DUAL RECONSTRUCTION OF PALEOECOLOGY AND WHOLE-PLANT HABIT USING STABLE CARBON ISOTOPES FROM DISPERSED LEAVES OF *LAUROZAMITES POWELLII*, AN UPPER TRIASSIC BENNETTITALEAN.

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Natural History Museum of Denmark
Geological Museum

Cornell University

The University of Vermont

Smithsonian
National Museum of Natural History

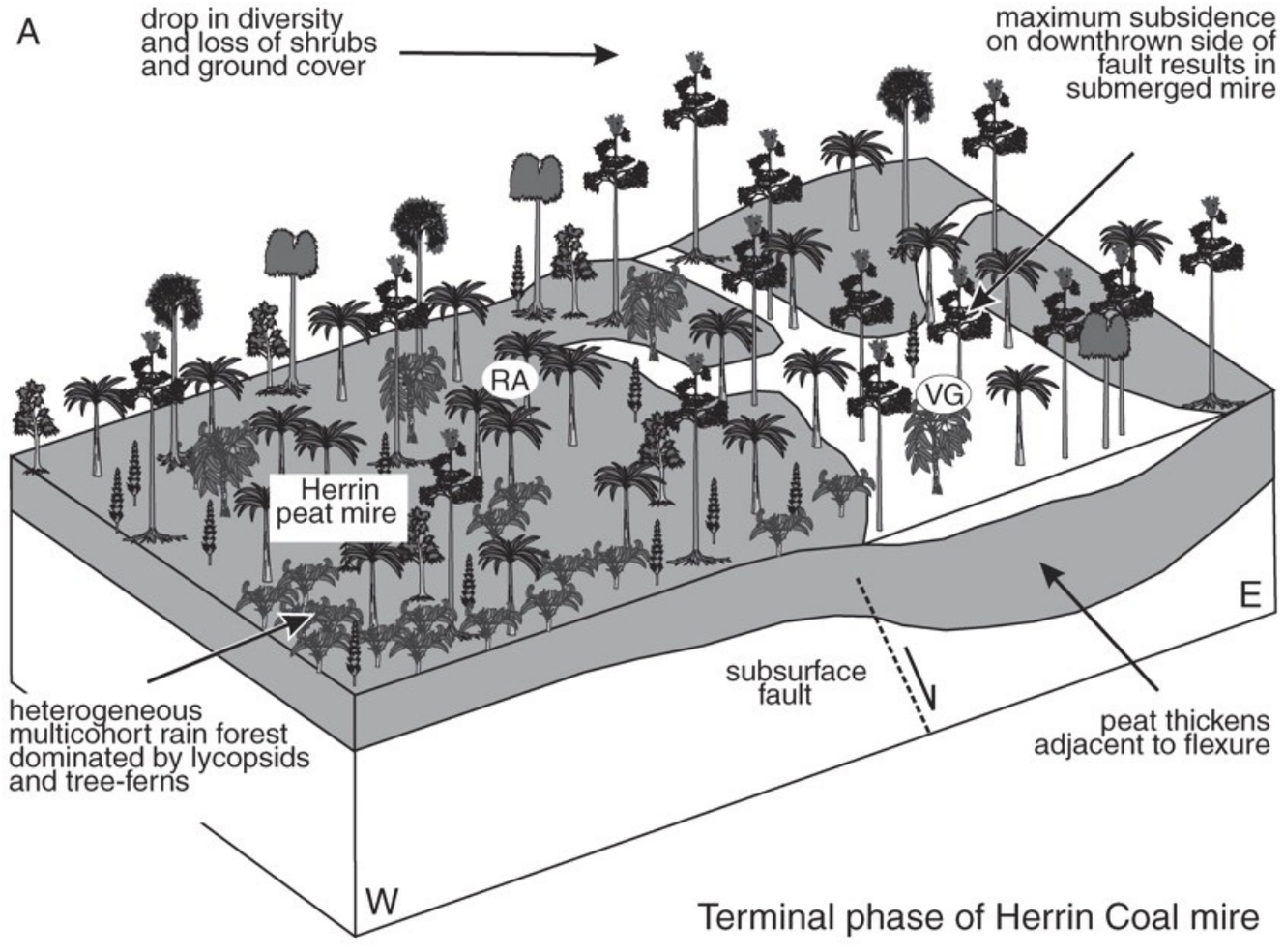
The Field Museum

Reconstructing Paleoenvironments

Hardwood Floodplain Forest

Clarkia, ID, USA - P40

Carboniferous Swamp



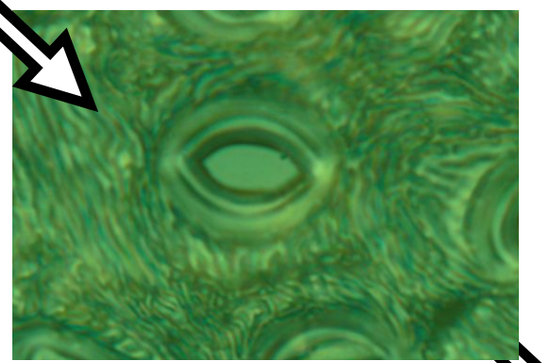
Di Michele et al. (2007)

