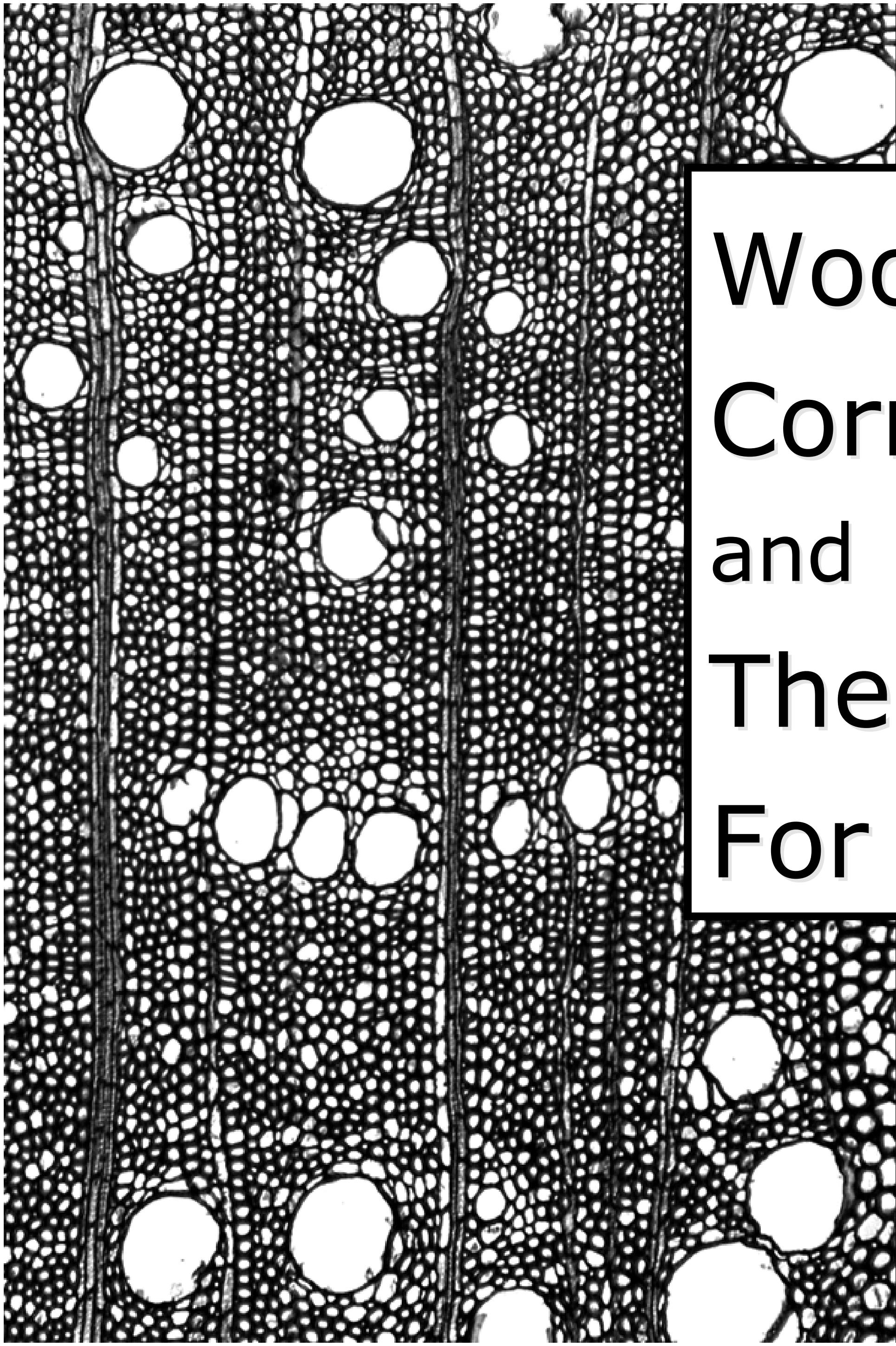
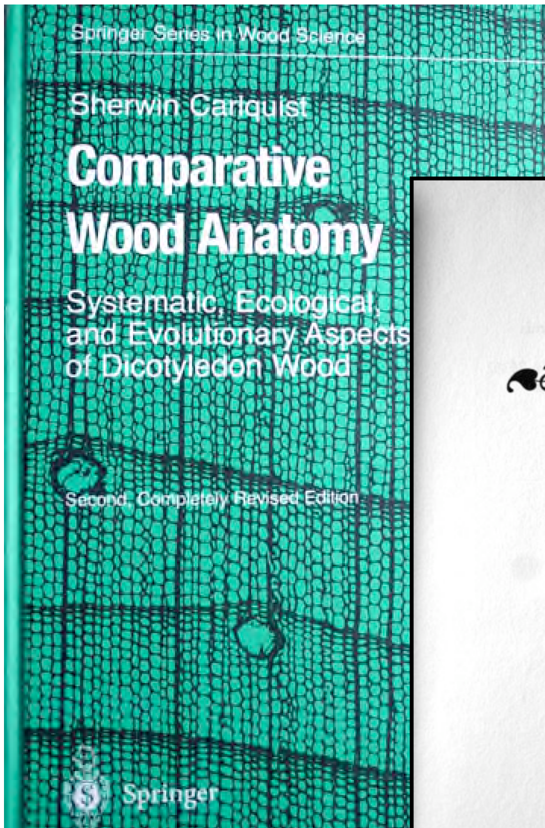
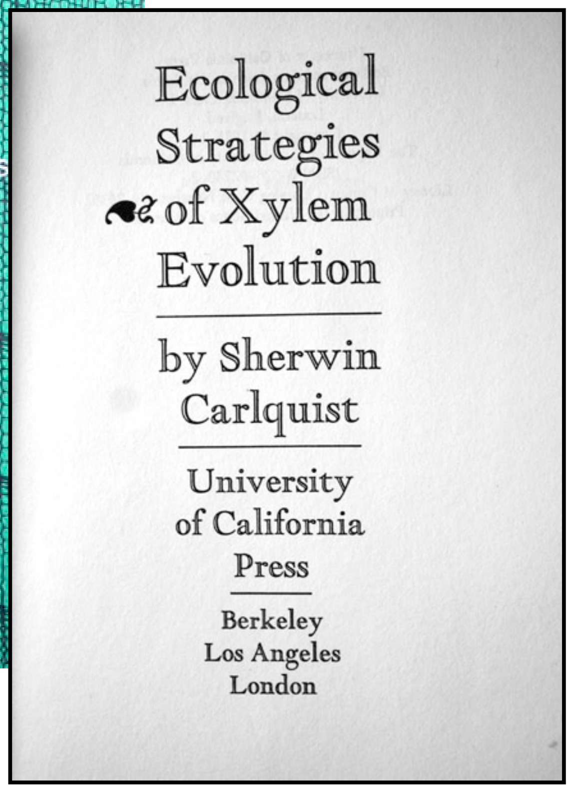


Wood Anatomical Correlations and The Fossil Record For Dicot Woods

First of Sherwin's Papers with Wood In The Title:

1957. Wood anatomy of the Mutisieae (Compositae). Tropical Woods 106: 29-45.



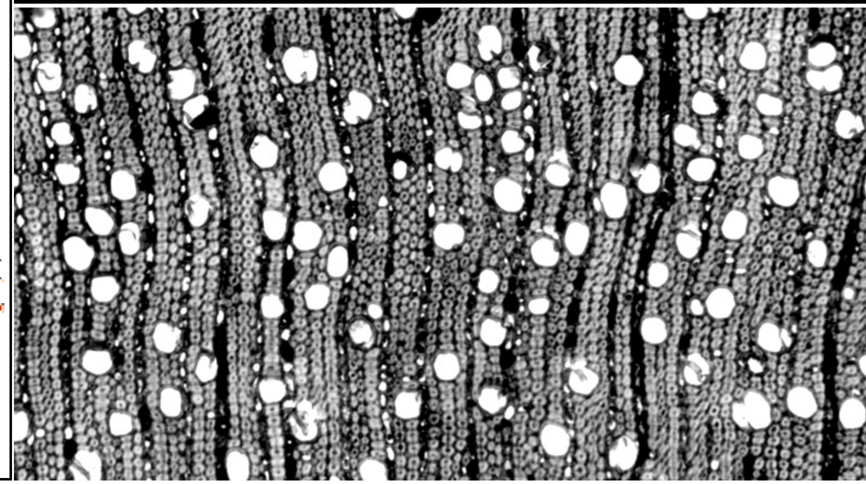


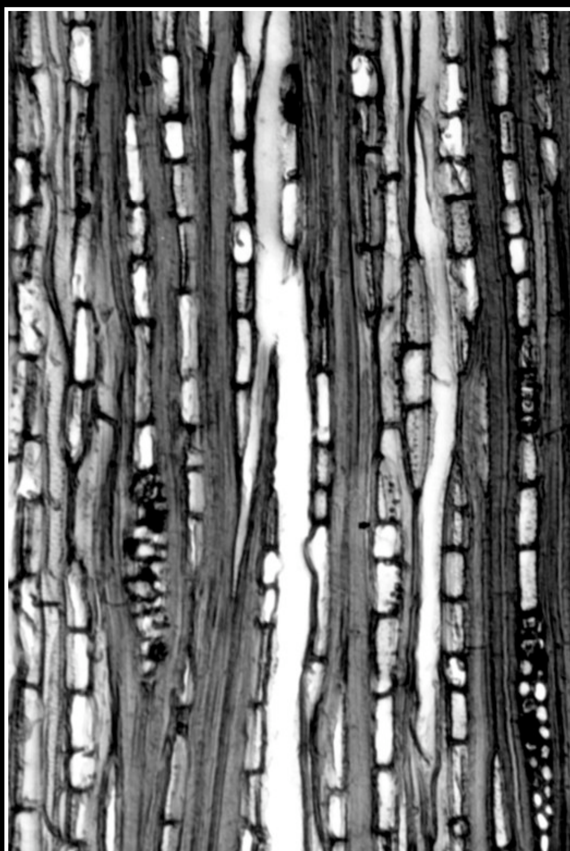
1977. Ecological factors in wood evolution: a floristic approach. Amer. J. Bot. 64: 887-896.

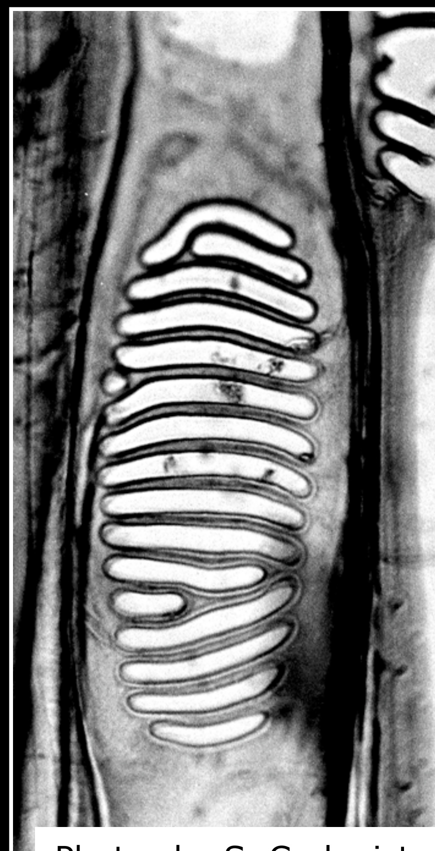
1982. Wood anatomy of *Illicium* (Illiciaceae): phylogenetic, ecological, and functional interpretations. Amer. J. Bot. 69: 1587-1598.

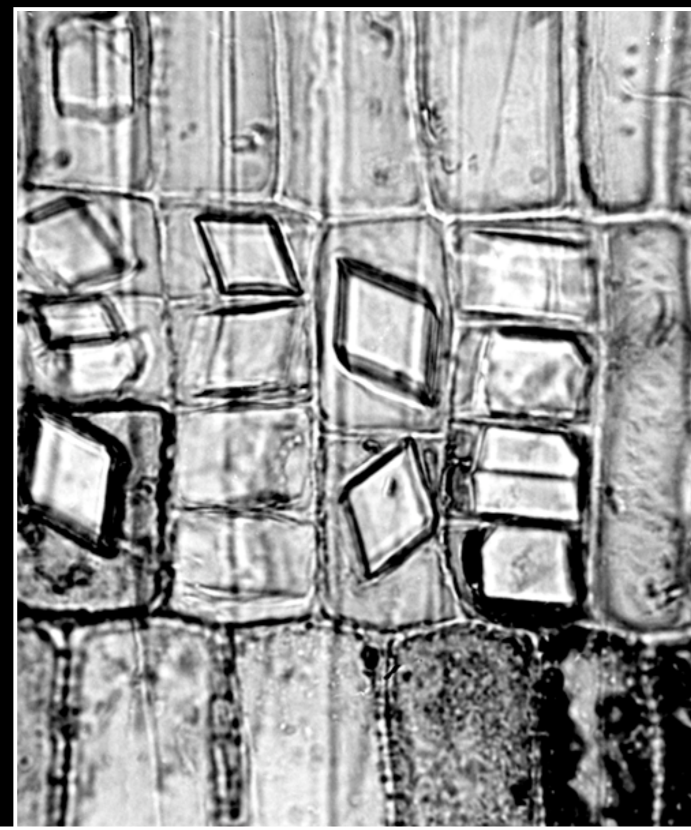
1984. Vessel grouping in dicotyledon wood: significance and relationship to imperforate tracheary elements. Aliso 10: 505-525.

BALANOPACEAE



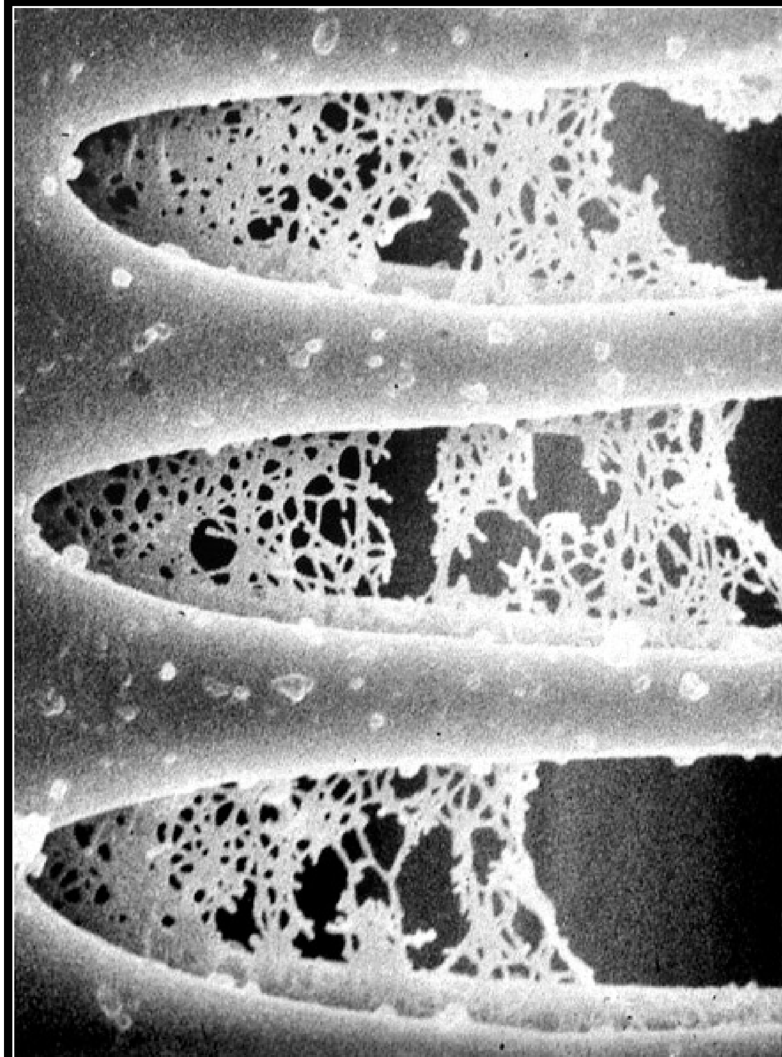


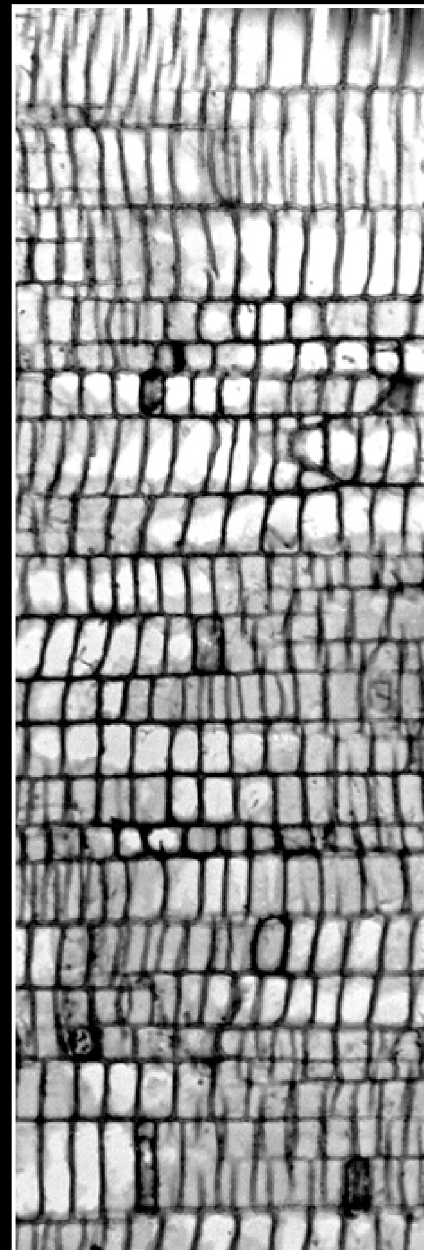


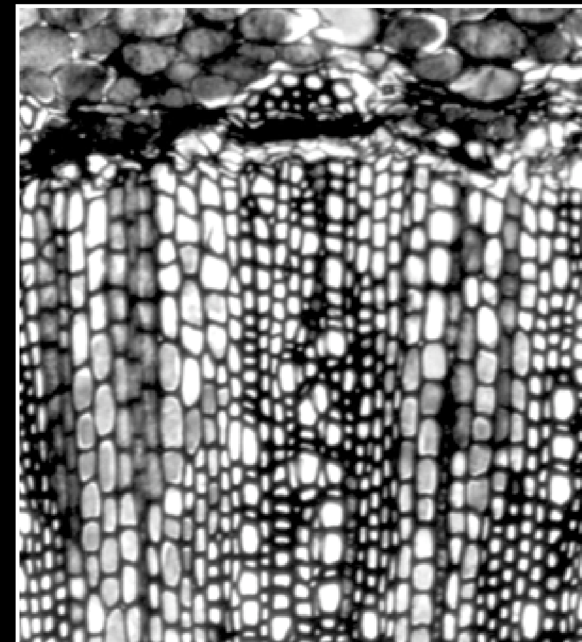


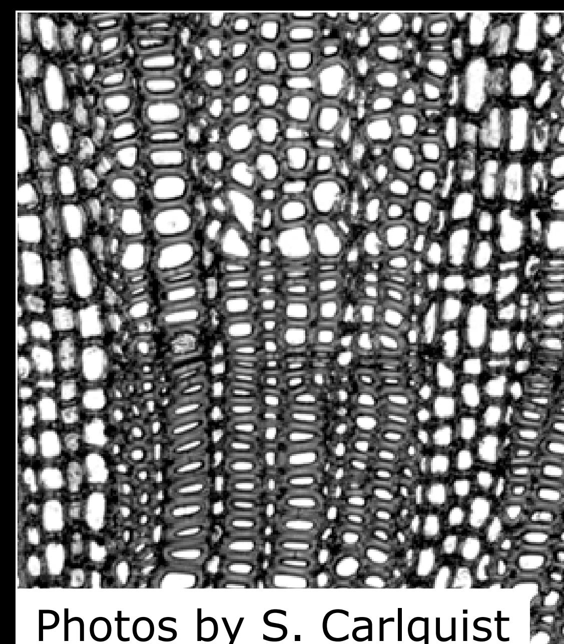
Photos by S. Carlquist,map Stevens Angiosperm Phylogeny web site

