PALEOBOTÂNICA (Parte I)



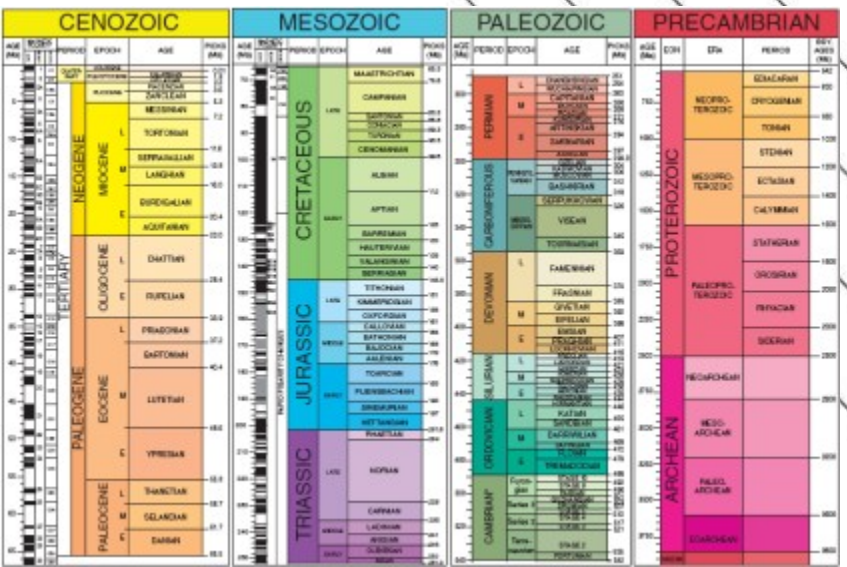
Profa. Raquel Cassino
Universidade Federal de Ouro Preto
Departamento de Geologia

EMBRYOPHYTA

Embriófitas: “plantas terrestres”

- “Embrião”

★ Algas X Plantas terrestres



PALEOBOTÂNICA

Objetivos

- Etapas evolutivas das plantas terrestres (significado, registro fóssil, idade).

- Floras características do Paleozóico e do Mesozóico.

PALEOBOTÂNICA

Partes desarticuladas



Tipos de Fósseis

- Carbonização
- Impressões
- Moldes e Contra-moldes
- Permineralização e Petrificação



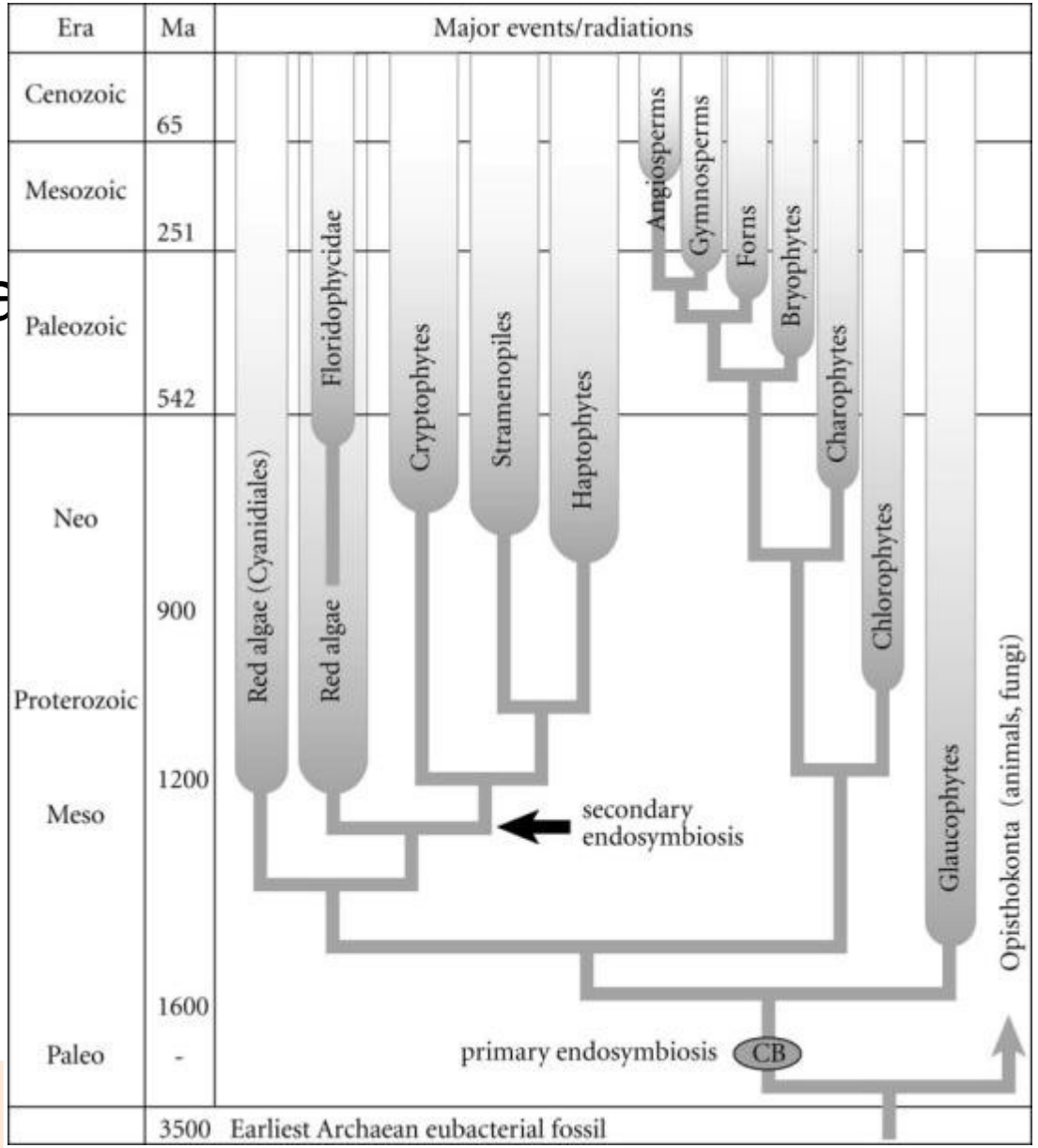
PALEOPALINOLOGIA

- Microfósseis orgânicos
- Palinomorfos



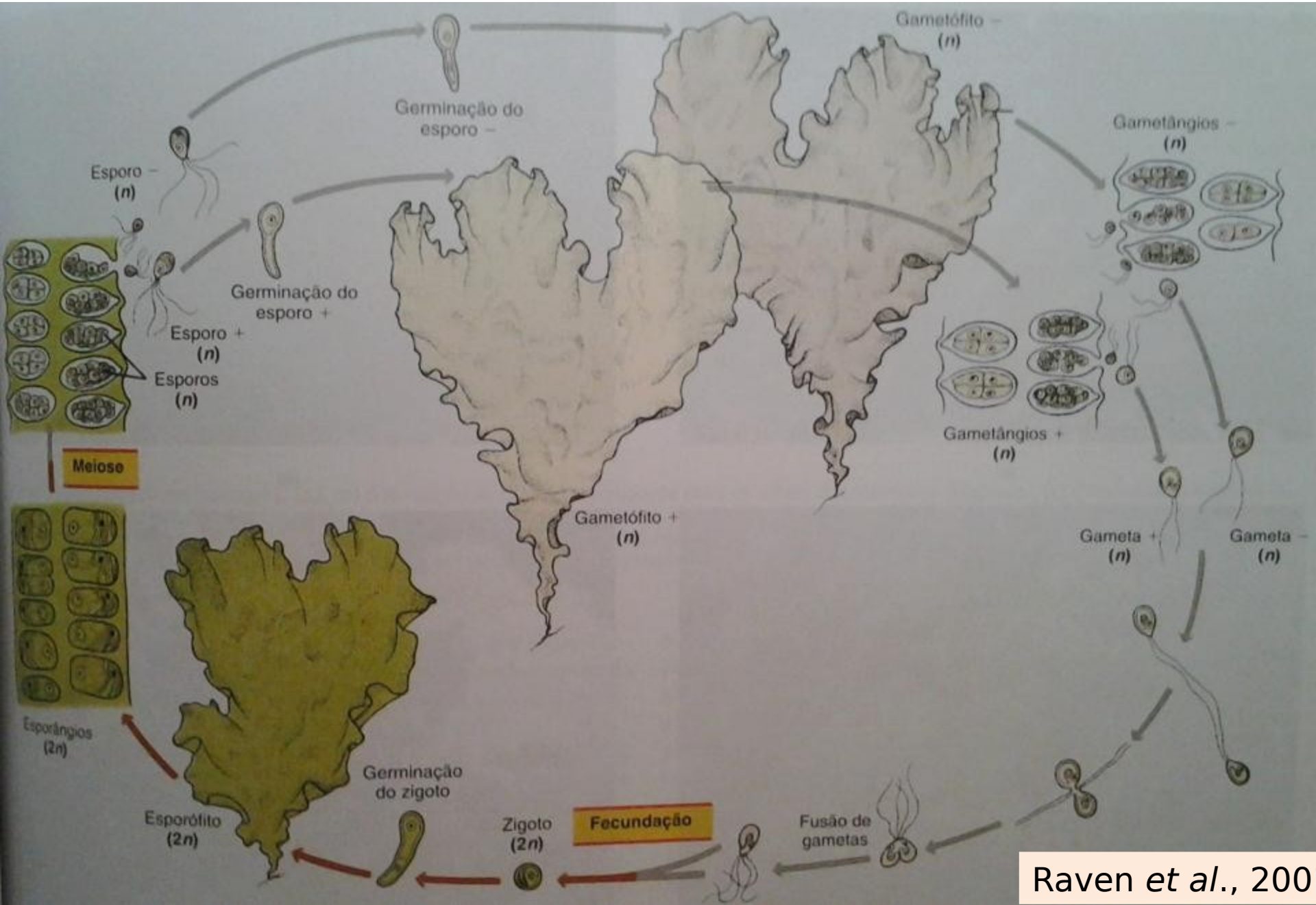
Mesoproterozóico e Neoproterozoico

- Diversificação das a



Benton & Harper, 2008

Algas – Ciclo de Vida



Raven *et al.*, 200

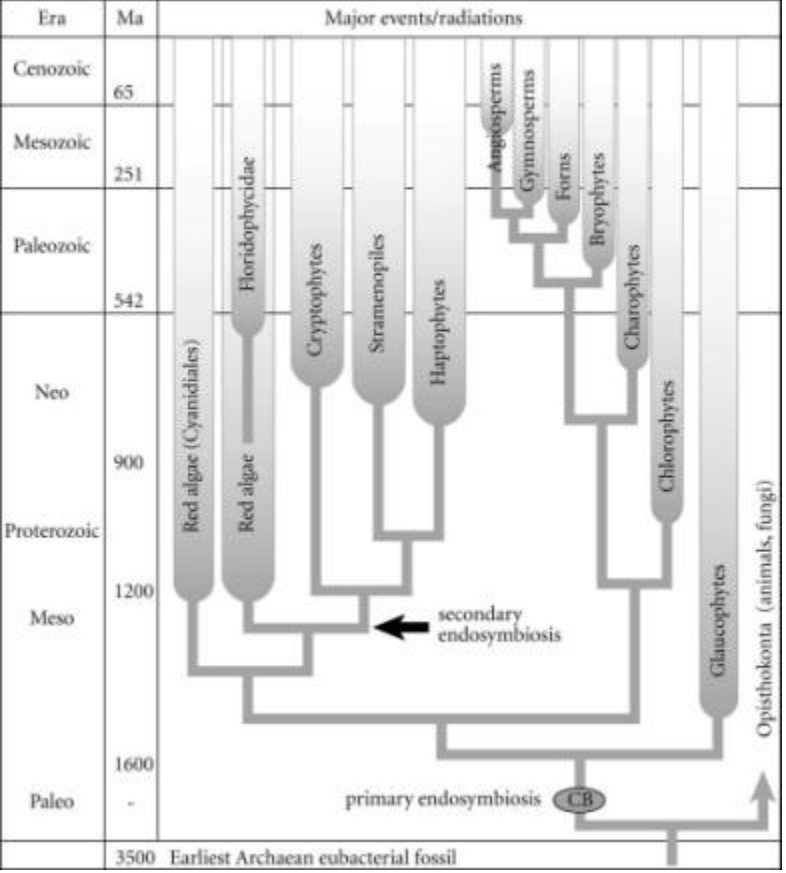
Briófitas – Ciclo de Vida



Raven *et al.*, 2001



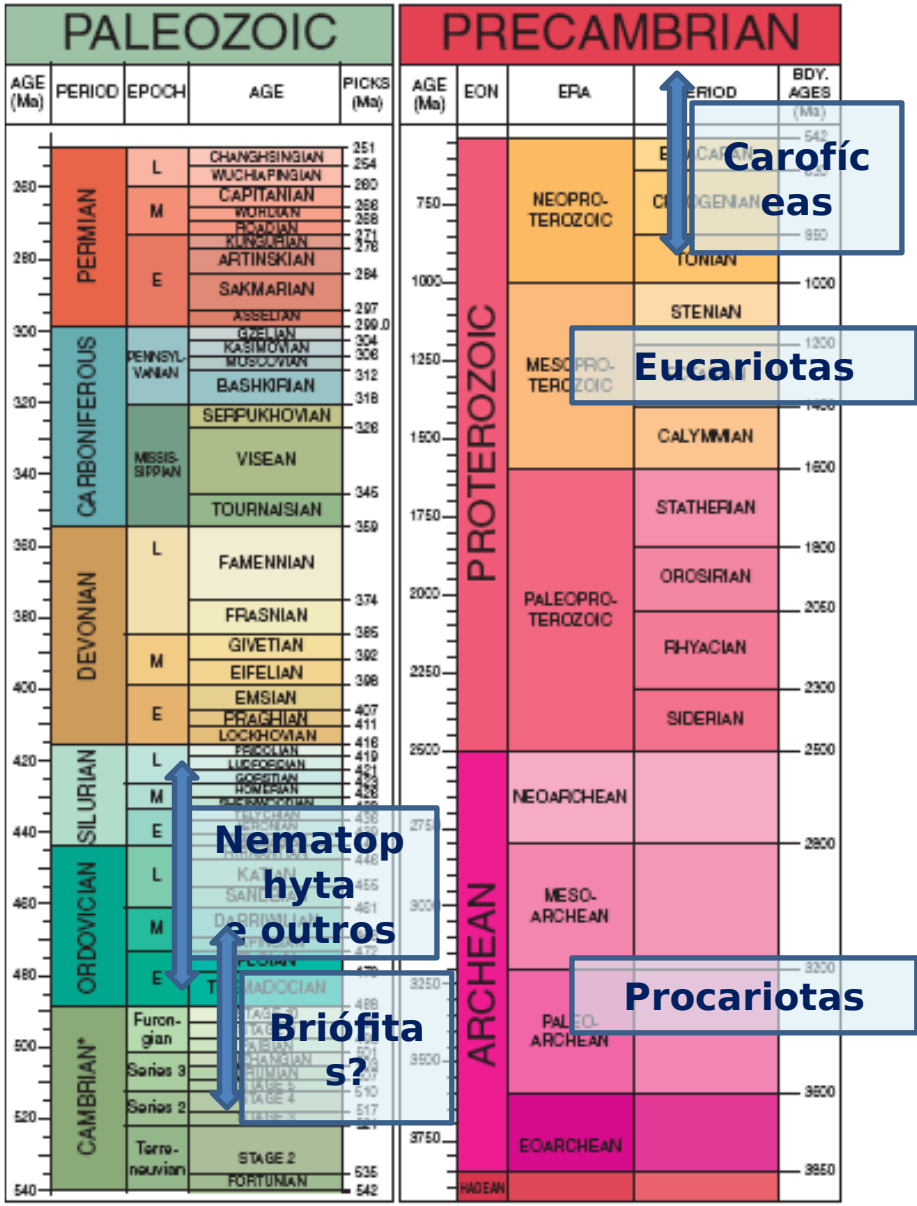
Etapa 1: Transição para a ter



Das algas verdes às primeiras plantas terrestres.

Quando?

Primeiras plantas terrestres = Briófitas?



SIÇÃO PARA A TERRA – Registro fó

Vários fósseis do Paleozóico inferior apresentam algumas, mas não todas, características das plantas terrestres.

ção para o ambiente terrestre: Nematophyta e Spongiophytaceae

Nemathophyta

Nematothallu Ordoviciano - Devoniano

Tubos, cutícula, “esporos” de vários tamanhos

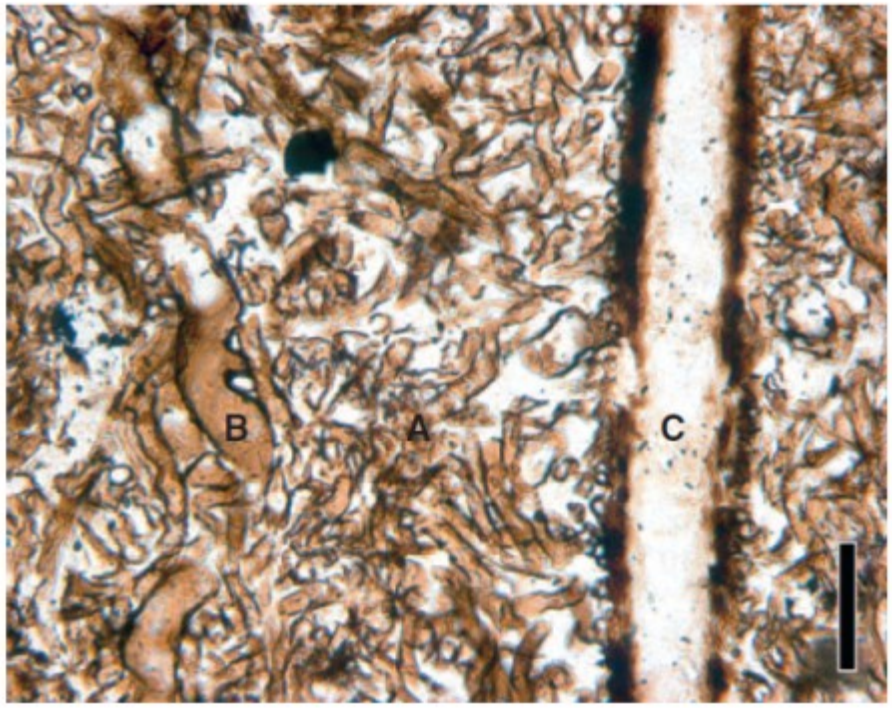
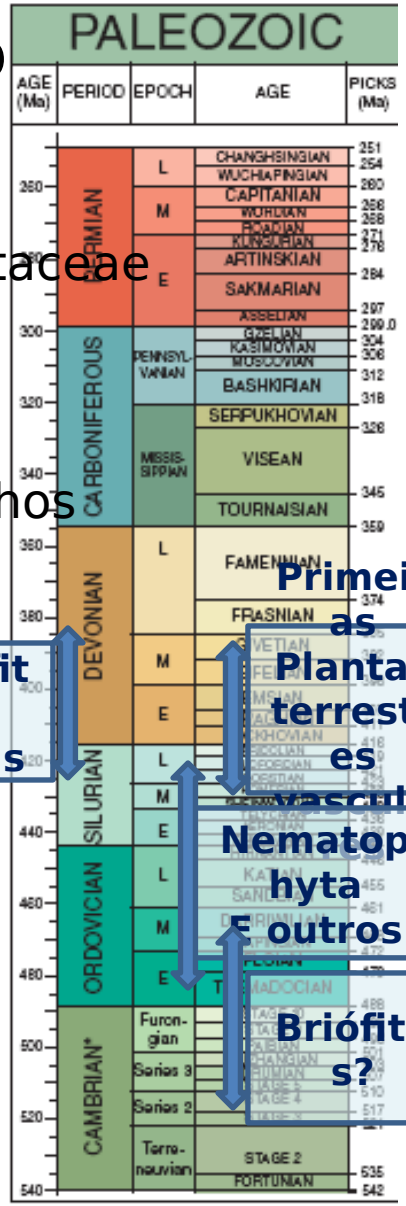


FIGURE 6.2 Longitudinal section of *Prototaxites southworthii* ... : A. binding, B. generative, and C. ... µm.

Taylor *et al.*, 2009

rototaxites

Siluriano - Devoniano



Zosterófitas Riniófitas

Primeiras Plantas terrestres vasculares

Nematophyta E outros

Briófitas?

SIÇÃO PARA A TERRA – Registro fóssil

Prototaxites Siluriano - Devoniano

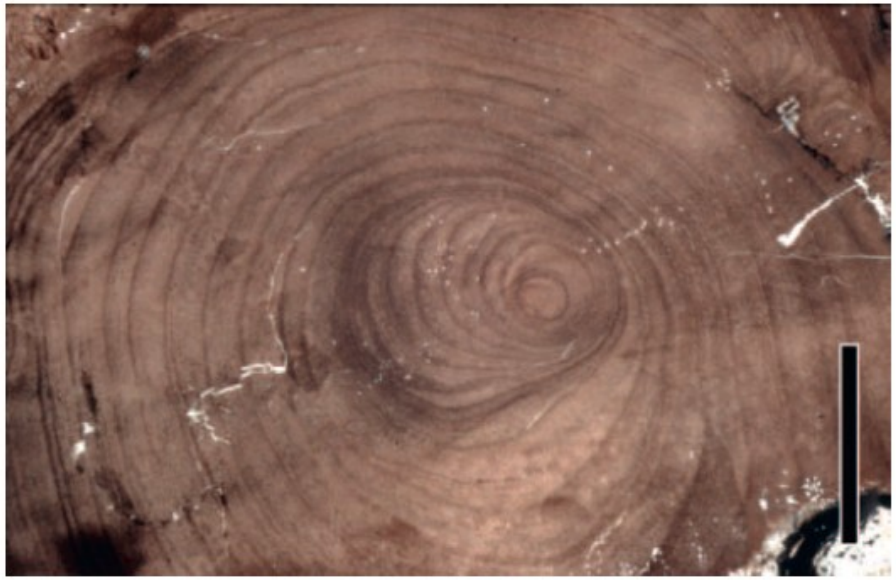


FIGURE 6.1 Cross section of *Prototaxites* showing eccentric incremental growth (Devonian). Bar = 3 cm.

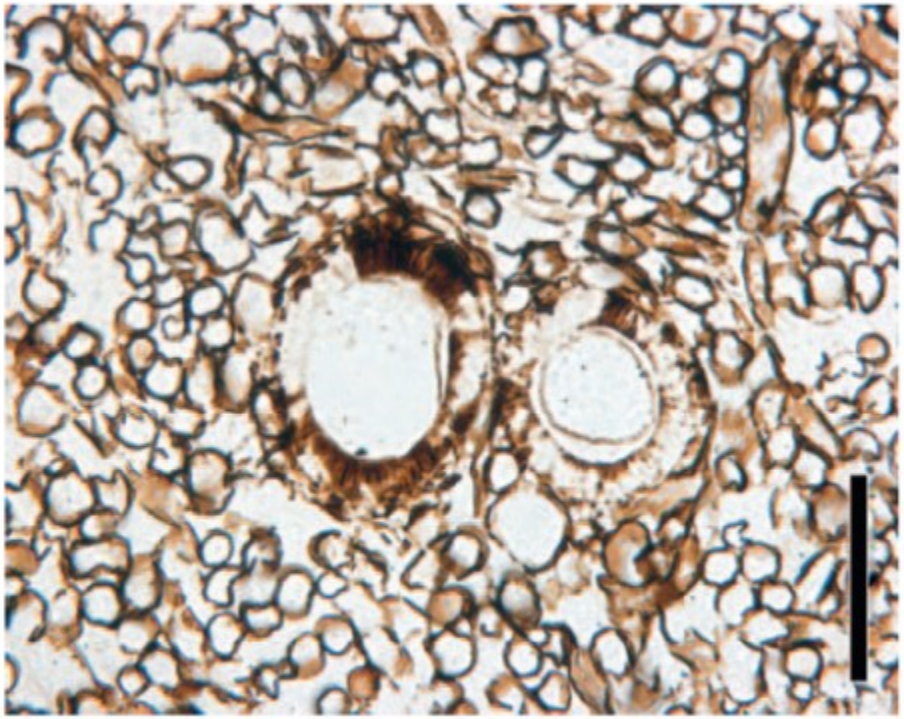


FIGURE 6.3 Section of *Prototaxites southworthii* showing large skeletal and narrow binding tubes/hyphe. (Devonian). Bar = 50 μm.

aylor *et al*., 2009

ANSIÇÃO PARA A TERRA

Nematoplexu Devoniano Inferior

Malhas com tubos de dois ou três tamanhos, tubos com poros.



FIGURE 6.9 *Nematoplexus rhyniensis* wide tube with helica
ckenings and narrow tube with septal pore (arrow) (Devonian)
ır = 100 µm. (Courtesy H. Hass.)

