A reference database of enamel texture microwear in extant rhinoceroses and its relevance for diet reconstruction of the fossil rhinocerotid *Stephanorhinus* (Mammalia, Perissodactyla)

Manon Hullot*[1,2], Manuel Ballatore[3], Pierre-Olivier Antoine[1], Gildas Merceron[4]

*: contact author, email: manon.hullot@umontpellier.fr

1: Institut des Sciences de l'Evolution de Montpellier (CNRS, IRD, Univ. Montpellier, EPHE, France)
UMR 5554, Place Eugène Bataillon, Université de Montpellier Bât 22, CC064
34095 Montpellier cedex 5
2: Ecole Normale Supérieure de Lyon (France)
15 parvis René Descartes, BP 7000, 69342 Lyon cedex 7

3: Via Antico Filatoio 7, Collegno (Italy)
4: PalEvoPrim (CNRS, Univ. Poitiers, France)
UMR 7262, Université de Poitiers Bât B35, TSA 51106
6 rue Michel Brunet, 86073 POITIERS Cedex 9

Background

Climatic changes might affect the ecology, the geographical distribution, and the lifespan of taxa. In the **late Pliocene–early Pleistocene** interval, major climatic variations and associated shifts in vegetation occurred in Europe, resulting for instance in the expansion of grasslands in Mediterranean regions.

We chose to study the impact of these climatic changes on rhinoceros diets using **dental microwear texture analyses** (i.e., DMTA) because:

- rhinoceroses are abundant and diverse in the fossil record [1];
- extant rhinoceroses have **various** herbivorous **diets** (Fig. 1);
- DMTA is a powerful tool to study diet and infer paleodiets.

We focused on three **French** samples of distinct species of ***Stephanorhinus*** of different ages and localities (see materials).

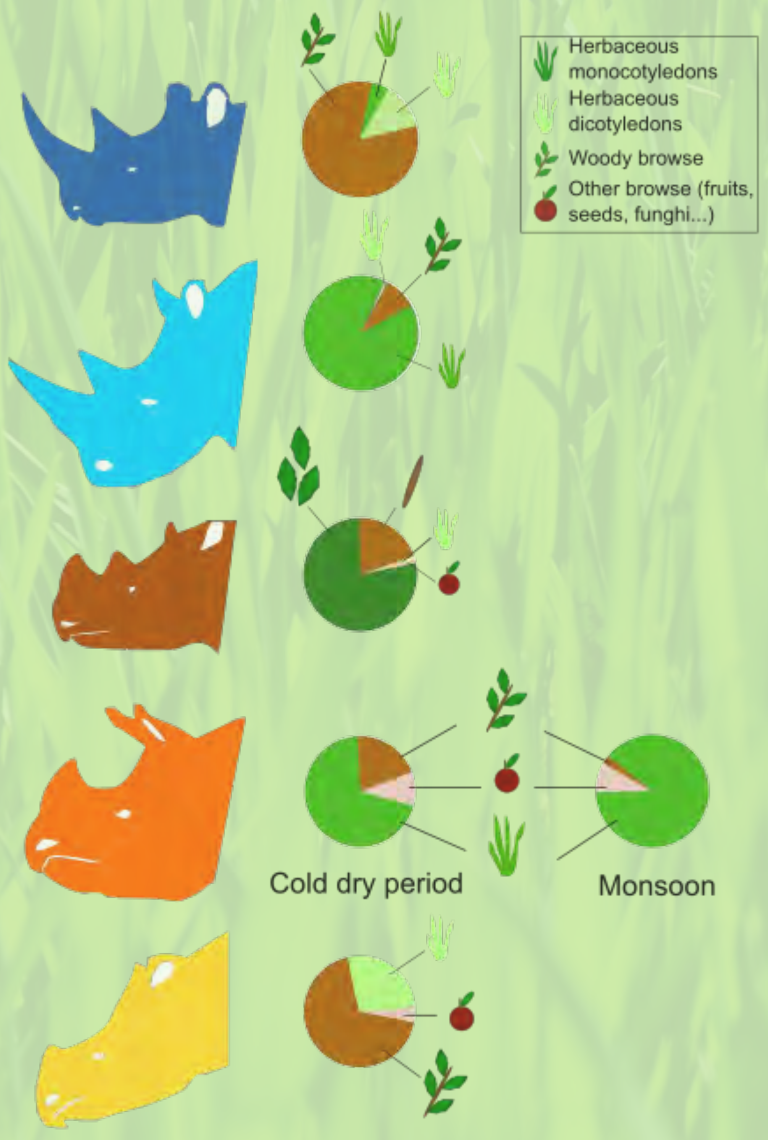

Figure 1: Diets of the extant rhinoceroses
Dark blue: *Diceros bicornis* (black rhinoceros), light blue: *Ceratotherium simum* (white rhinoceros), brown: *Dicerorhinus sumatrensis* (Sumatran rhinoceros), orange: *Rhinoceros unicornis* (Indian rhinoceros), yellow: *Rhinoceros sondaicus* (Javan rhinoceros).