CHLORANTHACEAE



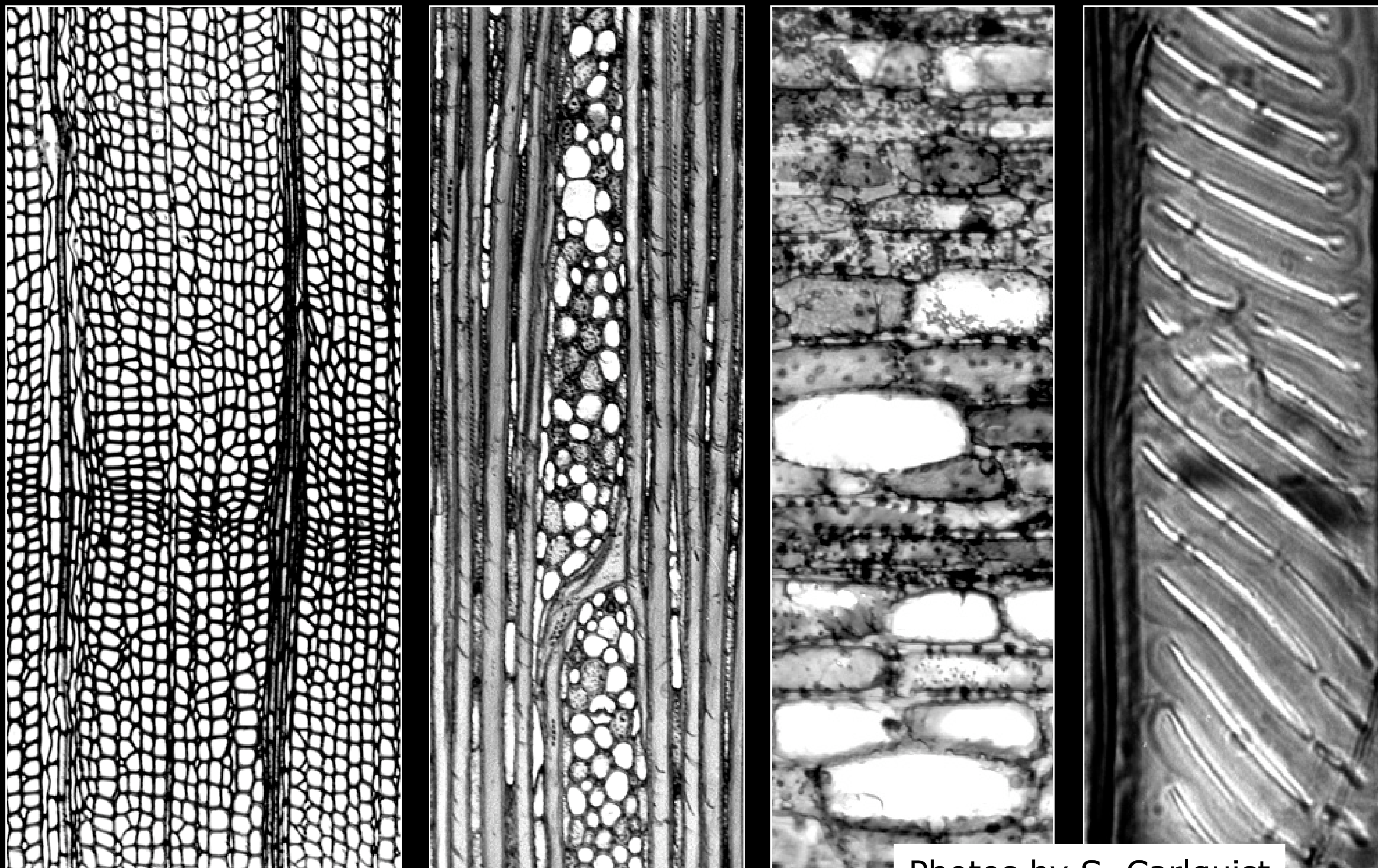






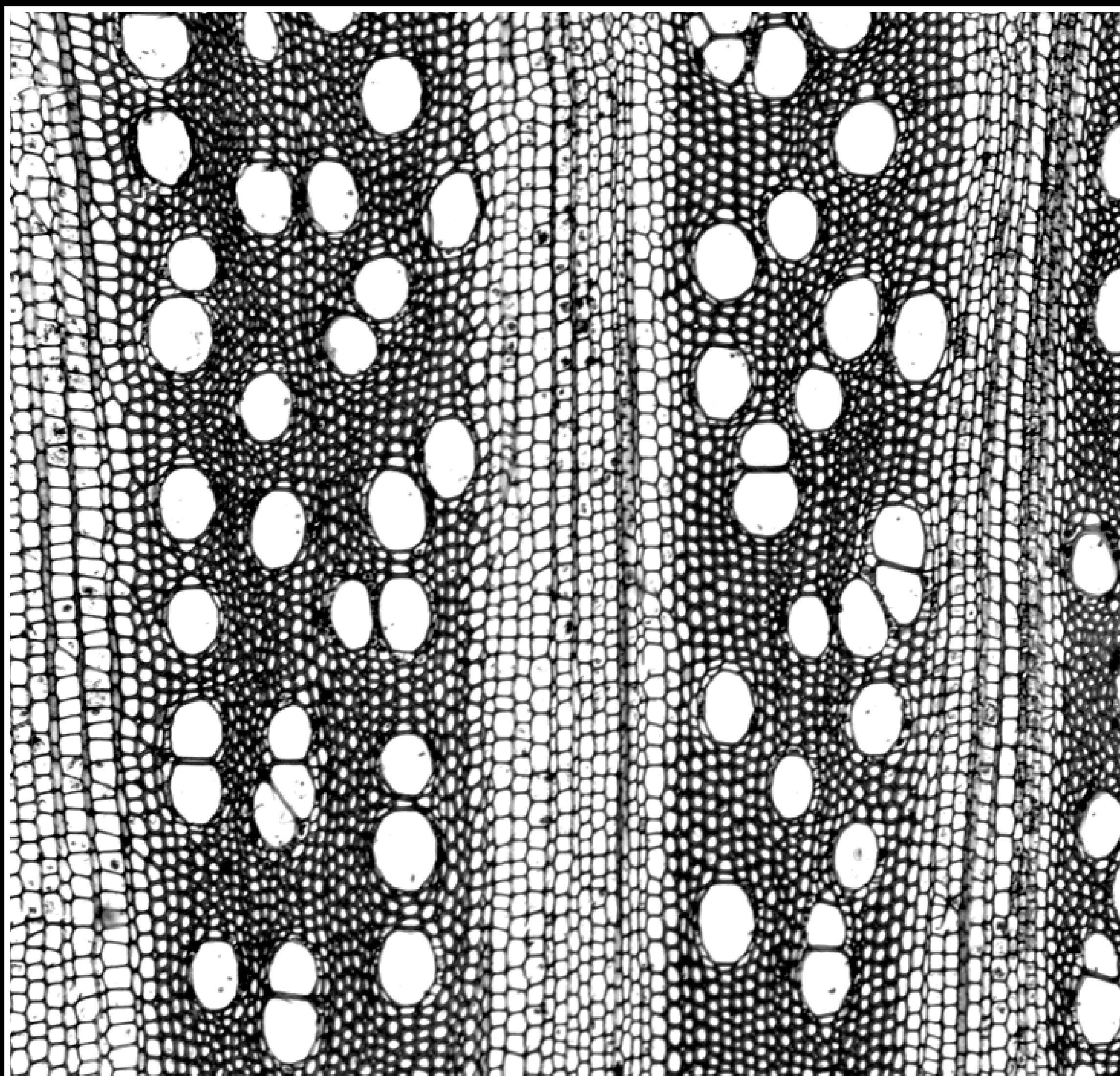
Photos by S. Carlquist

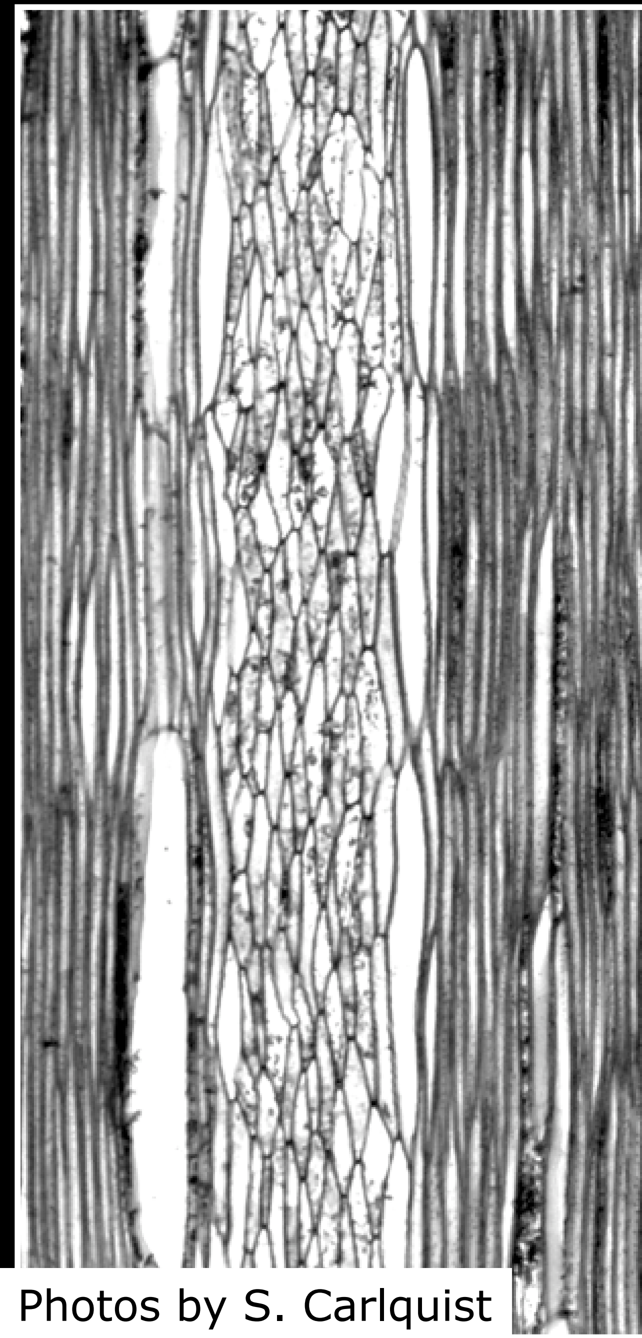
WINTERACEAE



Photos by S. Carlquist

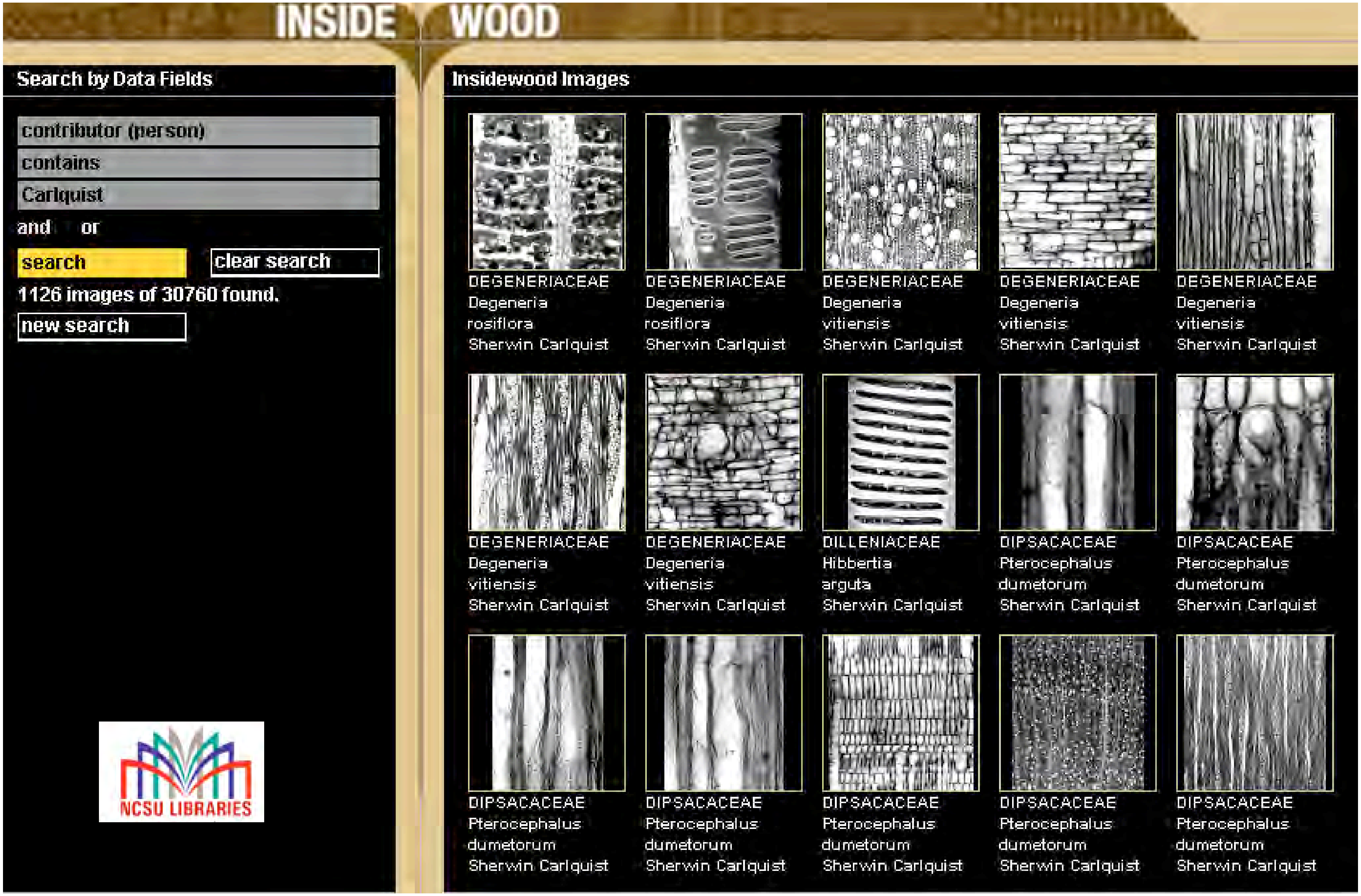
BEGONIACEAE





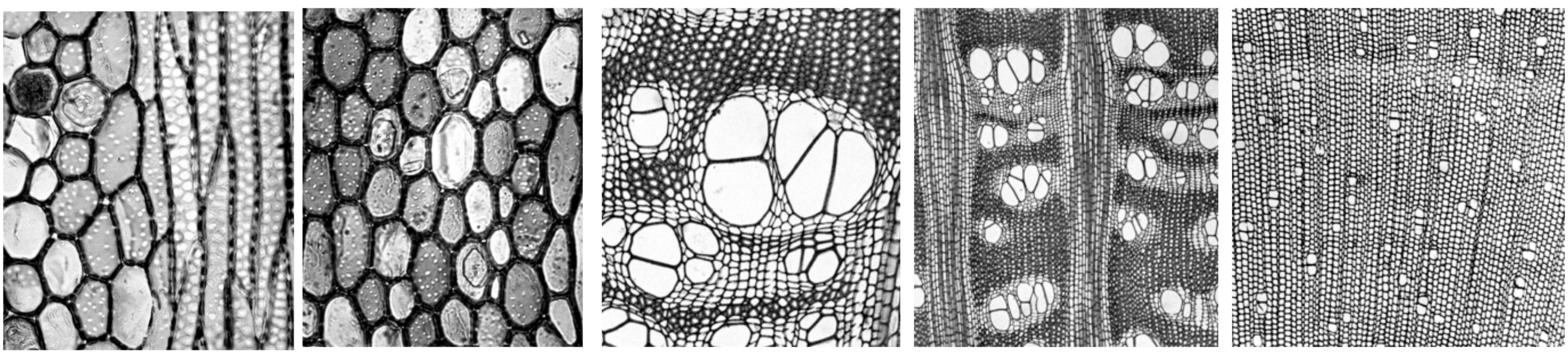
Photos by S. Carlquist

Sherwin sharing his images

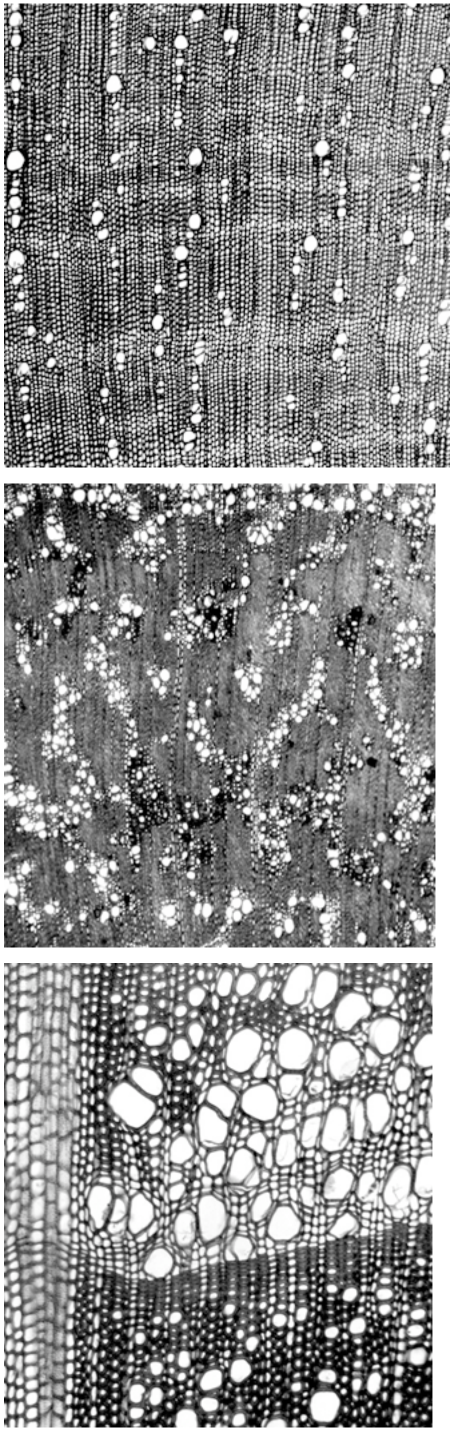


http://insidewood.lib.ncsu.edu/search

“The data from comparative wood anatomy appeal to me as vital sources of hypotheses -- and of materials for testing of hypotheses … natural experiments in ecological wood anatomy have produced compelling patterns.” Carlquist 1988



Photos by S. Carlquist



Objectives

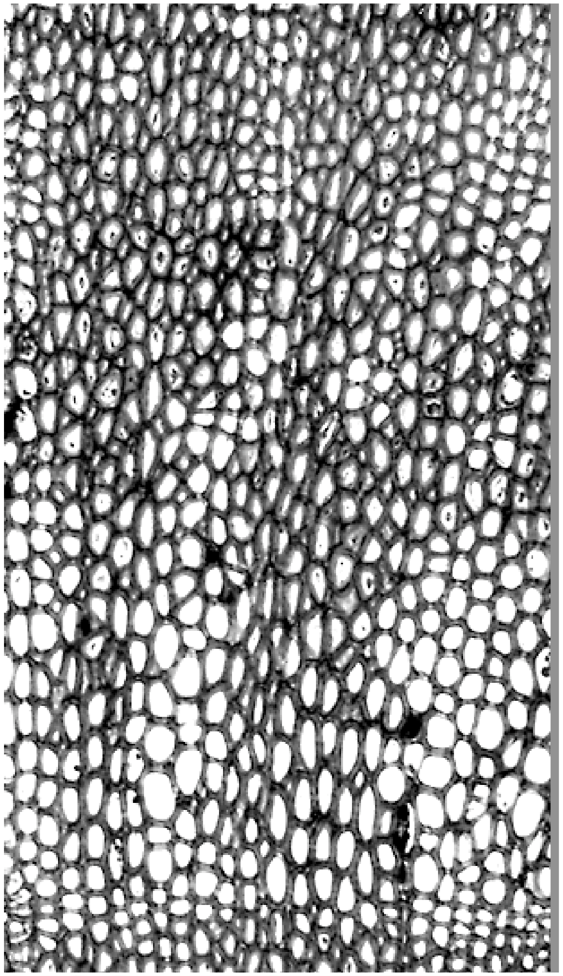
Look at some of those patterns by revisiting

Distribution

Geographic,
Systematic,
and Temporal

For some of the features and correlations discussed in Sherwin's publications.