Pachyte Siluriano Superior – Devoniano Médio

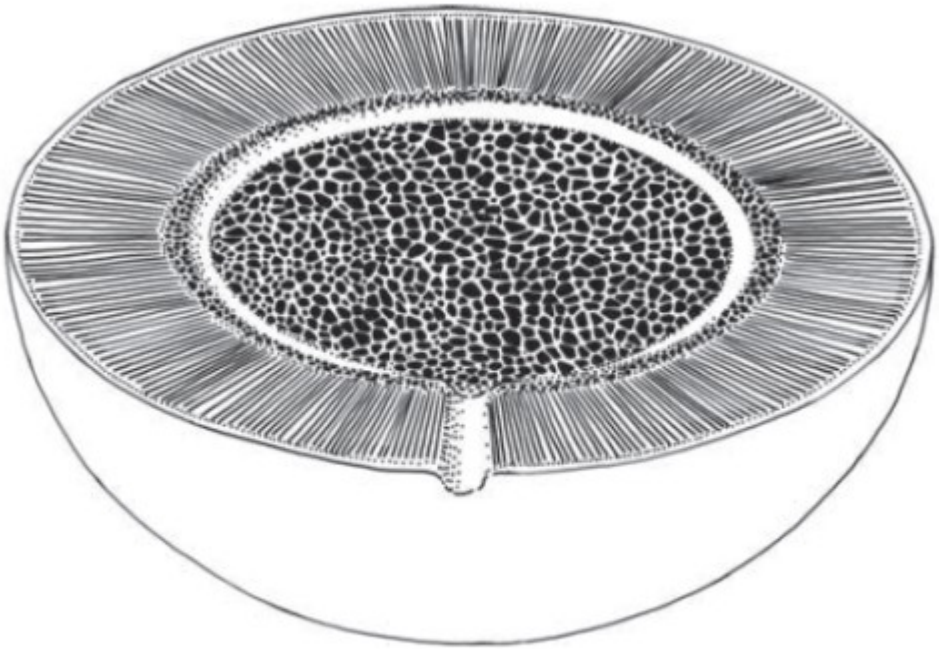


FIGURE 6.12 Diagrammatic view of *Pachytheca* showing two-layered wall. (From T. Taylor, 1988a.)

Taylor *et al.*, 2009

ISIÇÃO PARA A TERRA – Registro

Parka decipiens Siluriano Superior - Devoniano



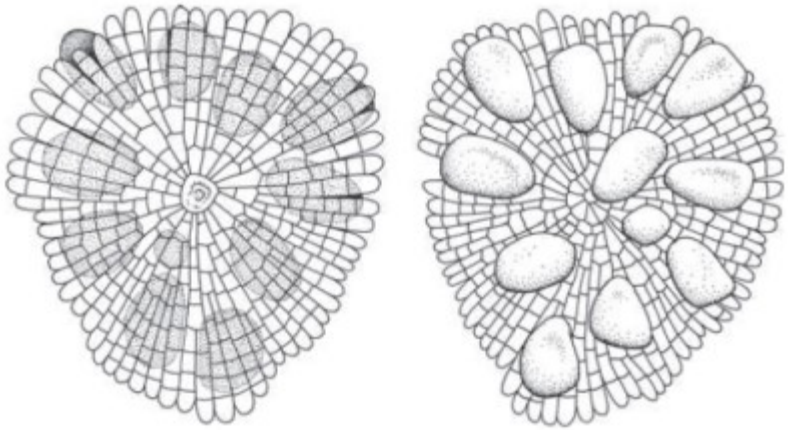
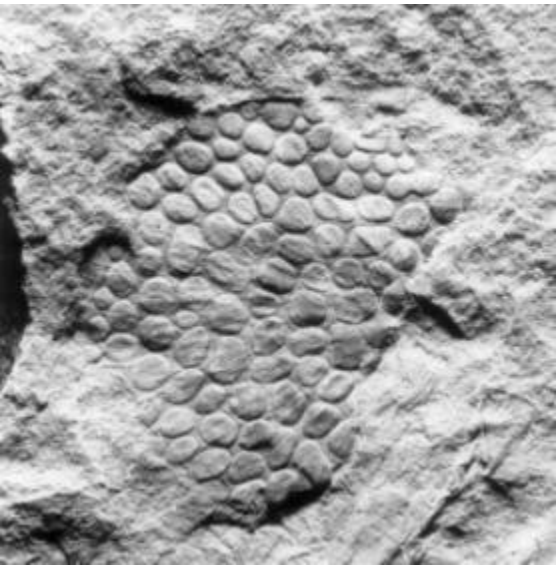


FIGURE 6.21 Suggested reconstruction of *Parka decipiens* showing lower (left) and upper surfaces. (From T. Taylor, 1988a.)

Esporângios
contendo pequenas
corpos semelhantes



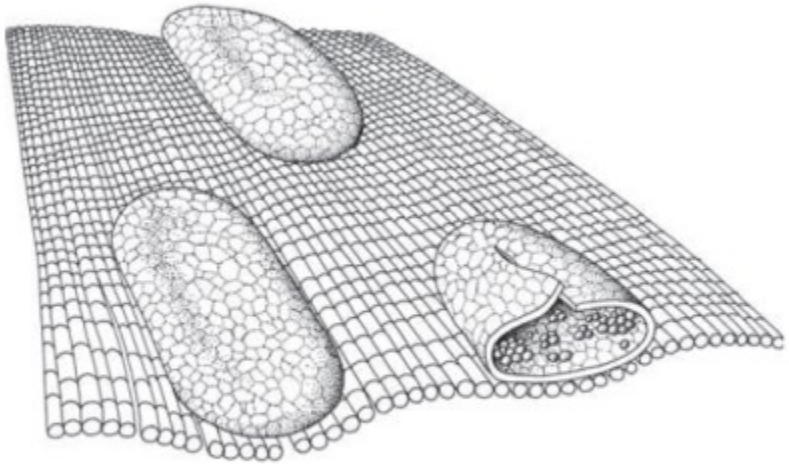


FIGURE 6.22 Diagrammatic reconstruction of *Parka decipiens* thallus with structures interpreted as sporangia. (From T. Taylor, 1988a.)

NSIÇÃO PARA A TERRA – Registro fóssil

lematophyta
pongiophytaceae
Outros fósseis

- Fragmentos isolados de cutículas, tubos e esporos

Criptoesporos: Cambriano Médio? – Ordoviciano - Siluriano

ônades, díades e tétrades; Inaperturados.



FIGURE 6.26 Quasiplanar cryptospore tetrad with thin enclos-
ing wall (Cambrian). Bar = 10μm. (Courtesy P. Strother.)

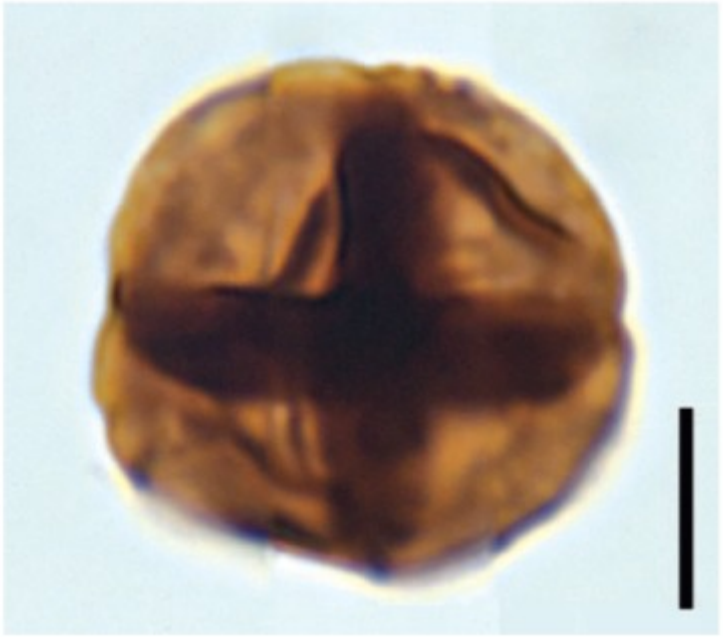


FIGURE 6.25 Quasiplanar cryptospore tetrad (Cambrian).
Bar = 5μm. (Courtesy P. Strother.)

Taylor *et al*., 2009

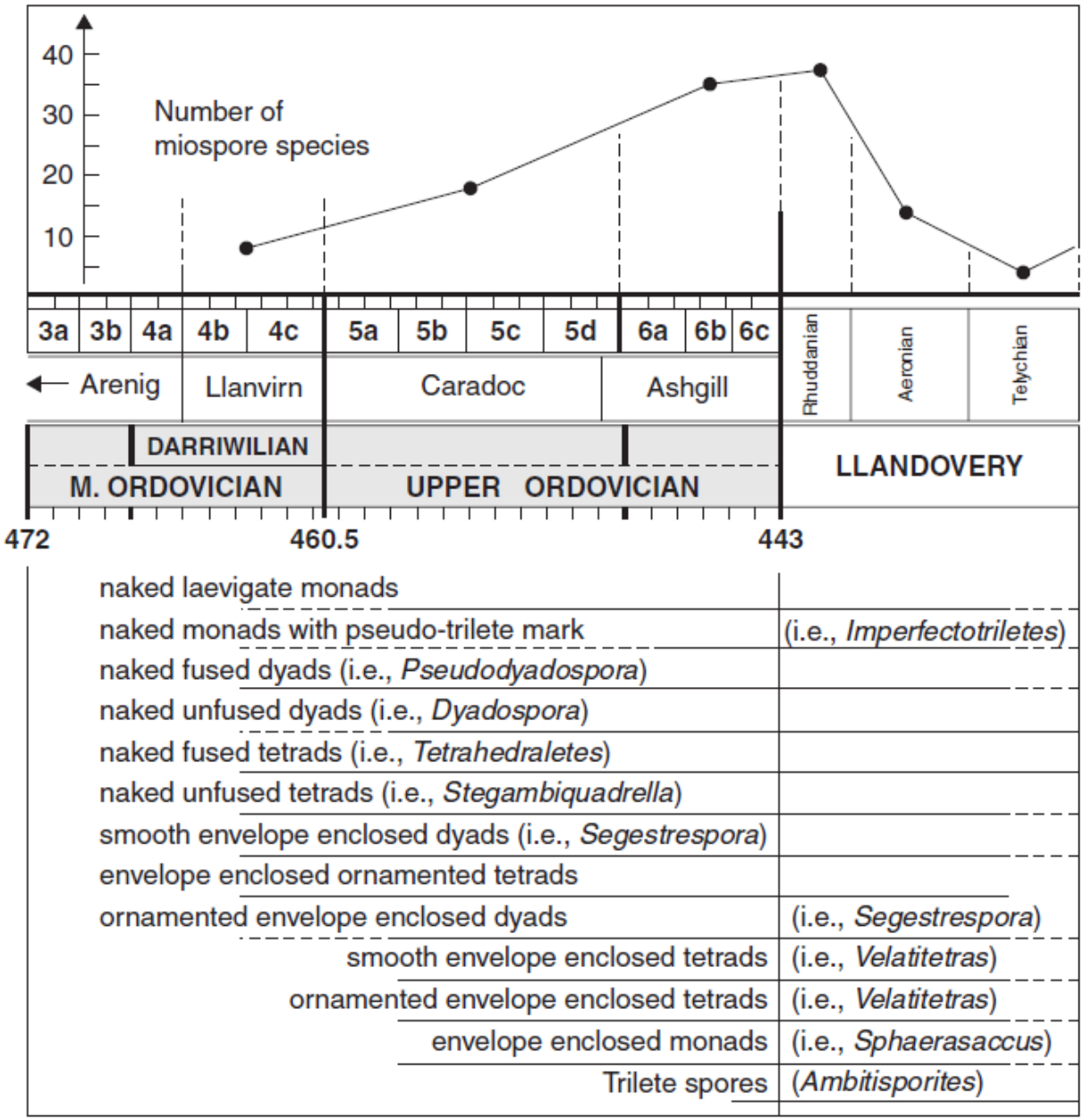
Esporos

Marca trilete

Siluriano

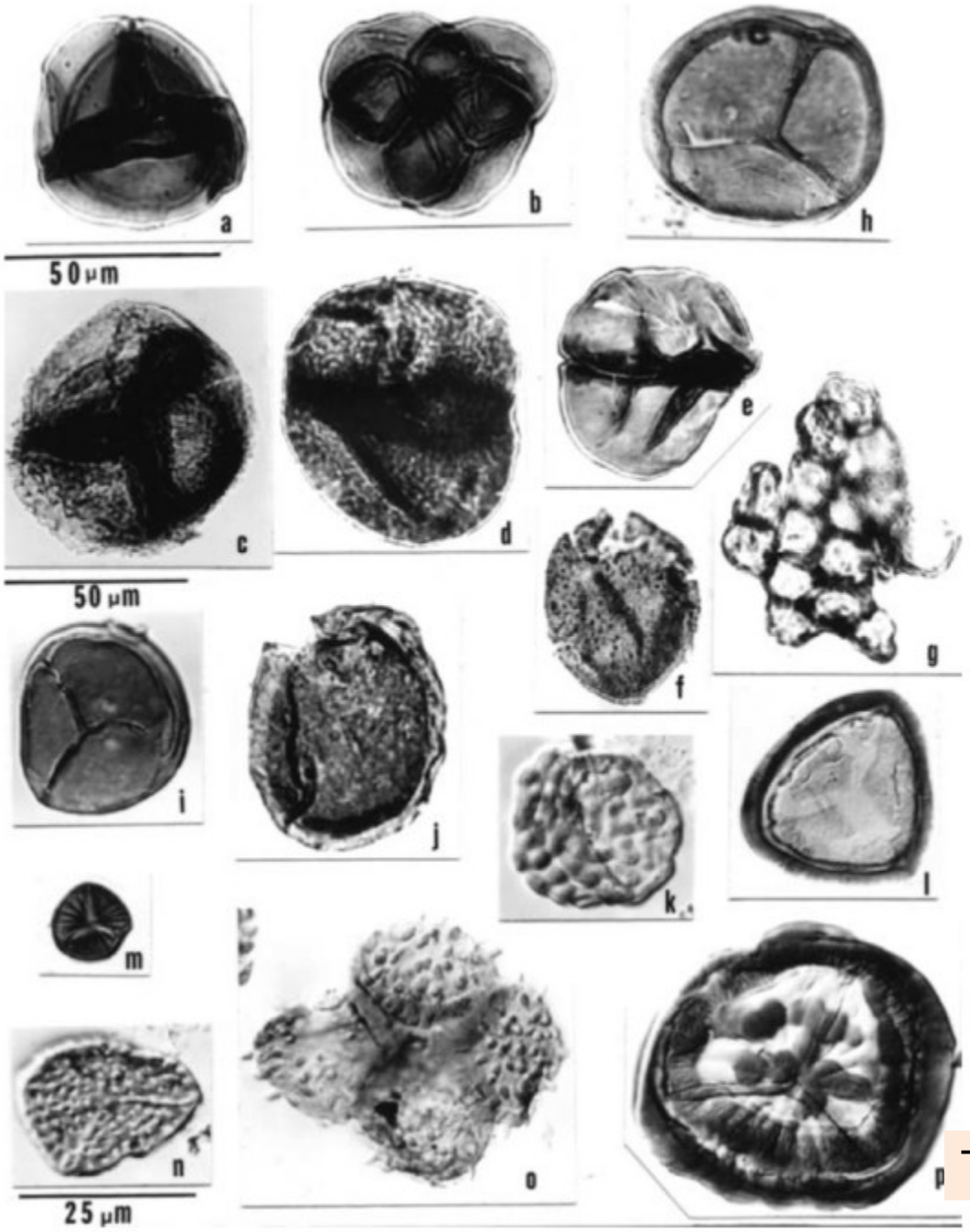


FIGURE 6.28 *Ambitisporites dilutus* (Silurian). Bar = 25 μm. (Courtesy P. Strother.)



Taylor *et al*., 2009

Palinomorfos do Siluriano



Traverse, 2007

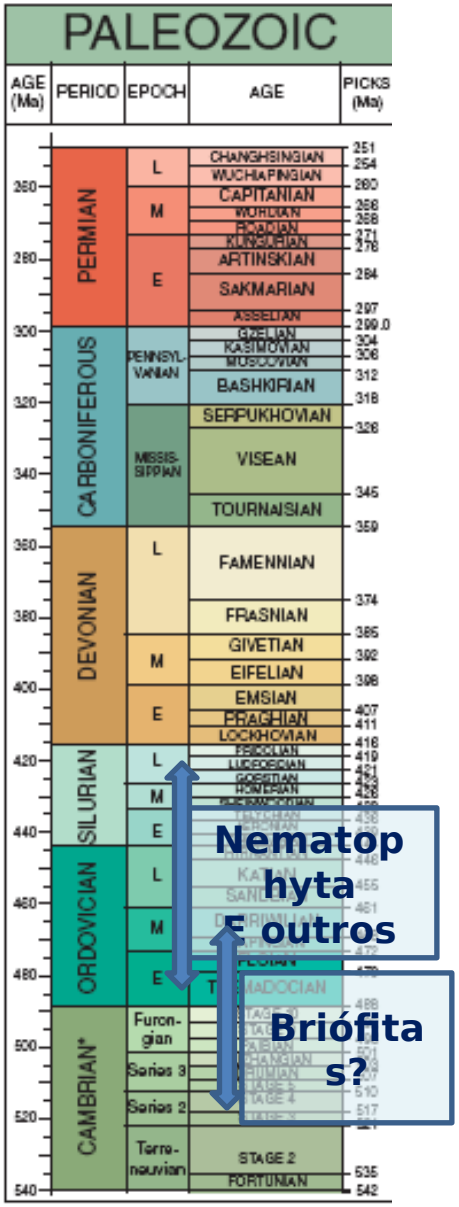
ANSIÇÃO PARA A TERRA

Etapa 1: Transição para a ter

O Registro fóssil indica que:

O surgimento de plantas adaptas ao ambiente terrestre ocorreu no: (Cambriano?) Ordoviciano – Siluriano Inferior

Esporos, cutículas, tubos, tubos com poros, nematófitas (*Nematothallus*) e outros como *Parka*.



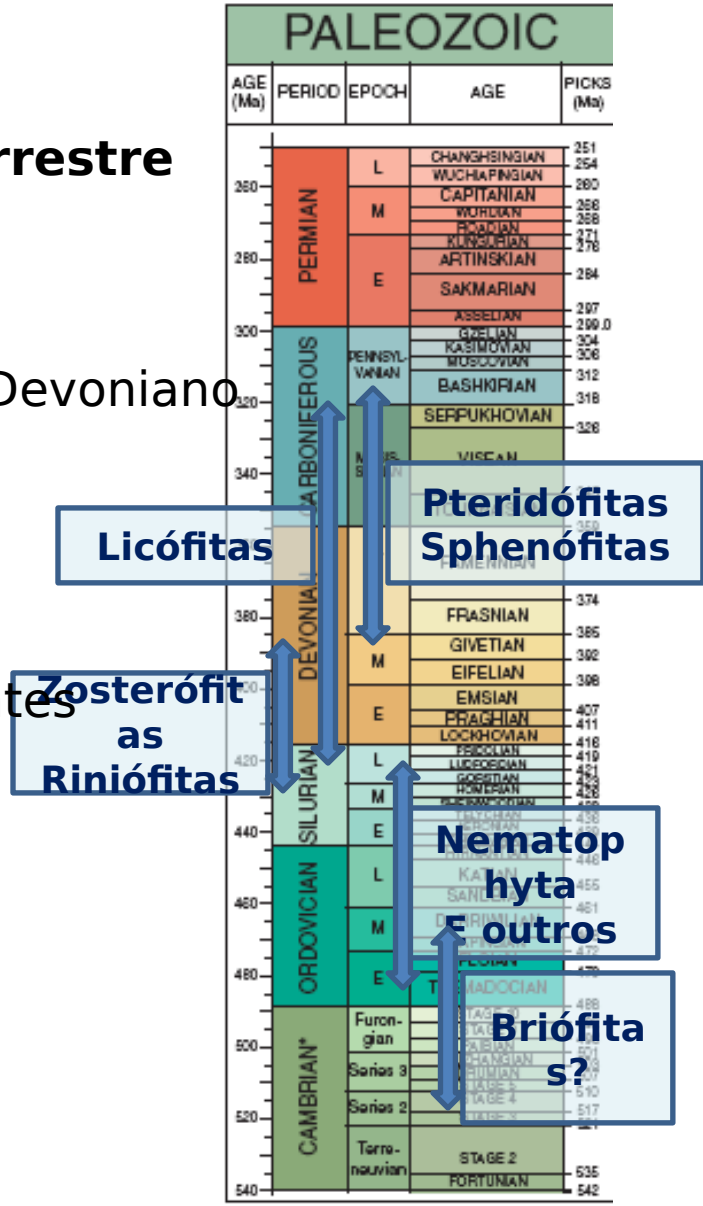
ANSIÇÃO PARA A TERRA

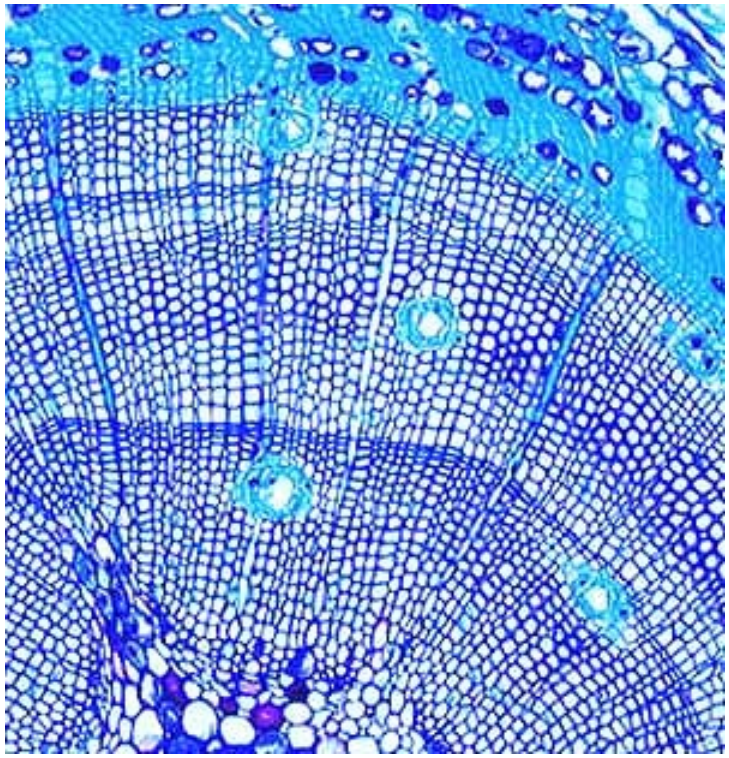
rgimento de plantas adaptas ao ambiente terrestre
doviciano – Siluriano Inferior

meira radiação de plantas terrestres
voniano inferior – Muitas formas se extinguem no Devoniano

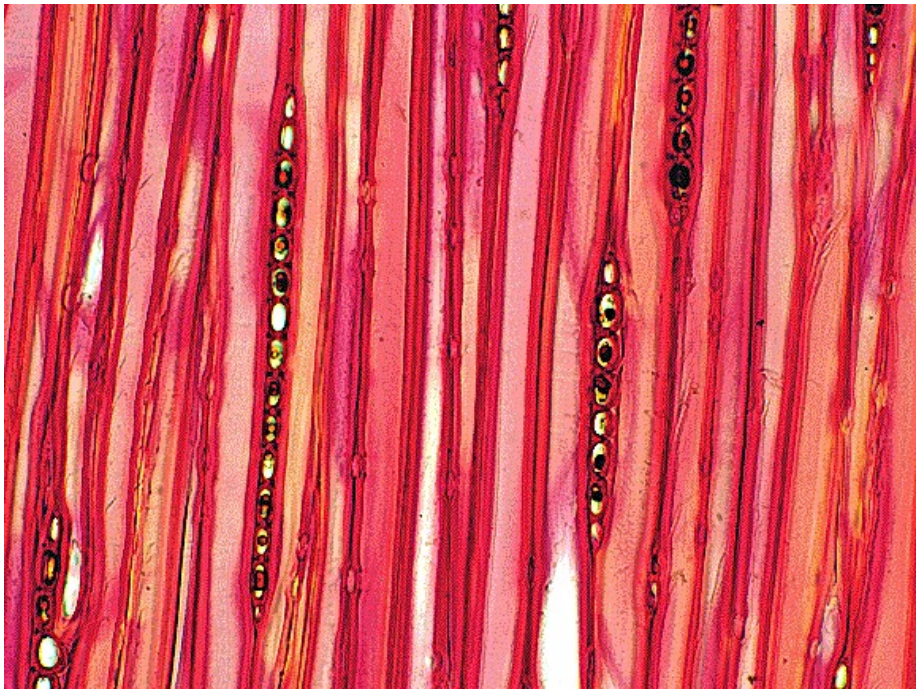
Adaptações fisiológicas e estruturais

- Fixação e absorção de água
- Suporte estrutural e transporte de água e nutrientes
  - Traqueídes (xilema)
- Proteção contra dissecação e radiação
  - Cutícula
- Estruturas para troca de gases
  - Estômatos
- Reprodução em ambiente terrestre
  - Esporos / sementes resistentes