Stable Carbon Isotopes & Fractionation

Atmospheric CO_2

$\delta^{13}C_{atm}$ = -8.2‰

$^{12}CO_2$ $^{13}CO_2$ $^{13}CO_2$ $^{12}CO_2$ $^{12}CO_2$



Populus balsamifera stomate

<u>Fractionation 1</u>: -4.4‰ $\delta^{13}C_{c_i}$ = -12.6‰

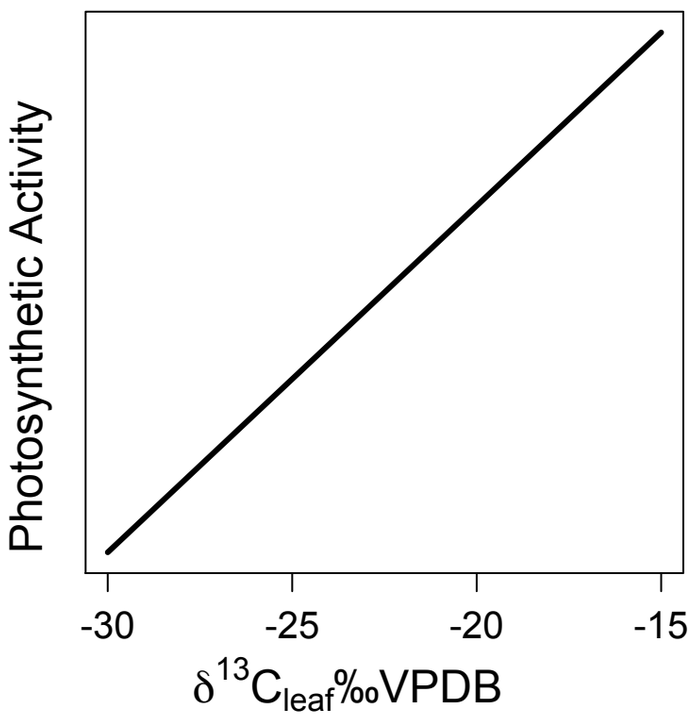
<u>Fractionation 2</u>: -14.4‰

$^{13}CO_2$ $^{12}CO_2$ $^{12}CO_2$

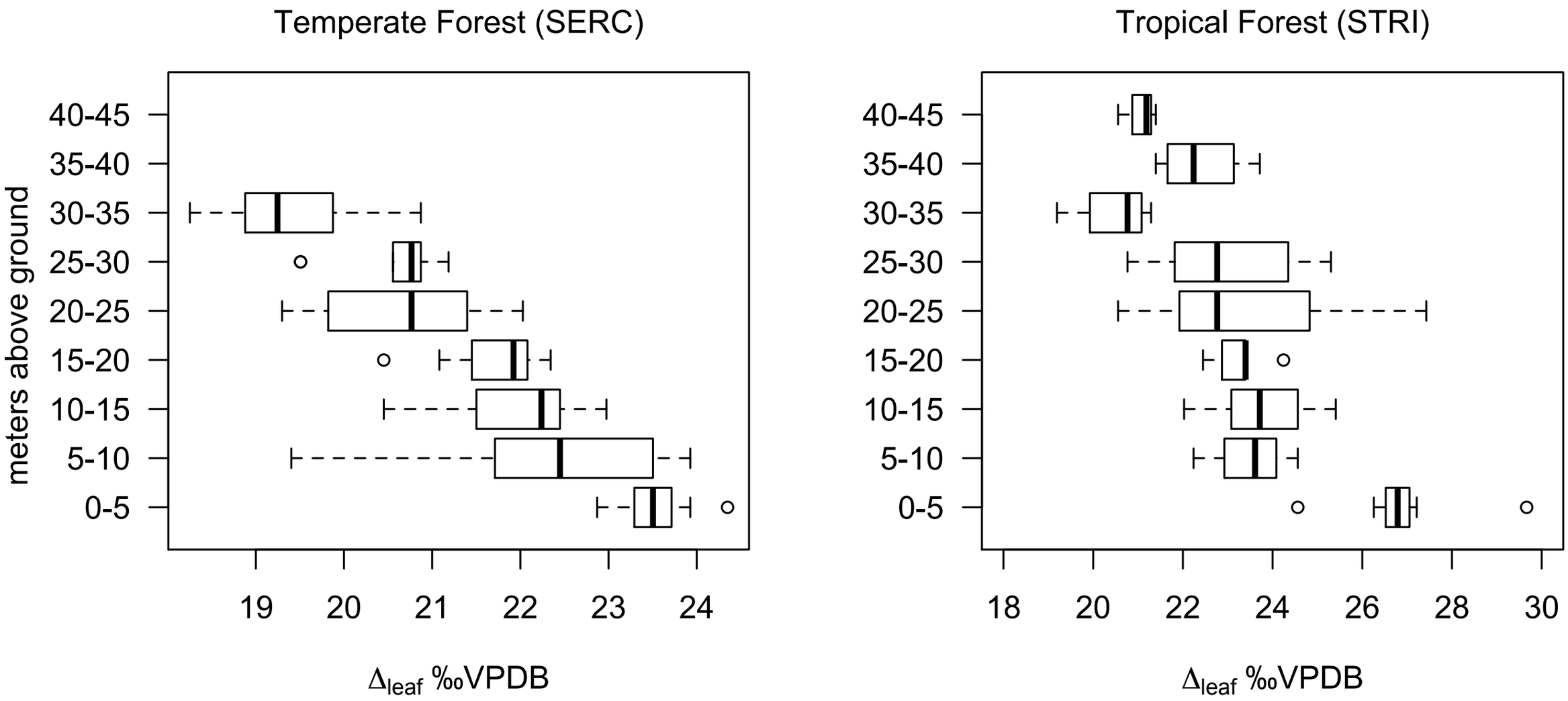
$\delta^{13}C_{leaf}$ = -27‰

RuBisCo

ADP ATP Calvin Cycle ATP ADP



Canopy Effect on Carbon Isotopes



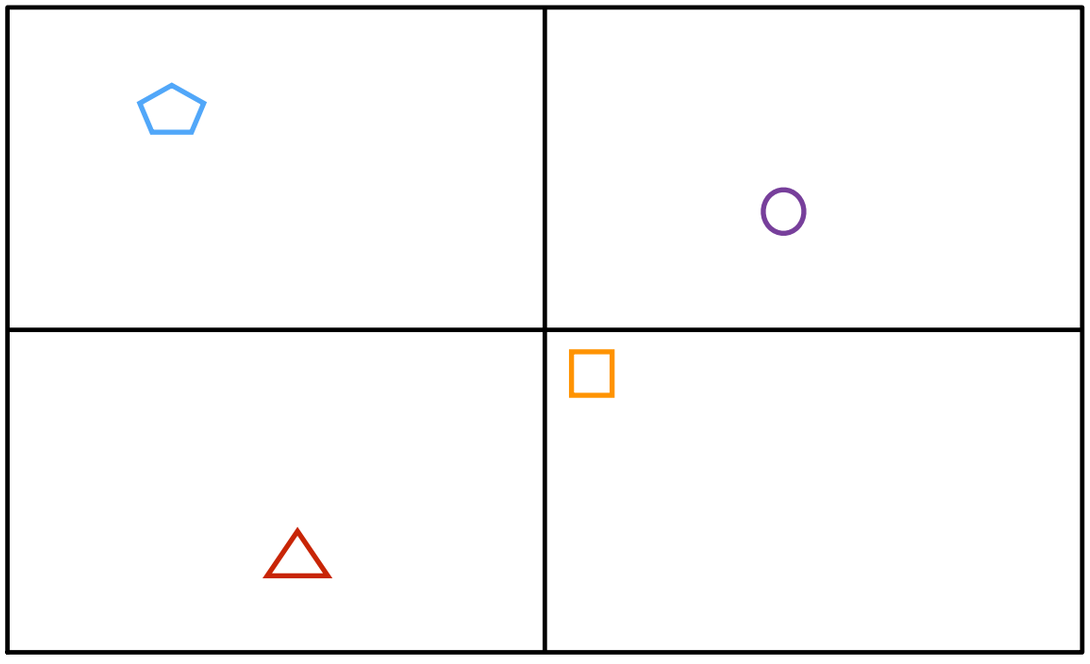
Graham et al. (2014) Isotopic characteristics of canopies in simulated leaf assemblages. *Geochimica et Cosmochimica Acta.*

