Hominin-Carnivore Competition at Pleistocene Springs in Olduvai Gorge

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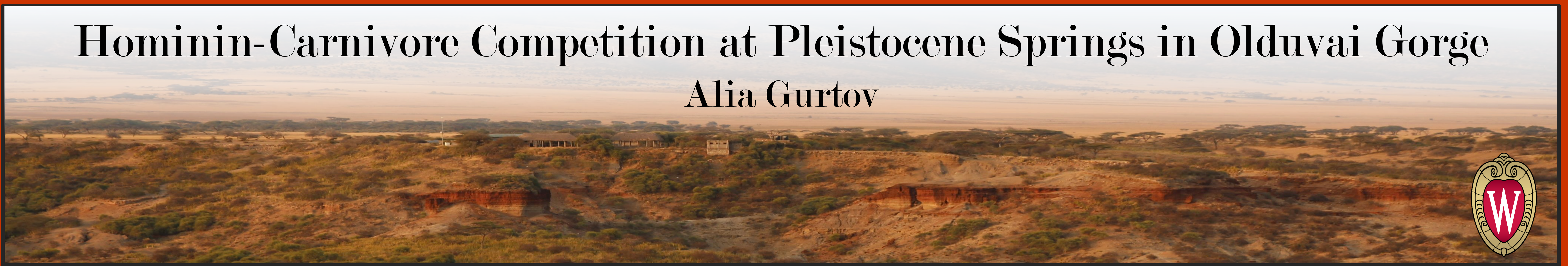


ABSTRACT

By 2.0 Ma, it is clear that hominins had begun eating archaeologically-visible quantities of meat. The persistent acquisition of meat placed hominins in competition with carnivores. In the extant African large carnivore guild, dominant species exert pressure on subordinate species to offset their activity times so as to avoid intraguild predation and kelptoparasitism (Hayward and Slowtow 2009). This temporal niche construction is constrained by the great degree of overlap in preferred prey types. As recent interlopers into the carnivore guild, hominins likely occupied a subordinate position within the carnivore hierarchy. As omnivores, however, they were not constrained by diet in the same way as their carnivore contemporaries. Did hominins minimize intra-guild competition by utilizing key habitats during seasons of reduced carnivore presence?

Here I present the first use of dental microwear texture analysis (DMTA) to explore hominin meat-foraging seasonality in Bed I of Olduvai Gorge, Tanzania. Pilot research has demonstrated that DMTA is capable of distinguishing between assemblages of impala (*Aepyceros melampus*) hunted by Hadza hunter-gatherers in the wet and dry seasons. Using impala microwear as an analog, I compare the microwear signatures of bovid prey species *Antidorcas recki* and *Parmularius altidens* at anthropogenic FLK Zinj and carnivore-generated FLK North to determine the predominant season of death for each taxon at each site. Both sites accumulated around freshwater springs during comparably xeric periods, contain the same bovid prey species, and provide strong stratigraphic and taphonomic evidence for confined phases of carcass deposition. The results indicate that hominins operated during the same seasons as the large carnivores at waterholes in the paleo-savanna, suggesting direct competition between these taxa.

PILOT STUDY: CAN DMTA DETECT IMPALA SEASON OF DEATH?

Between the years 1986 – 1988 and 2007 – 2012, HT Bunn collected the teeth of Hadza prey animals from observed kills and abandoned seasonal camps. From these collections, 29 impala individuals represented by first or second molars were selected and analyzed using Dental Microwear Texture Analysis (DMTA). Impala are a residential species that modify their diet seasonally, rather than their location as migratory species do. Their diet is categorized as "browser-grazer intermediate," (Gagnon and Chew, 2000). This composition changes seasonally so as to maximize green grass intake in the height of the wet season. As such, they are a good model for the extinct bovid *Antidorcas recki* at Olduvai Gorge, which appears to have been similarly adapted. Various measures of DMTA were then evaluated to determine if microwear tracks the season of death.

