

Paleontologia 2020 (Aula 8): *Terrestrialização*



"All the News
That's in the Record"

Devonian Times

Fourth E.

Fram Formation, Euramerica, Sunday, ~382 MYA



Tiktaalik, from the Nunavut Territory, Canada, has dazzled the scientific community and the world media.

"Fishapod" from the North!

Gaps in the fossil record are diminishing.

The dramatic discovery of [*Tiktaalik roseae*](#) has shed an impressive and informative transitional light between lobe-fin fishes and early tetrapods. This "fishapod", *Tiktaalik* is one of several recent

Red Hill: Late Devonian Window

While much attention has been shifted to Late Devonian investigations in the Canadian Arctic, Red Hill continues to provide an exceptional window onto the world of the first tetrapods. This Famennian locality hosts a diverse assemblage of tetrapods, lobe-fin fishes, other fishes, invertebrates and plants

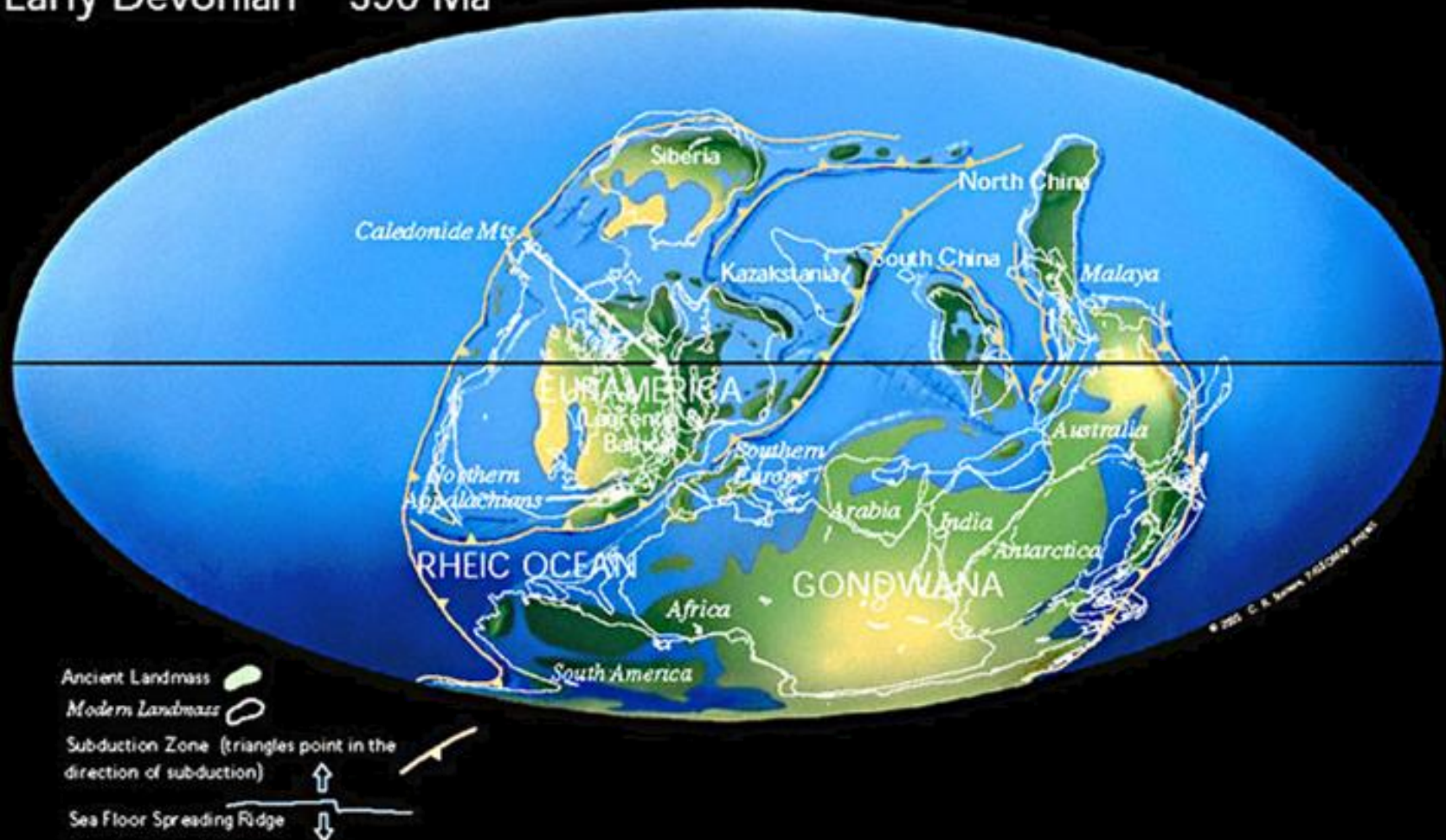
see [Who's Who at Red Hill](#)

Opportunity Knocked: Tetrapods Answered

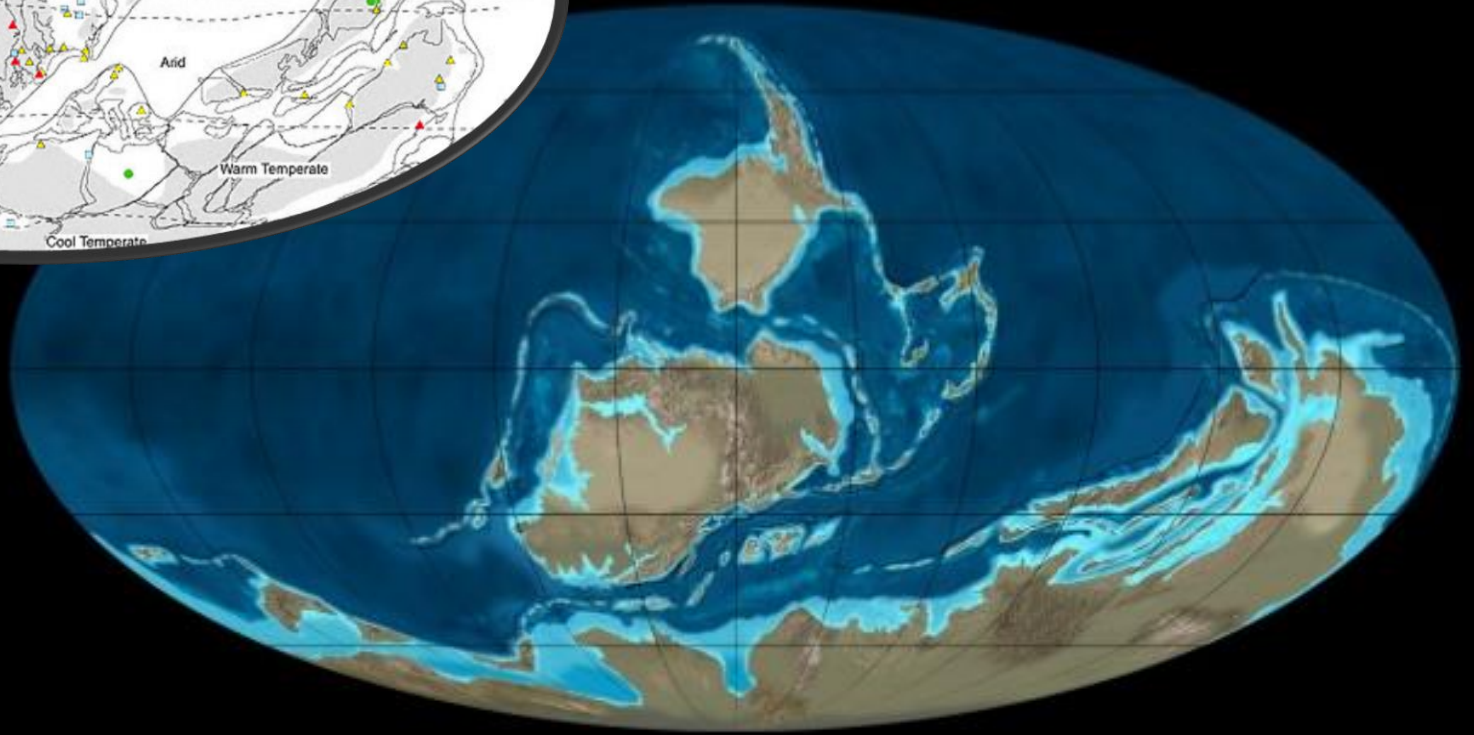
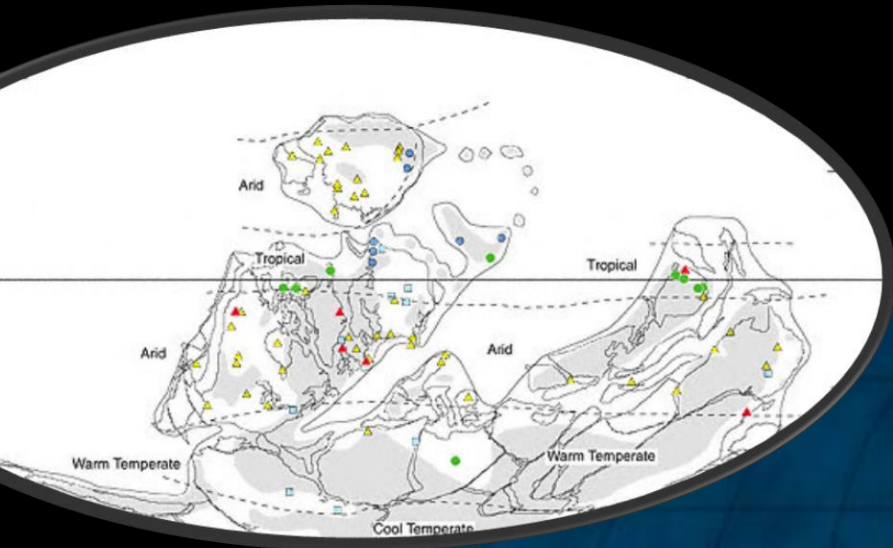
The Devonian Period (417-354 MYA) was a time of profound changes in terrestrial and aquatic ecosystems. These changes set the stage for the evolution of tetrapods and their expansion onto the land.

Devonian Times

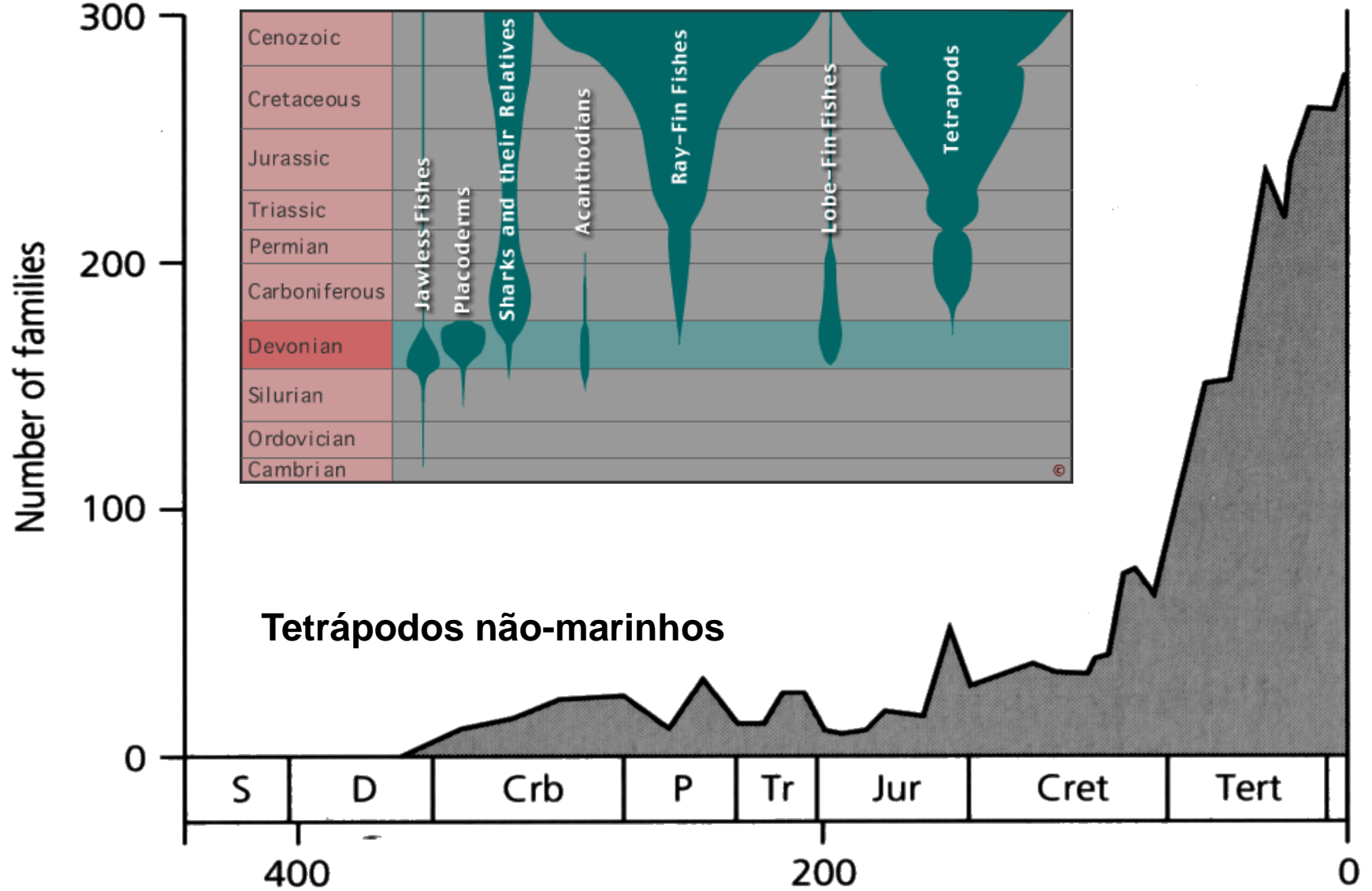
Early Devonian 390 Ma



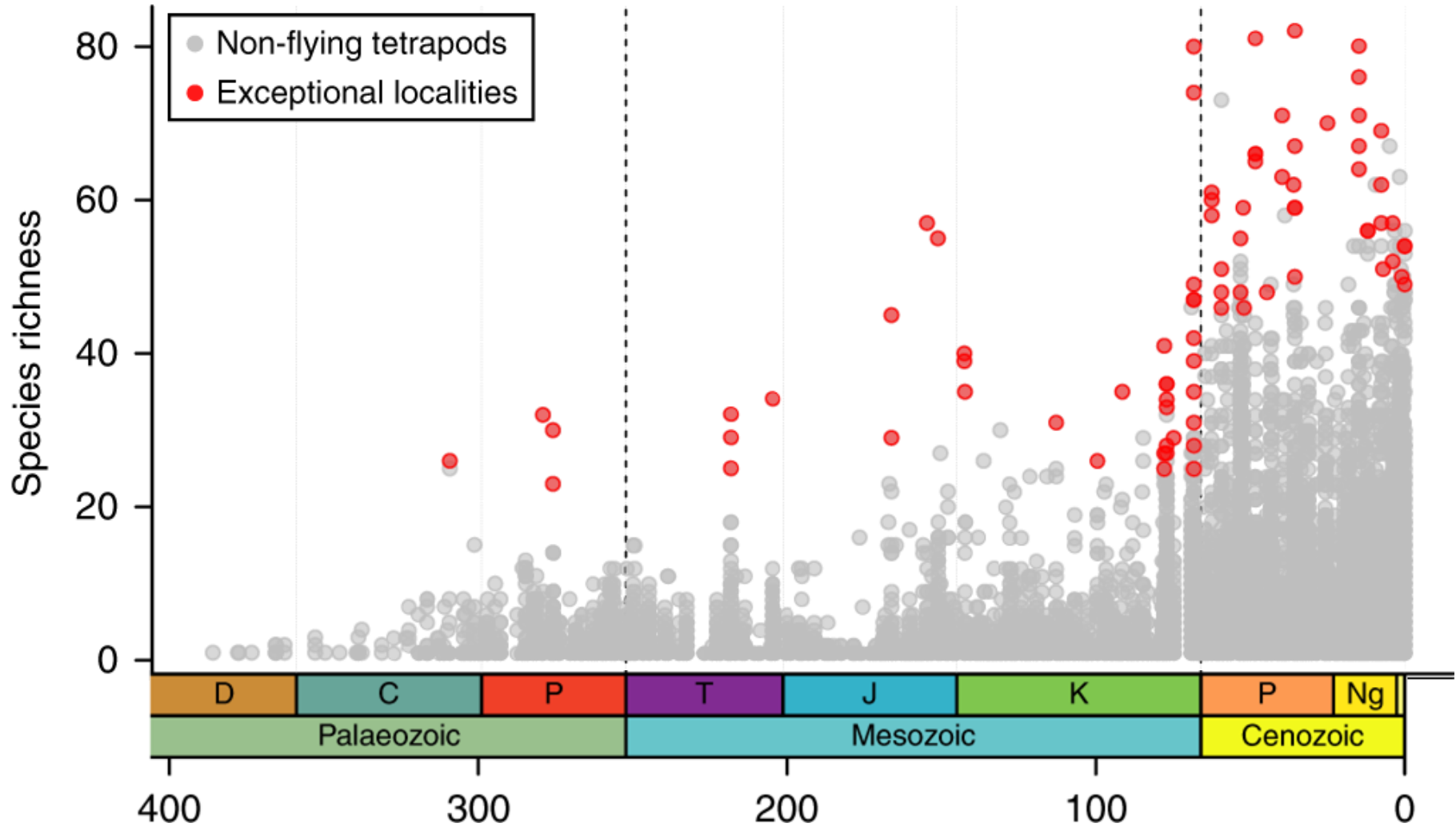
Devonian Times



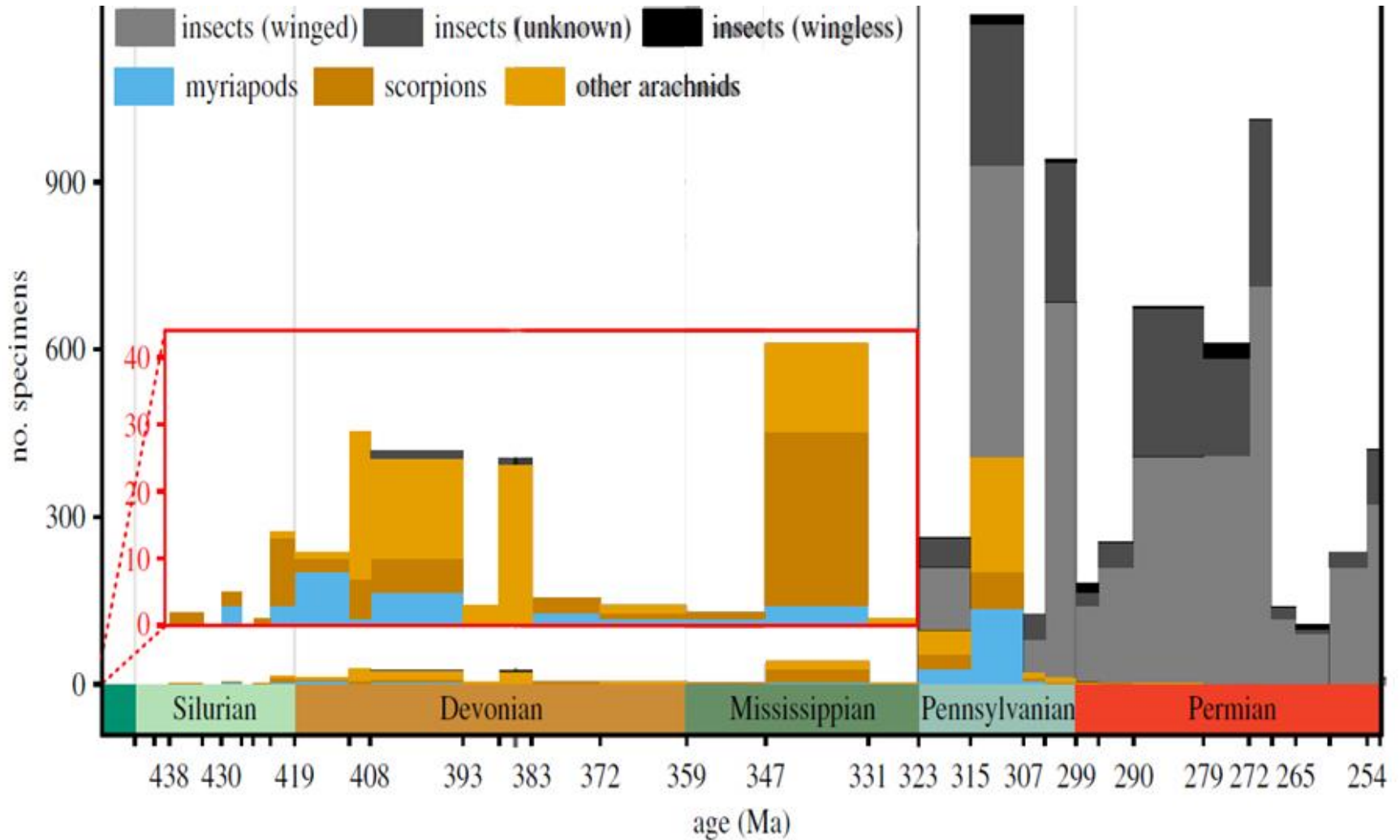
Vertebrados: tetrápodos



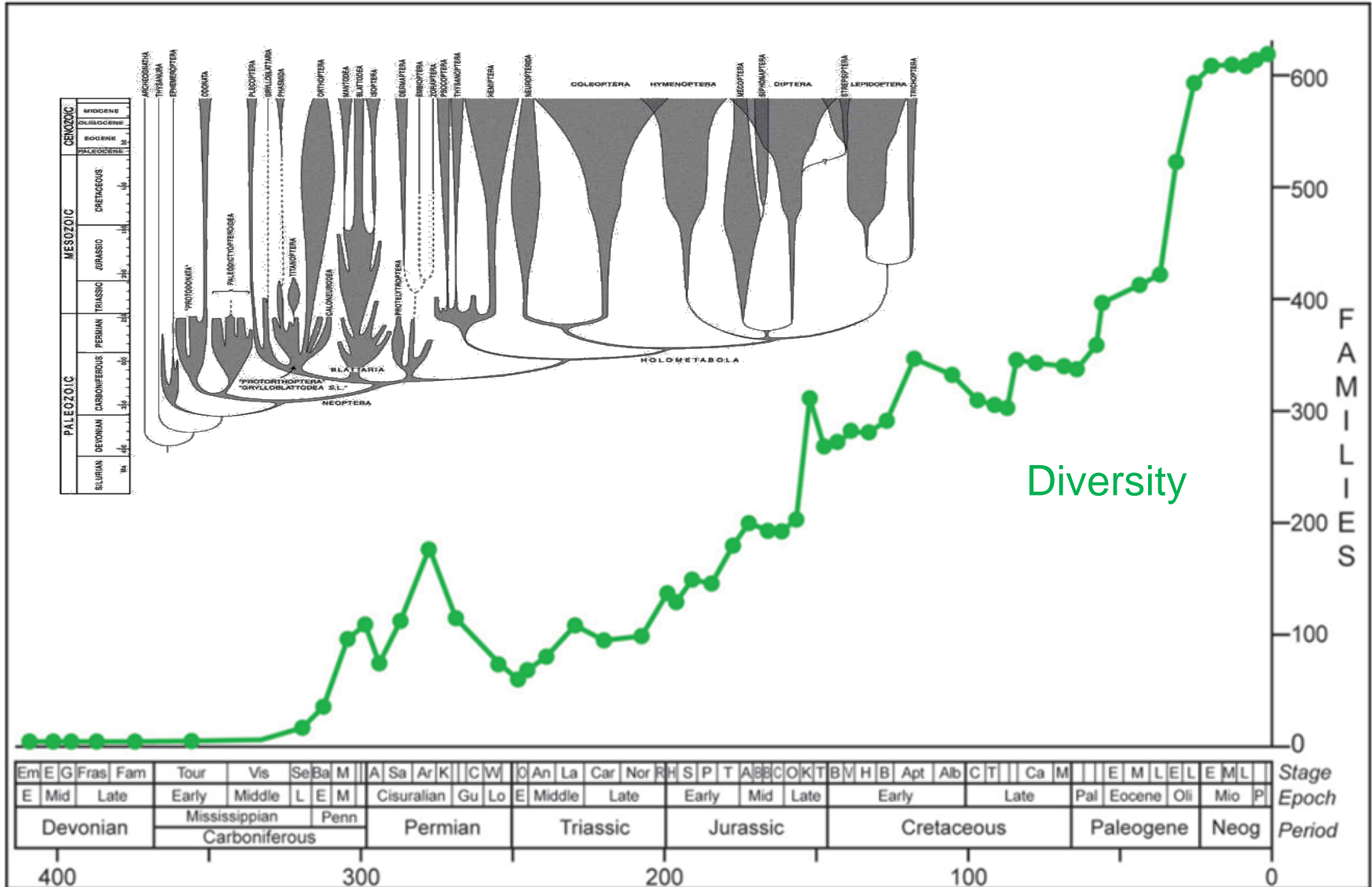
Vertebrados: tetrápodos



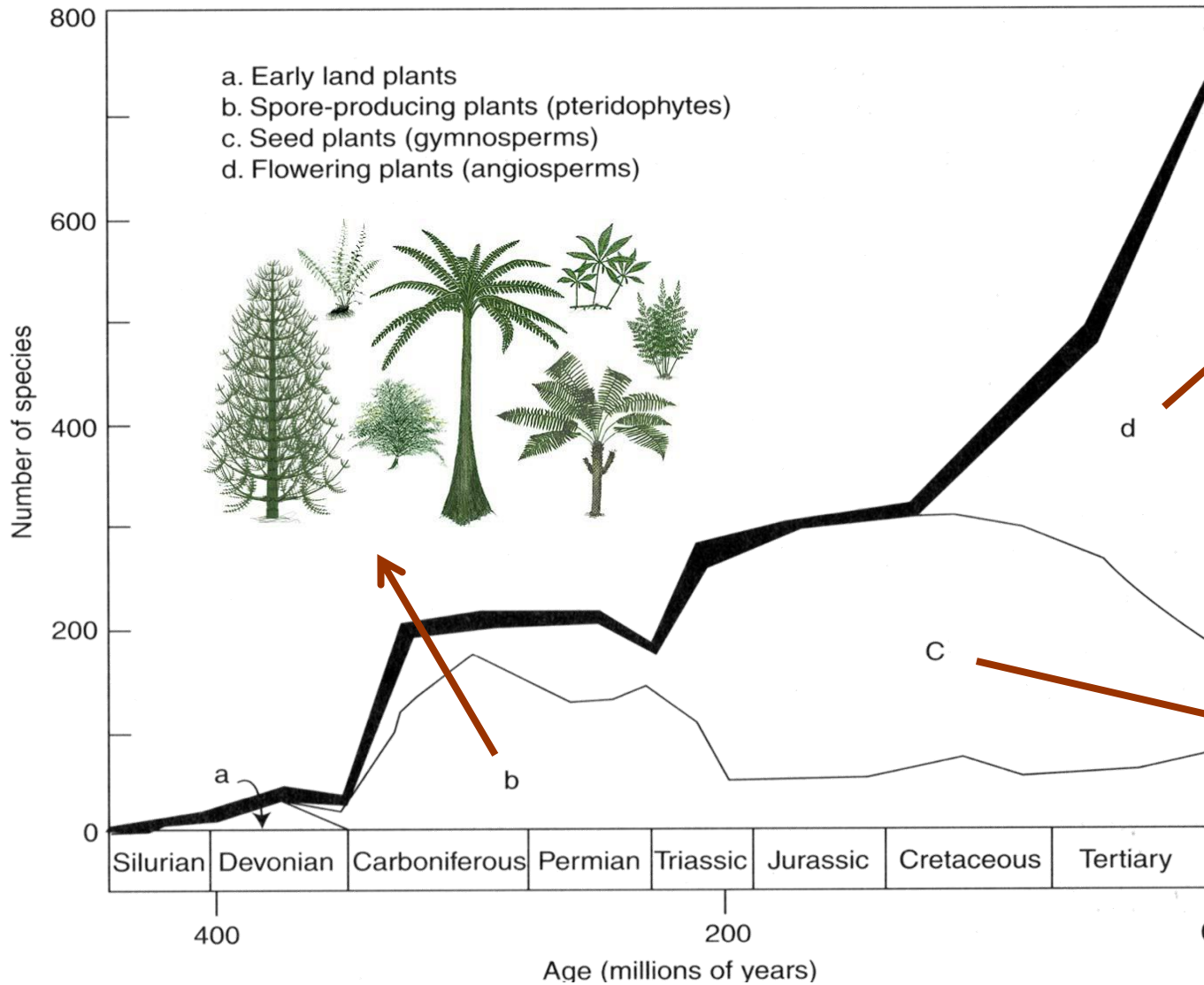
Artrópodes: miriápodes, insetos e aracnídeos



Artrópodes: insetos

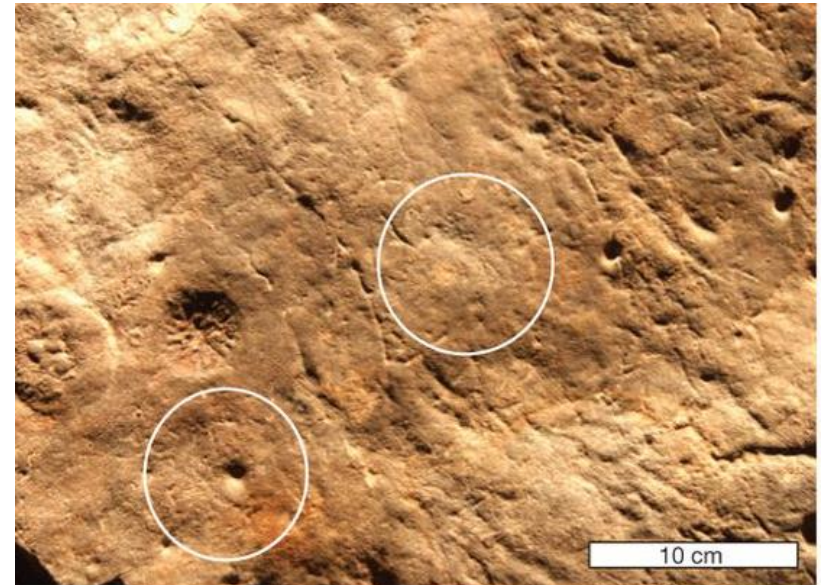
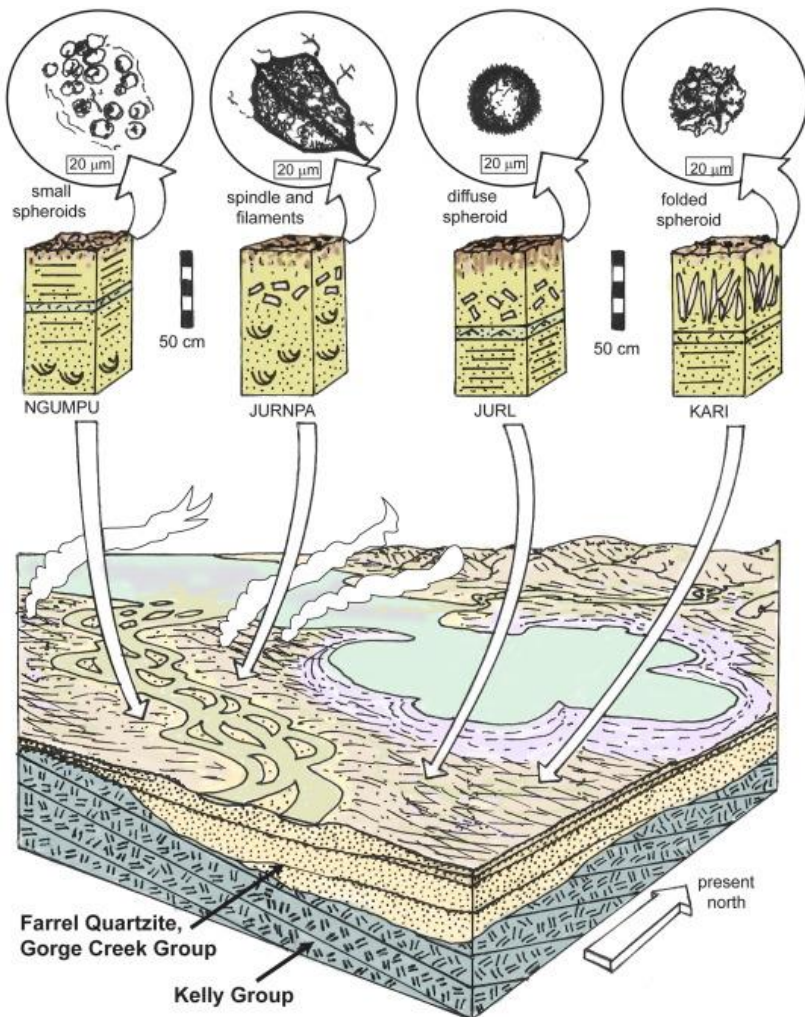


