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## Application Note – Extinct Mammal Hair Analysis

The diet of extinct mammals is often inferred from measurements of their tooth wear, after correlating with similar measurements in modern mammals whose diet has been observed. This study explores the correlation between tooth wear in antelopes and stable isotopes of carbon and nitrogen in their hair, with a view to possible inference of diet without examining teeth.

Medium to large-scale wear of mammal teeth (mesowear) has good correlation with indices of diet. An example is attrition by tooth-on-tooth contact (grinding) - measured by sharper cusps and more tooth-relief contrast - versus abrasion by contact with rough food, which causes weaker cusps and less relief. Six specific measurements (e.g. sharpness of cusps, e.g. crown height) have traditionally been combined into the two indices hypsodonty index and mesowear score. Hypsodonty index is more subjective, combining 3 classes of cusp sharpness with 2 classes of relief. Mesowear score is more objective, combining 4 distances measured on a sample tooth.

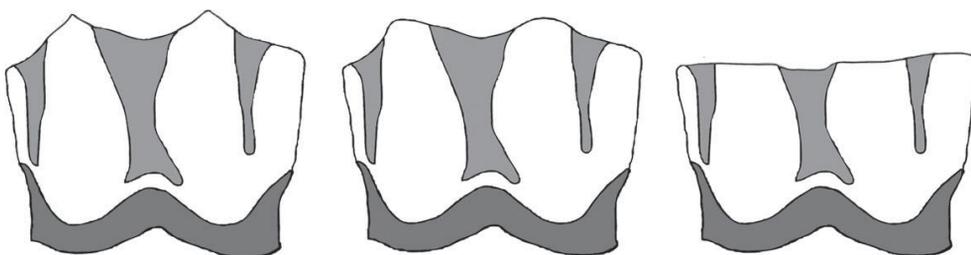


Figure 1 showing sharp cusps (high occlusal relief), round cusps (high occlusal relief) and blunt cusps (low occlusal relief) on antelope teeth

Stable carbon isotope ratio  $\delta^{13}\text{C}$  in a herbivore's hair reflects the proportion in the diet of plants of type C3 versus C4 (the two different types of photosynthesis); in general this allows a distinction between cool-season and tropical plants in the diet. Stable nitrogen isotope ratio  $\delta^{15}\text{N}$  reflects trophic level but is made variable by differences in climate and soil.

Both tooth wear and isotopes in hair are thought to represent diet on a timescale of months to a few years, so tooth wear and isotopes in hair might be expected to have significant correlations.

In the paper, Louys J et al (2012) Stable isotopes provide independent support for the use of mesowear variables for inferring diets in African antelopes \*, molar and hair samples from 104 wild African antelopes from 16 species, held in a Belgian museum, were analysed for mesowear and for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Three upper and three lower molars were measured from each specimen using digital callipers; hair was measured by a Sercon 2022 continuous flow isotope ratio mass spectrometer connected to a GSL elemental analyser.

The isotopic data from each tooth was correlated with the 4 variables used to create mesowear score (24 correlations in total). Results showed that  $\delta^{15}\text{N}$  was significantly correlated with all 4 variables of all six tooth types;  $\delta^{13}\text{C}$  was less well correlated with 3 of the 4 variables, being significant for only one tooth type for 1 of the variables.



Figure 2 The Sercon HS2022, the world's most sensitive small radius IRMS



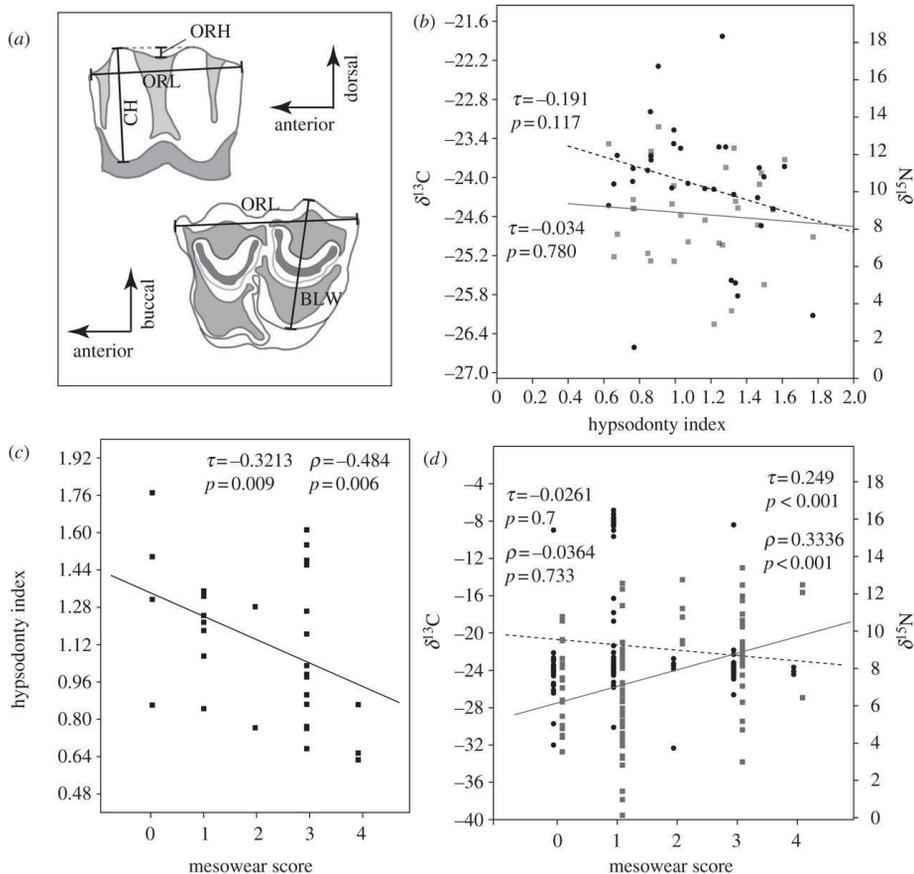


Figure 3 Results and correlations for hypsodonty index, mesowear score and  $\delta^{13}\text{C}$   $\delta^{15}\text{N}$  Isotopes.

In an attempt to reduce internal variability, species averages of isotope ratios were correlated with species percentages for all tooth types of each of the 4 variables used to create hypsodonty index, and with their final mesowear score (10 correlations in total). However, results were less satisfactory, with only one significant correlation, that of  $\delta^{13}\text{C}$  with percentage of round cusps. The authors suggested that significance might be improved if more specimens with undamaged second molars could be found, and if the number of specimens could be increased.

In conclusion, the analysis of carbon and nitrogen isotope ratios in hair from mammals has shown promise in diet characterisation. With significant correlation between mesowear score and  $\delta^{15}\text{N}$ , as well as significant correlation between  $\delta^{13}\text{C}$  and cusp sharpness and occlusal height.

Sercon would like to thank Dr Julien Louys at Griffith University for his assistance in producing this note.

\*Stable isotopes provide independent support for the use of mesowear variables for inferring diets in African antelopes Julien Louys, Peter Ditchfield, Carlo Meloro, Sarah Elton and Laura C. Bishop Proc. R. Soc. B 279, 4441–4446 (2012).