemblages can be entirely unrelated to human subsistence even when found in association with stone tools (Brain 1981; Domínguez-Rodrigo 2002; Domínguez-Rodrigo et al. 2007; Egeland & Domínguez-Rodrigo 2008; Egeland 2014; Plummer 2004).

Thanks to these findings, it is uncertain how important meat was to the diet of our early human ancestors or how often they had access to it (Egeland 2012). It is also uncertain how this meat was acquired. Some researchers argue that the animals were hunted (Domínguez-Rodrigo

2002), but others argue that the meat could simply have been actively (Bunn 1993) or passively scavenged (Blumenschine 1991). While the evidence is still controversial, the basic question concerning the importance of and access to meat in early human diets can inform how these factors impacted the behavior and evolution of humanity (Bunn 1991; Domínguez-Rodrigo 2002; Moleon et al. 2014). Additionally, broad questions like these are difficult to reach a consensus on considering the taphonomic variation between sites, in which case taking a site-by-site approach to the analysis is appropriate.

Therefore, the purpose of this research is to identify the general patterns of site use at the site of BK East through analysis of its faunal assemblage and to thereby expand the database of sites relevant to early hominin behavior.

MATERIALS AND METHODS

As one of the richest sources of evidence for paleoanthropological research, Olduvai Gorge in the Ngorongoro Conservation Area in Tanzania has thus far produced remains from over 60 hominins. It is therefore one of the best places for research on our early human ancestors during the early Pleistocene. Olduvai Gorge is about 295 feet deep, consists of both a main gorge and a side gorge, and is made up of seven stratigraphic formations (Beds I-IV, the Masek Beds, the Ndutu Beds, and the Naisiusiu Beds) ranging from 2.1 million to 15 thousand years old (Hay 1976; Figure 1).

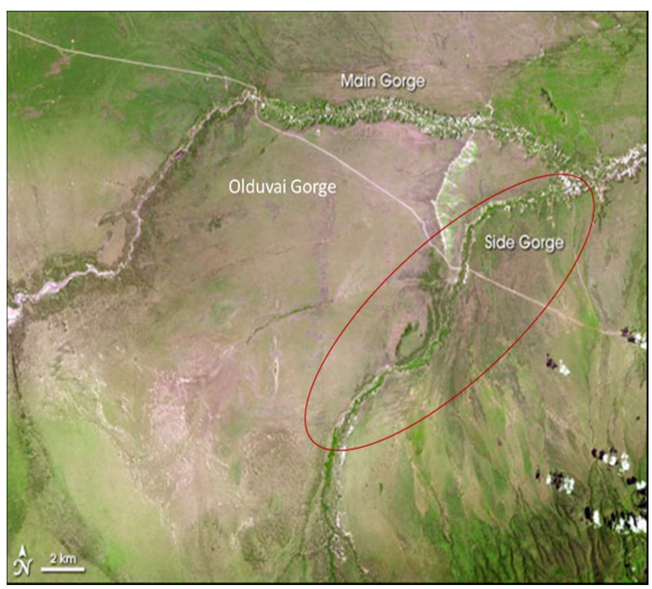

Figure 1. Aerial View of Olduvai Gorge (photo taken through Google Maps)

With excavations starting in 2014, Bell's Korongo East (BK East; c. 1.4 ma) has been found to produce a rich assemblage of lithic materials and well-preserved faunal remains, some of which bear butchery marks. BK East is located in Olduvai's side gorge in Bed II, just around the corner from Leakey's BK site. The site was formed in an alluvial setting, most likely within the channel of a low-energy braided river system, specifically on a riverbed. Excavations were conducted in Levels 1-3, with Level 1 being the most recent. Level 3 was found to contain a likely intrusion caused by runoff during the rainy season, so the specimens from the potentially affected plots were not included in this analysis.

