

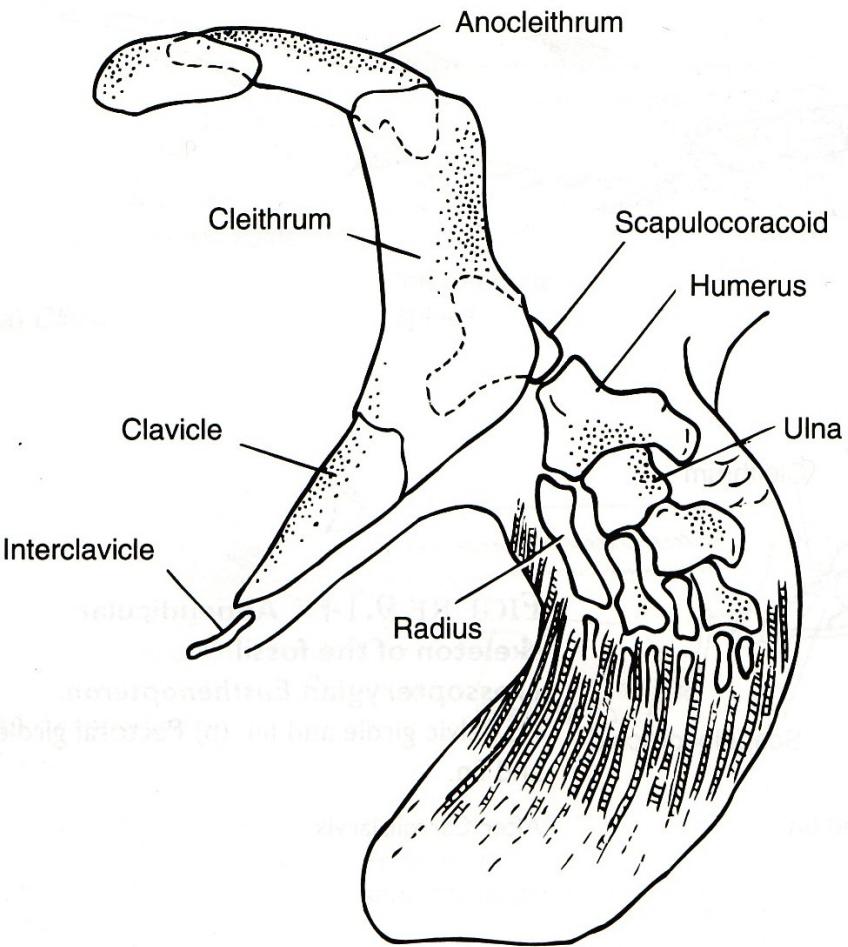
Smalto e dentina

Lo smalto e la dentina: disegno semischematico (**A**) e preparato istologico (**B**) che illustra i rapporti topografici fra i due tessuti e la direzione della loro produzione da parte delle cellule specializzate. Le unità strutturali fondamentali dello smalto sono i **prismi** o **bastoncini**, formazioni allungate disposte trasversalmente all'asse > del dente, che occupano l'intero spessore dello smalto, compreso fra la superficie interna, a contatto con la dentina, e la superficie libera. Ogni prisma ha un diametro è di 4÷8 μm ed è formato da una massa addensata di cristalli di idrossiapatite $[\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2]$.

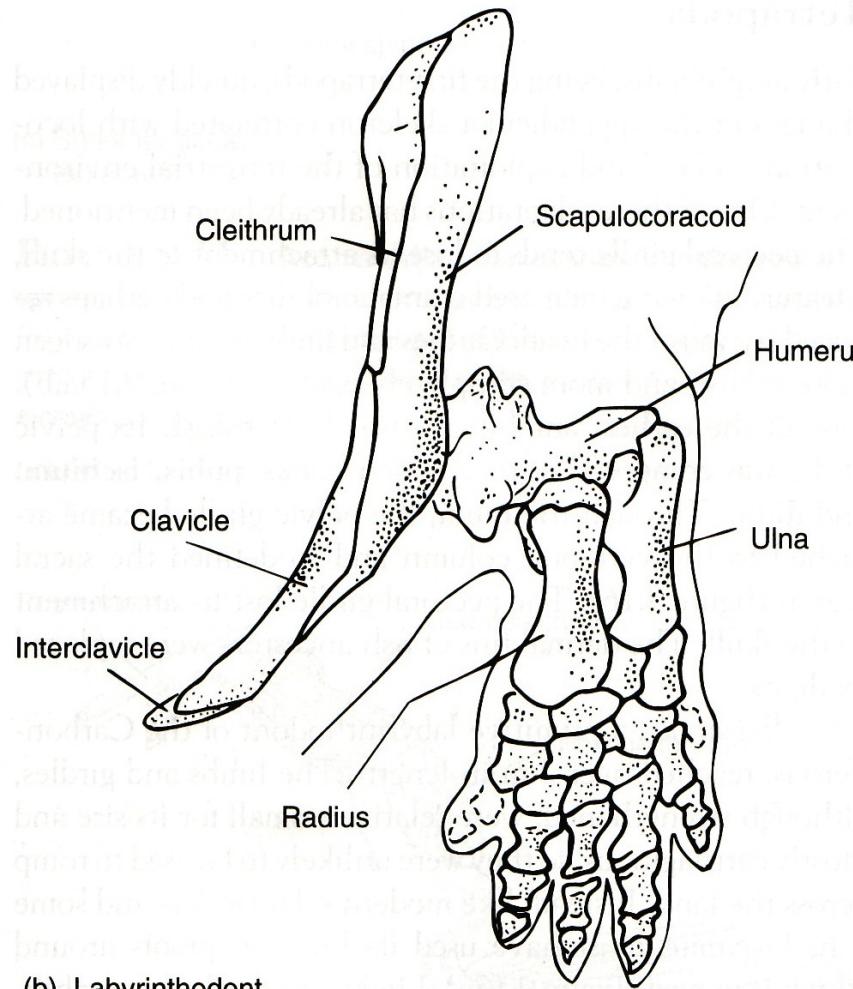


Smalto

Dentina o avorio

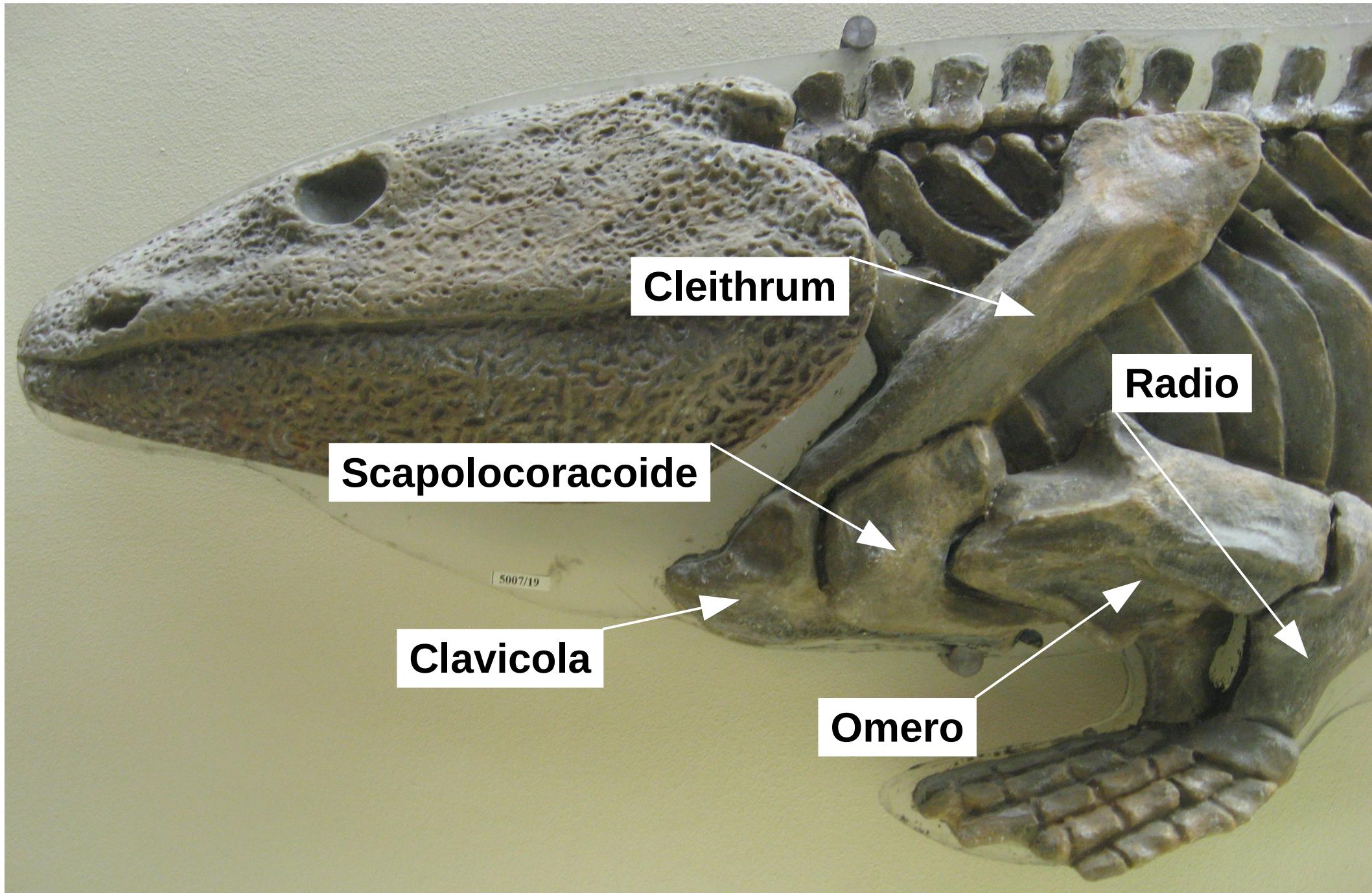


(a) Crossopterygian
Eusthenopteron

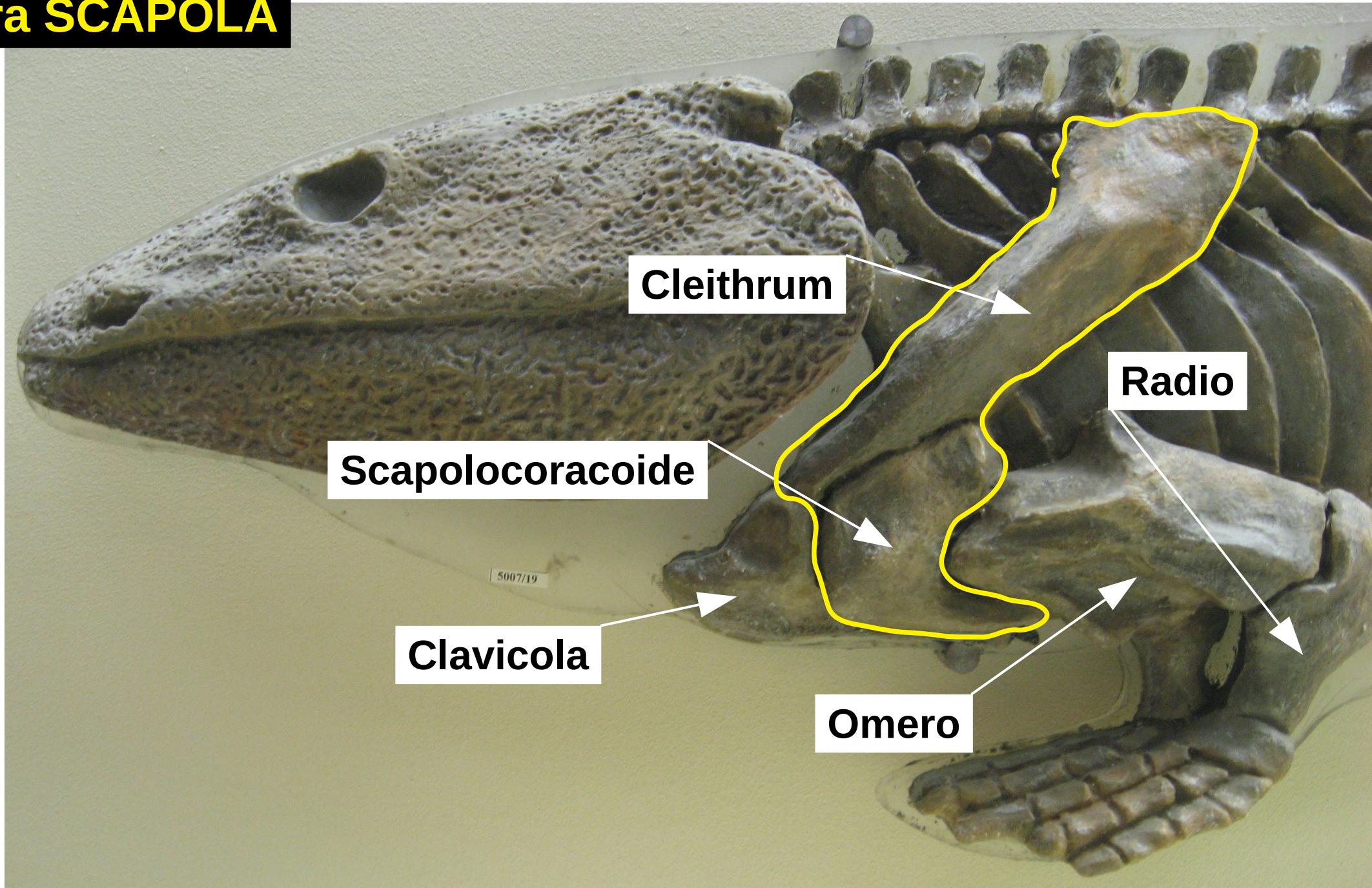


(b) Labyrinthodont
Eryops

Scheletro appendicolare del pesce a pinne lobate *Eusthenopteron* del Devoniano superiore (a) e dell'anfibio labirintodonte *Eryops* del Periodo Carbonifero (360÷290 Mya, b). Si noti la corrispondenza fra i vari segmenti ossei dell'arto toracico.