Carlquist Photos of Lamiaceae



To do so will use

Descriptive Data for Modern Woods From

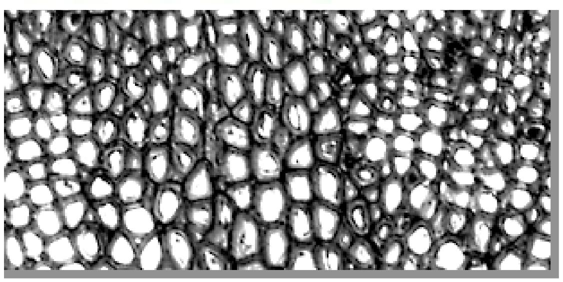
InsideWood web site

5,712 descriptions extant dicots
30,765 images

Fossil dicot wood information to be added

1,615 descriptions

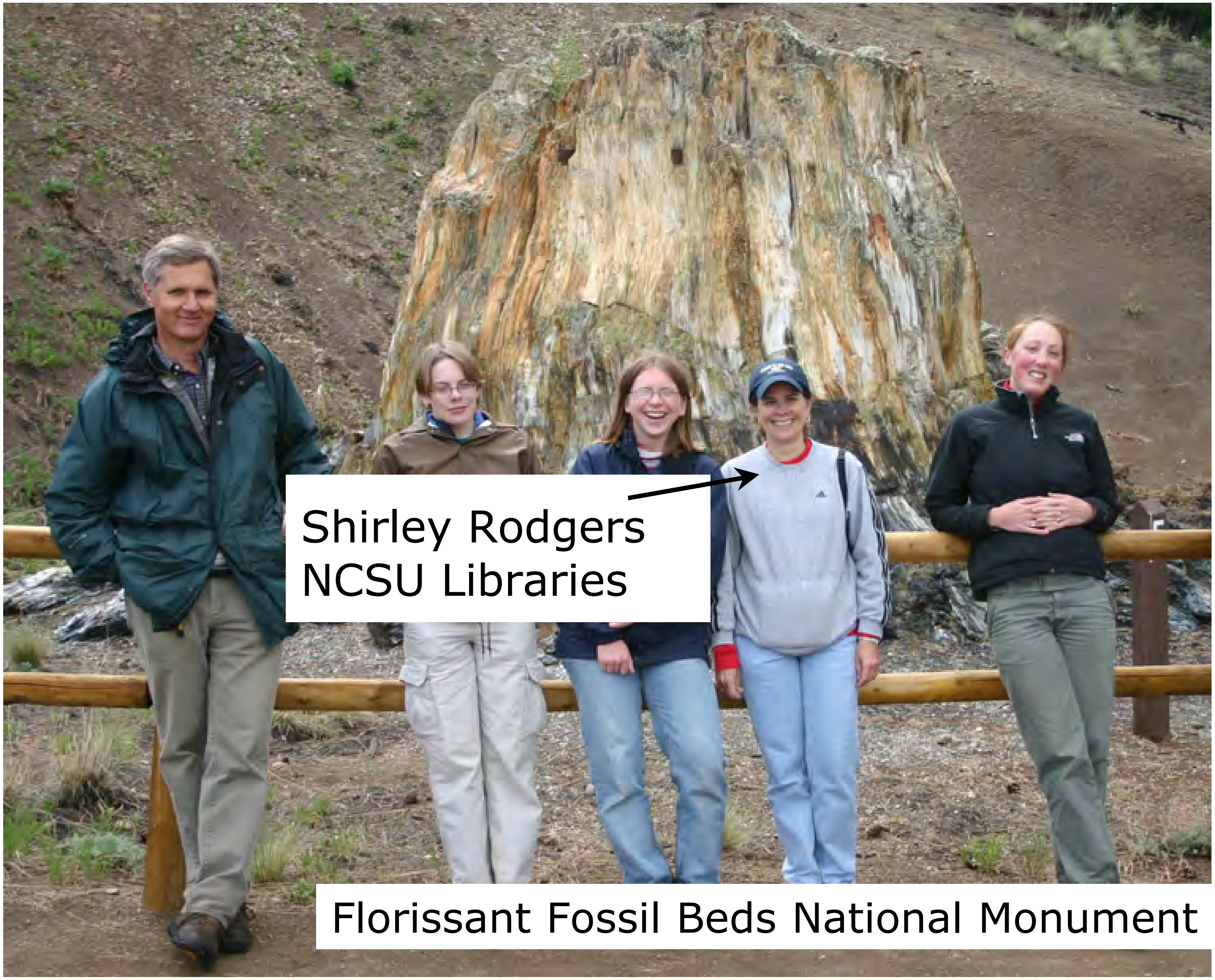
NCSU LIBRARIES http://insidewood.lib.ncsu.edu/search/



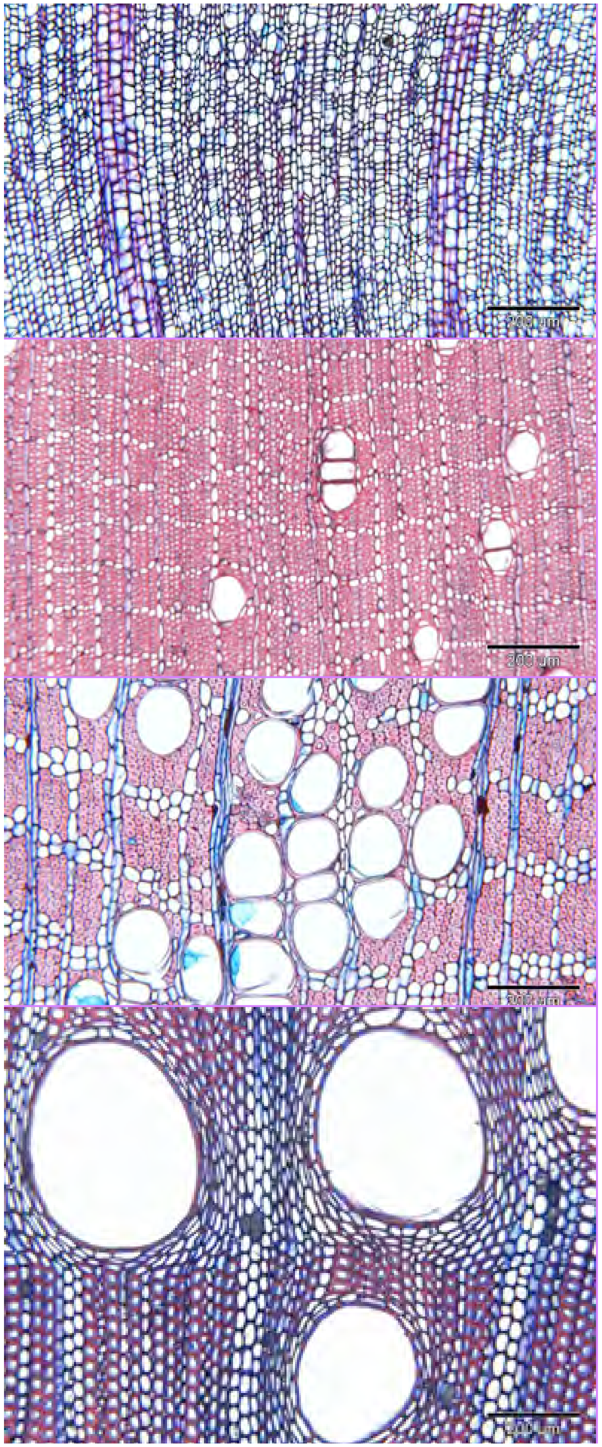
Support from
NSF BRC 0237368
NSF DBI 0518386

Misodendron angulatum S. Carlquist photo

InsideWood web site exists because of NCSU Libraries expertise.



Florissant Fossil Beds National Monument



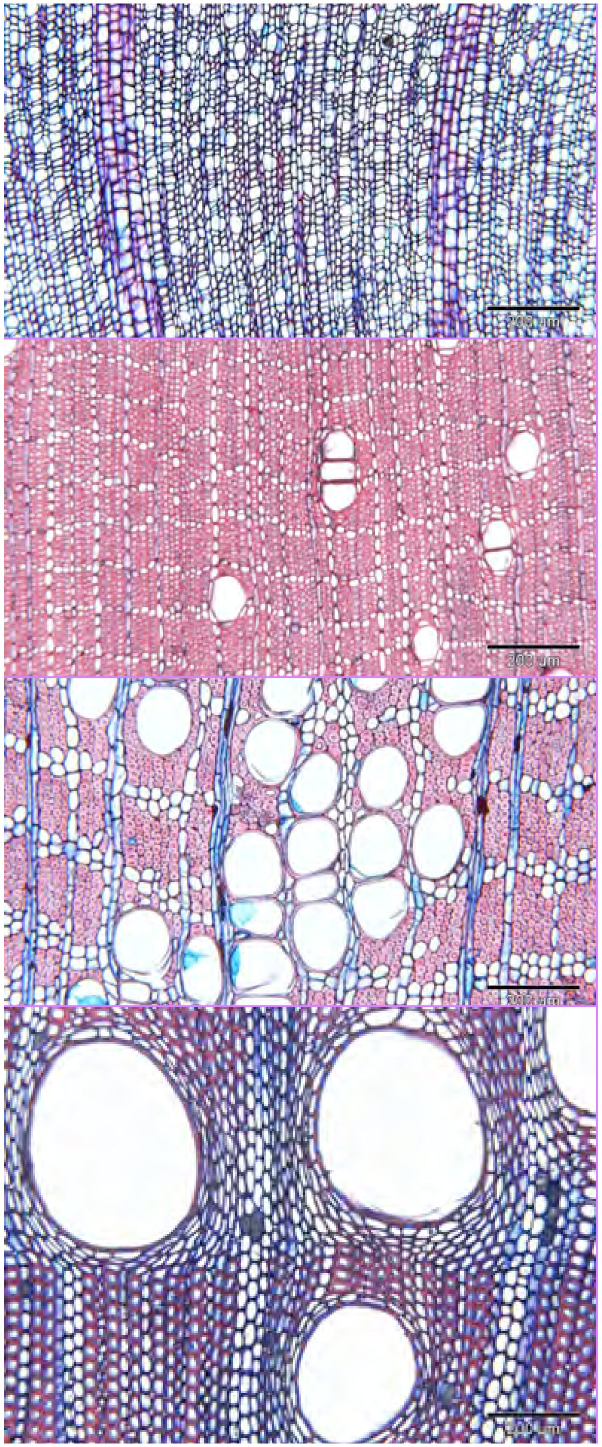
Vessel Diameter and Density

"… we can see a straight-line relationship between the vessel diameter and the number of vessels per square millimeter,

…relationship..always very close to inverse."

p. 204 *Ecological Strategies of Xylem Evolution.* Carlquist 1975

Photos of Ericales: Frederic Lens



Vessel Diameter
and
Density

Have Consequences for Conductive Efficiency and Safety

Photos of Ericales: Frederic Lens

Triangle of Wood Functions and Trade-offs

Work of
S. Davis
F. Ewers
U. Hacke
J. Sperry

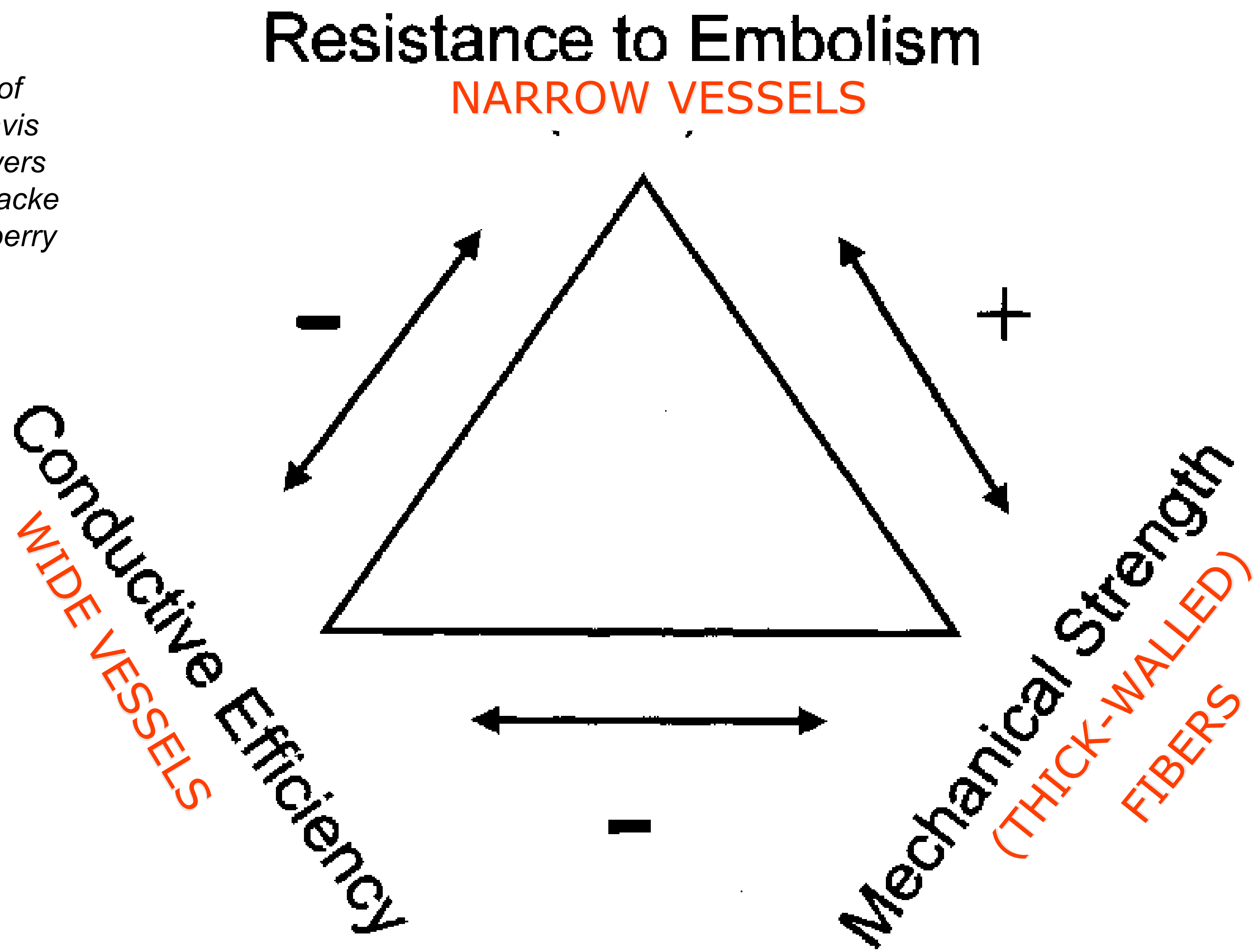
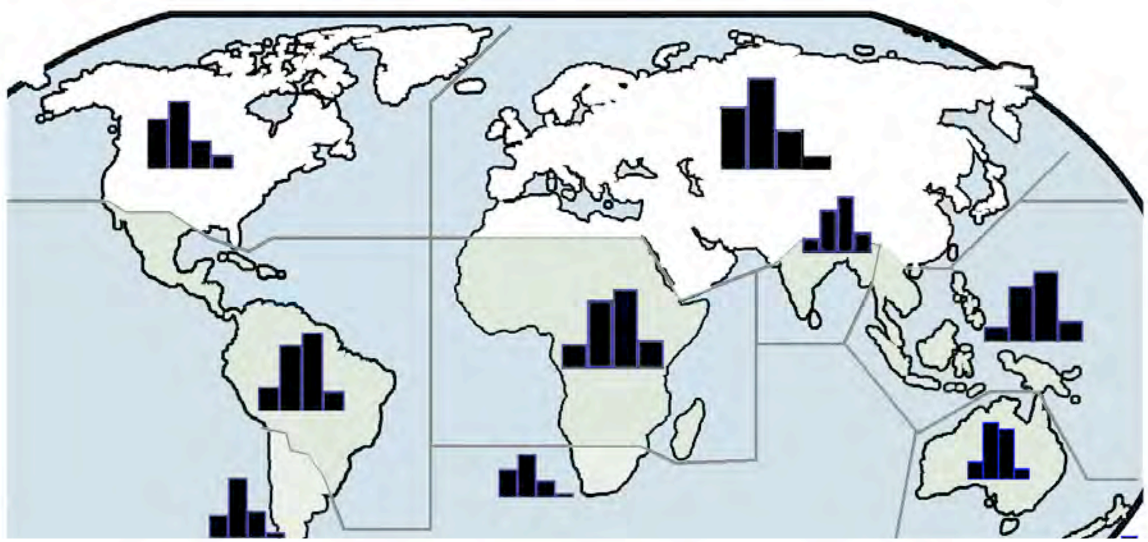
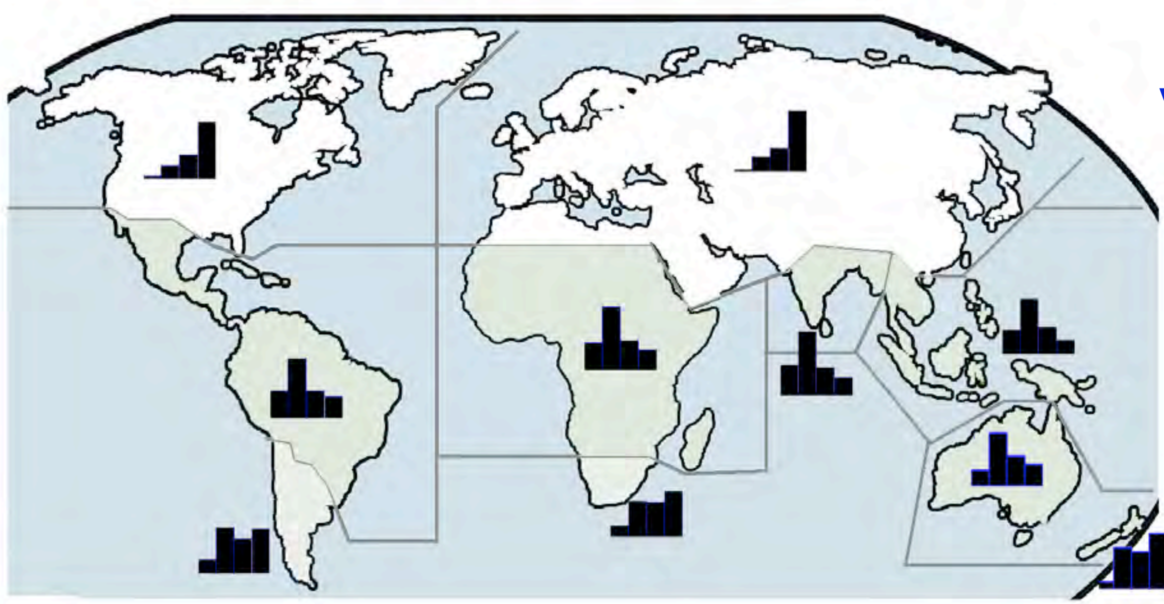


Diagram prepared by. F. Ewers 2004

Present-Day Woods





Vessel Diameter & Density Classes By Geographic Region

Tangential Diameters

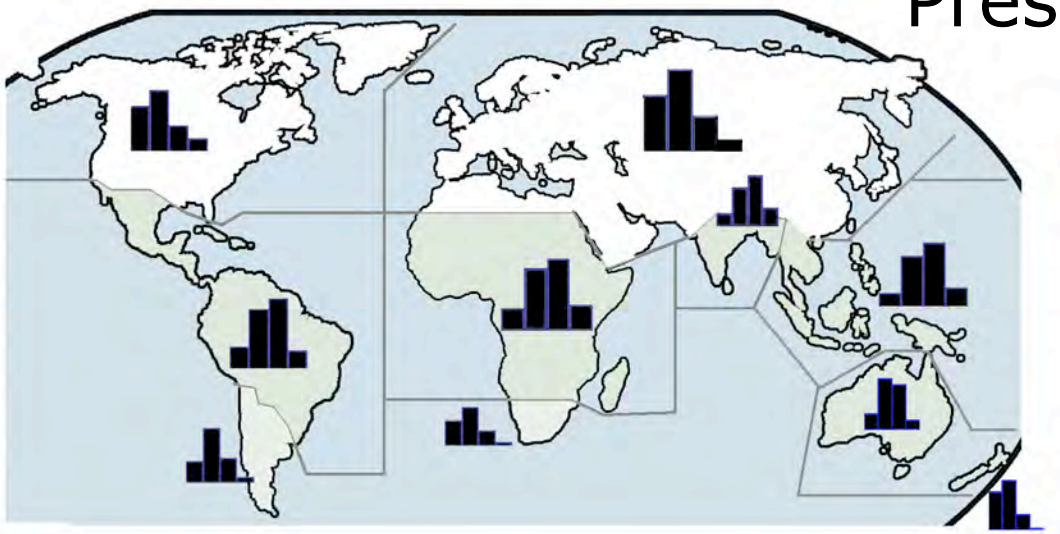
< 50 µm
50 - 100 µm
100 - 200 µm
> 200 µm

Vessels Per Sq. MM.