The faunal assemblage consisted of 106 of the specimens measuring >2cm that were recovered from the BK East site over the summer of 2018. Before removal for curation, their orientations and inclinations were taken with a Brunton compass. The aspect of the specimen facing skyward upon exposure was recorded, along with each specimen's exact location (X, Y, Z) using the total station. Data collection for the specimens was conducted back in camp (Table 1). These data were to reconstruct the taphonomic history of

Data Collection
Excavation level & unit
Taxa & body size class (Brain 1981; Bunn 1986)
Skeletal element & portion (Blumenschine 1988, 467)
Diaphyseal section (Bunn 1982)
Side & side up
Max. length & width
Degree of fusion
Breakage features (green, dry, or excavator; fracture angles; notches)
Presence or absence of landmarks (Lam et al. 1999; Hill 2001)
Presence and location of surface modifications (CM, TM, PM; Blumenschine et al. 1996; Dominguez-Rodrigo 1997)
Taphotypes (Dominguez-Rodrigo 2015)
Dentritic etching
Gastric etching (Lyman 1994)
Subaerial weathering (Behrensmeyer 1978)
Trampling
Sediment abrasion (Behrensmeyer et al. 1986)

Table 1. Data collected and recorded in the BK East database

the site, such as the types of fauna in the accumulation, the parts of the carcasses being deposited at the site, the agents processing and consuming these carcasses, how intensively the carcasses were being processed, and how long the elements were left out on the landscape.

The data analysis began with basic organization in Microsoft Excel. The analysis was conducted for both the total sample and by excavation level; consideration of the total sample was for a general overview of meat-eating activities at the site while the contrast between levels was to study change in site use over time. The Number of Identified Specimens (NISP) and the percentage NISP relative to the entire sample (%NISP) were calculated for the various taxa by body size, the element frequencies, skeletal portions, the diaphyseal sections, and the weathering stages. Raw counts were tallied for surface modifications.

Skeletal abundance was calculated using Number of Distinct Element (NDE) tallies since this method is more standardized and does not suffer from aggregation effects (Morin et al. 2017). Due to the small sample size, the NDEs were calculated by general body size (small = body sizes 1-2; medium = body size 3; large = body sizes 4+) rather than by taxon (Egeland and Domínguez-Rodrigo 2008). Next, to test for density-mediated attrition, Lam et al.'s (1999) mean mineral density values for specific sections of *Connachaetes taurinus* elements were aligned with Hill's (2001) landmarks as closely as possible. These landmarks and density values were then correlated with each landmark's NDE tallies. By doing this, any potential skew in the data due to preferential preservation based on density is taken into account and corrected for

TAXON	LEVEL 1	LEVEL 2	LEVEL 3
Alcelaphini (3a)	1	2	-
Bovid (3b + 4)	2	41	24
Bird	-	-	1
Crocodile	-	-	1
Fish	-	1	2
Hippo	1	-	-
Mammal	-	3	-
Probiscidean	1	-	-
Suid	-	1	-
Ungulate	2	12	6
US	-	3	2

Table 2. Distribution of taxa by level

by means of focusing on bones with high survival rates. These bones include the cranium, mandible, and limb bones, whereas bones with low survival rates include small, compact bones as well as axial elements (Egeland and Domínguez-Rodrigo 2008).

RESULTS

Assemblage composition and site integrity

Over half (67 of 106) of the specimens in this sample come from bovids, with 23 of these being Size Class 3 animals (Table 2). Other ungulates make up another large chunk of the sample. Also noteworthy is the presence of a suid, three fish, a crocodile, and a hippopotamus. The NDE for the total sample of 106 specimens is 30, with the most specimens coming from Level 2 and the least from Level 1 (Table 3). Medium-sized animals are the most typical in this sample (21 of the 30), followed by small animals (7 of the 30).

Size	Level 1	Level 2	Level 3
S	-	4	3
M	2	10	9
L	-	2	-

Table 3. NDE distributions by level

Most specimens showed <50% diaphyseal circumference, so preferential discard is not a major source of bias. Preferential preservation by mineral density was tested by analyzing its correlation with each element's NDE value per level. None of the levels showed statistically significant evidence for density-mediated attrition (r_{L1} = -0.16, r_{L2} = 0.01, r_{L3} = -0.20; Figures 2-4).

Skeletal element frequencies

The NISP for skeletal elements shows a combination of both axial and appendicular elements (Table 4). However, since Level 2 shows evidence for preferential preservation due to density the elements with high survival rates will be better represented. The weathering stages

