Morphometric study of the *Rotalipora* lineage (planktic foraminifera) during the middle and late Cenomanian

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Introduction

The Cenomanian (Late Cretaceous, ~94-100 Ma) time period can be used to determine planktic foraminiferal evolutionary history and interpret Earth's climatology. Planktic foraminifera are microorganisms that are abundant in the fossil record, making them a valuable group to study. This project examines the evolution of the genus *Rotalipora* (focusing on *R. cushmani*, *R. montsalvensis*, and *R. praemontsalvensis*) and their morphologic variability and relation to one another with the goal to better define the *Rotalipora* phylogenetic tree.

Late Cretaceous 94 Ma

Scotese, PaleoMap
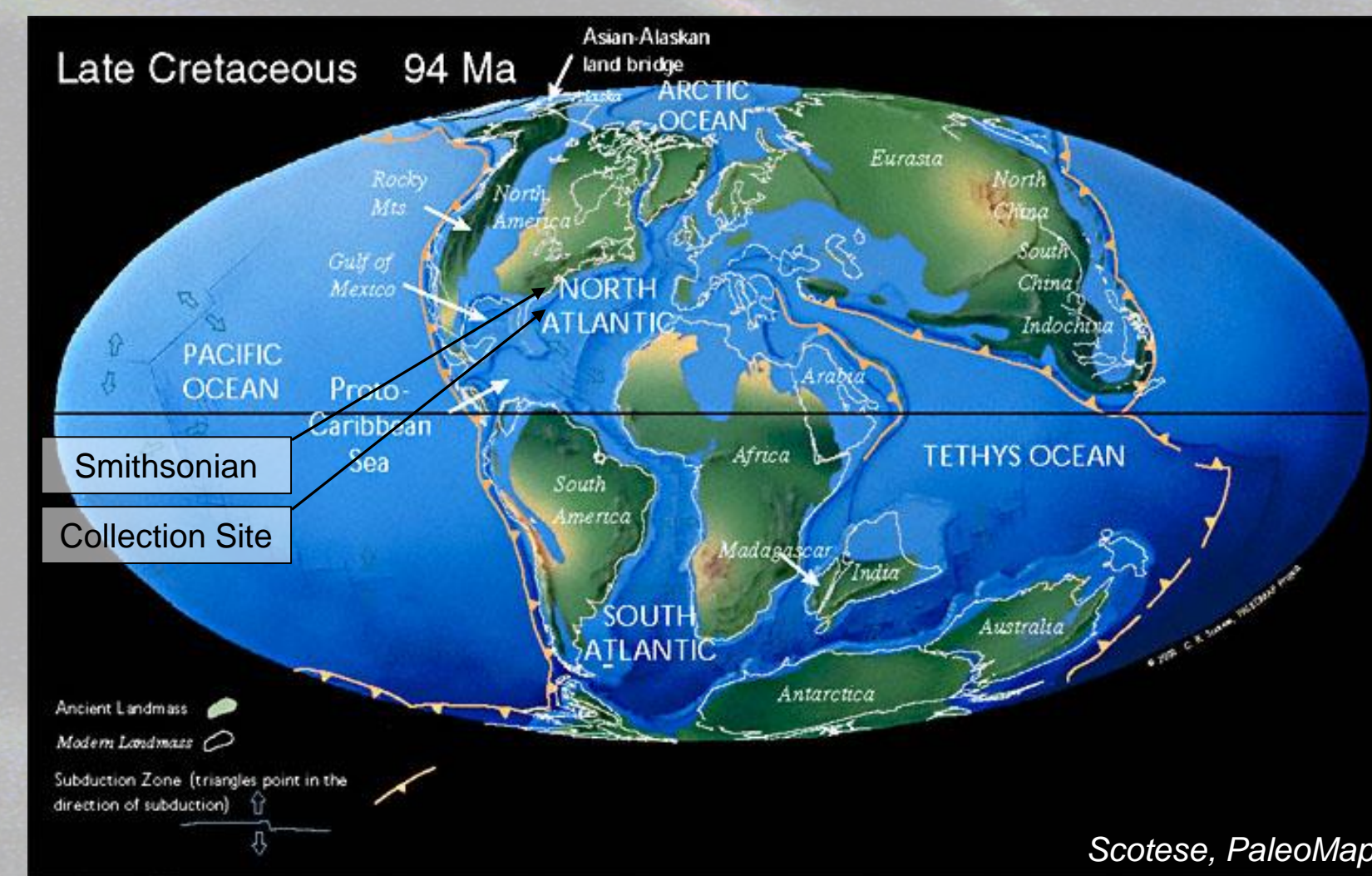
Samples were collected from Blake Nose Plateau, ~280 miles east of Daytona Beach, Florida.
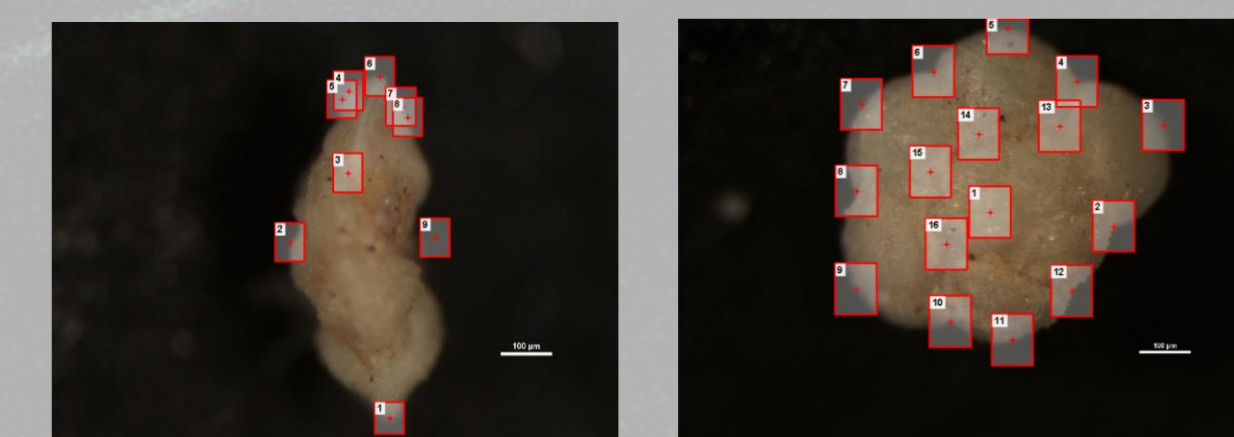
Methods