Conceptual Model for Mean & Standard Deviation

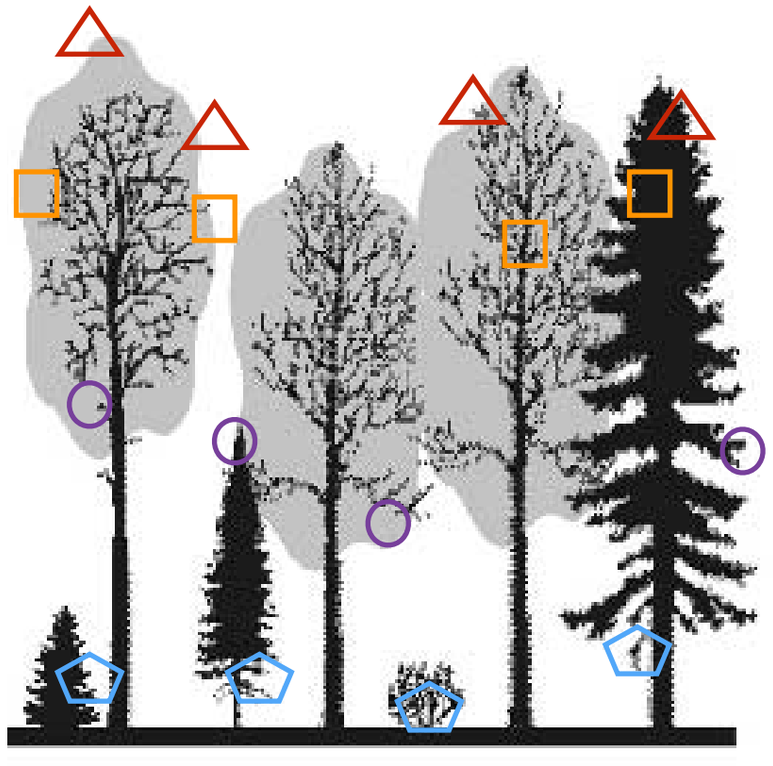
high mean

μ (Δ_{leaf} ‰VPDB)

