Footprints in the Landscape: Quantifying Bioturbation in Soils and Paleosols with Multistripe Laser Triangulation (MLT) Technology

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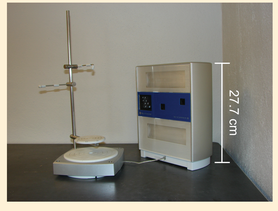
Purpose

- Use new MLT technology to quantify traces made from bioturbation

Methods

- We used a NextEngine 2020i MLT scanner

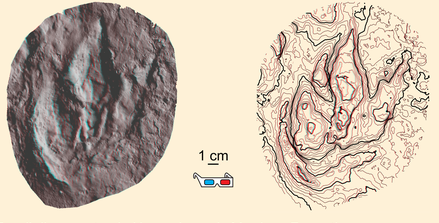
Lab set up



Field set up

Results

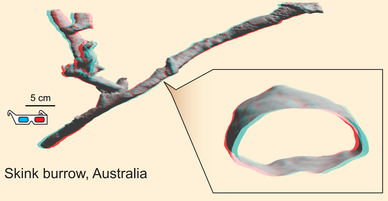
1. Stereo anaglyph images and contour maps



Fossil dinosaur track, Upper Jurassic Morrison Formation,
Contour interval = 1 mm

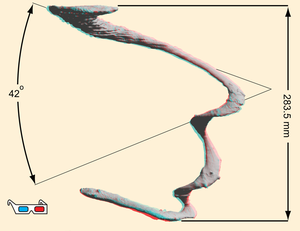
= indicates image can be viewed with 3D glasses

2. Cross-sections

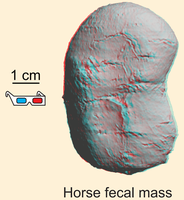


Skink burrow, Australia

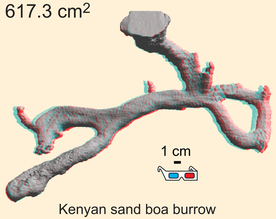
3. Length, angle, volume (V), and surface area (SA)



Brown scorpion burrow, Australia
V = 246.5 cm^3
SA = 617.3 cm^2



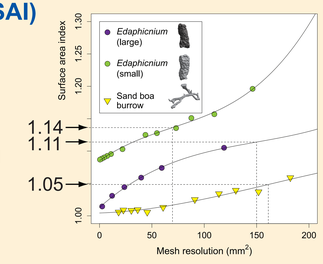
Horse fecal mass
V=44.5 cm^3
SA=73.0 cm^2



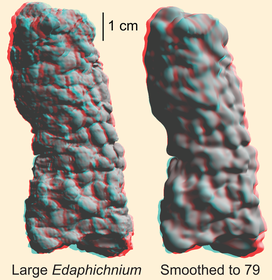
Kenyan sand boa burrow
V=516.7 cm^3
SA=910.9 cm^2

4. Surface area index (SAI)

- SAI = $\frac{\text{actual SA}}{\text{smoothed SA}}$
- We smoothed models by reducing the number of constituent polygons
- We graphically determined a standard smoothing amount for digital models.

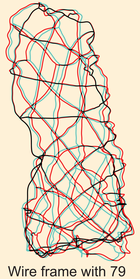


Small *Edaphichnium* (fossil earthworm castings, Paleogene)



Large *Edaphichnium* actual SA

Smoothed to 79 polygons



Wire frame with 79 polygons

- Visibly rougher traces have higher SAI values

5. Volume exploited (VE) and relative compactness (RC)

$$VE = \frac{\text{V of burrow}}{\text{V of bounding box}} \cdot 100 \qquad RC = V^{\frac{2}{3}} \cdot \frac{4.84}{SA}$$

VE = 1.2
Tiger beetle larva burrow

VE = 11.5
Wolf spider burrow

RC = 0.9
Fossil bee cell, Eocene-Oligocene

Significance

- Measurement precision is improved with MLT technology
- Burrow and track volumes provide information about porosity, compaction, aeration, drainage, soil turnover, and soil mixing rates
- Fecal volume can be used as a measure of soil additions
- Burrow surface areas are informative for gas exchange, water availability, and mineral weathering
- SAI values are characteristic of different bioturbators
- VE and RC measure efficiency of space usage by burrowers

MLT scanner.....$2,995
MLT scanner software.....$995
3D editing software.....$229
Quantitaive measures of the impact of modern and ancient soil biota.....**PRICELESS!**

Acknowledgments

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