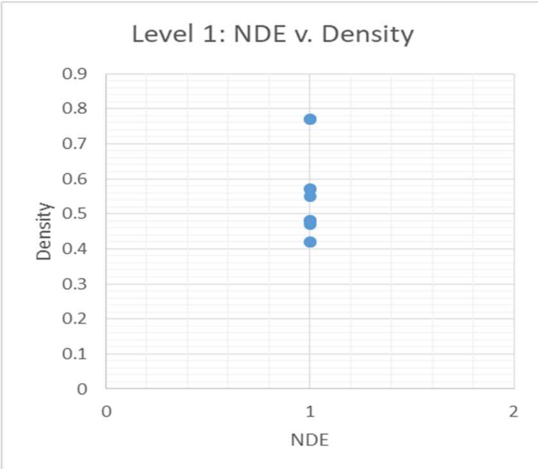

Figure 2. Density-Mediated Attrition for Level 1

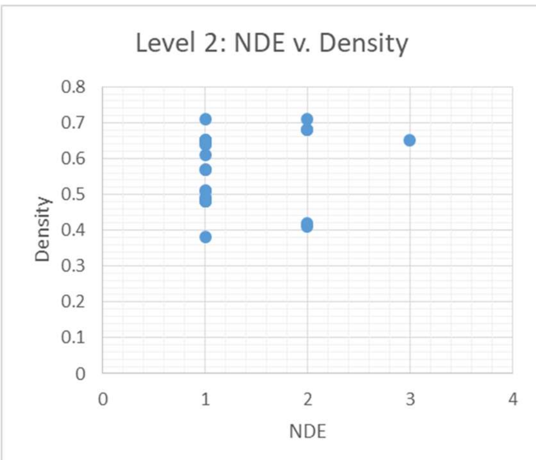

Figure 3. Density-Mediated Attrition for Level 2

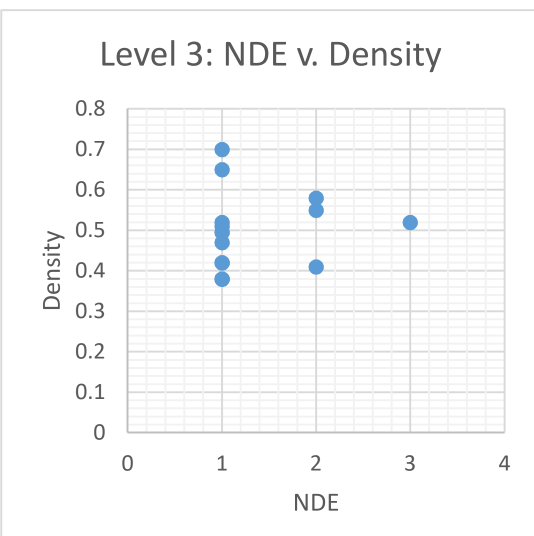

Figure 4. Density-Mediated Attrition for Level 3

that could be determined were predominantly found to be at either stage 1 or 2, with only five specimens at stage 3.

ELEMENT	LEVEL 1	LEVEL 2	LEVEL 3
Caudal Vertebra	-	1	-
Cervical Vertebra	-	-	1
7th Cervical V.	-	-	1
Cranial	-	1	-
Flat Bone	-	1	1
Femur	-	4	1
Humerus	-	6	1
Innominate	-	2	-
Long Bone	2	11	3
Lumbar Vertebra	-	-	3
Metacarpal	-	2	1
Mandible	1	2	4
Metatarsal	-	3	-
1st Phalanx	-	-	1
Rib	-	7	2
1st Rib	-	-	1
Radius	-	2	4
Scapula	-	3	1
Tibia	2	5	2
1st Tarsal	-	1	1
Thoracic vertebra	1	-	2
Ulna	-	1	-
Unspecified	-	5	5

Table 4. NISP by skeletal element

Bone surface modifications

Preservation of the cortical surfaces of the assemblage at BK East is typically excellent, although about eight specimens were covered with matrix to varying degrees. As for surface marks, the specimens show 14 instances of tooth marks (13.2%), 8 of cut marks (7.6%), and 6 of percussion marks (5.7%). The total number of specimens with surface modifications is 27 out of 106 total (25.5%), with tooth marks being the most common form (Table 5-8). Aside from a proboscidean, two ungulates, and a turtle/tortoise, all of the bones bearing surface modifications were bovid. Additionally, all but eight of the

Surface Modification	Level 1	Level 2	Level 3
TM	1	10	3
CM	-	5	3
PM	-	4	2

Table 5. Raw counts of specimens displaying surface modifications by level

Element	S	M/L
Femur	-	2
Humerus	4	3
Long bone	-	5
L. Vertebra	-	-
Metacarpal	2	-
Mandible	-	1
Metatarsal	-	-
Rib	-	-
Radius	-	2
Scapula	-	6
Tibia	-	4
Ulna	-	1