Materials & Methods

We conducted DMTA [2] on shearing and grinding facets (Fig. 2) of the protocone and protoconid/hypoconid of molars first in extant rhinoceros. We built a database with 62 wild shot specimens distributed in the five living species.

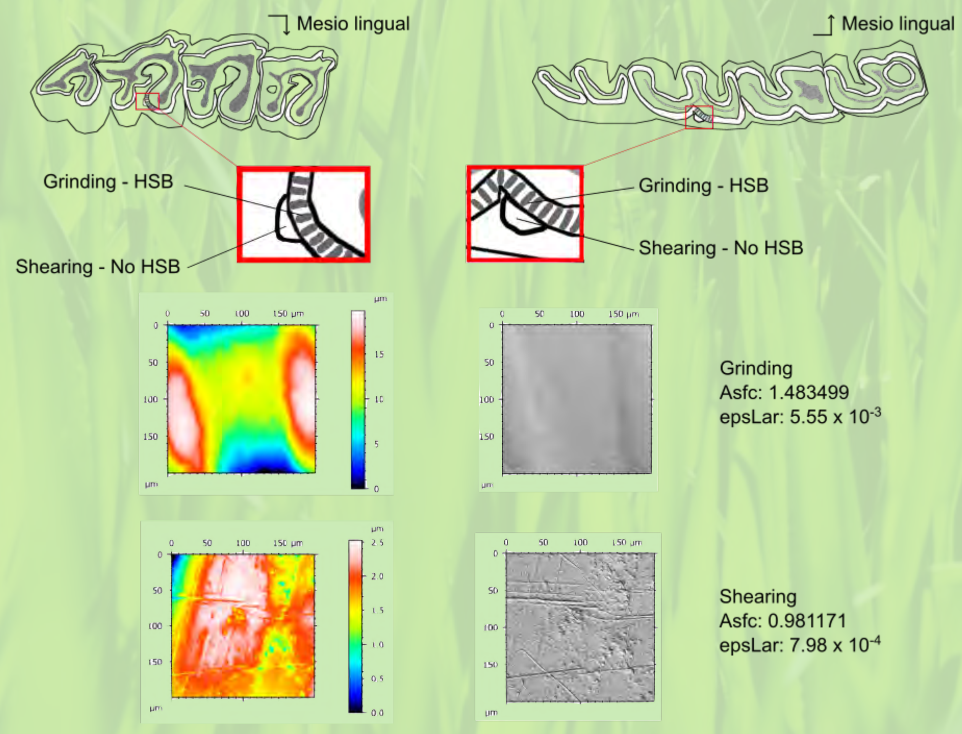

Figure 2: Precise localisation of the studied facets on second upper (left) and lower (right) molars.

Figure 3: Location of the sites
M: Montpellier, ~5.3 - 4.5 Mya, *S. megarhinus* (specimens from the collections of Montpellier); S: Sénèze, ~2.21 - 2.09 Mya, *S. etruscus* (© wsnyder); V: Vialette, ~3.1 Mya, *S. elatus* (author unknown).

Then, we used this database to infer the diet of the three fossil samples of *Stephanorhinus* from France (Fig. 3). All specimens (extant and fossils) are kept in various European museum collections.

White rhinoceros and its calf grazing

Results

We calculated and plotted the mean and standard deviation for three textural parameters (Fig. 4), from top to bottom: anisotropy (epsLar), complexity (Asfc) and fine textural fill volume (FTfv).