Plantas: traqueófitas



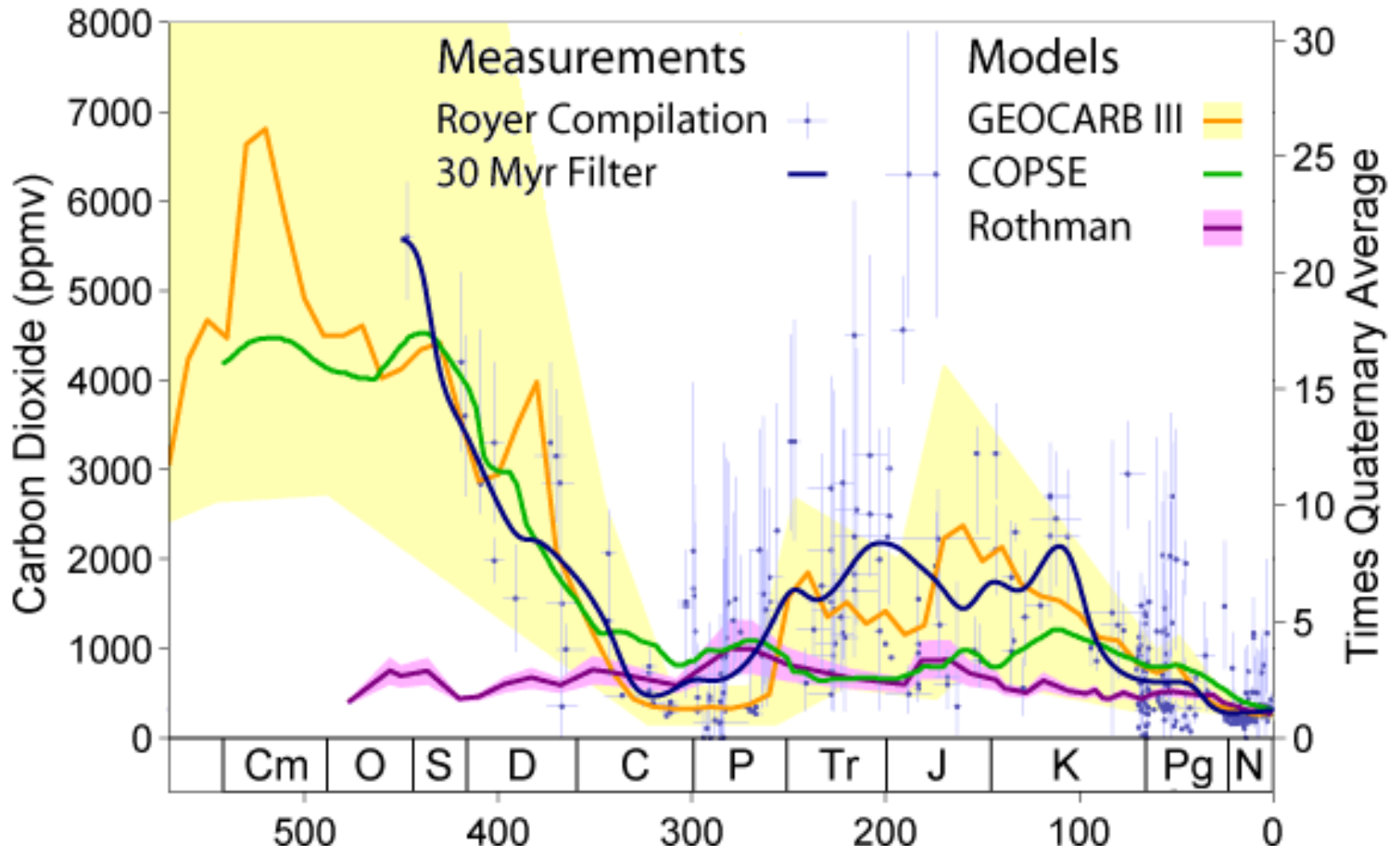
Solos pré-devonianos

Cianobactérias (paleosolos ricos em carbono) e líquens
 CO_2 atmosférico => chuva ácida



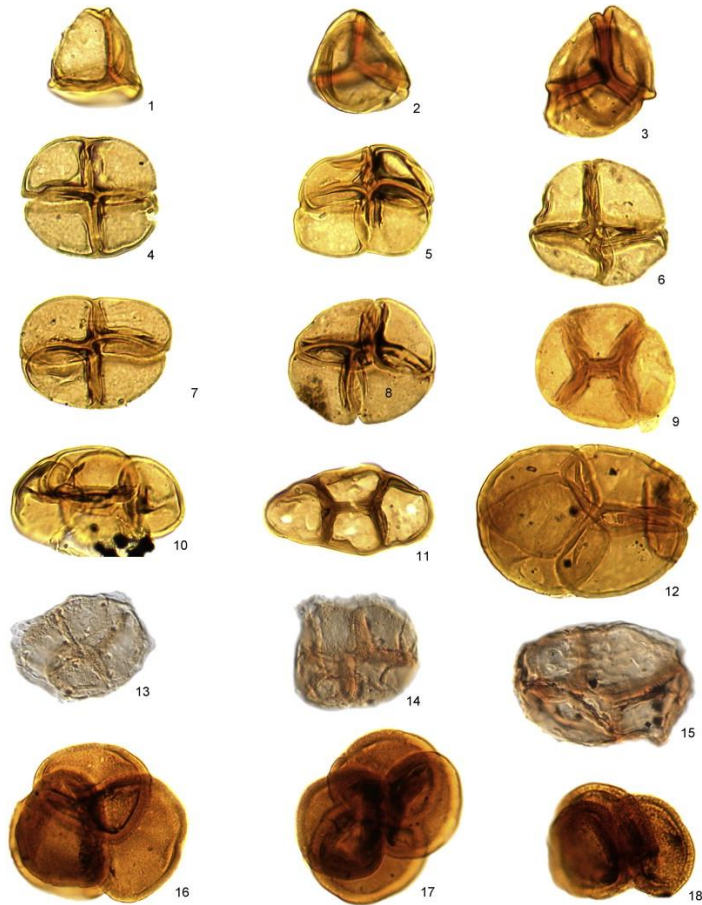
Solos pré-devonianos

CO₂ atmosférico => chuva ácida



Plantas pré-devonianas

Ordoviciano: esporomorfos e cutículas de plantas possivelmente aptas à vida Terrestre, bem como de “briófitas”



Nematothallus, EUA

Plantas pré-devonianas

Ordoviciano: esporomorfos

Fase vegetative esporifítica => Tracheophyta



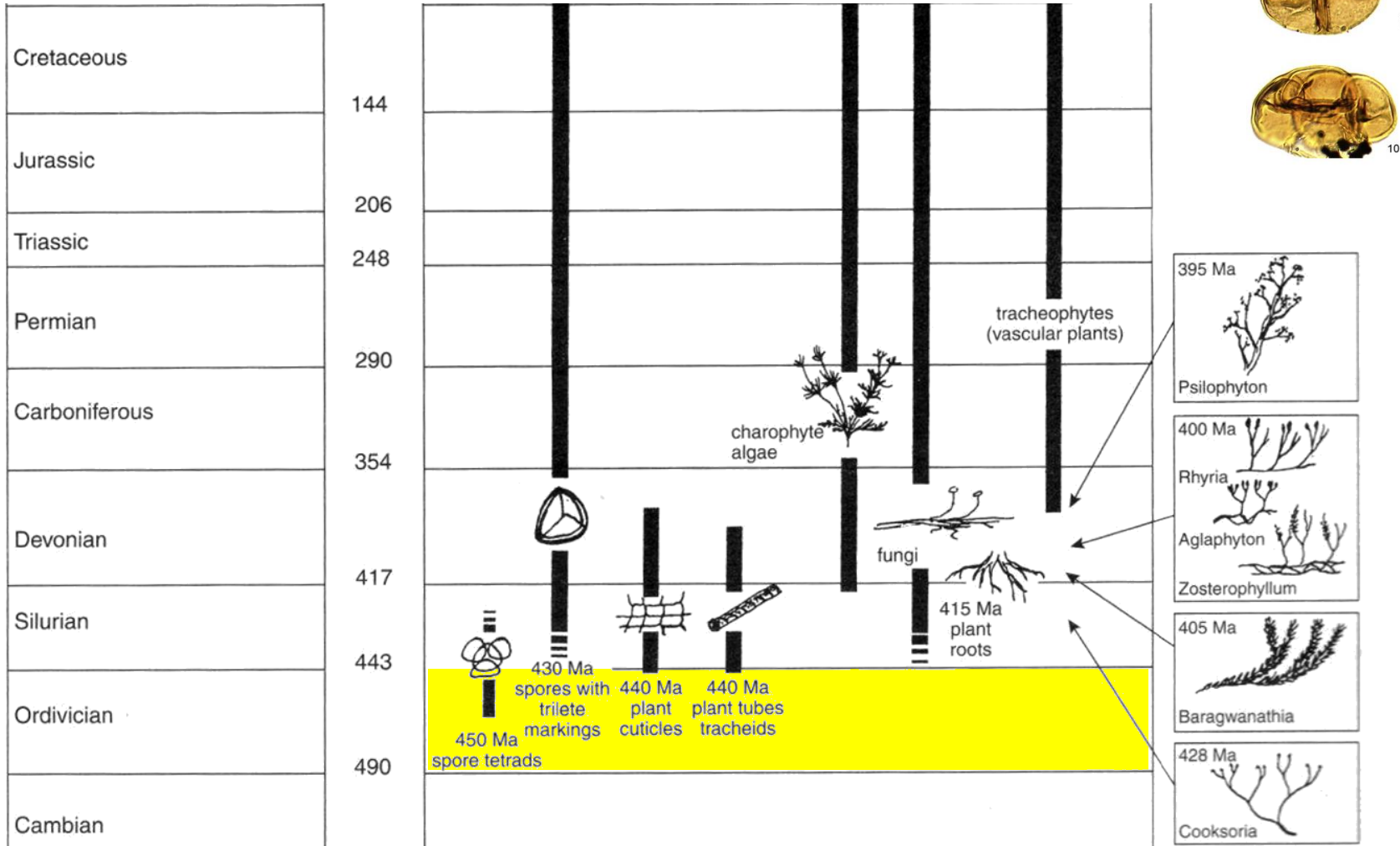
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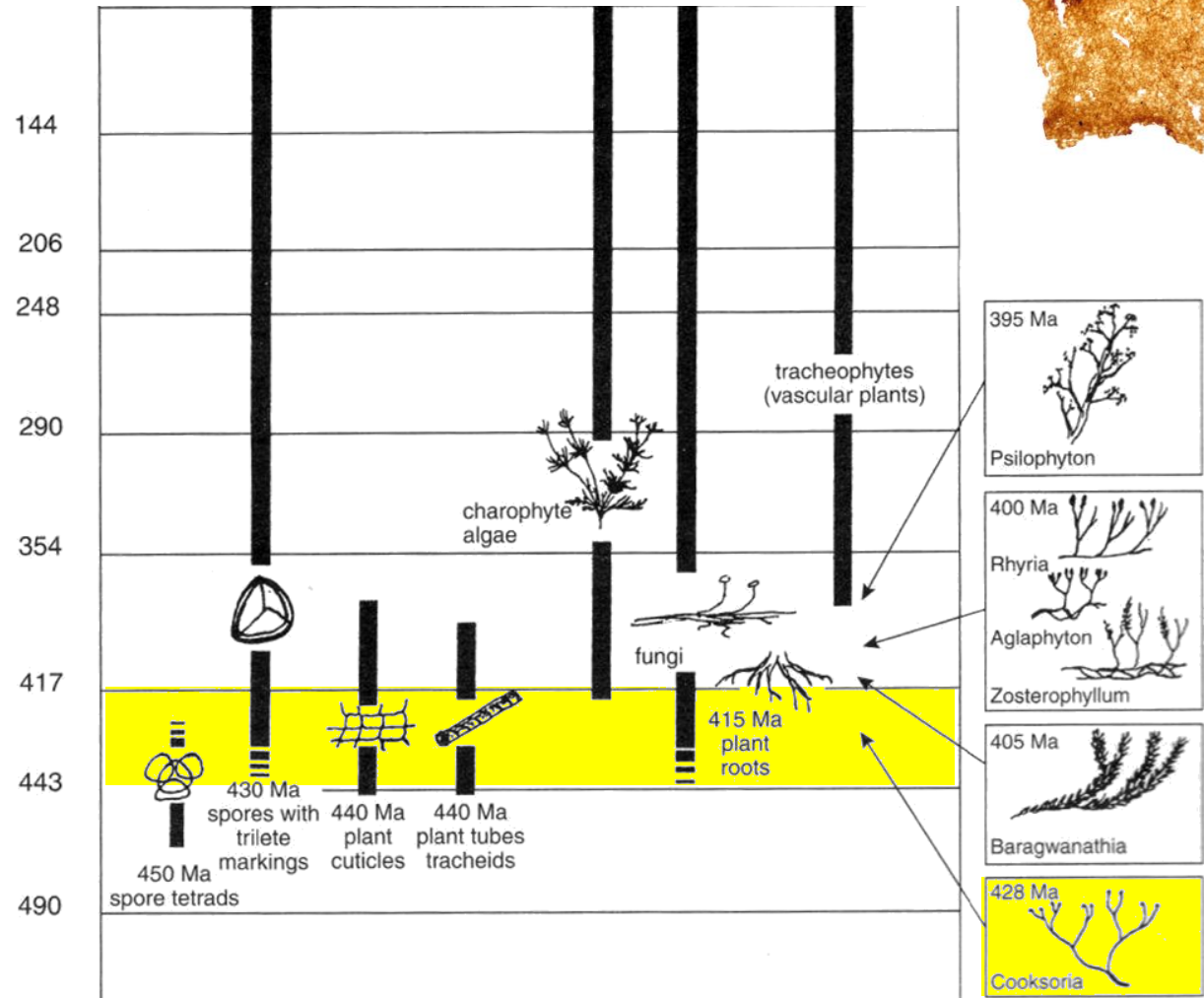
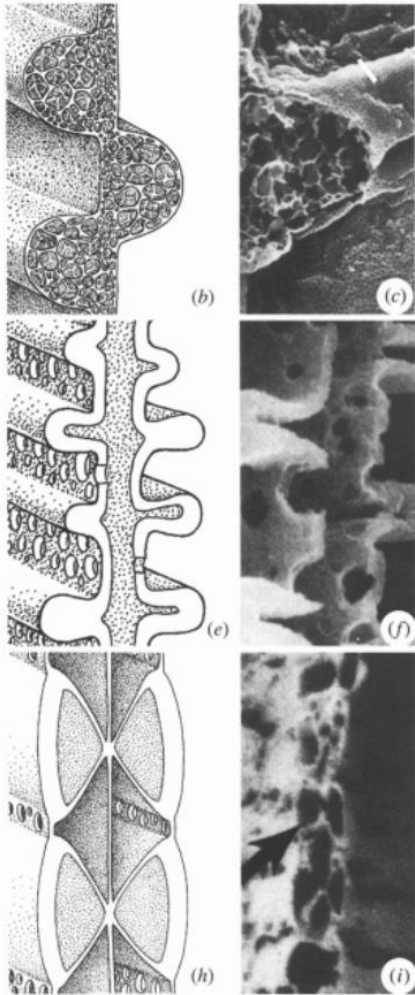


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Plantas pré-devonianas

Siluriano: traqueídeos e mais cutículas
Suporte, retenção e transporte de água



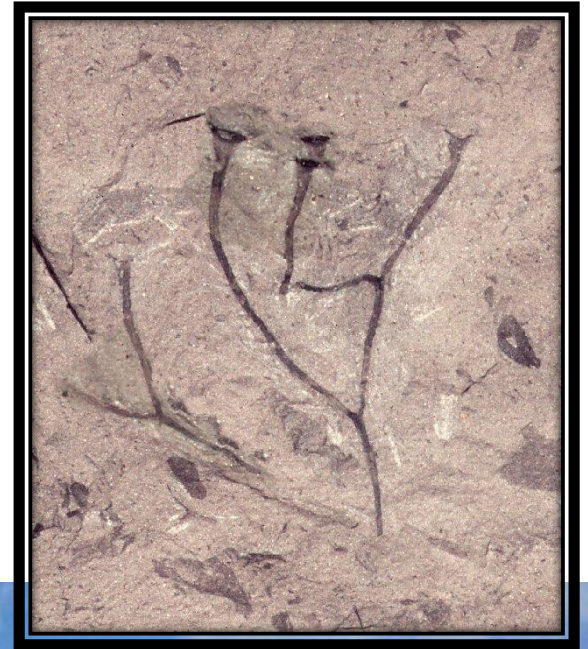
Plantas pré-devonianas

Siluriano: “rhyniofitódes” como *Cooksonia*



Plantas pré-devonianas

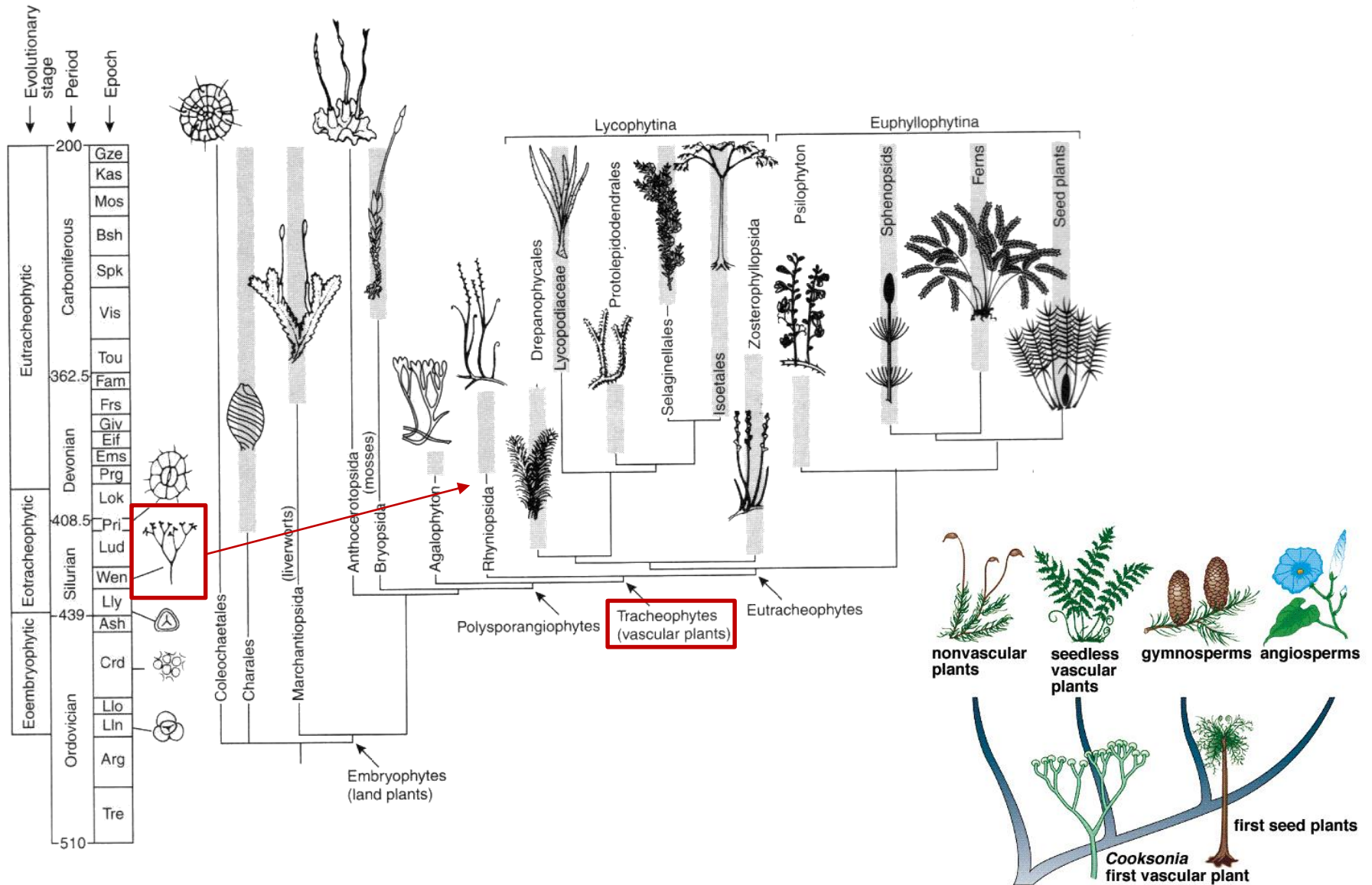
Siluriano: “rhyniofitódes” como *Cooksonia*



Devil's Bid Mountain, Irlanda

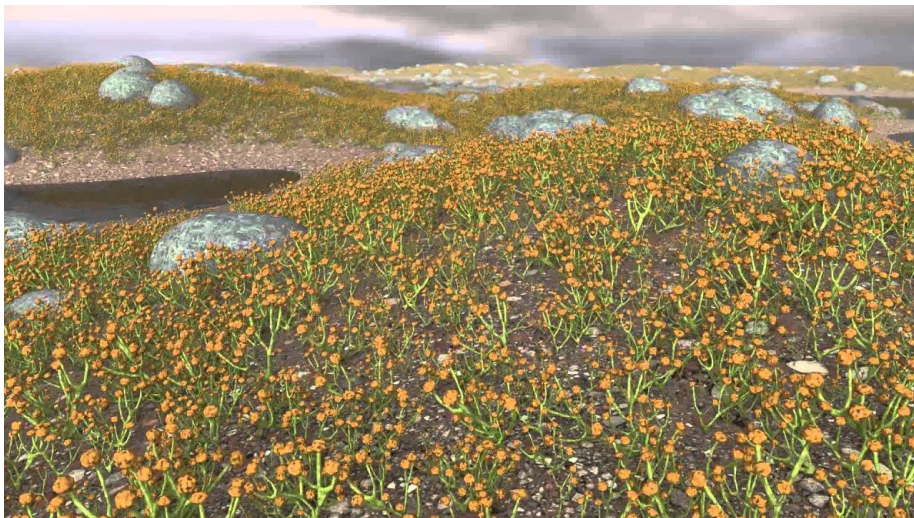
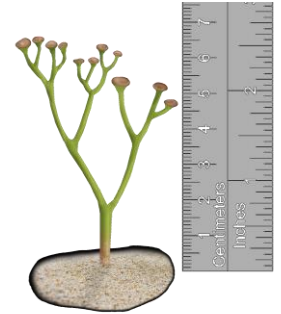
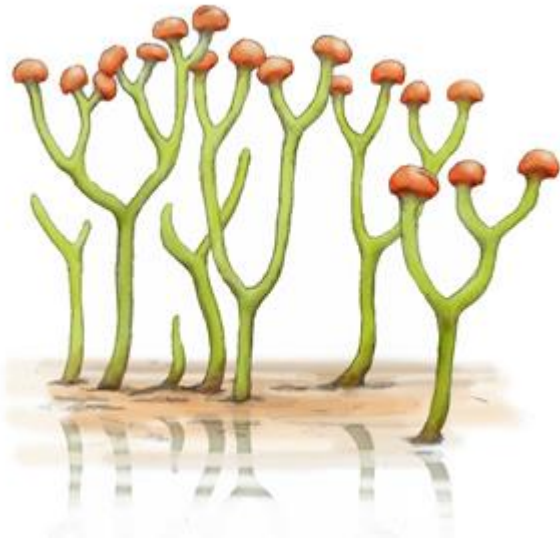
Plantas pré-devonianas

Siluriano: “rhyniofitódes” como *Cooksonia*



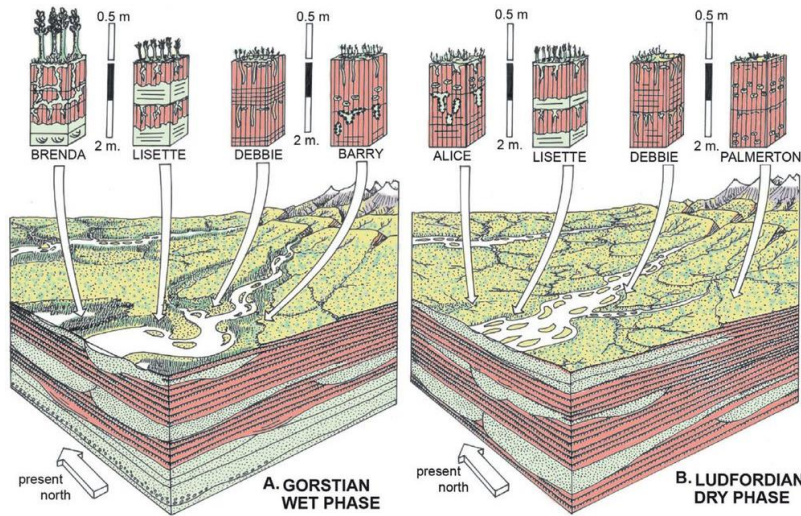
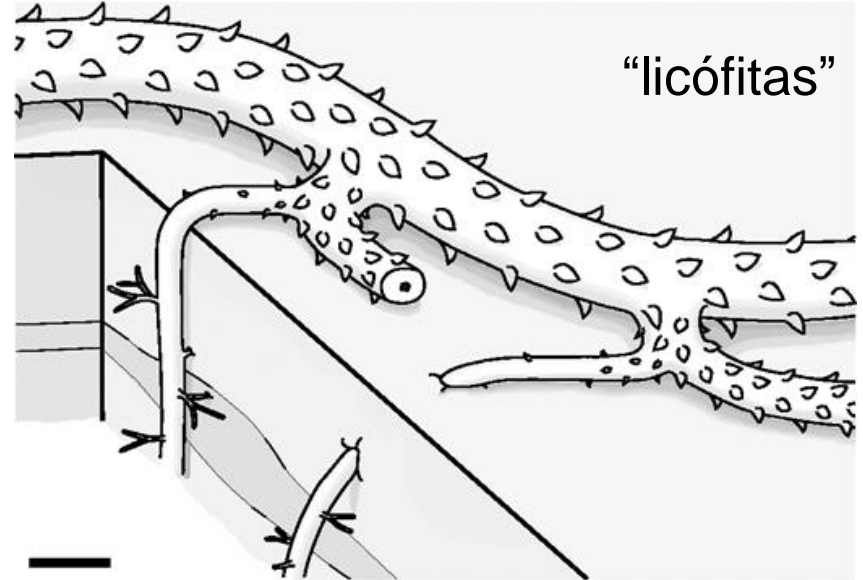
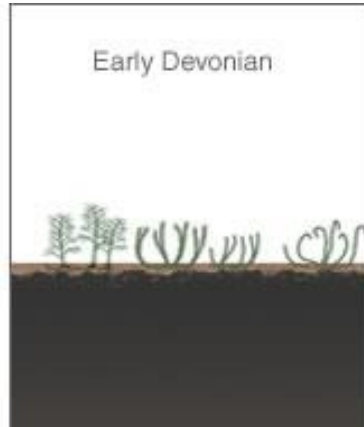
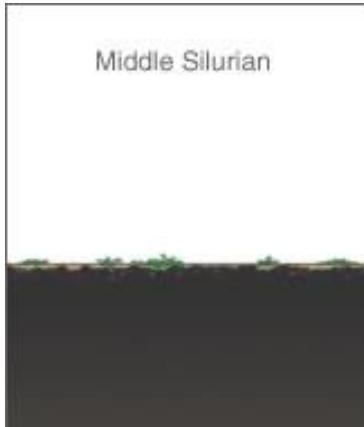
Plantas pré-devonianas

Cooksonia: ramos verticalizados simples bifurcantes e isonômicos
esporângios apical globular ou discóide



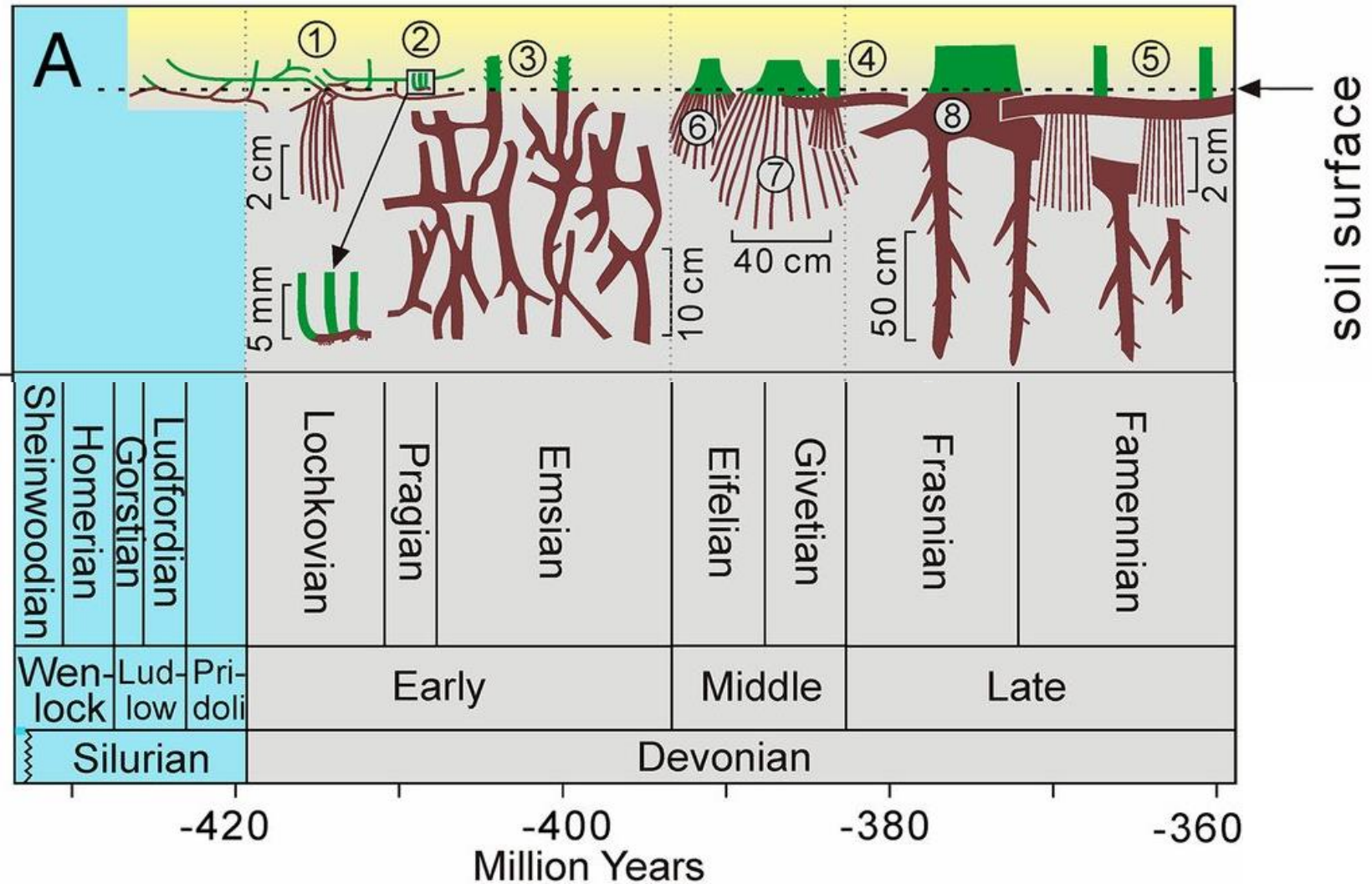
Plantas pré-devonianas

Siluriano: primeiras evidências de raízes (EUA)