< 5
5 - 20
20 - 40
> 40

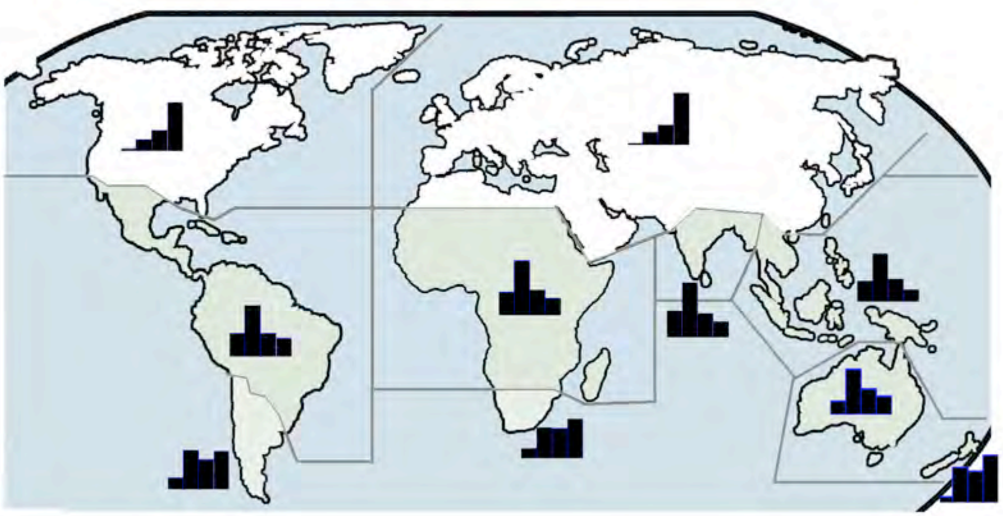
Data from InsideWood

Present-Day Woods



< 50 µm , 50 - 100 µm, 100 - 200 µm, > 200 µm --Mean Vessel Diameter

Similar patterns in North America and Temperate Asia and Europe



< 5 , 5 - 20, 20 - 40, > 40-- Vessels per sq. mm

Regions with high proportions of narrow vessels have low proportions of ‘few vessels per sq. mm’

"Large genera, distributed into different habitats, are like replicates of an experimental material, with the additional advantage of time for selection of optimal wood plans for each ecological habitat (we must note that wood is not the sole tool whereby a plant deals with water economy)."

Carlquist 1988

Preface "Comparative Wood Anatomy"

Allocasuarina torulosa

New South Wales, Queensland

understorey in open forest to tall open forest

A. acutivalvis

Shrub-small tree

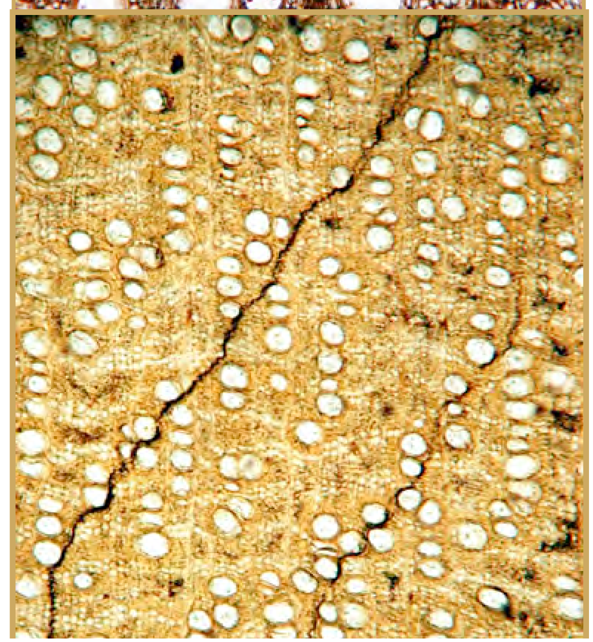
In heath, open woodland, rocky hillsides

VULNERABILITY INDEX

$$\frac{\text{Tangential Diameter (Mean)}}{\text{Vessels per mm}^2\text{ (Mean)}}$$

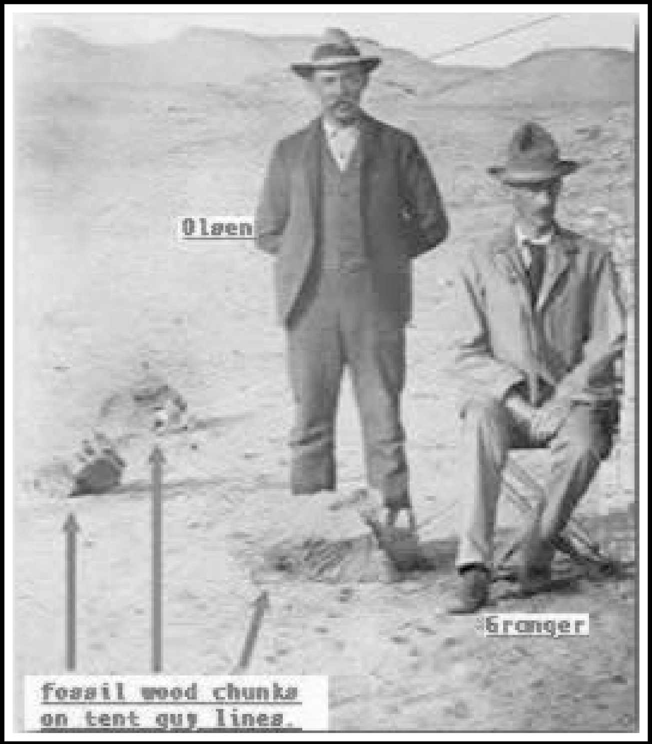
In fossil woods, vessel diameter and density usually are visible.

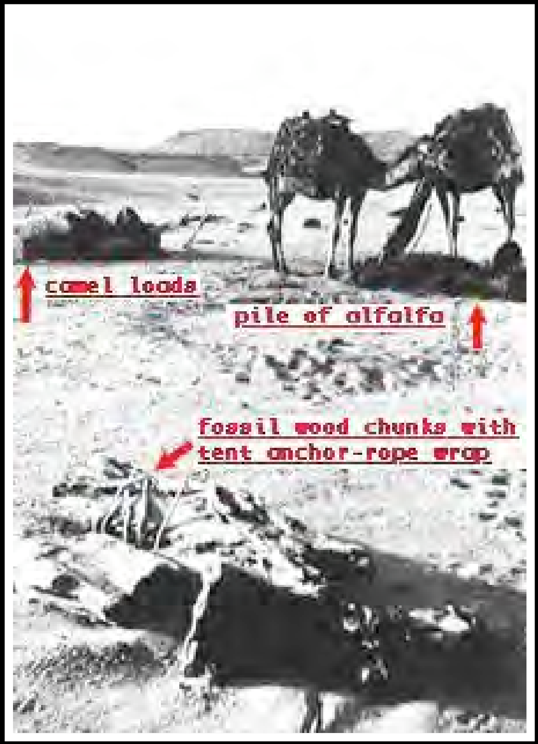
Consequently, V values appealing to paleobotanists as a means of characterizing an assemblage.



1977. Ecological factors in wood evolution: a floristic approach. Amer. J. Bot. 64: 887-896.

"Faiyum Diary Expedition to a Lost World: America's 1907 Fossil-Hunt to the Faiyum of Egypt"

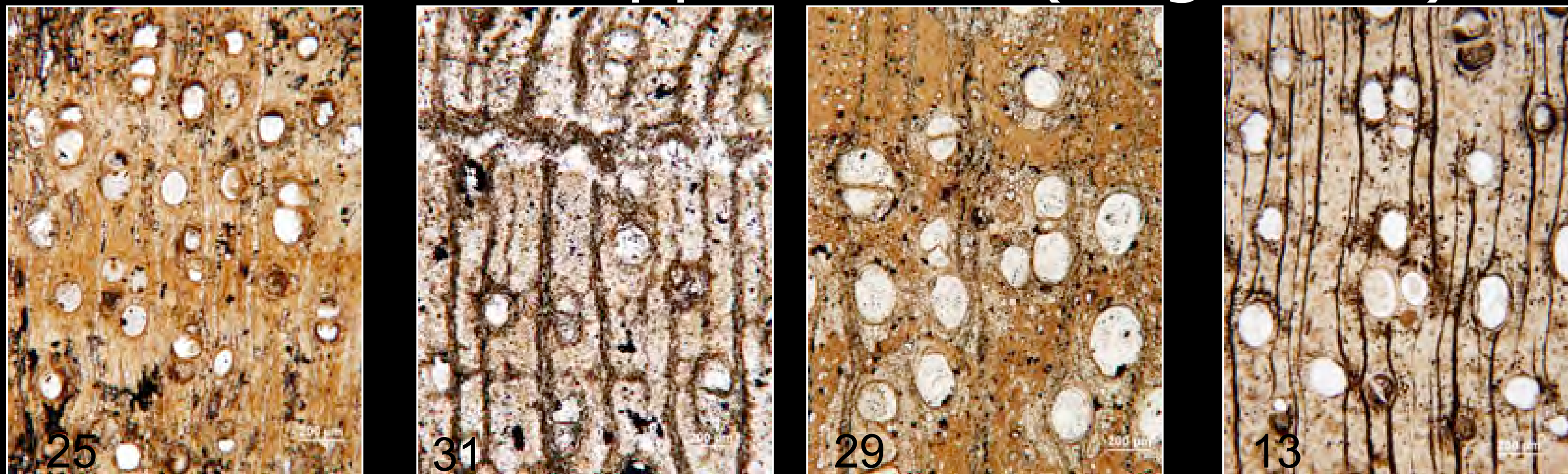




"To cook's left rear is a chunk of fossil tree ."

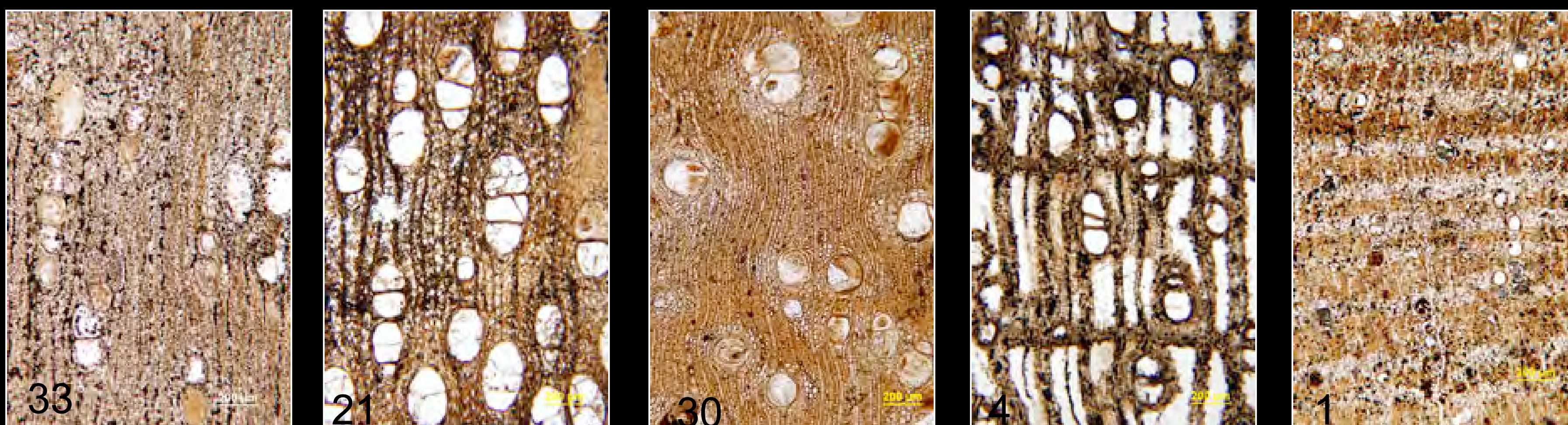
Images from The Granger Papers Project

FAYUM, EGYPT Upper Level (Oligocene)



Combretaceae, Leguminosae (Caesalpinoideae, Mimosoideae)

Lower Level (Eocene)



Sapindaceae, Malvaceae, Combretaceae, Leguminosae, Unknown

Wing, Tiffney, Wheeler in prep

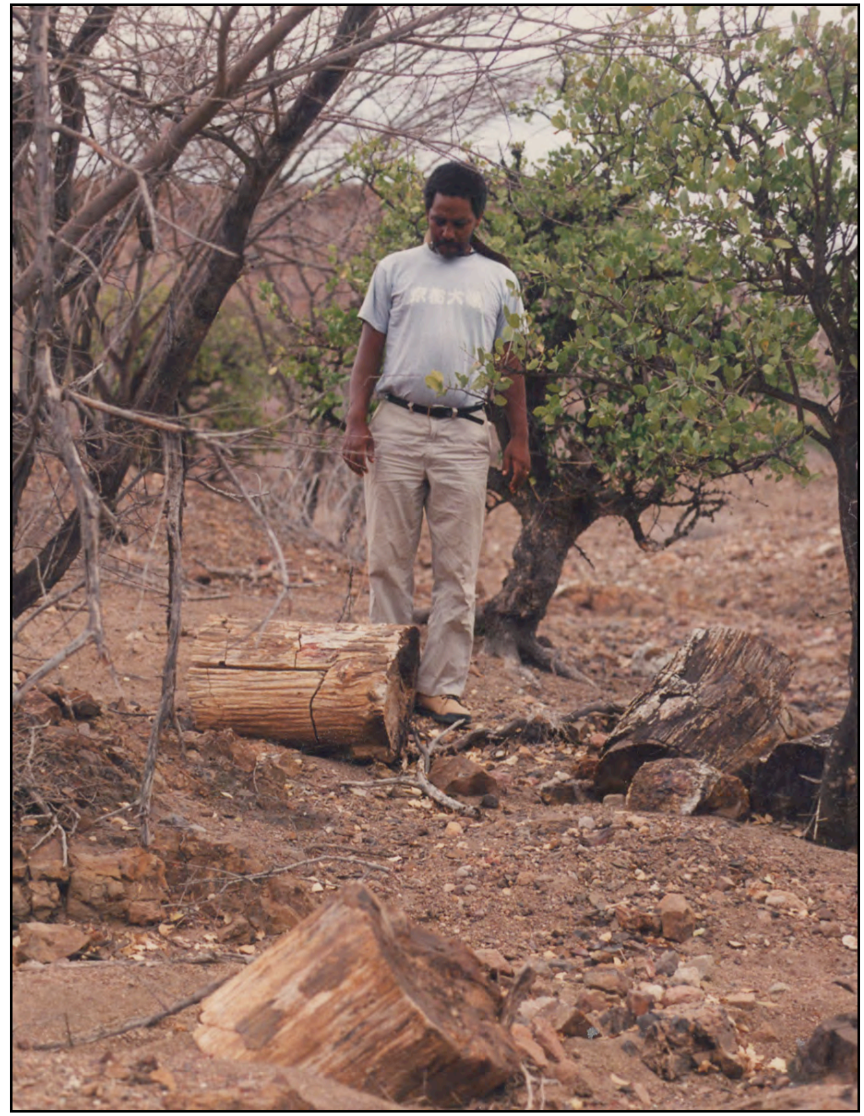
Locality FJ-18: Bakate Formation, s. Ethiopia.

J. Fleagle, SUNY collections

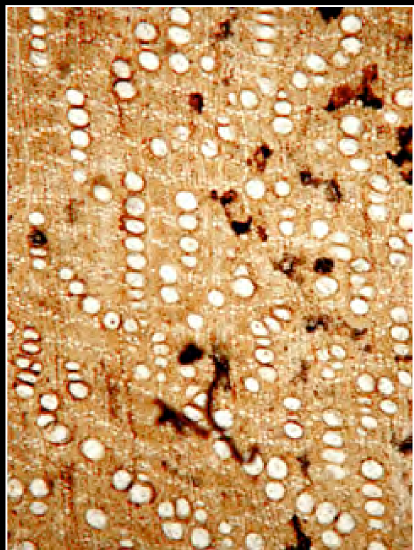
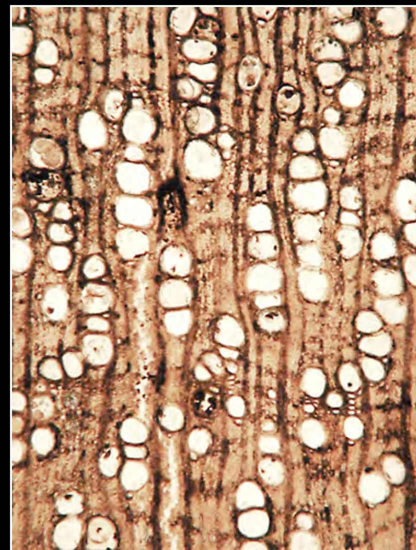
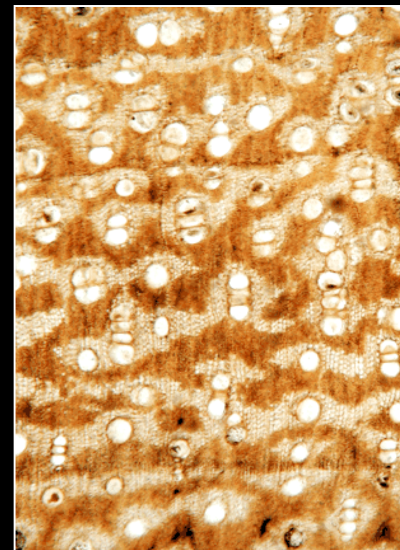
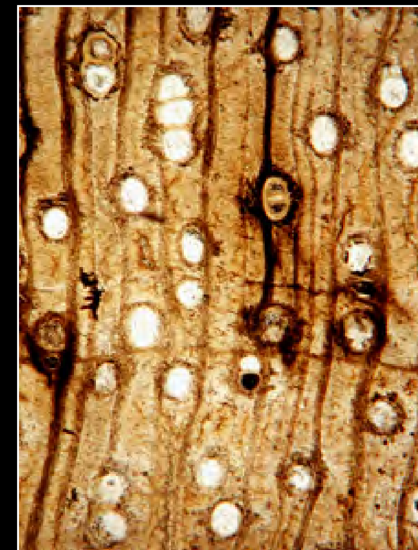
Fejej: Miocene.