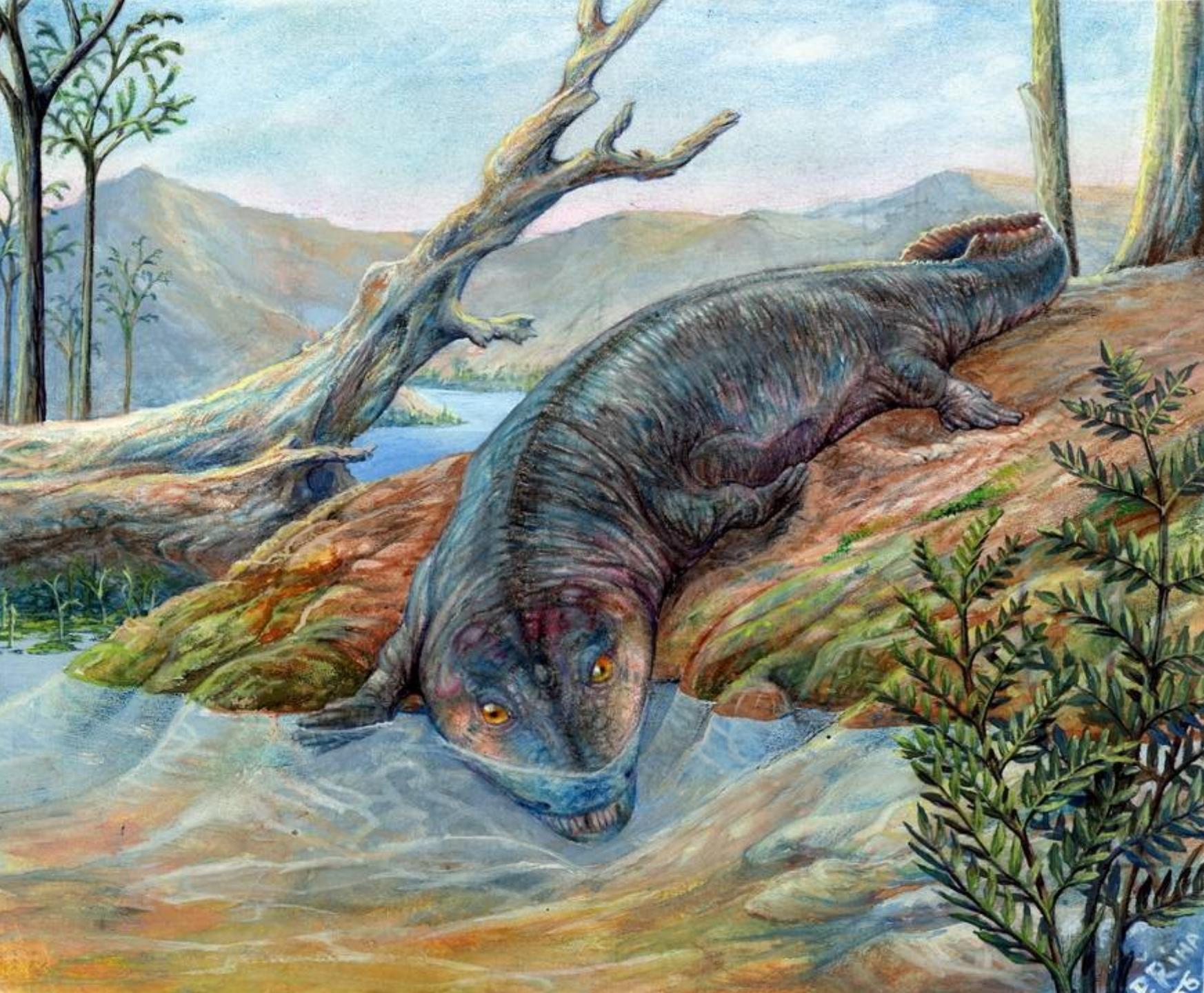


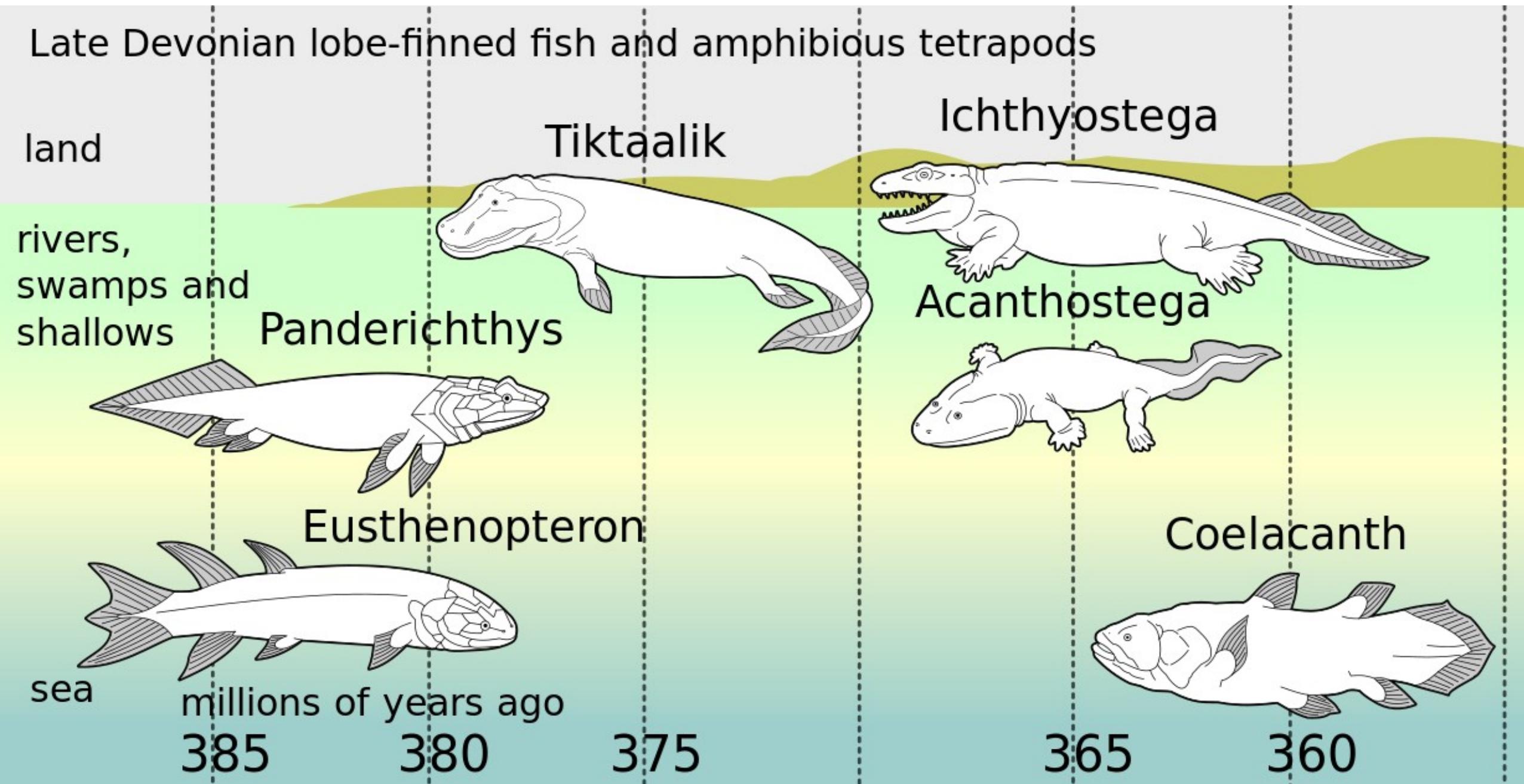
Futura SCAPOLA

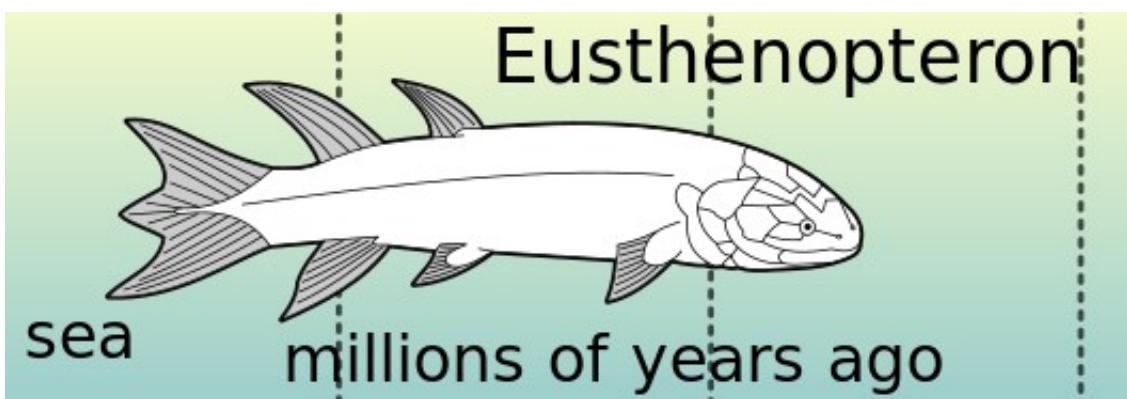


Classe:
Amphibia

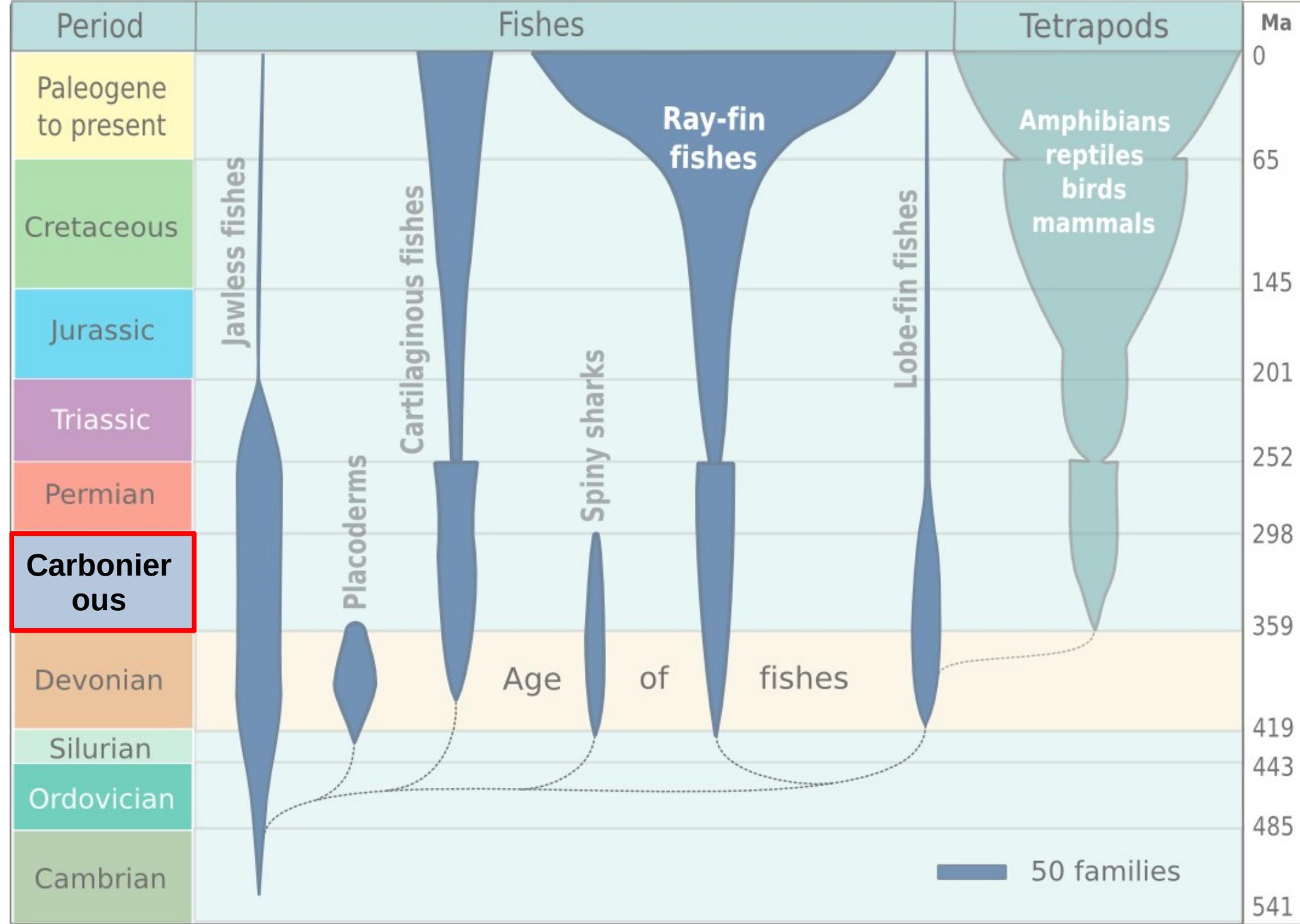
Sottoclasse:
Labyrinthodontia





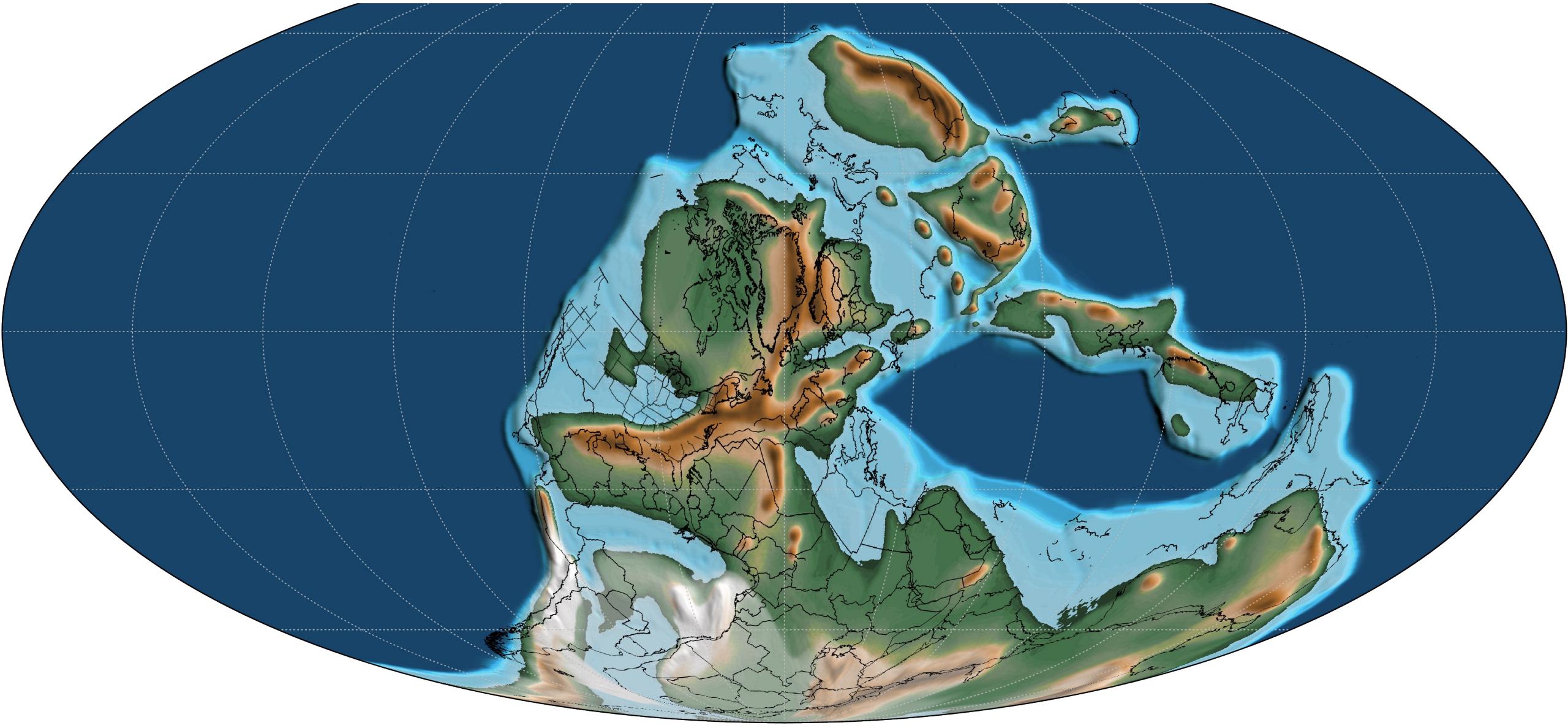


II Carbonifero



II Carbonifero

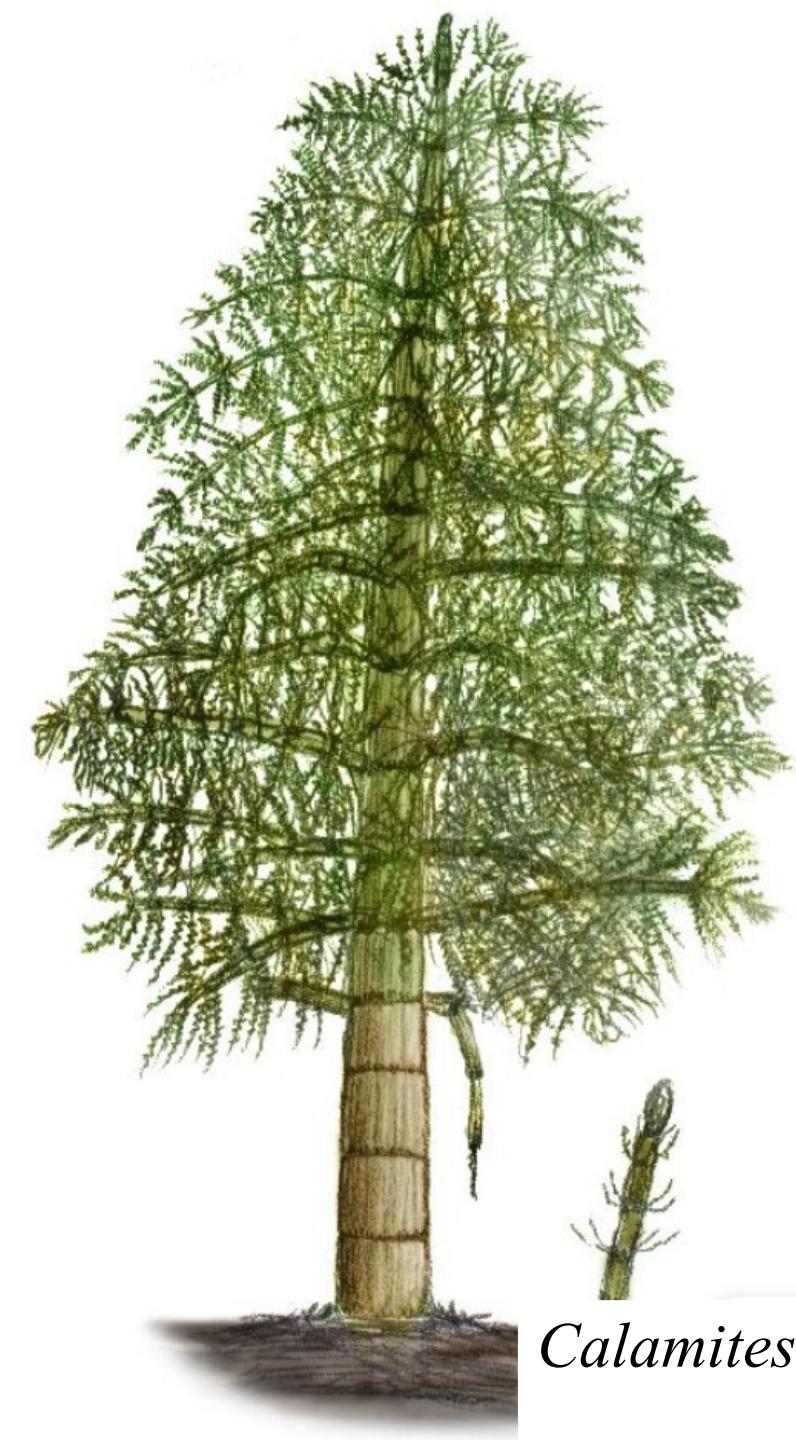
A map of Earth 330 million years ago, overlayed by a black outline of present-day countries in their respective locations



360	formazione di calotte glaciali al polo S	crittogramme vascolari arboree (lepidodendri) e gimnosperme arboree foreste pluviali tropicali acquitrinose in Euroamerica; flora a <i>Glossopteris</i> a Sud
350		Amniota animali sottili e vermiformi provvisti di denti (conodonti) con microstruttura particolare scoperti in Scozia
320		Primi sinapsidi in N America
	dal margine N del Gondwana si stacca la placca Adriatica o Egeide	Synapsida, Anapsida e Diapsida , distinti in base a numero, dimensioni e posizione delle fosse temporali Synapsida → Pelycosauria (N America - S Africa): primitivi Synapsida → Therapsyda (Russia, Cina, S Africa): antenati dei Mammiferi una sola apertura temporale laterale, le ossa postorbitale e squamoso unite dorsalmente, <u>articolazione quadrato-articolare</u>
290	il continente euroamericano si sposta verso N; le catene montuose di N Africa e N America bloccano i venti occidentali umidi dall'oceano → formazione di deserti fusione calotte polari, espansione subtropici	Sphenacodontidae (<i>Dimetrodon</i>), carnivori derivati dai pelicosauri: osso angolare della mandibola presenta una lamina ripiegata → sviluppo dell'orecchio medio nei sinapsidi successivi e nei mammiferi

Il Carbonifero

Grandi foreste: *Lepidodendron*, *Calamites*, *Sigillaria*



Calamites

Il Carbonifero

Grandi foreste:
Sigillaria



Sigillaria

Il Carbonifero

Arthropleura



II Carbonifero

Meganeura

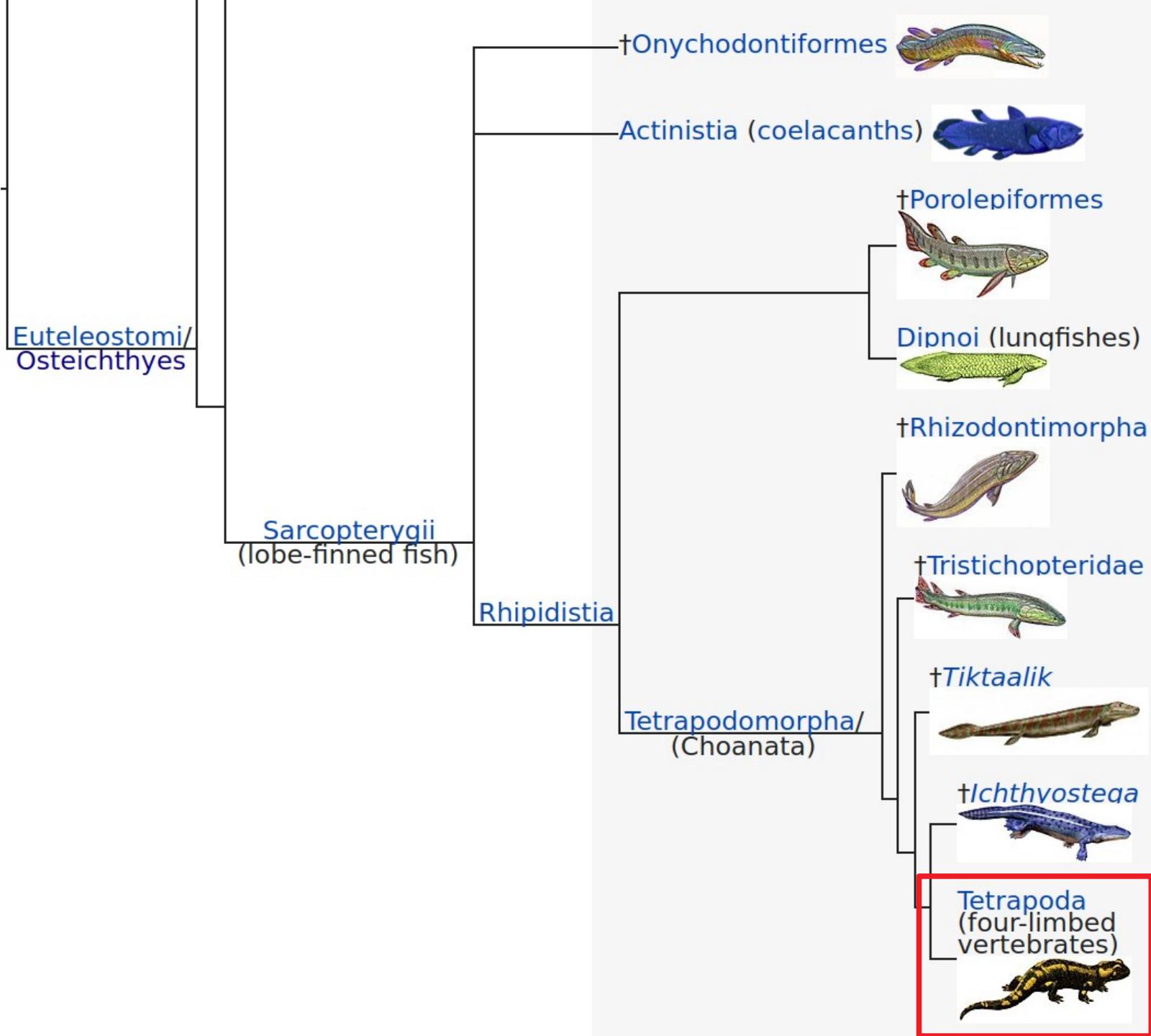


Reassembled paratype
imprint specimen LdLAP
392, reposed at the
Musée Fleury at
Lodève.
The wingspan is 68 cm.