Imaging
- Using a Nikon SMZ1500 Microscope, spiral and edge view orientations of the species are imaged
- Universal stage helps with easier and faster imaging
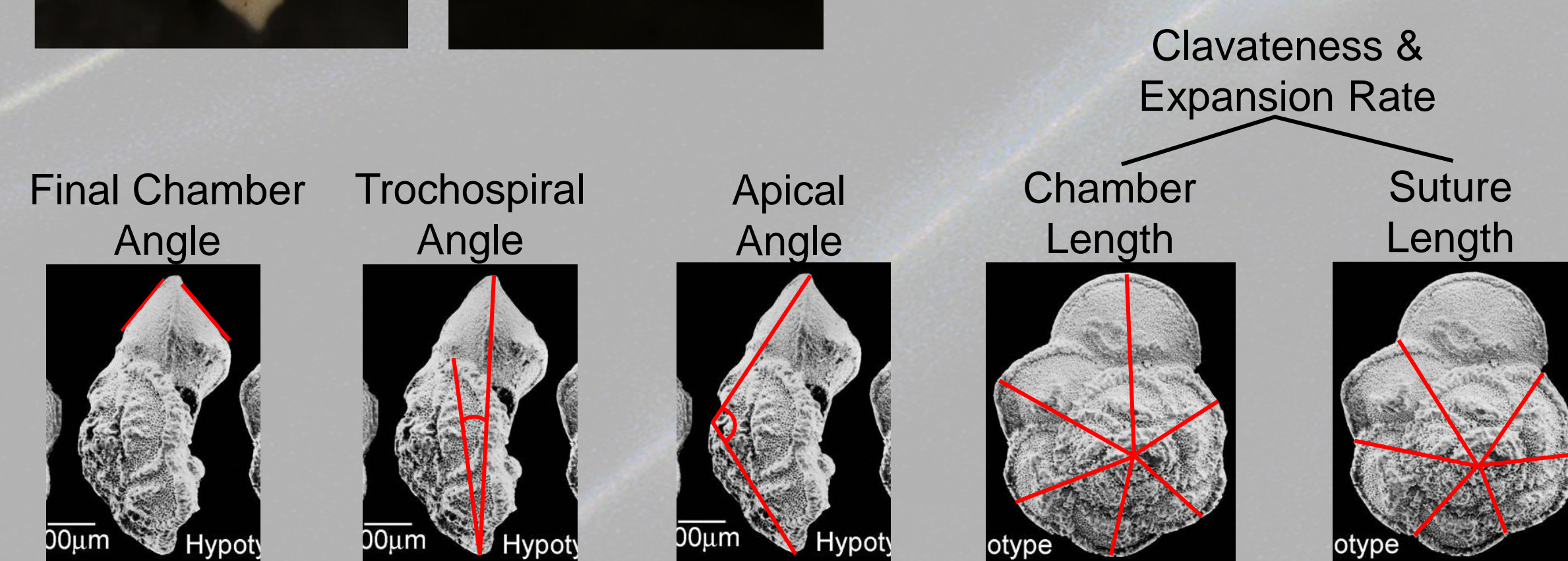

