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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Reconstructing Paleoenvironments

Hardwood Floodplain Forest

Carboniferous Swamp

Di Michele et al. (2007)

Clarkia, ID, USA - P40
Stable Carbon Isotopes & Fractionation

Atmospheric CO₂

δ¹³C atm = -8.2‰

Fractionation 1: -4.4‰  δ¹³C cₗ = -12.6‰

Fractionation 2: -14.4‰  δ¹³C leaf = -27‰

Populus balsamifera stomate

Photosynthetic Activity

δ¹³C leaf‰ VPDB

-30 -25 -20 -15

RuBisCo

Calvin Cycle

ATP

ADP

12CO₂ 13CO₂ 12CO₂ 13CO₂ 12CO₂ 13CO₂ 12CO₂
Canopy Effect on Carbon Isotopes

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 $\Delta_{\text{leaf}}$

Laurozamites

$\text{mean}(\Delta_{\text{leaf}}) = 18.7$

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

\[ \delta^{13}C \sim \text{Leaf Area} \]

-26.0
-25.5
-25.0
-24.5
-24.0

\[ \delta^{13}C \text{ VPDB} \]

Leaf Area (cm\(^2\))
Plant Architecture Results

\[ \delta^{13}C \sim UI \]

\[ r^2 = 0.06^{\text{ns}} \]

N = 30  
Undulation Index

\[ \delta^{13}C \sim AR \]

\[ r^2 = 0.04^{\text{ns}} \]

N = 30  
Aspect Ratio

mean UI = 1.27 \rightarrow \text{LAI} = \sim 1

(Dunn et al. 2015)
Interpretation of Plant Architecture Results

**Divaricate Growth Habit**

Model of Williamsonioid architecture.  
*Wielandiella angustifolia*  
*Laurozamites powellii*

Conclusions

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

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

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