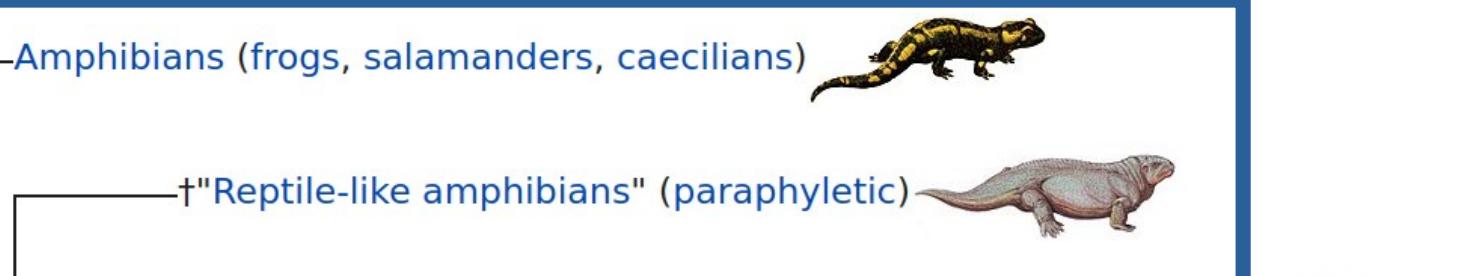
Regno: Animalia

Phylum: Chordata

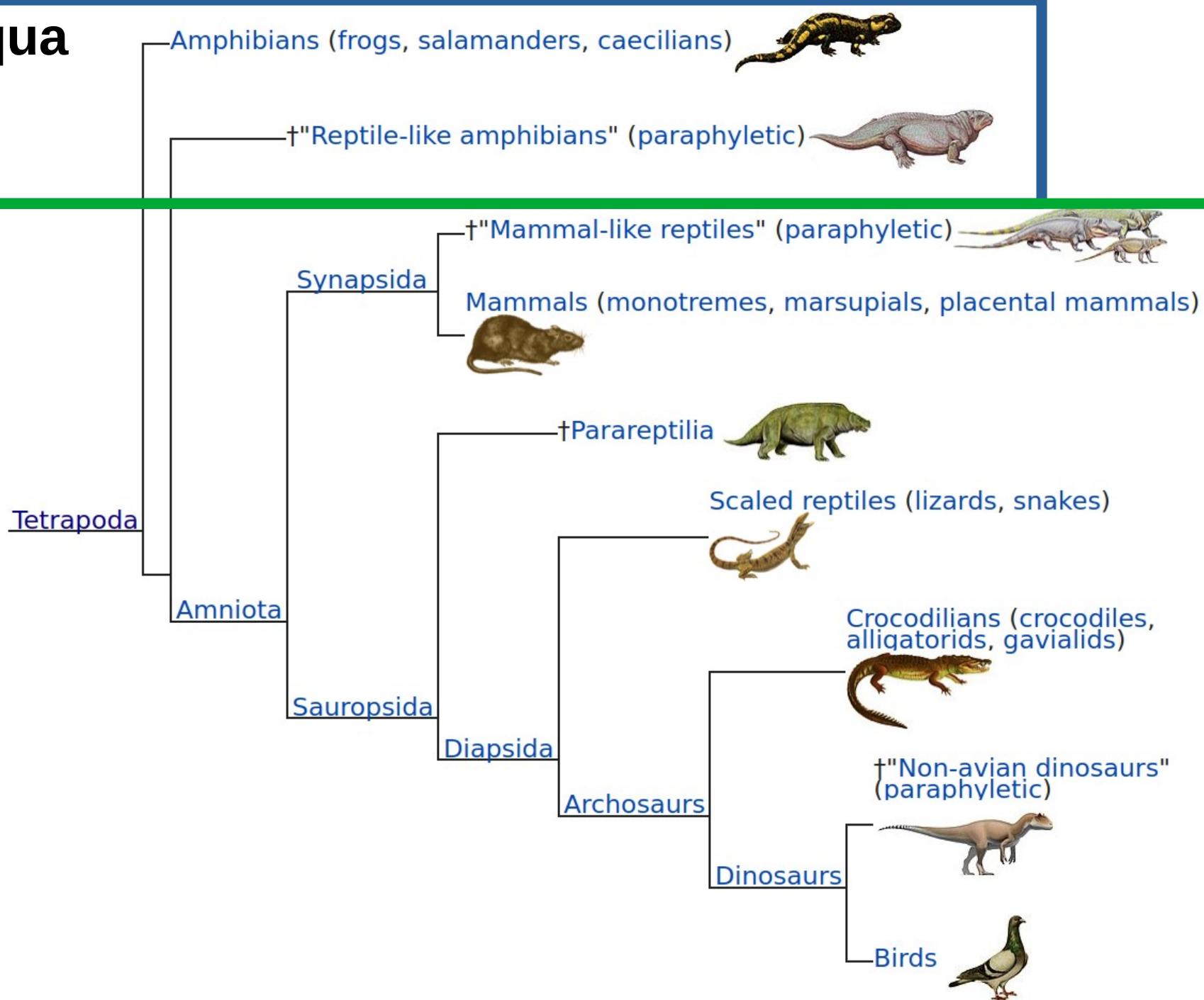
Superclasse: Tetrapoda



Anamni → legati all'acqua



Amnioti → svicolati dall'acqua



Regno: Animalia

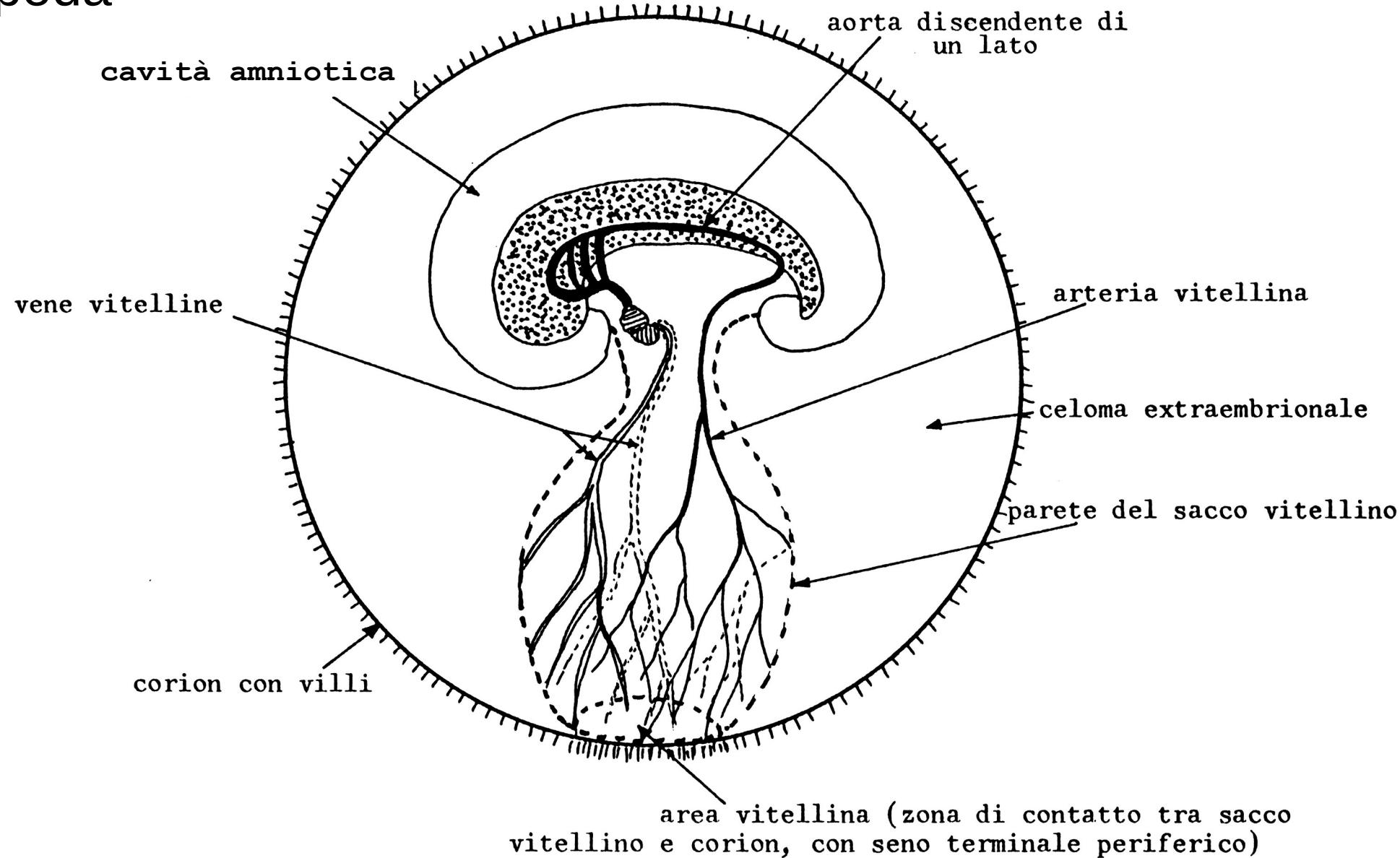
Phylum: Chordata

Superclass: Tetrapoda

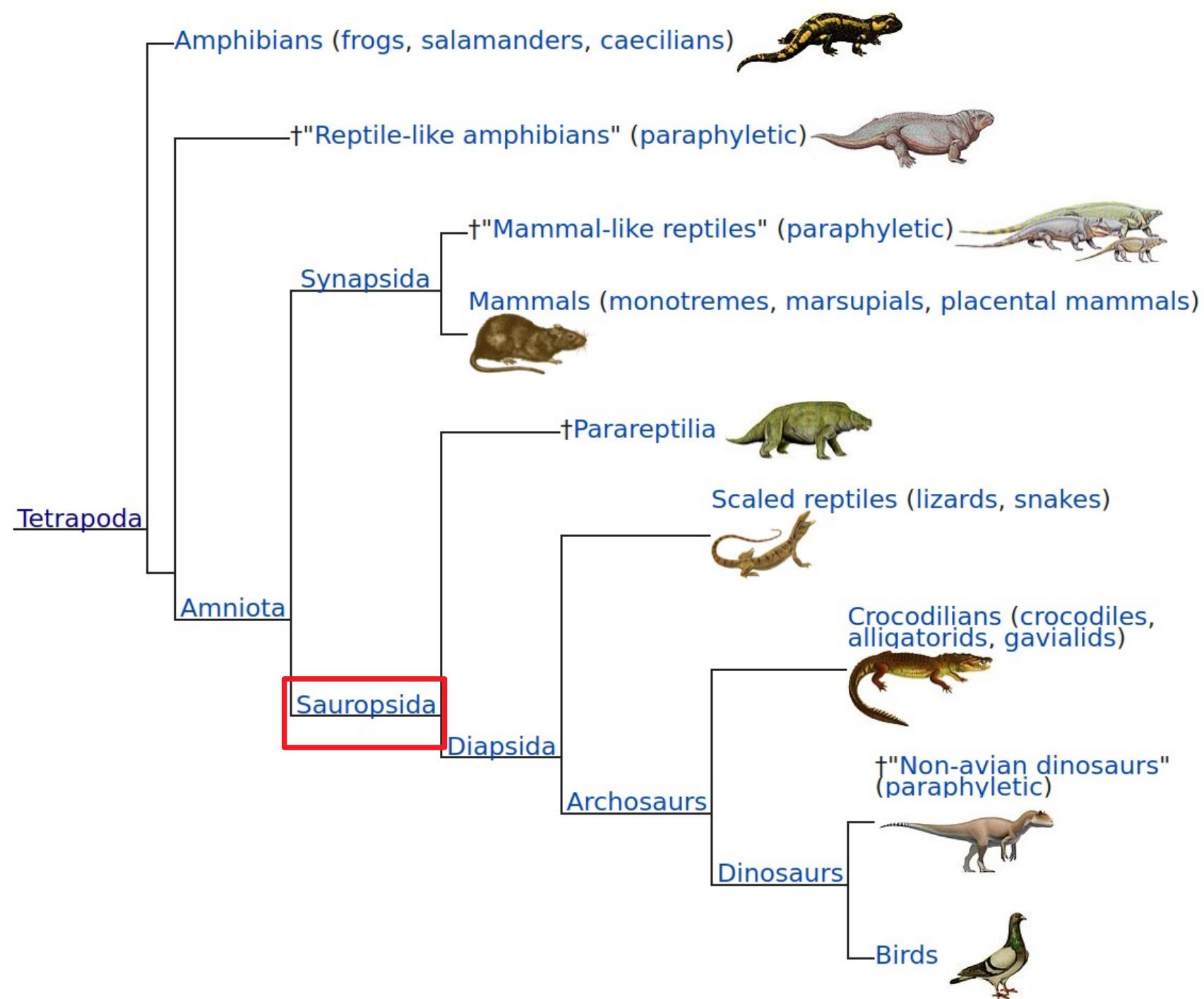
Clade: Amniota

SCHEMA DELLA CIRCOLAZIONE VITELLINA

(l'area punteggiata rappresenta il corpo dell'embrione)

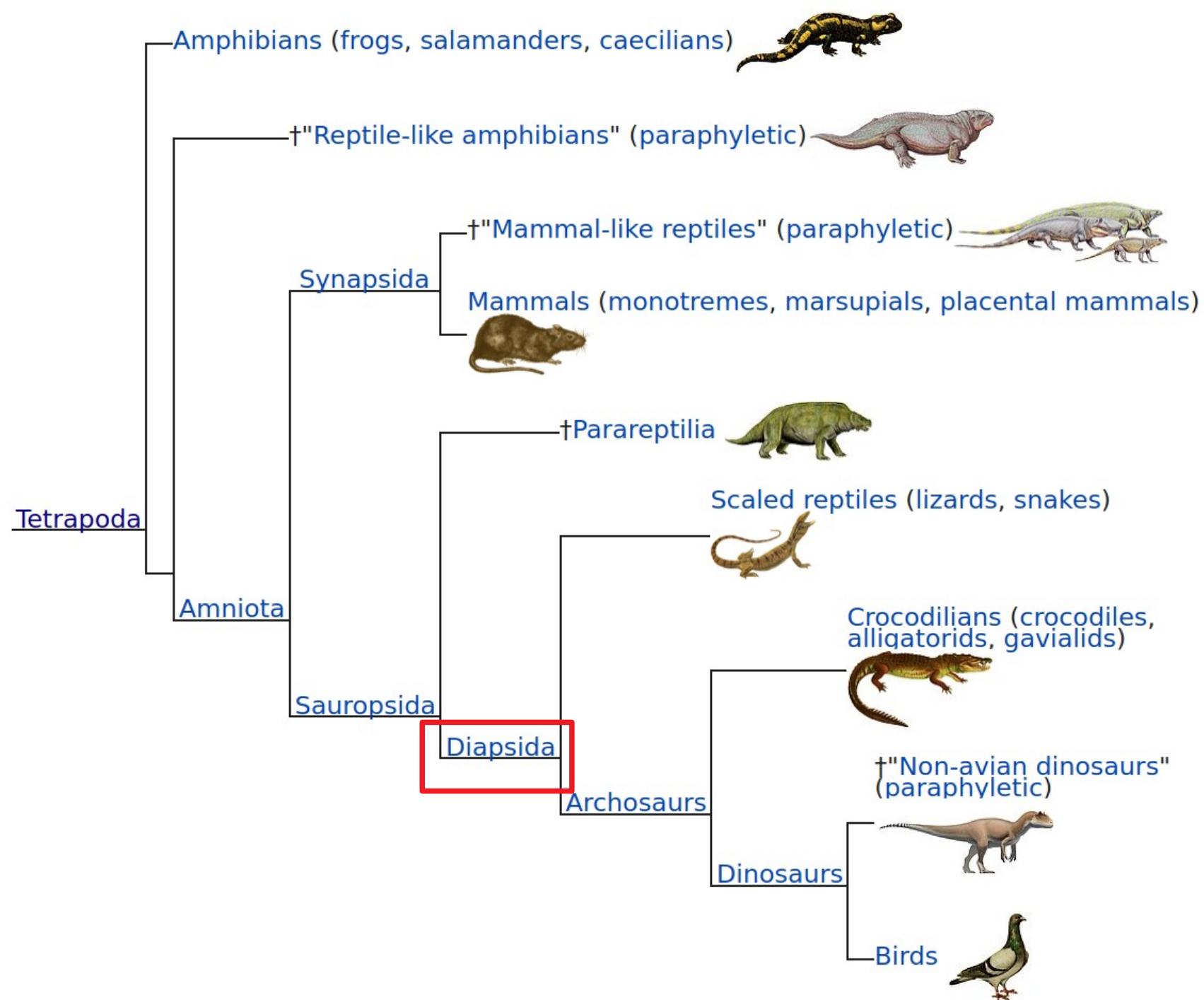


Regno: Animalia
Phylum: Chordata
Superclass: Tetrapoda
Clade: Amniota
Clade: **Sauropsida**



Sauropsids include all amniotes more closely related to modern reptiles than to mammals.