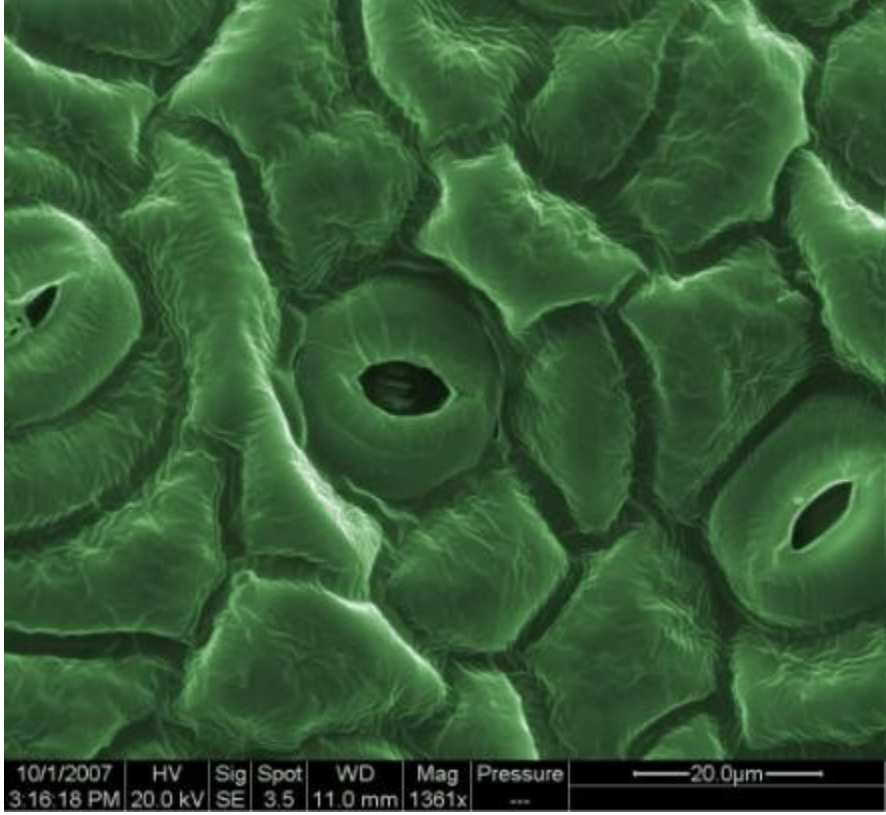


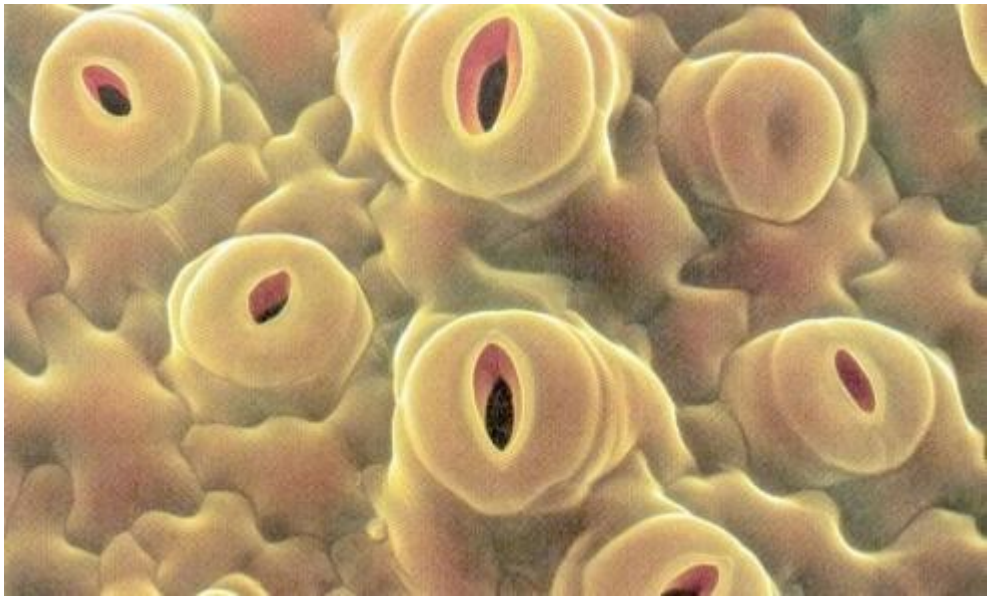


Traqueídes



Estômatos


10/1/2007
3:16:18 PM
HV
20.0 kV
Sig
SE
Spot
3.5
WD
11.0 mm
Mag
1361x
Pressure
20.0µm



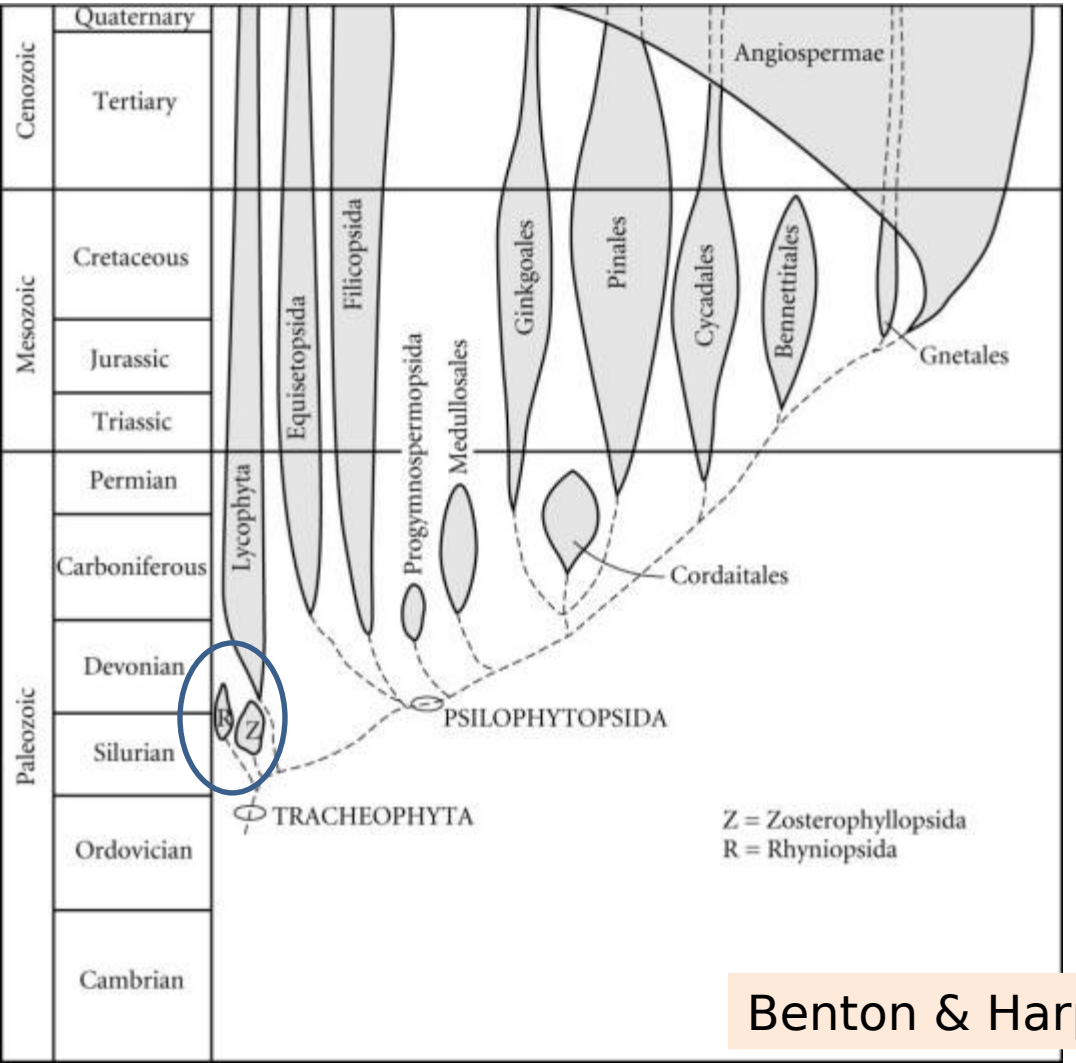
IRAS PLANTAS VASCULARES – Registro fóssil

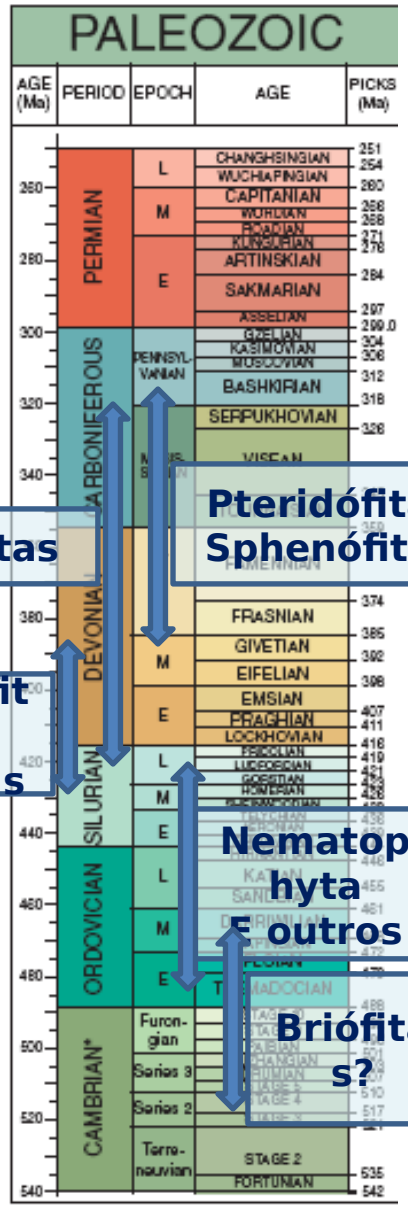
HYNIOPHYTA

Chert de Rhynie

Tecidos especializados para o transporte de água – xilema

Devoniano





Benton & Harper, 2008

RHYNIOPHYTA

- Eixos aéreos com ramificações dicotômicas com esporângios terminais
- Rizomas

Células de condução? = traqueídes?

Aglaophyton major

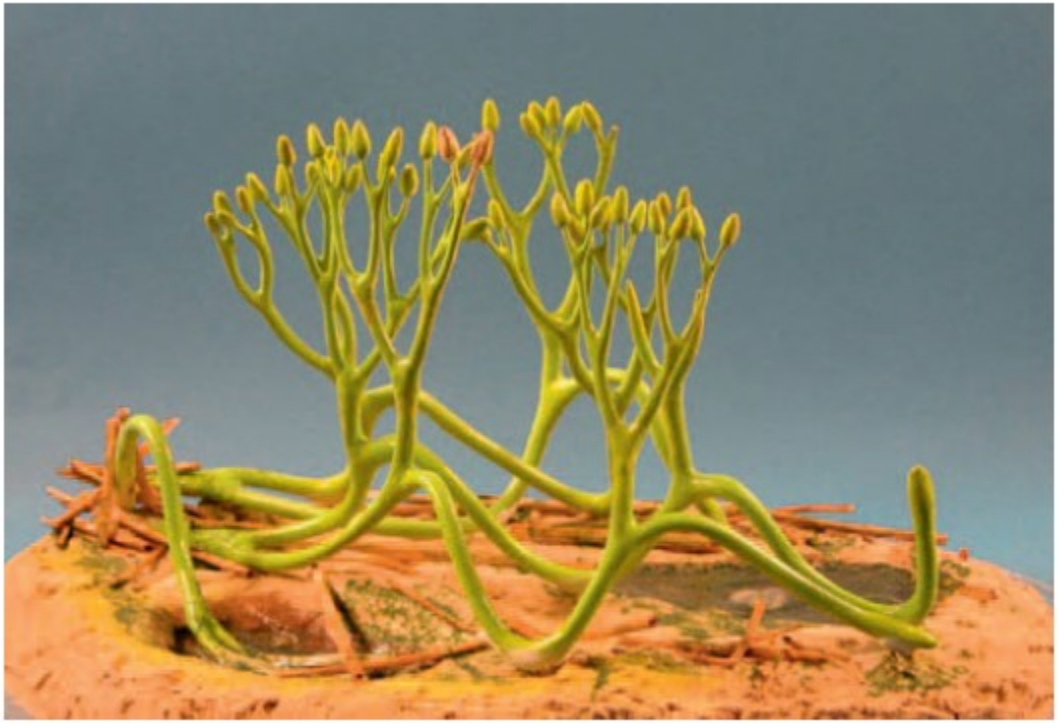


FIGURE 8.13 Model of *Aglaophyton major*. (Courtesy N. Trewin.)

Taylor *et al*., 2009



FIGURE 8.15 Stoma of *Aglaophyton major* (Devonian). Bar = 25 μm. (Courtesy H. Kerp.)



FIGURE 8.16 Longitudinal section of *Aglaophyton major* sporangium filled with spores (Devonian). Bar = 4 mm. (Courtesy H. Kerp.)



FIGURE 8.18 Transverse section of *Aglaophyton major* axis showing central strand and dark cell zone (arrow) containing arbuscules (Devonian). Bar = 650 μm.

Aglaophyton major

Taylor *et al.*, 2009

EIRAS PLANTAS VASCULARES – Registro fóssil

Cooksonia

Siluriano Superior - Devoniano



FIGURE 8.59 Several *Cooksonia* specimens from Brazil (Devonian). Bar = 5 mm. (Courtesy P. Gerrienne.)

Ramos dicotômicos
Esporângios terminais
Estômatos
Traqueídes?

Taylor *et al*., 200

EIRAS PLANTAS VASCULARES – Registro fóssil

OSTEROPHYLLOPHYTA

Siluriano Inferior – Devoniano Superior

Ramos dicotômicos
Ramos finais apresentam vernação circinada
Esporângios dispostos lateralmente
Próximas às Licófitas

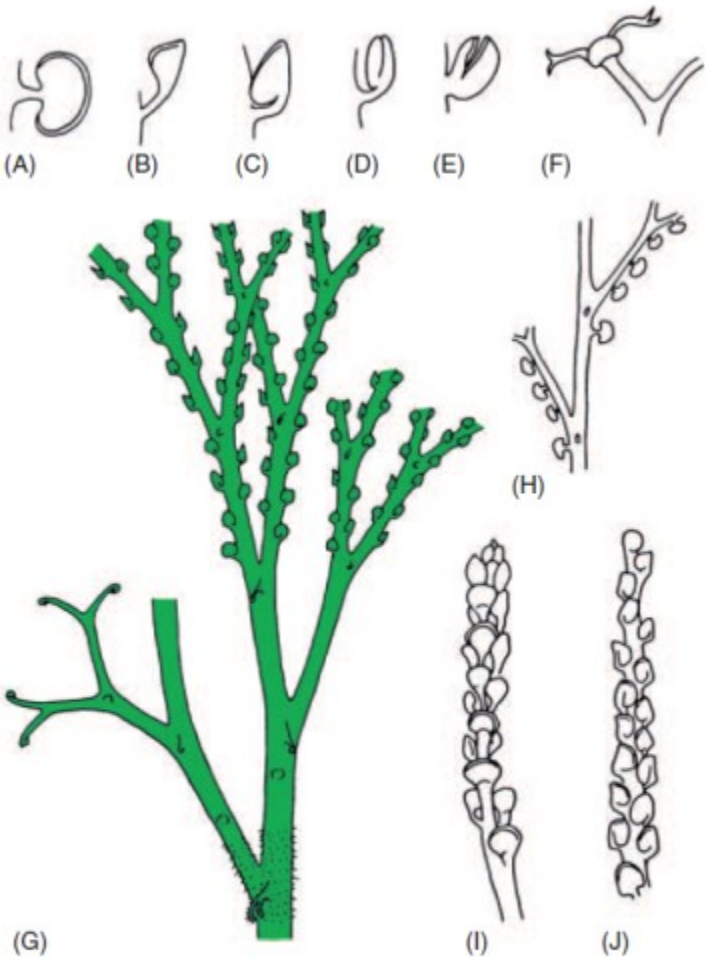
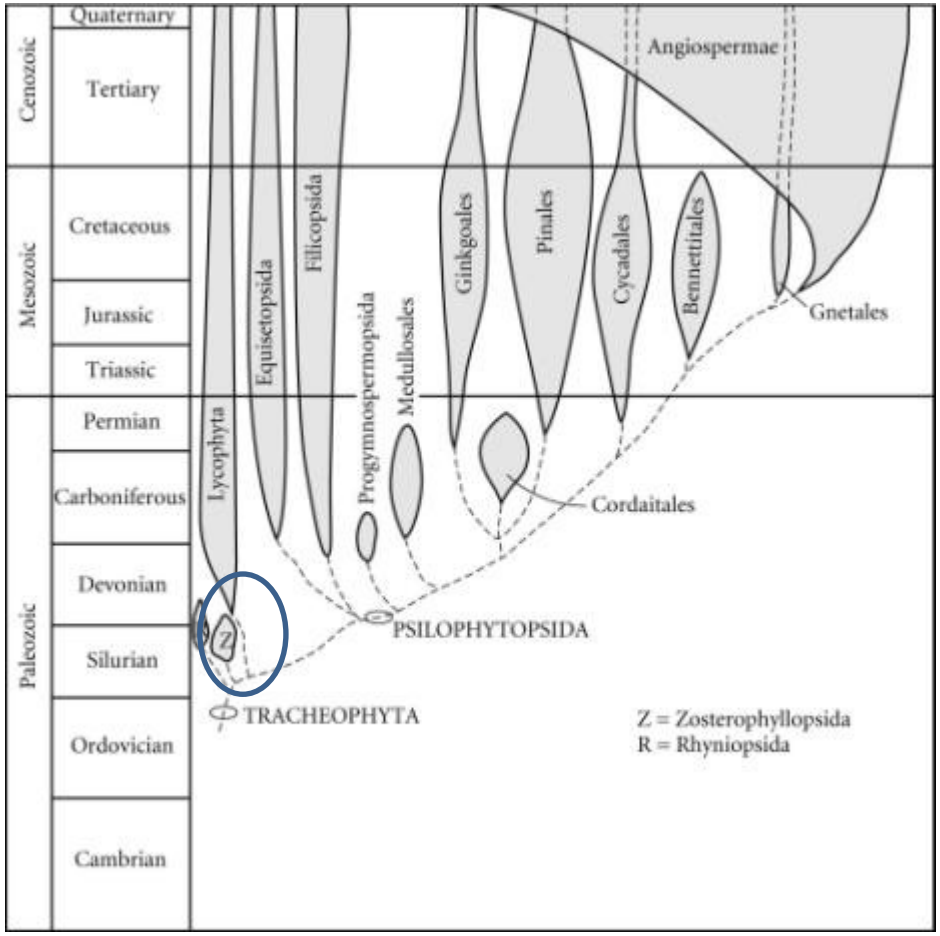


FIGURE 8.70 Morphology and arrangement of zosterophyll sporangia. **A,H.** *Gosslingia breconensis*; **B,I.** *Zosterophyllum myretonianum*; **C, J.** *Zosterophyllum fertile*; **D.** *Zosterophyllum spectabile*; **E.** *Sawdonia acanthotheca*; **F.** *Konioria andrychoviensis*; nian). (From Kenrick and Edwards,

Taylor *et al.*, 2009



Rhyniophyta

Asteroxylon: “folhas” pontiagudas; xilema estrelado.
Altura de até 1m.
Devoniano médio

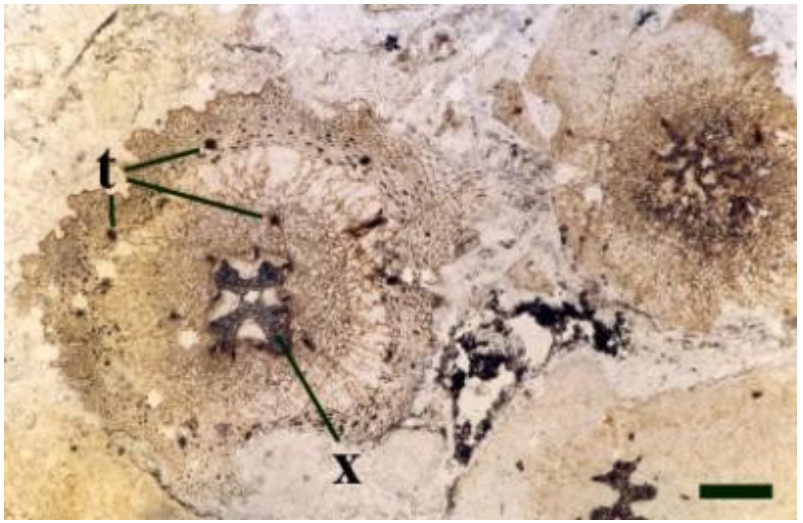


Reconstituições





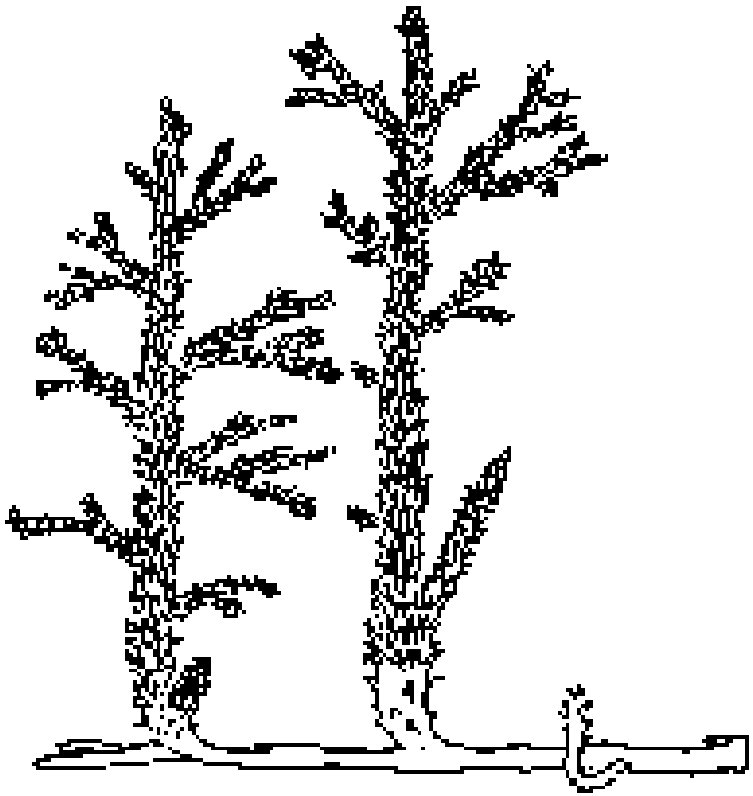
corte longitudinal



corte mostrando xilema estrelado

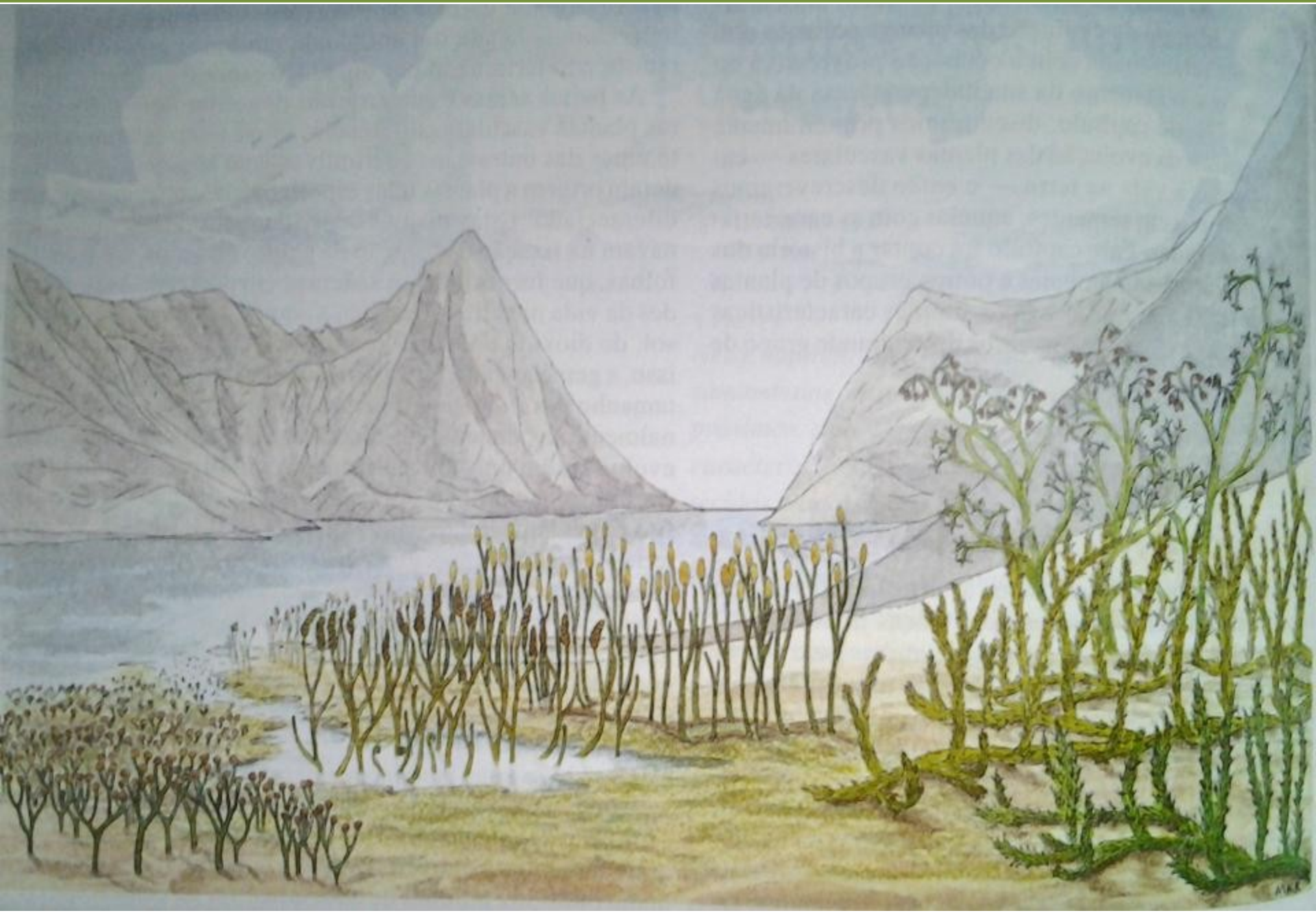


rizoma



Reconstituição de um *Asteroxylon mackiei*,
Devoniano da Inglaterrra

Flora do Siluriano - Devoniano



NTAS VASCULARES - LYCOPHYTA

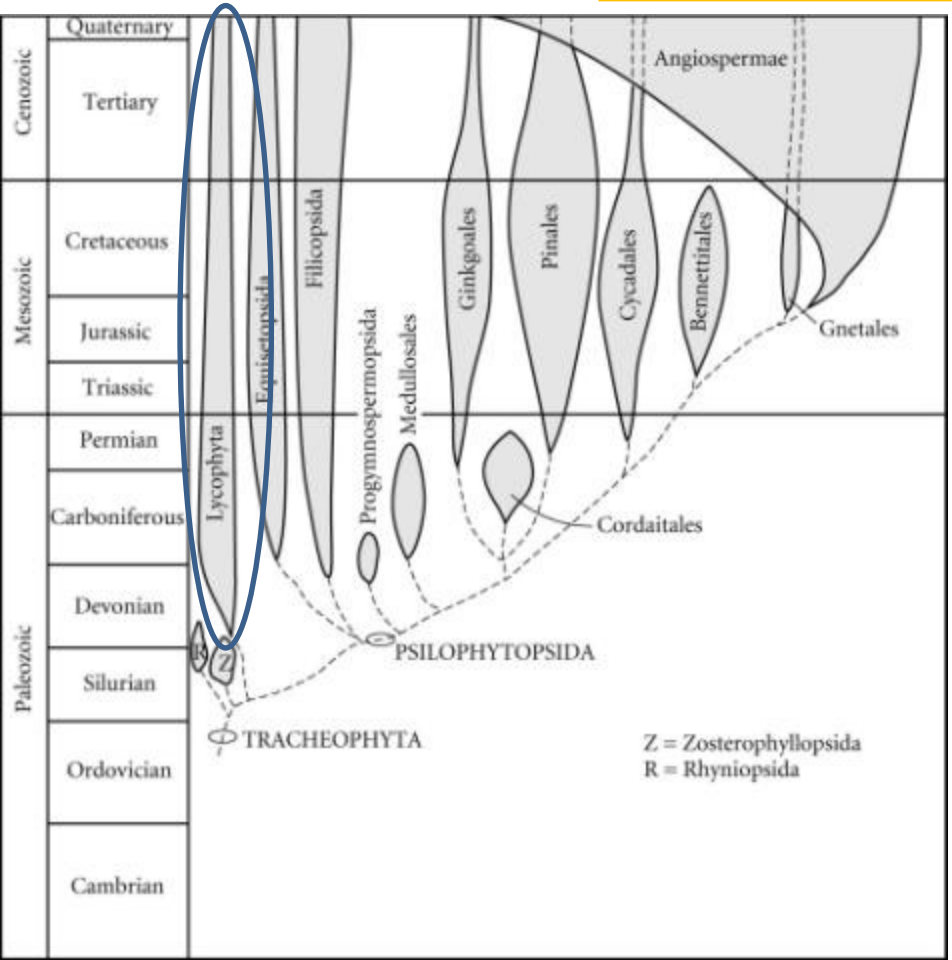
- Micrófilos dispostos helicoidalmente e esporângios situados na parte superior

