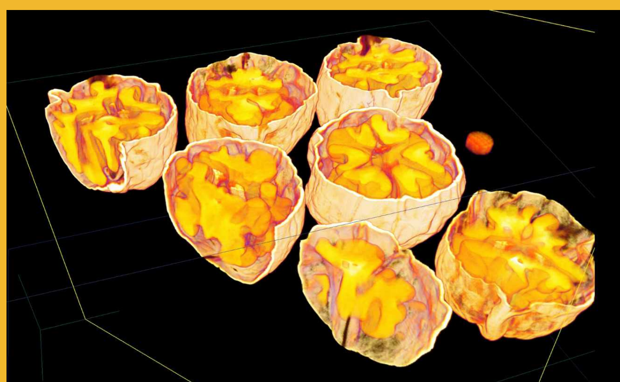
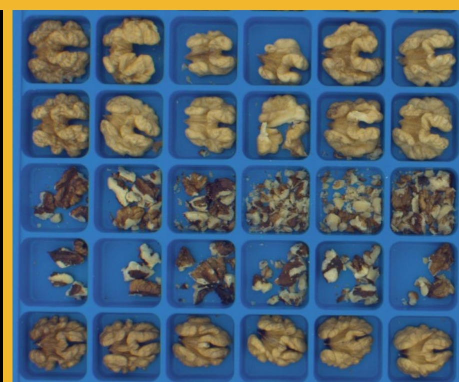
The shape and size of shells, kernels, and cracks —in a nutshell

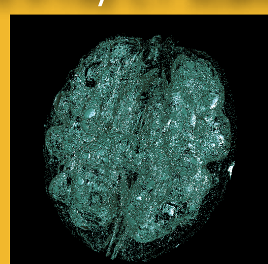


148 accessions X-ray CT scanned

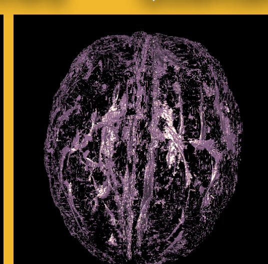


Qualitative crackability

Shell



Air



Packing Tissue

Kernel

Preprint
DOI: 10.1101/2023.09.26.559651

Python Code
github.com/amezqui3/walnut_tda

bioRxiv
THE PREPRINT SERVER FOR BIOLOGY

Phenotyping walnuts with X-ray CT scanning

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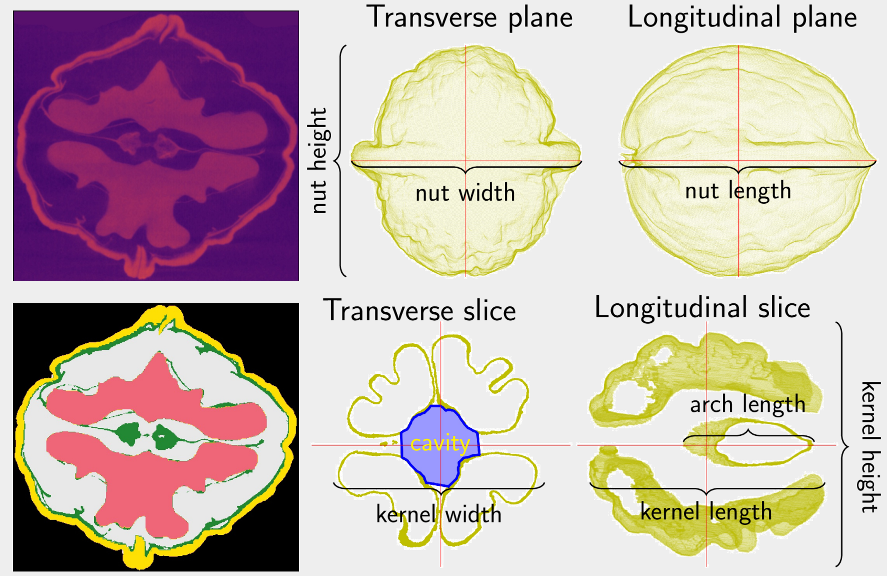
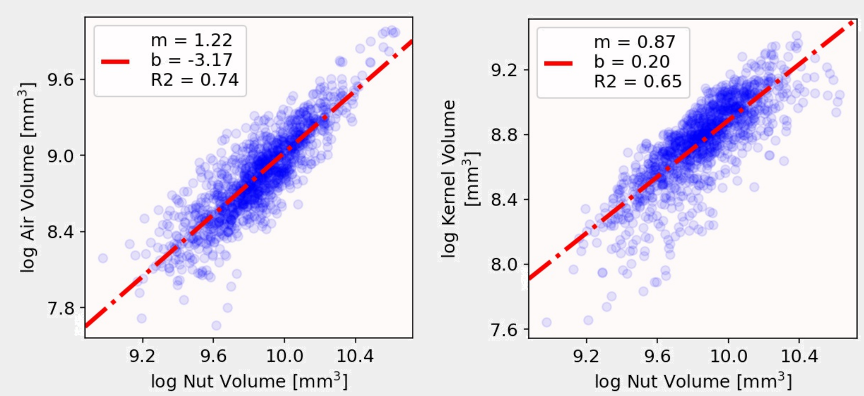
Materials and methods