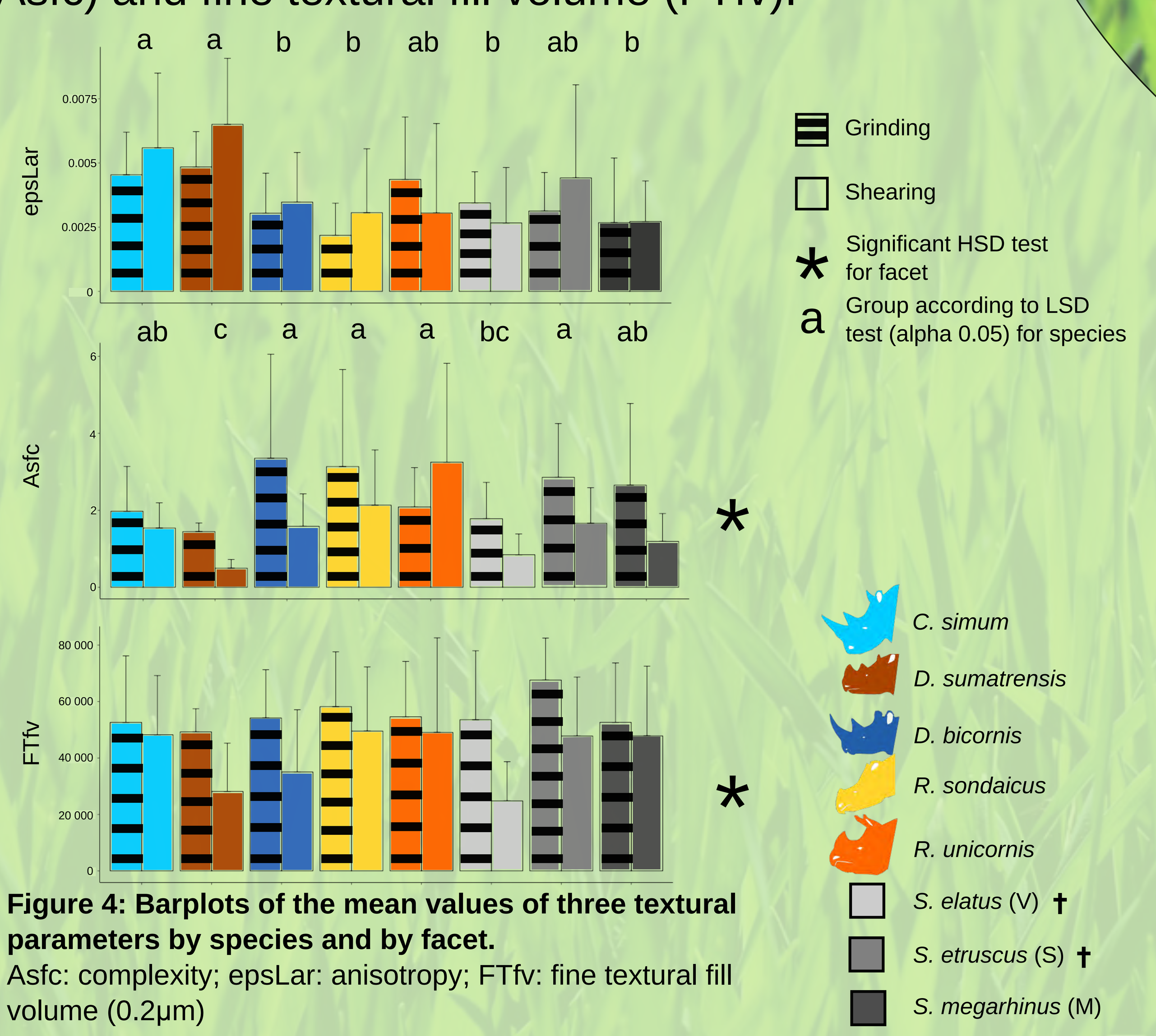

Figure 4: Barplots of the mean values of three textural parameters by species and by facet.
Asfc: complexity; epsLar: anisotropy; FTfv: fine textural fill volume (0.2µm)

Concerning the statistics:

- **MANOVA** on box cox transformed data suggested **differences by facet** (df= 1, p-value ~10^{-5}) and **species** (df= 7, p-value > ~4.10^{-5}). For fossils alone, no interspecific differences (df= 2, p-value ~0.1).
- **ANOVA** revealed that anisotropy explains interspecific differences, FTfv facet differences and complexity both (all p-values < 0.01). In Fig. 4, the results of post-hoc tests are shown when significant.