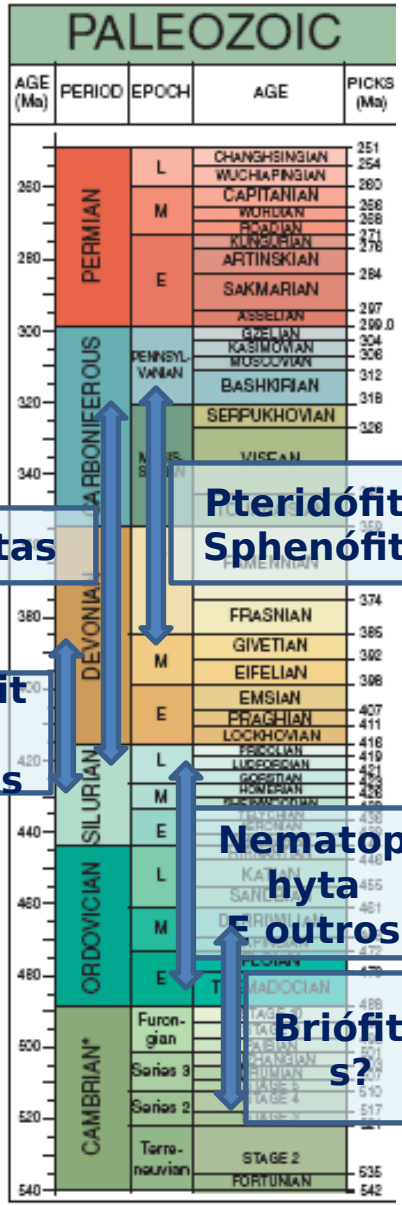
Surgimento das folhas verdadeiras

Planícies de inundação e margem de canais

Carbonífero

Siluriano Superior - Recente





Licófitas

Pteridófitas
Sphenófitas

Zosterófitas
Riniófitas

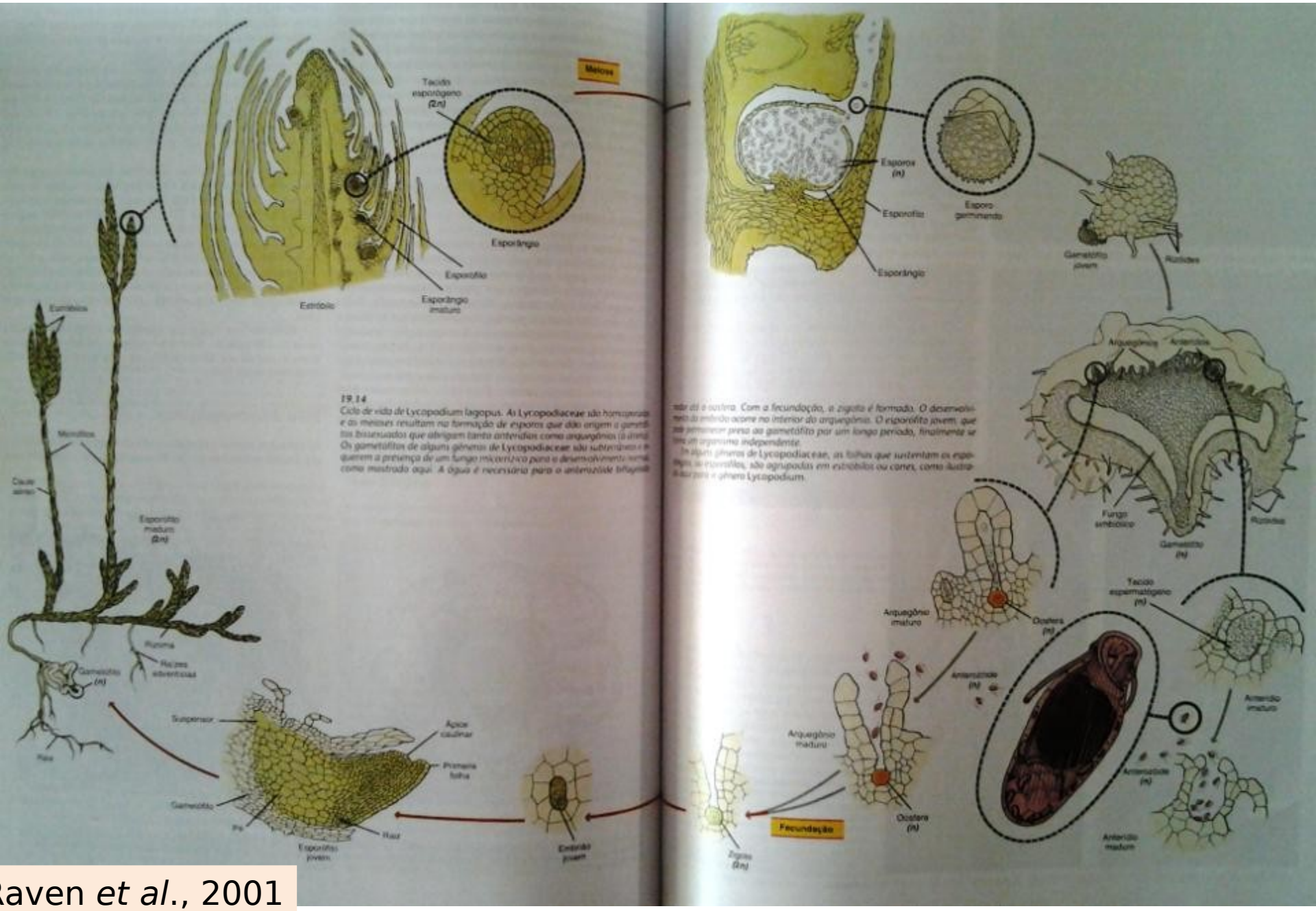
Nematophyta
E outros

Briófitas?



Lycopodium

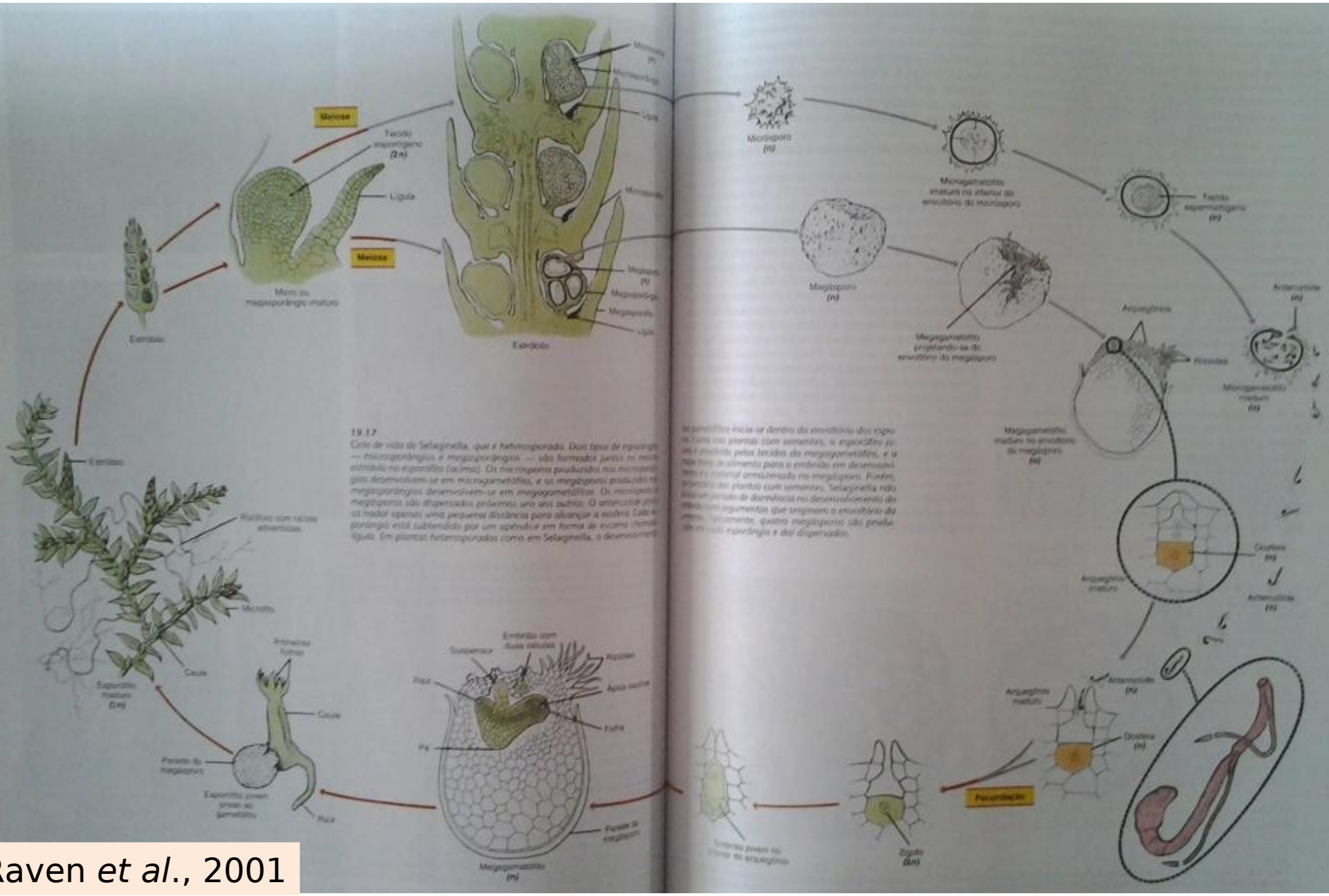
Licófitas – Ciclo de Vida



19.14
Ciclo de vida de Lycopodium lagopus. As Lycopodiaceae são homosporadas e as meioses resultam na formação de esporos que dão origem a gametófitos bissexuados que abrigam tanto anterídios como arquegônios (à direita). Os gametófitos de alguns gêneros de Lycopodiaceae são subterrâneos e requerem a presença de um fungo micorrízico para o desenvolvimento normal, como mostrado aqui. A água é necessária para a anterozóide biflagelado nadar até a oosfera. Com a fecundação, o zigoto é formado. O desenvolvimento do embrião ocorre no interior do arquegônio. O esporófito jovem, que pode permanecer preso ao gametófito por um longo período, finalmente se torna um organismo independente.
Em alguns gêneros de Lycopodiaceae, as folhas que sustentam os esporângios, os esporófilos, são agrupadas em estróbilos ou cones, como ilustrado aqui para o gênero Lycopodium.

Raven *et al.*, 2001

Licófitas – Ciclo de Vida



Raven *et al.*, 2001

Micrófilo

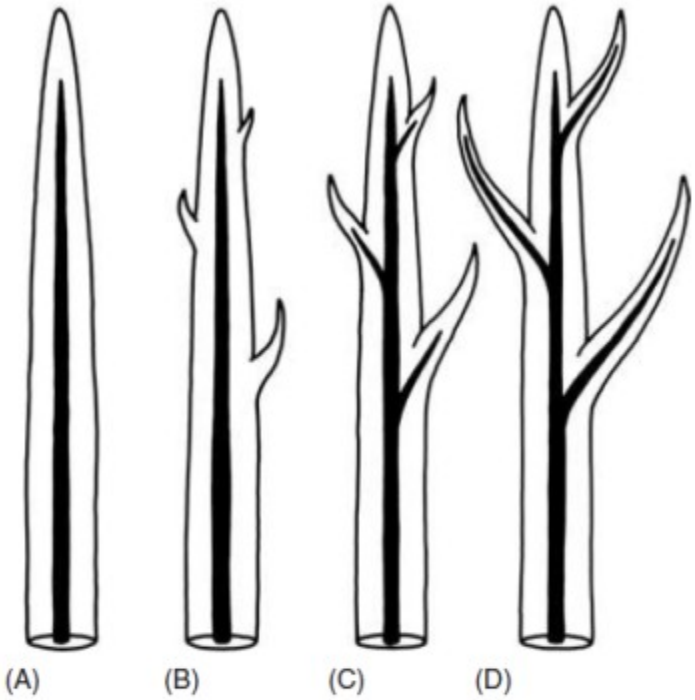


FIGURE 9.1 Hypothesized stages in the evolution of the microphyll. **A.** Vascularized axis (shaded area) lacking epidermal appendages (e.g., *Rhynia*). **B.** Axis with epidermal appendages in the form of spines or enations (e.g., *Sawdonia*). **C.** Axis with vascular traces extending to the base of the enation (e.g., *Asteroxylon*). **D.** Axis with vascularized microphylls (e.g., *Leclercqia*). (From Taylor and Taylor, 1993.)

Lycophyta
- Lycopsida
  - Drepanophycales (Devonian)
  - Protolepidodendrales (Devonian–Mississippian)
  - Lepidodendrales (Devonian–Permian)
    - Lepidodendraceae, Diaphorodendraceae, Sigillariaceae
  - Lycopodiales (Pennsylvanian–recent)
    - Lycopodiaceae
  - Selaginellales (Pennsylvanian–recent)
    - Selaginellaceae
  - Pleuromeiales (Triassic–Cretaceous)
  - Isoetales (Upper Devonian–recent)
    - Isoetaceae, Chaloneriaceae

Taylor *et al.*, 2009

EPIDODENDRALES

Devoniano - Permiano

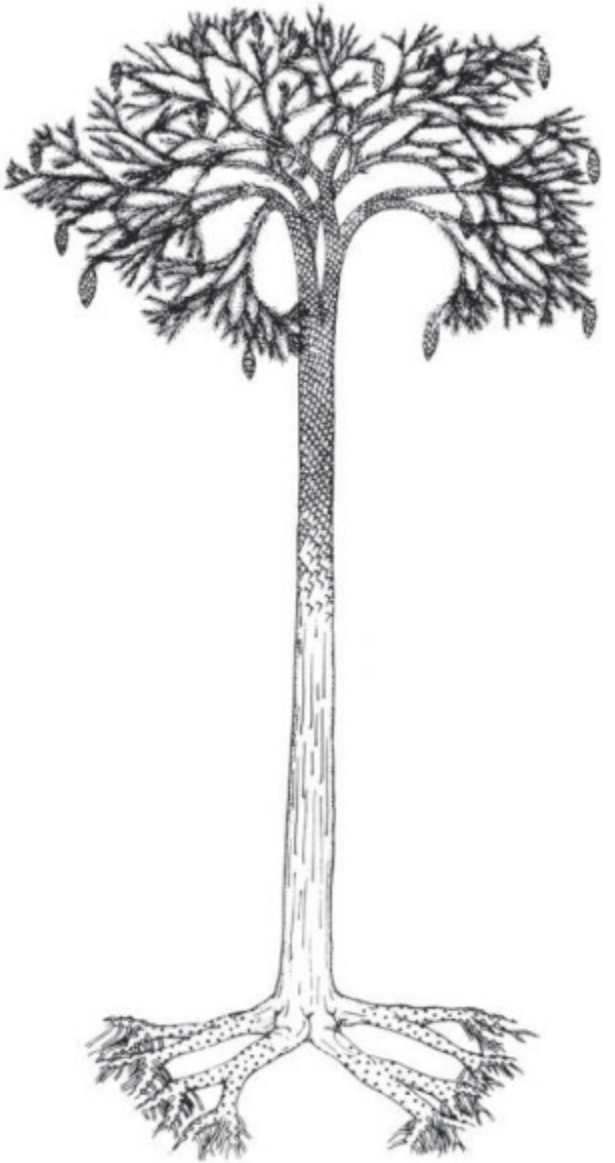
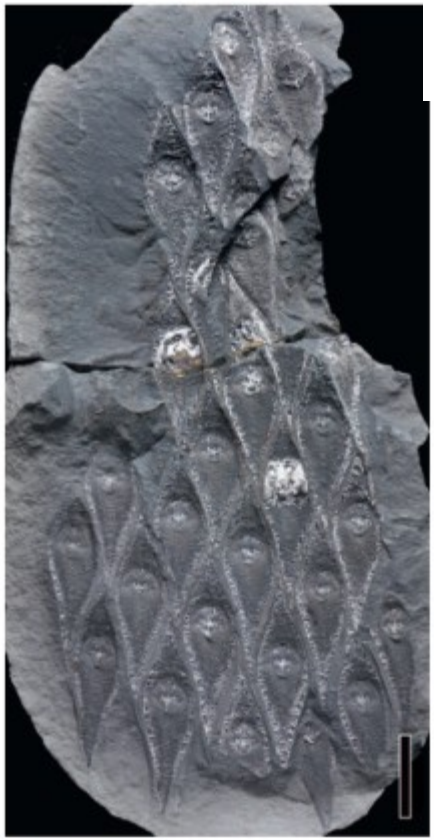


FIGURE 9.28 Suggested reconstruction of an arborescent lycopsid (e.g., *Lepidodendron*). (Courtesy D. A. Eggert.)



GURE 9.33 *Lepidodendron* leaf bases (Pennsylvanian). Bar = m. (Courtesy BSPG.)



FIGURE 9.32 Several *Lepidodendron* leaf cushions preserved in a Mazon Creek nodule (Pennsylvanian). Bar = 3.5 mm.

Lepidodendron
Troncos
Almofadas foliares.

Taylor *et al*., 200



FIGURE 9.37 Three prominent oval branch scars along a *Lepidodendron* axis (Pennsylvanian). Bar = 4 cm.

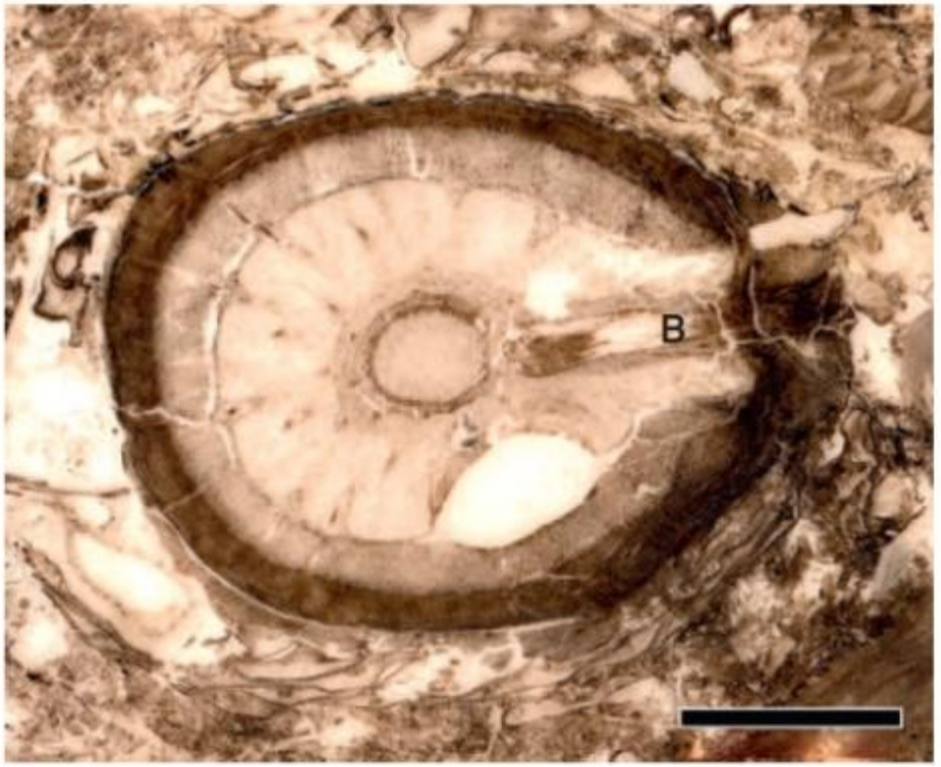
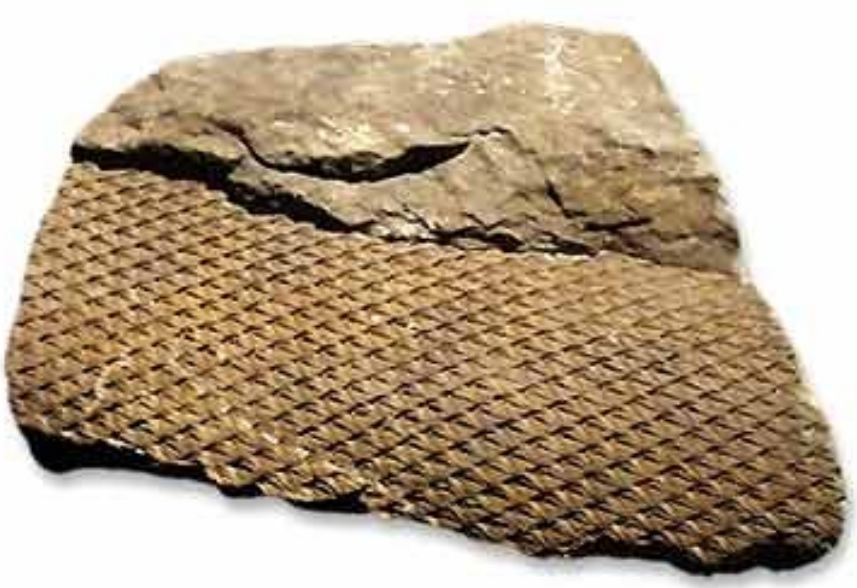


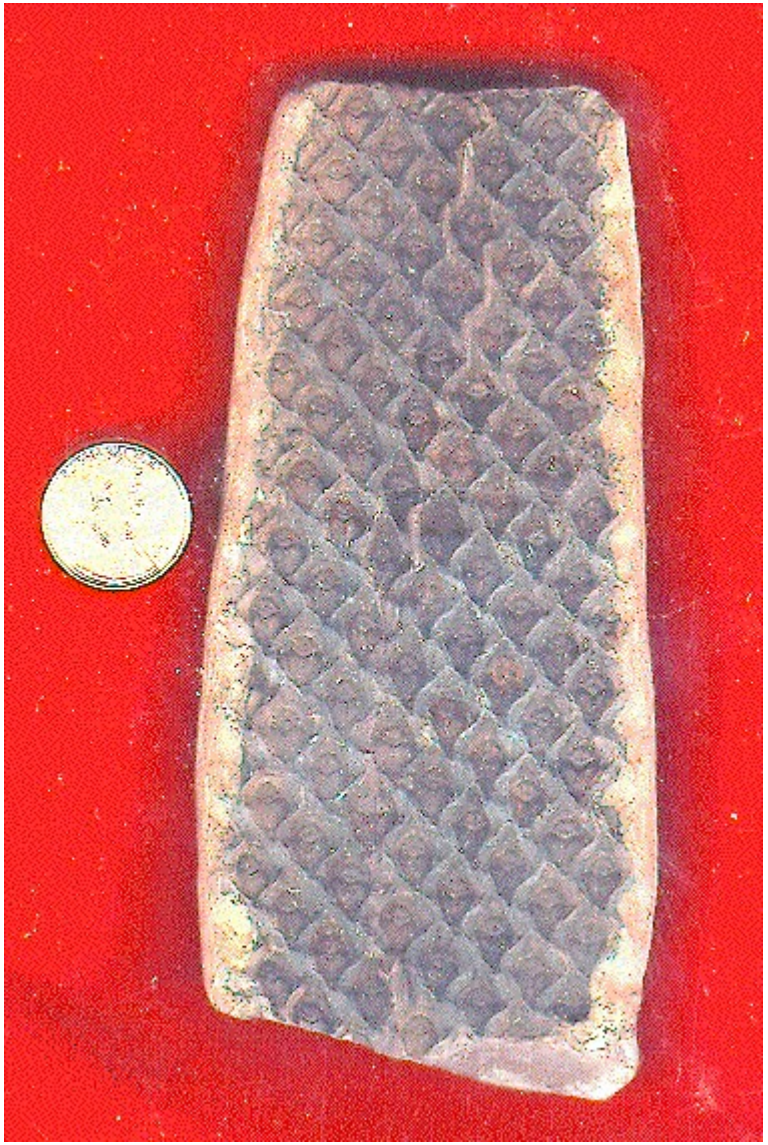
FIGURE 9.39 Arborescent lycopsid (*Lepidodendron*) showing branch trace (B) (Pennsylvanian). Bar = 1 cm.