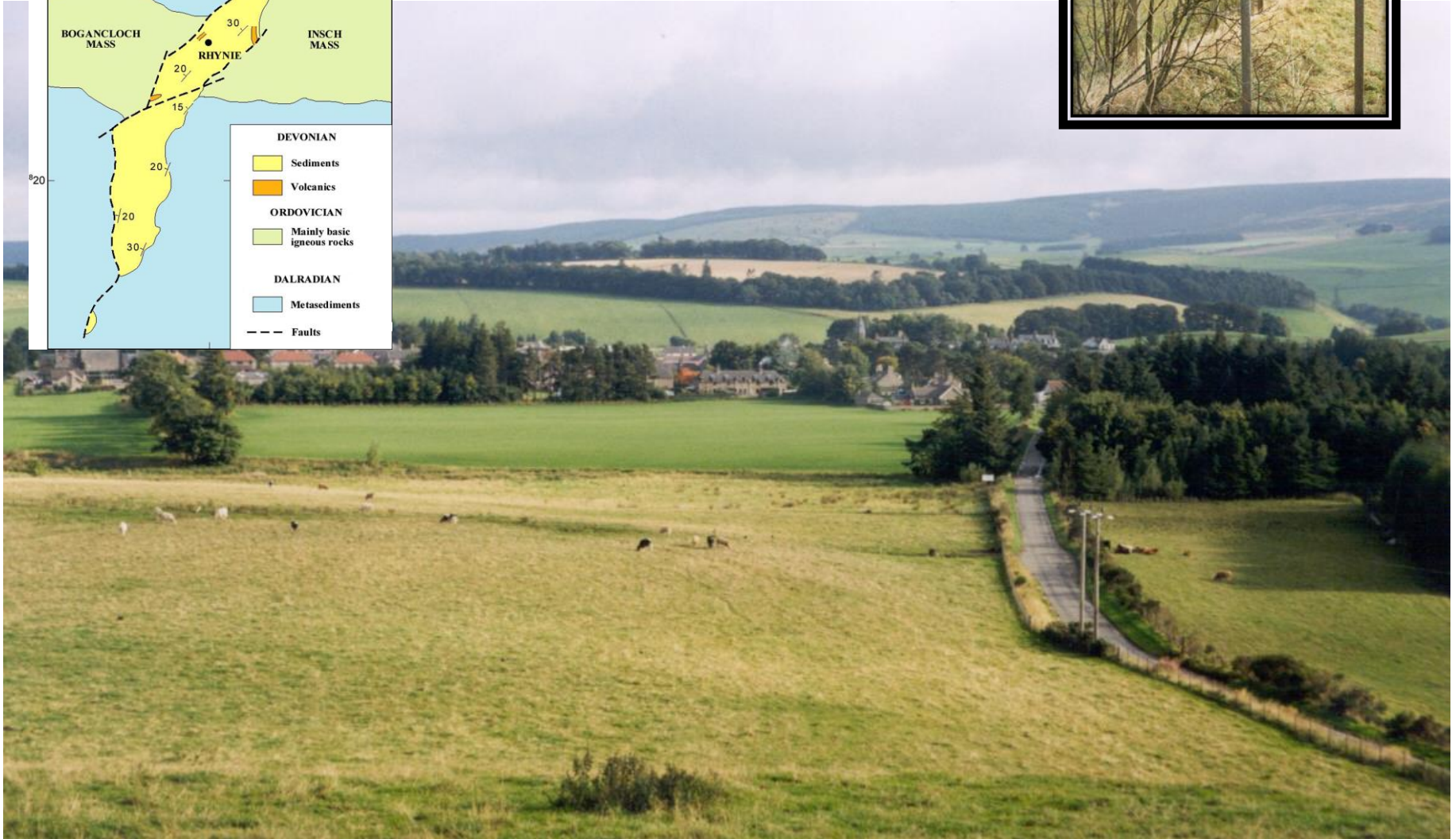
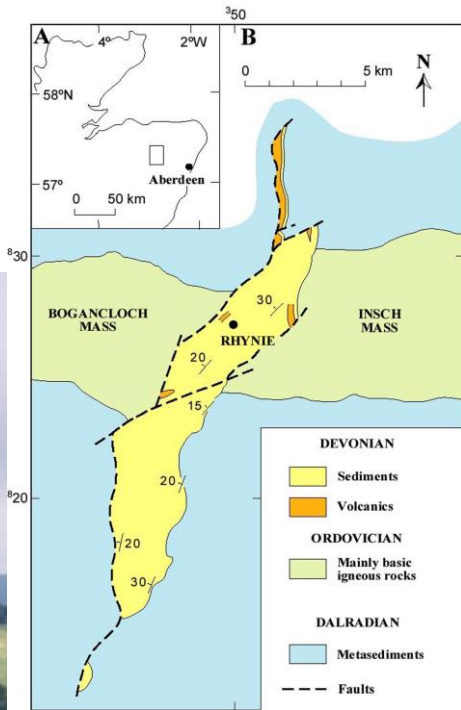
A revolução devoniana

Raízes e solos



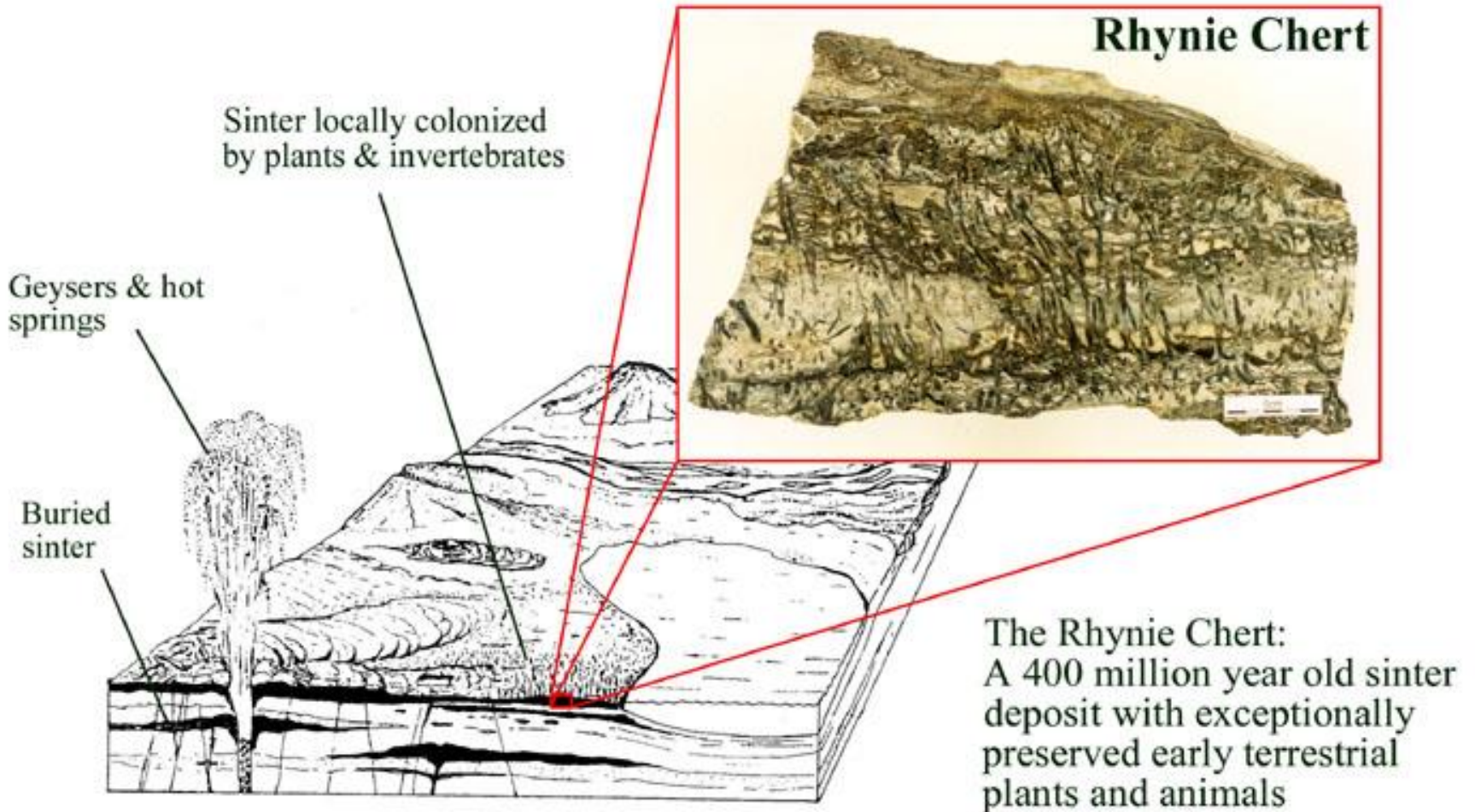
A revolução devoniana

Rhynie Chert



A revolução devoniana

Rhynie Chert



A revolução devoniana

Rhynie Chert



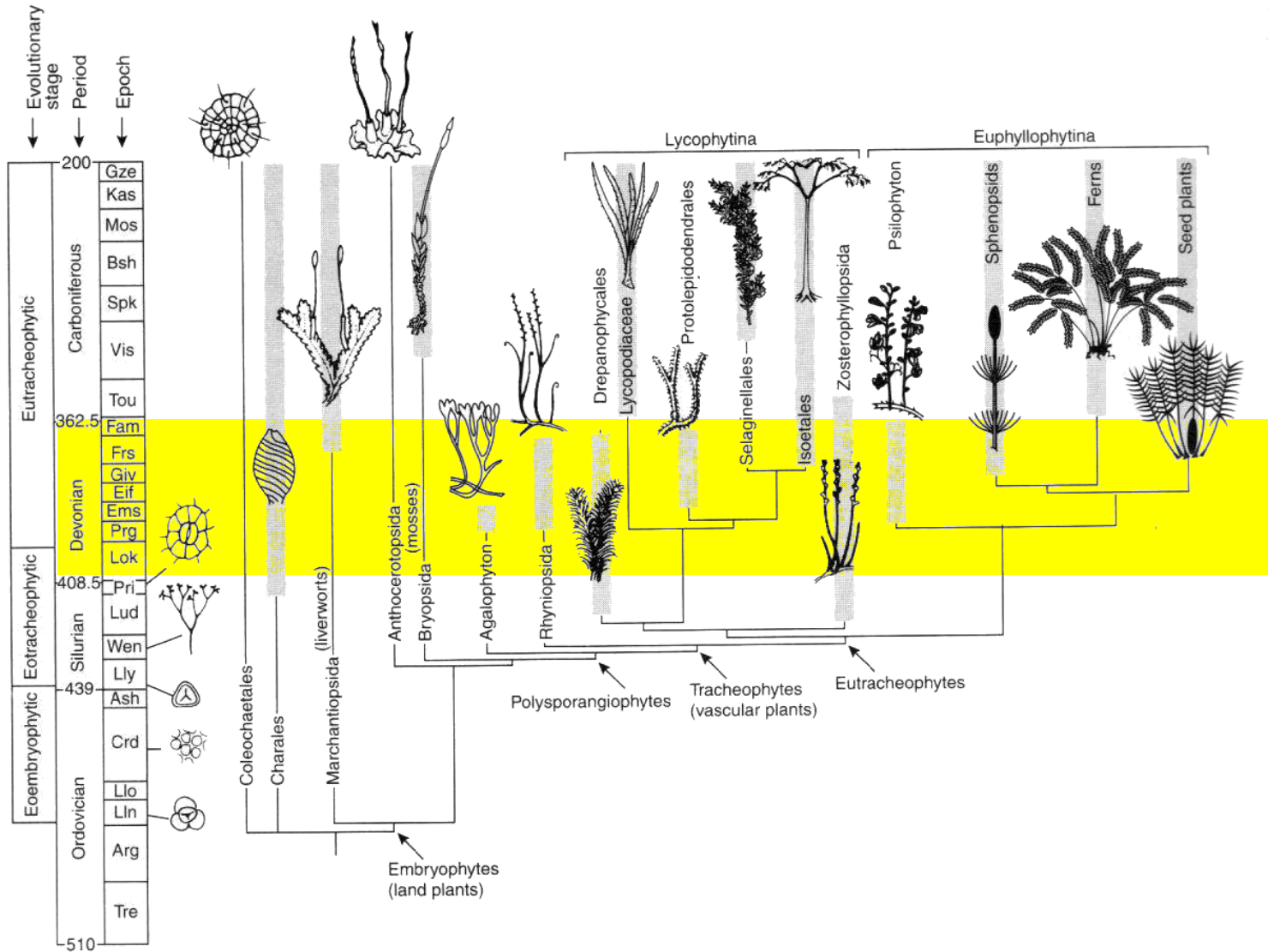
A revolução devoniana

Rhynie Chert



A revolução devoniana

Rhynie Chert

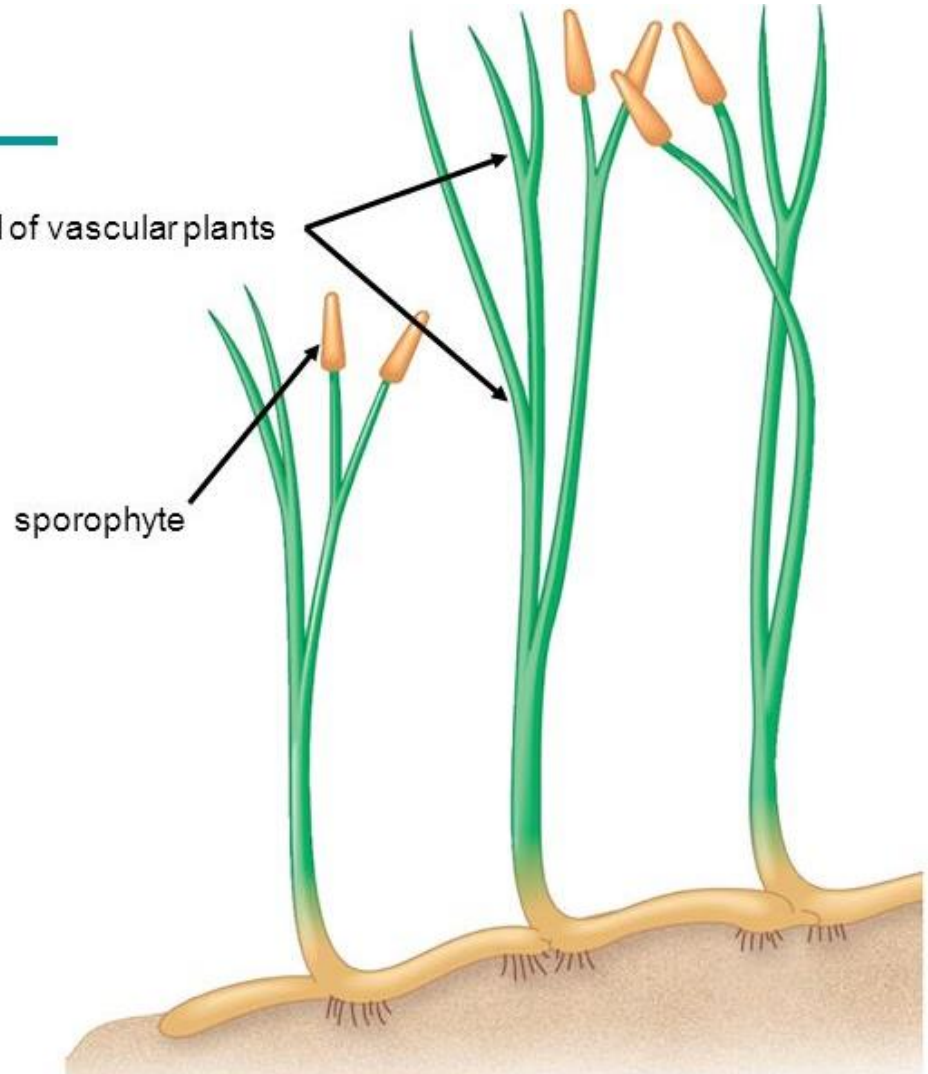
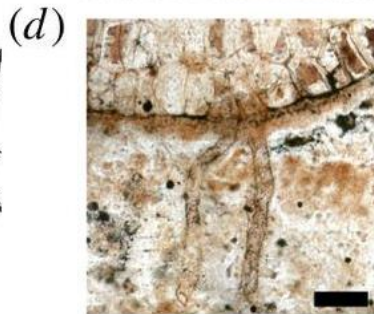
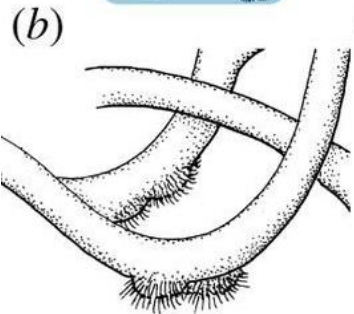
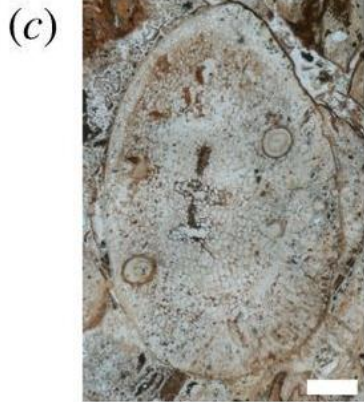
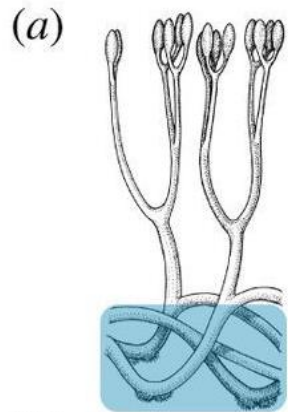


A revolução devoniana

Aglaophyton

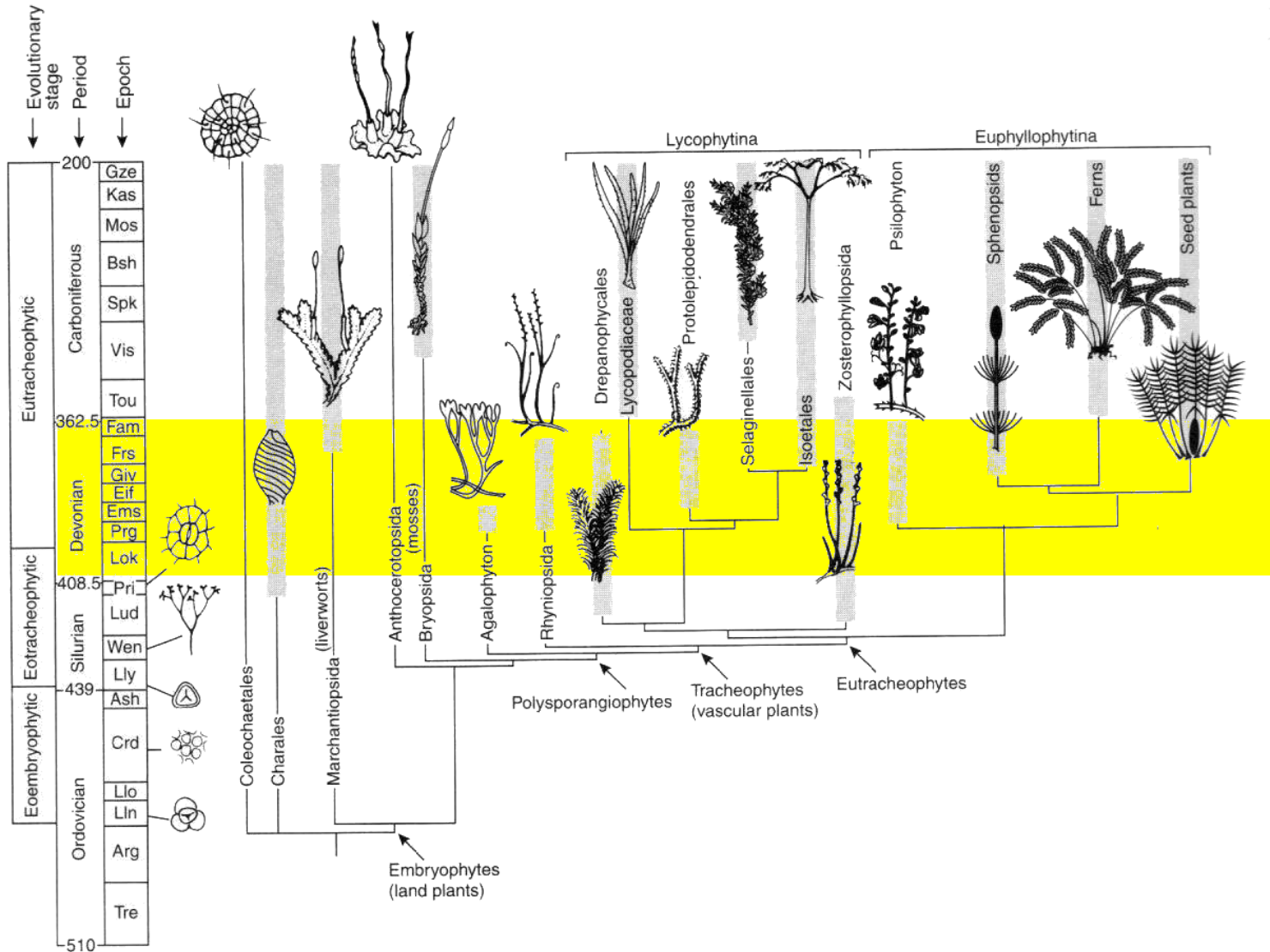
Aglaophyton major

branching is typical of vascular plants



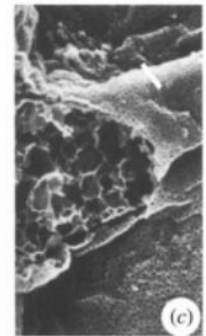
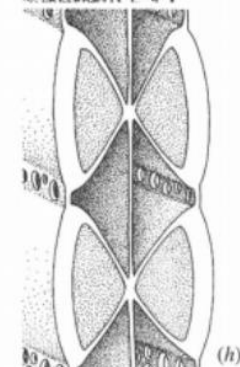
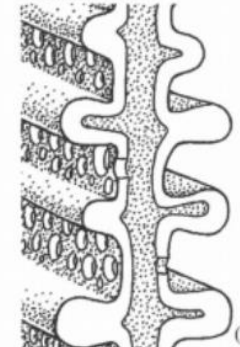
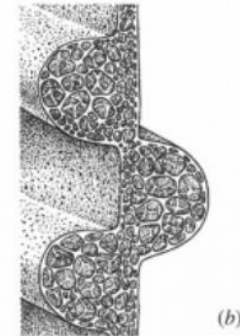
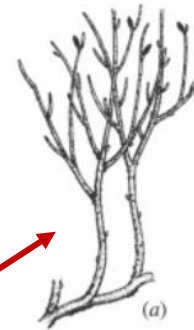
A revolução devoniana

Tracheophyta: traqueídeos “verdadeiros”



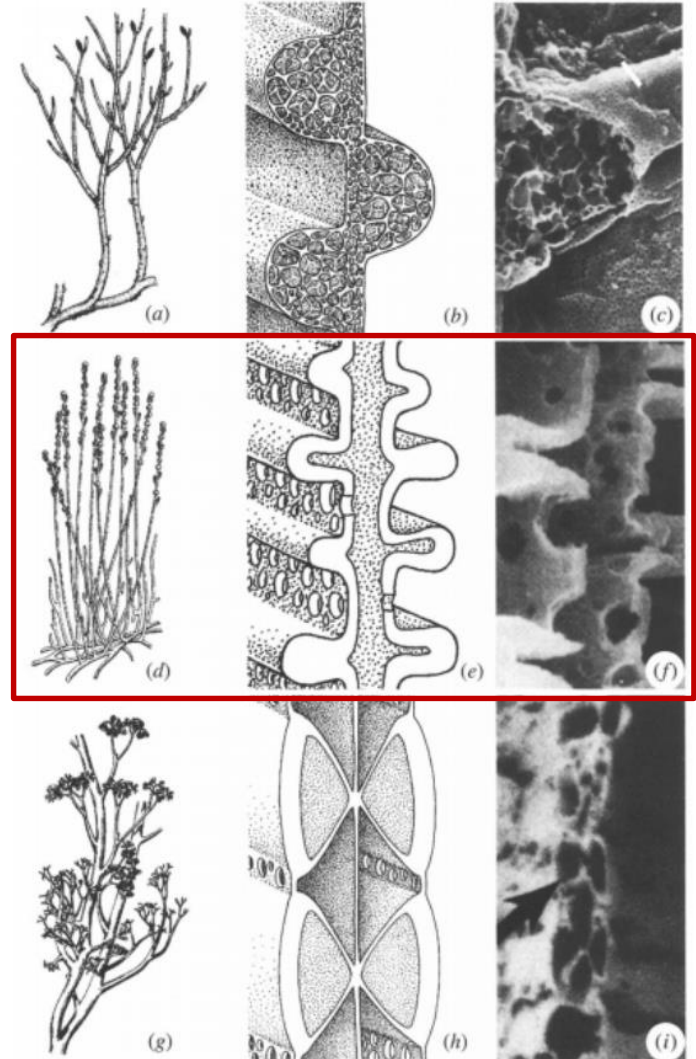
A revolução devoniana

Tracheophyta – Rhyniopsida – *Rhynia*



A revolução devoniana

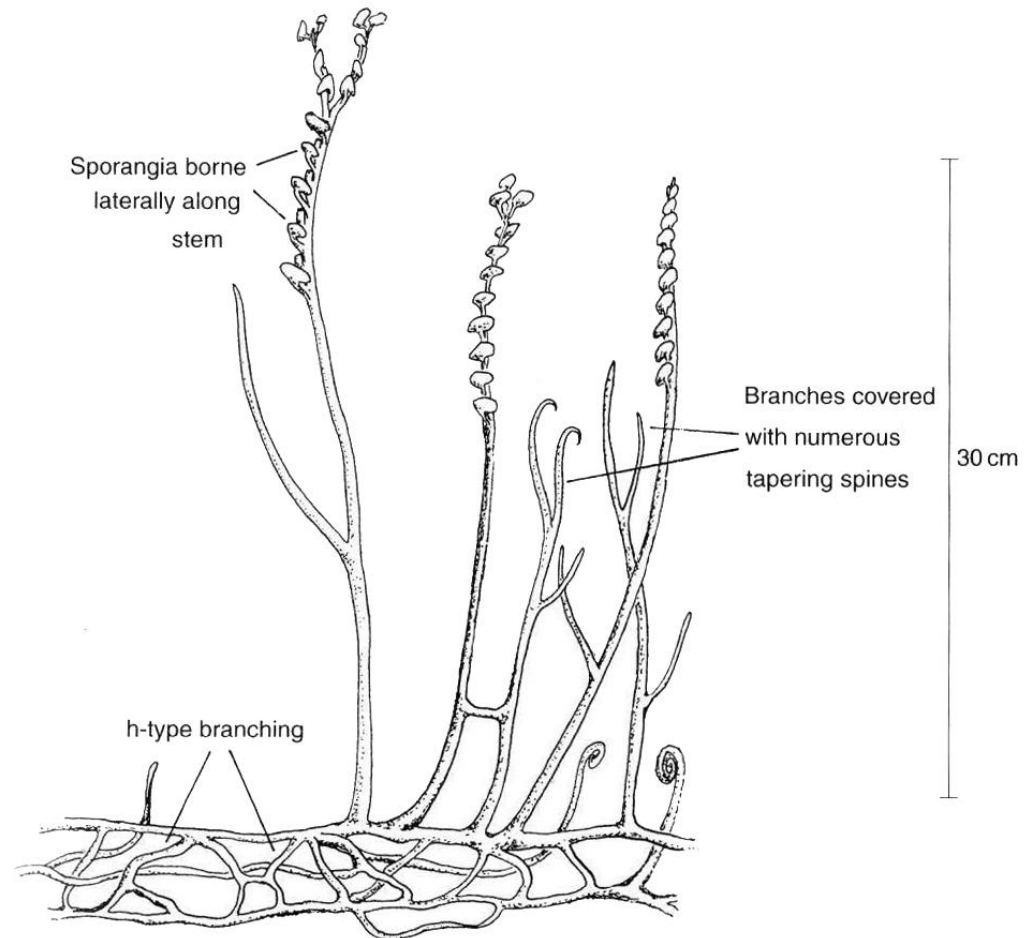
Tracheophyta – Lycophytina – *Zosterophyllum*



A revolução devoniana

Tracheophyta – Lycophytina – *Zosterophyllum*

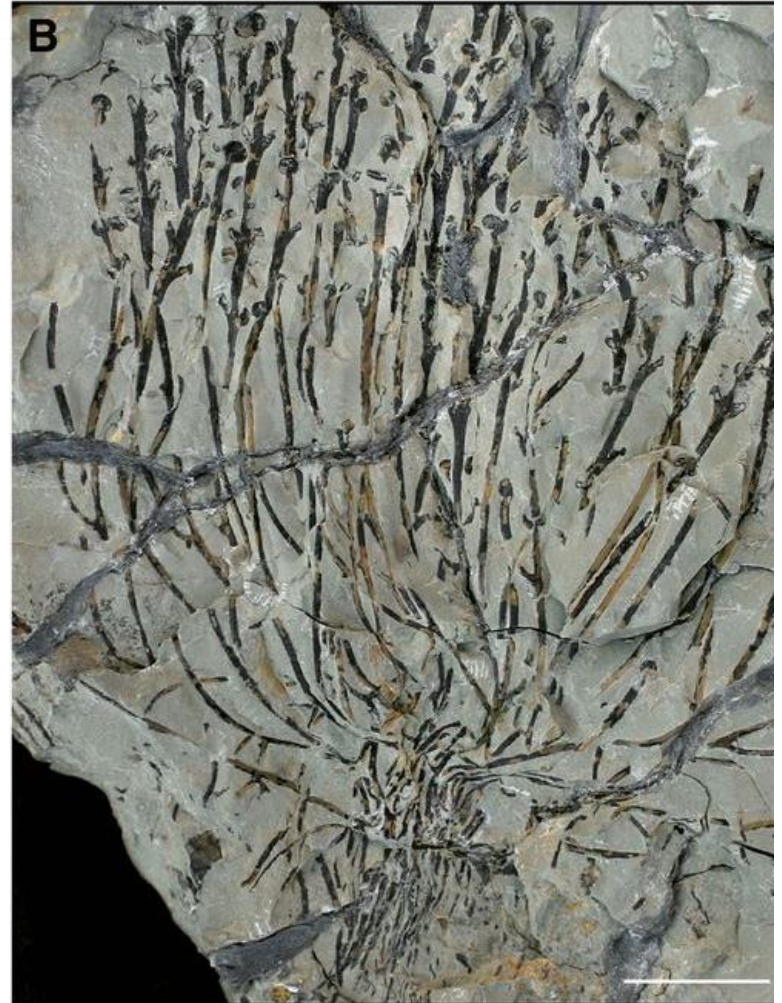
Esporângios laterais, ramos não-reprodutivos e rizomas complexos



A revolução devoniana

Tracheophyta – Lycophytina – *Zosterophyllum*

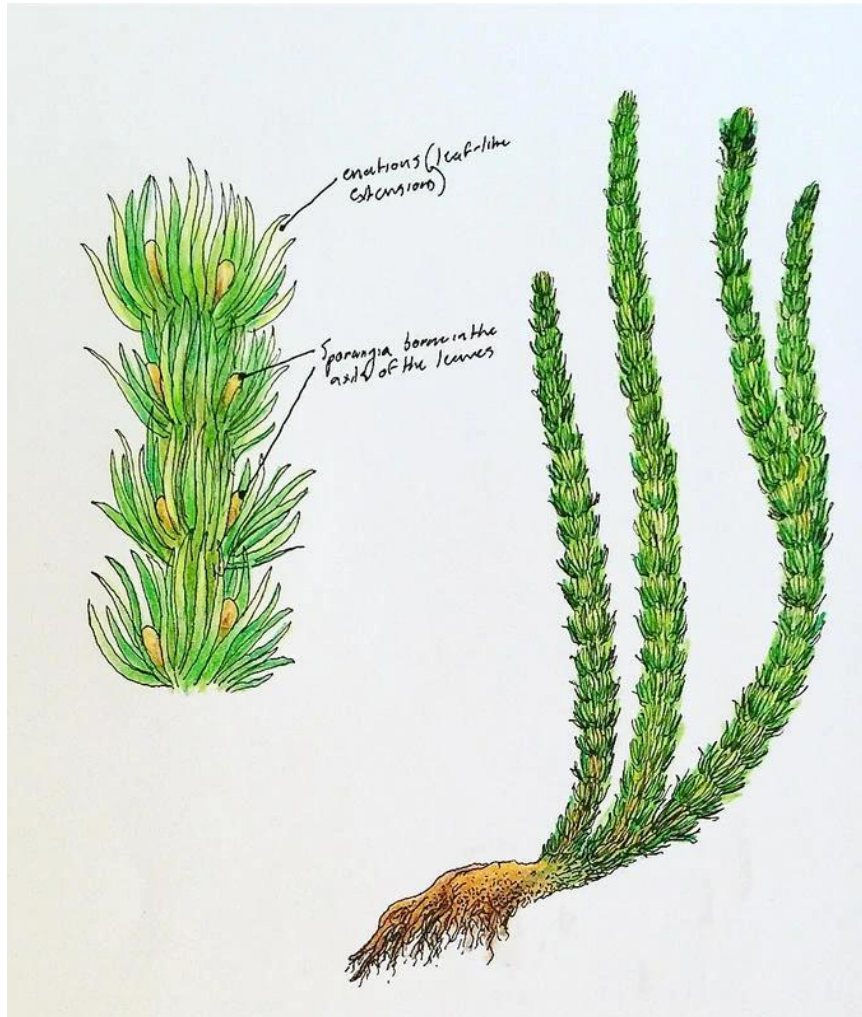
Esporângios laterais, ramos não-reprodutivos e rizomas complexos