Regno: Animalia
Phylum: Chordata
Superclass: Tetrapoda
Clade: Amniota
Clade: Sauropsida
Clade: **Diapsida**

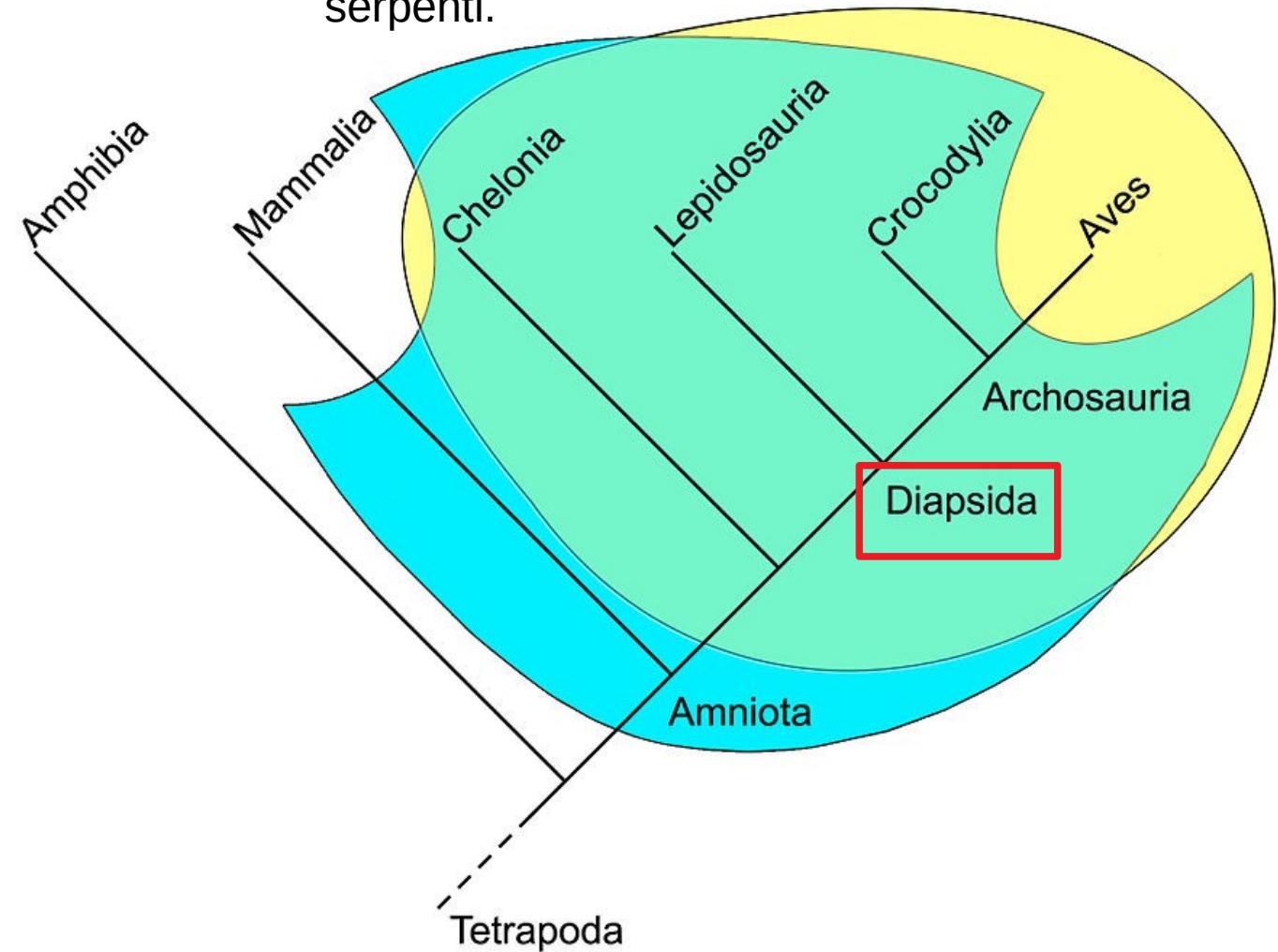


I Diapsidi

Gruppo di tetrapodi che svilupparono due aperture in ogni lato del cranio, dette ***finestre post-orbitali*** (da cui il significato del nome in greco, due arcate)

 Sauropsida
Reptilia

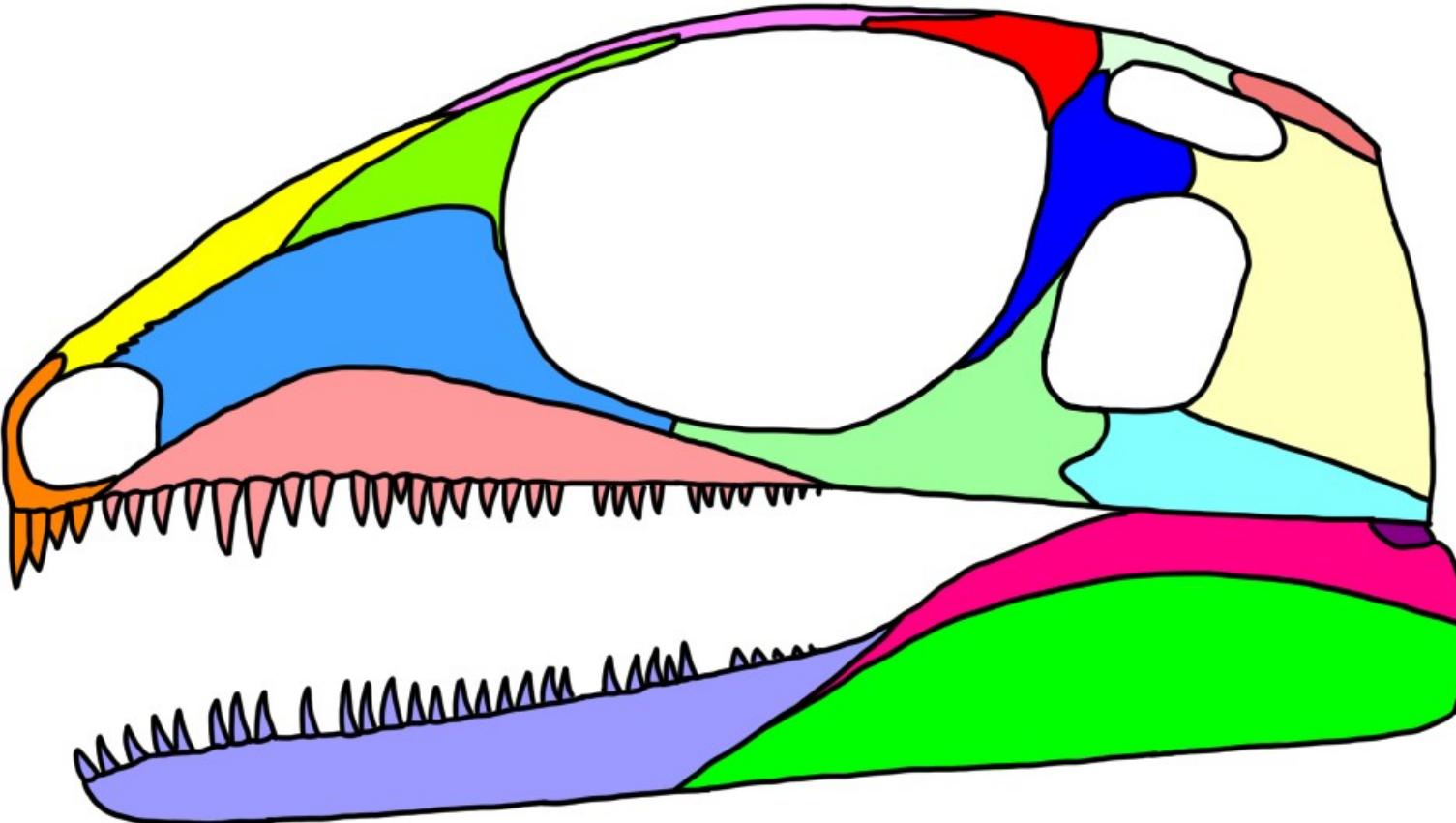
I **lepidosauri (Lepidosauria - dal greco *lepis* - "squama", e *sauros* - "lucertola")** sono un gruppo di rettili, caratterizzati da un corpo ricoperto da squame sovrapposte, che include le lucertole ed i serpenti.



Cladogram of Tetrapoda

I Diapsidi

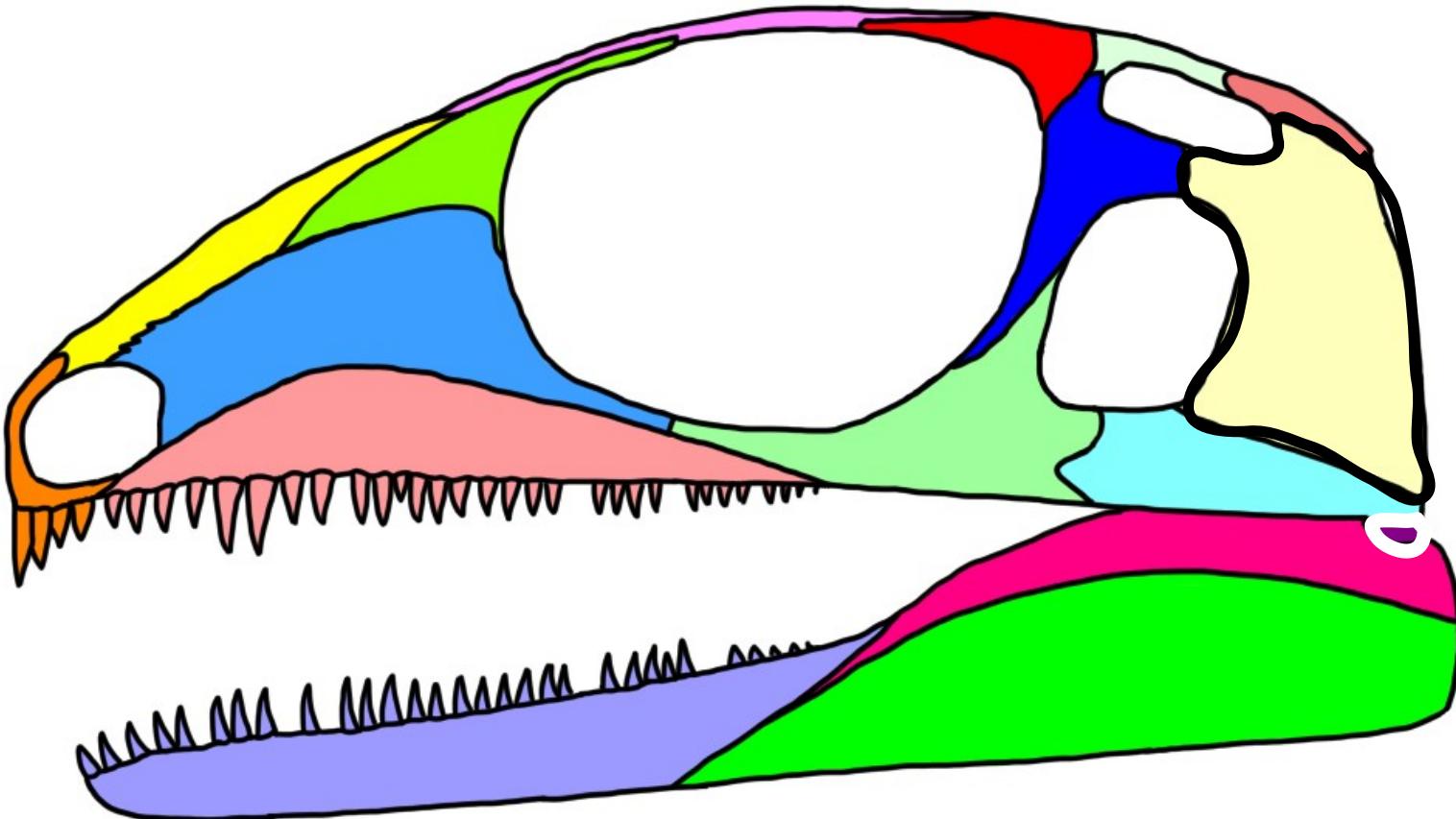
- Lucertole
- Serpenti
- Coccodrilli
- Uccelli



■ Premaxilla	■ Frontal	■ Quadratojugal
■ Nasal	■ Postfrontal	■ Quadrate
■ Maxilla	■ Parietal	■ Dentary
■ Prefrontal	■ Postorbital	■ Surangular
■ Lacrimal	■ Squamosal	■ Angular
■ Jugal	■ Supratemporal	

I Diapsidi

- Lucertole
- Serpenti
- Coccodrilli
- Uccelli



Premaxilla
Nasal
Maxilla
Prefrontal
Lacrimal
Jugal

Frontal
Postfrontal
Parietal
Postorbital
Squamosal
Supratemporal

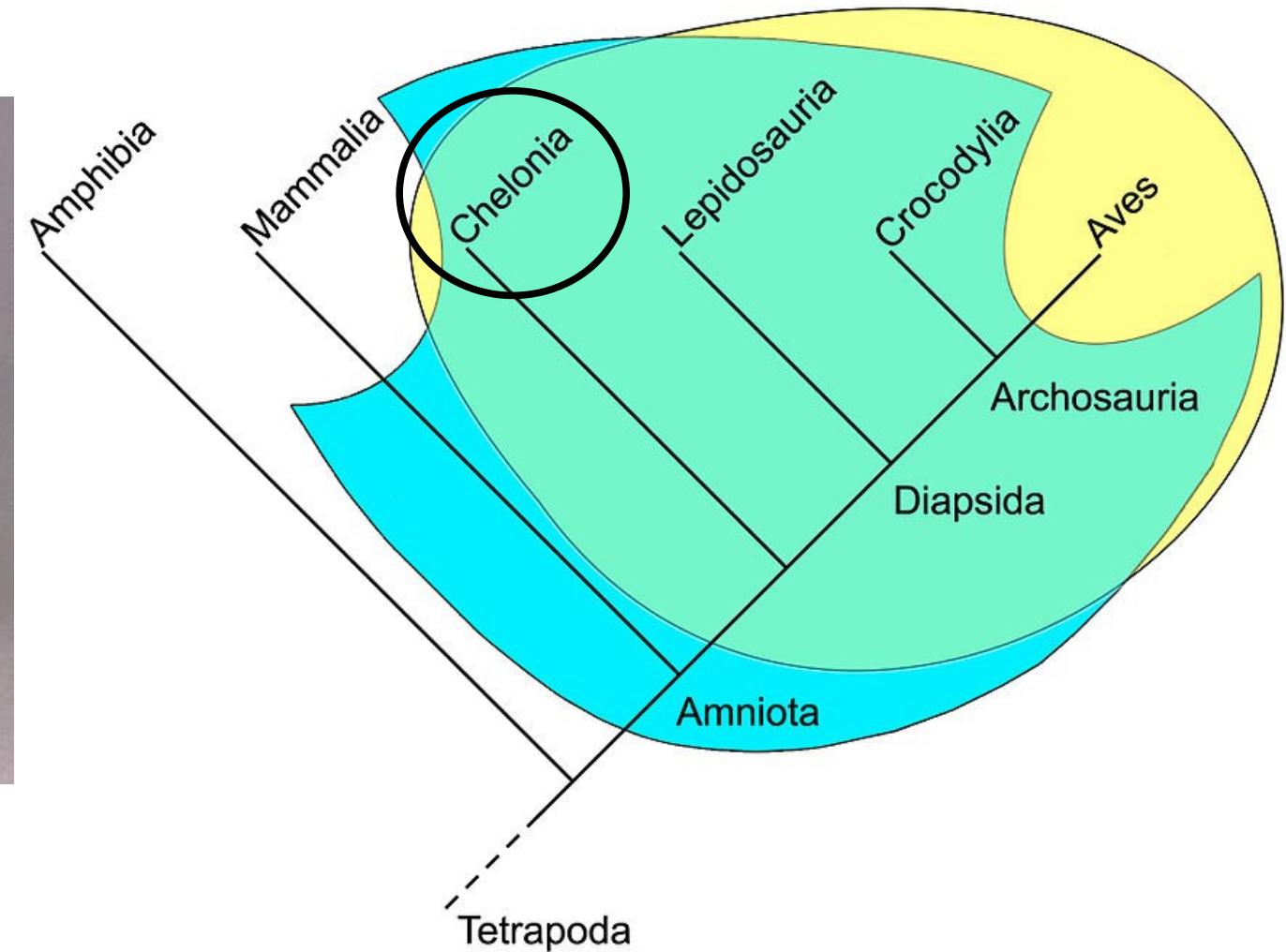
Quadratojugal
Quadrato
Dentary
Surangular
Angular