Taylor *et al.*, 2009

Lepidodendron







Lepidodendron







Folhas
Lepidophyllum

Taylor *et al*., 2009

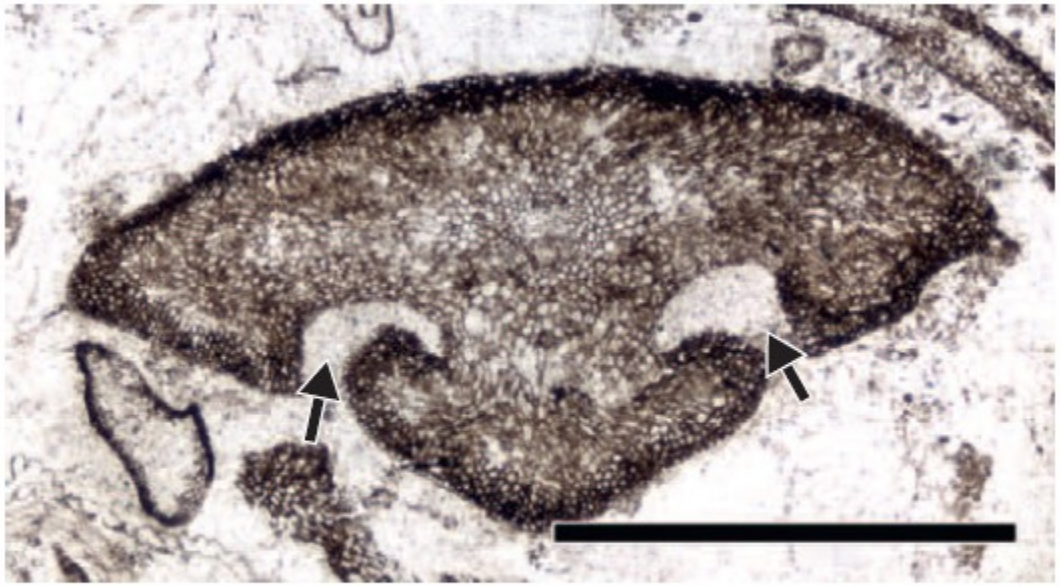


FIGURE 9.48 Cross section of *Lepidodendron* leaf. Note two abaxial furrows (arrows) where stomata are located (Pennsylvanian). Bar = 1.5 mm. (Courtesy BSPG.)

Raízes
Stigmaria



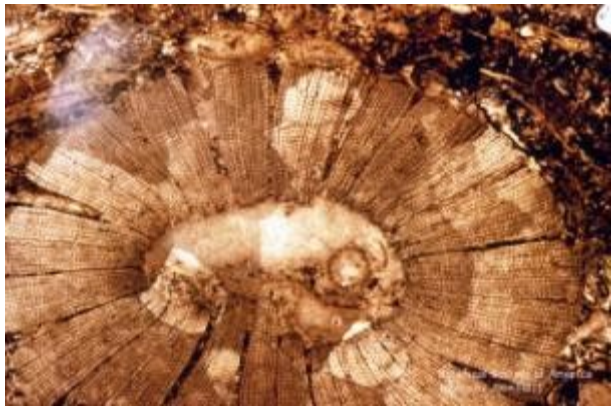
FIGURE 9.51 Cast of *Stigmaria* sp. showing pattern of rootlet scars (Pennsylvanian). Bar = 1 cm.



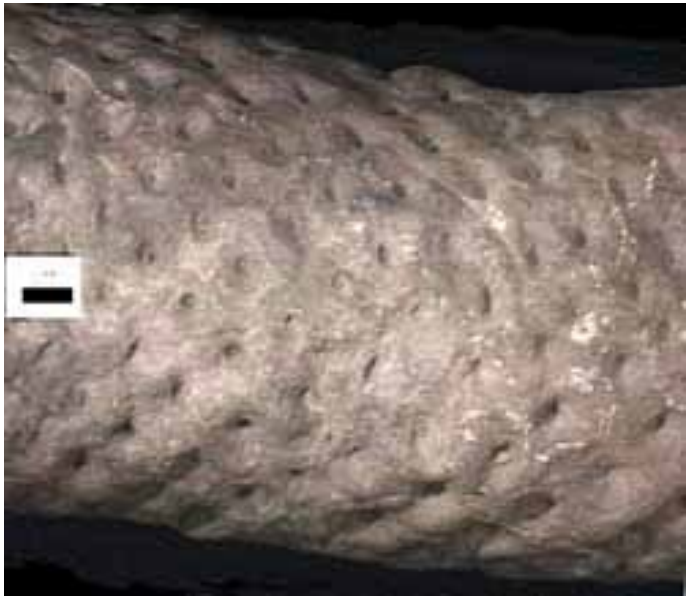
E 9.49 *Stigmaria ficoides* compression showing laterally attached rootlets (Pennsylvanian). E

Taylor *et al*., 200

Stigmaria – raízes de lepidodendrales









Lepidostrobus



FIGURE 9.58 Compressed *Lepidostrobus* cone (Pennsylvania
Bar = 2 cm.

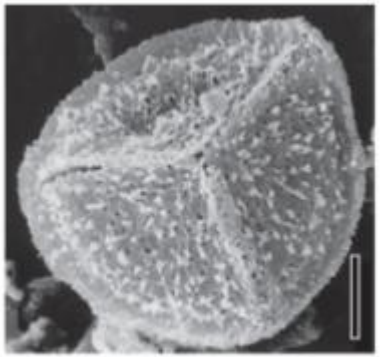


FIGURE 9.64 Proximal surface of *Lycosporia*-type spore showing surface ornament, trilete suture, and equatorial cingulum (Pennsylvanian). Bar = 7 μm.



FIGURE 9.59 Compression specimen showing axis of *Lepidostrobus* cone with helically attached sporophylls (Pennsylvanian). Bar = 1 cm.

Taylor *et al*., 2009



Lepidostrobus



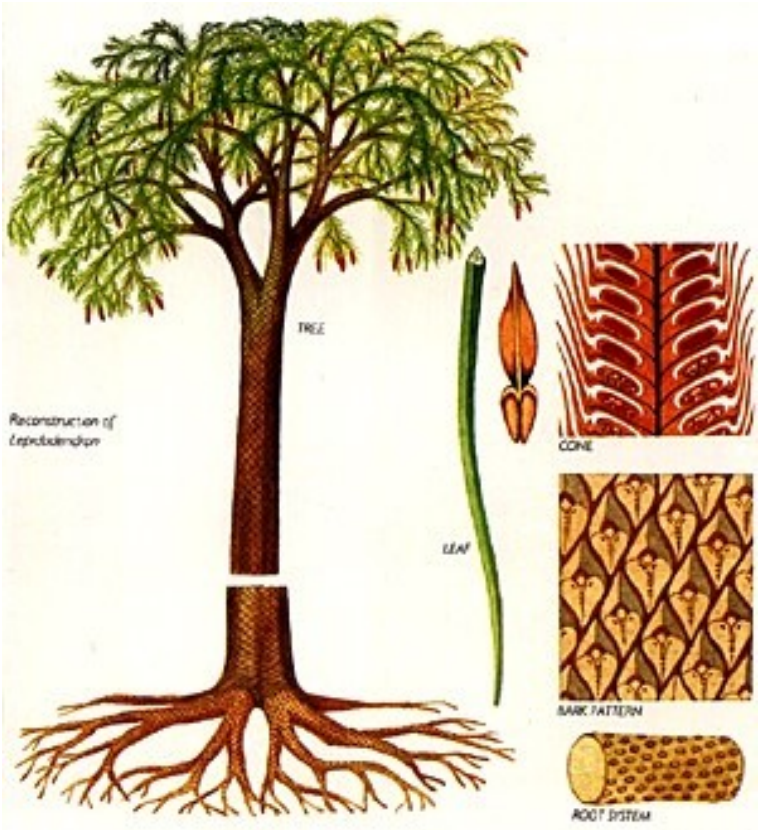


FIGURE 9.68 Compressed *Lepidocarpon* cone (Pennsylvanian). Bar = 1 cm.



FIGURE 9.66 Megaspore of the *Triletes*-type showing proximal triradiate ridge and ornamentation (Pennsylvanian). Bar = 1 mm.

Taylor *et al.*, 2009


Reconstruction of
Lepidodendron
TREE
LEAF
CONE
BARK PATTERN
ROOT SYSTEM

Sigillaria



FIGURE 9.83 Suggested reconstruction of *Sigillaria* tree (Pennsylvanian). (Courtesy D. A. Eggert.)

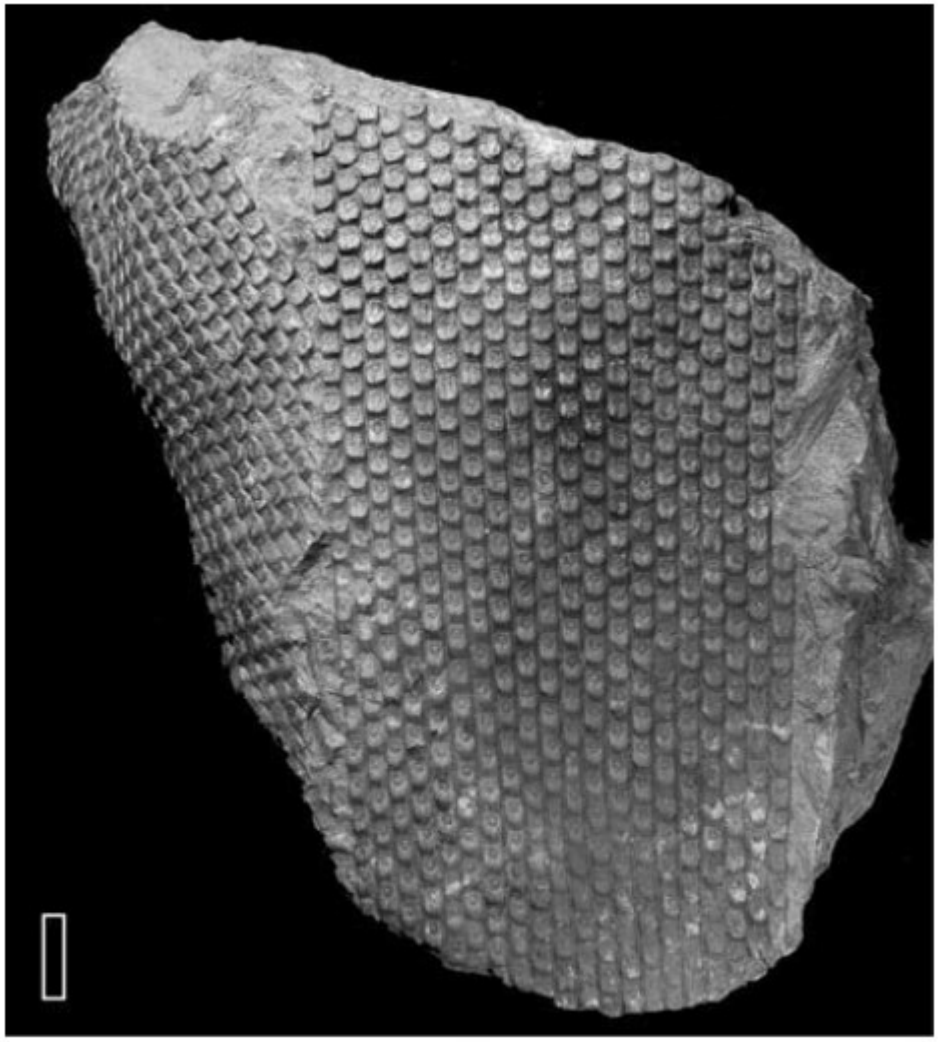


FIGURE 9.84 *Sigillaria mammillaris*, stem surface with leaf bases (Pennsylvanian). Bar = 2 cm. (Courtesy BSPG.)

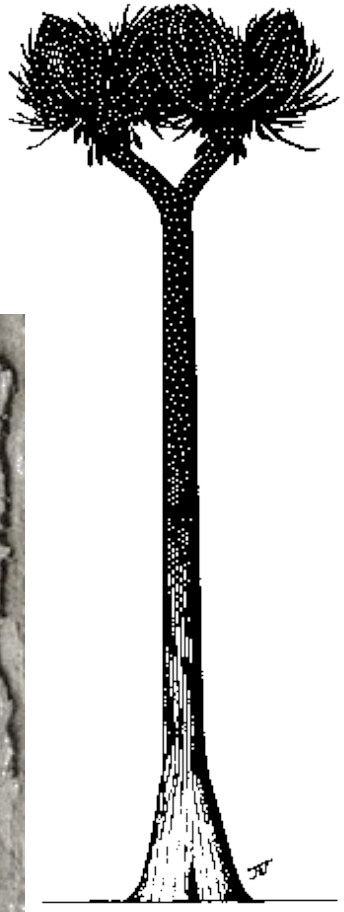
Taylor *et al.*, 2009

Sigillaria – troncos colunares com escassa ramificações; folhas alongadas; almofadas foliares hexagonais.









Sigillaria







PHENOPHYTA

Pseudoborniales (Devonian)

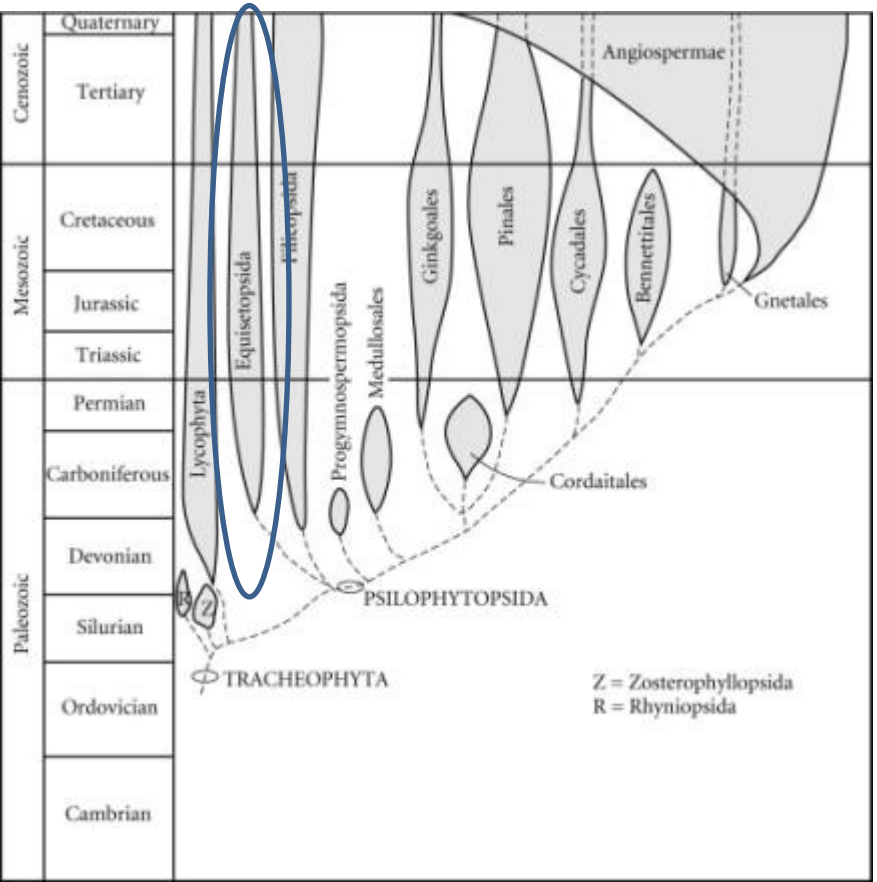
Sphenophyllales (Devonian–Triassic)

Equisetales (Devonian–recent)

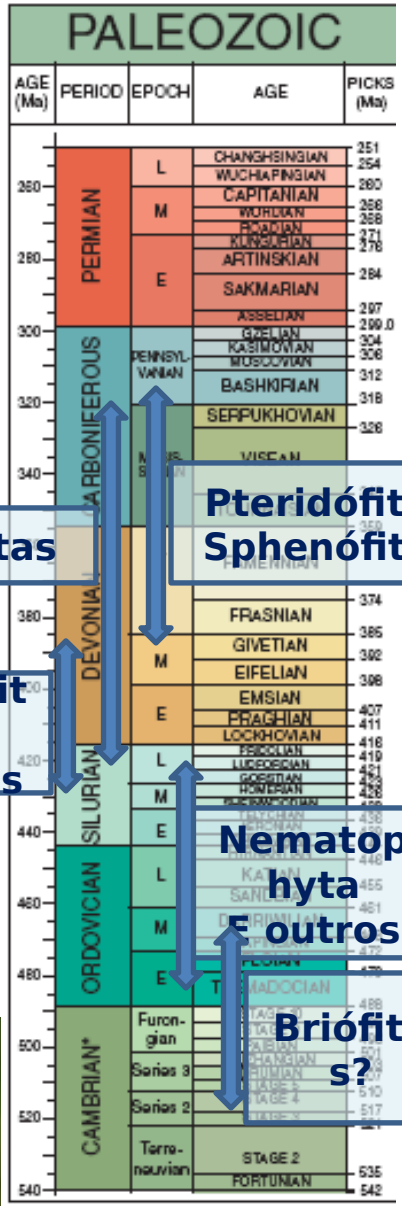
- Calamitaceae
- Tchernoviaceae
- Gondwanostachyaceae
- Equisetaceae

Devoniano - Recente









Licófitas

Pteridófitas
Sphenófitas

Zosterófitas
Riniófitas

Nematophyta
E outros

Briófitas?

Calamites



FIGURE 10.36 Suggested reconstruction of *Cala*
Calamitina. (From Taylor and Taylor, 1993.)



FIGURE 10.30 Compressed calamite stem showing internodal
ribs and furrows (Pennsylvanian). Bar = 2 cm.



FIGURE 10.35 *Calamites gigas*, stem (steinkern) *in situ*
(Permian). Bar = 10 cm. (Courtesy M. Barthel.)

Taylor *et al.*, 2009

Calamitaceae – *Calamites*

Carbonífero sup. – Permiano sup.







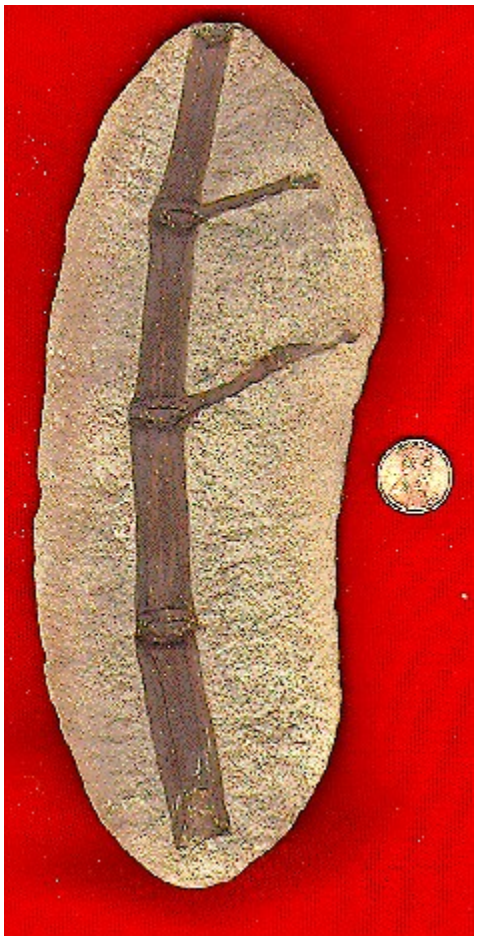




FIGURE 10.51 *Myriophyllites gracilis*, compressed calamitean roots with lateral rootlets (Pennsylvanian). Bar = 2 cm. (Courtesy BSPG.)



FIGURE 10.55 Several whorls of *Asterophyllites* leaves (Pennsylvanian). Bar = 2 cm.

Taylor *et al.*, 2009

Annularia (folhas de Calamites)



FIGURE 10.53 Axis with eight whorls of *Annularia* leaves (Pennsylvanian). Bar = 1 cm.

FIG
num



FIGURE 10.61 *Annularia stellata* leafy branch (Pennsylvanian). Bar = 6 cm. (Courtesy BSPG.)

Taylor *et al*., 2009



FIGURE 10.59 Cluster of attached calamite cones (Pennsylvanian). Bar = 1 cm.



FIGURE 10.60 Fertile calamite branch bearing several small cones (Pennsylvanian). Bar = 1 cm.

Taylor *et al*., 200

ALAMITALES



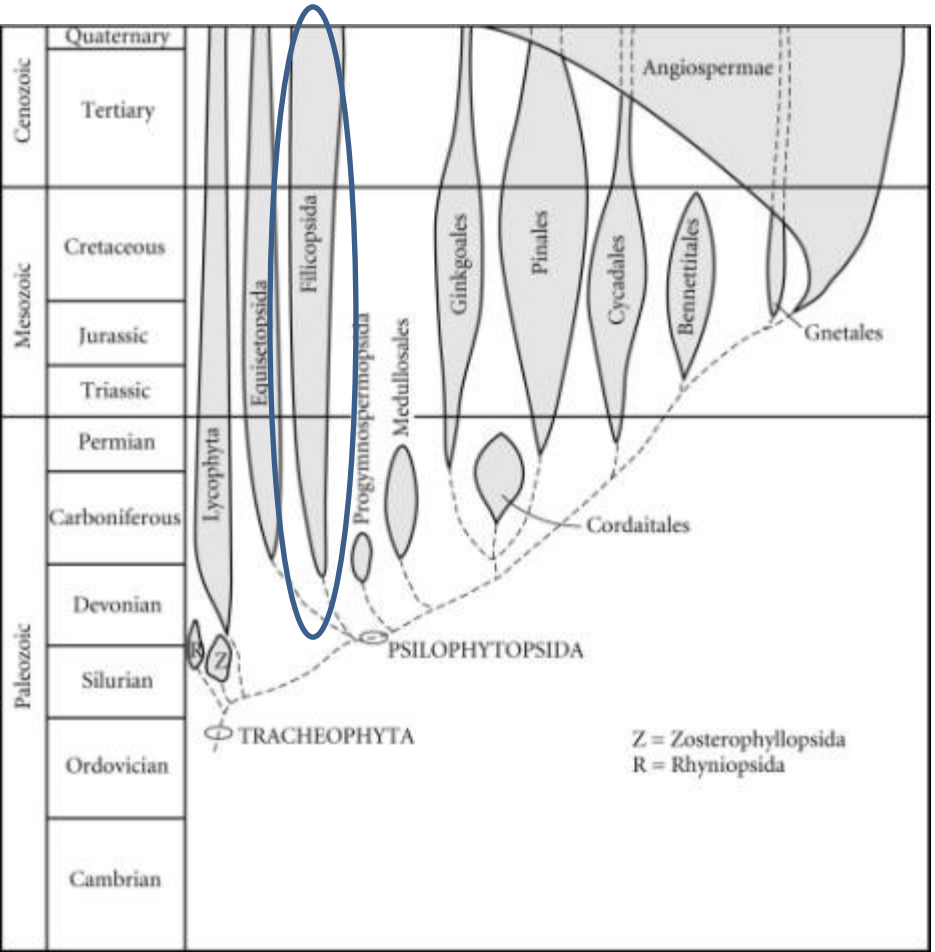
TERIDOPHYTA

Megáfilo (folhas) Devoniano - Recente

Psaronius – Carbonífero superior ao Triássic

ndes de *Psaronius* - *Pecopteris*

ova radiação no Jurássico - Cretáceo





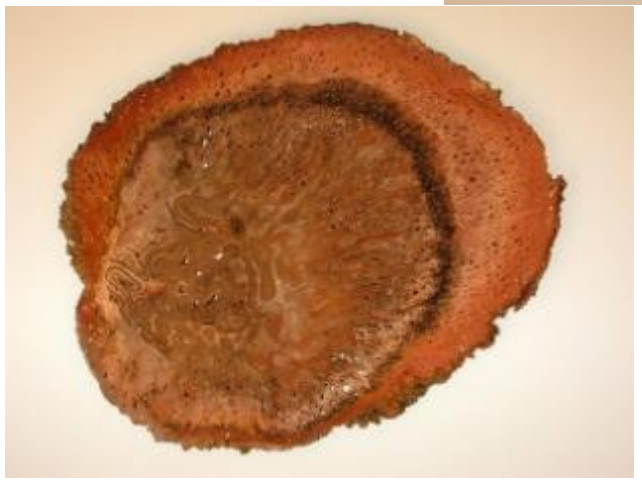


TERIDOPHYTA

saronius – Carbonífero superior ao Triássico

dica clima quente e úmido.