A revolução devoniana

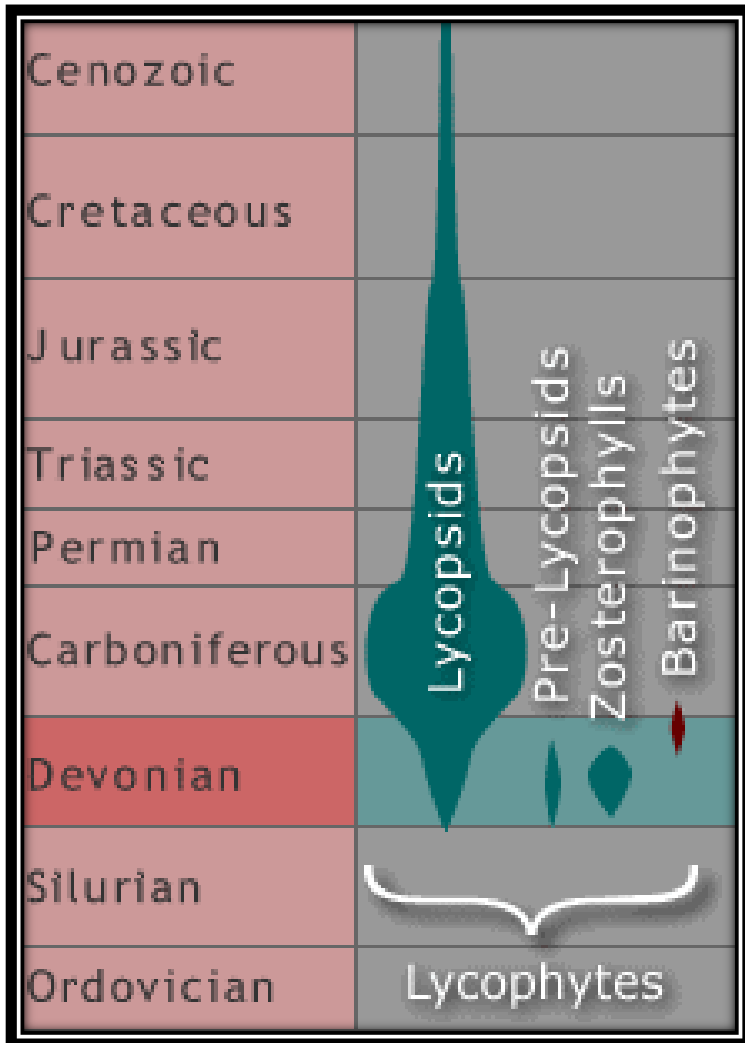
Tracheophyta – Lycophytina – *Baragwanathia*

Micrófilas verdadeiras



A revolução devoniana

Tracheophyta – Lycophytina



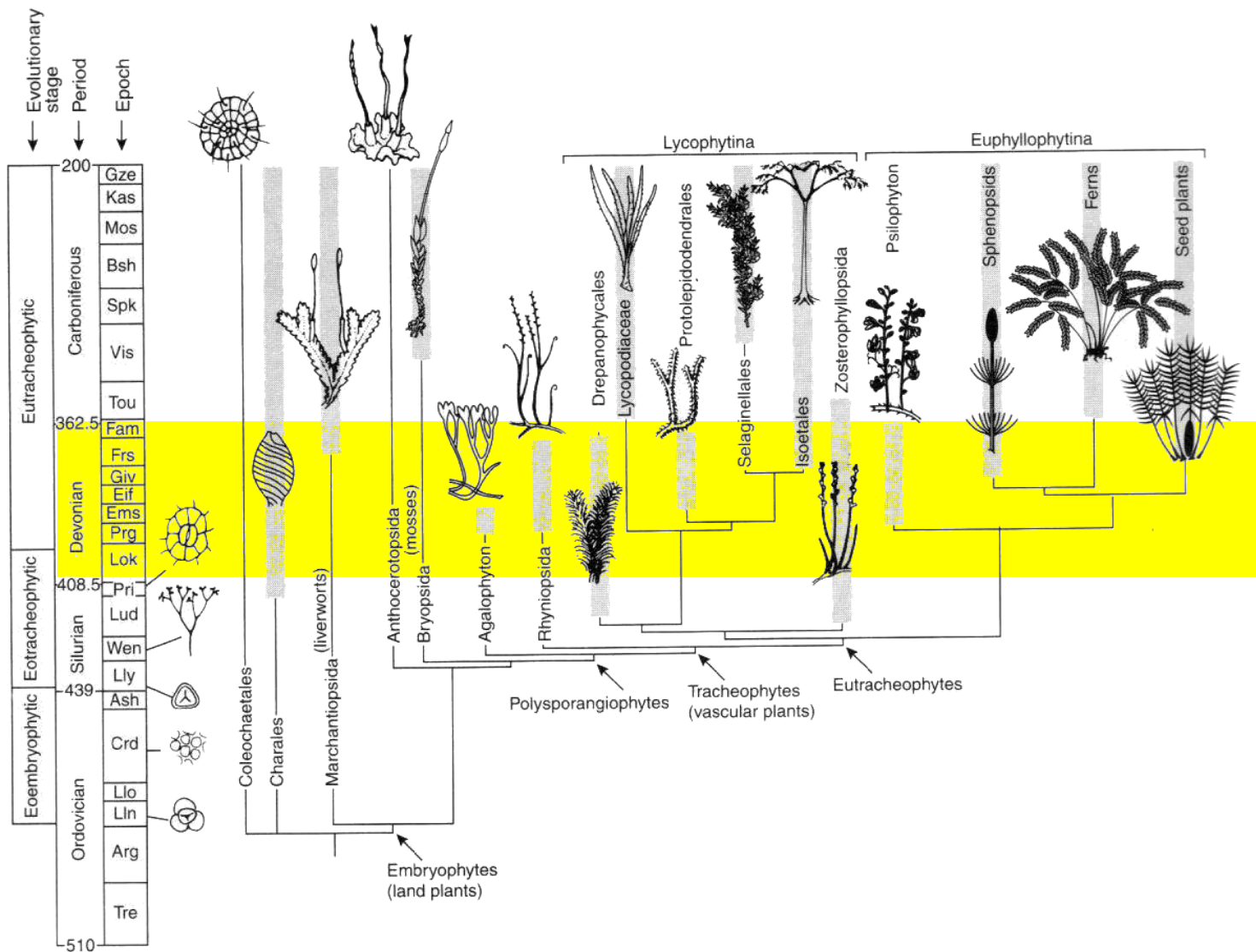
A revolução devoniana
Tracheophyta – Lycophytina



Selaginella

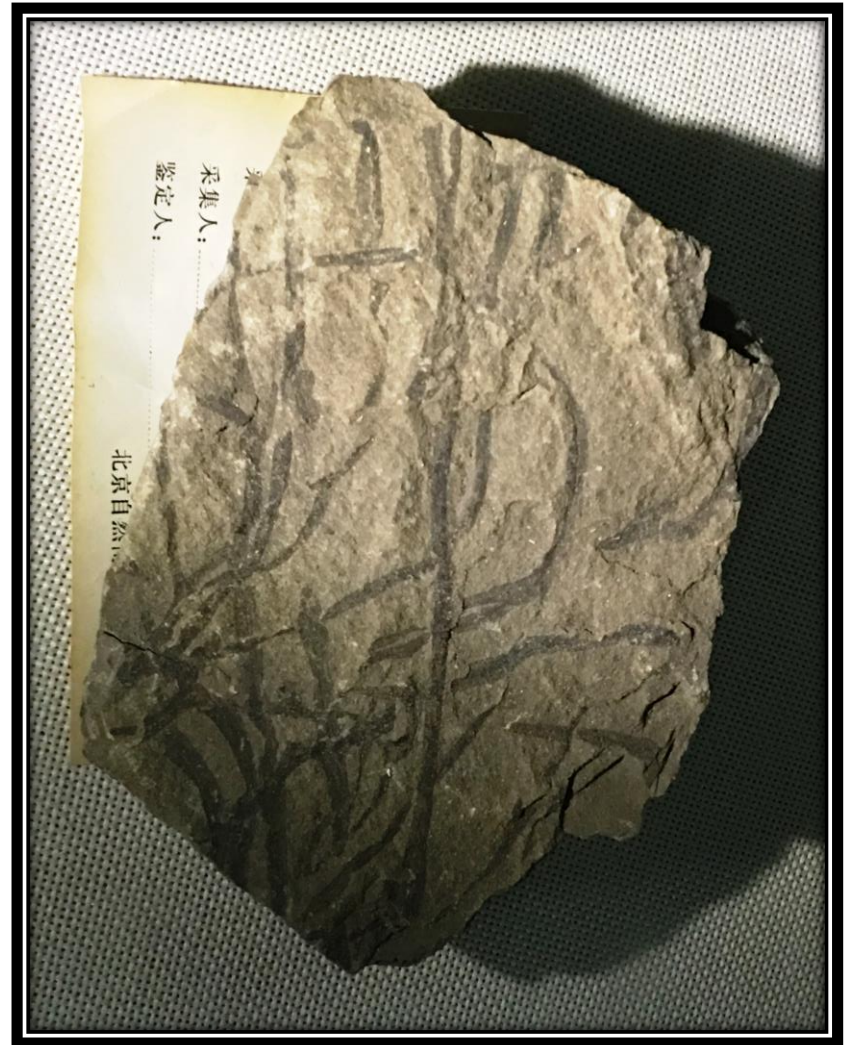
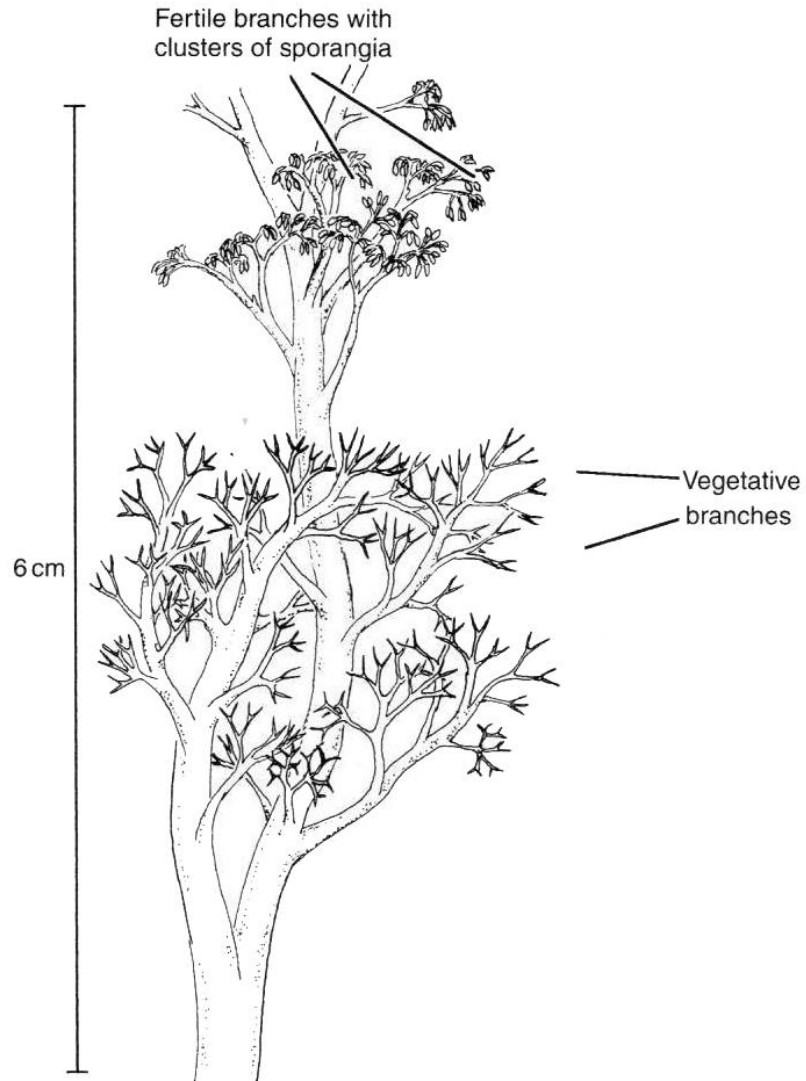
A revolução devoniana

Euphylophytina: samabaias, esfenófitas e espermatófitas



A revolução devoniana

Tracheophyta – Euphyllophytina – *Psilophyton*



A revolução devoniana

Tracheophyta – Euphyllophytina – Sphenopsida



Equisetum

A revolução devoniana

Tracheophyta – Euphyllophytina – Sphenopsida

Calamites



A revolução devoniana

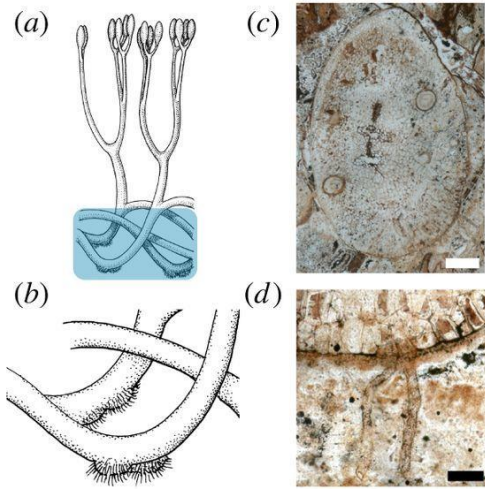
Florestas Devoniano Superior: licófitas e esfenófitas arbóreas



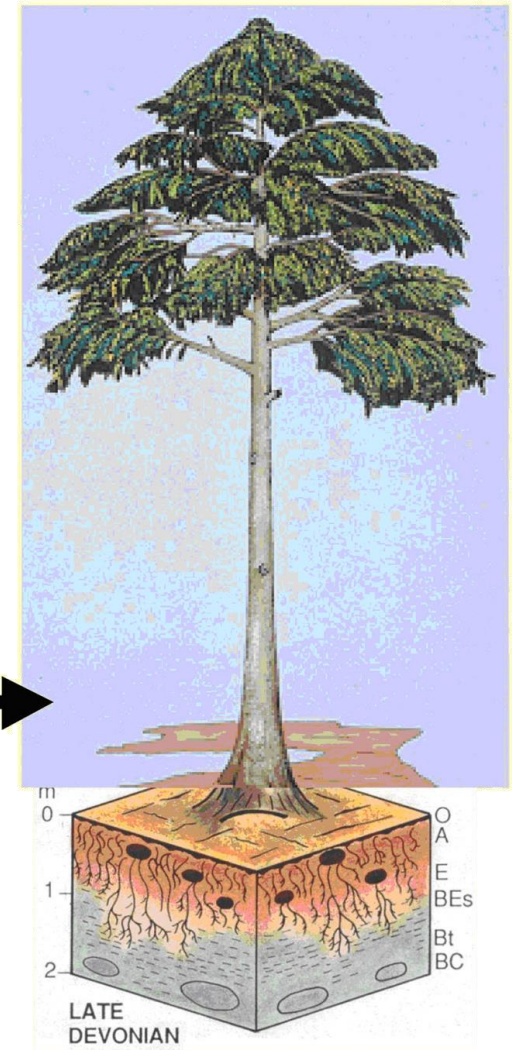
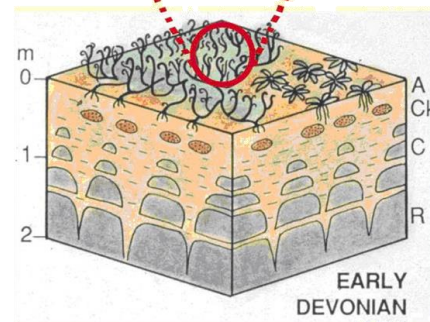
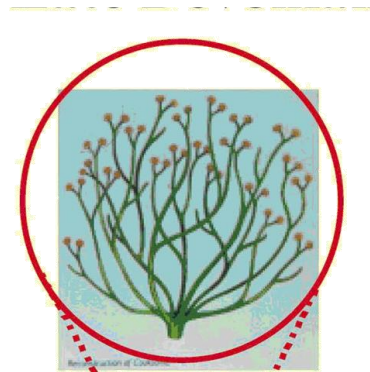
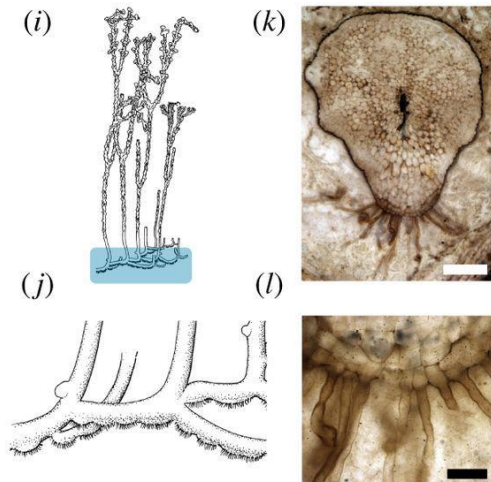
A revolução devoniana

Raízes e solos

Aglaophyton majus

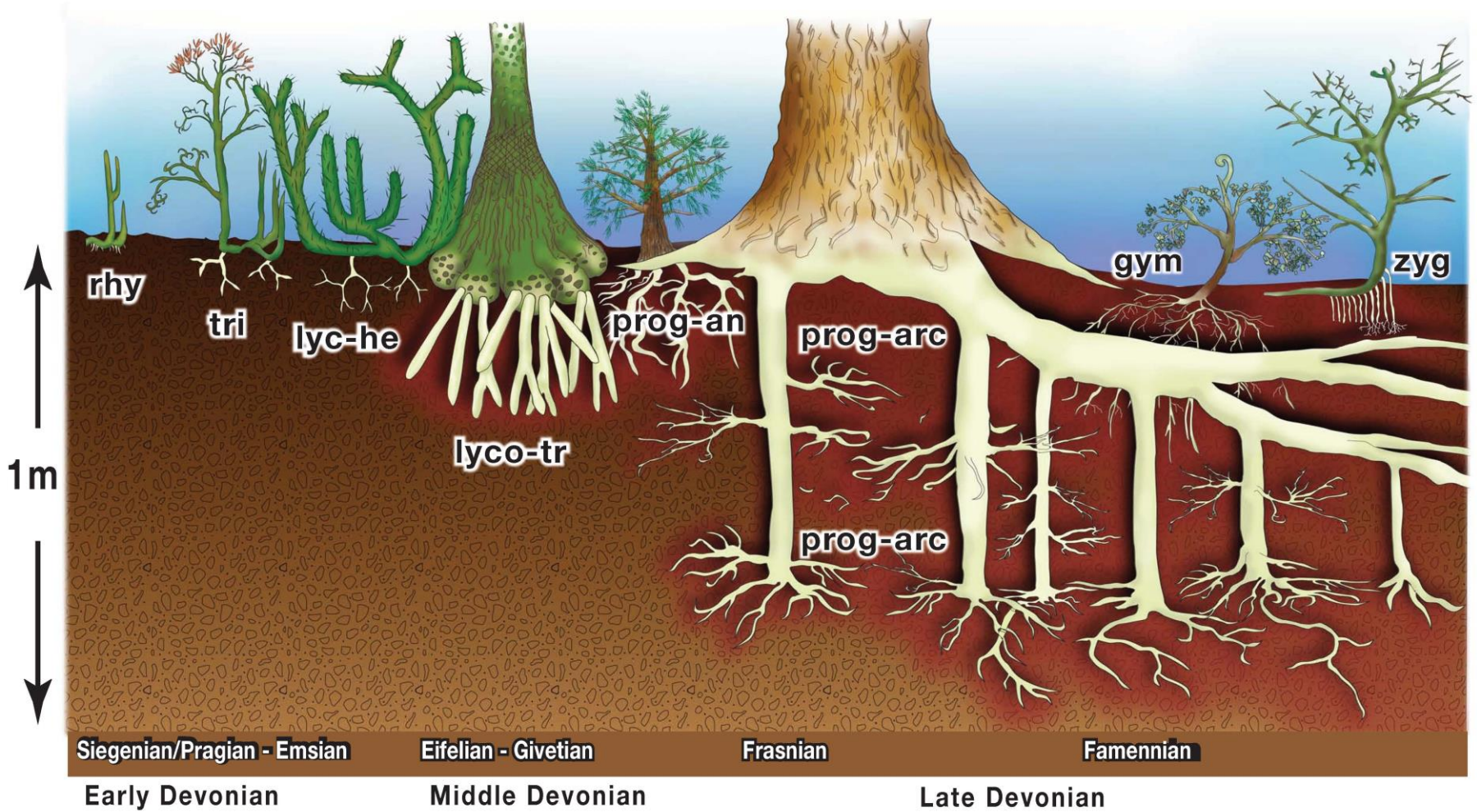


Nothia aphylla



A revolução devoniana

Raízes e solos



Invertebrados terrestres

Ordoviciano: *Skolithos* e criptobiose



Invertebrados terrestres

Siluriano - Miriapoda

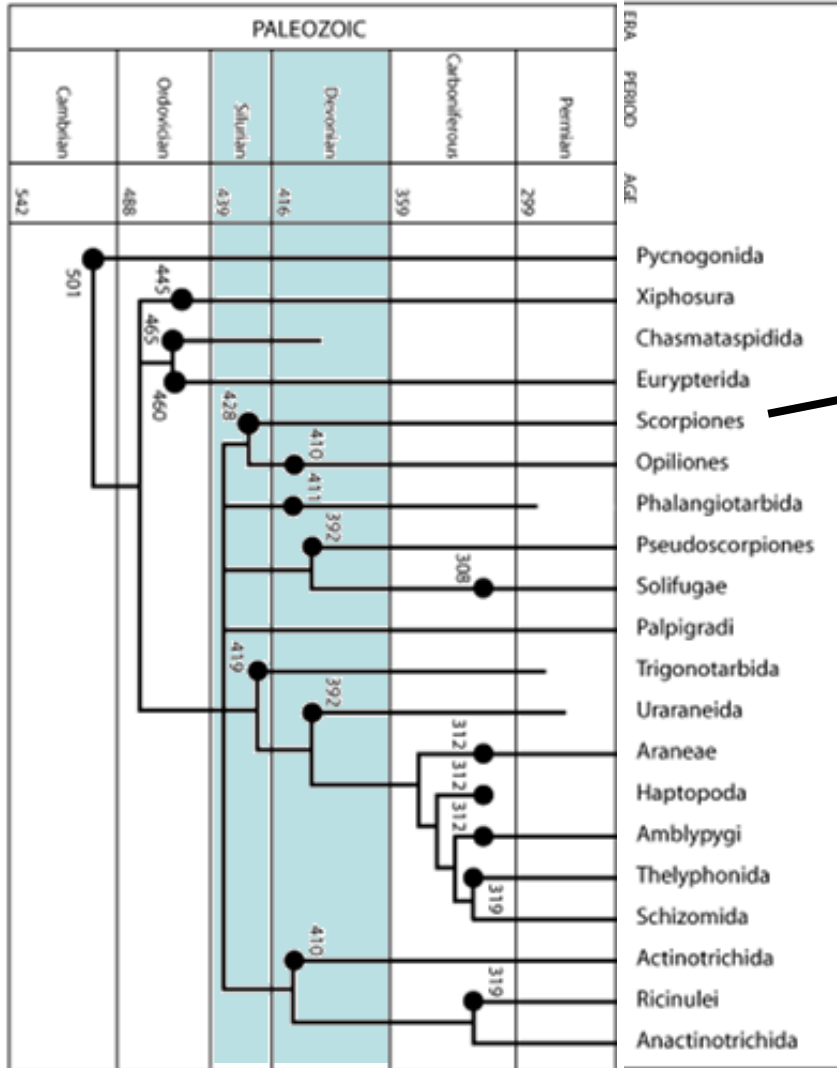
Pneumodesmus

Siluriano da Escócia

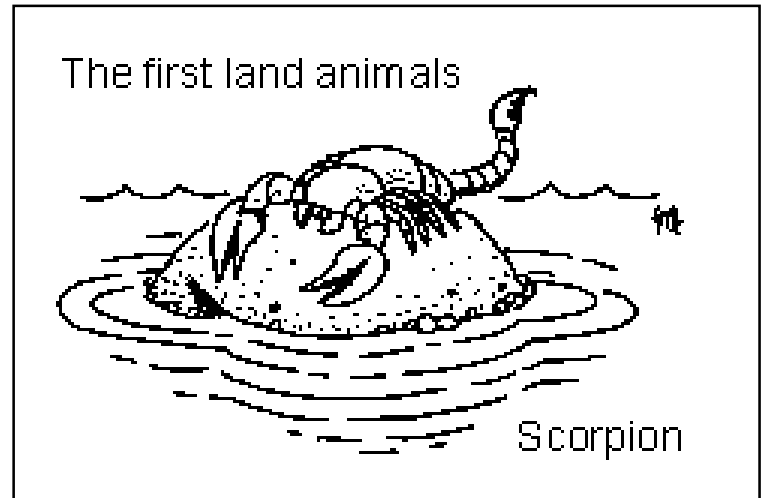
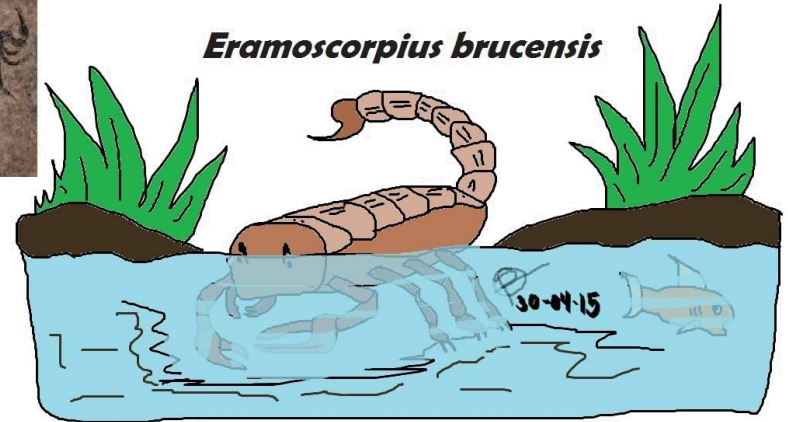


Invertebrados terrestres

Siluriano - Escorpiones



Eramoscorpius brucei



Invertebrados terrestres

A partir do Devoniano, os escorpiões colonizam o meio terrestre
No Carbonífero as formas com brânquias desaparecem e
os escorpiões se tornam exclusivamente terrestres

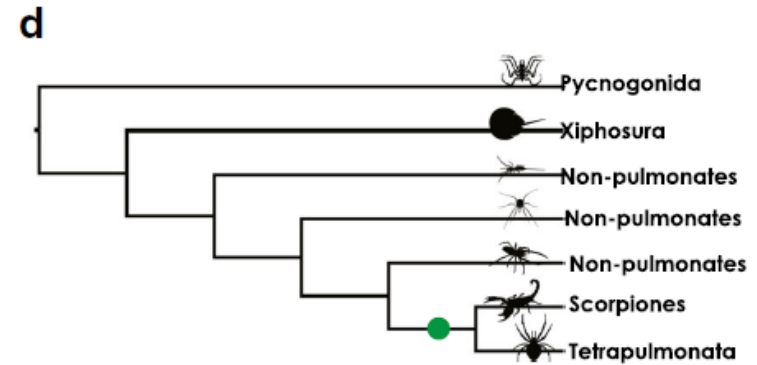
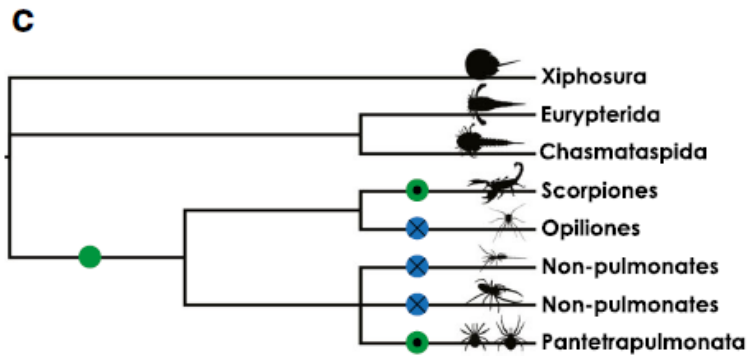
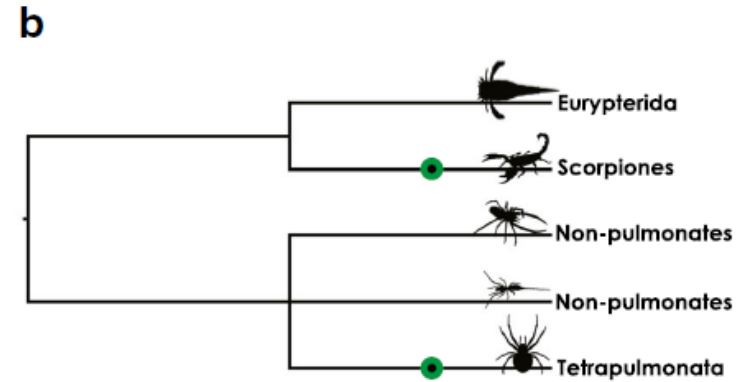
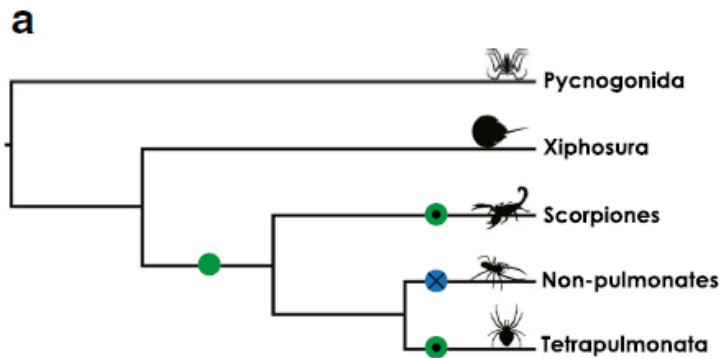


Paleophonus
Siluriano da Suécia



Invertebrados terrestres

Afinidade com os Eurypterida



Homologous book lungs



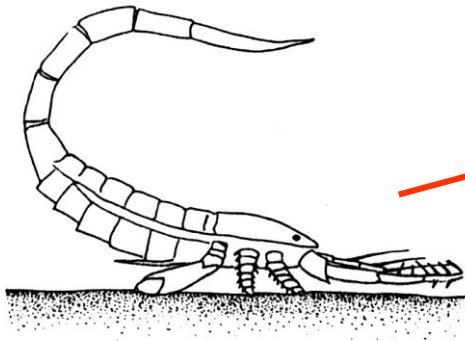
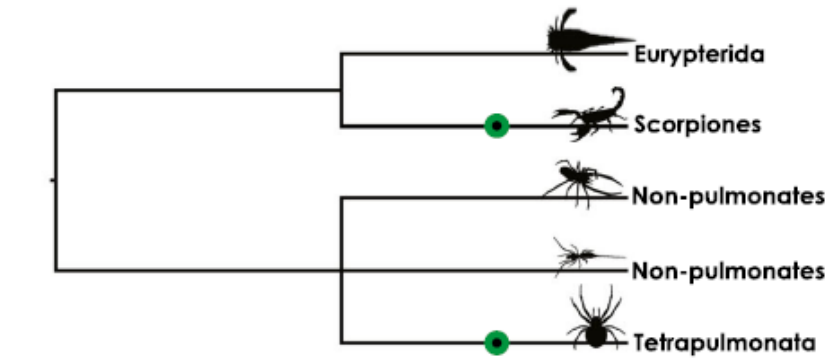
Loss of book lungs