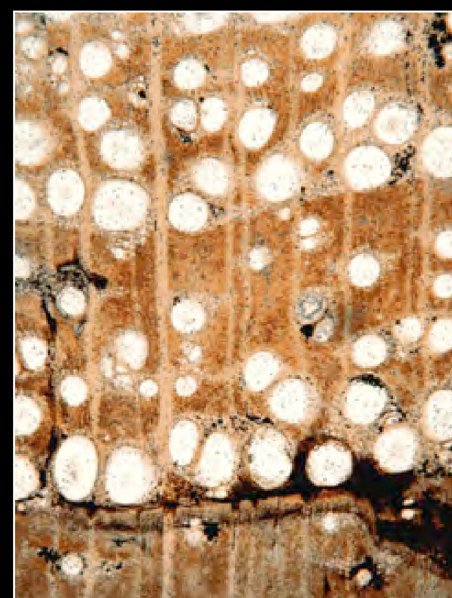
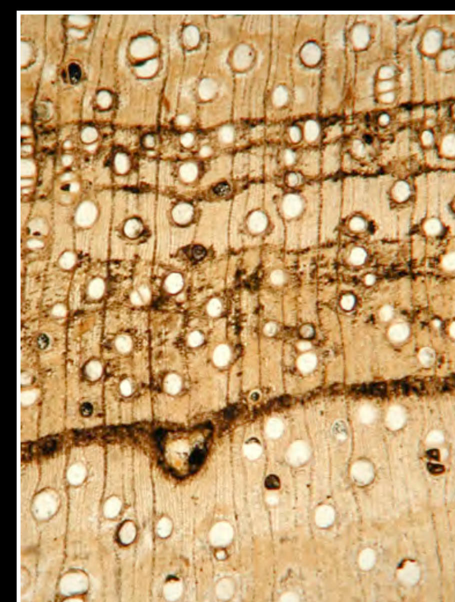
Minimum 16.18 ± 0.05 million yrs.

Significant hominoid fossils



FEJEJ, ETHIOPIA Miocene

Sapotaceae, Leguminosae (Caesalpinoid & Mimosoid), Bignoniaceae, Combretaceae

Wheeler, Wiemann, Fleagle, in press

VULNERABILITY: V Values

Fayum Upper Level: 13.6 - **31** - 56

Fayum Lower Level: 8.1 - **26** - 47.2

Fayum Values High Vulnerability
Suggesting Low Water Stress

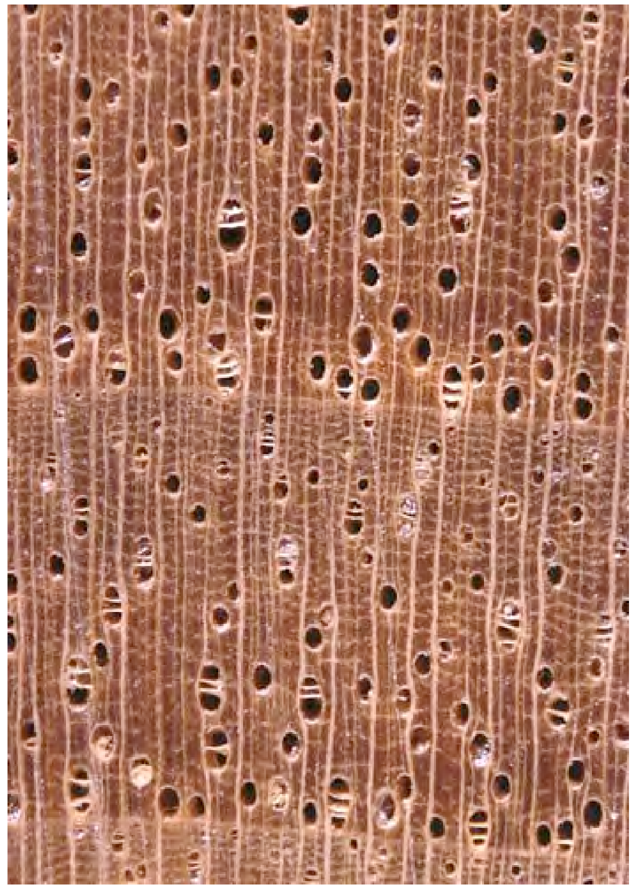
Fejej: 0.2 - **5.4** - 19.8

Fejej Values Indicate Drier Conditions

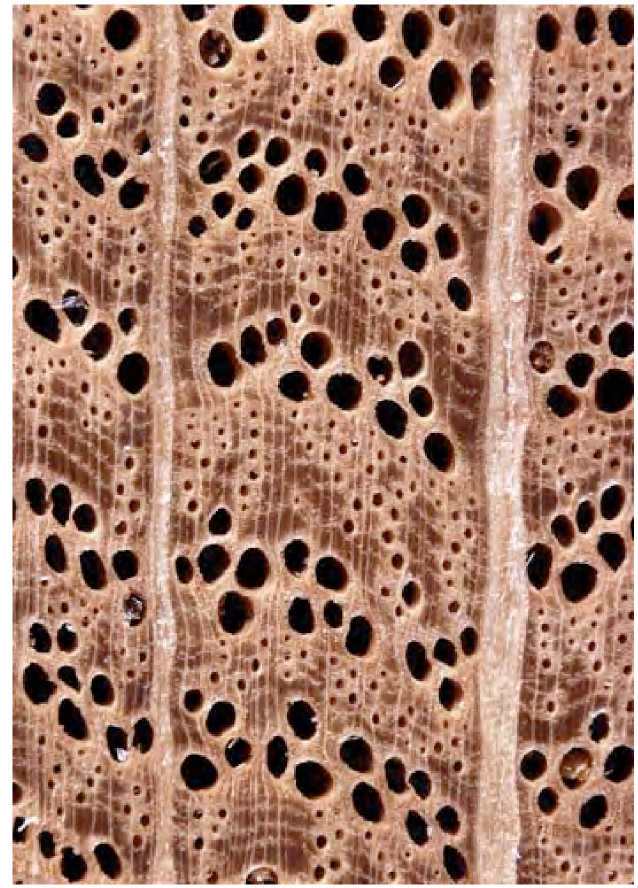
Note: wood with 19.8 value an *Acacia* (deep roots)

POROSITY

Diffuse Porous



Semi-Ring Porous

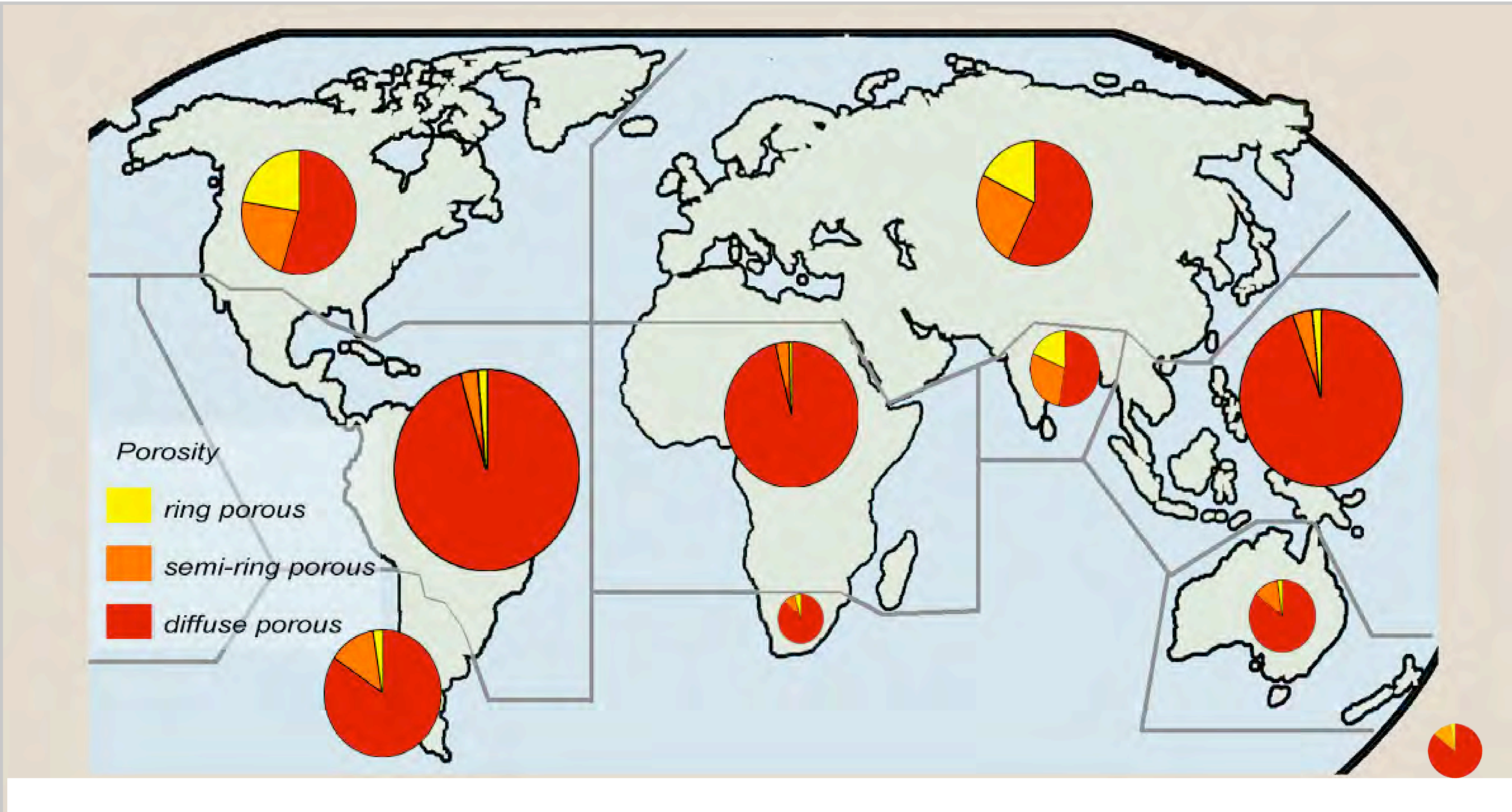


Ring Porous

Photos: L.Y.T. Westra

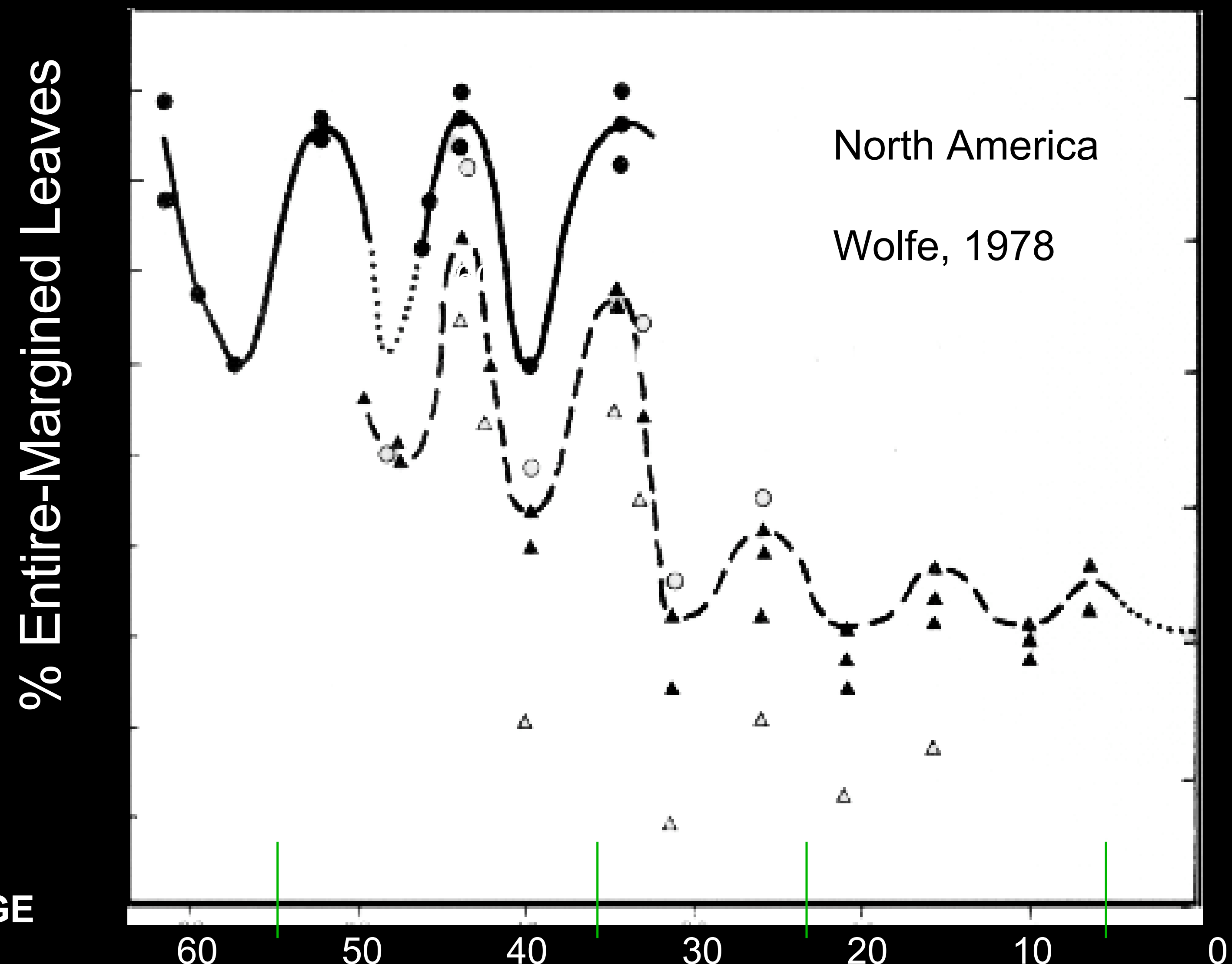
How Do Porosity Types Vary by Region?

Ring Porosity (yellow) N. Hemisphere Phenomenon



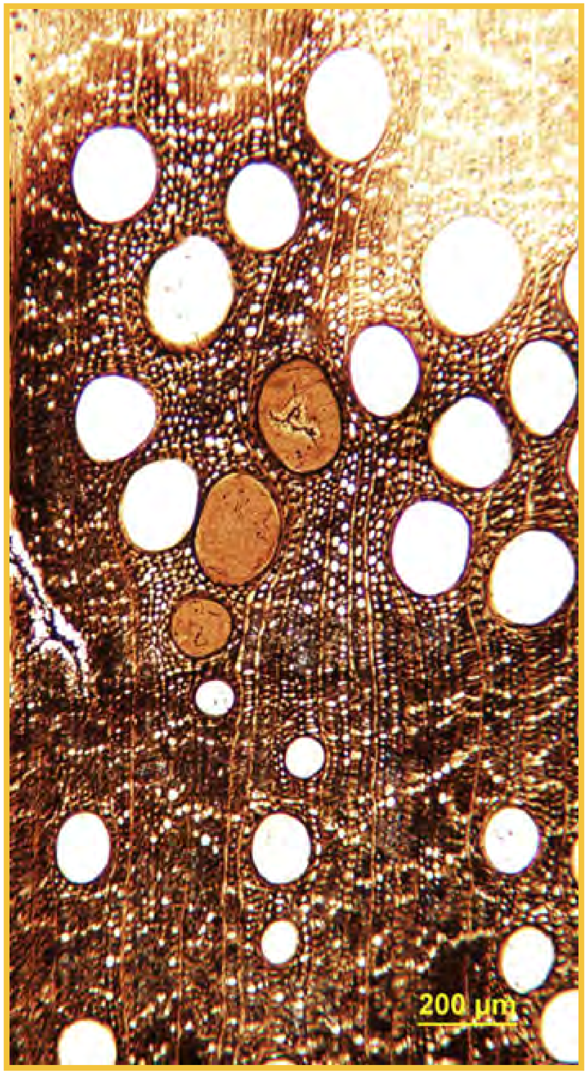
Ring porous woods rare in the S. Hemisphere (Gilbert 1940)
Likely because 'temperate S. Hemisphere' mostly evergreen

Known for decades that at end of Eocene dramatic change in climate.