- 1264 individuals → 149 accessions
- 49 morphological phenotypes:
  ↪ lengths, areas, absolute and relative volumes, …
- 12 traits of commercial interest:
  ↪ kernel weight, ease of kernel removal, shell strength

Allometry reveals biophysical limits



- If nut volume increases by 2X
  ↪Then air volume increases by 2.3X
  ↪Walnut diameter capped at 15cm (6")
  ↪Diameter larger than 1.6cm (⅝")
- If nut volume increases by 2X
  ↪Kernel volume only increases by 1.8X

Acknowledgements

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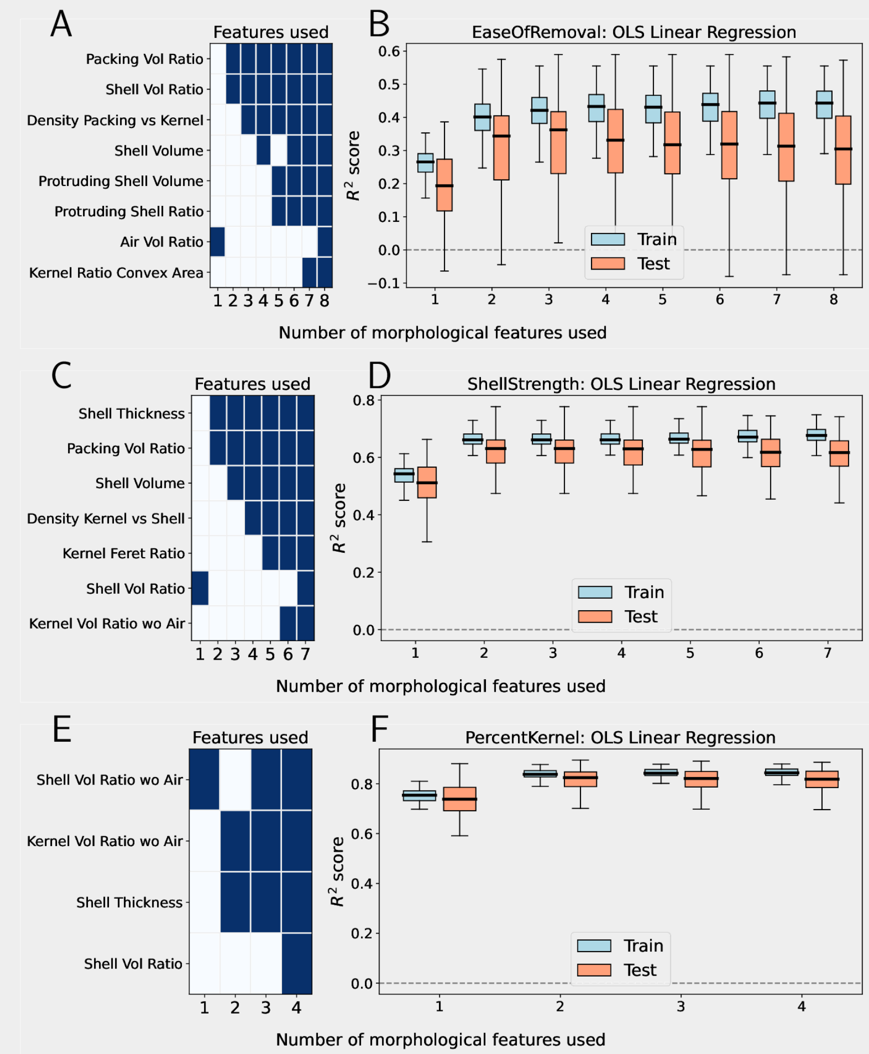
References

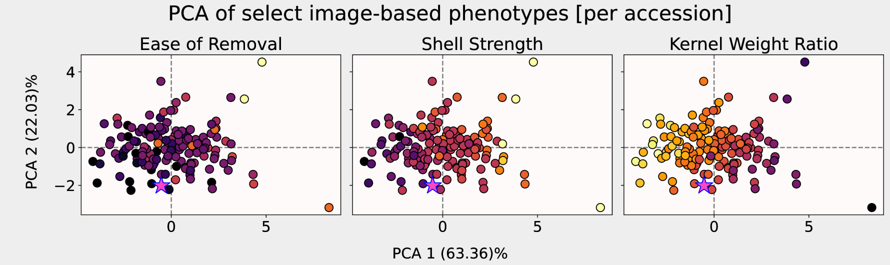
[1] Bernard, A., Hamdy, S., Le Corre, L. *et al.* (2020) "3D characterization of walnut morphological traits using X-ray computed tomography," *Plant Methods*, **16**, 115.

Phenotyping → better walnut breeding



- Stepwise linear regression to model commercial traits using only morphological traits
- Determine shape traits that contribute the most to the predictive model
- Perform a 70/30 train/test split to avoid overfitting
- Use only traits with significant Spearman correlation
- **Relative tissue volume and thickness is all you need!**
- Inexpensive phenotyping platforms focused solely on volumetric analyses

Future directions: domestication



- Earliest Himalayan accession is notoriously hard to crack open yet it is morphologically average
- There must be a subtle yet fundamental morphological change when walnut was domesticated
- Inexpensive platforms → More phenotyping
  → More data → Better math models
  → Insights into breeding and domestication