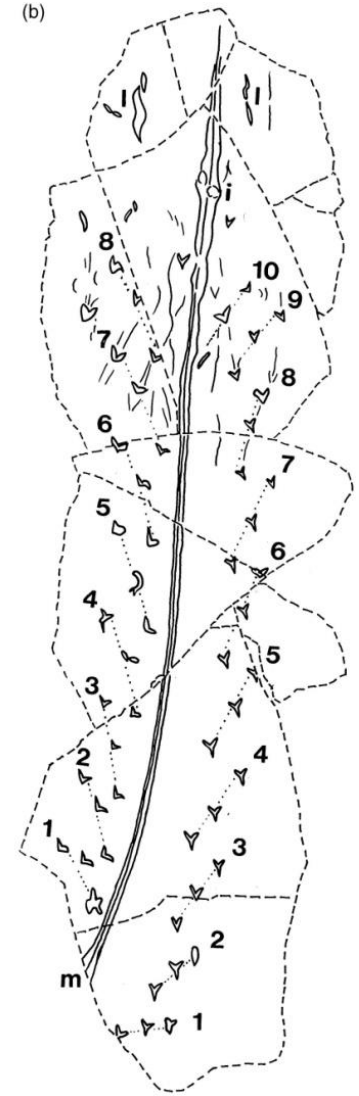
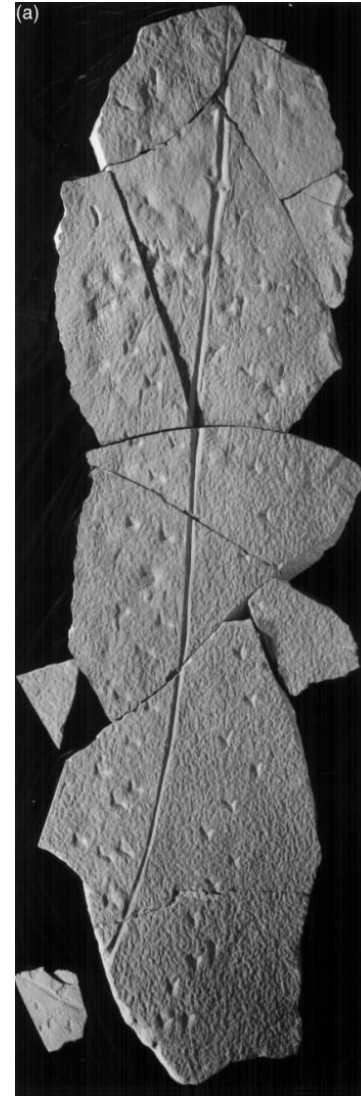
Convergent book lungs

Invertebrados terrestres

Afinidade com os Eurypterida

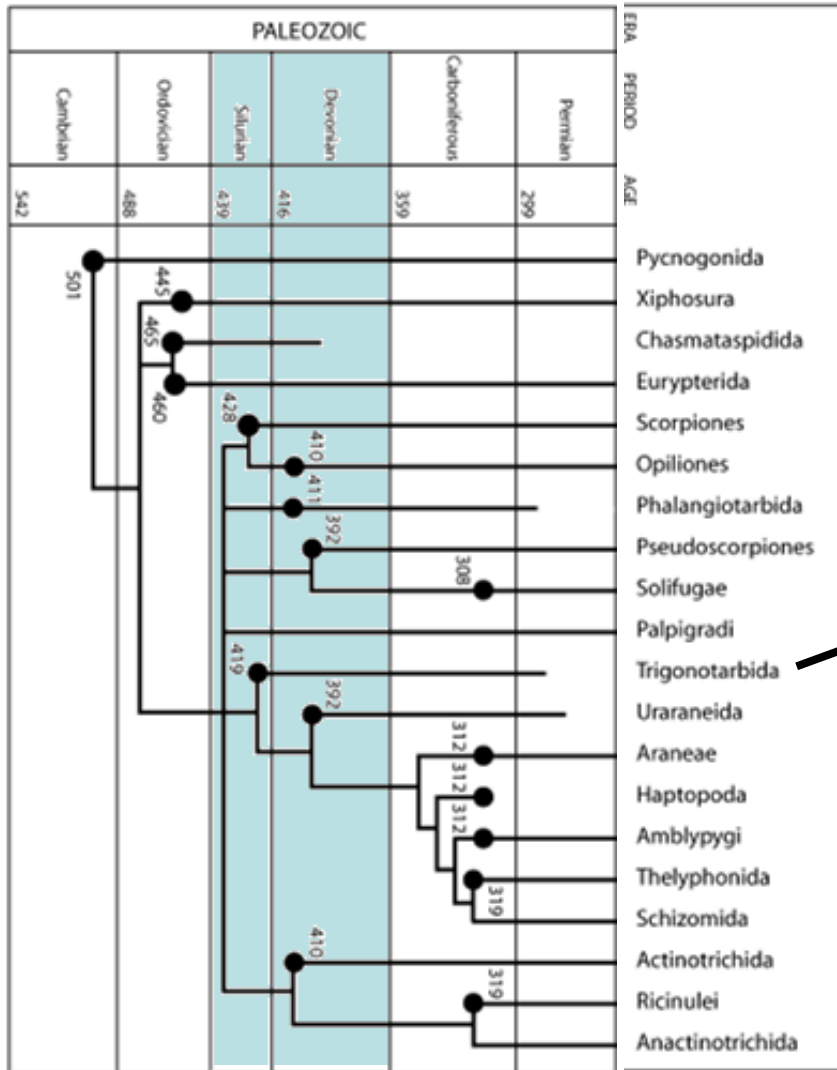


Traços de euriptérico terrestre do Devoniano do Candá



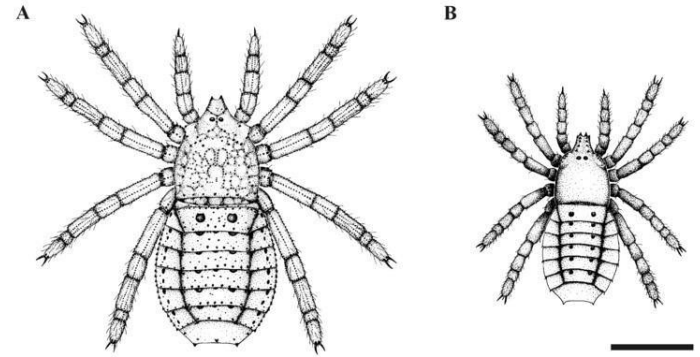
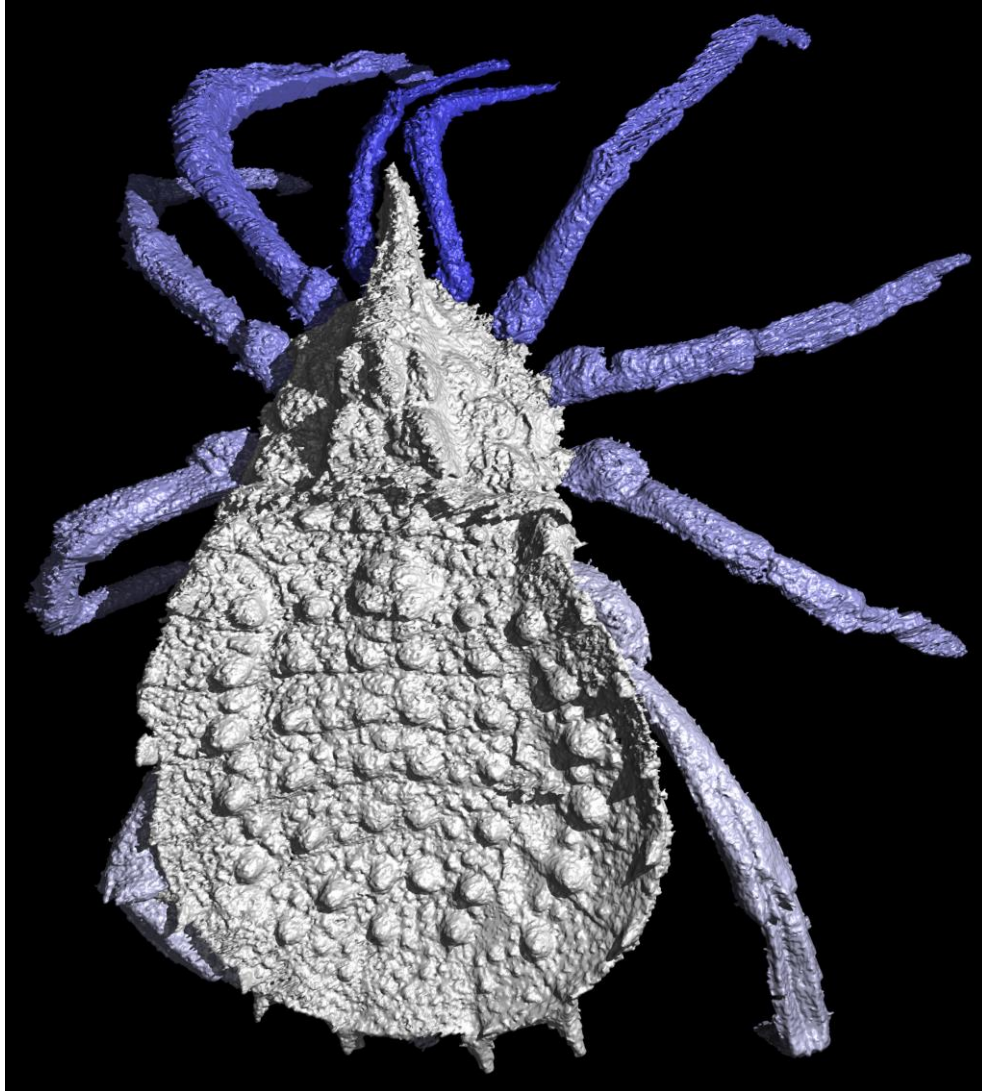
Invertebrados terrestres

Invertebrados terrestres - Chelicerata



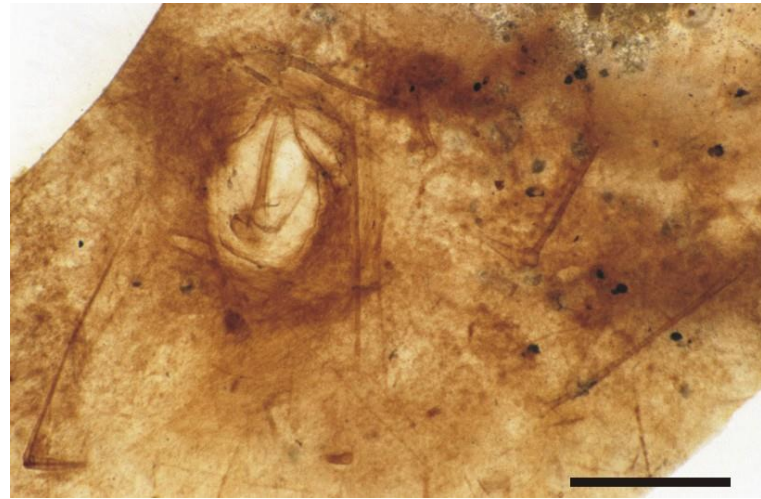
Invertebrados terrestres

Invertebrados terrestres – Chelicerata - Trigonotarbida

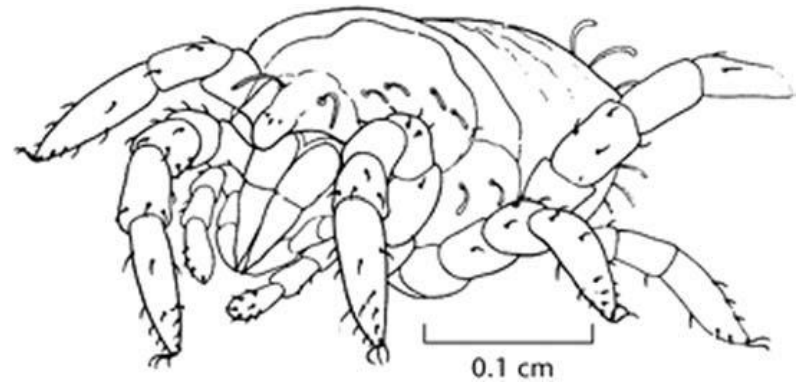


A revolução devoniana

Invertebrados terrestres de Rhynie – carnívoros e detritívoros



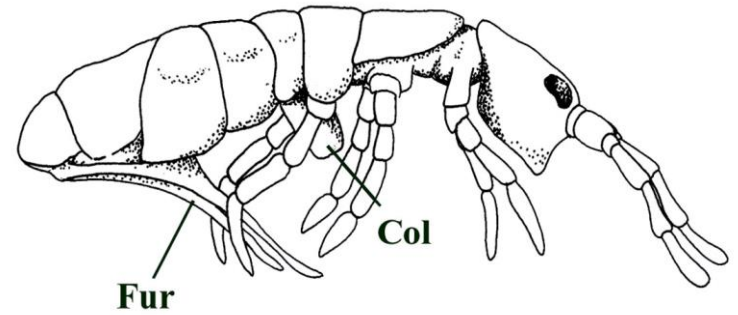
Eophalangium (Opiliones)



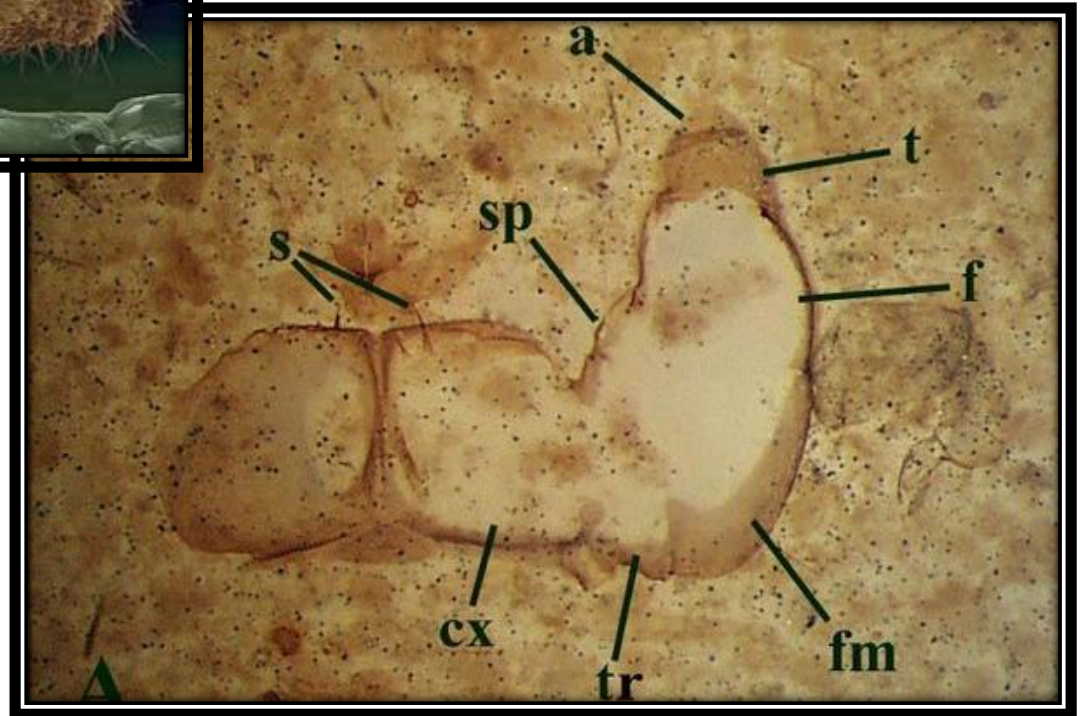
Protacarus (Acari)

A revolução devoniana

Invertebrados terrestres de Rhynie - Hexapoda

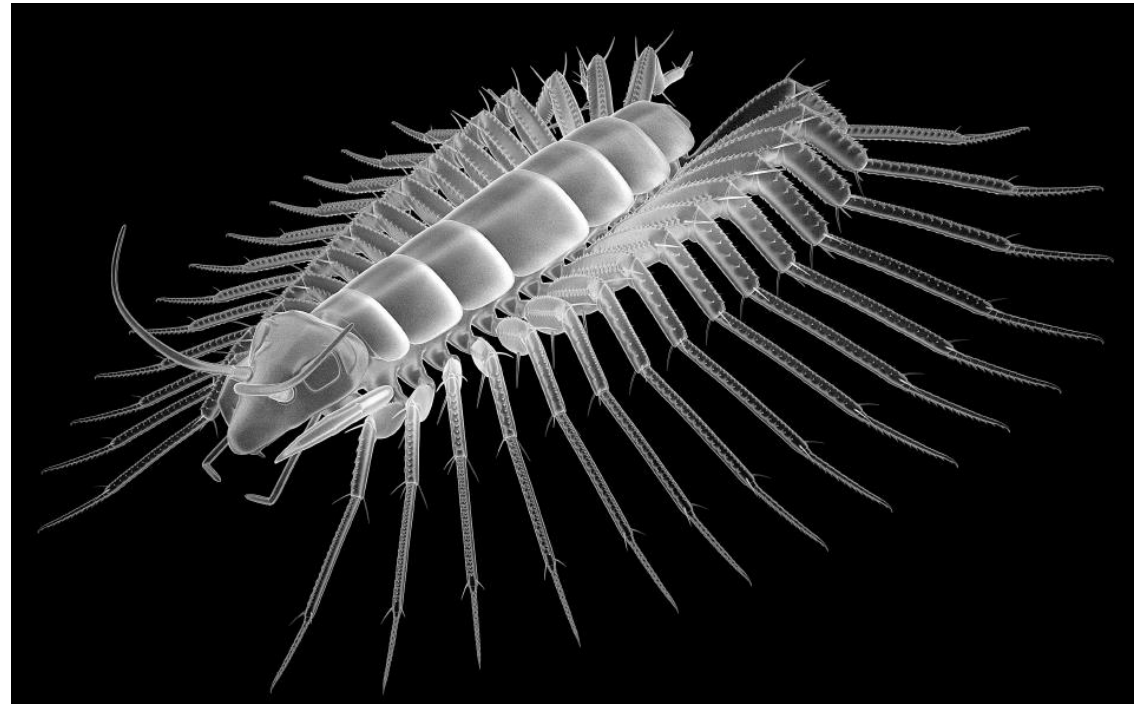


Rhyniella (Collembola)



A revolução devoniana

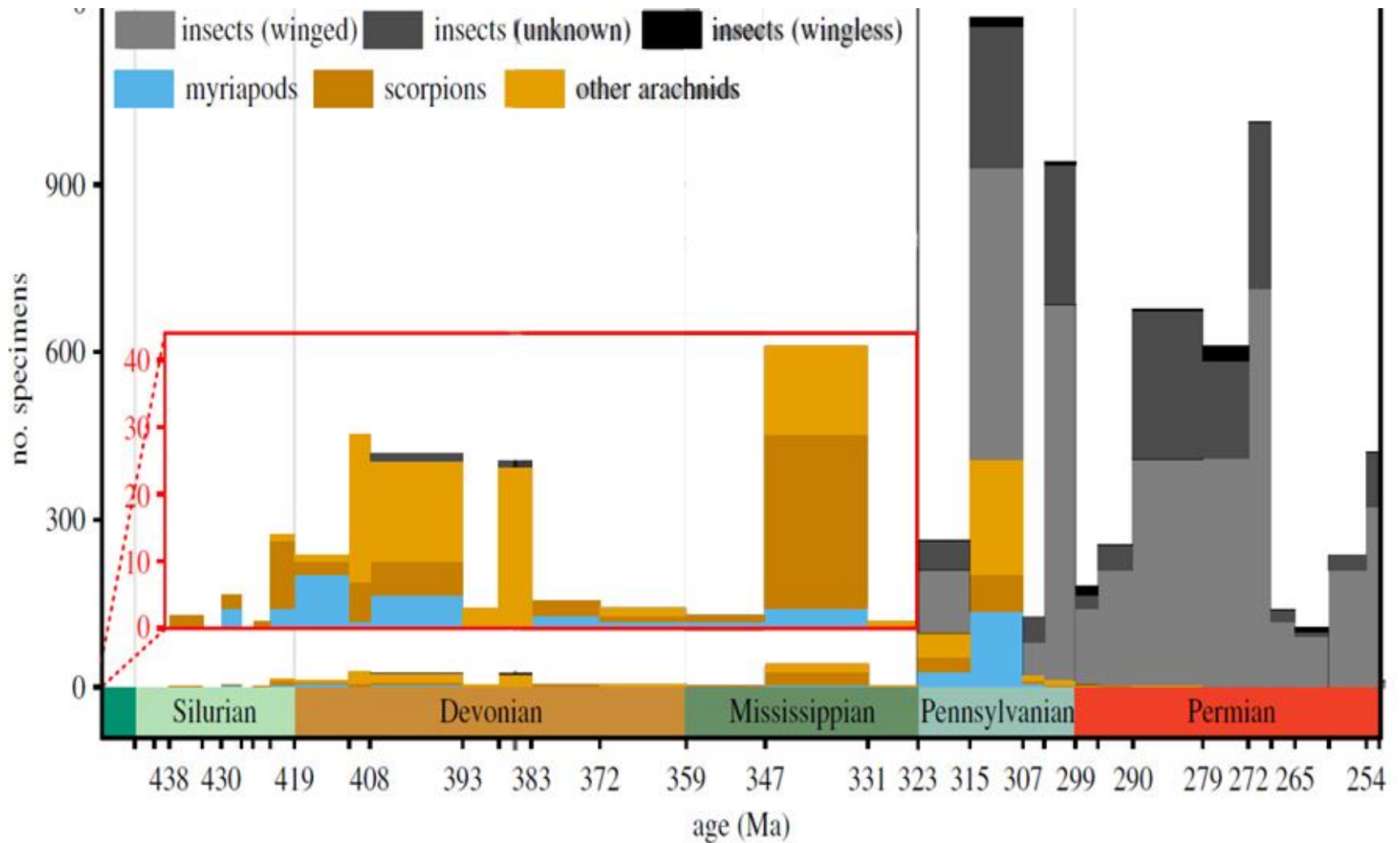
Invertebrados terrestres de Rhynie - Hexapoda



Rhyniognatha (miriápode?)

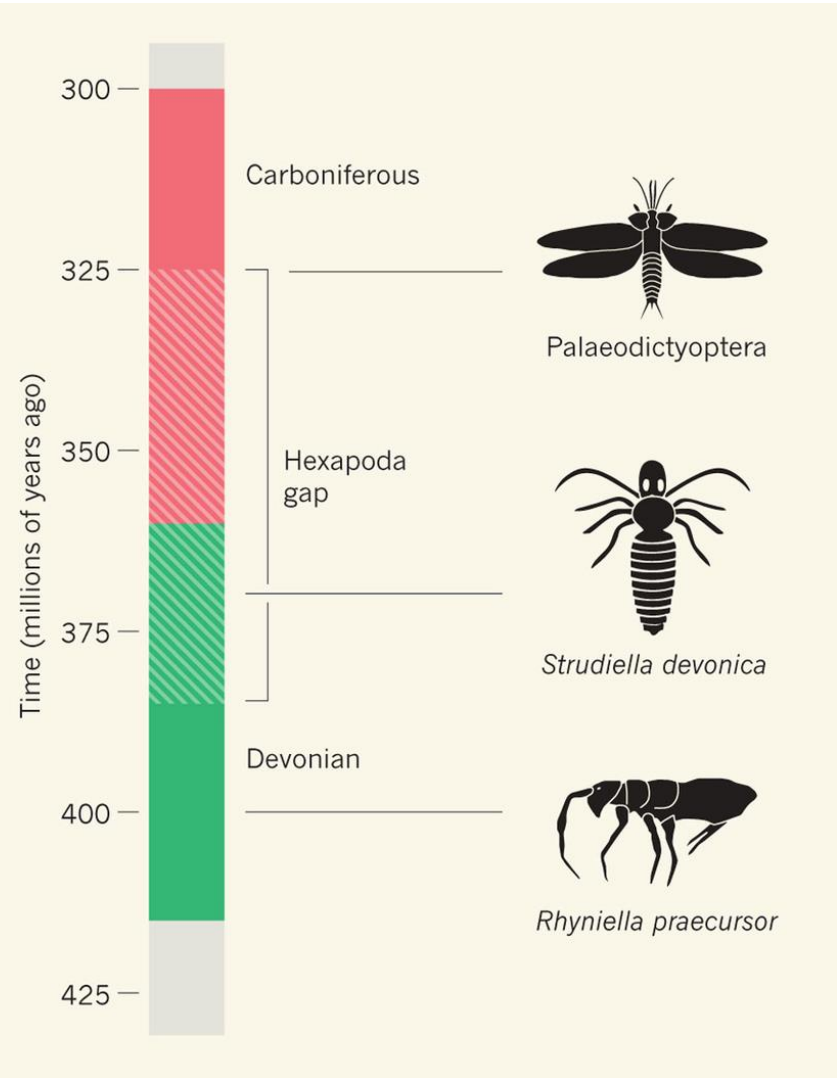
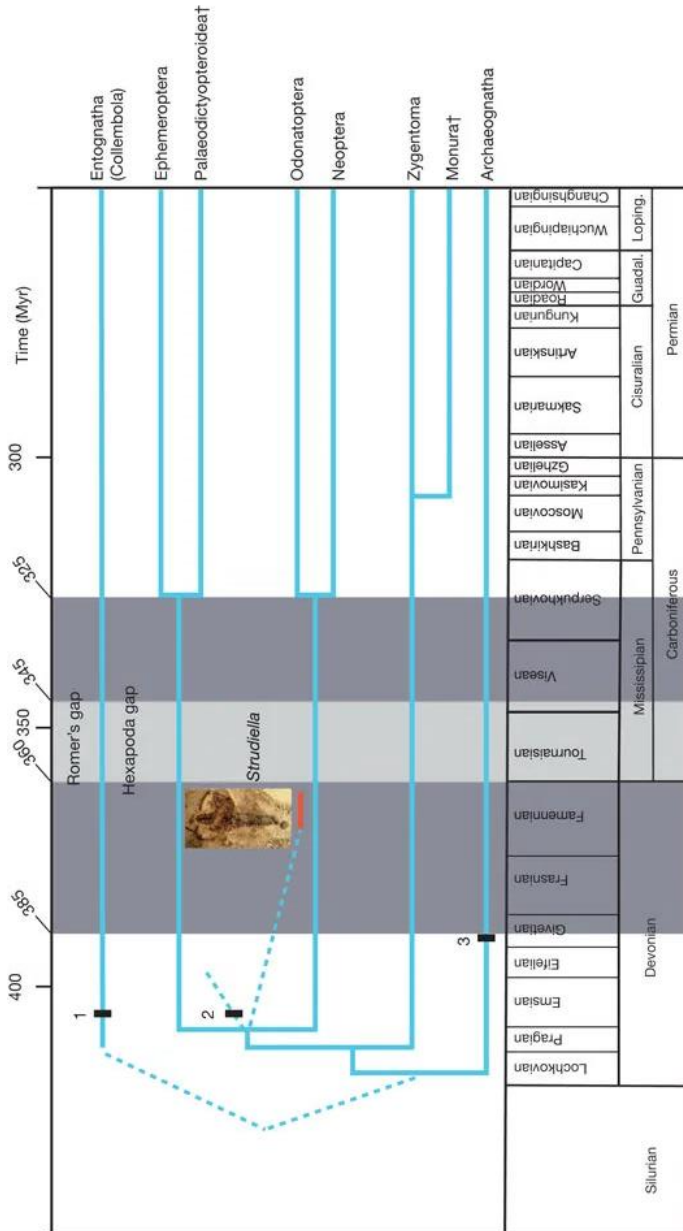
A revolução devoniana