PILOT STUDY CONCLUSION

Wet and dry season of death in *A. melampus* can be statistically distinguished by mean heterogeneity

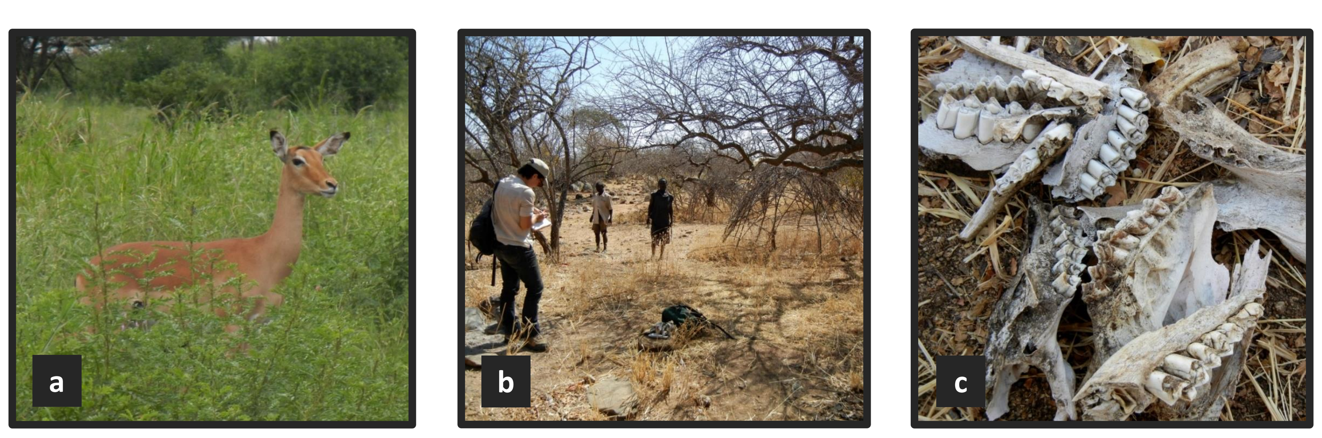


Image a. female impala in the wet season. **b., c.** collecting teeth from an abandoned camp. Photos by HT Bunn.

METHODS

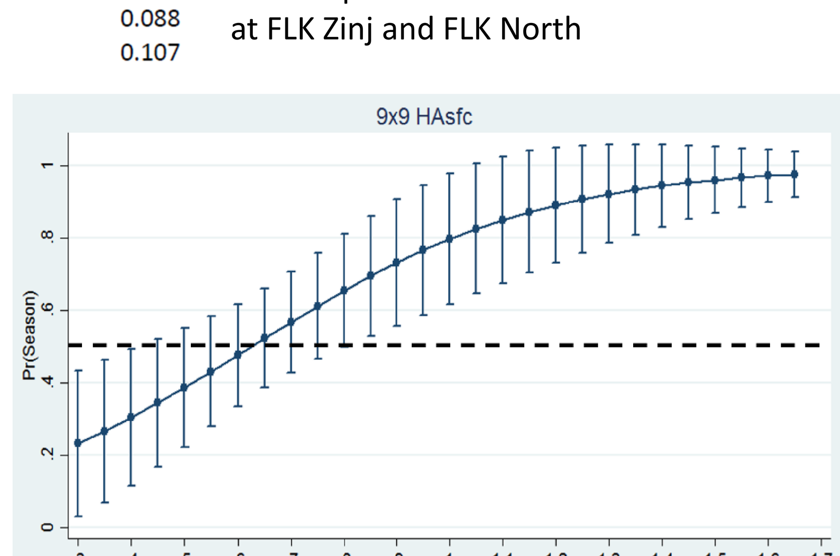
Each tooth was scanned using a white-light confocal profiler microscope at 100x objectification. On each tooth, four adjacent scans were taken along a single enamel cusp. The microwear profiles were then fed into Toothfrax and Sfrax software packages. The means of the resulting values for wet and dry season samples were compared using Satterthwaite's t-test (or Welch's t-test).

PILOT STUDY RESULTS

Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Asfc	0.036	17.682	0.972	0.031	0.885
epLsar	-0.616	11.392	0.550	0.000	0.001
Smc	1.040	20.654	0.310	0.086	0.083
Tfv	-2.024	14.693	0.062	-2029.034	1002.624
2x2HAsfc	0.882	15.289	0.392	0.038	0.043
3x3HAsfc	0.911	18.707	0.374	0.038	0.042
4x4HAsfc	2.082	19.364	0.051	0.091	0.044
5x5HAsfc	0.981	14.693	0.342	0.063	0.064
6x6HAsfc	1.984	20.964	0.060	0.109	0.055
7x7HAsfc	2.067	19.857	0.052	0.134	0.065
8x8HAsfc	1.892	20.160	0.073	0.134	0.071
9x9HAsfc	2.040	23.380	0.053	0.192	0.094
10x10HAsfc	1.818	24.389	0.081	0.161	0.088
11x11HAsfc	1.958	26.579	0.061	0.209	0.107

Table 1. Results of a Satterthwaite's t-test comparing heterogeneity (Hasfc) at multiple scales between *P. altidens* at FLK Zinj and FLK North

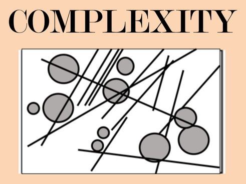
Mean heterogeneity is significantly higher in impala that died in the wet-season. These data suggest that impala in the Hadza hunting range consumed items with a broader range of physical properties in the wet season, or that grit obscured microwear variability in the dry season. This pilot study is a successful preliminary step towards understanding seasonal hominin meat-foraging strategies in the Early Pleistocene.