I Cheloni (tartarughe)

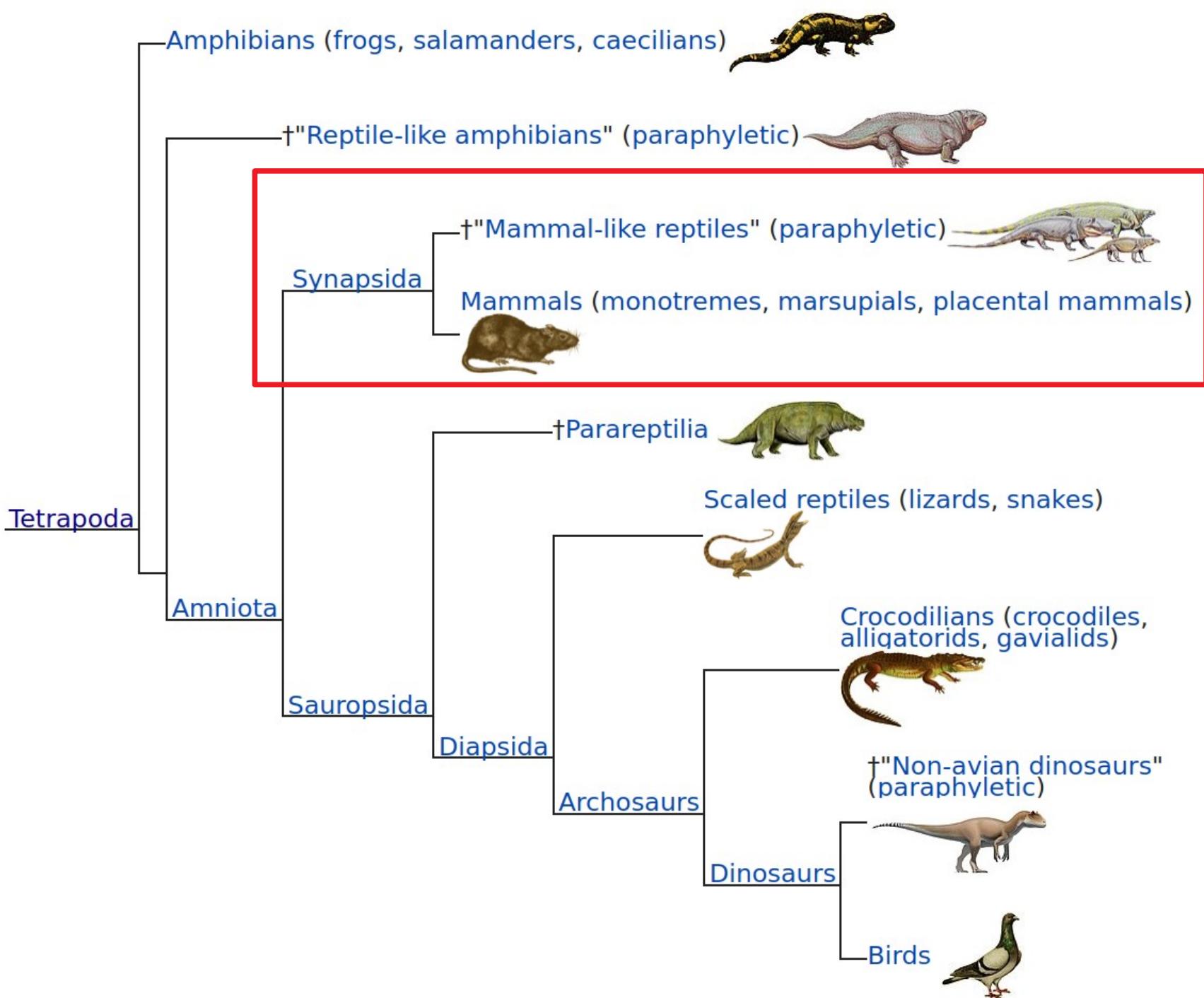
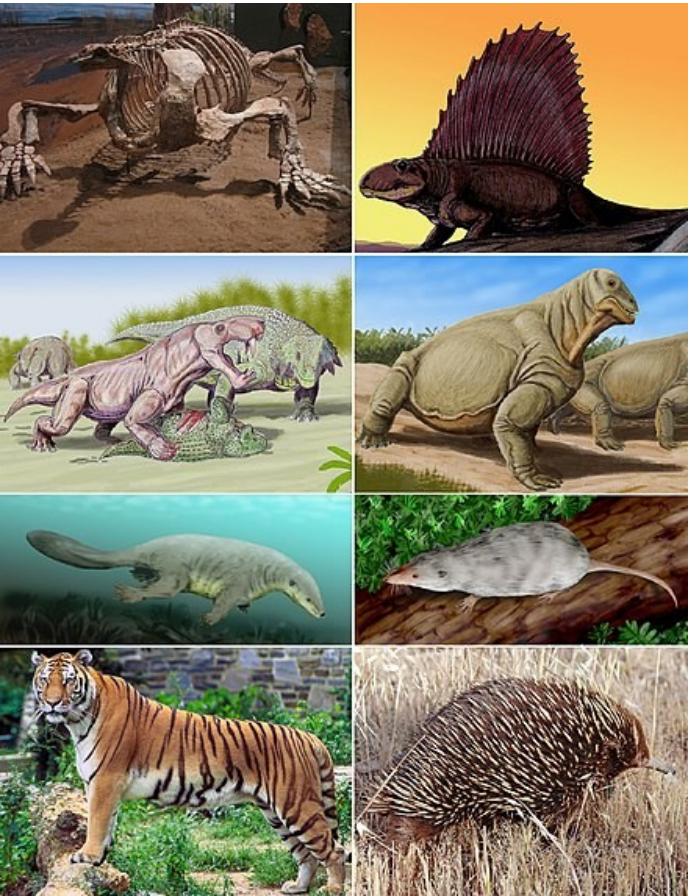
Sauropsida
Reptilia



Cranio di un esemplare adulto
di tartaruga verde (*Chelonia mydas*)



Regno: Animalia
Phylum: Chordata
Superclass: Tetrapoda
Clade: Amniota
Clade: Synapsida

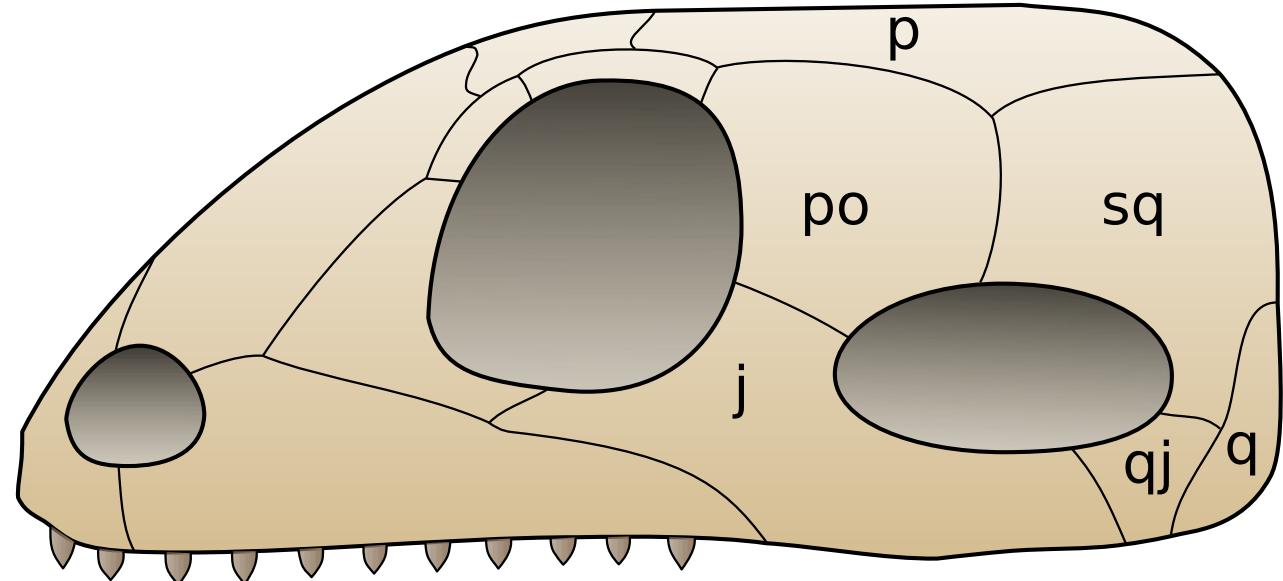


I Sinapsidi

- **Pelicosauri** (primitivi)
- **Terapsidi** (antenati dei Mammiferi)

The synapsids are distinguished by a single hole, known as the **temporal fenestra**, in the skull behind each eye. This schematic shows the skull viewed from the left side.

The middle opening is the orbit of the eye; the opening to the right of it is the temporal fenestra.



Skull of Synapsida

j : jugal

p : parietal

po : postorbital

q : quadrate

qj : quadratojugal

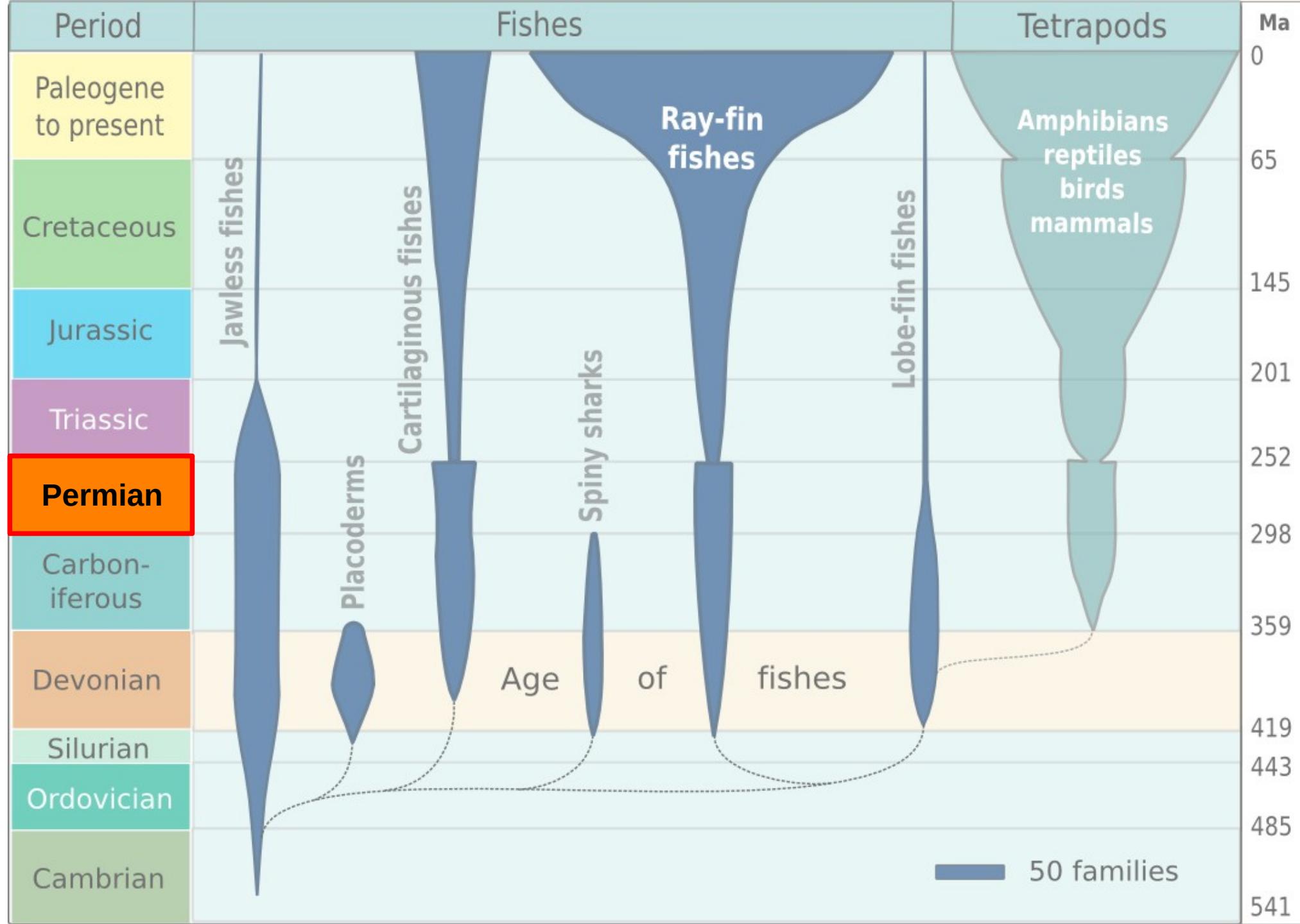
sq : squamosal

Transizione Carbonifero-Permiano: inizia l'era dei Sinapsidi

303÷307 Mya:

- L'inaridimento climatico provoca il collasso della foresta pluviale del Carbonifero
- *Lepidodendron*, *Calamites*, *Sigillaria* sostituite da Fanerogame ed altre conifere, più resistenti alla siccità
- Molte regioni della Pangea si trasformano in deserti → **red beds**
The Carboniferous rainforest collapse left behind vast regions of desert within the continental interior
- Amniotes, which could better cope with these drier conditions, rose to dominance in place of their amphibian ancestors

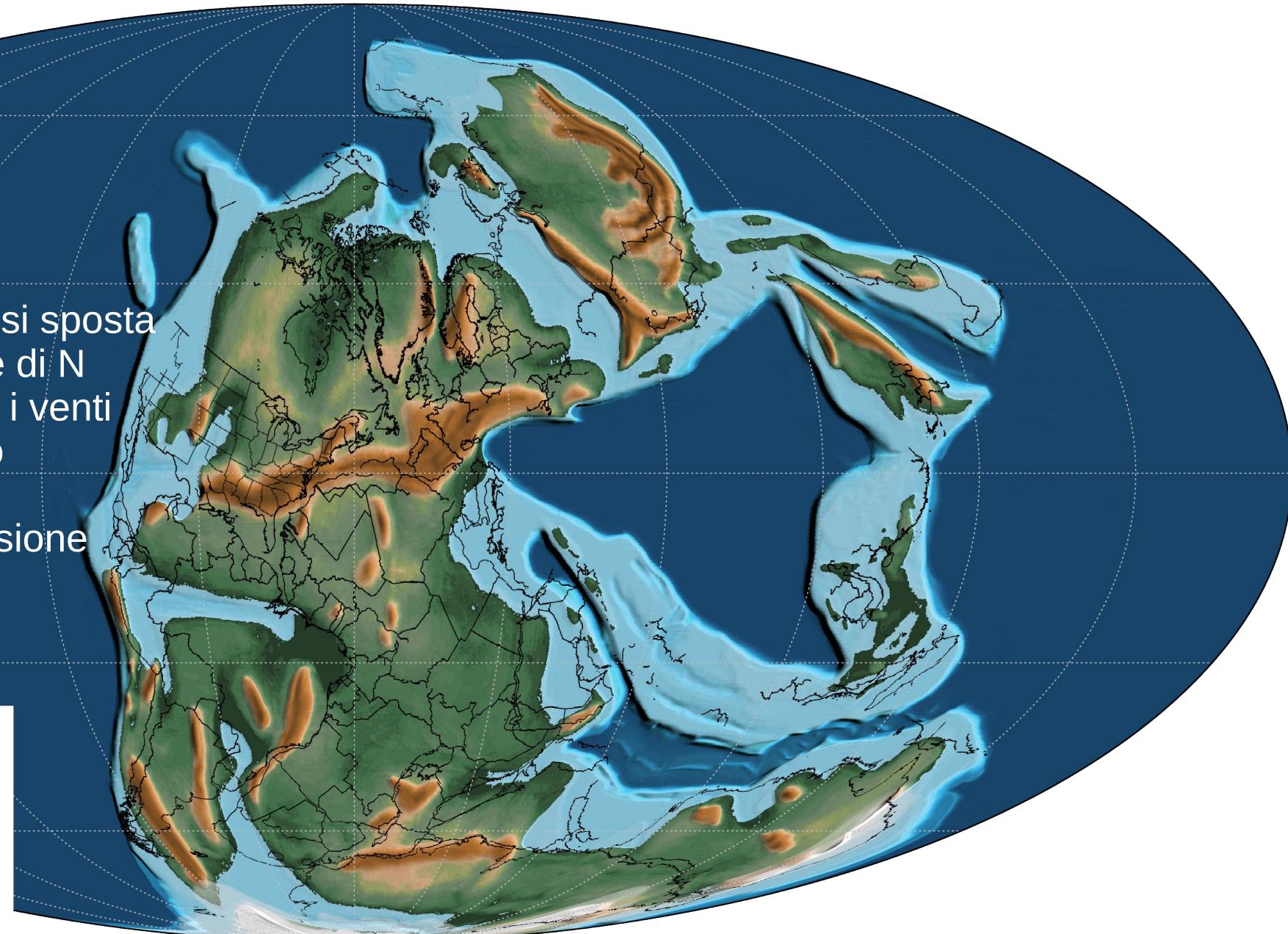
Il Permiano



Il Permiano

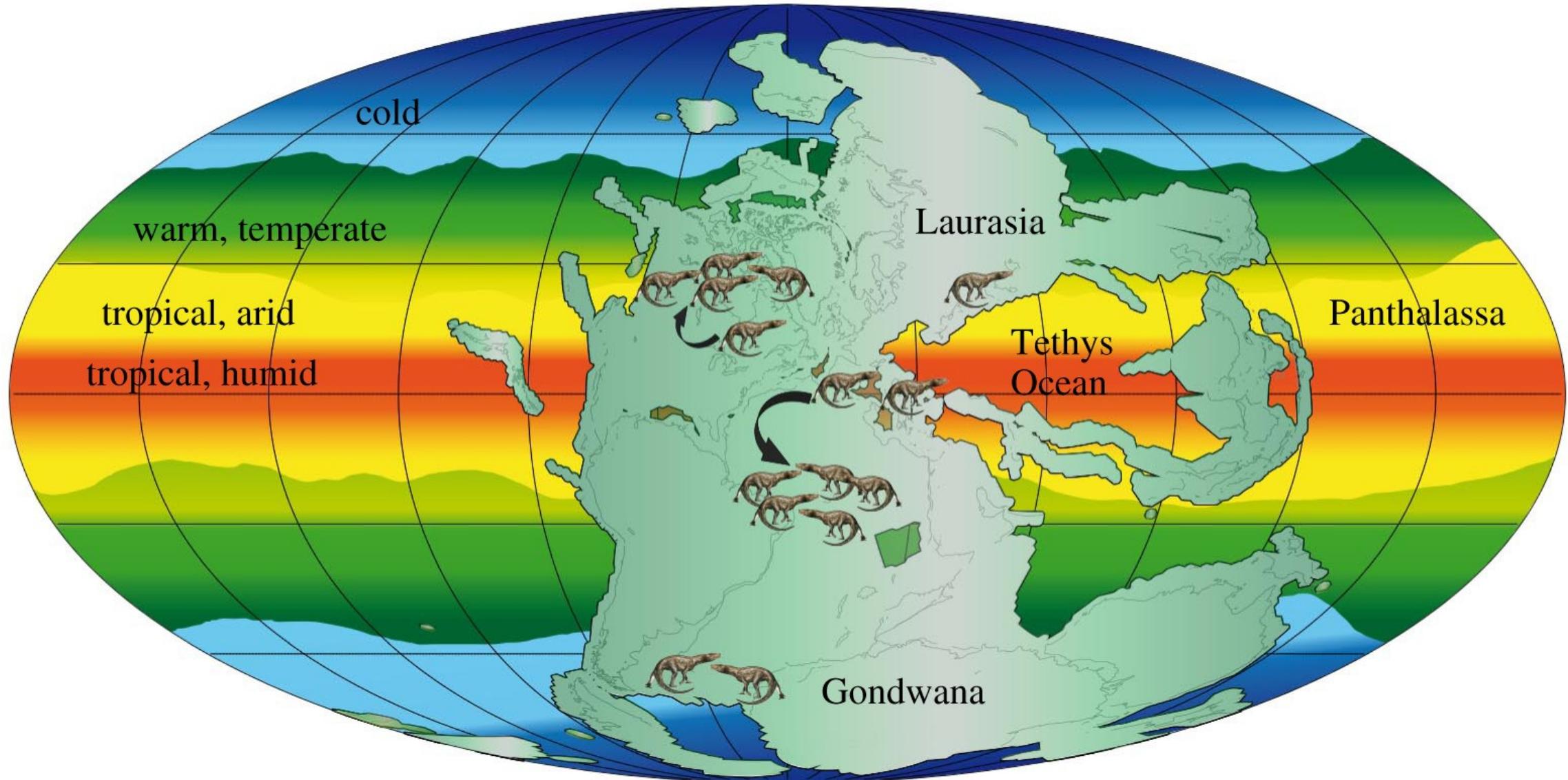
Il continente euroamericano si sposta verso N; le catene montuose di N Africa e N America bloccano i venti occidentali umidi dall'oceano
→ formazione di deserti
fusione calotte polari, espansione subtropici

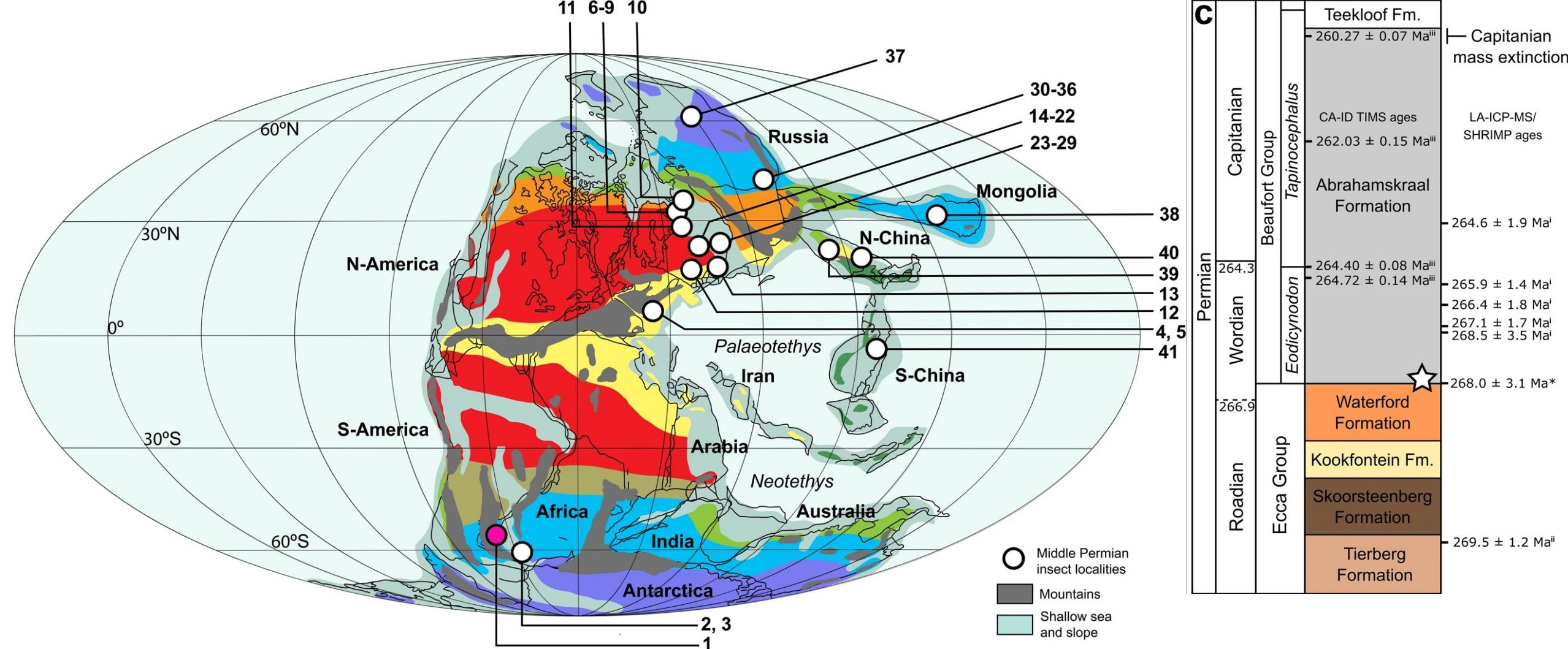
A map of Earth 275 million years ago, overlayed by a black outline of present-day countries in their respective locations



Flora e fauna del Permiano superiore

(prima della catastrofe)





Climates		Modern vegetation analogues	
Tropical Everwet	Tropical	Humid	Tropical rain forest
		Humid summers	Tropical deciduous forest
		Semihumid	Savanna
Desert	Subtropical	Arid	Desert
Winter Wet		Warm summers	Sclerophyllous woody plants
Warm Temperate	Temperate	Humid	Temperate evergreen forests
Cool Temperate			Nemoral broadleaf deciduous forest
Mid-latitude Desert	Cool temperate	Dry summers	Steppe
		Arid	Desert
Cold Temperate	Cold temperate		Boreal coniferous forest

1	Onder Karoo	11	Kopylovo	21	Chatmak Tomak
2	Lawley	12	Bogatyi	22	Chekarda
3	Hammanskraal	13	Schuni	23	Kargala
4	Lodève	14	Sardyk River	24	Sakmara
5	Petit Coulet Redon	15	Takhtachour Ravine	25	Ouralesky Mine
6	Soyana	16	Tikhie Gory	26	Cherepanovka
7	Beloshchel'e	17	Sarapul'skiy Rayon	27	Yamansarovo
8	Letopala River			28	Tuembetovo
9	Sheimo-Gora	18	Chepanikha	29	Starosieka
10	Vostochno-Novikbozhsky	19	Kostovaty	30	Terekhino
		20	Galevo	31	Uskatskiy well
				32	Prokopevsk
				33	Ningxia
				34	Yu County
				35	Zelenyi Lug
				36	Kaltan
				37	Kerbo
				38	Bot-Tologoi/Tavan Tolgoi
				39	Ningxia
				40	Houdong
				41	

Article | [Open access](#) | Published: 30 October 2022

South African Lagerstätte reveals middle Permian Gondwanan lakeshore ecosystem in exquisite detail

[Rosemary Prevec](#) , [André Nel](#), [Michael O. Day](#), [Robert A. Muir](#), [Aviwe Matiwane](#), [Abigail P. Kirkaldy](#),
[Sydney Moyo](#), [Arnold Staniczek](#), [Bárbara Cariglino](#), [Zolile Maseko](#), [Nokuthula Kom](#), [Bruce S. Rubidge](#),
[Romain Garrouste](#), [Alexandra Holland](#) & [Helen M. Barber-James](#)

[Communications Biology](#) 5, Article number: 1154 (2022) | [Cite this article](#)

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Abstract

Continental ecosystems of the middle Permian Period (273–259 million years ago) are poorly understood. In South Africa, the vertebrate fossil record is well documented for this time interval, but the plants and insects are virtually unknown, and are rare globally. This scarcity of data has hampered studies of the evolution and diversification of life,

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[Results](#)

[Discussion](#)

[Methods](#)

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[References](#)

[Acknowledgements](#)

[Author information](#)