low mean



small - σ (Δ_{leaf} ‰VPDB) - large

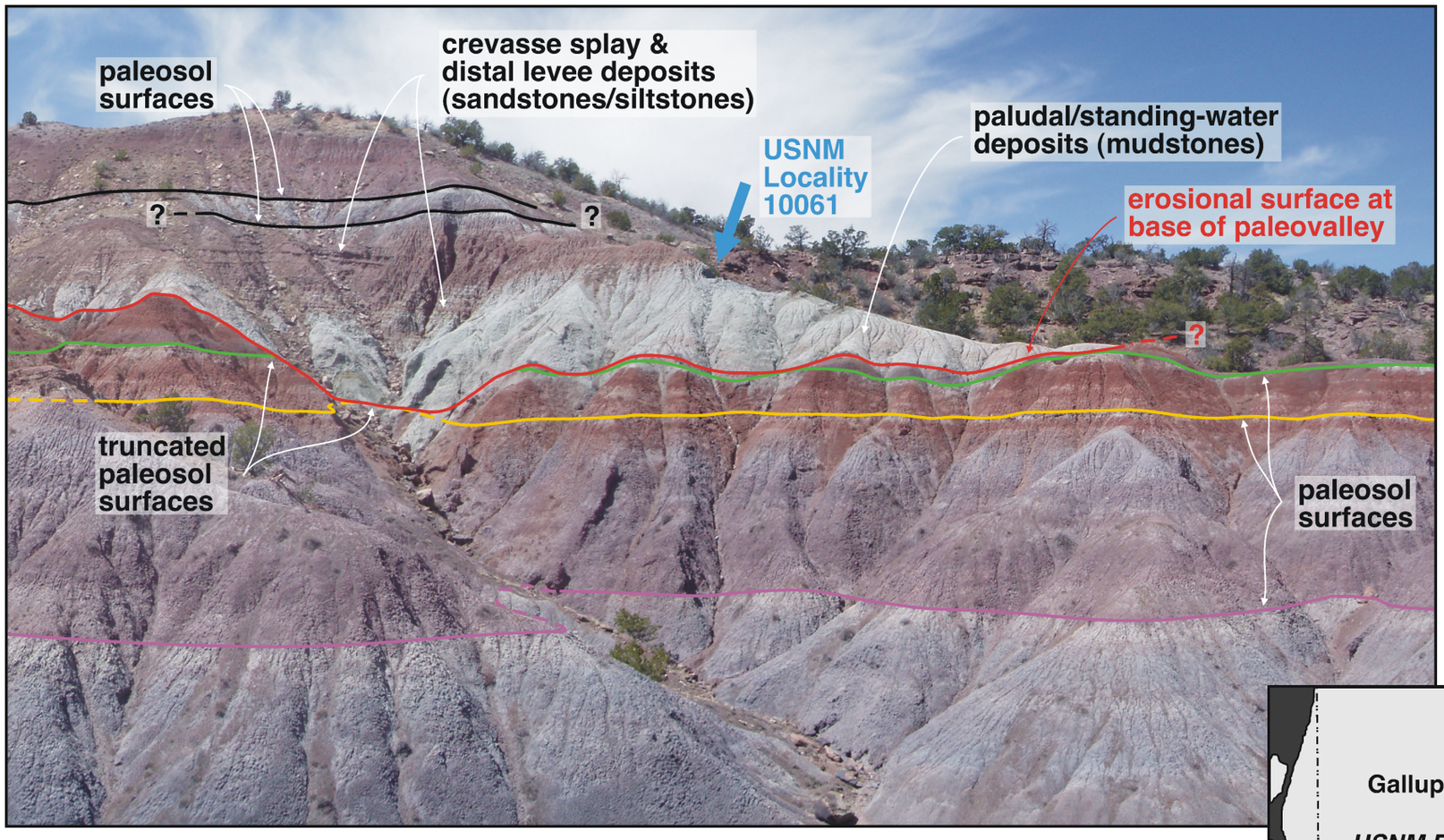


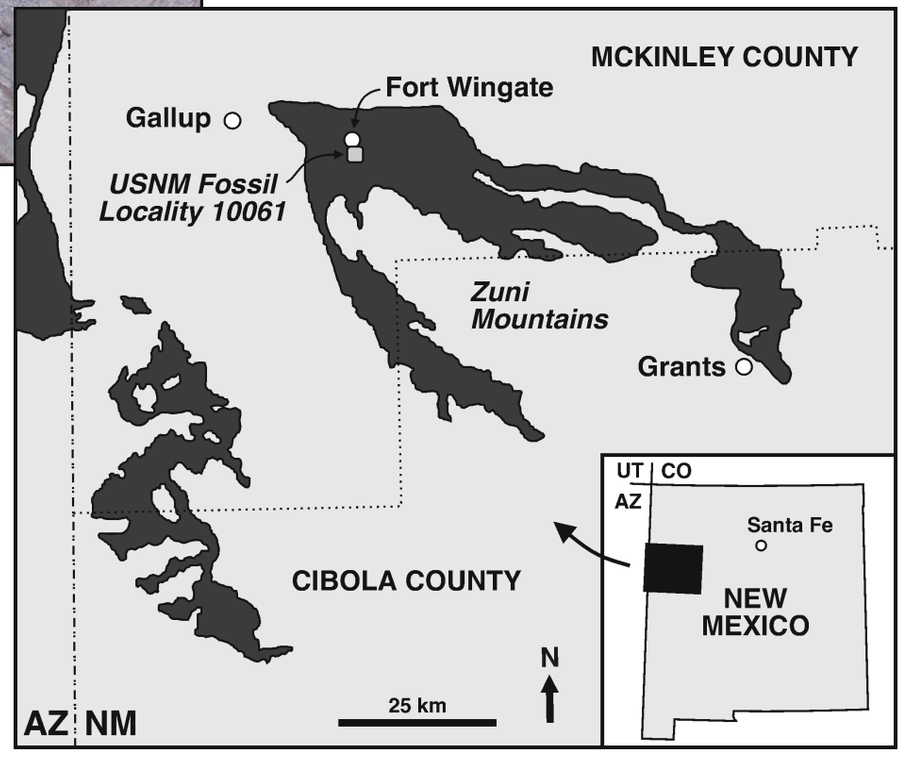
Chen and Popadiouk (2002).

Objectives

- Reconstruct the light environment of *Laurozamites powellii* using the carbon isotopic mean-standard deviation model.
- Apply the canopy effect to reconstruct the architecture of the plant.

Geologic Setting

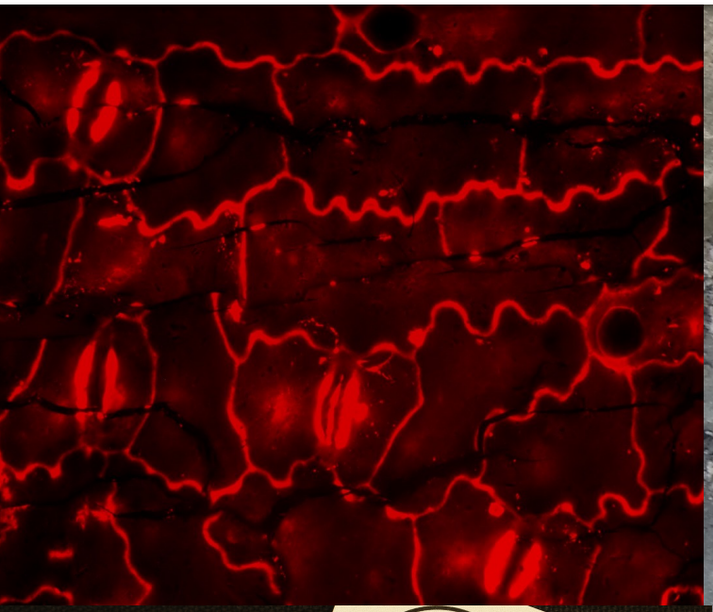


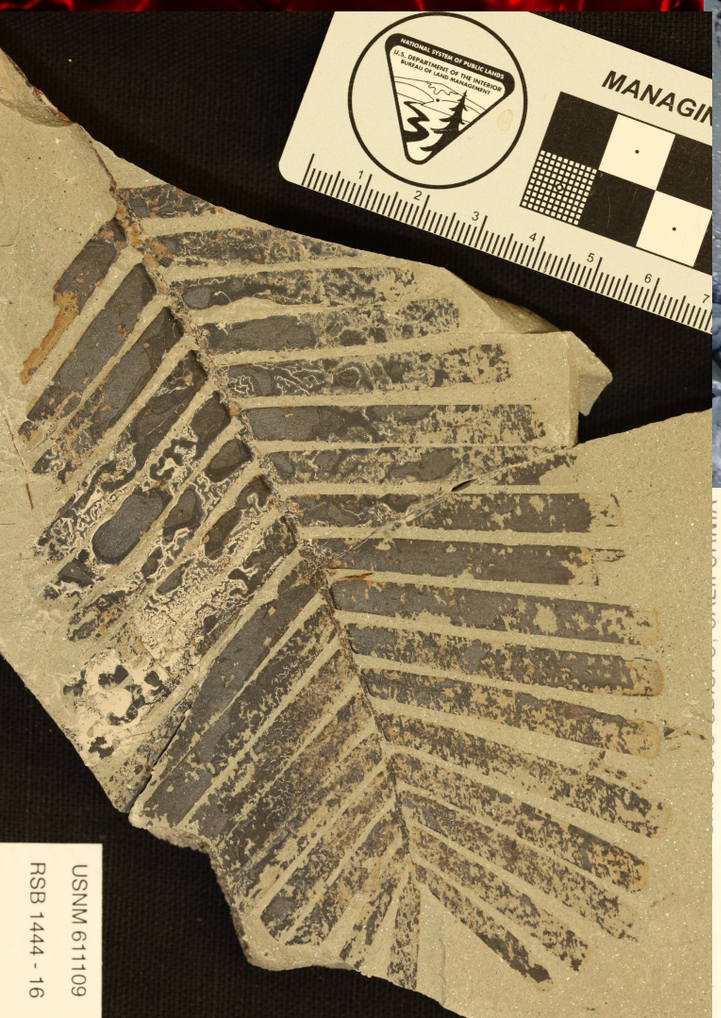


USNM 10061 - Upper Triassic, Upper Carnian (~ 230 mya)