Hexapoda gap



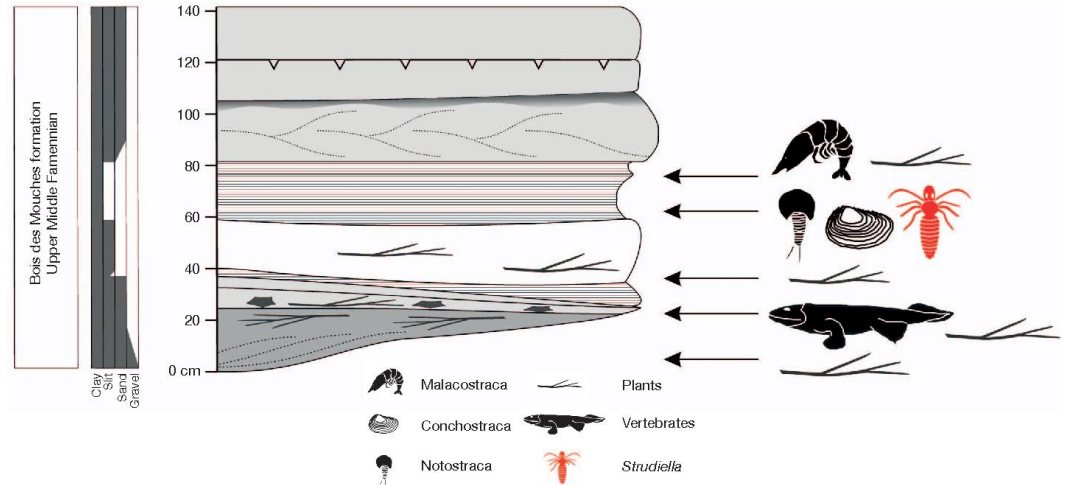
A revolução devoniana

Hexapoda gap

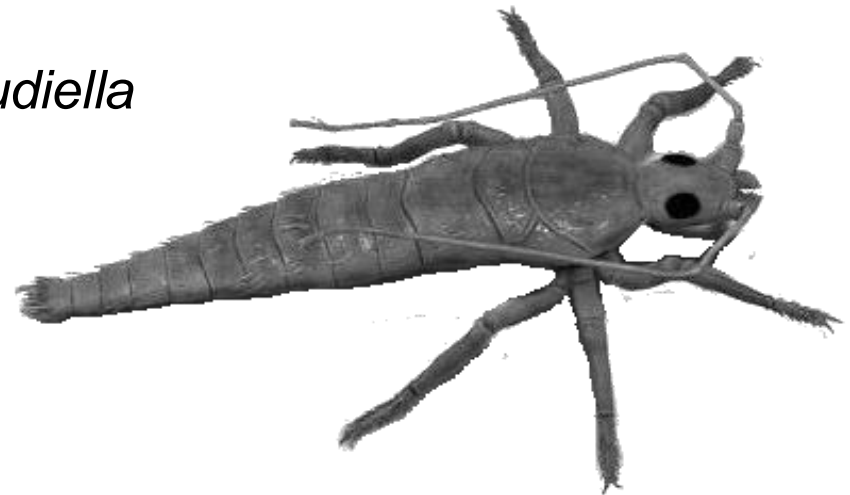


A revolução devoniana

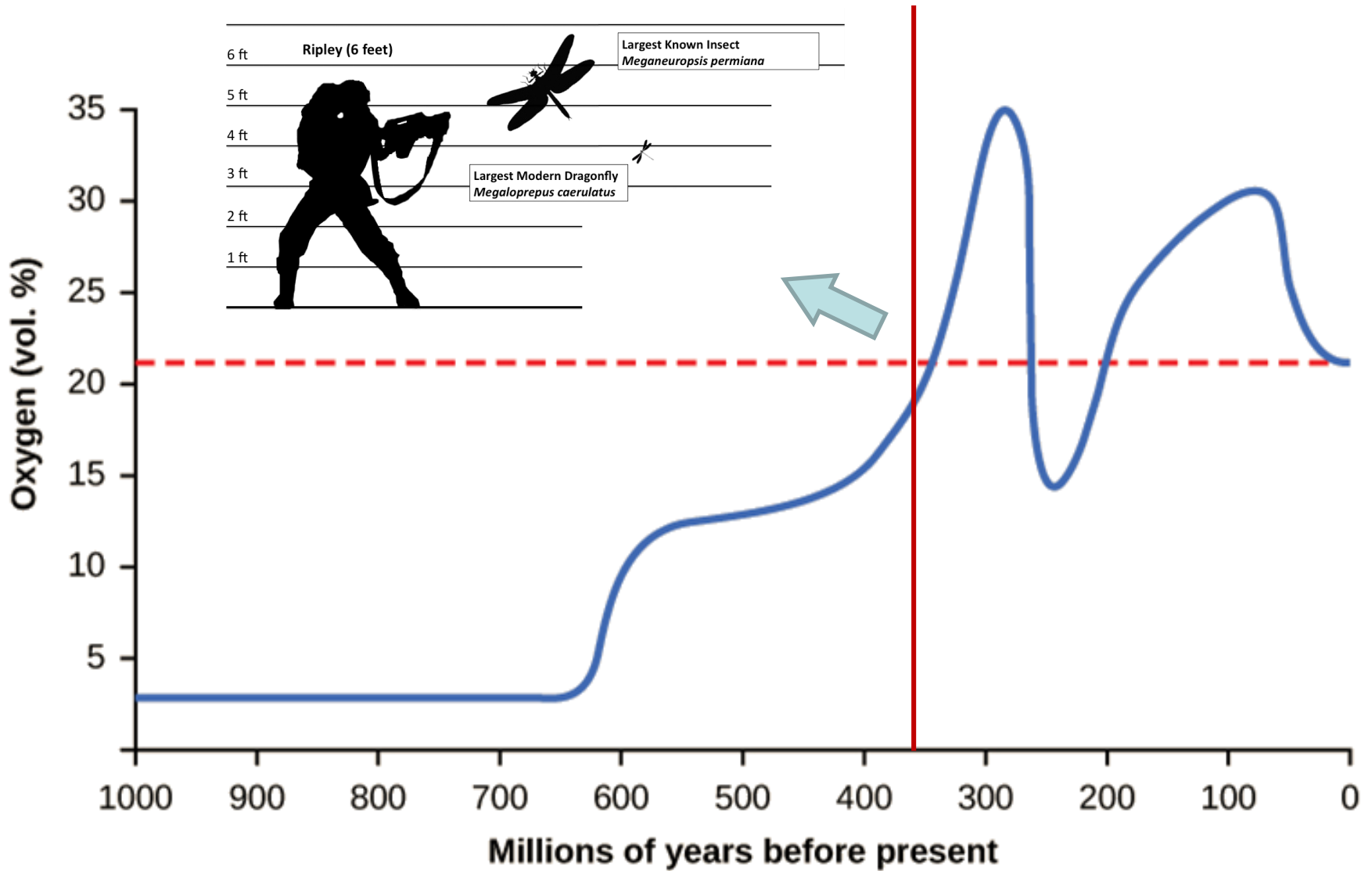
Hexapoda gap



Strudiella



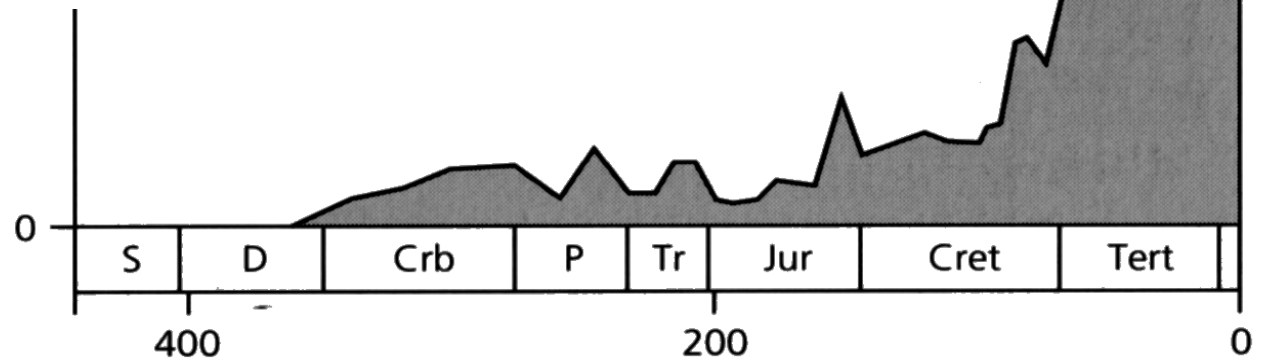
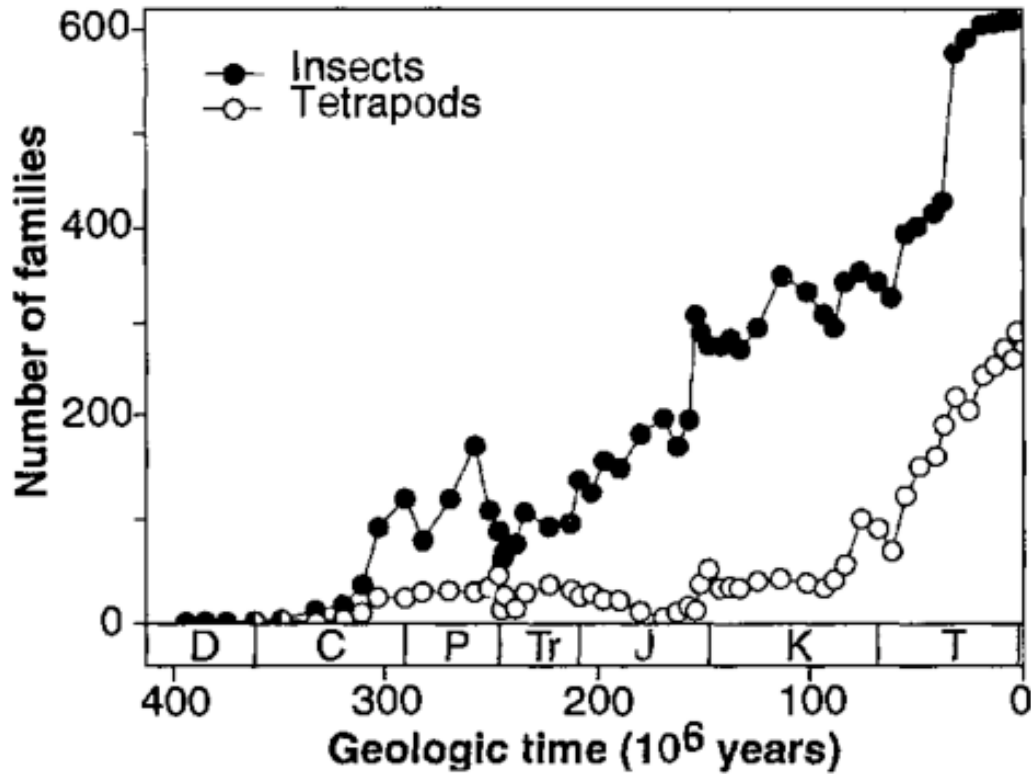
A revolução devoniana



Floresta carbonífera

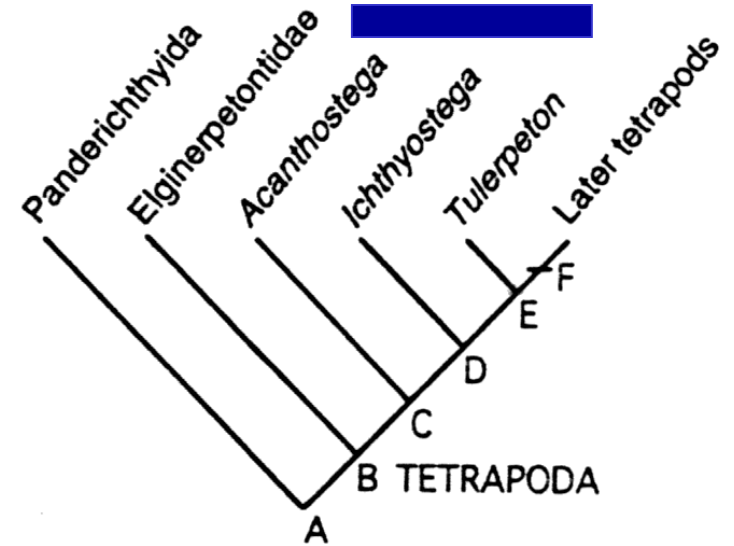
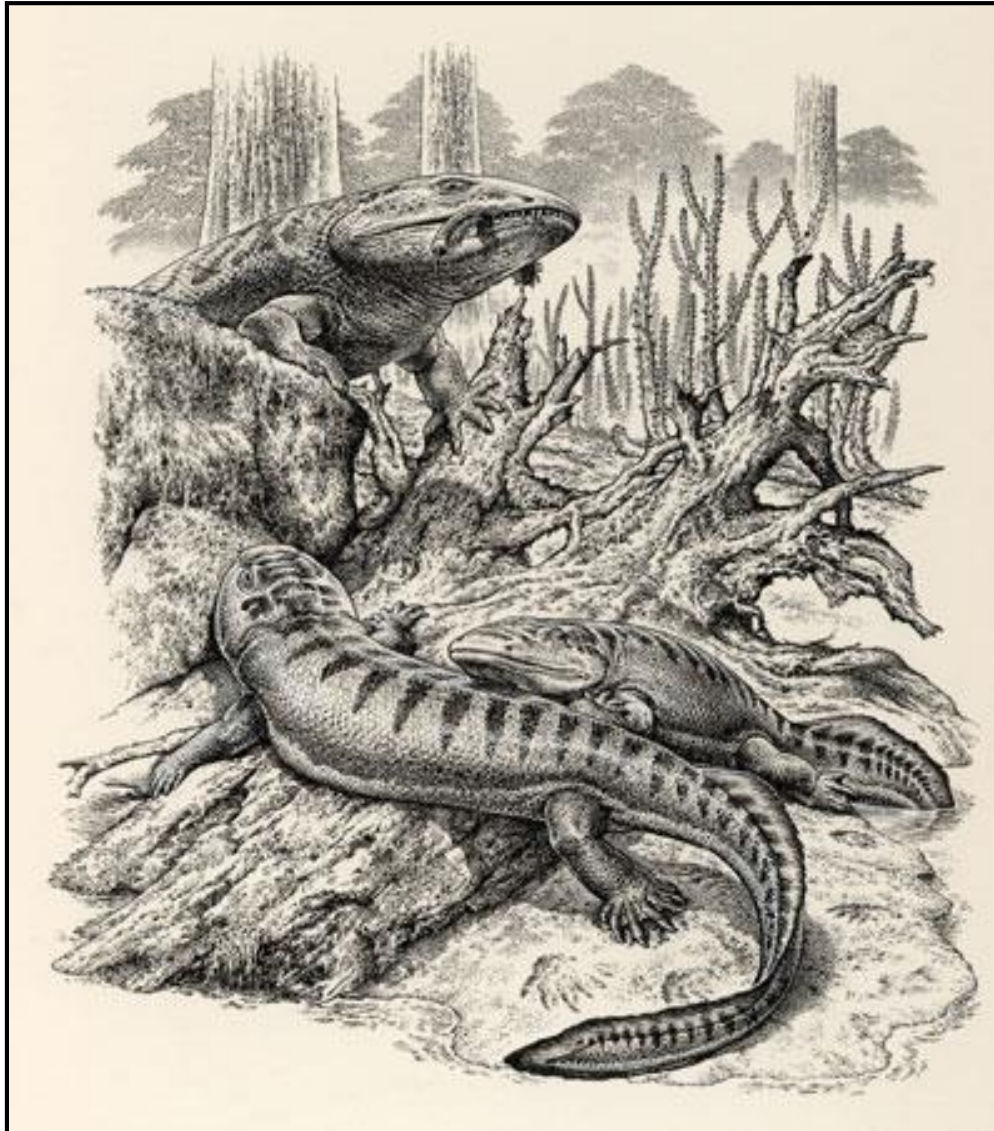


Vertebrados: tetrápodos



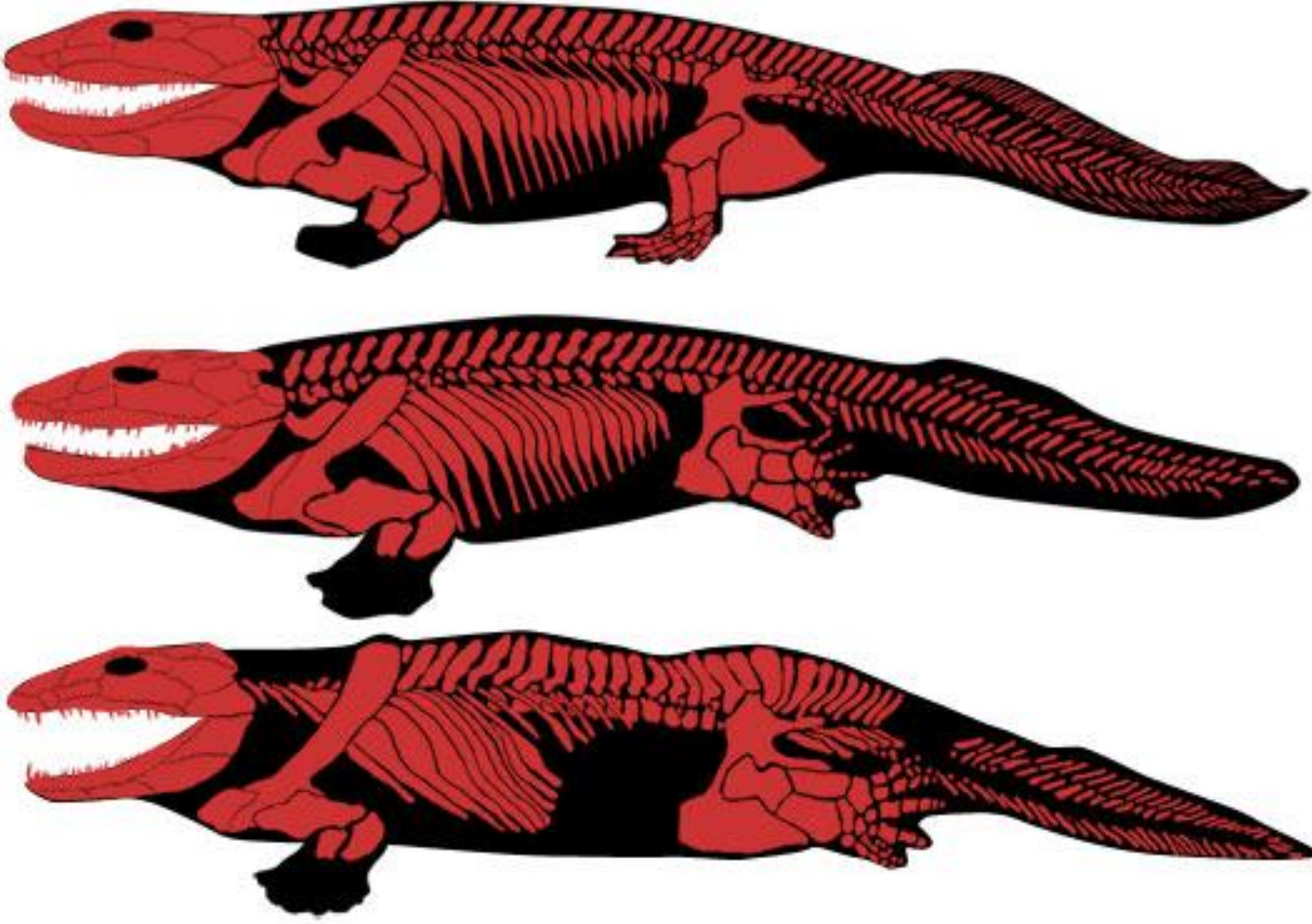
“Ichthyostegalia” (Devoniano superior)

Grupo parafilético: inclui *Ichthyostega* e *Acanthostega* (Groenlândia)



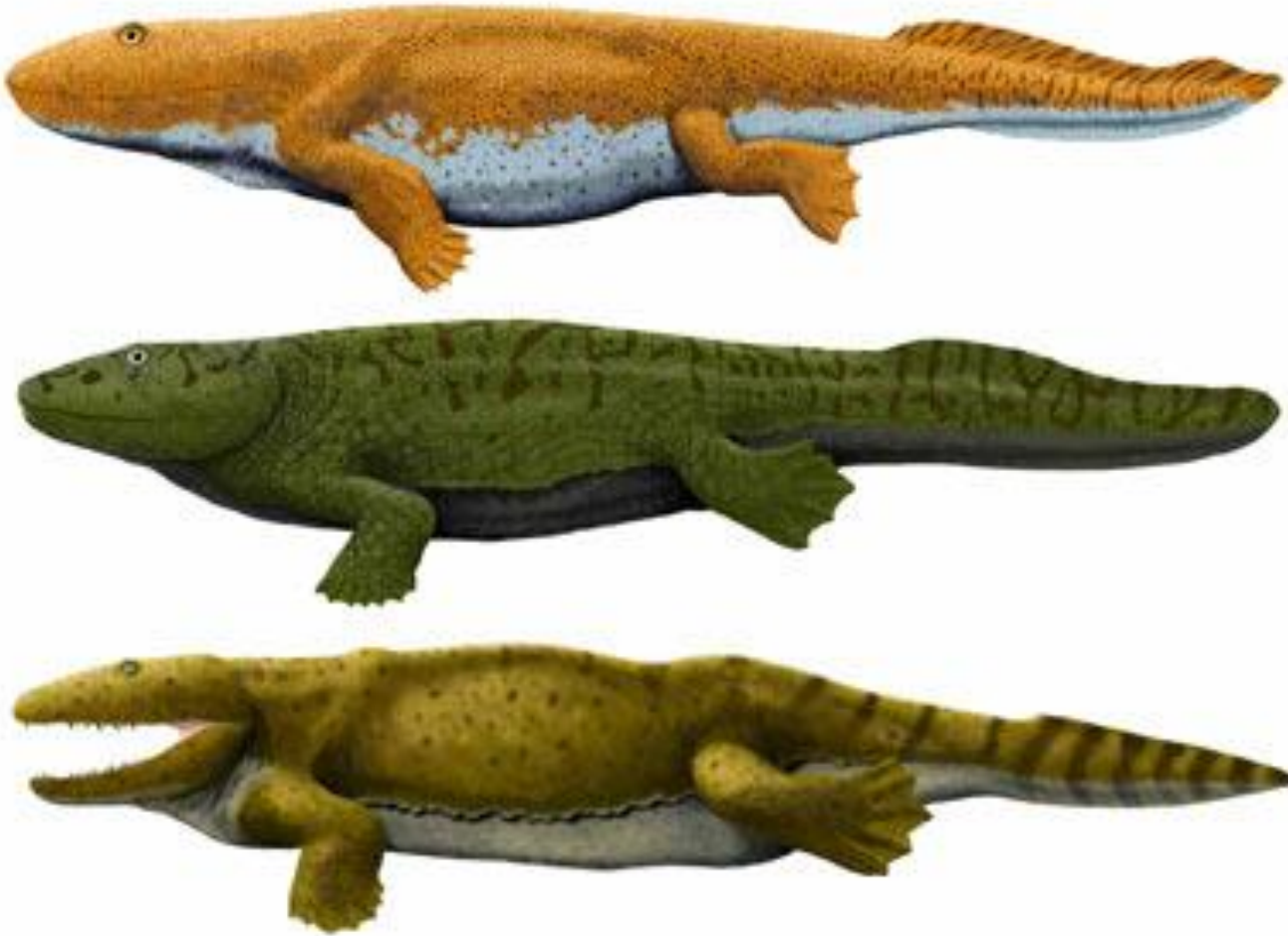
Formas de águas continentais
Ichthyostega e *Acanthostega*

“Ichthyostegalia” (Devoniano superior)



Ichthyostegia

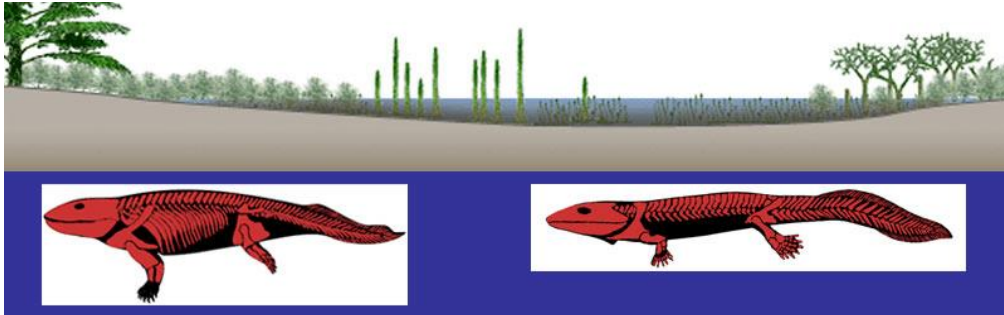
“Ichthyostegalia” (Devoniano superior)



Ichthyostegia

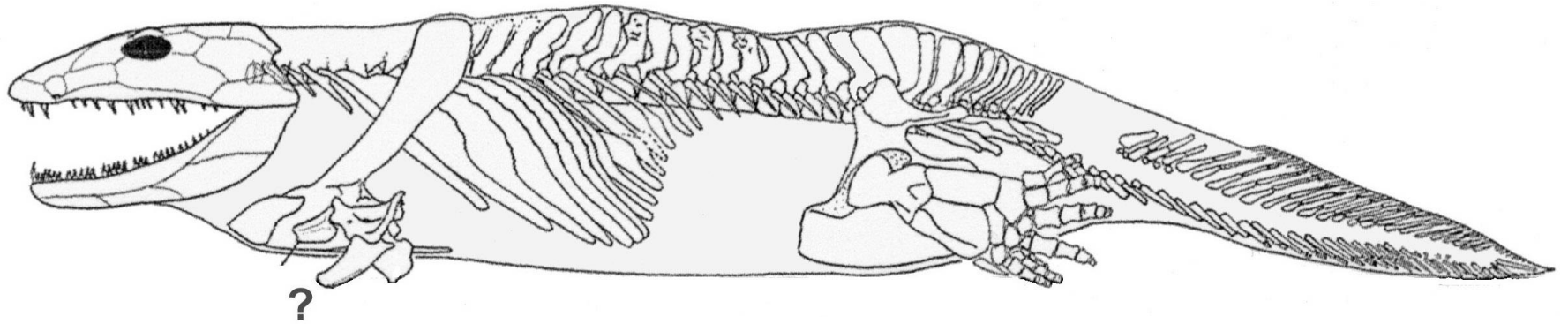
“Ichthyostegalia” (Devoniano superior)

Acanthostega seria algo mais aquático



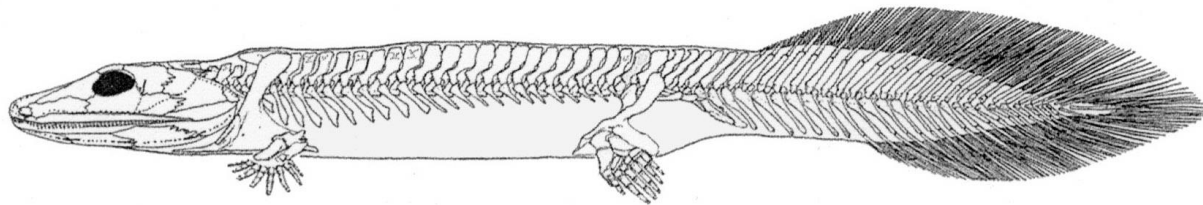
"Ichthyostegalia" (Devoniano superior)

Acanthostega seria algo mais aquático



Ichthyostega

10 cm



Acanthostega

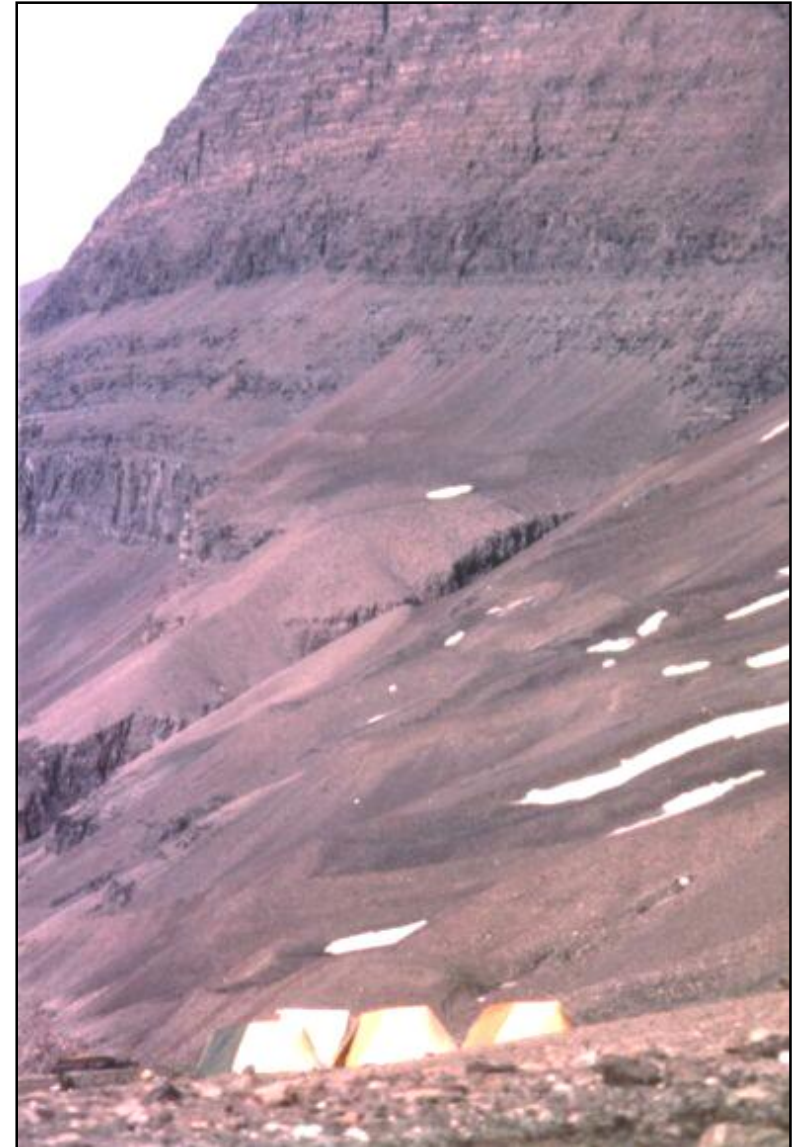
“Ichthyostegalia” (Devoniano superior)

Groenlândia: passado e presente



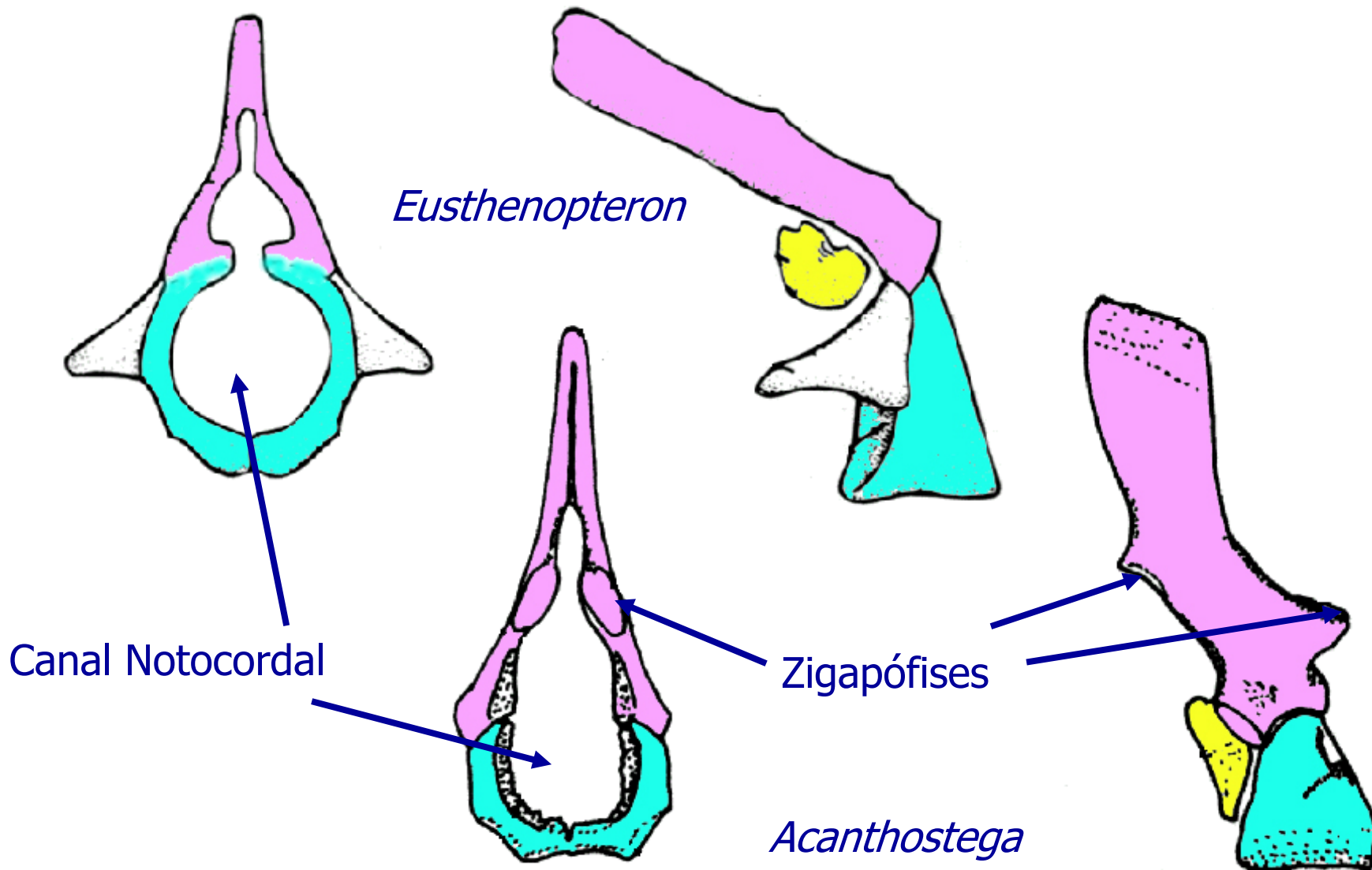
Passado

Presente



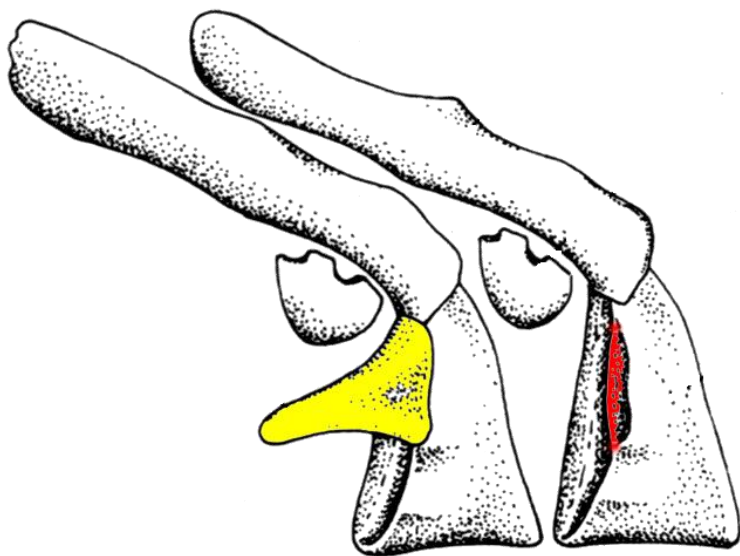
Tetrapoda (Devoniano – Recente)

Caracteres derivados: vértebras com pré- e pószigapófises



Tetrapoda (Devoniano – Recente)

