Hominin dietary implications of plant nutritional properties from the southern African Lowveld

Emma J. Devereux,1,2,4, Oliver C. C. Paine,2, Corli Wigley-Coetse5,6, Jacqueline Codron3,4,5, Daryl Codron3,4, Christina Ryder3,4, Matt Spoonheimer7, Amanda G. Henry2

1 – Faculty of Archaeology, Stellenbosch University 2 – Nutritional & Isotopic Ecology Lab (NIEL), University of Colorado Boulder 3 – School of Natural Resource Management, Nelson Mandela University, George, South Africa 4 – Scientific Services, Stoksta, South Africa 5 – Flinders University’s Research Park, South Australia 6 – Faculty of Natural & Agricultural Sciences, University of the Free State 7 – Department of Anthropology, Boston College

We present pilot data on nutritional properties (%Crude Protein %Acid Detergent Fiber, or protein/fiber, ratios) of wild plants growing in savanna habitats from SANParks Kruger National Park (KNP), South Africa. Protein/fiber ratios are regarded as good indicators of forage palatability, particularly when comparing leaves (e.g. Chapman et al, 2002).

Part I: Intrag regional plant nutritional variation: Fig. 1-3 plot protein/fiber ratios by plant organ, plant type & habitat. Fig. 2-6 plot leaf values only (known prime foods).

Part II: Interregional plant nutritional variation: Fig. 4-6 Compare Lowveld data with data from the southern African Highveld (Cradle of Humankind National Park) & East Africa (Amboseli National Park, Kenya). Dry season data only.

Introduction

By ~3.5 Ma, hominins began incorporating C₃ plant foods into their diets. Biochemical evidence suggests that East African *Paranthropus* became a C₃ plant food specialist. However, how these C₃ plants were able to meet the nutritional requirements of a large-bodied, hominin primate remains an open question, despite the fact that C₃ vegetation dominates modern savanna ecosystems.

The nutritional profile of plant foods resources from within modern savanna ecosystems, and their plant community composition across Africa, is also poorly understood.

Prior research suggests that plant nutritional variation is related to climate & geography, and significant differences exist between eastern & southern Africa, particularly among C₄ monocots (Paine et al, 2019; 2018).

Here we explore whether nutritional differences can be seen within & between plant species across habitats & seasons in the southern African Lowveld of Kruger National Park (KNP), a potential hominin savanna landscape. We explore the potential drivers of these differences, and compare our results to prior work in the South African Highveld and East Africa.

Our results may help us address questions about the dietary behaviour between eastern & southern African *Paranthropus*.

Methods

We collected plant samples from the dry season in SANParks Kruger National Park, South Africa in July 2018. We have grouped our transects into three broad habitat categories - grassland, woodland & wetland (following Reed et al, 2013) that are representative of landscapes that early hominins are thought to have inhabited. Transects were randomly placed within each habitat type & consisted of Modified-Whittaker sampling plots measuring 20m by 50m, with subplots of varying sizes nested within (Stoichigri et al, 1995). We collected four individual samples of the most abundant grass, sedge, tree & forb species (when available). Samples were separated into their constituent organs for analyses (e.g. seed, leaf, fruit & storage organs).

After measuring toughness values of fresh samples using a portable mechanical tester, we dehydrated them in the field at 40°C, sealed dried samples in paper bags with desiccant & exported them to NIEL for nutritional analyses. We present results for %Crude Protein to %Acid Detergent Fiber ratios. Crude protein was measured with a LECO® FP 528 nitrogen analyser using the standard %Nx0.2 conversion to obtain %CP.

Wet samples were stored in a desiccant. Dry samples were sealed in plastic bags & stored in a −20°C fridge. We used a LECO® (NIR600) for the NIR analysis.

A statistical analysis conducted using LIMMA together with the R Bioconductor package was used to validate the results. A one-way ANOVA was conducted on the plant species belonging to the C₃ groups. These results were compared with the C₄ groups present in the Lowveld.

Acknowledgements

- Our thanks to Dr Daryl Codron & Dr Jaac Codron for their generous, expert help, & to Joanne & Ethan Codron for their good humour.
- Our thanks to SANParks Kruger National Park, Marion Thompson at Shingwedzi, Samantha Malusa & Ginti Mabuza at Stoksta, our game guards Thomas at Stoksta, & Herman at Shingwedzi, & all staff who facilitated us & our fieldwork.
- Many thanks to Jac, Karen & all the staff at Kenjara Lodge, Johannesburg for their hospitality.
- This is a research project, in whole or in part, of the Nutritional & Isotopic Ecology Lab NIEL lab at CU Boulder.
- This PhD project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research & innovation programme, Grant agreement No. 757-777-06 (HARVEST), Project part of the H2020 group at Leiden University.

Keynote

- Nutritional variation in plant food resources can be observed across savanna habitats.
- *A posteriori* models of plant food nutritional values reveal significant inter- & intra-taxon variation, challenging hypotheses regarding food quality & the predominance of certain plant foods in early hominin diet.
- Protein/fiber ratios from South African Lowveld habitats are intermediate between the South African Highveld & East African savanna habitats.
- Nutritional differences were most pronounced among the grasses, indicating that C₃ grasses & sedges can be highly variable. Results suggest some grasses are high quality food resources.
- Such differences may have implications for the different carbon isotope ratios observed between eastern & southern African *Paranthropus*.
- Further analysis of the macronutrient and antifeedant content of these samples is currently taking place, as is elemental analysis of samples from all three regions.