Laurozamites powellii - Williamsoniaceae, Bennettitales

(Fontaine) Weber & Zamudio-Varela





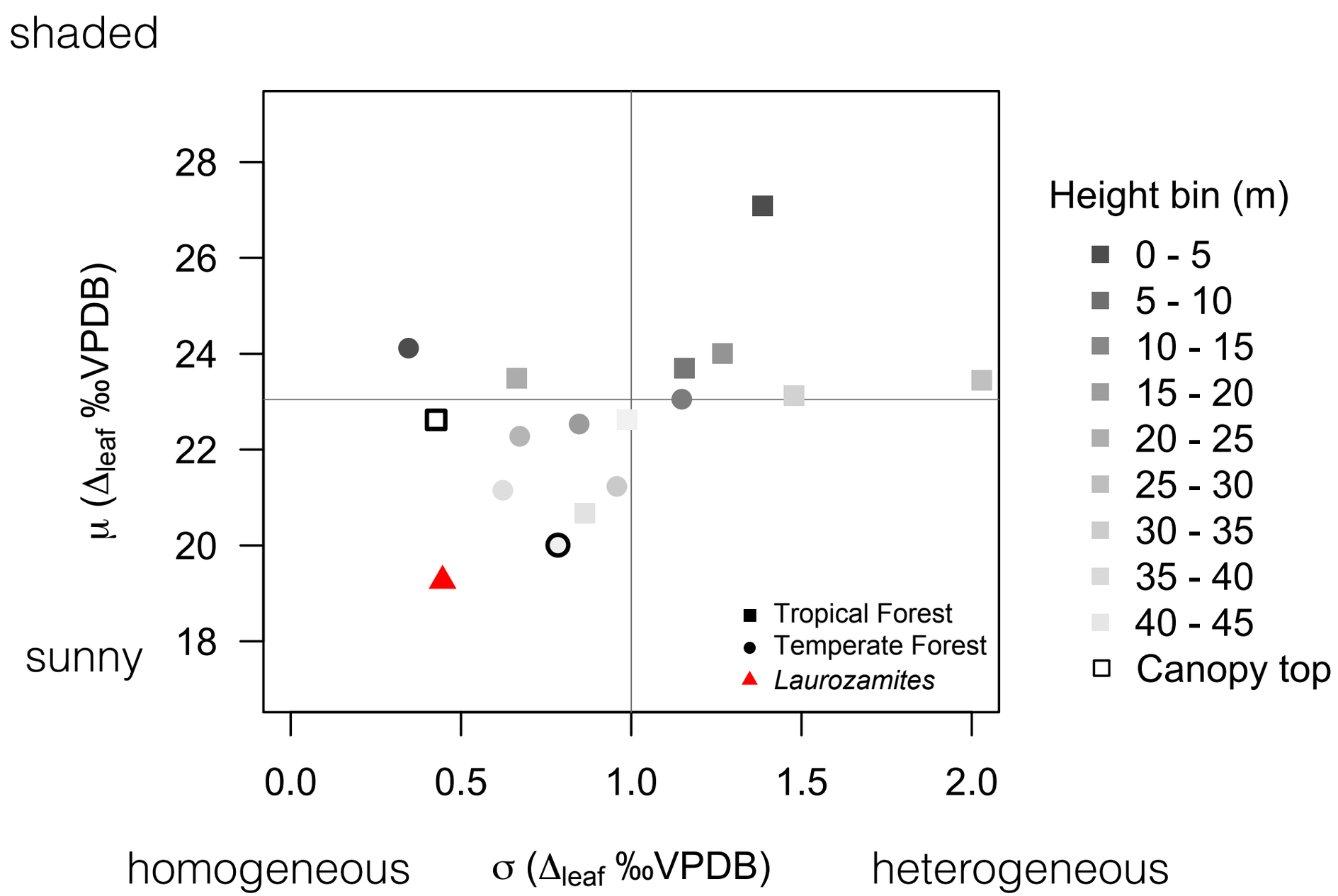
Methods

Carbon Isotopes: 64 leaves measured. 80% in triplicate.

Leaf physiognomy: leaf area. Data modeled for incomplete specimens (N = 12) using leaf area ~ pinna length^2 (r^2 = 0.944).

Undulation Index: 42 leaves measured from 617 cells.