Table 6. Tooth mark frequencies by skeletal element

Element	S	M/L
Femur	-	12/5
Long bone	-	7
L. Vertebra	8	4
Rib	3	-
Radius	-	2

Table 7. Cut mark frequency by element

Element	M/L
Femur	1
Humerus	2
Metatarsal	2
Radius	3

Table 8. Percussion mark frequencies by element

elements showing surface modifications were medium-sized animals. Of those surface modifications for which location on the element was recorded, marks on the mid-shaft were most common. Only one specimen, a size 3a bovid radius from Level 2, showed more than one type of surface modification (Specimen #209; a cut mark overlapped by a tooth mark). This shows at least some evidence for butchery by humans, and the specimen showing overlap shows that in at least one instance humans gained access to a medium-sized bovid carcass before carnivore damage was inflicted.

According to Domínguez-Rodrigo et al. (2015), taphotypes assigned to specific long bones (humerus, femur, radius, ulna, and tibia; must preserve at least a portion of full diaphyseal circumference) can hint at the general taphonomic agent that was modifying the carcass. Taphotype classification system I is numbered from 1-15. Starting with the complete bone (taphotype 1), this category assigns taphotypes based on degree of epiphyseal deletion. Classification system II is numbered from 0-8 and is based on the location of tooth marks and furrowing on the bone, starting with no modifications (taphotype 0). Therefore, taphotypes from Classification System I and II were assigned to specimens where possible. The taphotypes recorded for the BK East assemblage was then compared to the taphotypes typical of lions, jaguars, and spotted hyenas, and were found to align most closely with lions (Ibid, 40; Table 9).

Element	Taphotype I	Carnivore taxa	Taphotype II	Carnivore taxa
Tibia	1	Lion, jaguar, spotted hyena	0	Lion
Femur	6	N/A	0	Lion
Tibia	4	Spotted hyena	0	Lion
Humerus	15	None	1, 3	Lion, jaguar, spotted hyena
Radius	13	None	1	Lion, jaguar, spotted hyena

Table 9. Assigned taphotypes as compared with which carnivore taxa most commonly cause the damage resulting in those taphotypes

DISCUSSION

Since different taxa are adapted to specific environments their remains can provide very broad environmental context for the site. Alcelaphines, for example, prefer the open savanna grasslands and suids typically prefer semi-open environments. Crocodiles, fish, and hippopotami need habitats with sources of permanent, slow-moving or standing water. Therefore, the taxanomic frequencies fit well with Hay's (1976) findings that this site would have existed near a paleolake. A riverbed was located in the same general area as open and semi-open savanna habitats, as well as some sort of permanent water source such as a lake. The evidence from the weathering stages additionally suggests that these bones were not left out on the landscape for very long (Behrensmeyer 1978).

Based on the surface modifications and especially so with Specimen #209, it is very likely that humans were gaining at least some primary access to both meat and marrow at BK East. The percentage of all specimens from the BK East faunal assemblage in this sample that show surface modifications is also impressive (25.5%). Based on the taphotype analysis from Domínguez-Rodrigo et al. (2015), lions were the most likely carnivore modifiers of the BK East assemblage based on a very small sample size from BK East. While preferential preservation does not appear to bias the faunal assemblage data, it is important to take into account that the five recorded taphotypes for the BK East assemblage were not compared to those taphotypes typical of hominins, and that carnivores aside from lions could also have contributed to the assemblage.

CONCLUSIONS

During the Early Pleistocene, human evolution took an important turn away from apes and towards modern humans through the creation and use of modified stone tools and the access to, butchery, and regular consumption of large animals (over 10 kg). This is evidenced by the accumulations of artifacts such as animal bones, plant remains, and stone tools these early humans left behind at the world's earliest archaeological sites (Potts 1991). These developments were especially important because they led to further developments, such as the transportation of materials to home bases (Potts 1991) and an increase in brain size at the expense of more efficient digestion. However, the degree to which meat eating and hunting by hominins was important at BK East remains unclear.

There is still much work to be done with this assemblage. Statistical testing for any significant differences between the three levels must be conducted. The sample size should be expanded as well, as it is very small. Data comparisons with actualistic studies must also be completed in order to obtain at least a generalized answer to the question of what taphonomic agents contributed to the formation of this assemblage.

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