Change in Incidence Porosity in Quercoideae

Middle Eocene

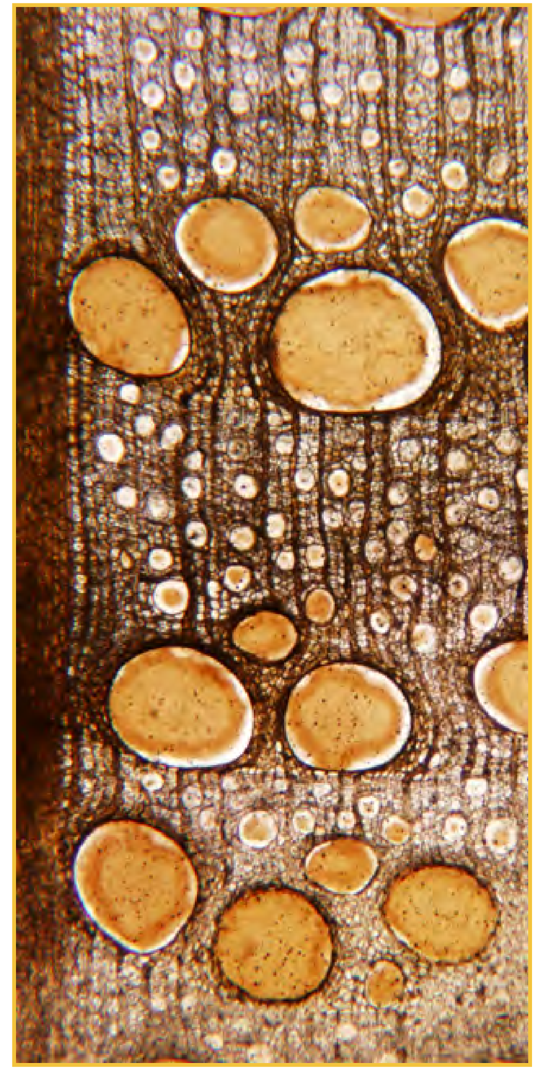


Clarno Nut Beds, OR

Late Eocene

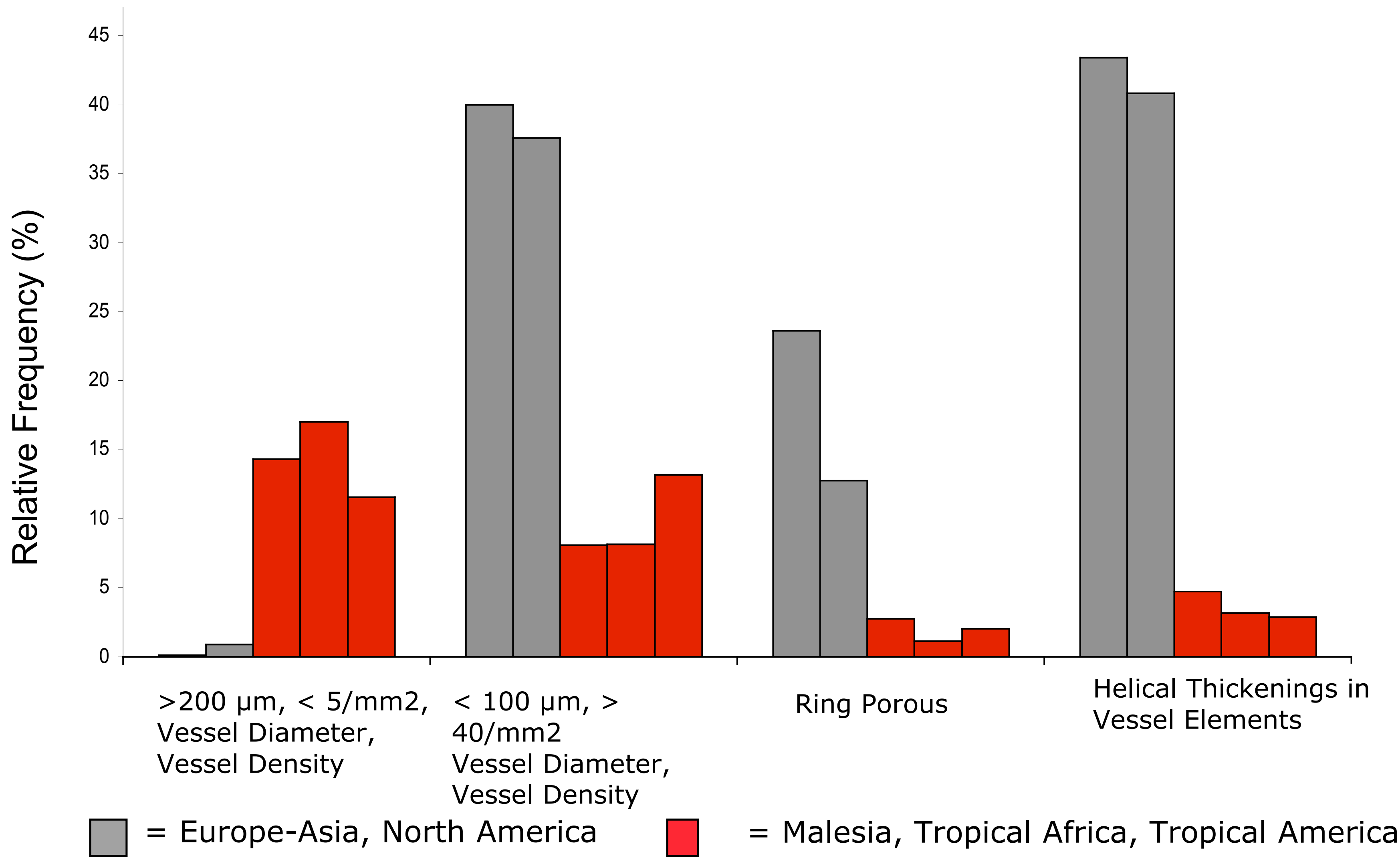
Post, OR

Middle Miocene

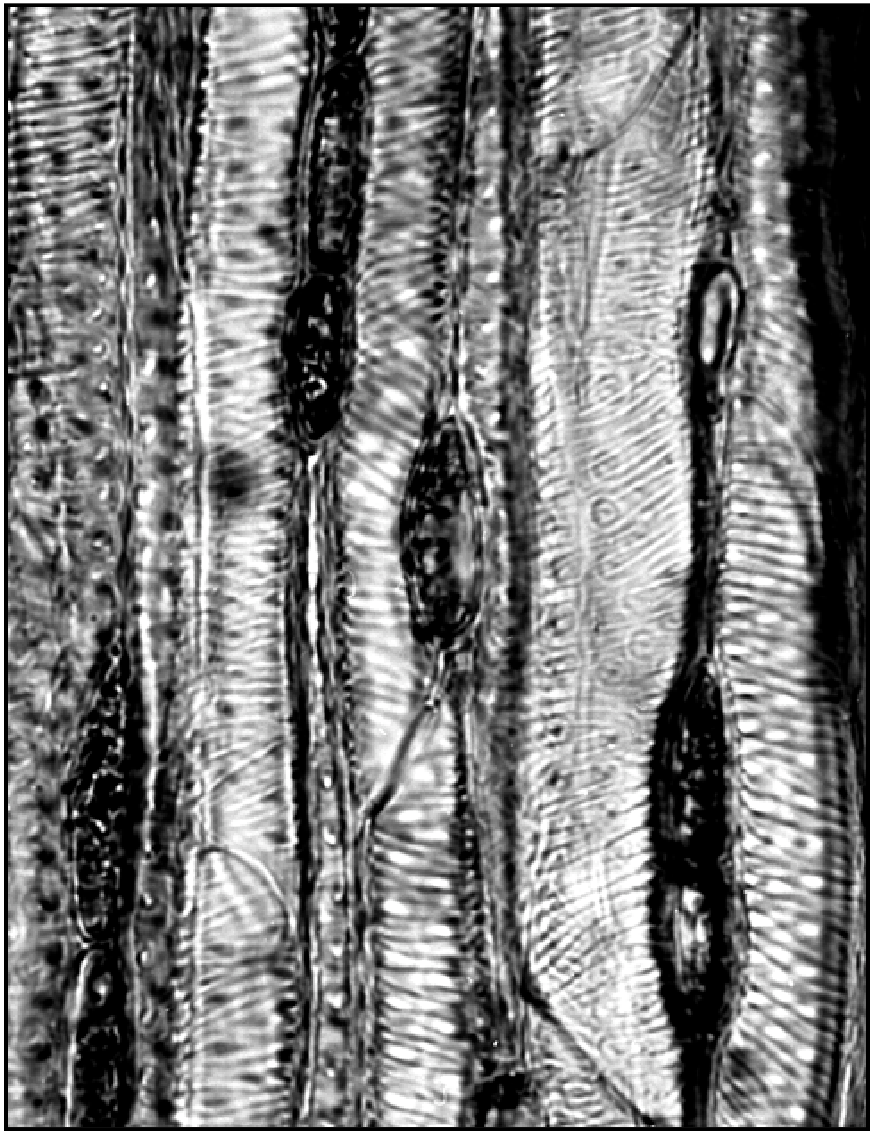


Vantage, WA

Incidences of Features in Recent Woods
“Temperate” vs. “Tropical”

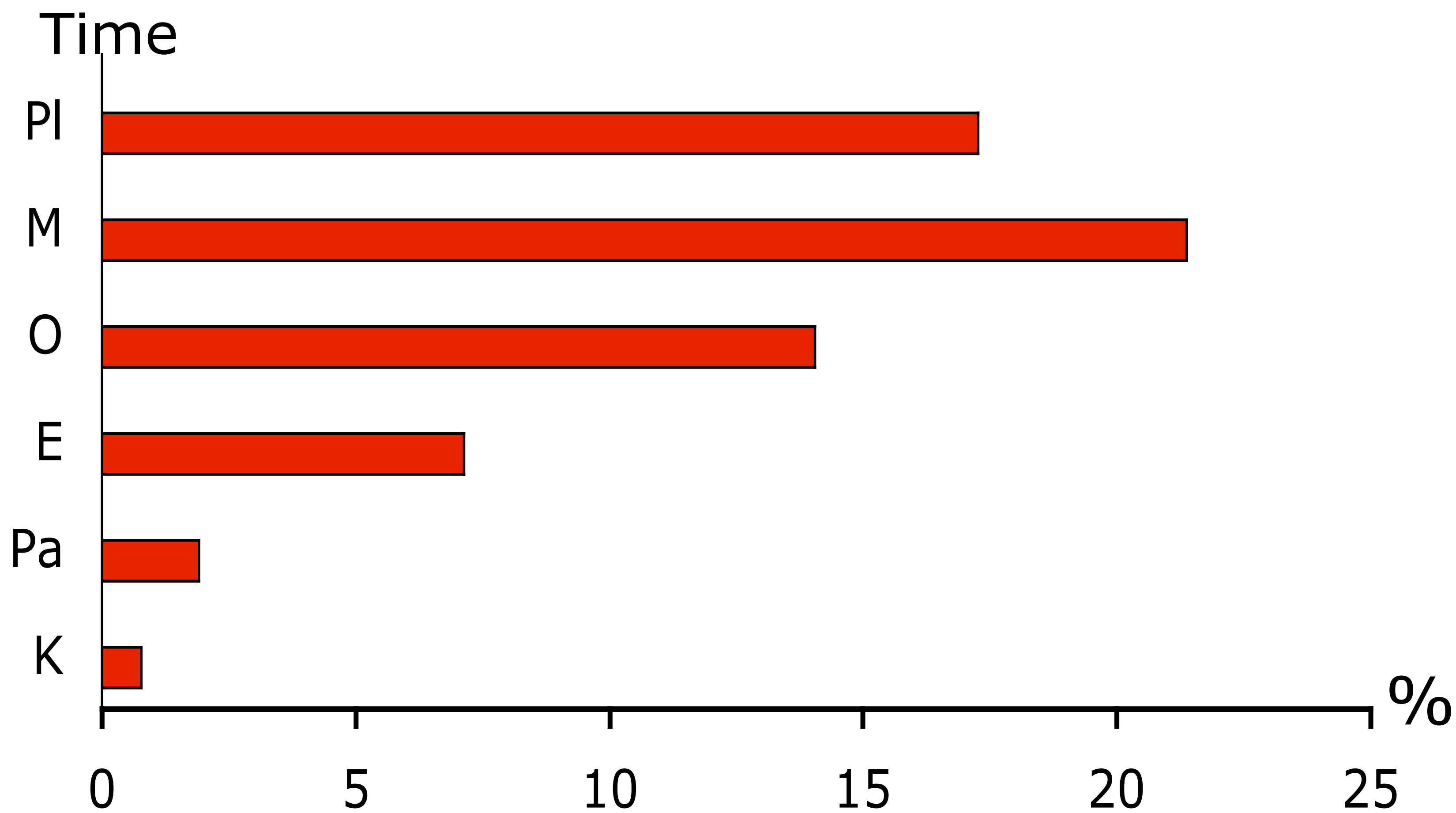


Helical Thickenings in Vessel Elements



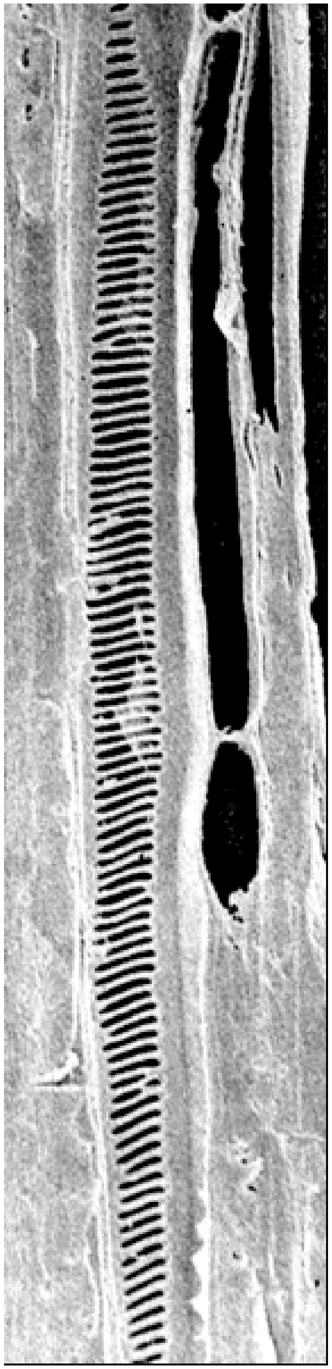
Function?
"..might have effect of forestalling air embolism formation and spread, or else they might aid in refilling of embolized vessels."

In the Northern Hemisphere--
Does The Incidence of Helical Thickenings in Vessel Elements Change Through Time?



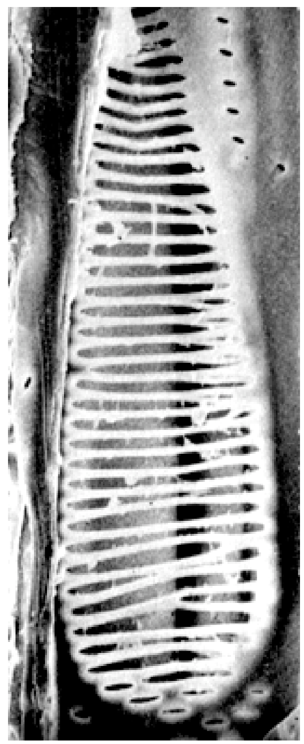
PERFORATION PLATES

"Climatic events that are more seasonal will tend to encourage evolution towards greater conductive efficiency, such as loss of bars on perforation plates."

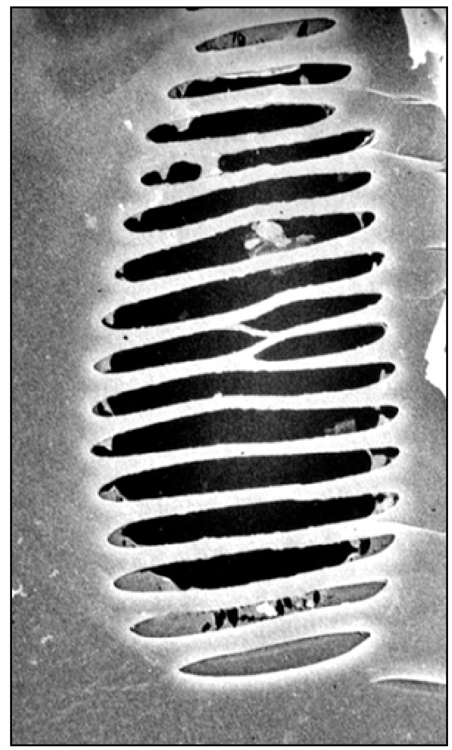


Ascarina

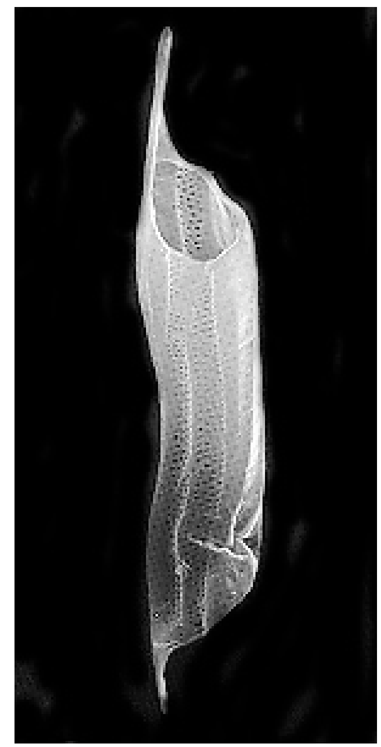
Illicium



Symplocos

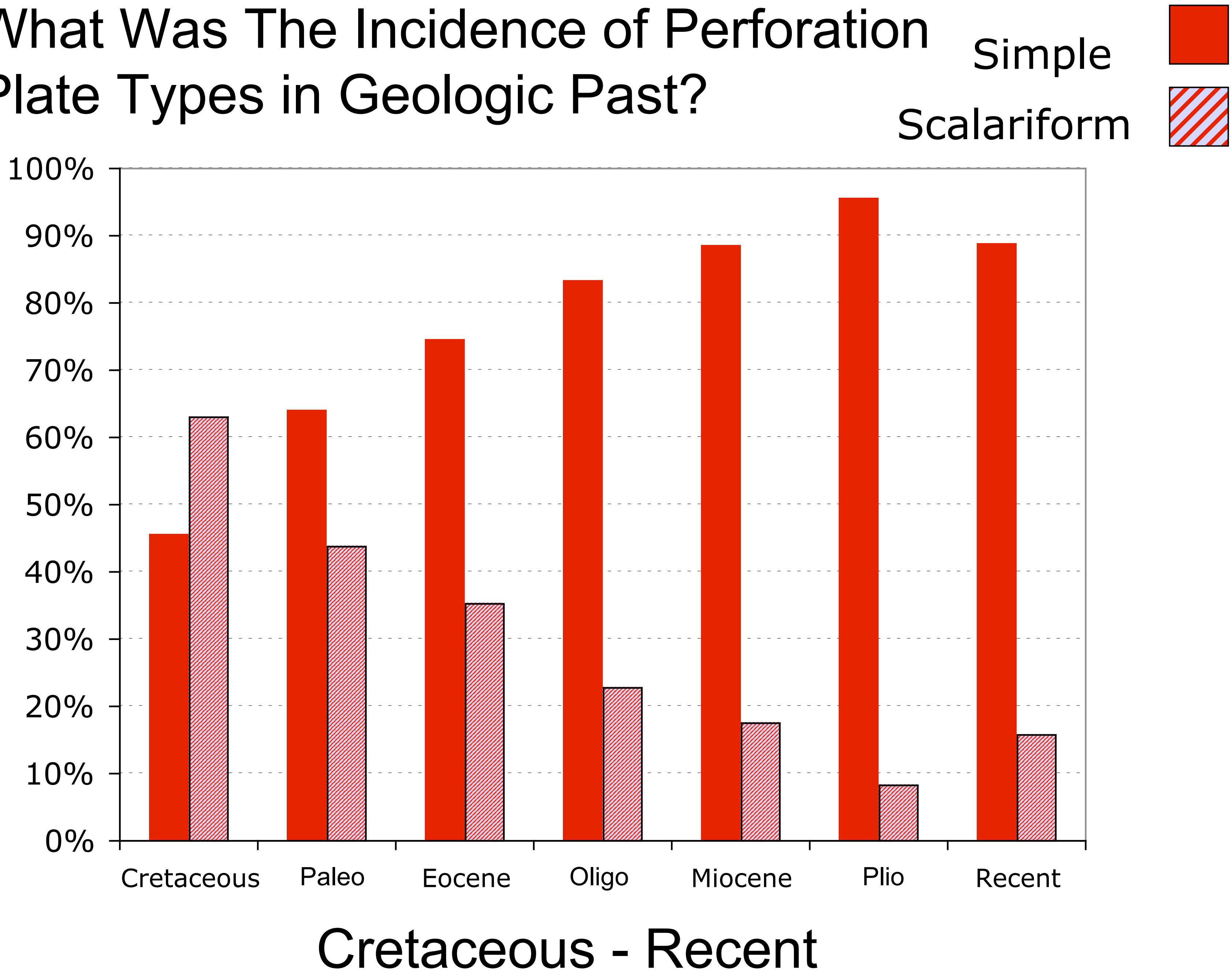


Illicium



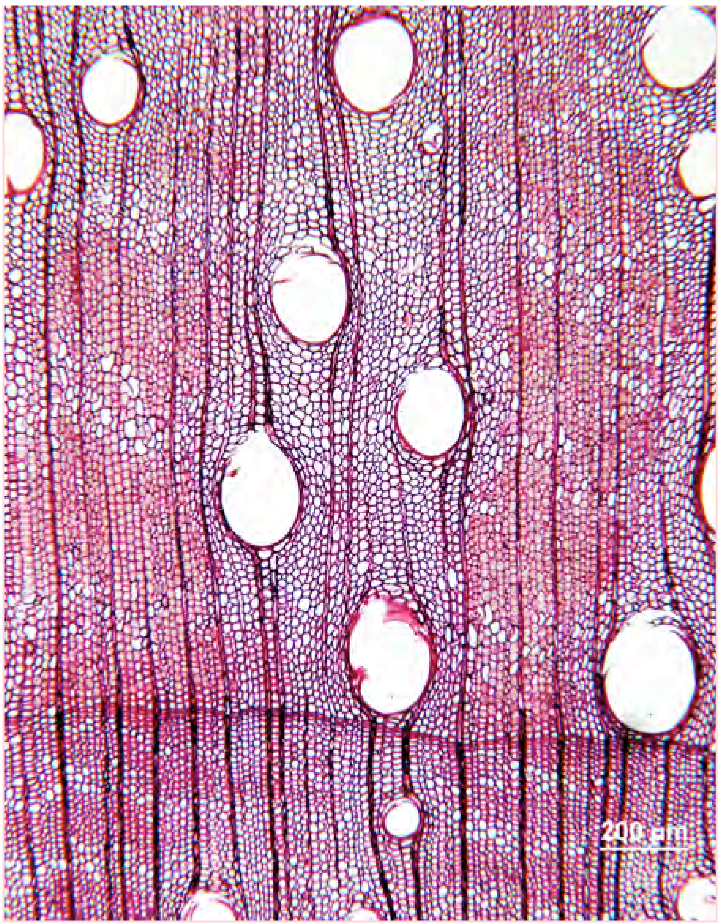
Acer

What Was The Incidence of Perforation Plate Types in Geologic Past?