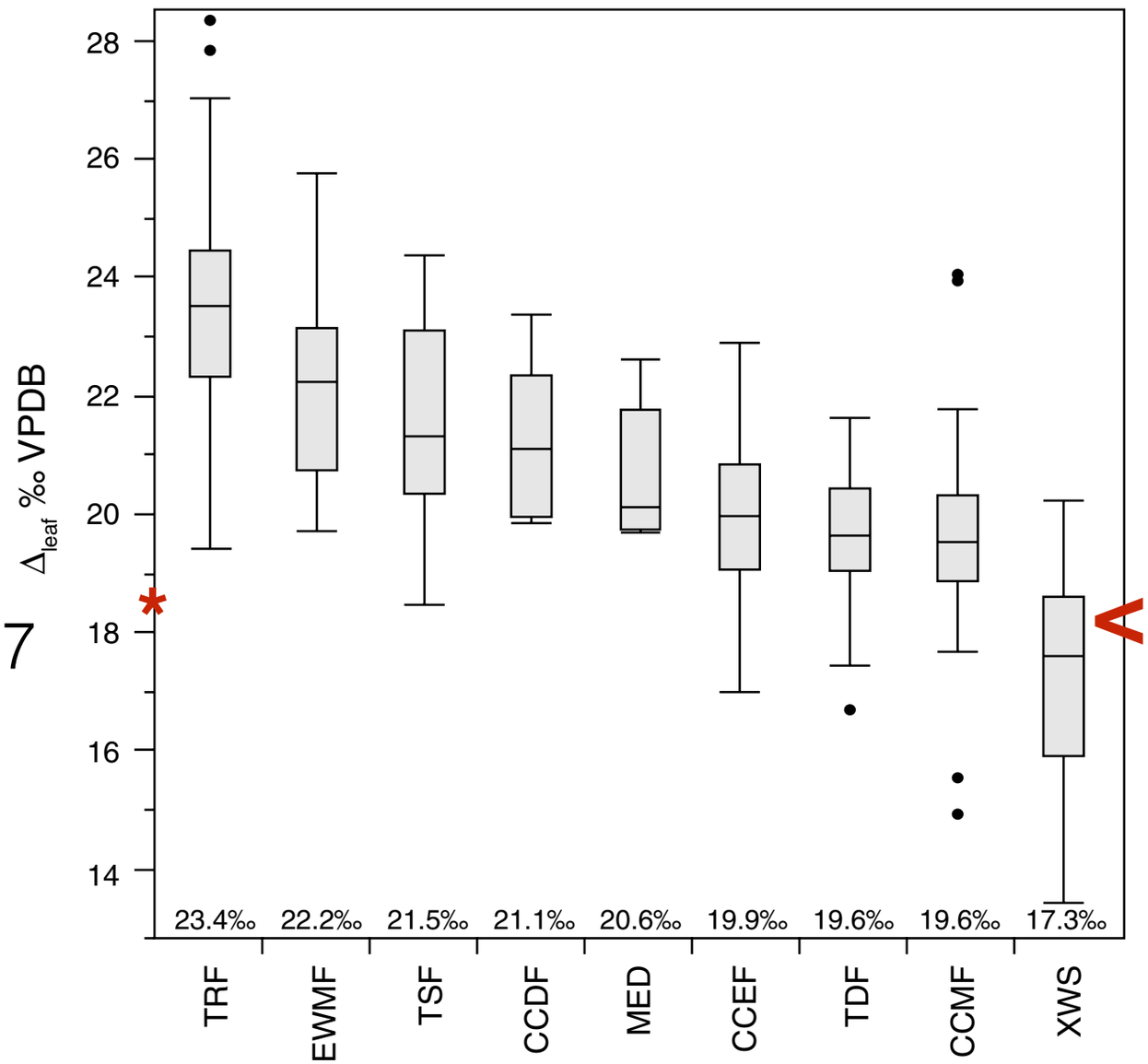
Reconstructing the Light Environment



Tropical and temperate forest data from Graham et al. (2014) Isotopic characteristics of canopies in simulated leaf assemblages. *Geochimica et Cosmochimica Acta.*

