TRIDENT -Surface sampling as diet discrimination enhancement

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TRIDENT – Surface sampling as diet discrimination enhancement

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Abstract:

Since almost three decades, dental microwear has been used as a dietary indicator, Walker et al. (1978). It is commonly accepted that scratches are the result of abrasive grassy diets, that pits mainly result from the consumption of fruit/seeds and that leaves and soft diets produce lower enamel wear. Thanks to progress in microscopy and interferometry, smaller surface details are caught, which makes more accurate fractal analyzes possible. Scott et al. (2006) have proposed several fractal parameters whereas Schulz et al. (2010) have tested the more "industrial" parameters from the ISO 25178 norm in conjunction with the fractal parameters.

In the present work, the authors propose a complementary approach using an enlarged set of parameters: height parameters, spatial parameters and fractal parameters. The dental facets of modern ungulates including the African grazing hartebeest antelope (*Alcelaphus buselaphus*; N=15), the European leaf browsing moose (*Alces alces*; N=15) and the African fruit browsing duiker (*Cephalophus silvicultor*; N=15) were scanned (200 × 280µm) using the Leica DCM8 confocal and interferometric optical profiler.

Instead of solely performing the surface texture analysis over the whole scan surface, we also generate a set of 1024 [512×512 points = 66×66 µm] areas for every scan. Thus, for the 45 individuals and for all parameters mentioned above, we generate *Mean*, *Median*, *5%-* and *95%-quantiles*, *Minimal* and *Maximal* values and the *Mean of the 10 highest values and Mean of the 10 lowest values* over the 1024 automatically generated areas. Surfaces were first treated using a 2nd order polynomial process or using an 8th order polynomial process.

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From the 286 generated parameters, a one-way analysis of variance identifies only 12 as discriminating at best the three species. Most of these 12 parameters are not means but minimum, maximum, value of 5 and 95% quantiles of the field parameters. When generating a Principal Component Analysis with these 12 variables, we identified three groups of correlated variables (Fig. 1). From these groups of variables, the most pertinent are used to perform a K-means classification (without any *a priori* specific assignation). The analysis classifies individuals into three groups highly dominated by a single species (Fig. 1). It is worth noting that the classification produced with the area resampling approach provides better results than the analysis on the whole surface.

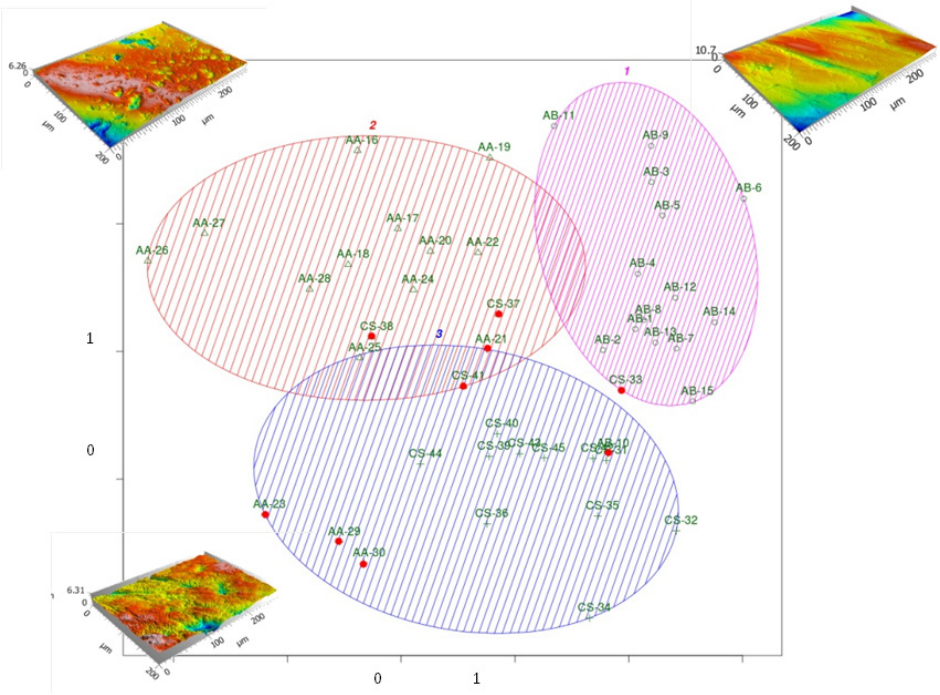

Fig. 1. Principal Component Analysis on the 12 parameters discriminating at best the three species. Dental surface textures of the hartebeest (AB) at the top right, the moose (AA) at the top left and the duiker (CS) at the lowest left corner. The ellipses represent the superimposed results of the K-mean classification based on the three most powerful parameters (misclassified individuals in red dots).

The present study is an exploration of alternative parameters and the way to extract them (resampling procedures or a signal analysis per scan). Our results show that a unique value for a whole area is far from being the best way to discriminate between two surfaces. Resampling areas within a given surface allows for a higher discriminating power by focusing on the distribution on surface texture parameters rather than just on central values. The programming language

used is Fortran; results are formatted with Python scripts and the data are analyzed with R.

References:

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