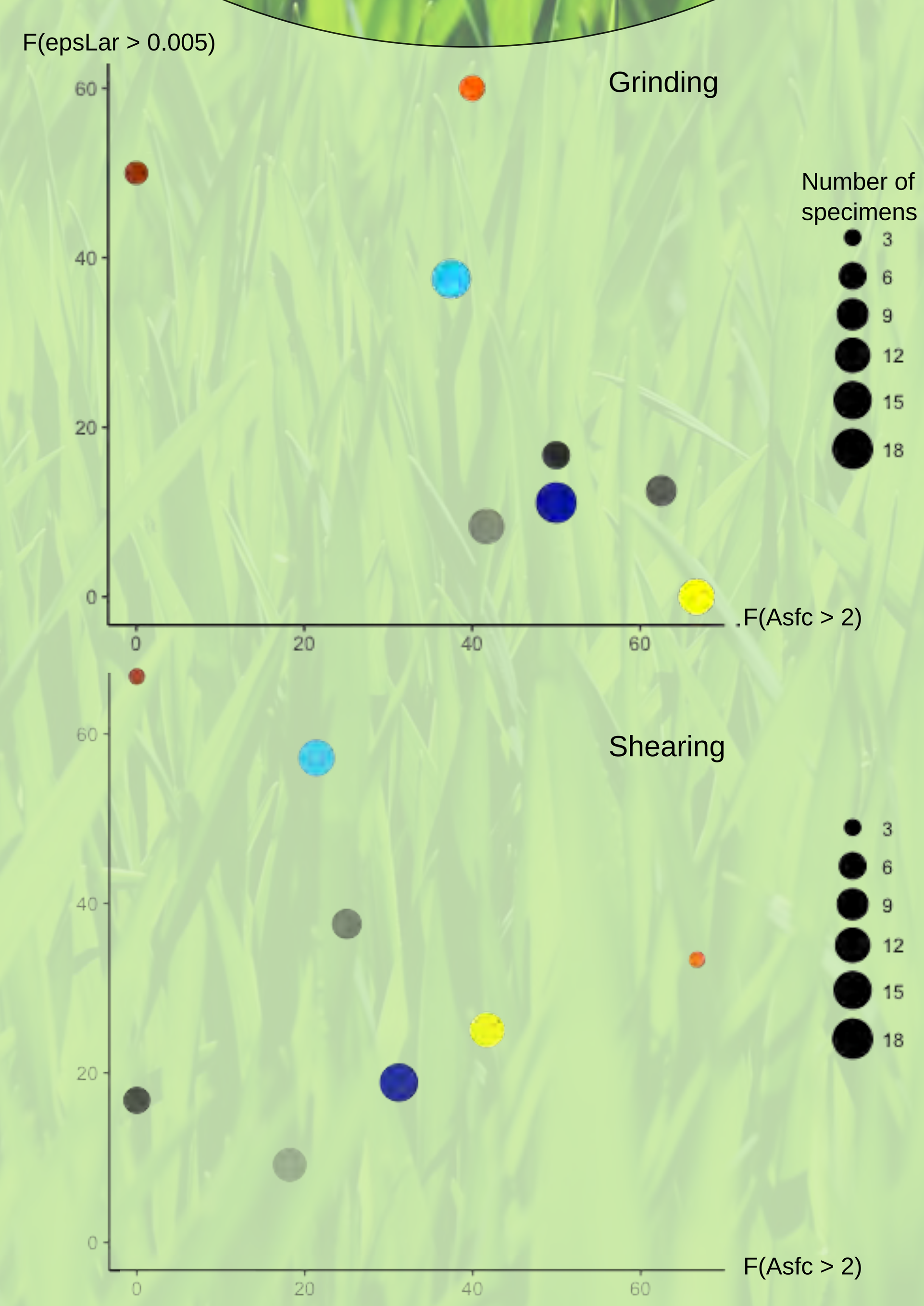

Figure 5: Bubble charts of the percentage of anisotropic specimens against that of complex ones.

Few fossil specimens are anisotropic ([3,4]; epsLar > 0.005): less than 20% for both facets and species, except for shearing of *Stephanorhinus etruscus* (Fig. 5).

Discussion and Conclusions

- **Extant** species display **significant differences** in their microwear. The high anisotropy for the Sumatran rhinoceros was unexpected but might be due to bamboo and tough leaves consumption.
- Both facets provided complementary results:
  Grinding facet: the three *Stephanorhinus* samples cluster with the extant browsers *D. bicornis* and *R. sondaicus*, pointing towards **similar browsing paleodiets** for all three fossil samples.
  Shearing facet: differences between fossils and between fossil and extant samples might be due to paleodiets with **no real living analog** and/or to **different masticatory processes**.
- A browsing diet for ***S. etruscus*** sample implies the **persistence of local forested patches** during the **Pleistocene** around **Senèze**. Yet, the greater prevalence of anisotropic specimens for this sample might reflect the incorporation of **tough items in the diet** such as grasses or leaves.

References

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