Interpretation of Forest Type from Δ_{leaf}

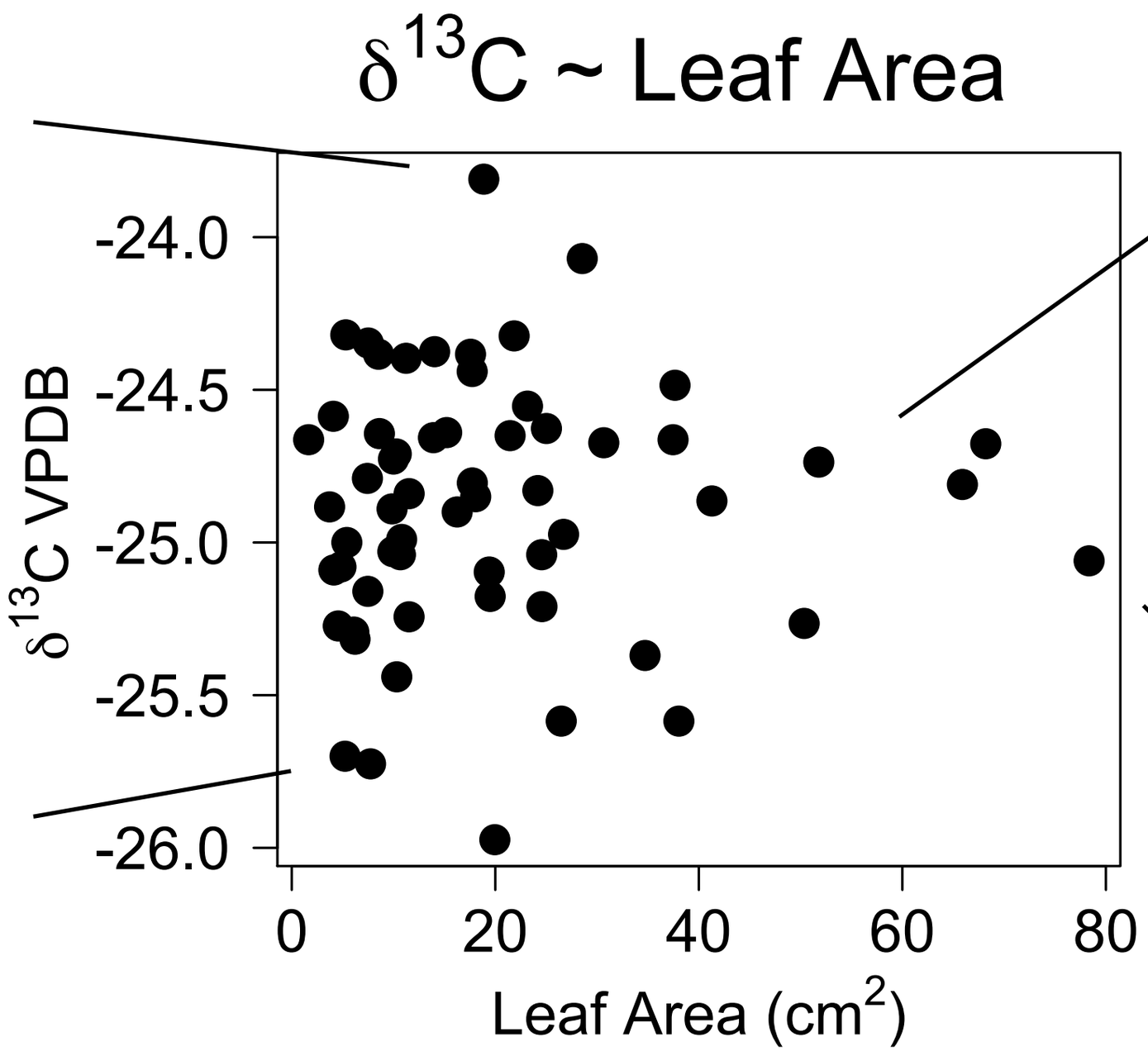
Laurozamites
mean(Δ_{leaf})= 18.7

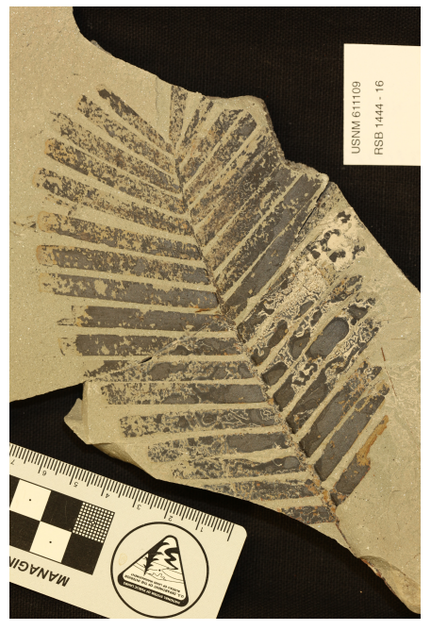


* Xeric Woodland/Scrubland

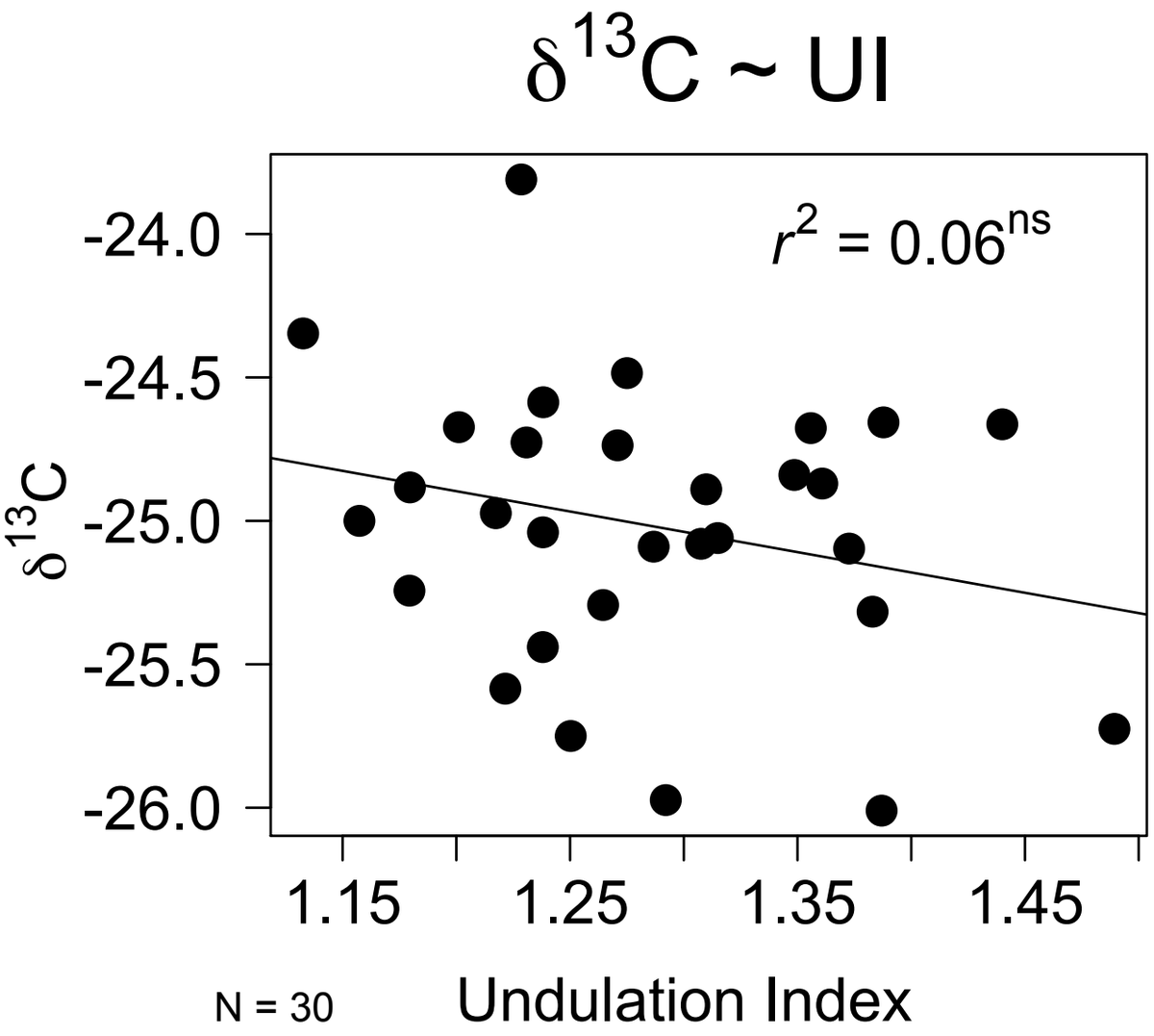
Diefendorf et al. (2010). Global Patterns in Leaf ^{13}C Discrimination and Implications for Studies of Past and Future Climate. *PNAS*