Taking Measurements
- 11 qualitative descriptive terms (e.g. accessory aperture position and types of sutures)
- 14 quantitative parameters constructed by ~40 measurements

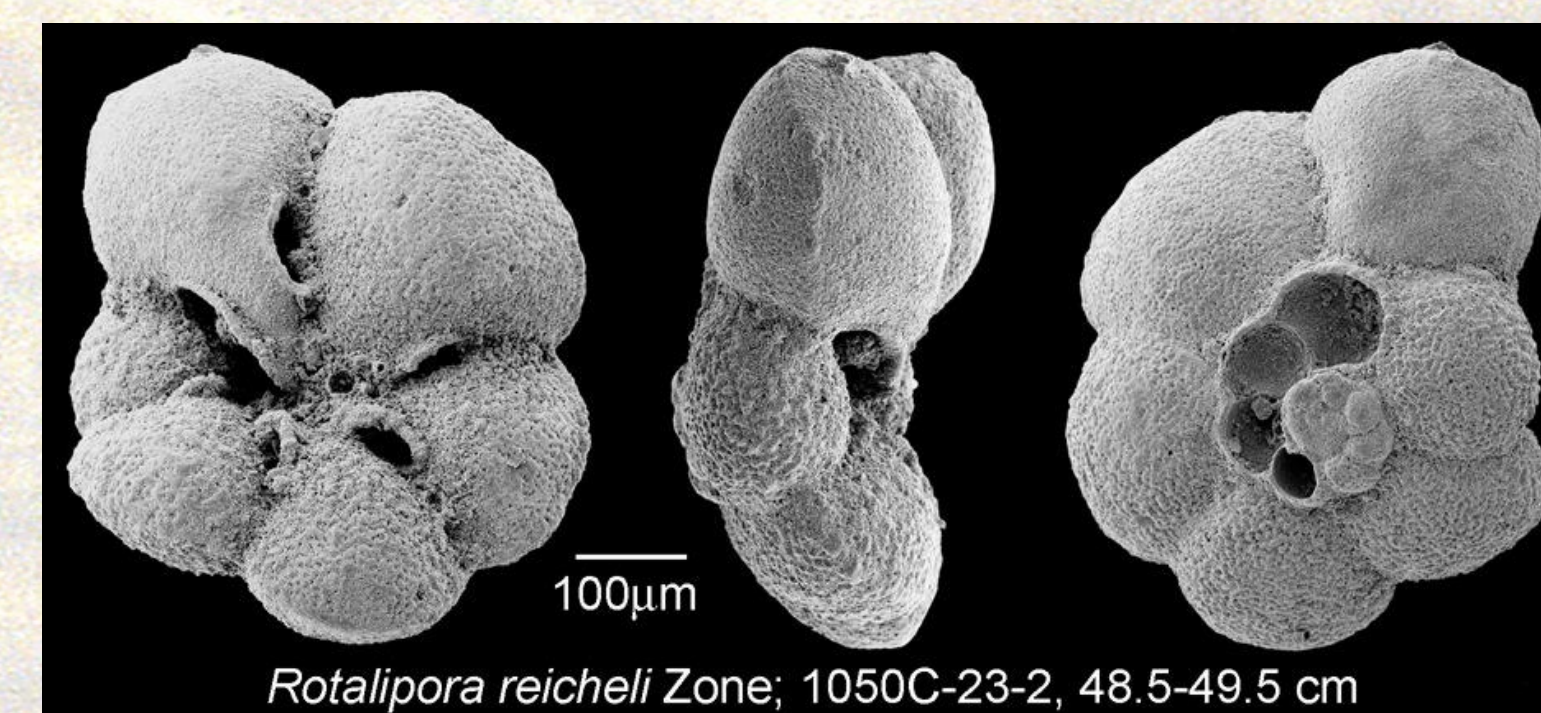Manual Measurements

Automated Measurements

Clavateness & Expansion Rate