Graph 1. Logistic regression showing probability of a value belonging to the wet or dry season for 9x9 HAsfc

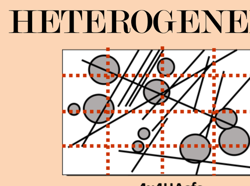
DENTAL MICROWEAR TEXTURE ANALYSIS

COMPLEXITY



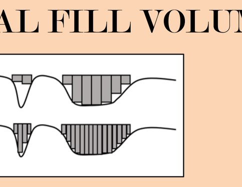
Complexity (*Asfc*) reflects food hardness. More complex surfaces have relief at more scales of measurement. **Scale of maximum complexity (*Smc*)** reflects the size of wear-causing particles.

HETEROGENEITY



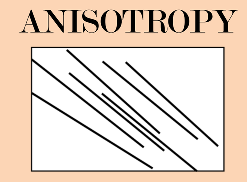
Heterogeneity of Asfc *(HAsfc)* reflects differences in the size and variability of wear-causing particles. More heterogeneous surfaces have more variable textures across the measured surface.

TEXTURAL FILL VOLUME

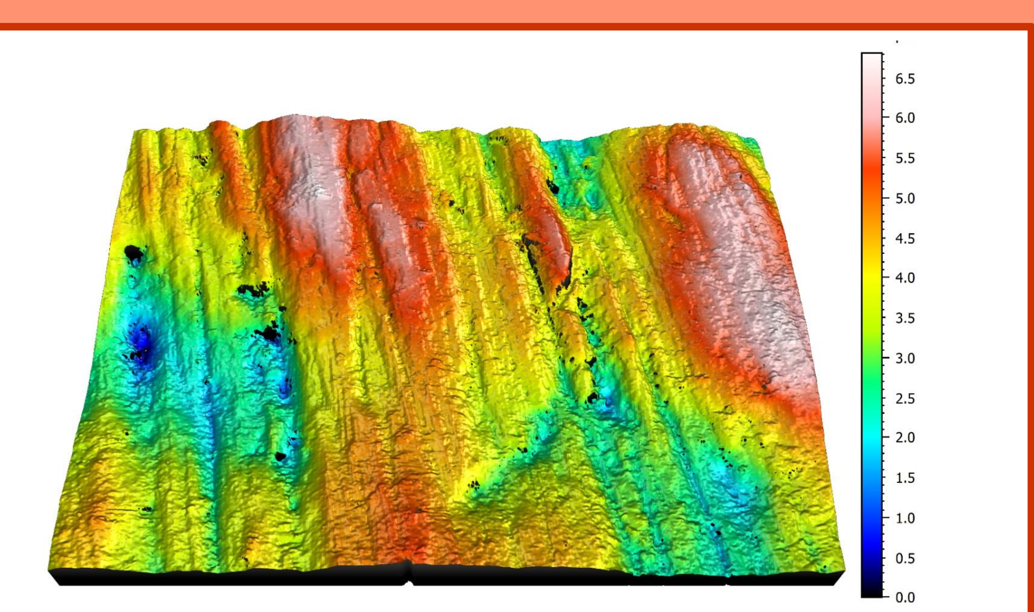


Textural fill volume *(Tfv)* is total fill volume minus structural fill volume. More pitted surfaces have higher *Tfv*.

ANISOTROPY



Exact proportion Length-scale anisotropy of relief (*epLsar*) is a proxy for food toughness. The more parallel the striations on the teeth, the tougher the diet. The variable is



FOSSIL STUDY RESEARCH QUESTION

What does DMTA tell us about seasonal meat foraging by hominins at Olduvai Gorge—were they using seasonal niche partitioning to avoid direction competition with carnivores?