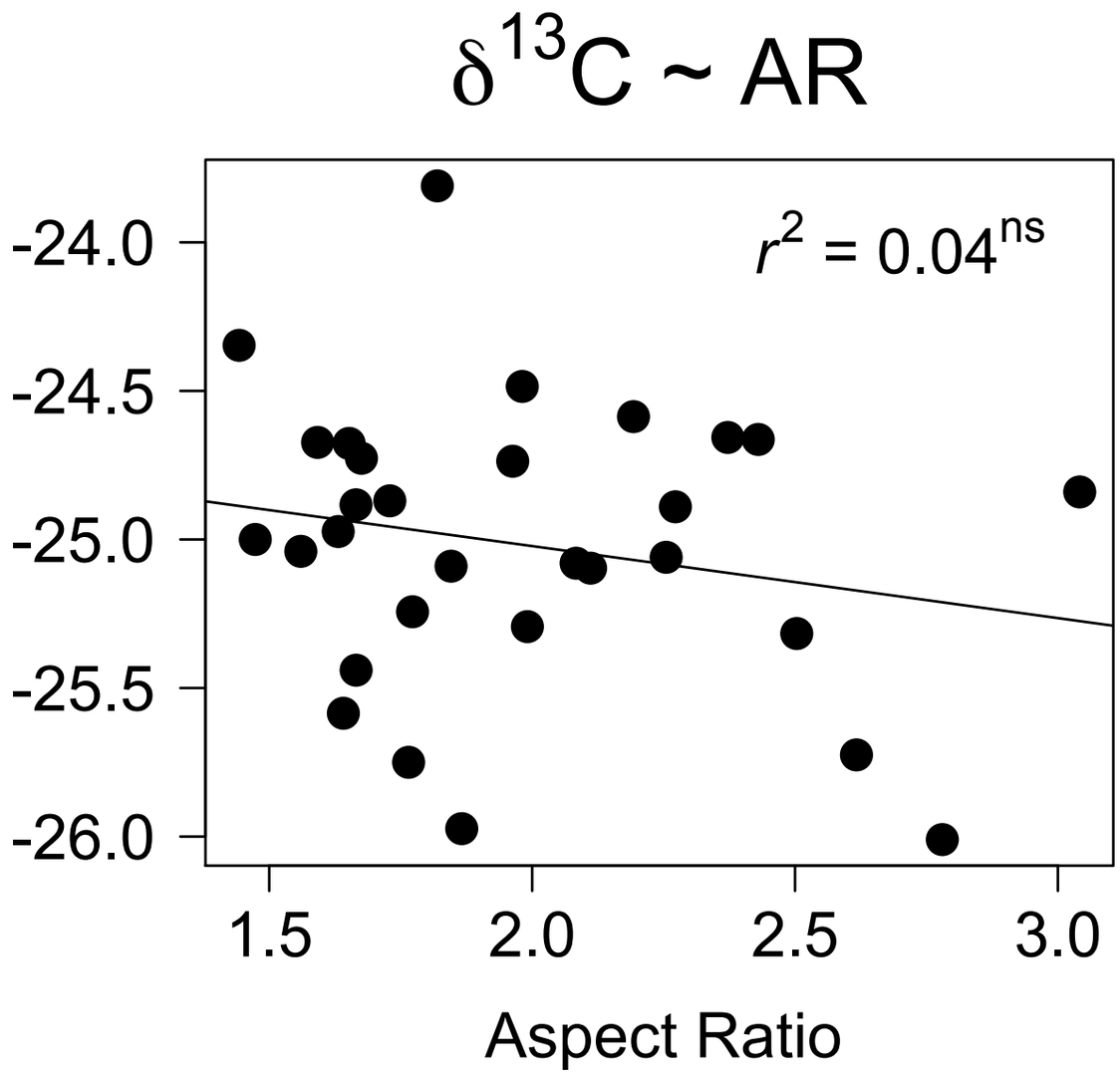
Plant Architecture Results





Plant Architecture Results

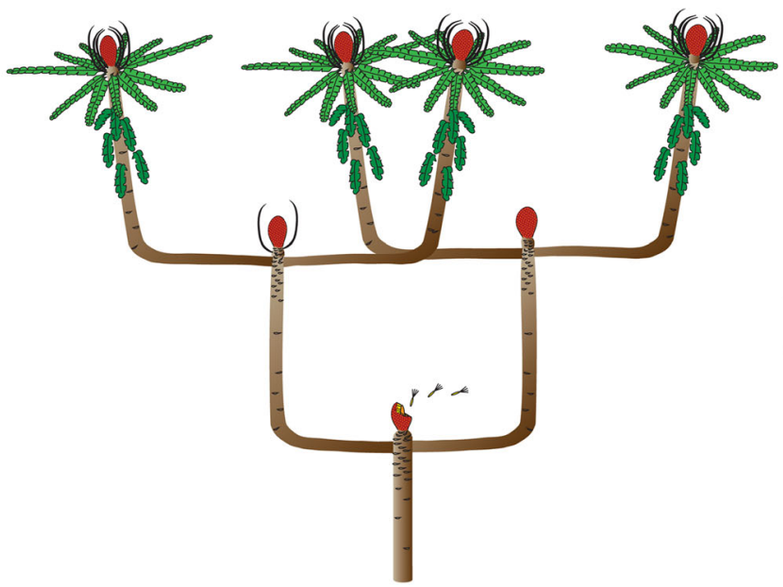




mean UI =1.27 -> LAI = ~ 1
(Dunn et al. 2015)

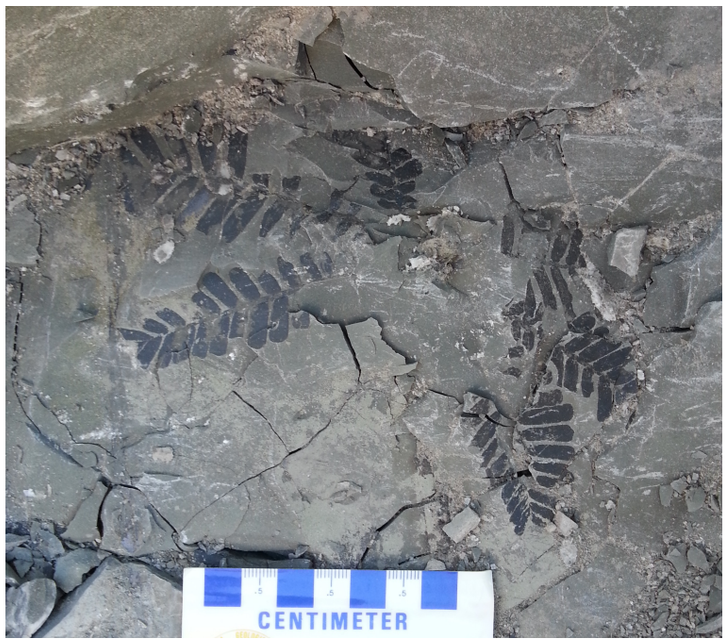
Interpretation of Plant Architecture Results

Divaricate Growth Habit



Model of Williamsoniid architecture.

Wielandiella angustifolia



Laurozamites powellii

Pott and McLoughlin. (2014). Divaricate Growth Habit in Williamsoniaceae (Bennettitales): Unravelling the Ecology of a Key Mesozoic Plant Group. *Palaeobiodiversity and Palaeoenvironments*.

Conclusions

- *Laurozamites powellii* grew in a homogeneous, high light environment.

- Xeric woodland or scrubland forest type is indicated by the mean(Δ_{leaf}) when compared to other forest types.

- Relationship of $\delta^{13}C$ and leaf area suggest most leaves - regardless of size - experienced similar light environments, consistent with a divaricate growth form.

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Andrea Lini, Scott Wing

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