TERIDOPHYTA

aronius – Carbonífero superior ao Triássico

ondes de *Psaronius* - *Pecopteris*











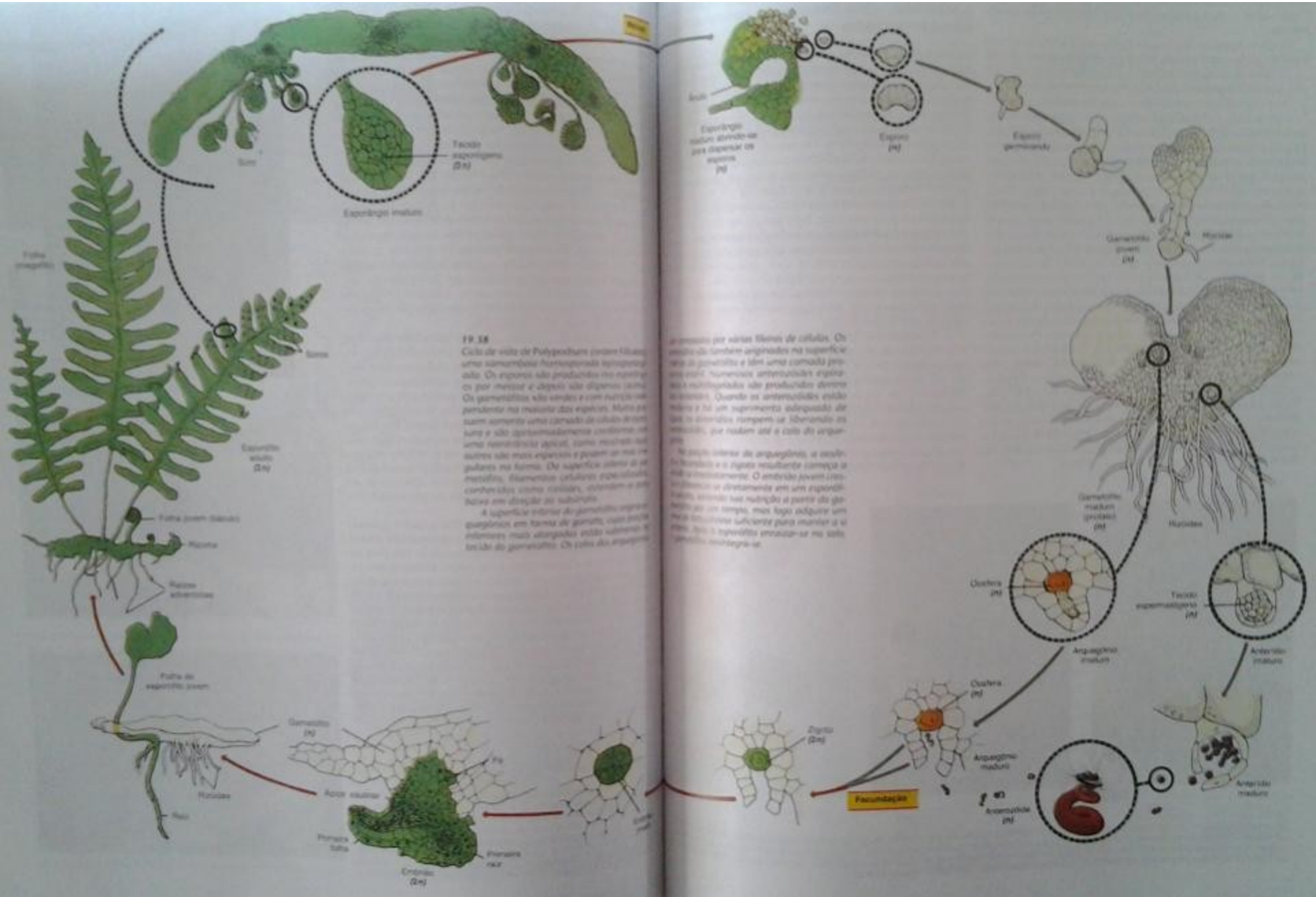


Pecopteris





Pteridófitas– Ciclo de Vida



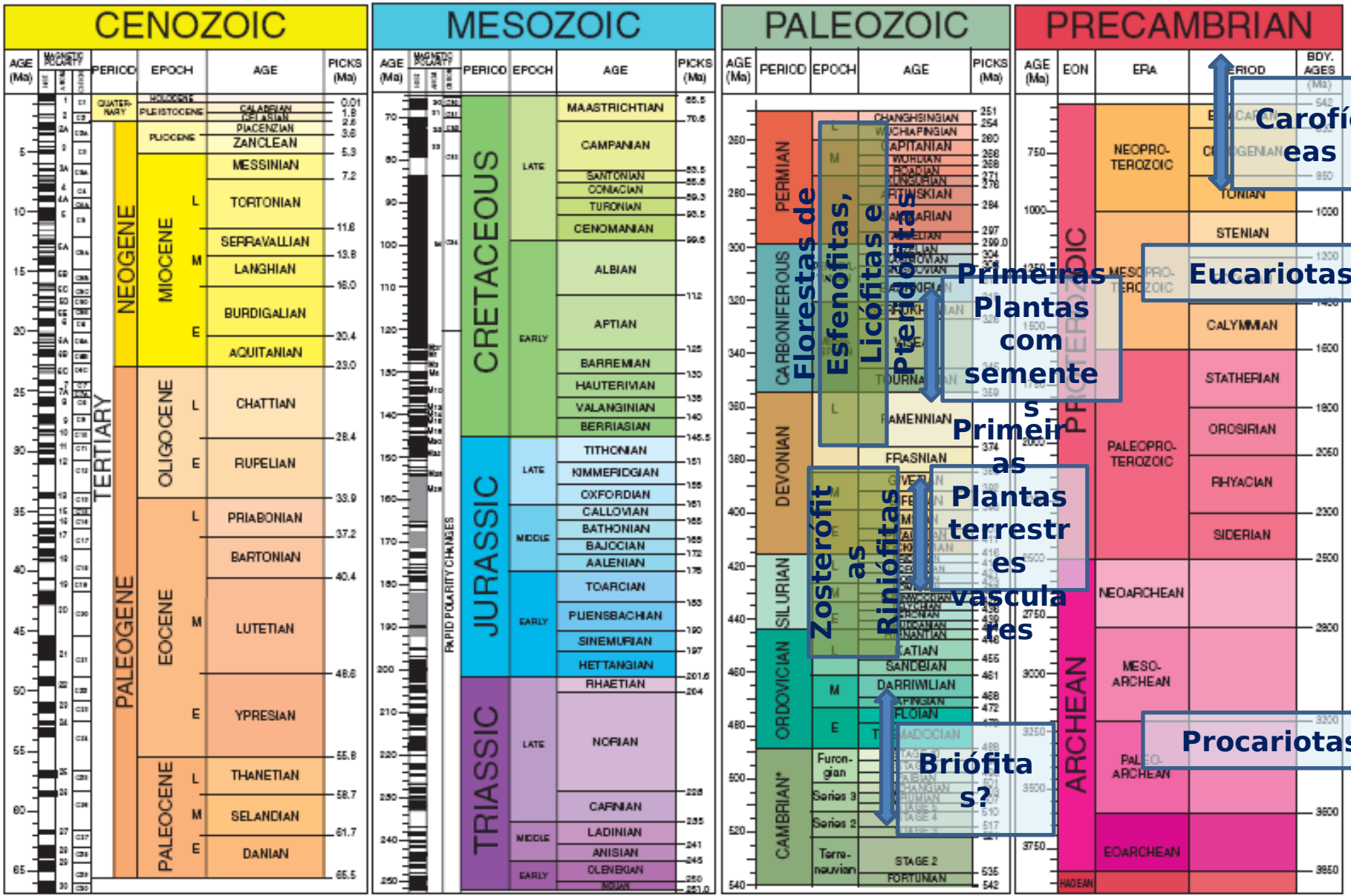
Flora do Carbonífero



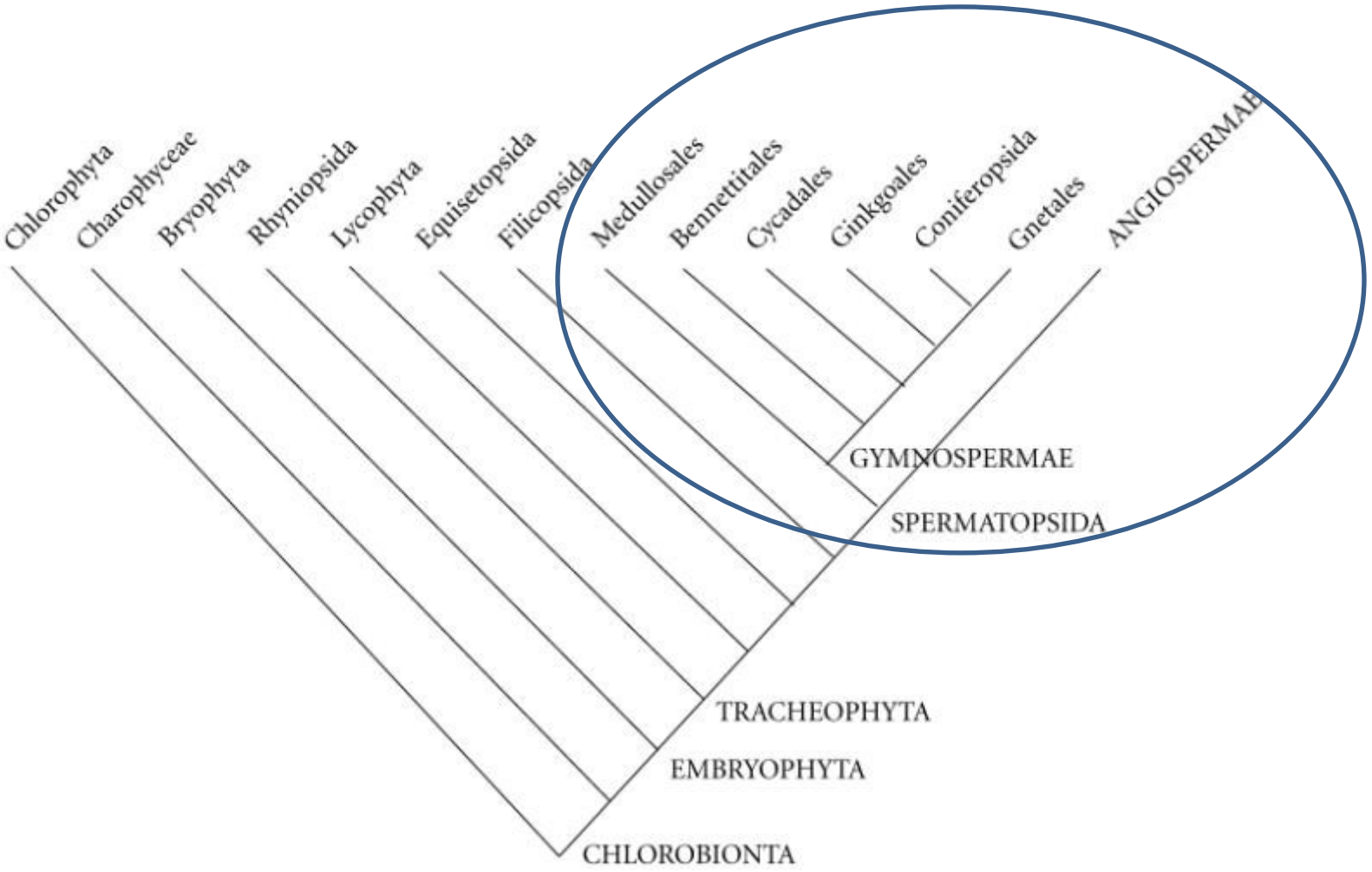
Flora do Carbonífero



GIMENTO DAS PLANTAS COM SEMENTES



GIMENTO DAS PLANTAS COM SEMENTES



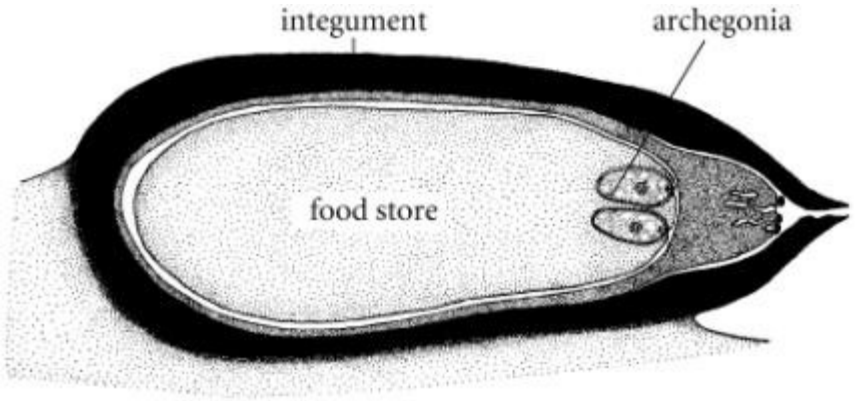
GIMENTO DAS PLANTAS COM SEMENTES

- Retenção e germinação do megásporo sobre a planta mãe (esporófito)
- Desenvolvimento do gametófito feminino até estágio de maturidade reprodutiva
- Planta mãe com condições para desenvolvimento do micrósporo em gametófito masculino, cujos gametas devem alcançar o gametófito feminino para efetuar a fecundação

Grãos de pólen

- Em suma: toda parte do ciclo que antes ocorria no meio externo passa a ocorrer sobre o esporófito

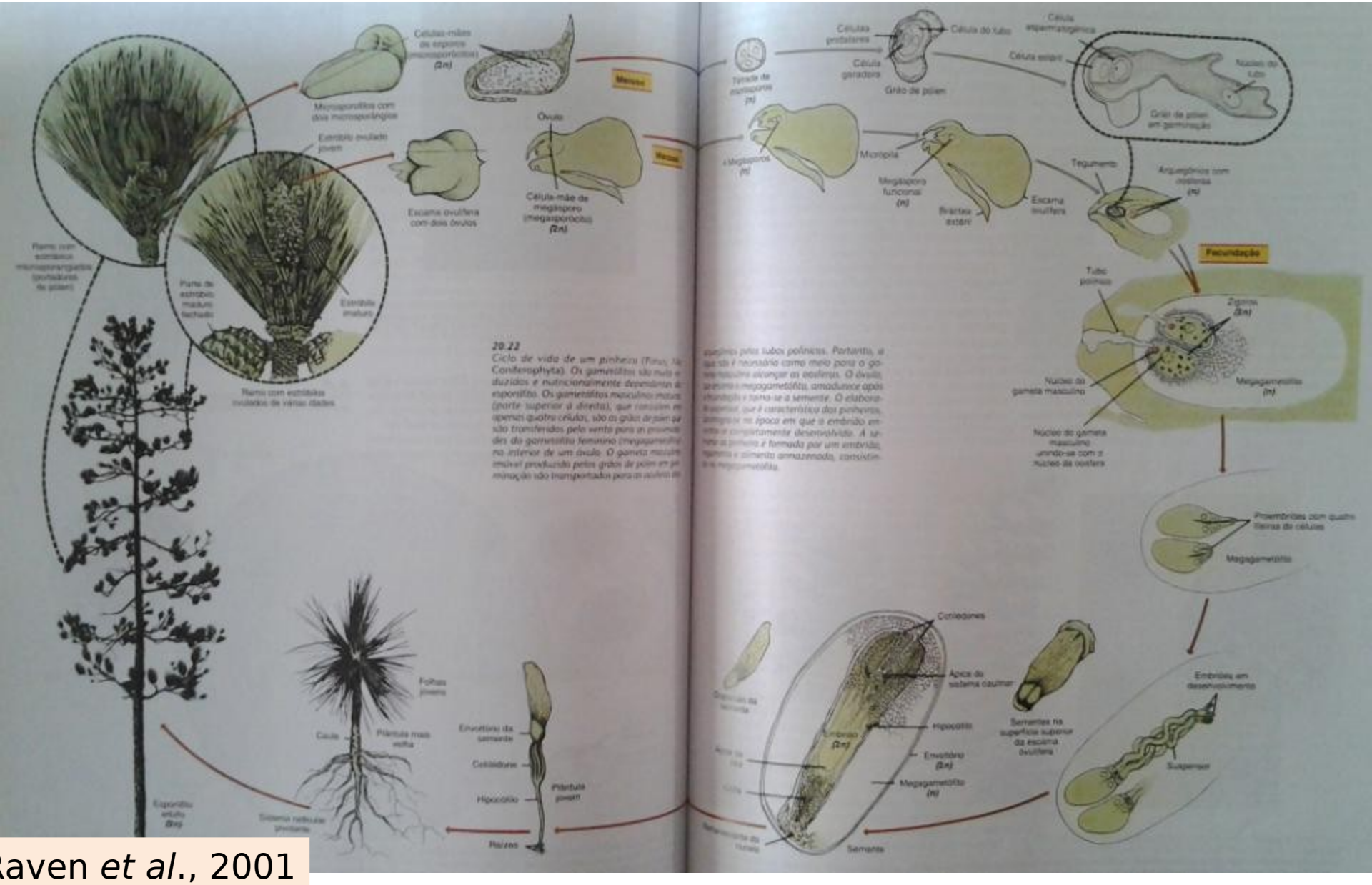
- Para ser chamado de **óvulo** (ou de **semente**, quando fecundado) o gametófito deve estar protegido por tegumento e possuir estrutura semelhante à micrópila (local para receptação do micrósporo)



Conquista definitiva do ambiente terrestre
Colonização de outros ambientes

Traqueídes típicos

Gimnospermas – Ciclo de Vida



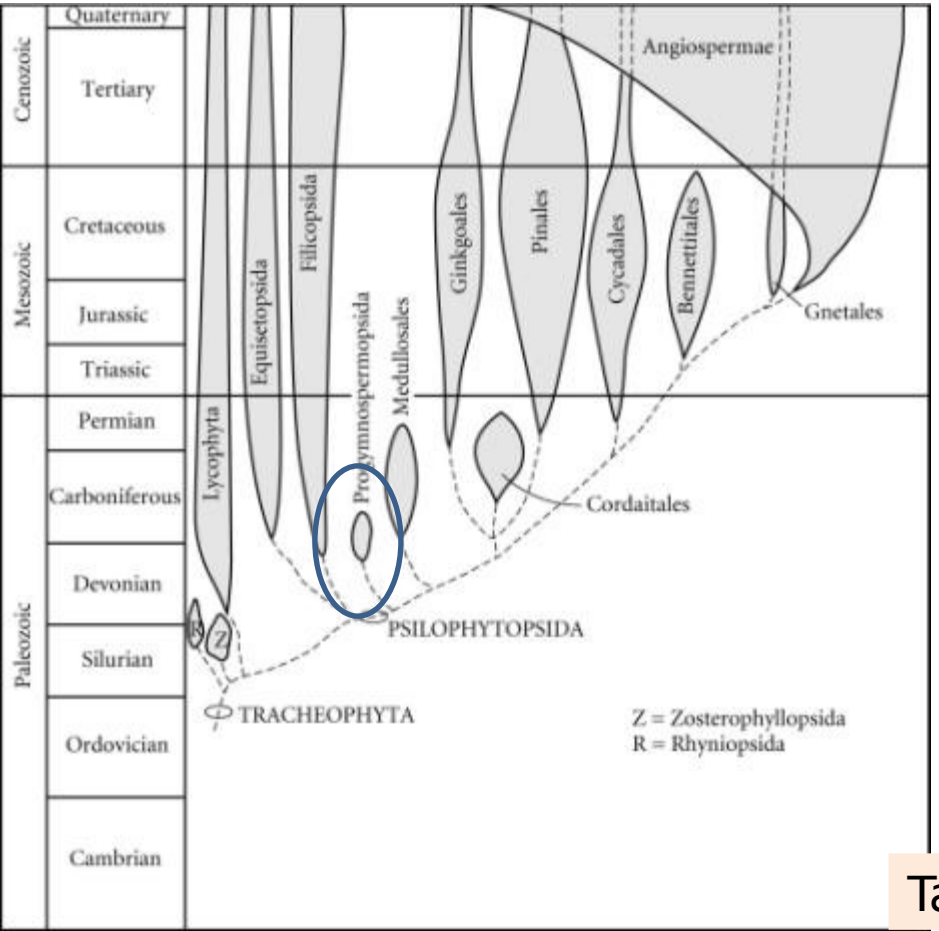
Raven *et al.*, 2001

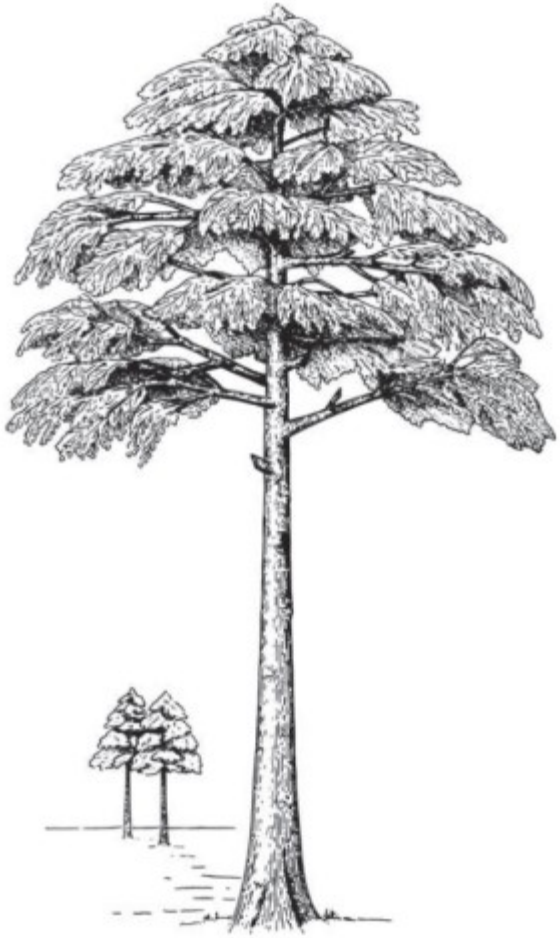
PROGIMNOSPERMAS

Archaeopteris

Devoniano Médio – Carbonífero Inferior

Anatomia dos troncos moderna
Modo de crescimento





Taylor *et al*., 2009

2.2 Suggested reconstruction of *Archaeopteris* (From Beck, 1962.)

Archaeopteris



FIGURE 12.3 Branch with leaves of *Archaeopteris fimbriata* (Devonian). Bar = 2.5 cm. (Courtesy BSPG.)

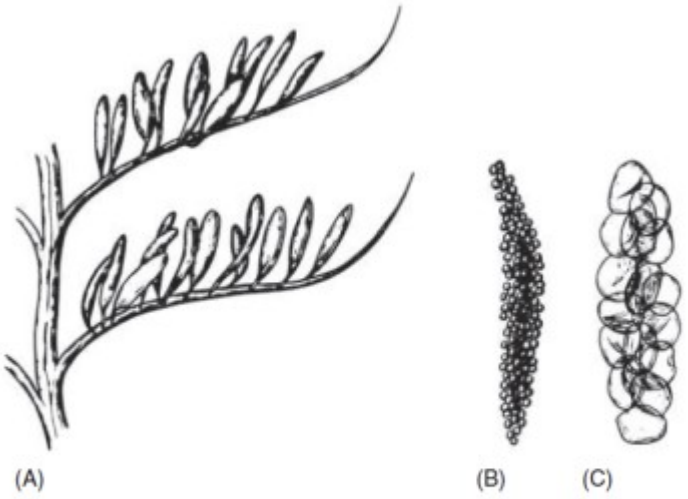


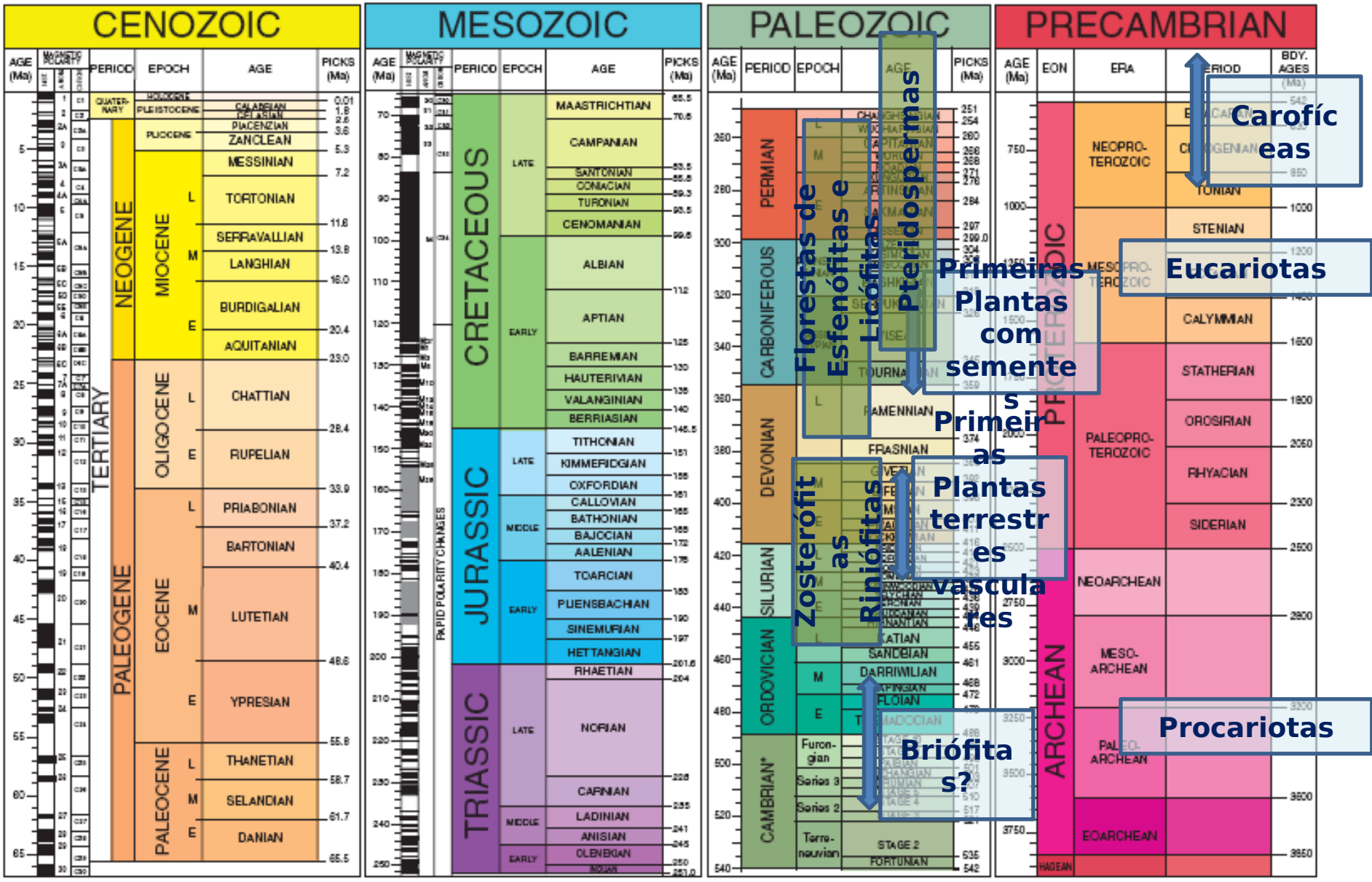
FIGURE 12.10 A. *Archaeopteris* sporophyll bearing sporangia. B. Aggregation of microspores. C. Aggregation of megaspores. (From Andrews, 1961.)