Final Chamber Angle | Trochspiral Angle | Apical Angle | Chamber Length | Suture Length

Results

100µm Hypotype
Robaszynski & Caron, 1979, Pl. 8, fig. 2

Rotalipora cushmani (n=49)
- Ridges on spiral side
- "Y-shape" surface texture on umbilical side
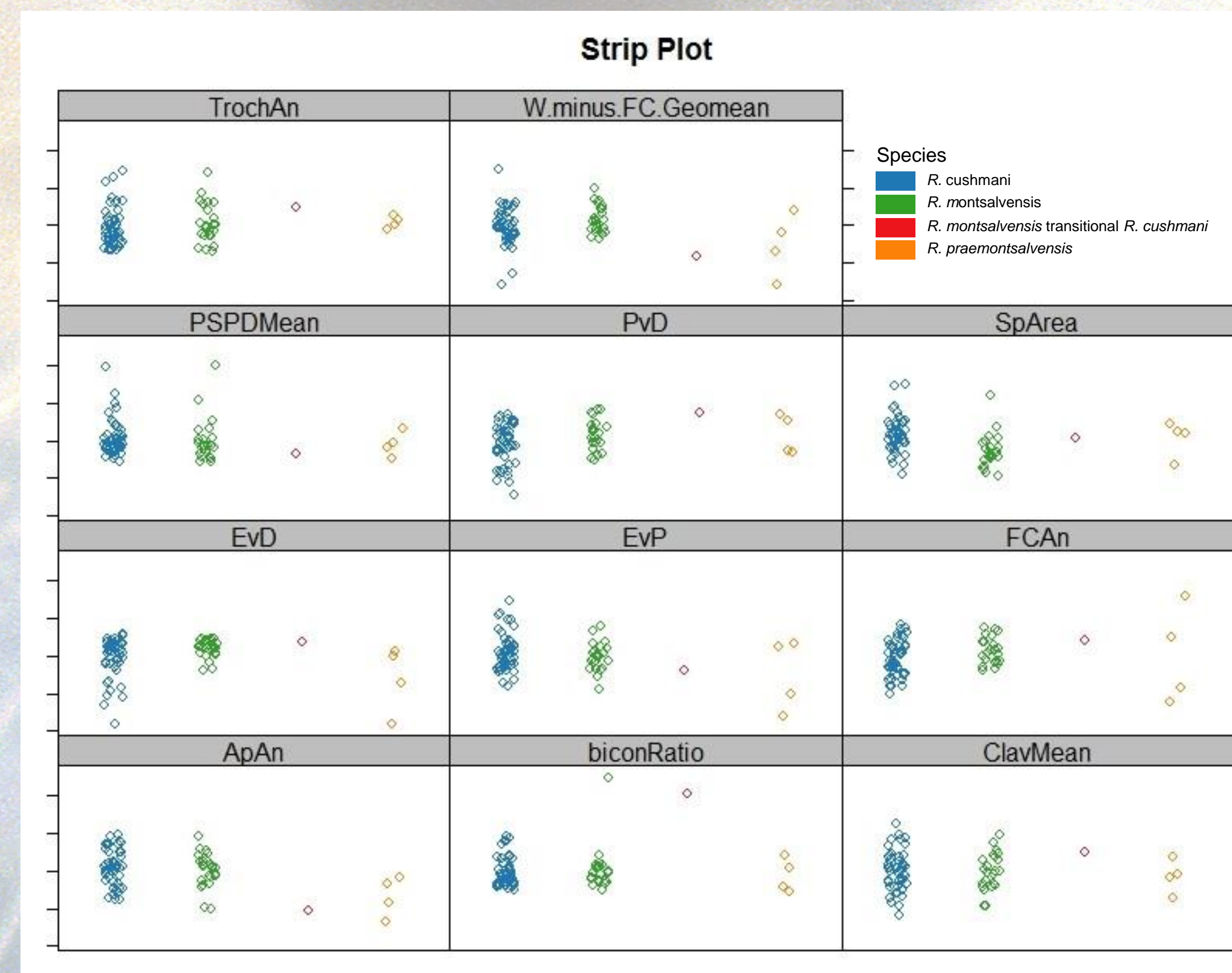- Moderately biconvex
- Well-defined keel