BACKGROUND

- Hypotheses about the evolution of the human body plan, behavioral flexibility, and modern life history each presume the substantial inclusion of meat in the diet of early *Homo*.
- The earliest evidence for hominin meat-eating appears in the Early Pleistocene of eastern Africa, when the climate was becoming more arid and seasonal (deMenocal, 2004).
- Seasons dramatically alter the temporal and spatial distribution of food and water, which can intensify the selective pressure to modify behaviors on a seasonal scale.
- Encounter rates with large carnivores increases around waterholes in the dry season, when prey biomass is aggregated around this limited resource.
- Eating more meat placed hominins in direct competition with large carnivores, their former predators. Researchers have suggested that this competition influenced the evolution of hominin body size and technology (Shipman and Walker, 1989).

To evaluate hominin meat-foraging seasonality as a function of carnivore competition, the DMTA of prey animals at anthropogenic FLK Zinj and carnivore-generated FLK North is compared following the methods presented in the pilot study. Predators of *A. recki* are predicted to hunt in wooded environments like FLK Zinj and FLK North year-round, as modern leopards do, while predators of *P. altidens* may have relied on these habitats more in the dry season, like modern lions. Due to casting errors, sample sizes here are small, and this will be corrected in future analyses.

FOSSIL STUDY CONCLUSION

Hominins foraged for the same prey during the same seasons at FLK Zinj as penecontemporaneous carnivores hunted at FLK North

FOSSIL STUDY RESULTS

Table 2. Number of fossil individuals in each sample

Site	N of *A. recki*	N of *P. altidens*
FLK Zinj	5	3
FLK North	14	11

Satterthwaite's t-test for *Antidorcas recki*

Heterogeneity of Area-scale fractal complexity	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig.(2 - tailed)	Mean Difference	Std. Error Difference
2x2HAsfc	4.189	0.056	-0.758	9.647	0.466	-0.051	0.067
3x3HAsfc	2.178	0.158	-1.104	5.175	0.318	-0.146	0.133
4x4HAsfc	0.765	0.394	-0.889	5.499	0.411	-0.116	0.131
5x5HAsfc	1.546	0.231	-1.034	5.641	0.343	-0.186	0.180
6x6HAsfc	0.189	0.669	-0.970	6.604	0.366	-0.159	0.164
7x7HAsfc	0.077	0.785	-0.326	7.997	0.753	-0.052	0.161
8x8HAsfc	0.705	0.413	-0.742	5.985	0.486	-0.158	0.213
9x9HAsfc	0.007	0.935	-0.443	8.030	0.670	-0.110	0.249
10x10HAsfc	0.000	0.983	-0.317	8.032	0.760	-0.085	0.269
11x11HAsfc	0.348	0.563	0.291	16.719	0.774	0.133	0.456

Table 3. Results of a Satterthwaite's t-test comparing heterogeneity (Hasfc) at multiple scales between *A. recki* at FLK Zinj and FLK North

Satterthwaite's t-test for *Parmularius altidens*

Heterogeneity of Area-scale fractal complexity	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
2x2HAsfc	3.041	0.107	1.394	6.100	0.212	0.057	0.041
3x3HAsfc	5.025	0.045	0.056	11.678	0.957	0.003	0.051
4x4HAsfc	5.361	0.039	0.207	11.360	0.839	0.008	0.041
5x5HAsfc	2.803	0.120	0.373	11.900	0.716	0.019	0.052
6x6HAsfc	2.705	0.126	0.505	12.000	0.623	0.028	0.055
7x7HAsfc	1.241	0.287	0.351	7.868	0.735	0.021	0.059
8x8HAsfc	1.206	0.294	-0.606	7.133	0.563	-0.032	0.052
9x9HAsfc	0.059	0.812	-0.363	3.547	0.737	-0.034	0.095
10x10HAsfc	0.029	0.867	-0.302	3.094	0.782	-0.032	0.107
11x11HAsfc	0.048	0.830	-0.357	3.507	0.742	-0.033	0.094

Table 4. Results of a Satterthwaite's t-test comparing heterogeneity (Hasfc) at multiple scales between *P. altidens* at FLK Zinj and FLK North

The results of the Satterthwaite's t-test comparing DMTA between fossil sites suggest that hominins were eating *A. recki* and *P. altidens* at FLK Zinj at the same times of the year as carnivores hunted these species at FLK North. While hominin diurnal activity is a strategy that avoids the larger carnivores, which prefer to hunt at night, it appears that carnivore competition did not drive omnivorous hominins to offset their carnivory on a seasonal basis. In fact, modern hunter-gatherers living in savanna and arid environments in Africa experience their greatest hunting success in the dry season, when competition at waterholes is at its greatest. Under similar circumstances, competitive hominins like those who made FLK Zinj may likewise have faced down carnivores to obtain their prey.

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