) Fertile branch of *Archaeopteris* showing adaxial sporangia. (Devonian). Bar = 6 mm. (Courtesy

Taylor *et al*., 2009

TERIDOSPERMA Carbonífero Inferior - Cretáceo



IRAS PLANTAS COM SEMENTES – Registro fóss

TERIDOSPERM

Grupo artificial

Carbonífero Inferior - Cretáce

"Fetos com Sementes"

ementes diretamente conectadas às folhas

Glossopteridal

Carbonífero Superior - Triássico



FIGURE 14.174 *Glossopteris* leaf showing reticulate venation (Permian). Bar = 2.5 cm. (Courtesy H. Kerp.)



FIGURE 14.178 Suggested reconstruction of a *Glossopteris* plant and associated organs. (From Gould and Delevoryas, 1977.)

Taylor *et al*., 2009



FIGURE 14.171 *Glossopteris stricta* (Permian). Bar = 1 cm.

TERIDOSPERMAS

Glossopteridales



FIGURE 14.183 *Gangamopteris* sp. leaf (Permian). Bar = 1 cm. (Courtesy S. McLoughlin.)

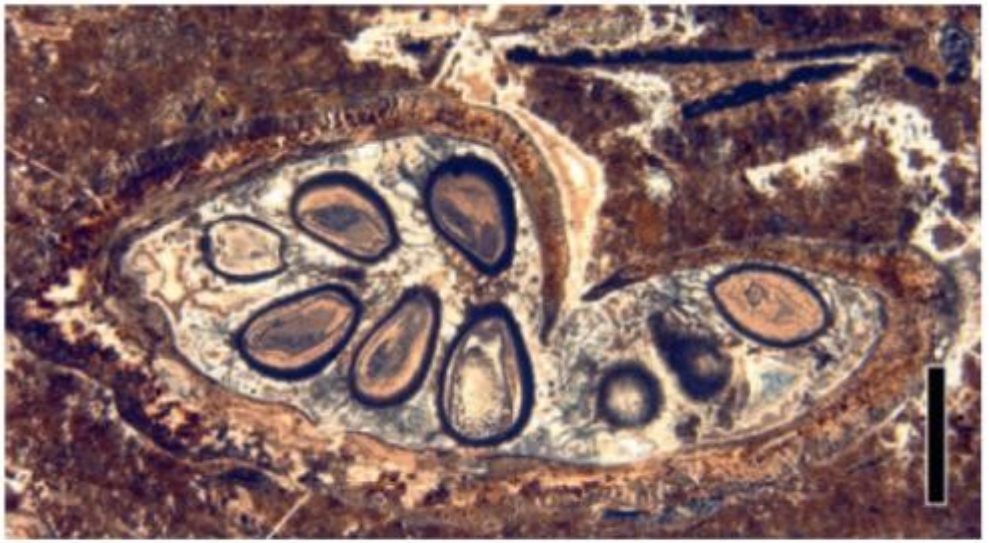


FIGURE 14.190 Megasporophyll of *Homevaleia gouldii* showing several seeds (Permian). Bar = 1 mm. (Courtesy P. Ryberg.)

Taylor *et al.*, 2009

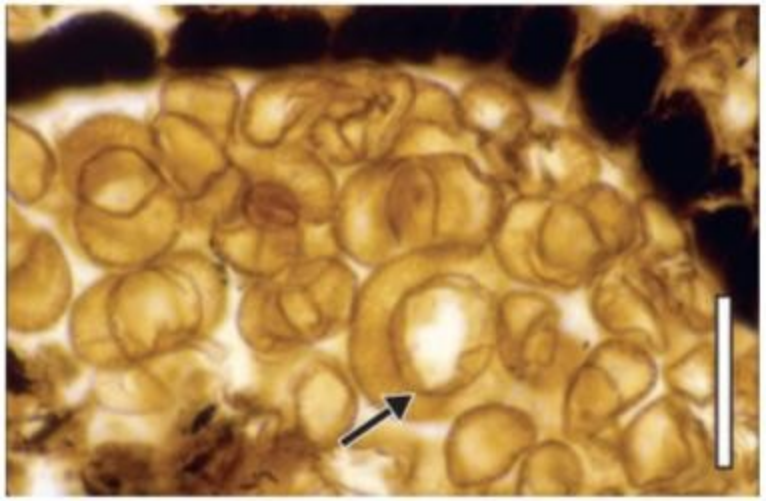


FIGURE 14.218 Monosaccate (arrow) and bisaccate pollen grains in a glossopterid pollen sac. Bar = 50 μm. (Courtesy S. McLoughlin.)

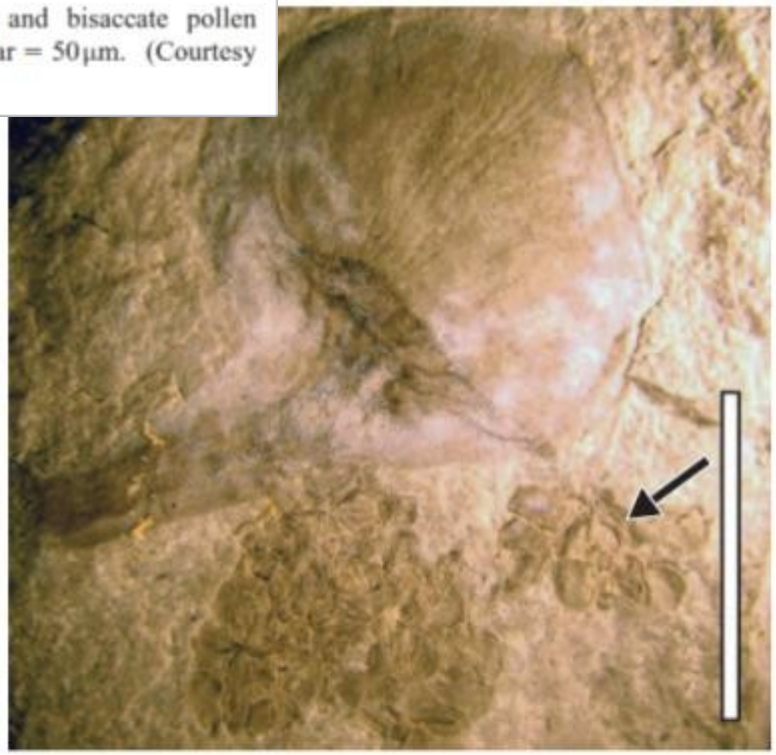


FIGURE 14.215 *Eretmonia natalensis* with aggregation of pollen sacs (arrow) near stalk (Permian). Bar = 6 mm. (From White, 1978; Courtesy P. Ryberg.)

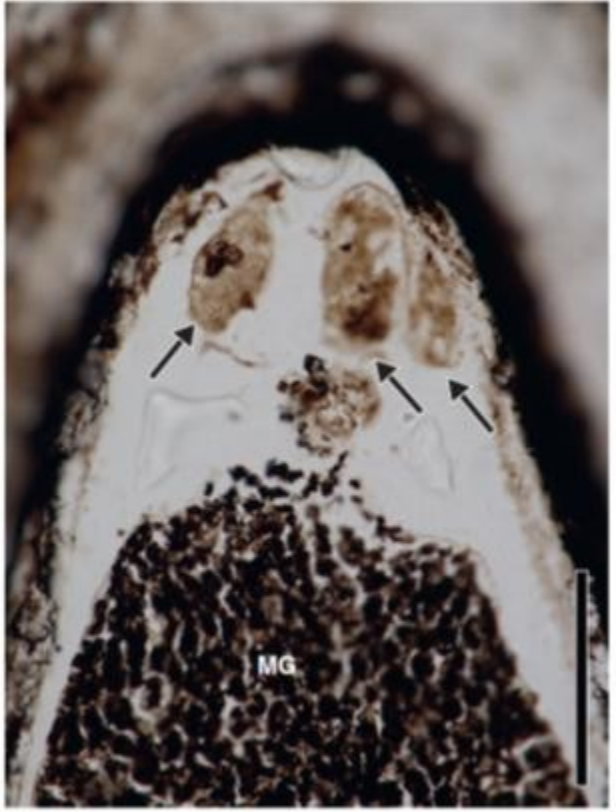
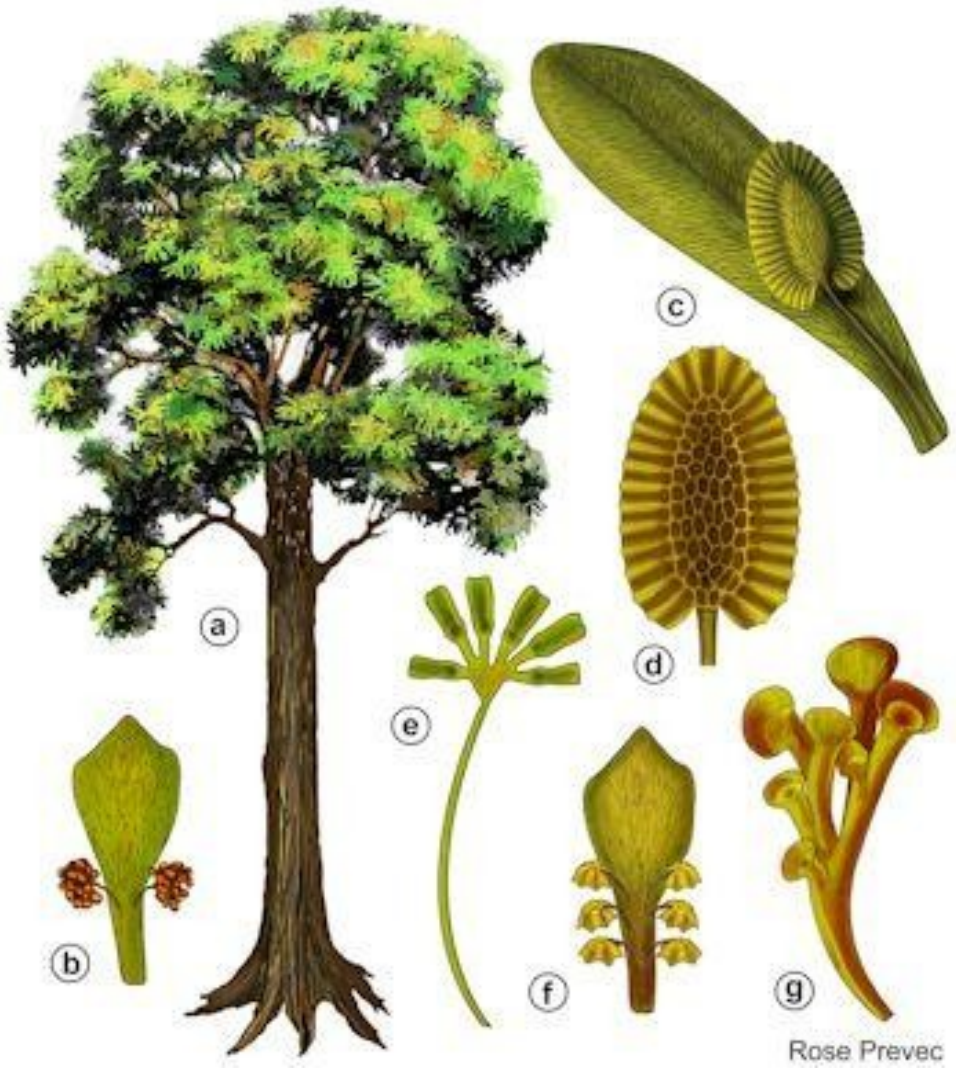
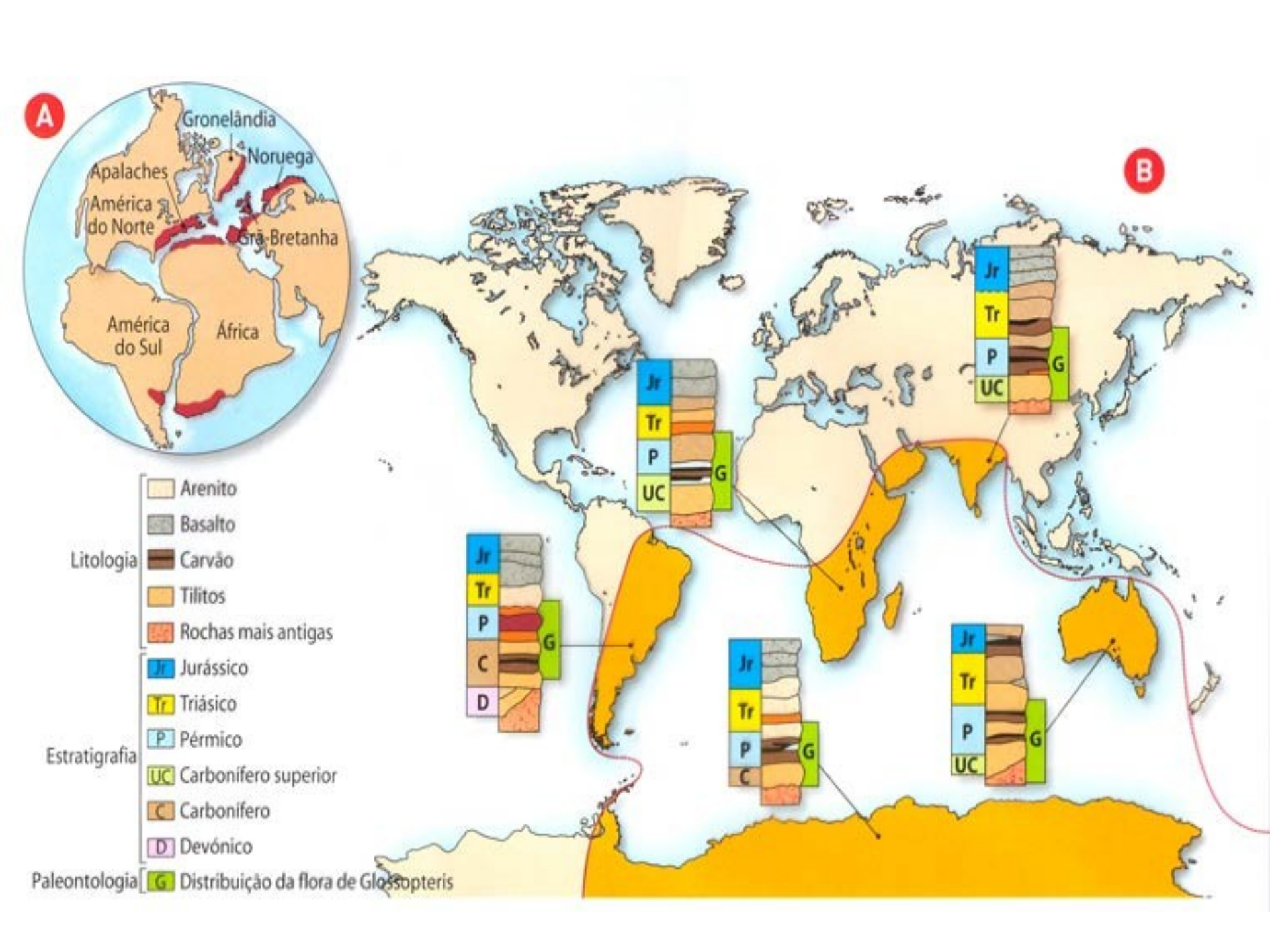


FIGURE 14.192 Micropylar end of *Glossopteris homevalensis* ovule showing pollen tubes (arrows) and megagametophyte tissue (MG) (Permian). Bar = 0.25 mm. (Courtesy H. Nishida.)

aylor *et al*., 2009

a)- árvore *Glossopteris*;
b)- estrutura produtora de pólen (*Eretmonia*);
c)- estrutura ovulífera presa a uma folha;
d/g)- exemplos de frutificações

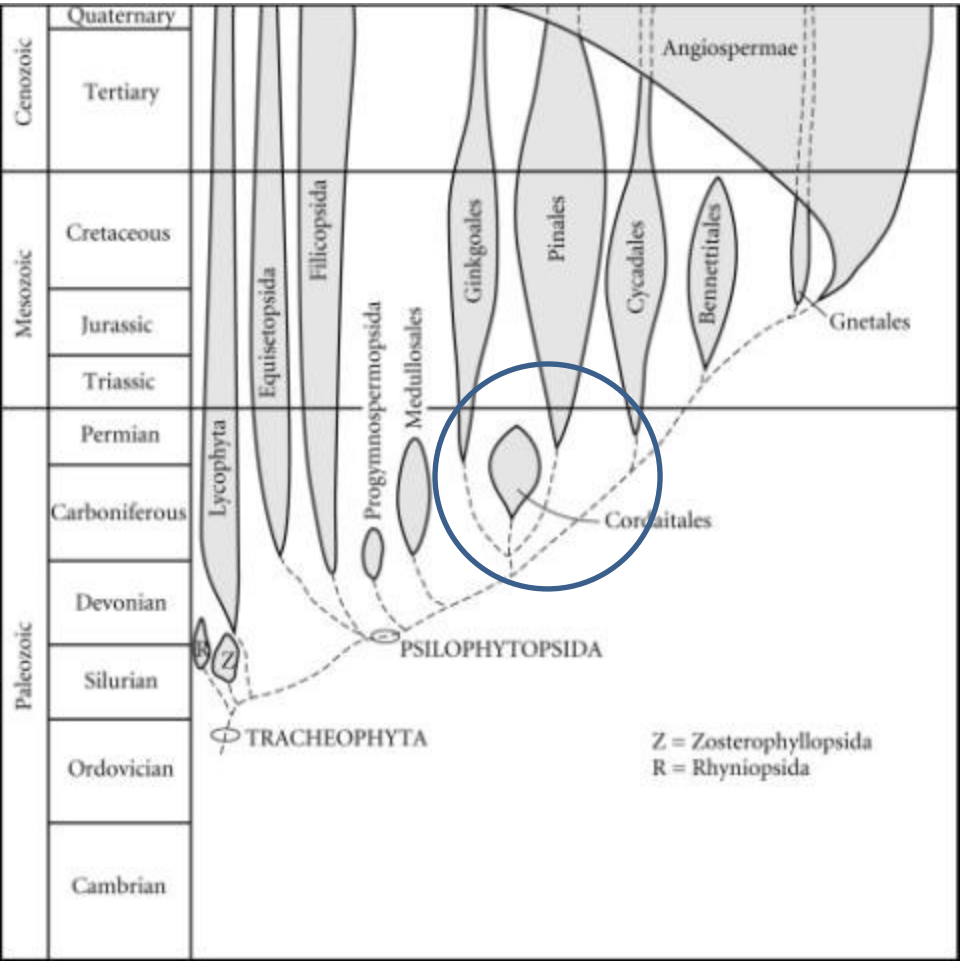



A
Gronelândia
Noruega
Apalaches
América do Norte
Grã-Bretanha
América do Sul
África
B
Jr
Tr
P
UC
C
D
G
Litologia
Arenito
Basalto
Carvão
Tilitos
Rochas mais antigas
Estratigrafia
Jurássico
Triásico
Pérmico
Carbonífero superior
Carbonífero
Devónico
Paleontologia
Distribuição da flora de Glossopteris

GIMNOSPERMAS’ Grupo artificial

Carbonífero - Presente

Presença de estróbilos (“cones”)



Taylor *et al.*, 2009

CORDAITALES

Carbonífero - Permiano

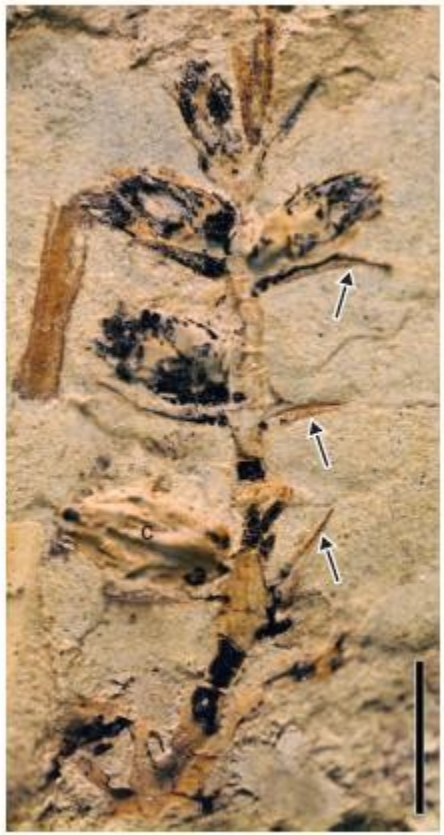


FIGURE 20.16 Compressed cordaitean strobilus showing several secondary fertile shoots (C) along the primary cone axis. Note conspicuous bracts (arrows) (Pennsylvanian). Bar = 5 mm.

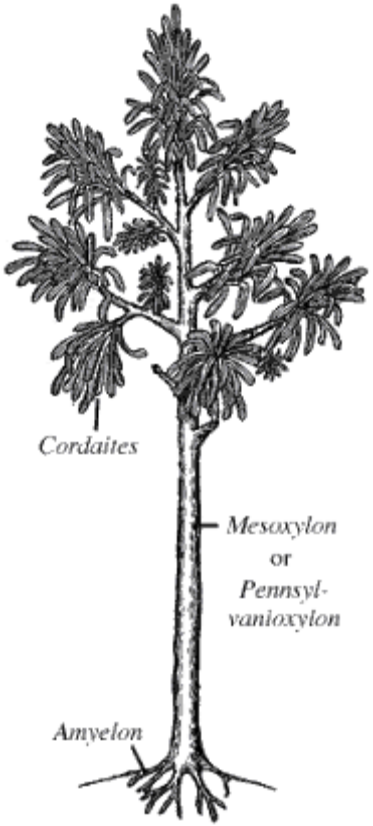


FIGURE 20.9 Cordaite branch tip with several leaves. (Pennsylvanian). Bar = 2 cm.

Ordem Cordaitales (extinta) – Carbonífero inferior ao Permiano

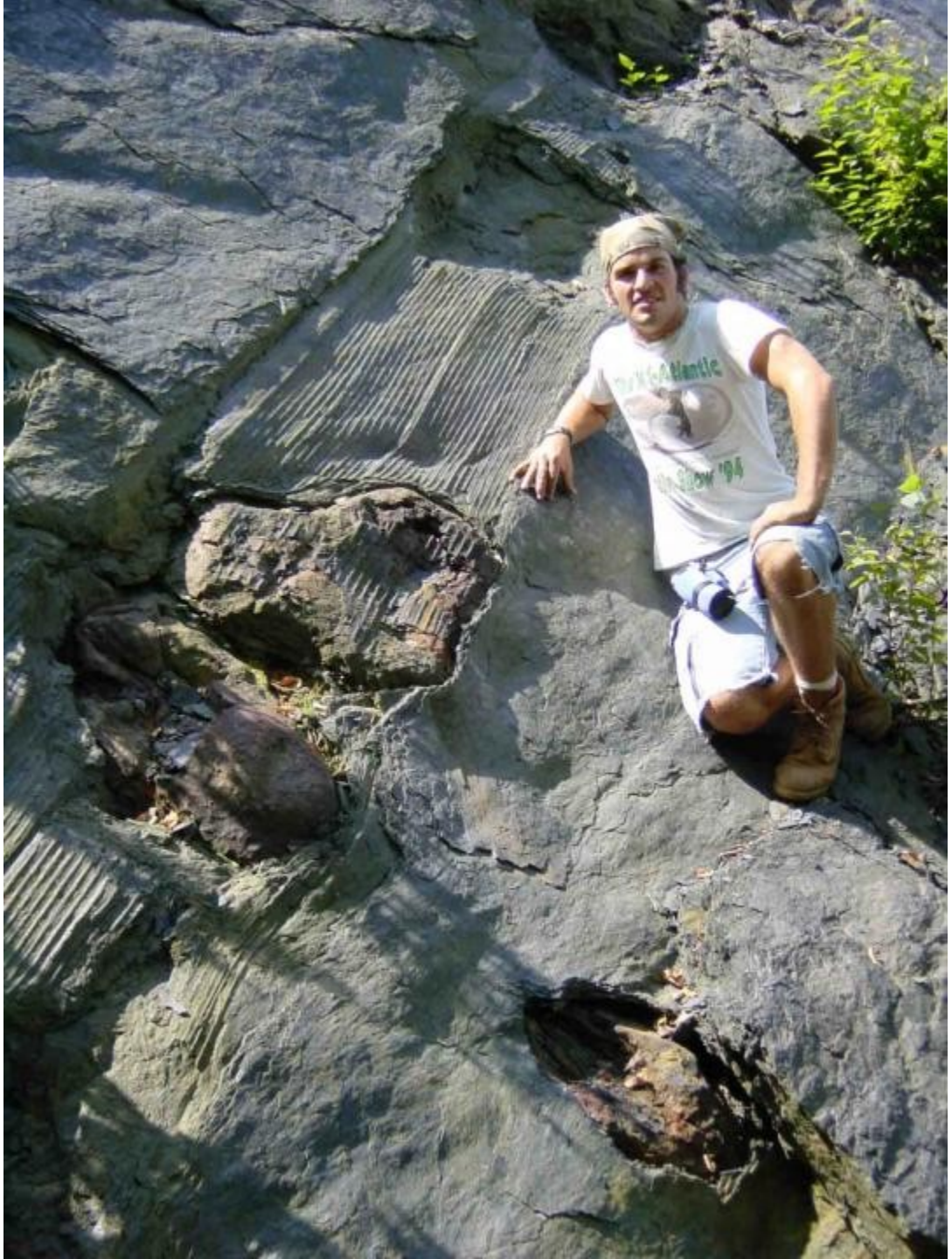
Gênero: *Cordaites*

mangues, pântanos





Molde de tronco de *Cordaites* em afloramento



Cordaites





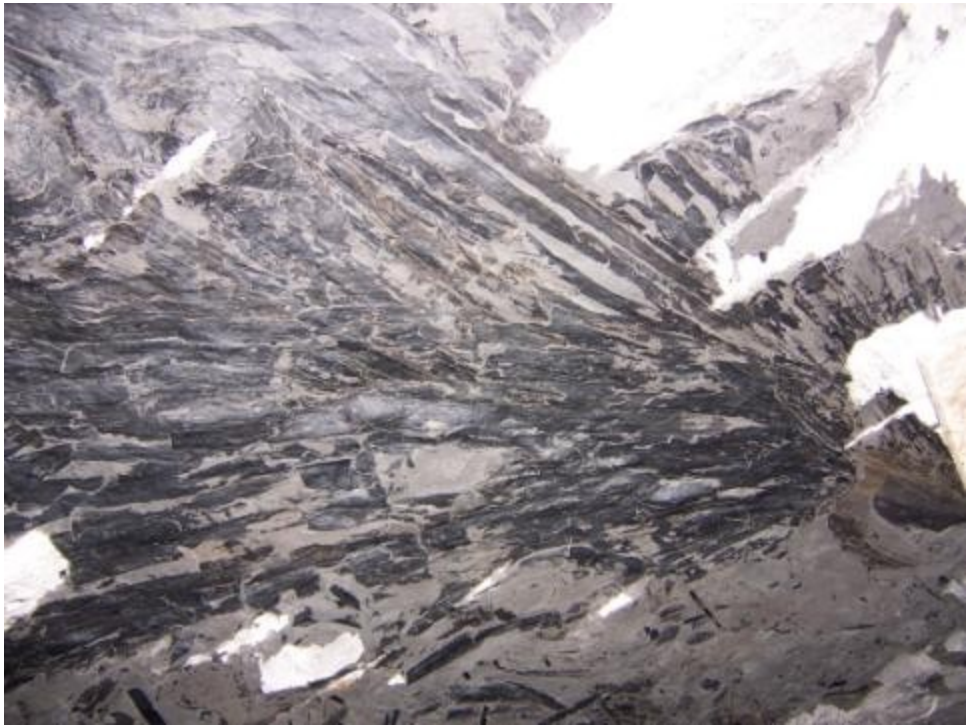




FIGURE 20.18 Longitudinal section of *Cordaitanthus concinnus* pollen cone. Arrows indicate pollen sacs (Pennsylvanian). Bar = 2 mm.