100µm

Rotalipora globotruncanoides Zone; 1050C-23-7, 13-15 cm
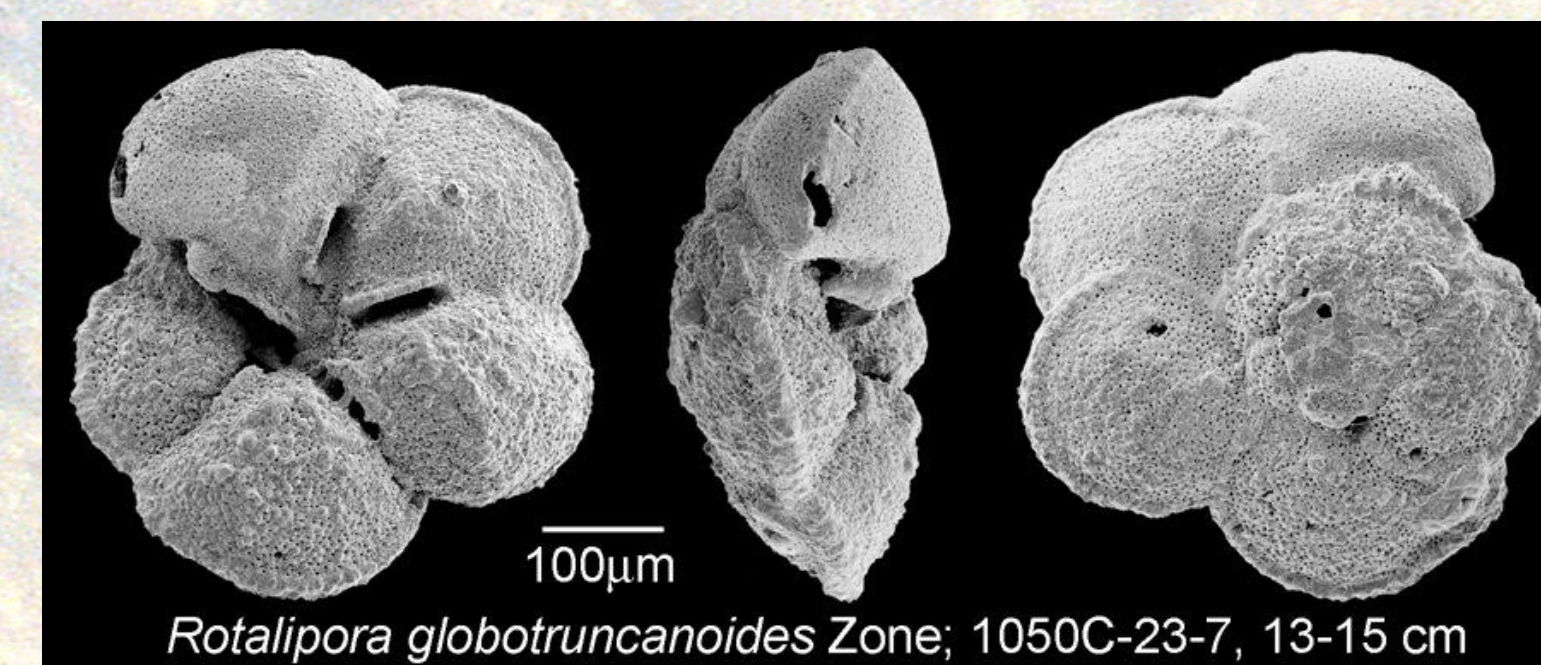
Rotalipora montsalvensis (n=24)
- Inflated chambers
- Biconvex
- Well-defined keel