Caracteres derivados: costelas bem desenvolvidas e dicocéfalas



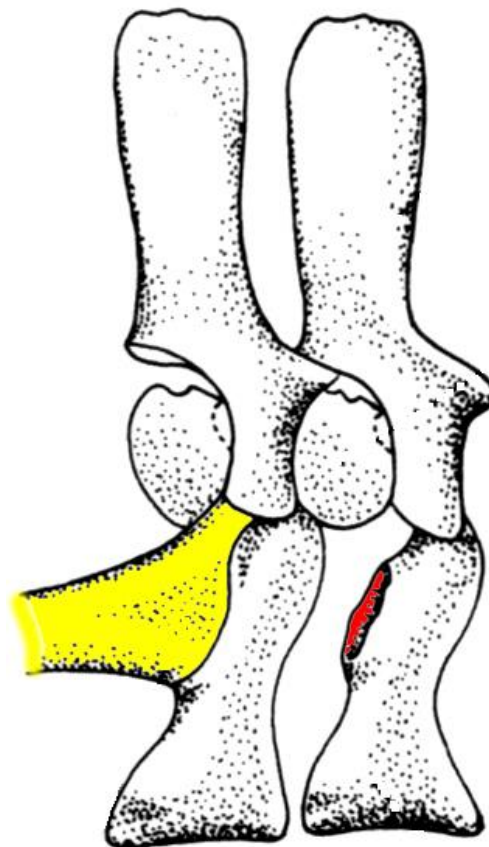
Eusthenopteron



Costelas



Articulações



Ichthyostegia

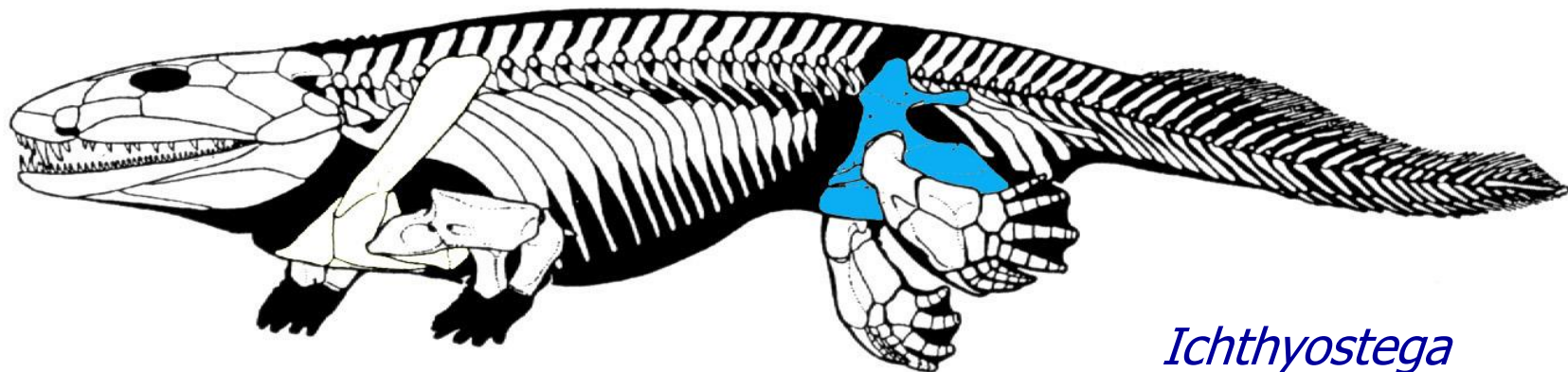
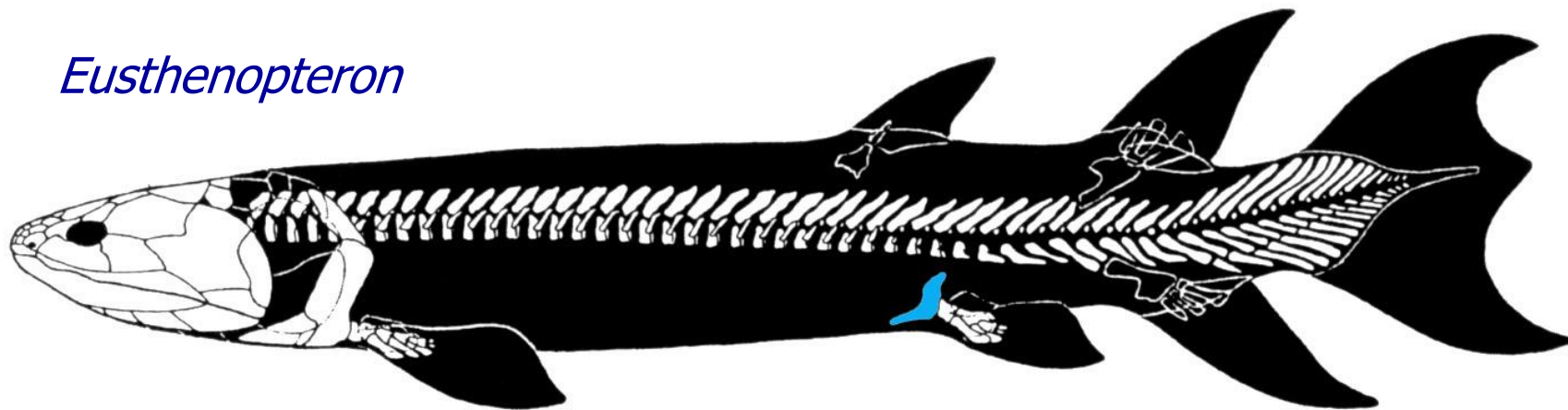


Acanthostegia

Tetrapoda (Devoniano – Recente)

Caracteres derivados: ílio ligado à coluna vertebral

Eusthenopteron

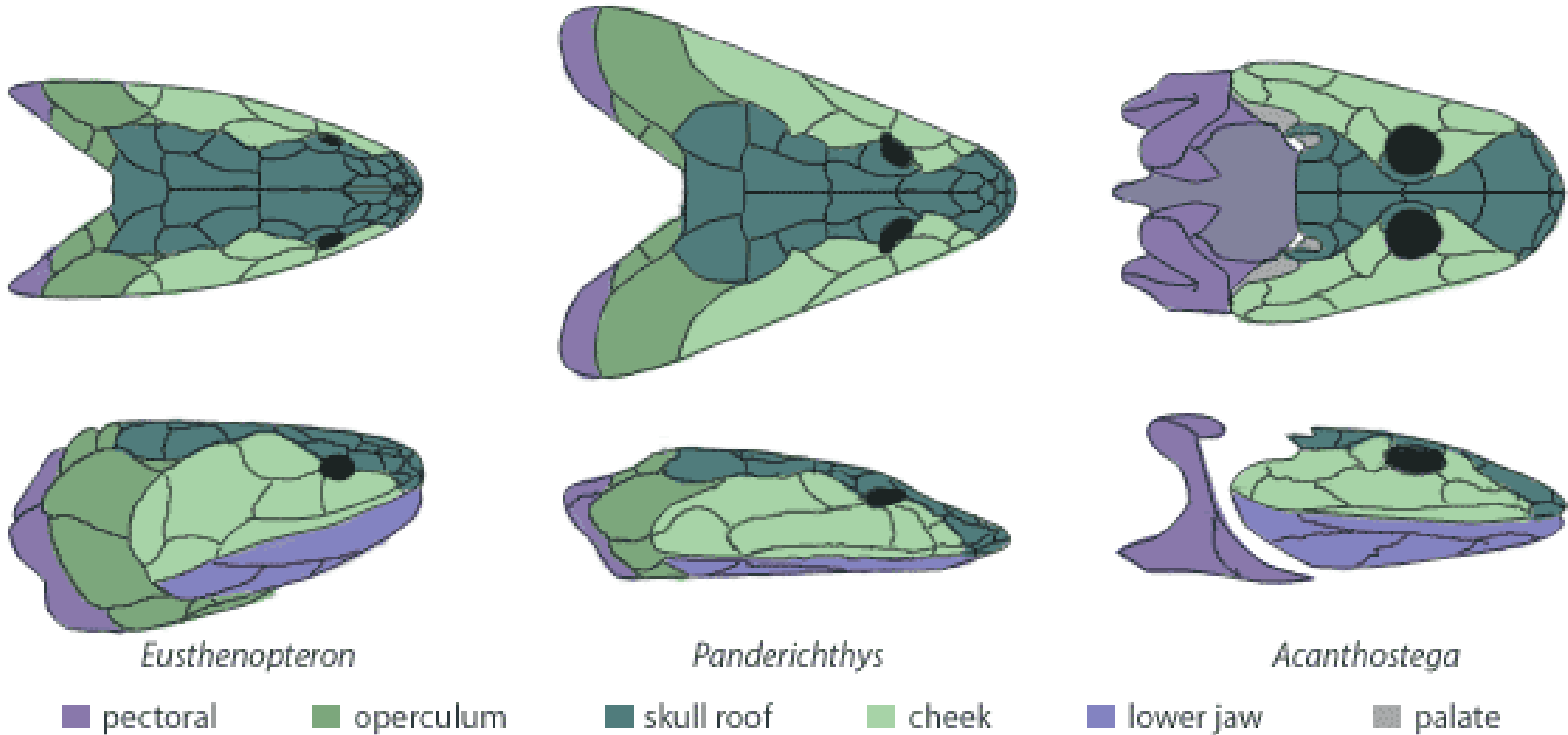


Ichthyostega

Tetrapoda (Devoniano – Recente)

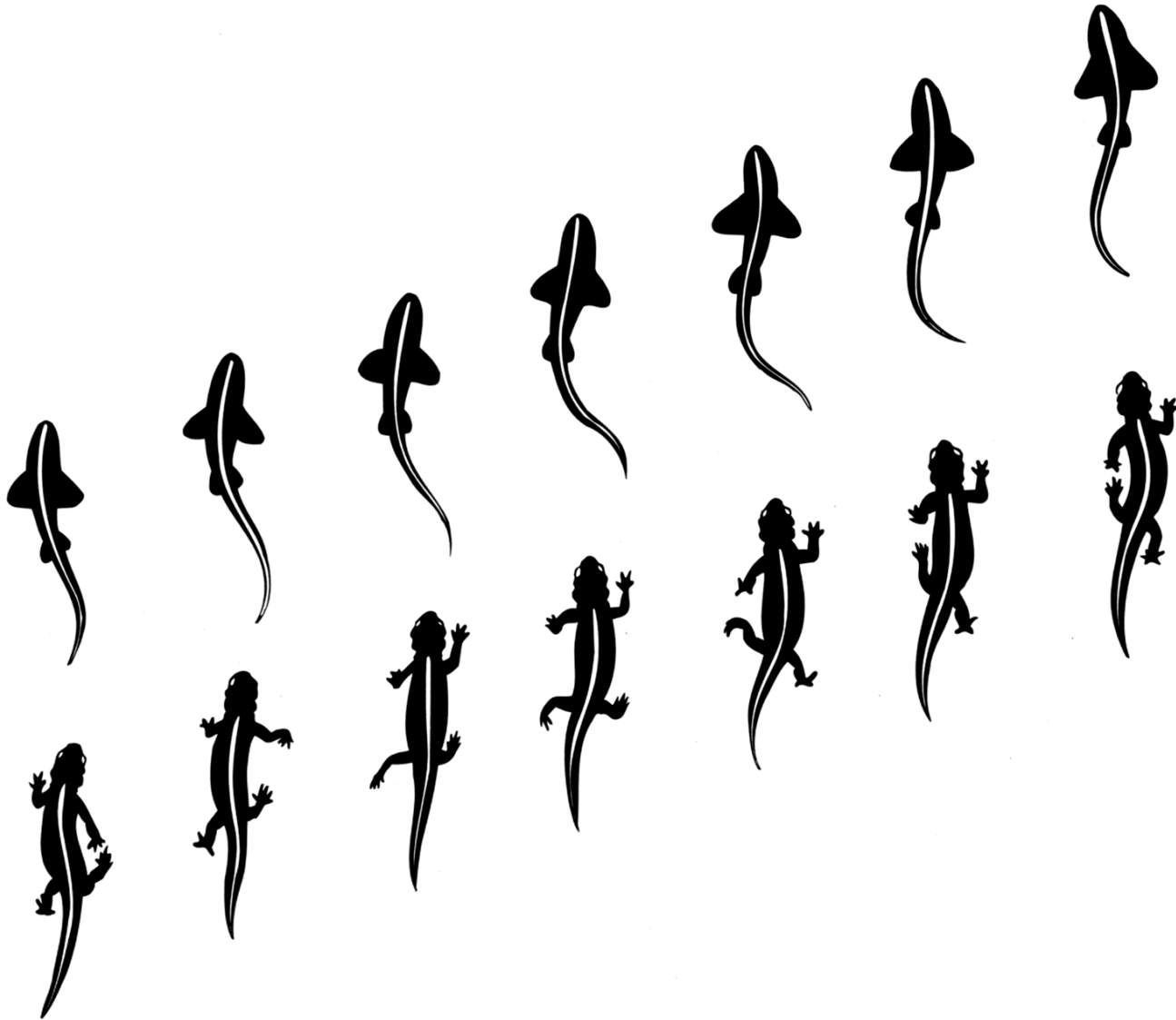
Caracteres derivados: cintura escapular se separa do crânio

redução dos elementos dérmicos da cintura escapular



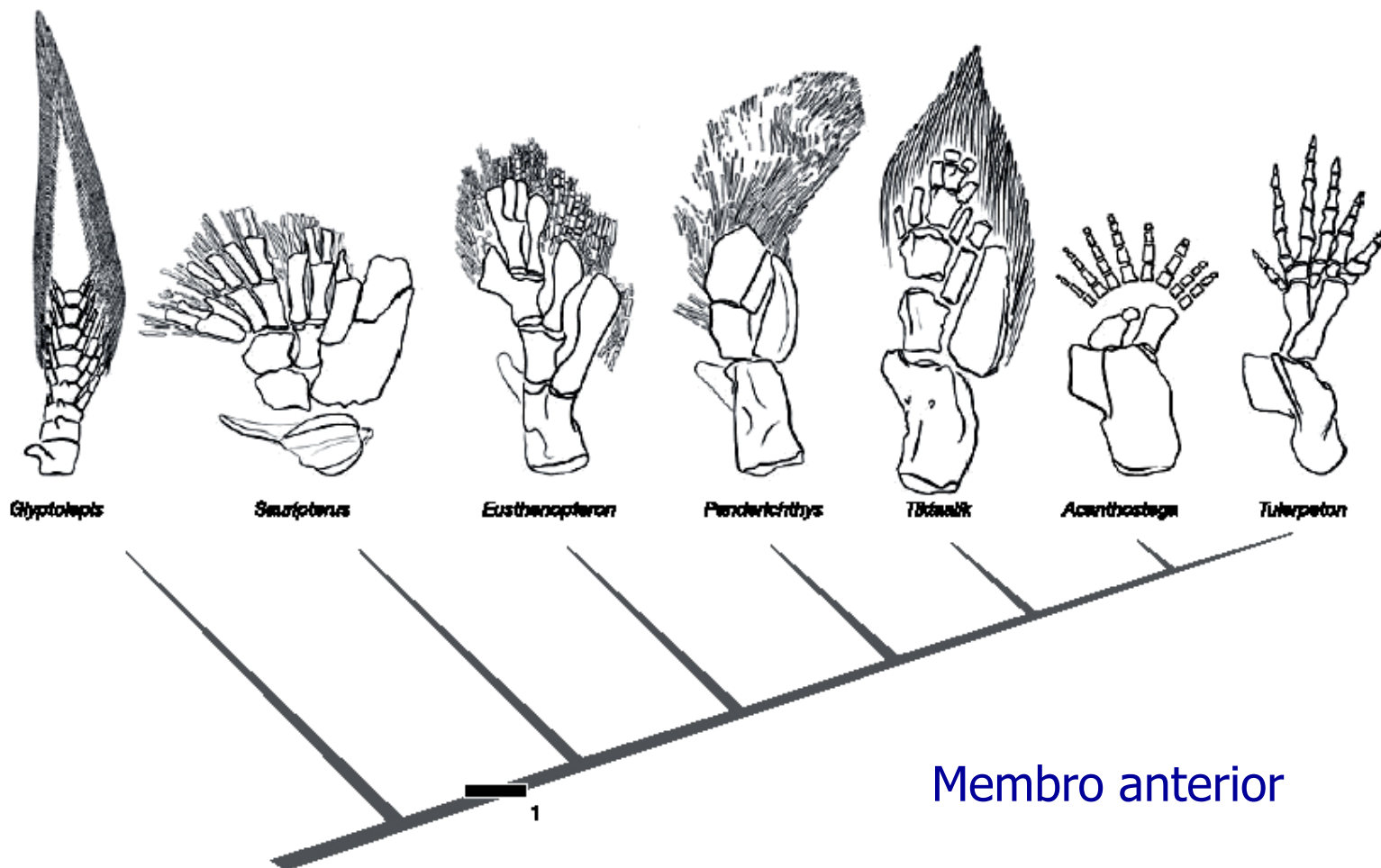
Problemas da vida na terra

Locomoção: tetrápodos basais caminham por ondulações laterais do corpo, suportadas pelas patas



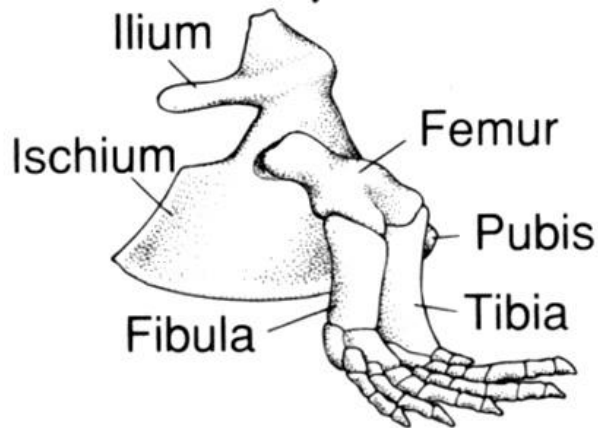
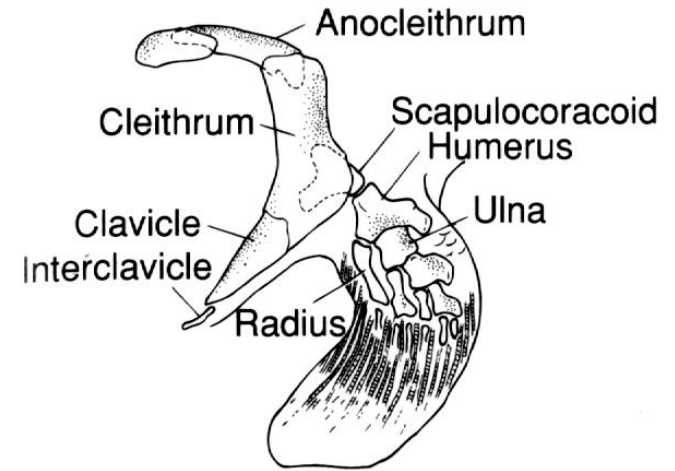
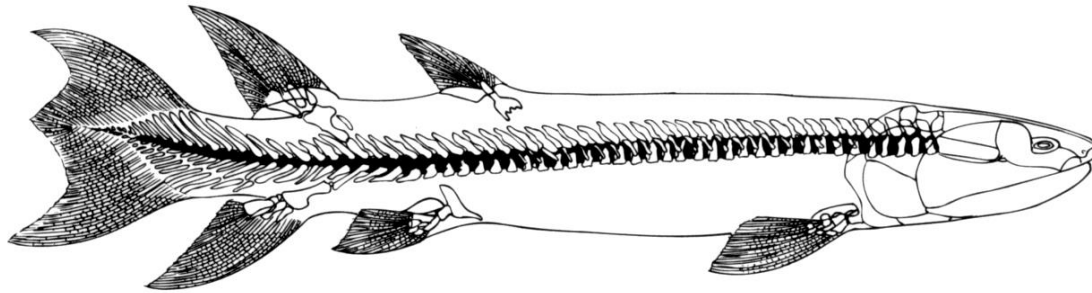
Tetrapoda (Devoniano – Recente)

Caracteres derivados: perda de raios nas "nadadeiras" pares e dígitos desenvolvidos

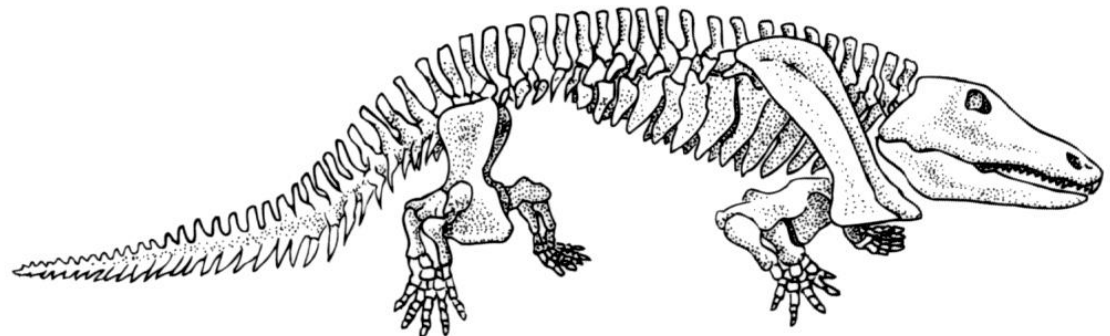


Problemas da vida na terra

Locomoção: terápodos com plataforma de apoio mais robusta formada por *manus/pes* com dígitos



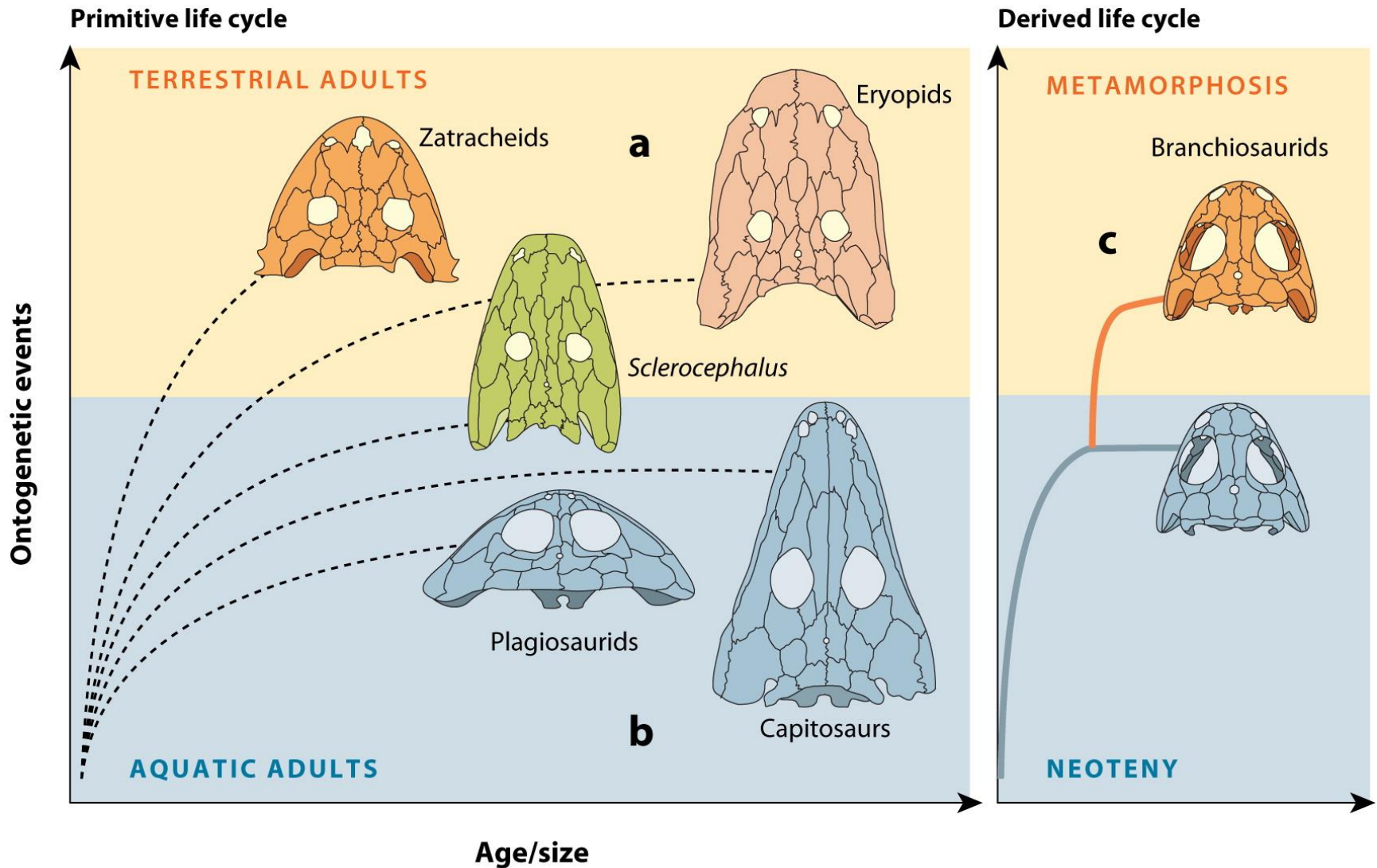
Coluna vertebral



Cinturas e membros

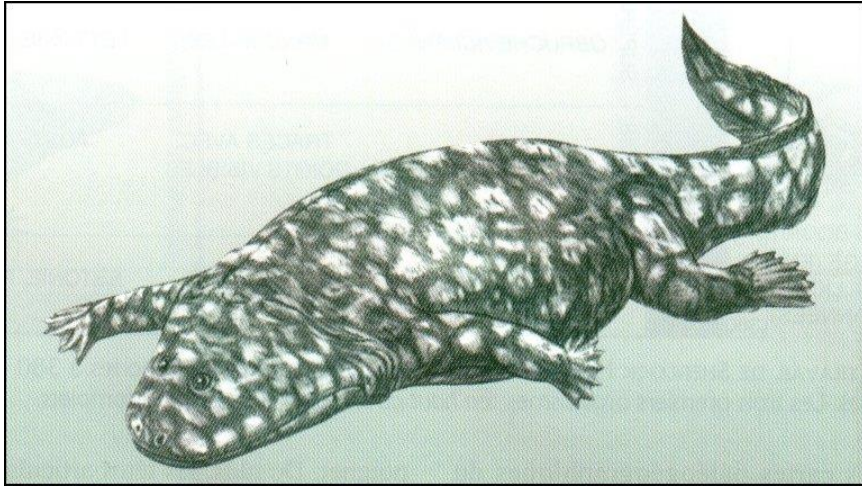
Problemas da vida na terra

Reprodução: presença de estágio larval aquático

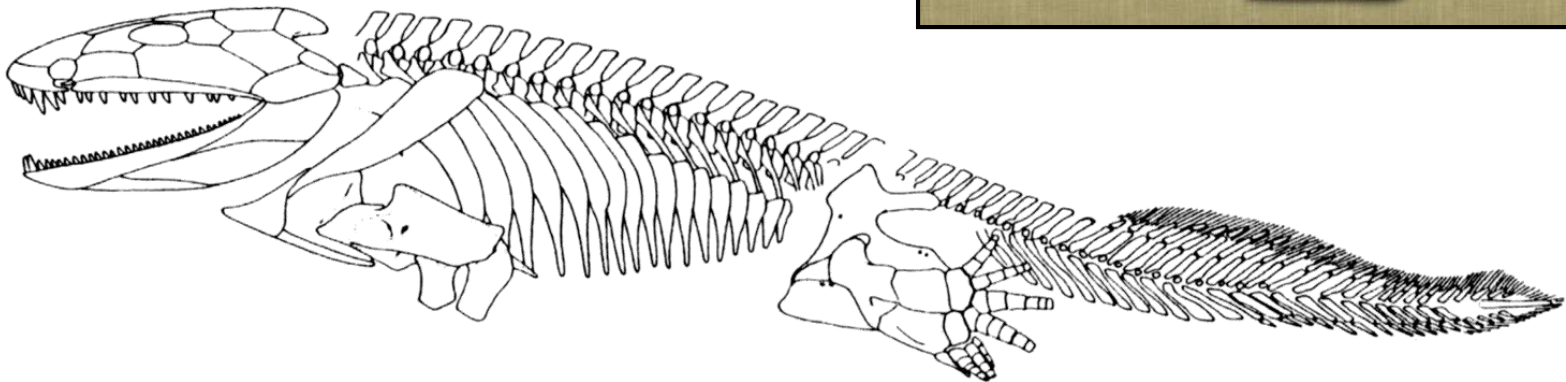


"Ichthyostegalia" (*Acanthostega* e *Ichthyostega*)

Adaptações para vida aquática: corpo pisciforme,
patas em forma de nadadeiras

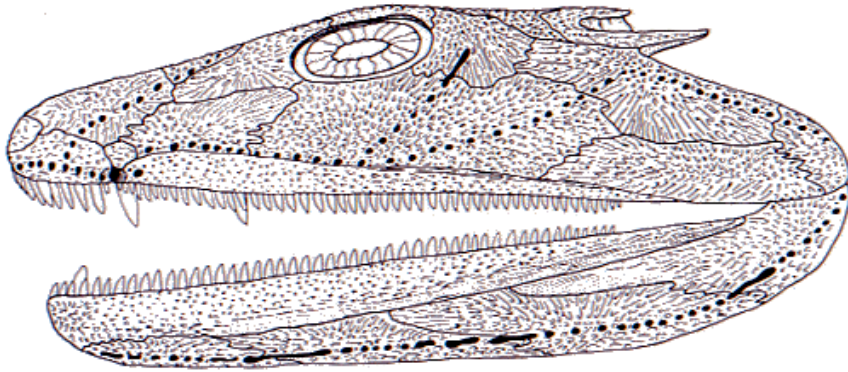


Ichthyostega

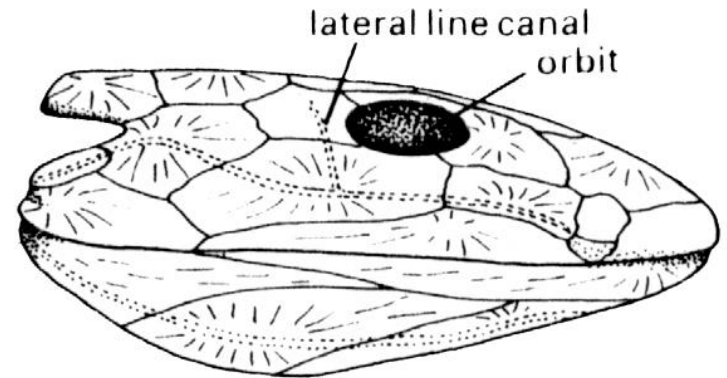


"Ichthyostegalia" (*Acanthostega* e *Ichthyostega*)

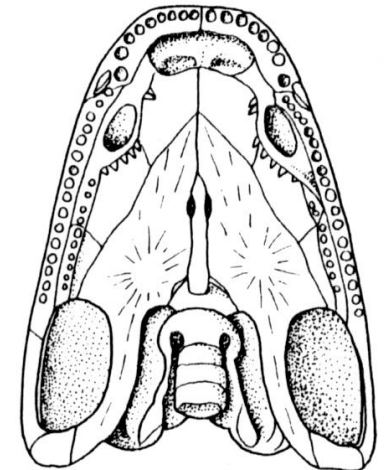
Adaptações para vida aquática: linha lateral no crânio



Acanthostega



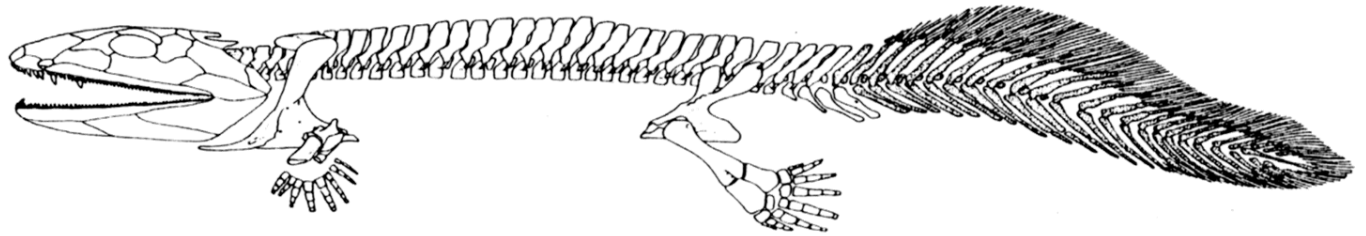
Ichthyostega



"Ichthyostegalia" (*Acanthostega* e *Ichthyostega*)

Adaptações para vida aquática: grande nadadeira caudal

Nadava por ondulações do corpo, mas poderia caminhar na terra



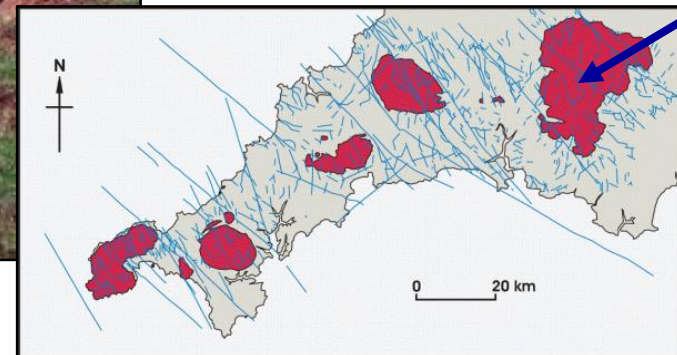
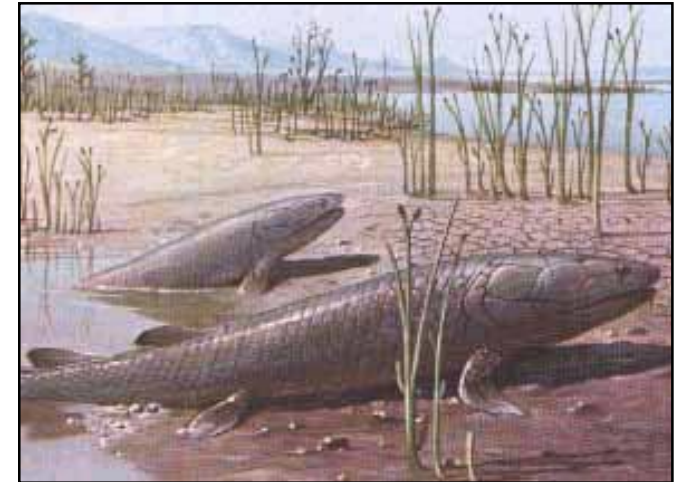
Acanthostega



Conquista do ambiente terrestre

Teoria clássica (A. S. Romer): momentos de aridez no Devoniano isolava corpos d'água em resecamento, favorecendo formas com capacidade de locomoção em terra firme e com respiração aérea

“Old Red Sandstone”