Cordaitales

Estróbilo masculino com sacos polínicos

Flora do Carbonífero



GIMNOSPERMAS”

GINKGOPHYTA

Carbonífero - Recente

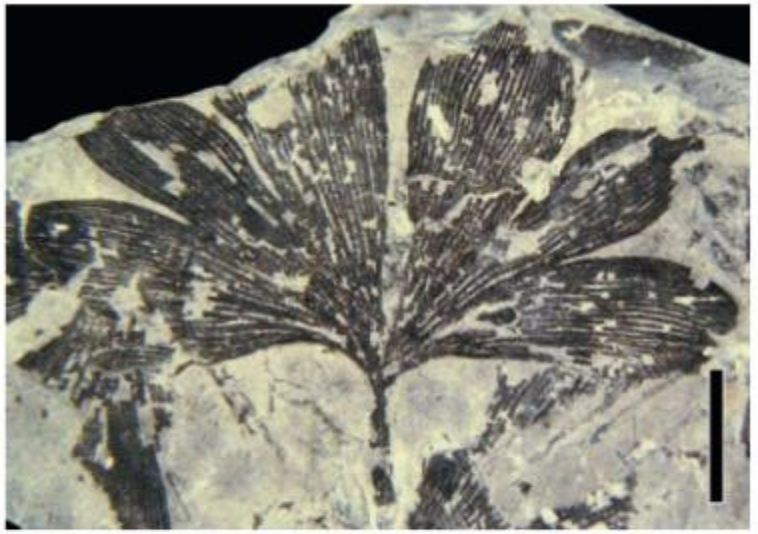
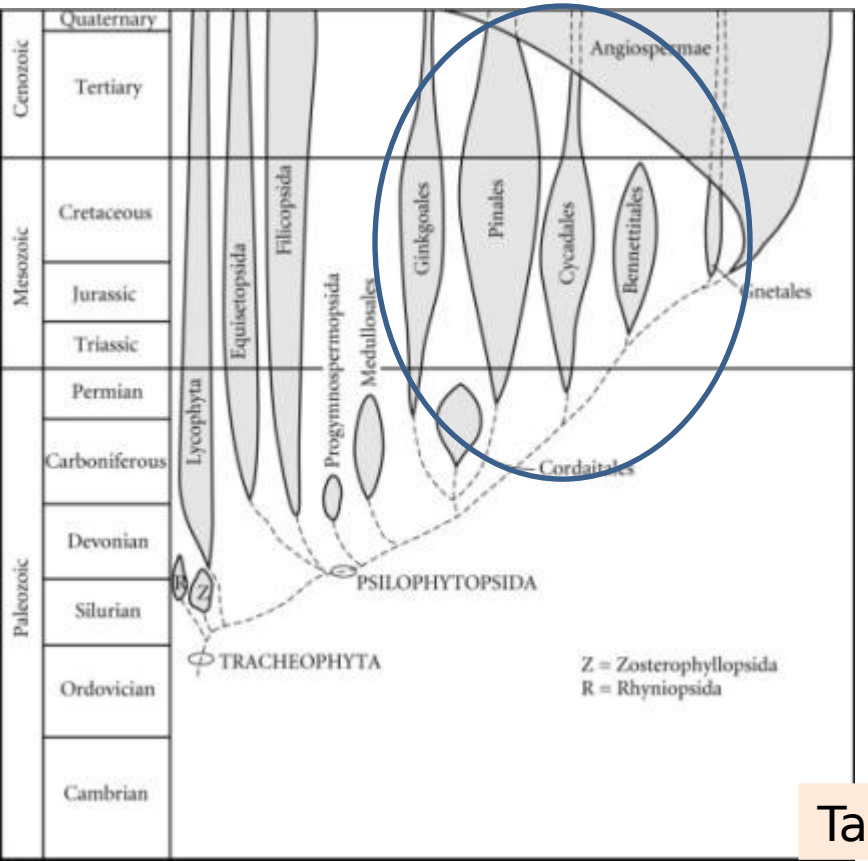


FIGURE 18.12 *Ginkgo* sp. leaf (Cretaceous). Bar = 1 cm. (Courtesy J. Watson.)



Taylor *et al.*, 2009



FIGURE 18.10 *Ginkgoites tigrensis* showing basal venation (Cretaceous). Bar = 1 cm.

GIMNOSPERMAS”

CONÍFERAS

Carbonífero - Recente

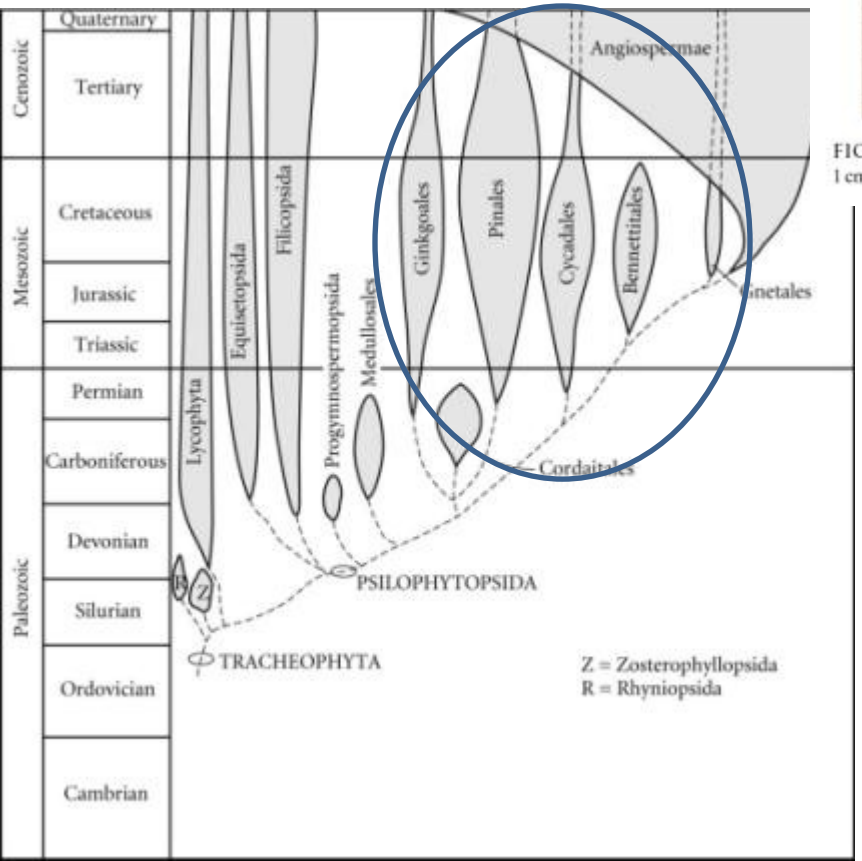




FIGURE 21.42 *Swedenborgia* sp. seed cone (Triassic). Bar = 1 cm. (Courtesy K.-P. Kelber.)



FIGURE 21.31 *Pseudovoltzia liebeana* leafy branch (Permian). Bar = 1 cm. (Courtesy H. Kerp.)

Taylor *et al*., 2009

GIMNOSPERMAS”

GNETALES



FIGURE 19.44 *Welwitschia*-type pollen grain associated with *Drewria* (Cretaceous). Bar = 15 μm. (Courtesy G. R. Upchurch.)

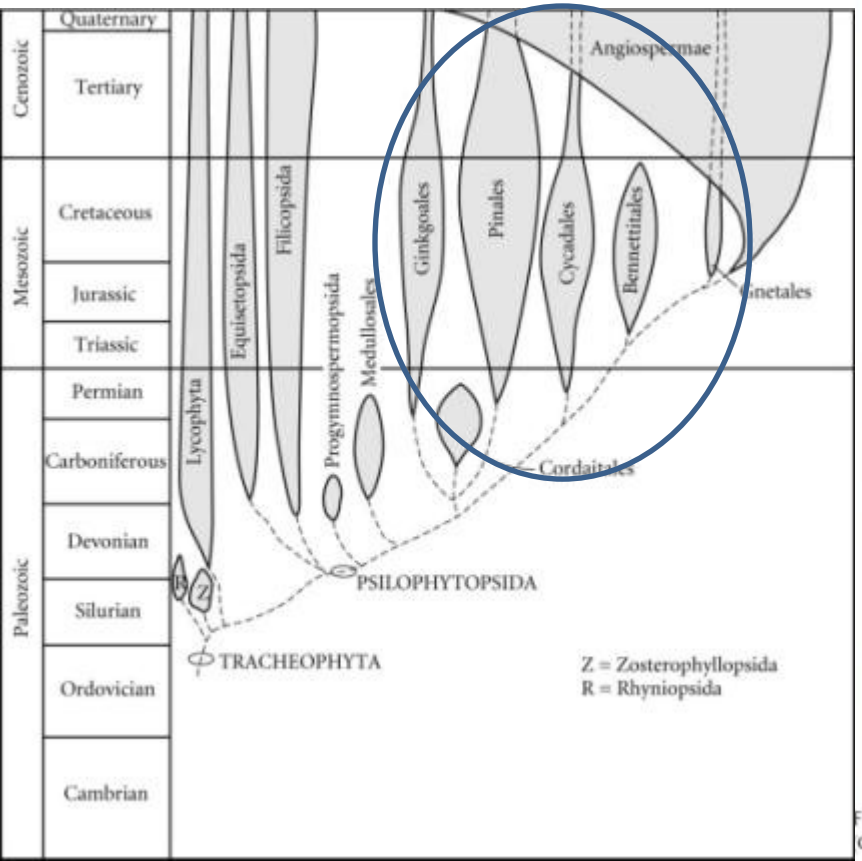




FIGURE 19.47 Several cones of *Welwitschiostrobus murilii* (Cretaceous). Bar = 5 mm. (Courtesy D. L. Dilcher and T. A. Lott.)

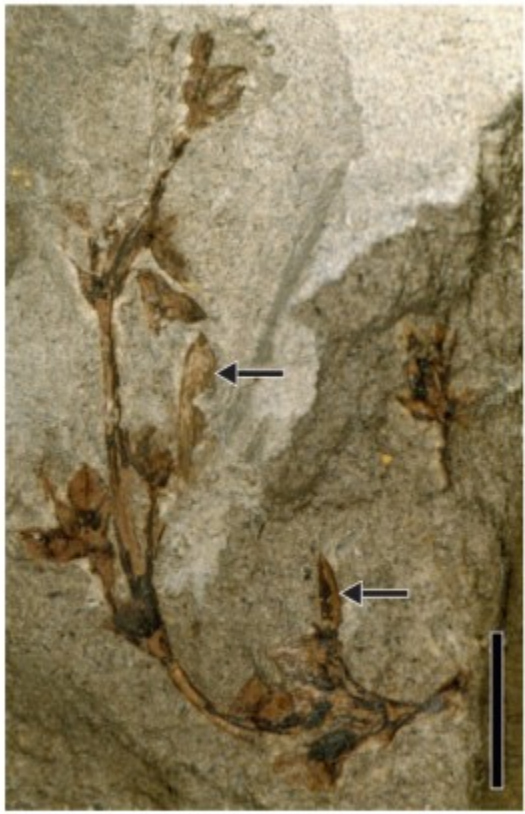
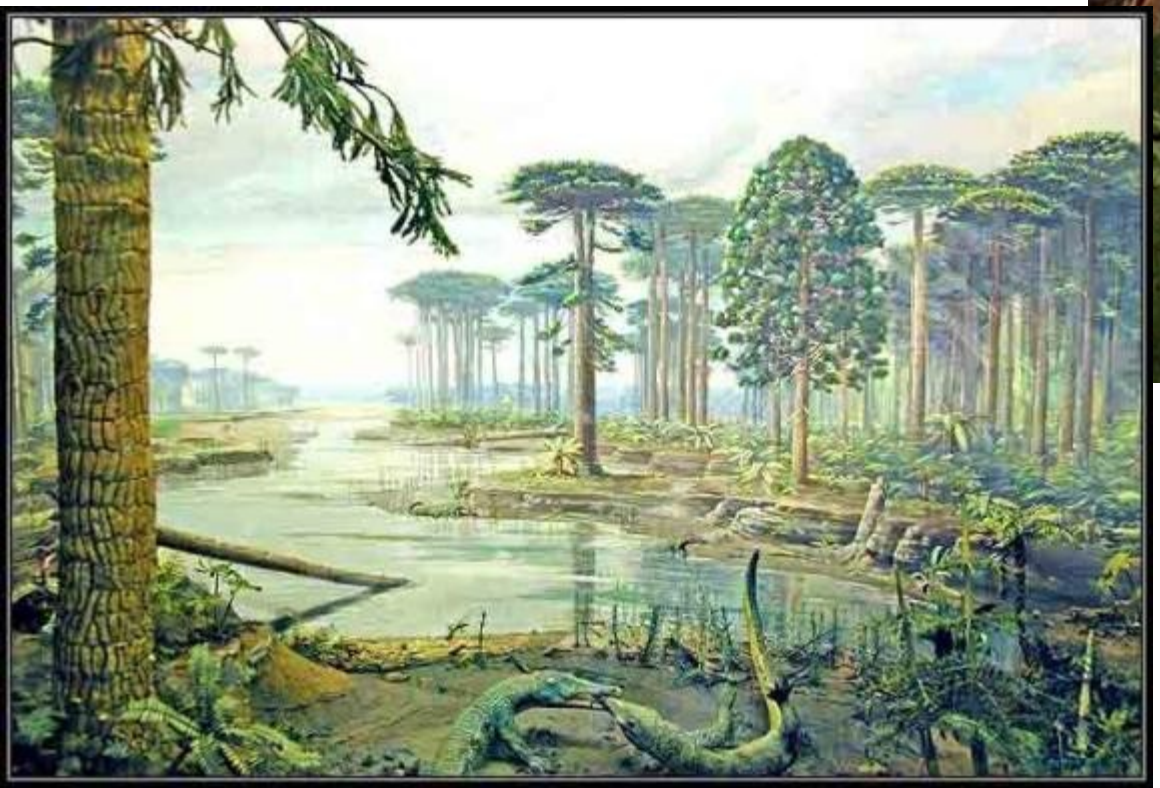


FIGURE 19.40 *Drewria potomacensis* showing vegeta leaves (arrow) and axillary reproductive shoots (Cretaceo Bar = 3 mm. (Courtesy G. R. Upchurch.)

Taylor *et al*., 200

Flora do Permiano - Triássico





ENTÃO:

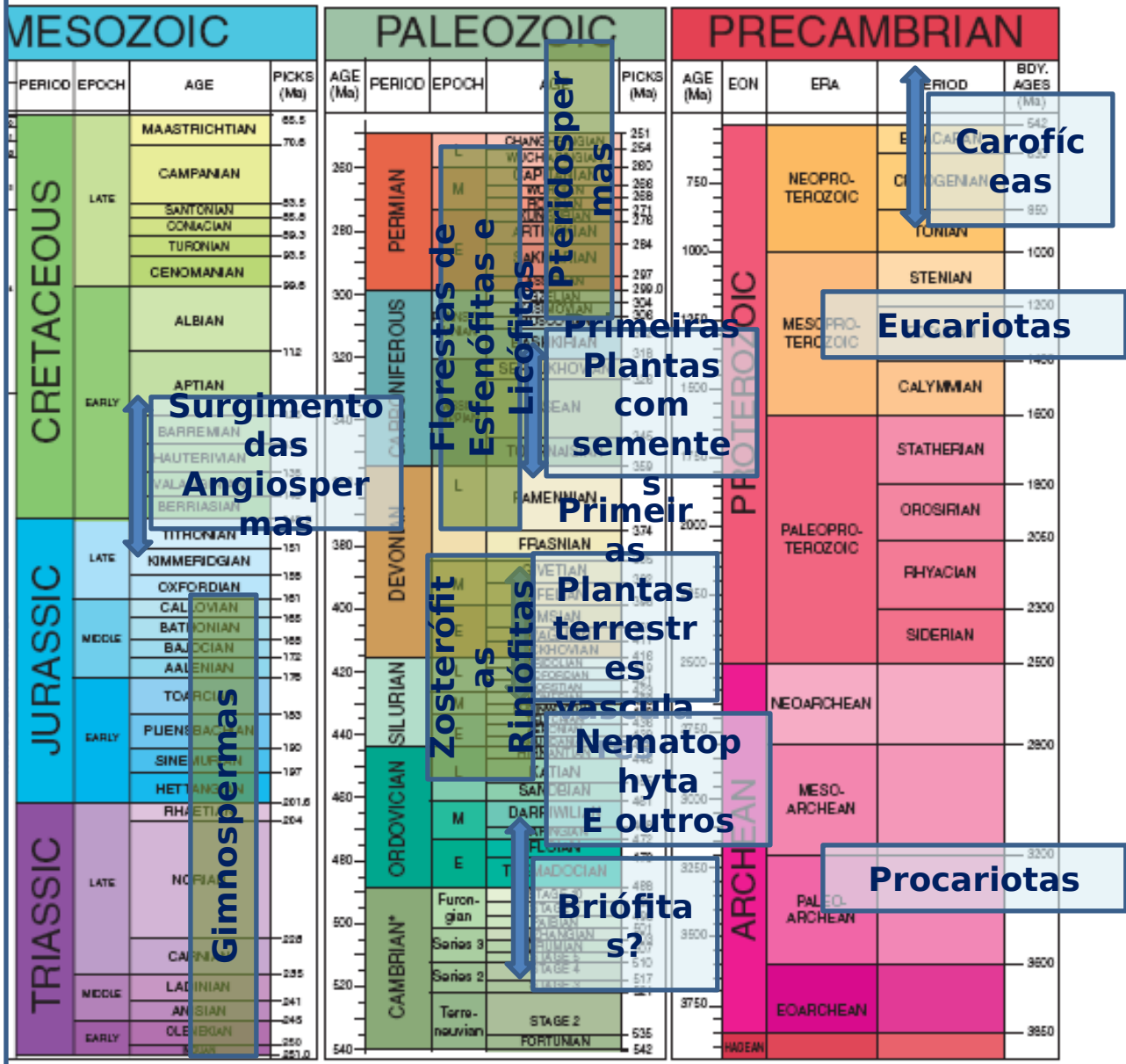
Pré-Cambriano - Surgimento das algas verdes

Cambriano / Ordoviciano - Surgimento das primeiras plantas terrestres (não-vasculares) – algumas provavelmente associadas as briófitas atuais.

Registro fóssil: criptoesporos, esporos, fósseis de nematófitas e outros.

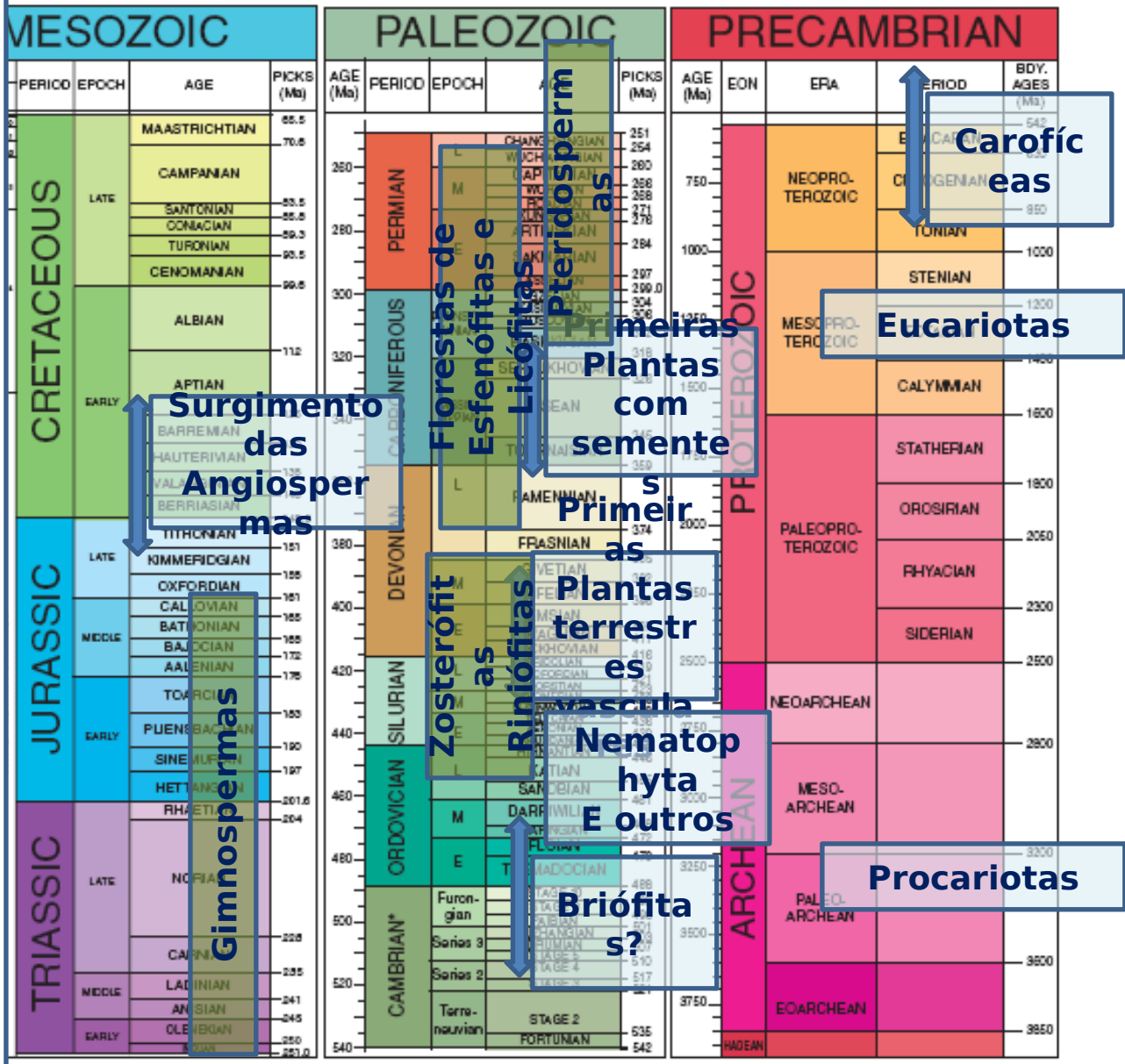
Características: gametas protegidos, embrião.

Ambiente de vida: próximo à água.



Ordoviciano / Siluriano – Surgimento das primeiras plantas terrestres vasculares.
Registro fóssil: Riniófitas e Zosterófitas.
Características: células de condução – xilema.
Ambiente de vida: próximo à agua.

Devoniano / Carbonífero – florestas de licófitas, esfenófitas e pteridófitas.
Registro fóssil: Lepidodendrales, Calamitales e outros. Depósitos de carvão.
Características: porte arbóreo, folhas



Carbonífero – Surgimento das primeiras plantas com semente.

Registro fóssil: Pteridospermas (Glossopteridales), Cordaitales. Grãos de pólen.

Características: sementes, traqueídes típicos.

Ambiente: terrestre, conquista de ambientes mais áridos.

Permiano / Jurássico – Florestas de Pteridospermas e Gimnospermas.