Vasicentric Tracheids

"Occurrence of tracheids depresses vessel groupings."

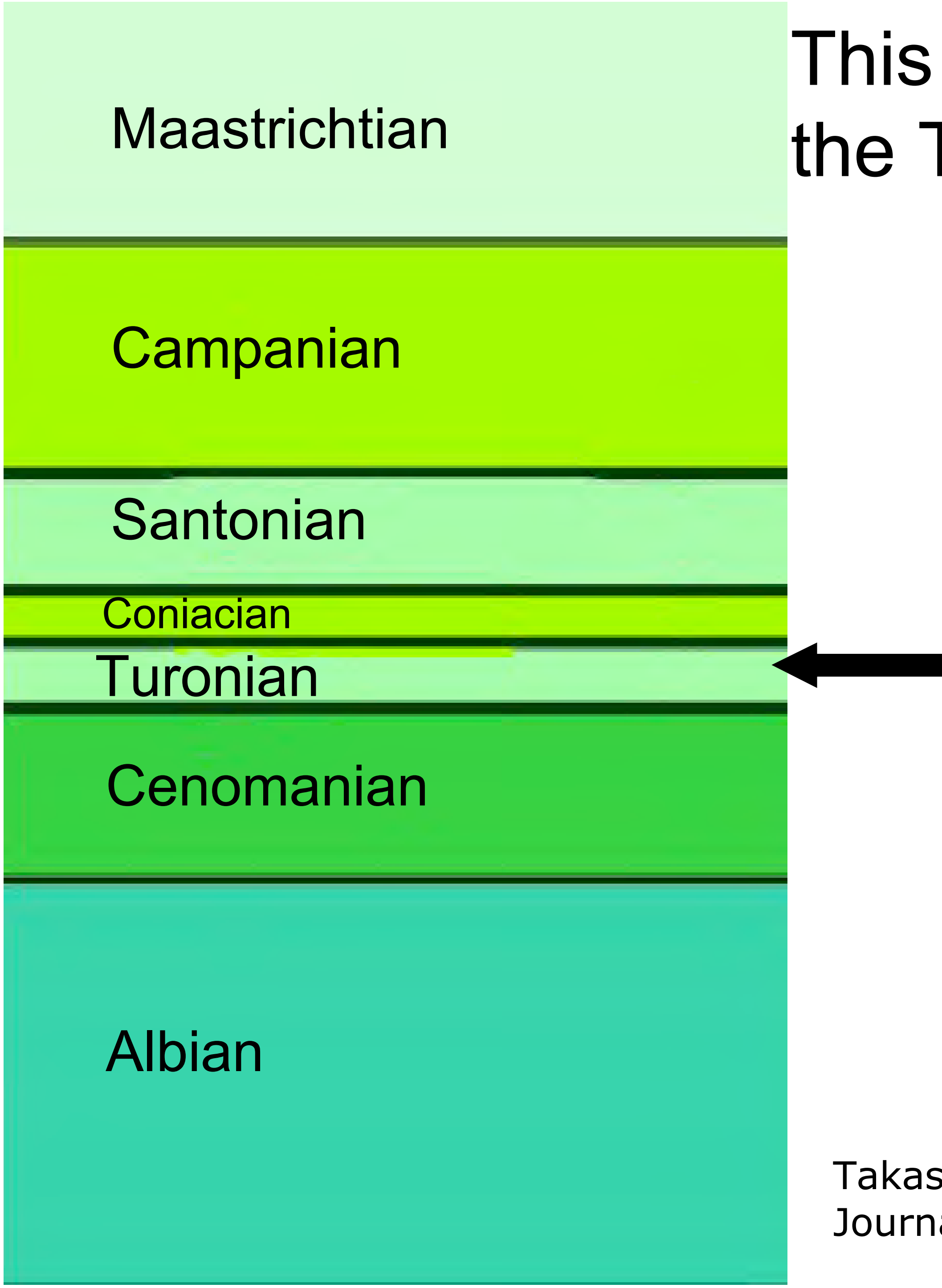


“Occurrence of tracheids depresses vessel groupings.”

Incidence of Vasicentric / Vascular Tracheids & Exclusively solitary vessels > 100 μm?

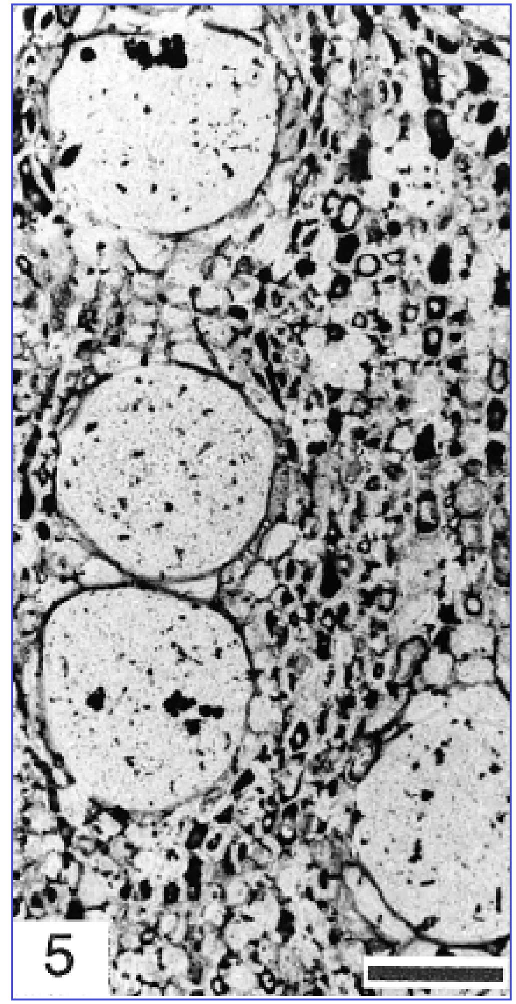
Observed	Expected	% Deviation
149	35	+ 325

ALSO (scattered and low incidence) in
Berberidopsidales, Celastrales,
Fabales (Polygalaceae), Gentianales,
Oxalidales, Ranunculales, Rosales,
Scrophulariaceae, Solanales, Santalales



This pattern appears in the Turonian.

Yezo Group, Japan



Castanoradix cretacea

Takashi, K. & M. Suzuki. 2003. IAWA Journal 24 (3): 269– 309

Septate Fibers

"….function.. regarded as like that of axial parenchyma.

Species with septate fibers might be expected, therefore, not to have abundant axial parenchyma…"

Bischofia javanica (Phyllanthaceae) FPRI, Tsukuba, Japan

Septate Fibers only
and
Rare Axial Parenchyma

Observed	Expected	% Deviation
343	105	+ 229

Primarily in Malpighiales

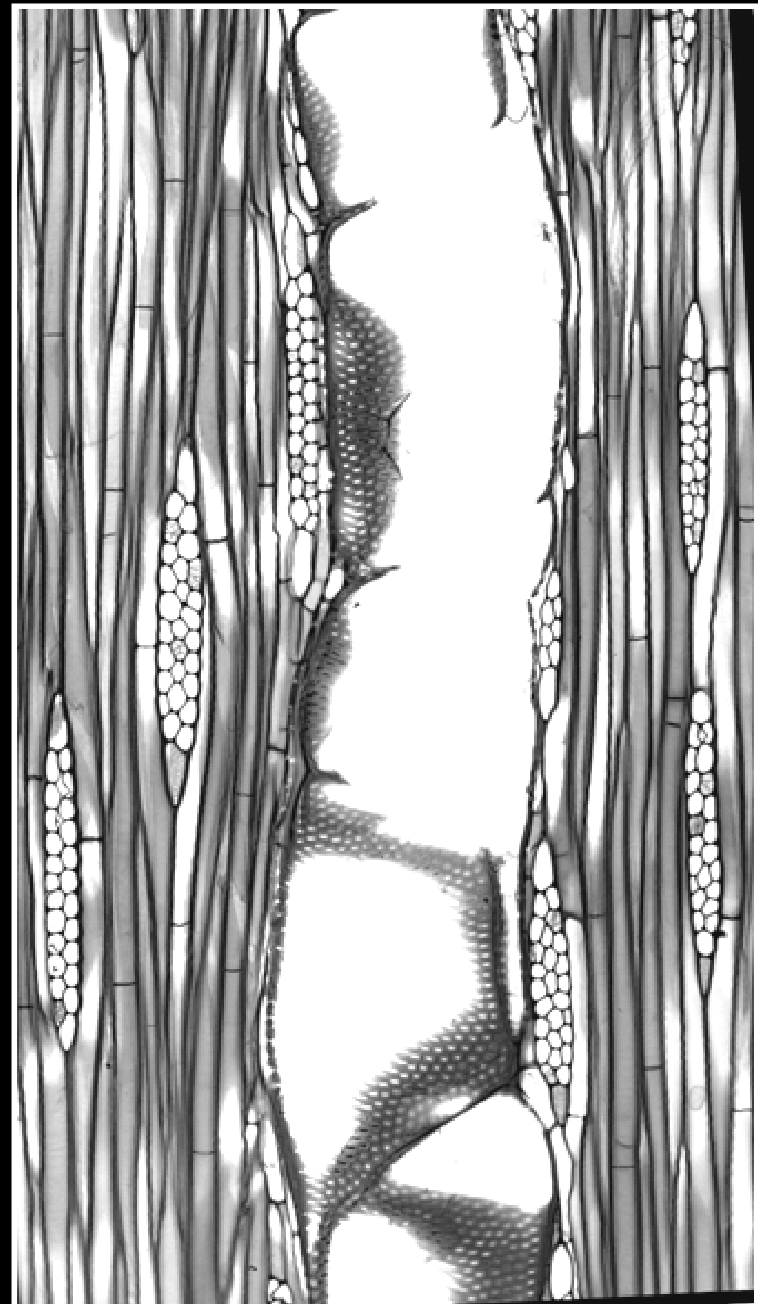
Also

Gentianales

Laurales

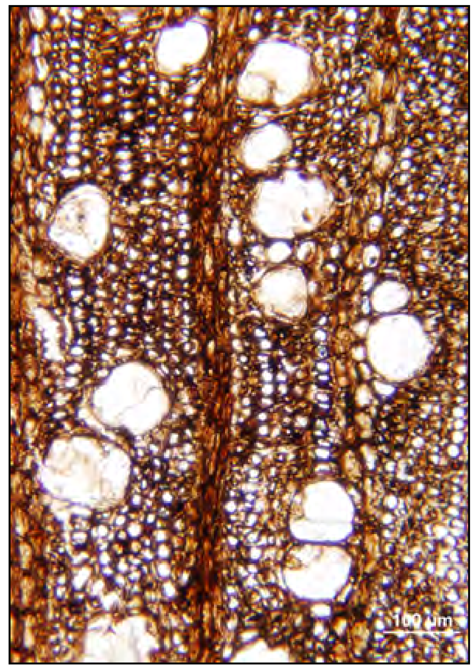
Sapindales

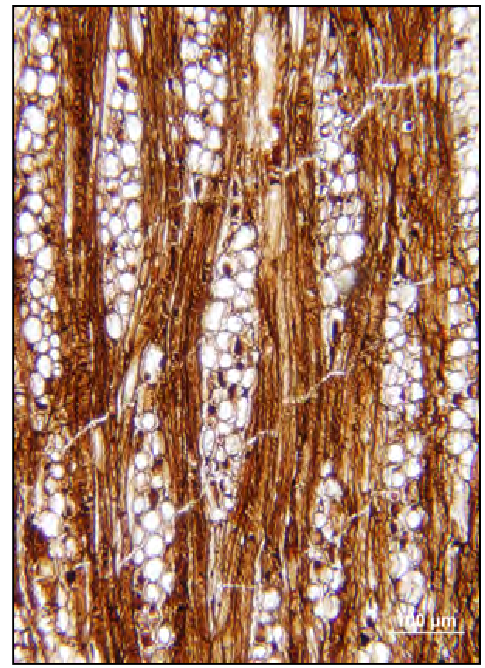
(Burseraceae, Anacardiaceae)



Canarium euphyllum (Burseraceae)
RMCA, Tervuren, Belgium

This pattern common in
Cretaceous Dicots,
Appears in the Albian
and occurs in all stages.



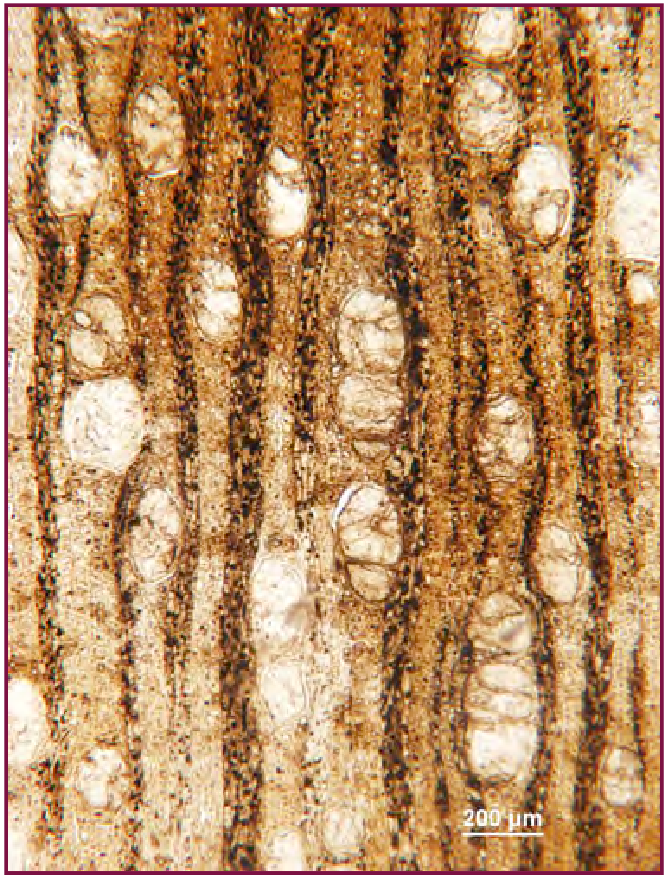


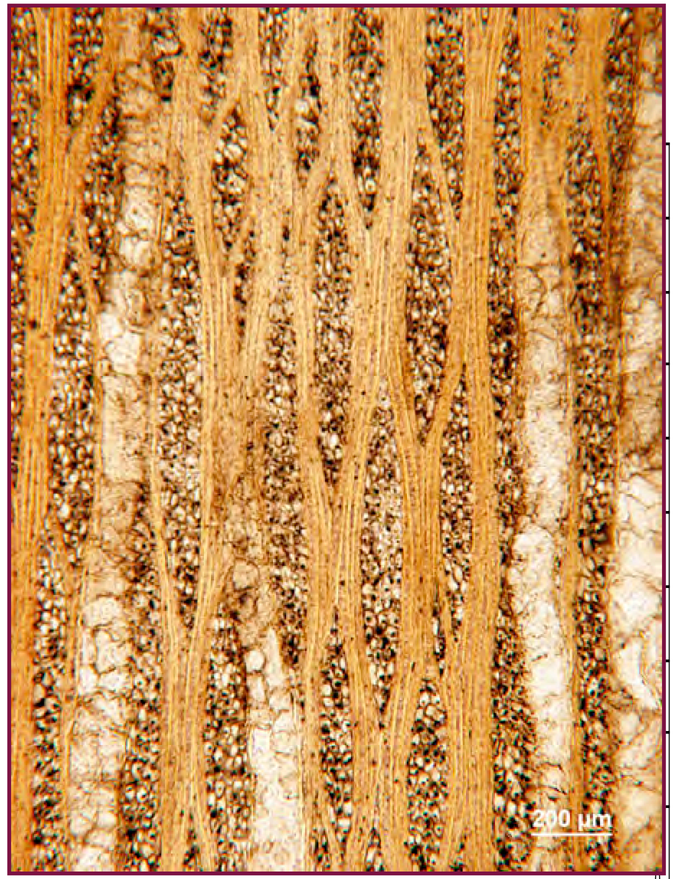
Paraphyllanthoxylon utahense
Cedar Mt. Formation, Utah

Paraphyllanthoxylon arizonense Bailey 1924

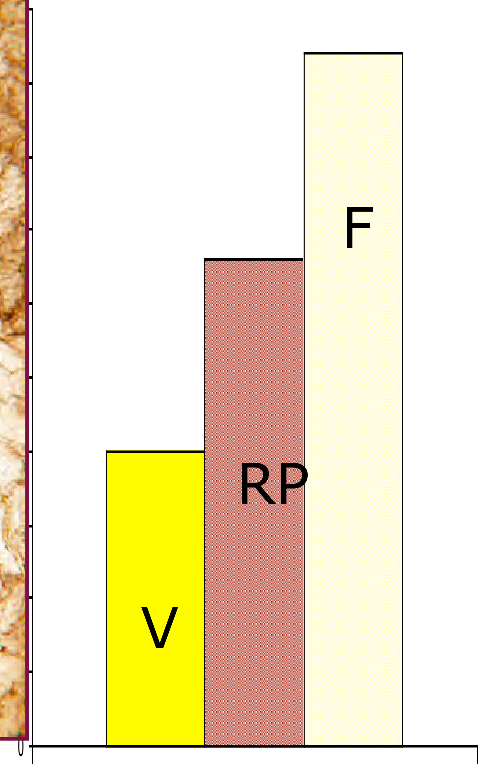
Vessels: 20 %

33 % Ray Parenchyma & 47 % Septate Fibers ('living fibers')





80% living cells

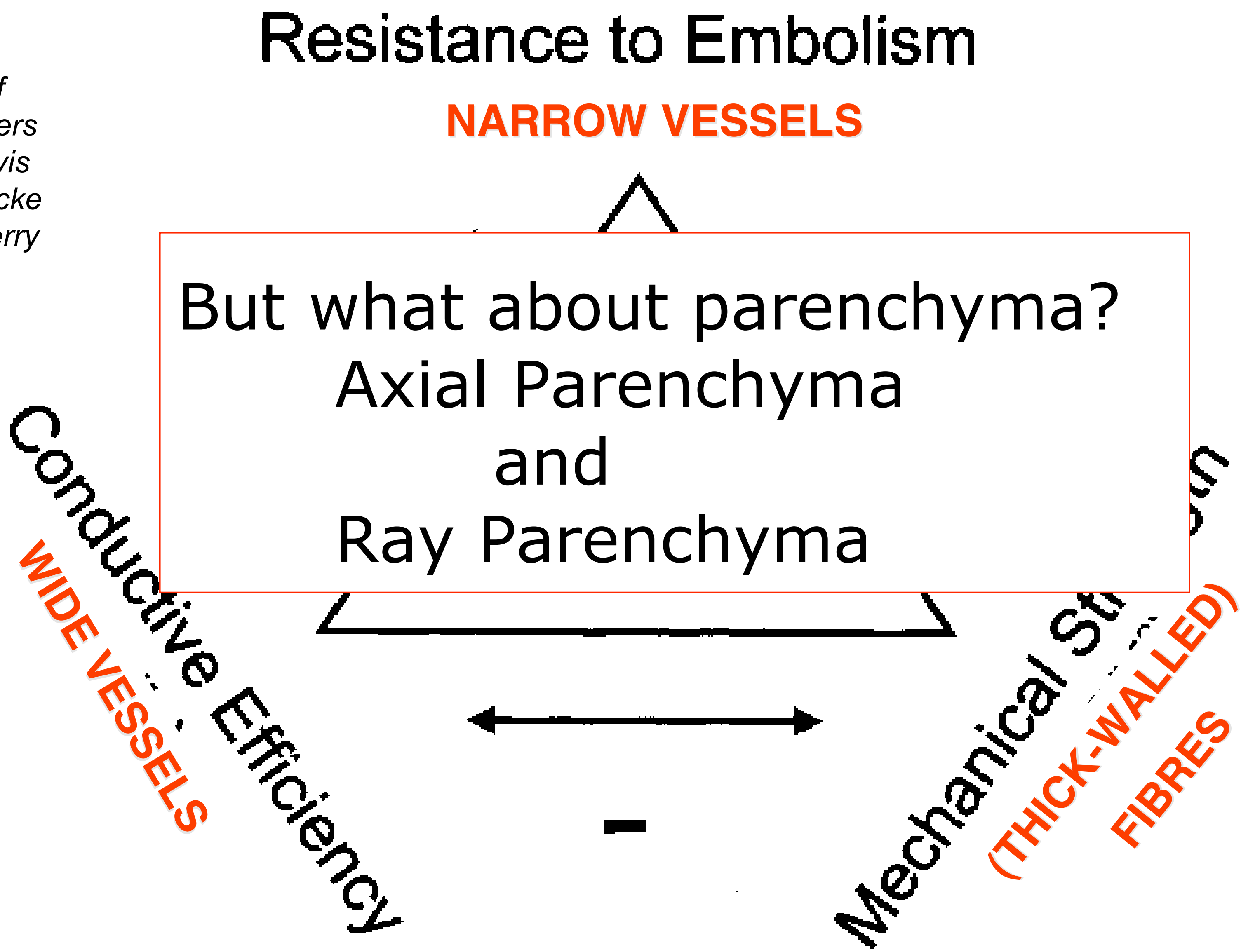


Cenomanian, Mogollon Rim, AZ, collected 2000

Diameters > 50 cm

Triangle of Wood Functions and Trade-offs

Work of
F. Ewers
S. Davis
U. Hacke
J. Sperry



But what about parenchyma?