100µm

Rotalipora reicheli Zone; 1050C-23-2, 48.5-49.5 cm

Rotalipora praemontsalvensis (n=4)
- Inflated, globular chambers
- Biconvex
- Chamber surface smooth
- Present but not well-defined keel

Strip Plot

A strip plot was constructed using variables from the heat map. In each variable, *R. cushmani* consistently shows higher variability than *R. montsalvensis*. *R. cushmani* has a greater number of individuals than *R. montsalvensis*, which could account for *R. cushmani* appearing to have higher variability. However, for PvD and EvD, the *R. cushmani* grouping clearly deviates from *R. montsalvensis*.

Term	Meaning
TrochAn	Trochospiral Angle
W.minus.FC.Geomean	Geometric mean of the Expansion Rate excluding Final Chamber (FC)
PSPDMean	Previous Suture Point Distance Mean
PvD	FC Perpendicular vs. FC Circle Diameter
SpArea	Spiral Area
EvD	FC Equator vs. FC Circle Diameter
EvP	FC Equator vs. FC Perpendicular
FCAn	Final Chamber Angle
ApAn	Apical Angle
biconRatio	Biconvexity Ratio
ClavMean	Clavateness Mean

Conclusions

Heat Map

A heat map was constructed with 11 variables, showing a phylogenetic tree of the three species. Variables were removed to either reduce apparent noise within the dataset, or due to redundancy with other measures.