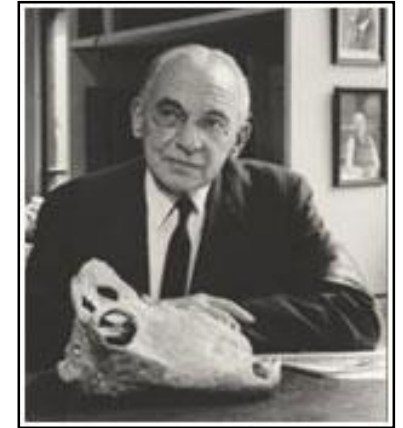
Devon

Conquista do ambiente terrestre

“Patas surgiram para os organismos permanecerem na água”



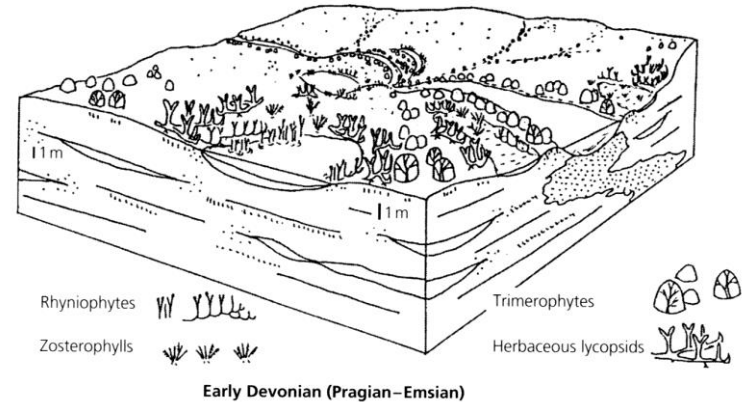
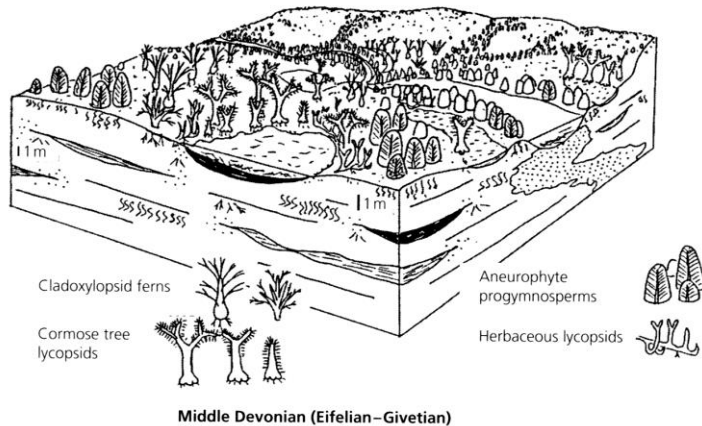
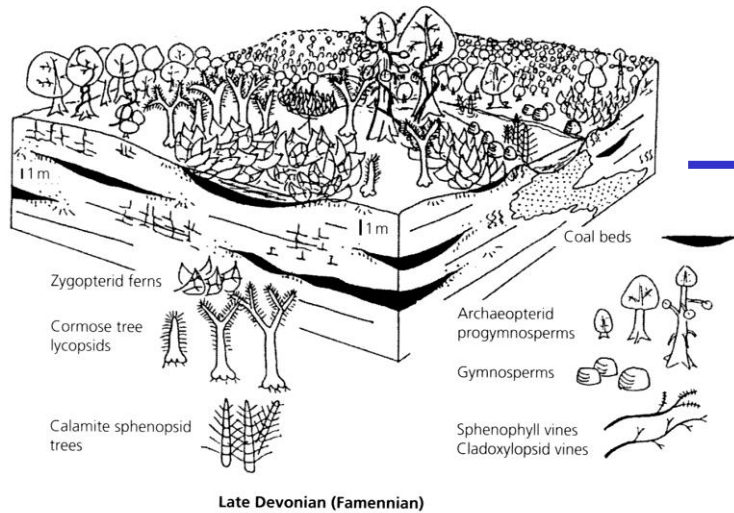
Romer considerava os primeiros tetrápodos tipicamente aquáticos



Conquista do ambiente terrestre

Problemas : evidencias de secas no Devoniano são controversas

Red-beds pode formar-se em qualquer ambiente oxidante como as florestas que ocorriam em baixas latitudes no Paleozóico superior



Conquista do ambiente terrestre

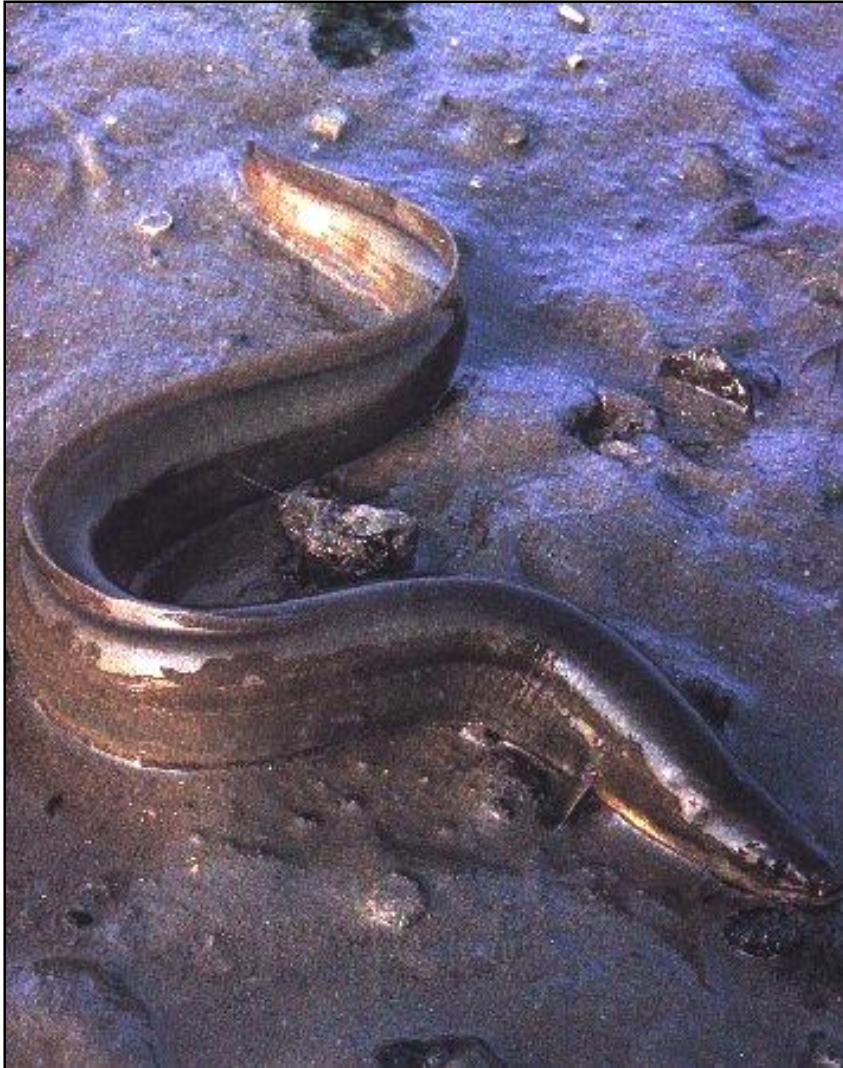
Problemas: em geral, os "anfíbios" de áreas desérticas não abandonam lagos secos



Cyclorana alboguttata

Conquista do ambiente terrestre

Problemas : modificações anatômicas muito profundas para hábito relacionado à comportamento eventual



A maioria dos "peixes" atuais que se aventuram em ambiente subaéreo (e.g.: enguias, pirambóia) carecem de estruturas "tipo patas"

Conquista do ambiente terrestre

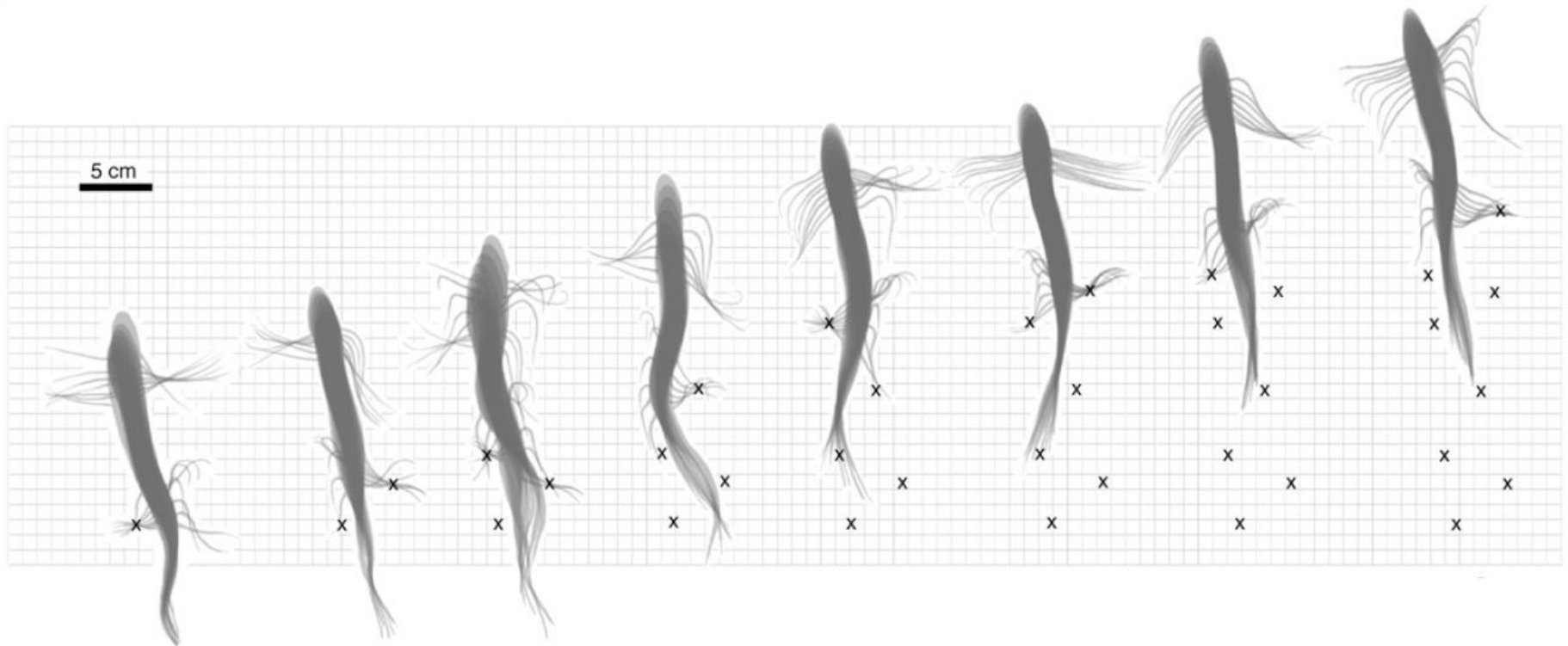
Problemas: formas tipicamente aquáticas podem "caminhar"



*Antennarius
multiocellatus*

Conquista do ambiente terrestre

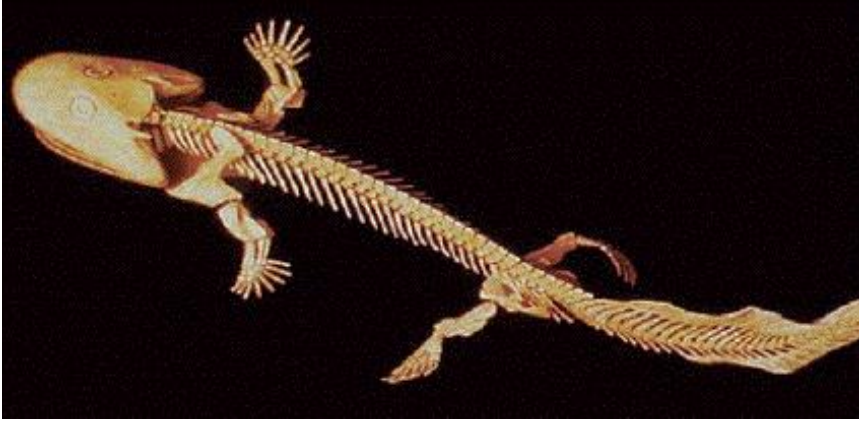
Problemas: formas aquáticas podem "caminhar"



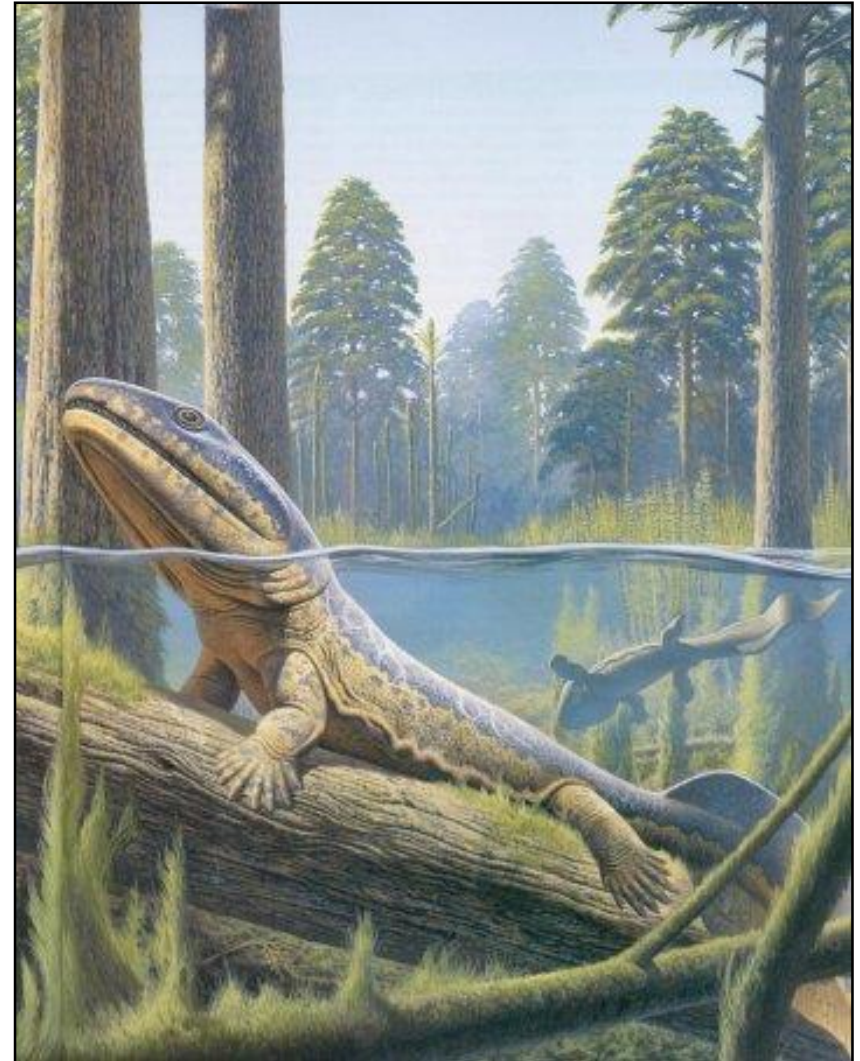
Protopterus

Conquista do ambiente terrestre

Importante dissociar o surgimento de estruturas tipo pata,
da locomoção tipo "caminhar" e da terrestrialidade

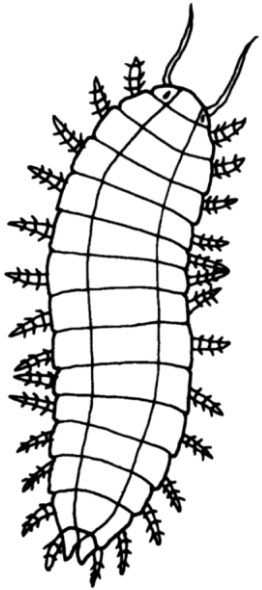


Caracteres de tetrápodos surgiram
antes da terrestrialização,
como adaptações à ambientes
subaquáticos rasos, sendo que
representavam "pré-adaptações"
à ambientes terrestres



Conquista do ambiente terrestre

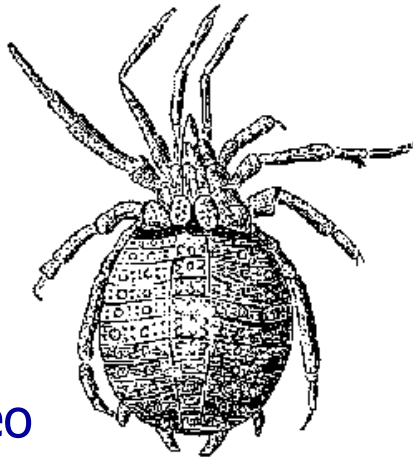
Terrestrialização deve ter sido condicionada à procura de novos recursos (pouco explorados nos ambientes continentais), bem como para escapar da maior pressão de predação dos ambientes aquáticos



Miriápode

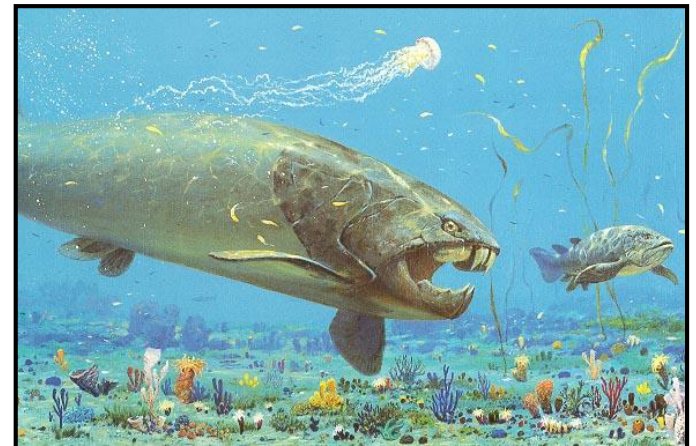


Euriptérido



Trigonotarbídeo

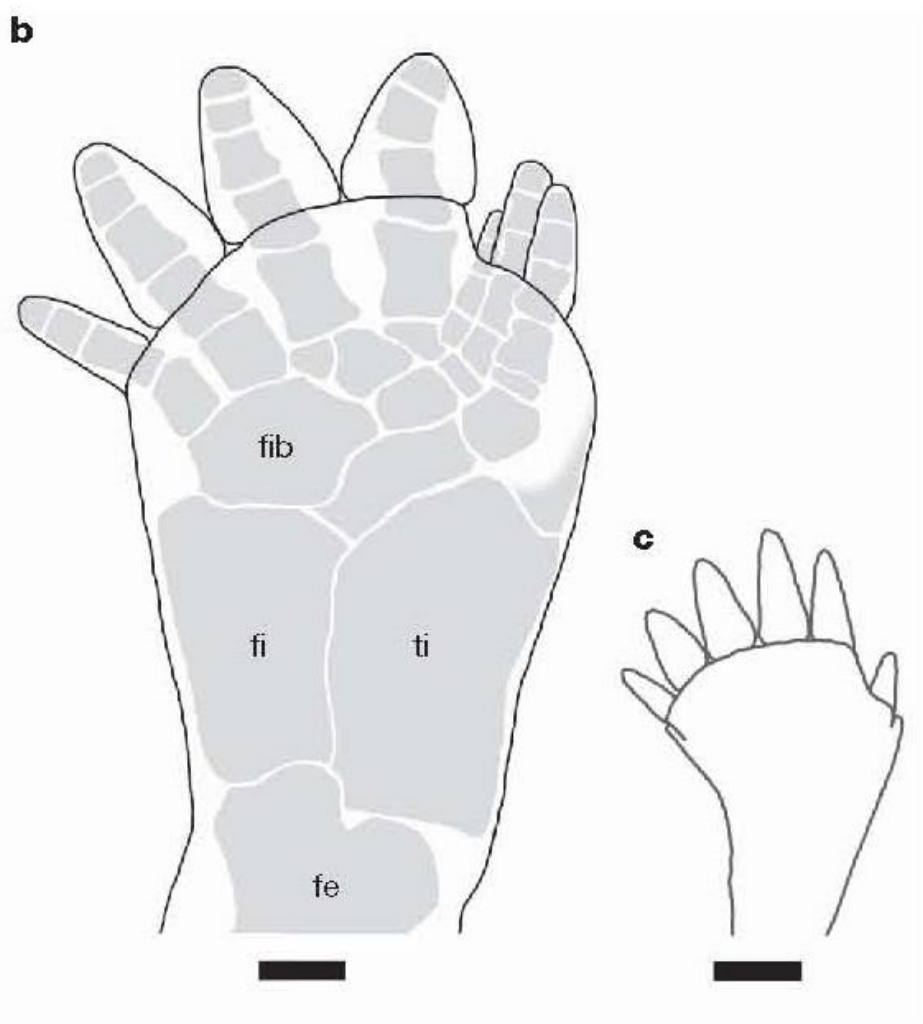
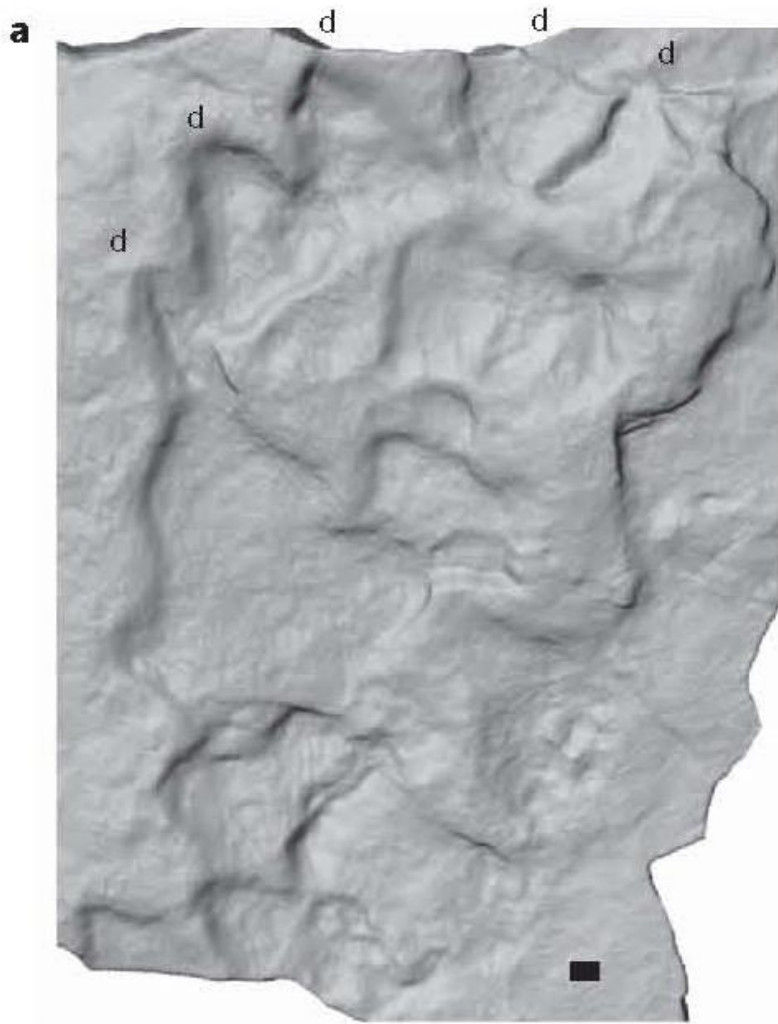
"Peixes"



Pegadas de Zachełmie (Eifeliano da Polônia)

Origem mais antiga do padrão locomotor de Tetrapoda

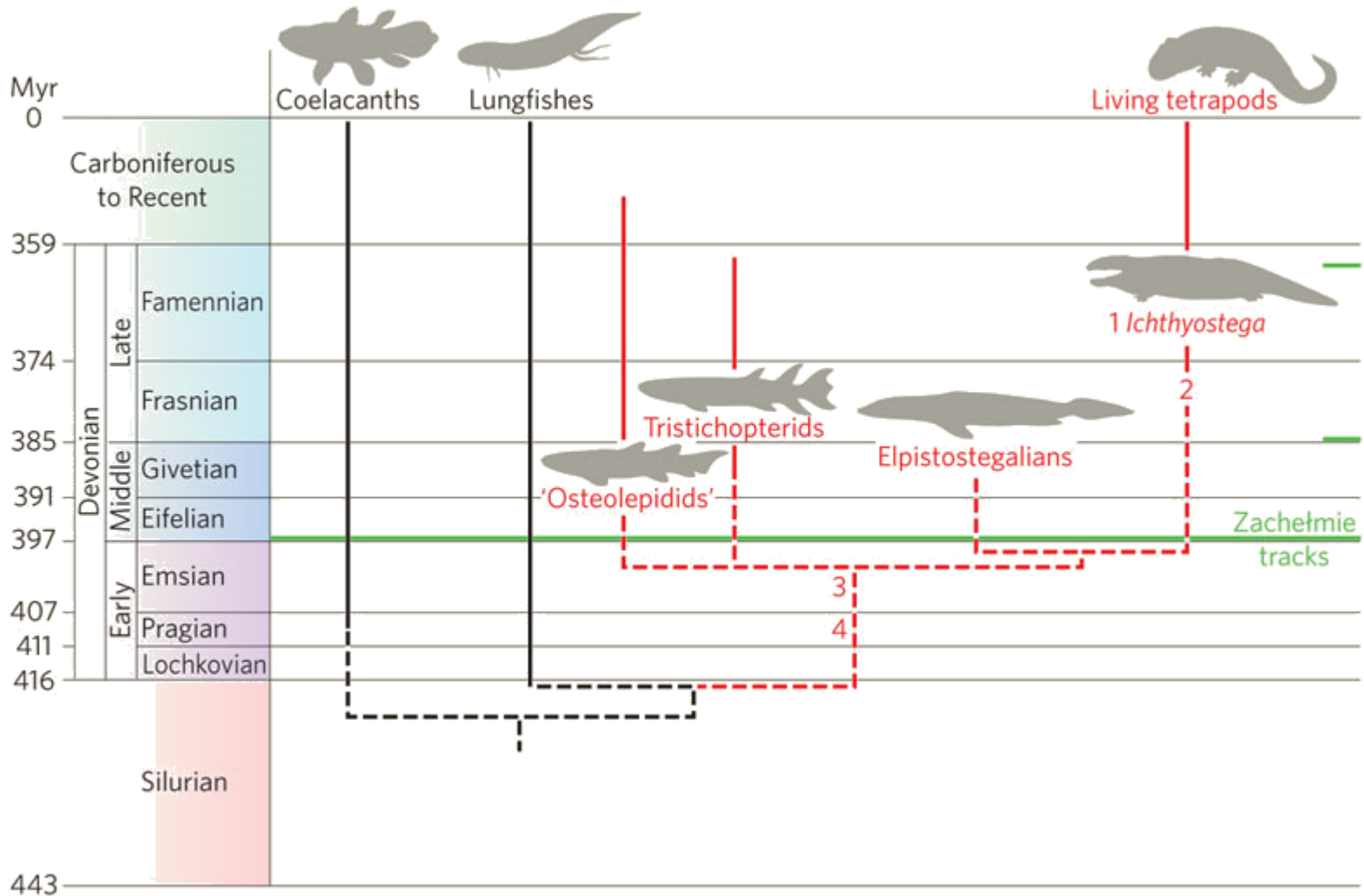
Gosth Lineage? Convergências?



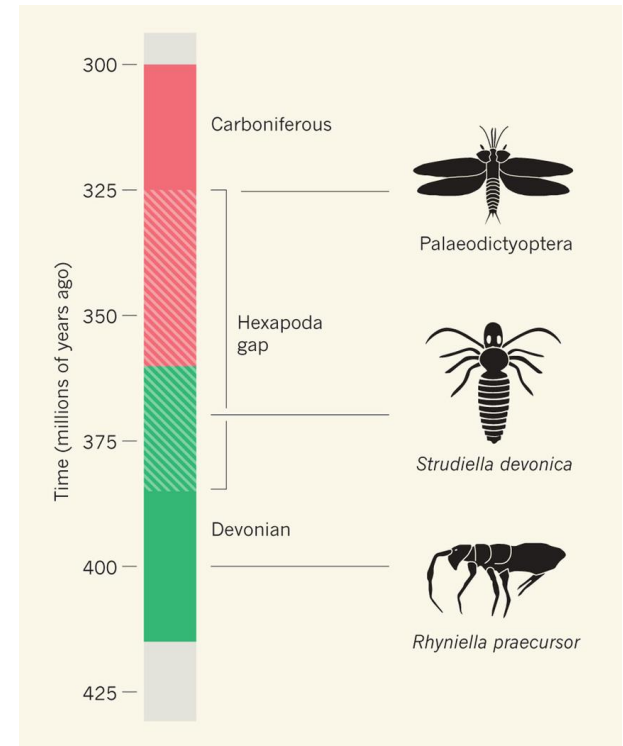
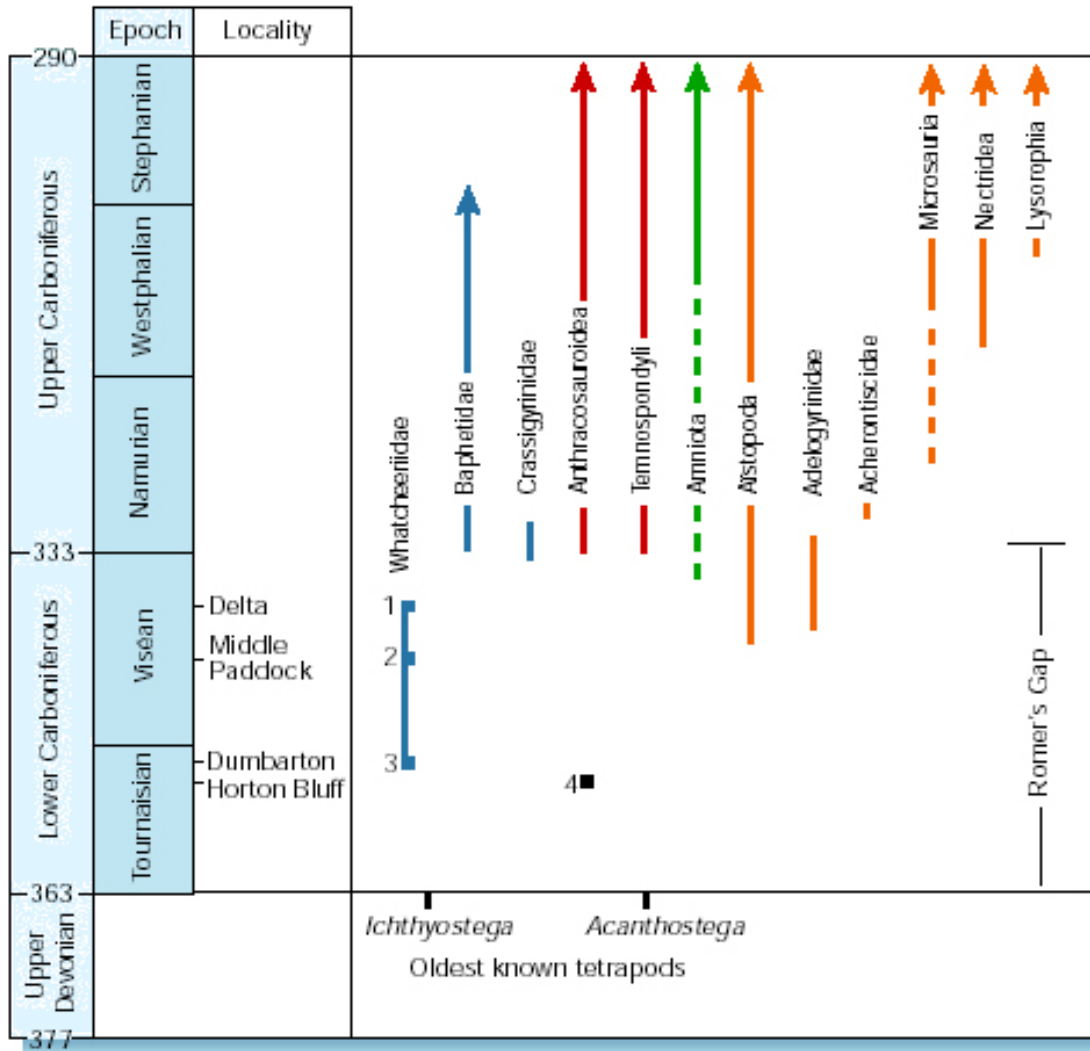
Pegadas de Zachełmie (Eifeliano da Polônia)

Origem mais antiga do padrão locomotor de Tetrapoda

Gosth Lineage? Convergências?



Romer's gap





bbc.co.uk/science

**WALKING
WITH MONSTERS**

LIFE BEFORE DINOSAURS