Axial Parenchyma

and

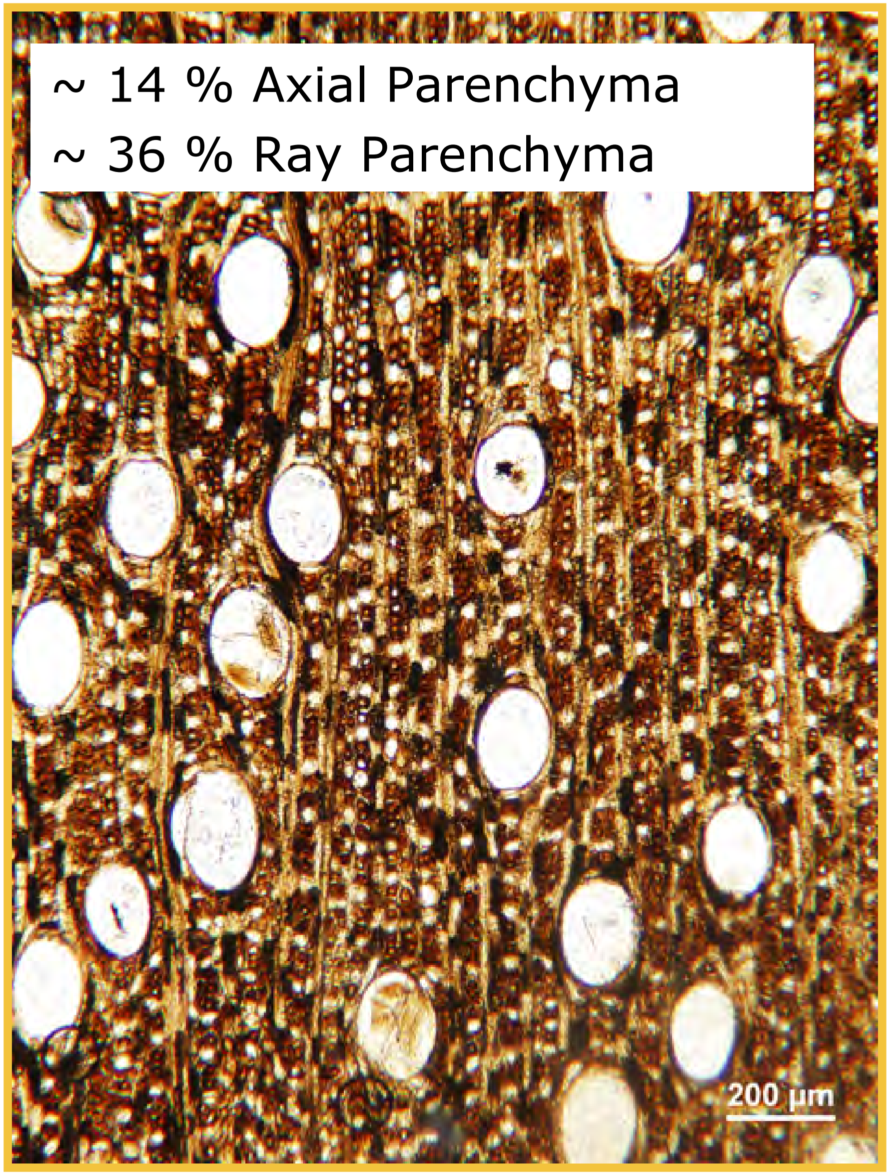
Ray Parenchyma

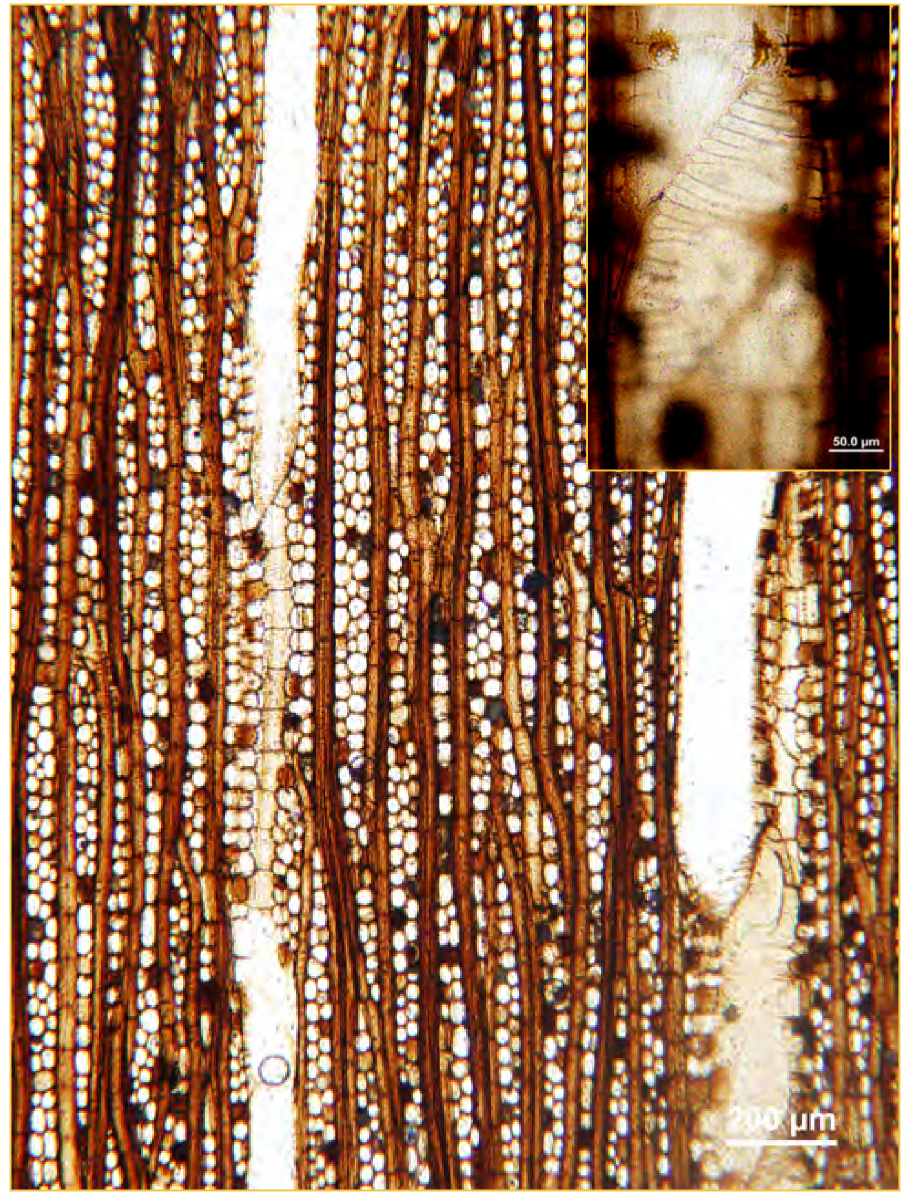
Late Cretaceous Trees

Campanian:
Top Left: Crevasse Canyon Fm, New Mexico, 6 Stumps
Stump diameters: 30 x 45 cm (min) to 75 x 80 cm (max).
All *Metcalfeoxylon* type *[Gary Upchurch, photo, and collections]*

Below: Aguja Fm, Big Bend, Texas. Stump diameters: 23 cm (min) to 1.3 m (max).

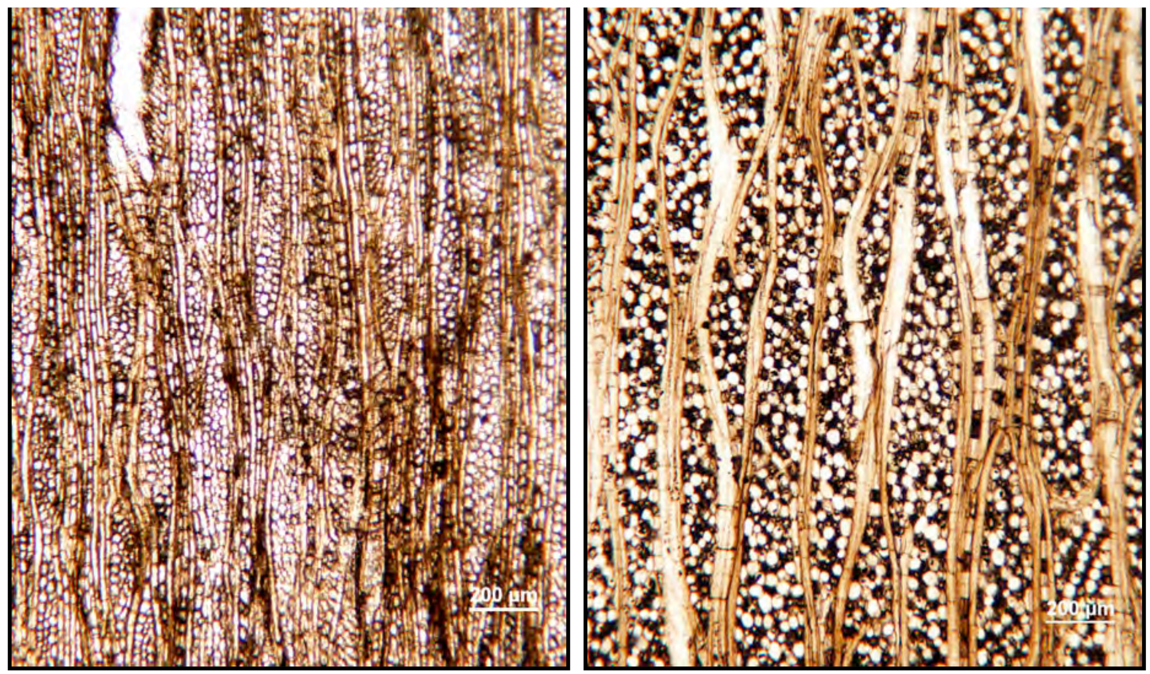
Metcalfeoxylon Campanian, NM





High Proportions of Storage Cells in Cretaceous Trees….Consequences?

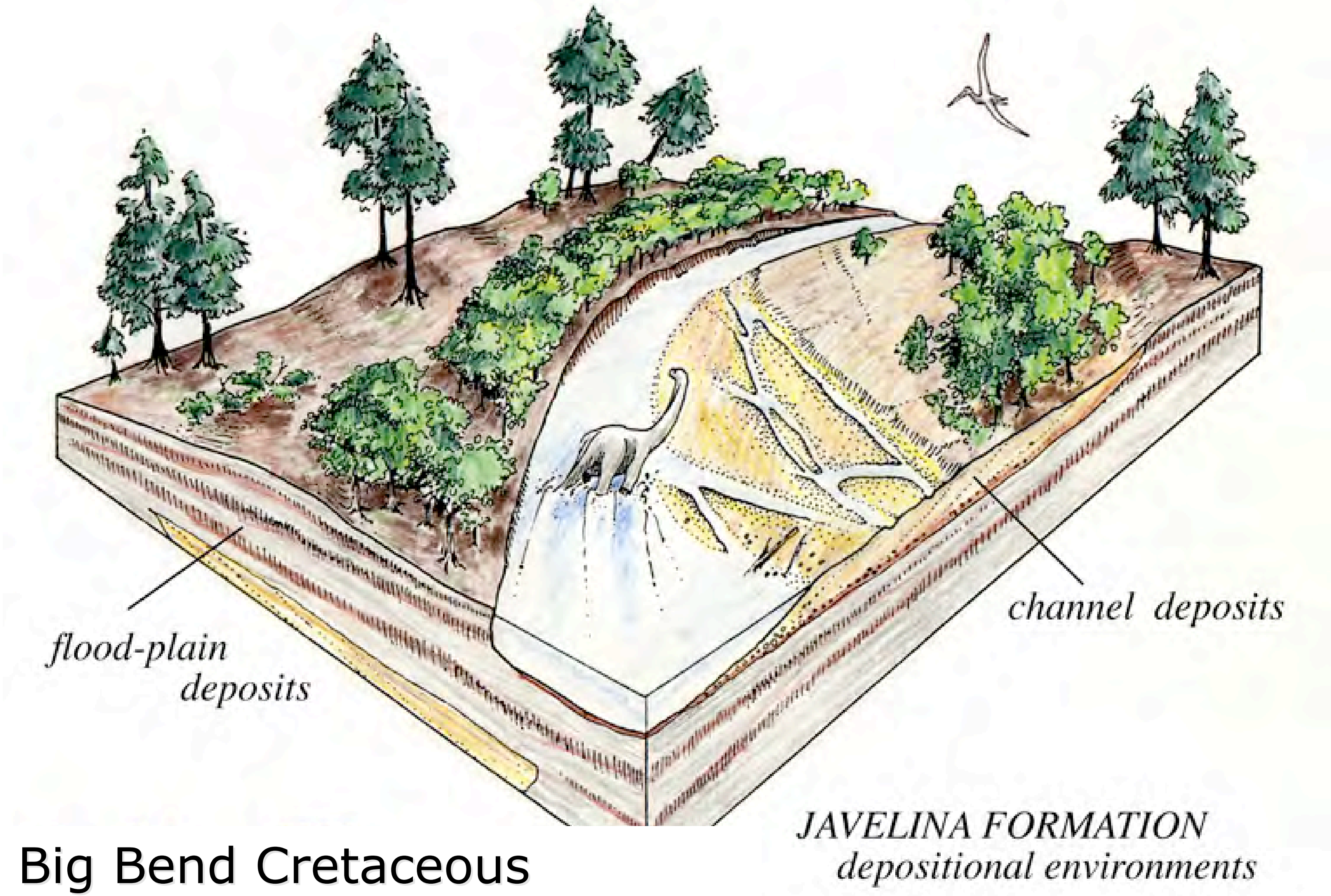
Storage? Water Relations?
Wound Responses? Response to heavy cropping?
Mechanical Properties?



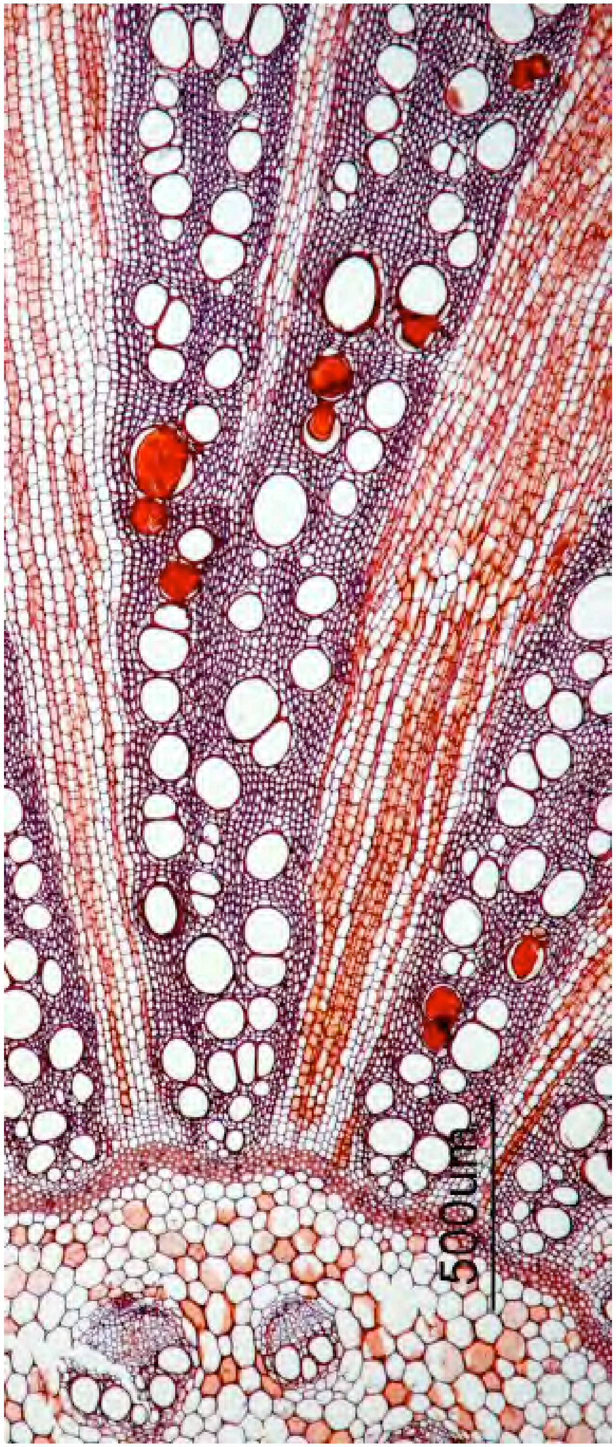
Madagascar *Adansonia*
Lisa Bouchet photo

Aguja Formation, Upper Campanian, Texas.

Late Cretaceous was different



Big Bend Cretaceous
Tom Lehman reconstruction



CONCLUSIONS:

“The data from comparative wood anatomy appeal to me as vital sources of hypotheses -- and of materials for testing of hypotheses … natural experiments in ecological wood anatomy have produced compelling patterns.” Carlquist 1988