The heat map shows a grouping of *R. montsalvensis*, *R. praemontsalvensis*, and high variability of *R. cushmani*.
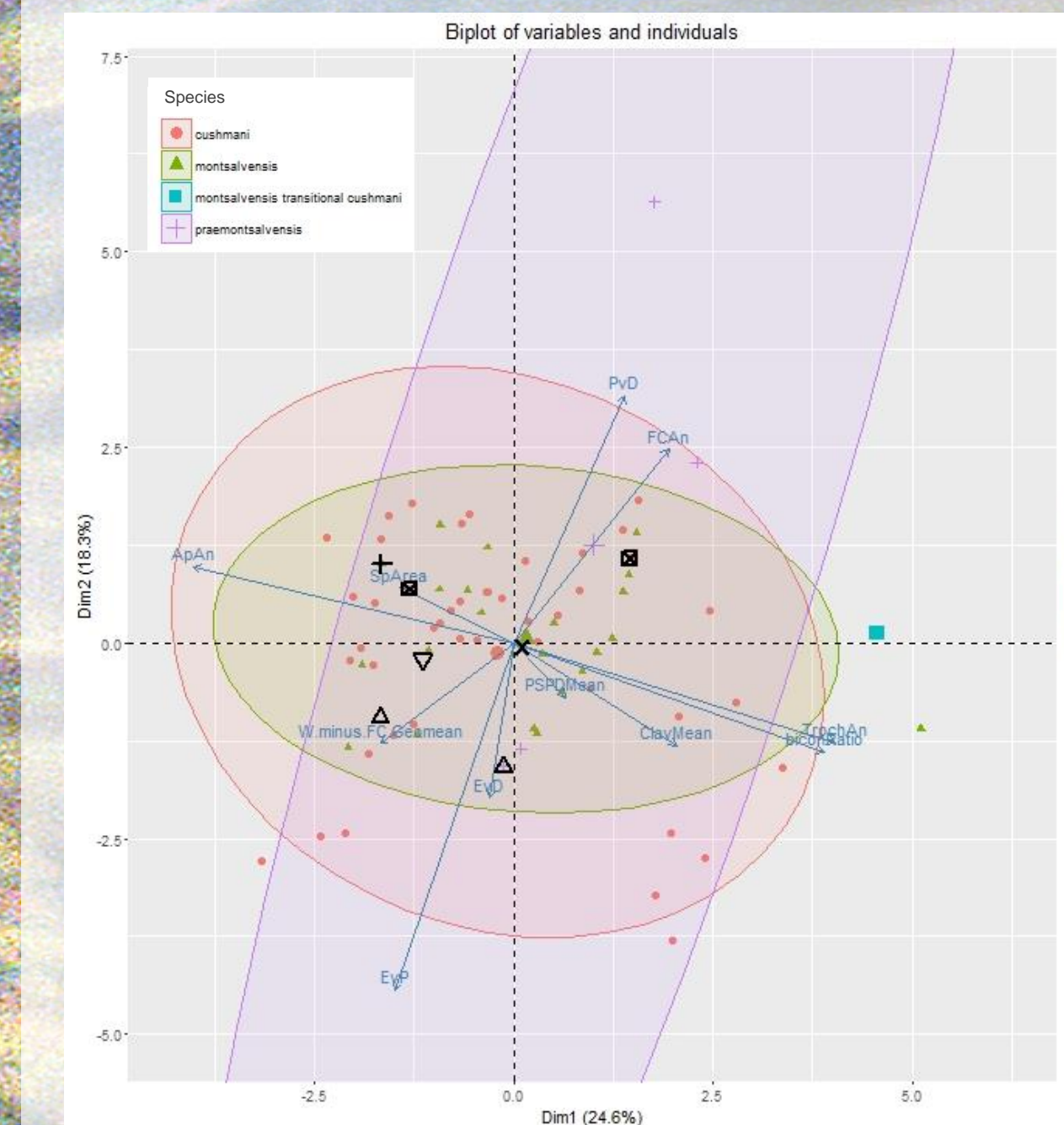
This biplot uses the individual species as points and the 11 characteristics as vectors. The horizontal axis is the first principal component and the vertical axis is the second. The black symbols represent the type material.

R. cushmani has two groups within the described oval – one near the center and another to the bottom right. *R. montsalvensis* is generally found in the center of the plot, and *R. praemontsalvensis* has one outlier that causes its oval to be much wider.

Considering how little data have been collected on *R. praemontsalvensis* (due to its rarity in samples), comparison with the other species is premature, but it is noteworthy that three of the four individuals clustered well together. The morphology of *R. cushmani* is highly variable compared to the other species, which is most apparent on the strip plot. Given these results, these three species can be more easily distinguished by qualitative data rather than quantitative (e.g. the ridge and "y-shape" surface ornament on *R. cushmani*).

Future study will examine the *Rotalipora* lineage with a more stratophenetic approach so as to give the most accurate understanding of its phylogeny. The collected data will continue to be examined quantitatively to see if there are other methods that can better define the species. These data will also be used in a subsequent study of Cenomanian planktic foraminiferal morphospace, with comparisons of the variability within species and higher-level taxonomic units.

Acknowledgements/References

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