Reconstruction of trees of *Glossopteris* at the Middle Permian Onder Karoo locality in South Africa with male (a_i) and female (a_{ii}) reproductive organs inset

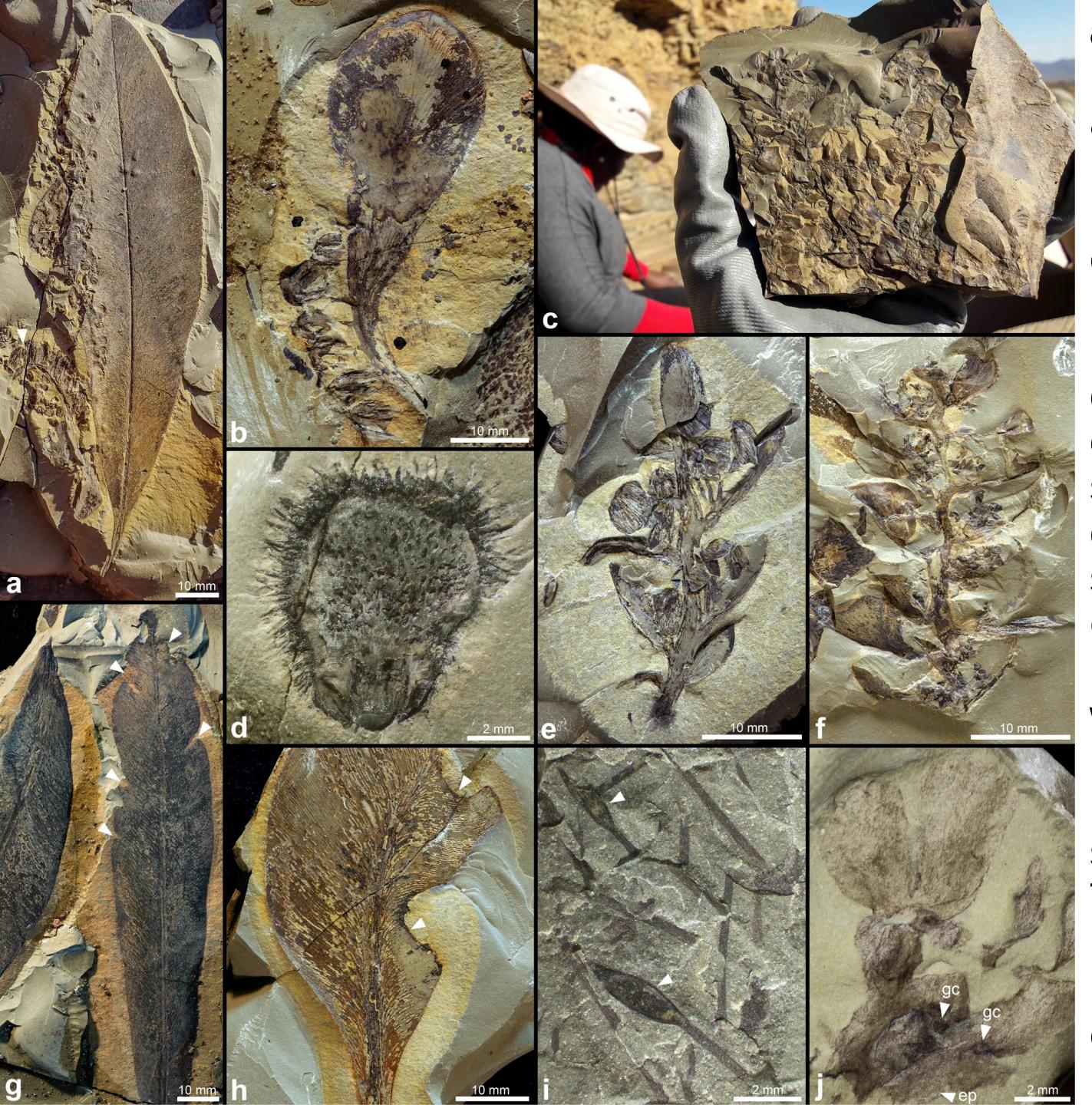
Tapinocaninus



Eodicynodon



This reconstruction is based on new fossil information from the Onder Karoo Lagerstätte and regional occurrences of the vertebrates of the Eodicynodon Assemblage Zone in the southern Karoo Basin. The landscape is of a standing body of water, probably a pool, on the delta plain of a river as it enters the Karoo Sea (seen in the distance). Trees are *Glossopteris*, with buttress roots, epicormics shoots on the trunks, and leaves borne in whorls (with evidence of insect damage). Delicate horsetails of the genus *Phyllotheca* line the edges of the water bodies, and colonize the surrounding marshes. The large vertebrates in the middle distance are the therapsids *Tapinocaninus*, those in the foreground are the dicynodont *Eodicynodon*. Beneath the surface of the water, a Rhinesuchus amphibian can be seen hunting Namaichthys fish. Inset, a male (i) and female (ii) reproductive cones of the *Glossopteris* plant; b bryophytes: thallose liverwort (i), moss gametophytes with sporophytes (ii); c terrestrial insects: (i) protozygopteran (damselfly predecessor); (ii) achenorrhynchian (leafhopper); (iii) Prosbolid hemipteran; (iv) protelyopteran; (v) archaeorthopterid; (vi) plecopteran (adult stonefly); (vii) grylloblattodean; (viii) coleopteran (beetle); aquatic invertebrates: (ix) water mite (*Hydrachnidia*); (x) plecopteran (stonefly nymph); (xi) leech (*Clitellata*); (xii) palaeodictyopteran nymph.



a *Glossopteris* leaf with abundant platyspermic seeds to the left. Arrow indicates adjacent *Lidgettonia* sp. 1 fructification, the likely source of the seeds. **b** *Lidgettonia* sp. 1: large scale leaf with at least five pairs of cupules attached. **c** Slab showing mixed mat of male and female cones of the *Glossopteris* plant. **d** New dictyopteridean, seed-bearing glossopterid fructification *Ottokaria*. **e** Female cone of *Glossopteris* plant: multiple *Lidgettonia* sp. 2 fertiligers attached to a shoot. **f** Male cone of *Glossopteris* plant: multiple *Eretmonia* sp. polleniferous scales attached to a shoot. **g** ***Glossopteris* leaves**, arrows indicate sites of margin-feeding by insects. **h** ***Glossopteris* leaf** with arrows indicating large excisions caused by insect feeding, note pronounced staining of plant reaction tissue. **i** Probable moss sporophytes, arrows indicate moss capsules. **j** Thalloid liverwort with dichotomous branching, notched termini, hydroids, typical epidermal patterning (ep, arrow) and possible gemma cups (gc, arrows).

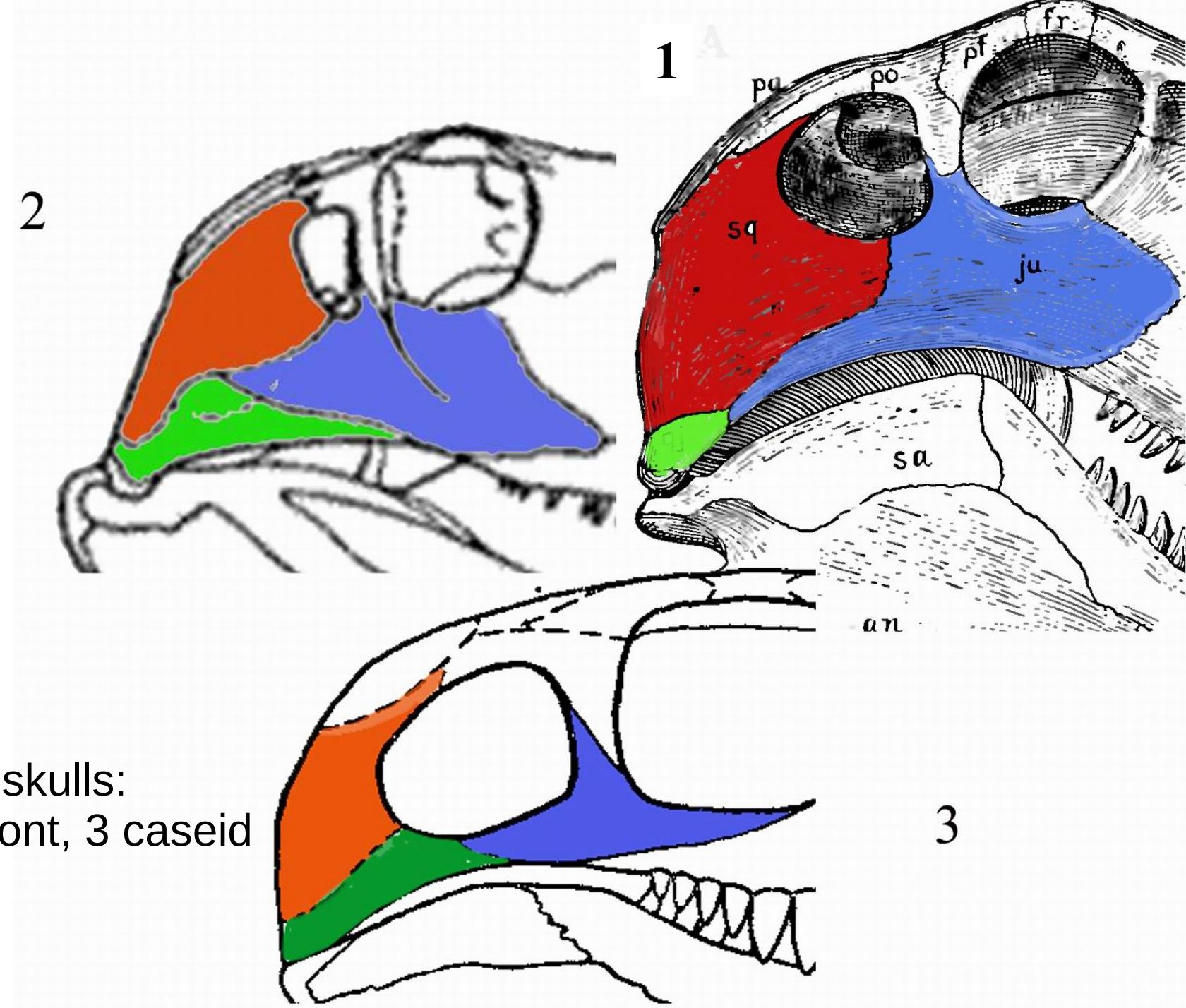
I Pelycosauri

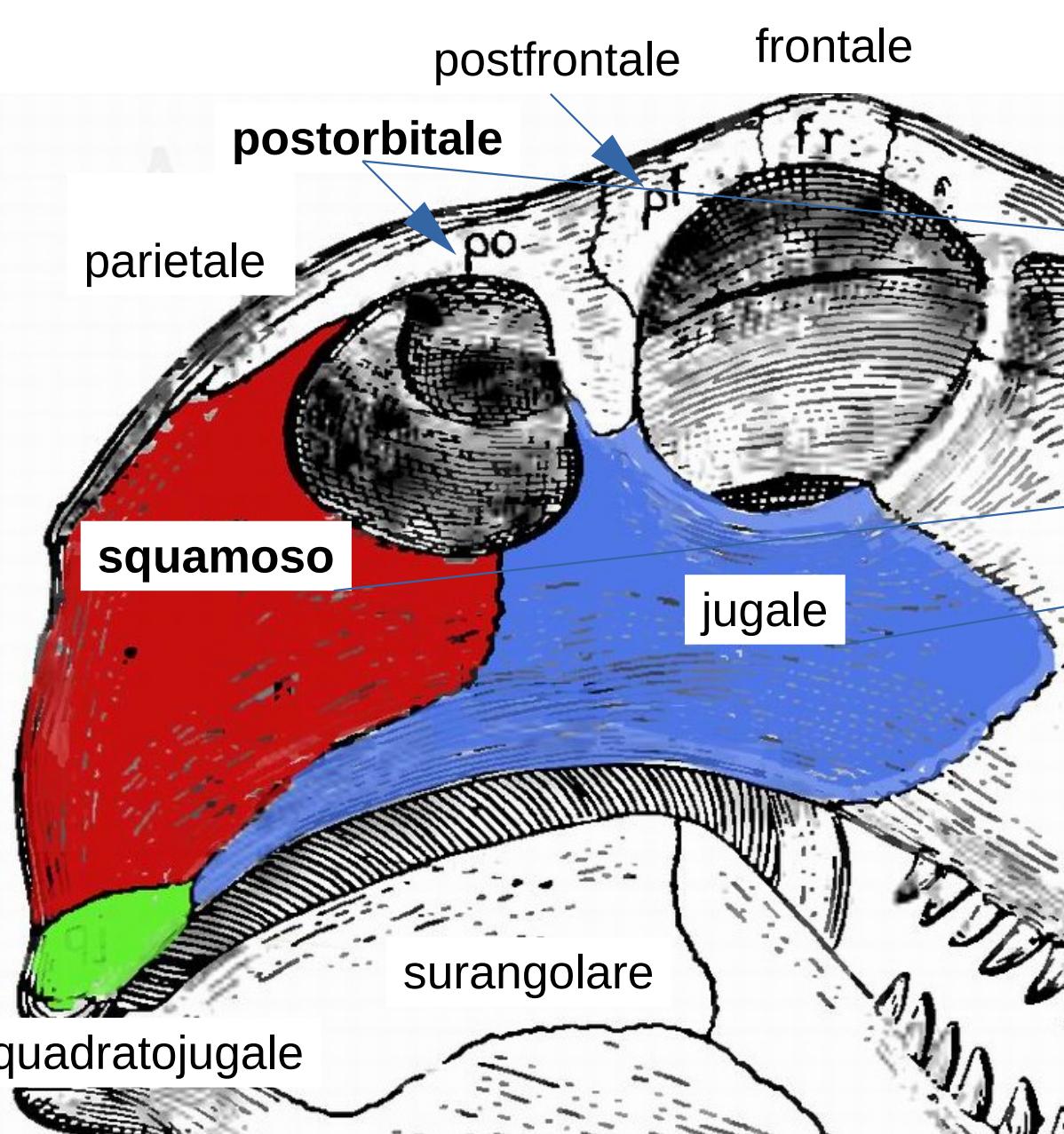
The taxon Pelycosauria was introduced by E. D. Cope in the nineteenth century for the North American members of what subsequently became recognized as the **most primitive members of the Synapsida**.

By the time of Romer and Price's (1940) *Review of Pelycosauria*, which is one of the great classics of vertebrate palaeontological literature, the term was universally accepted.

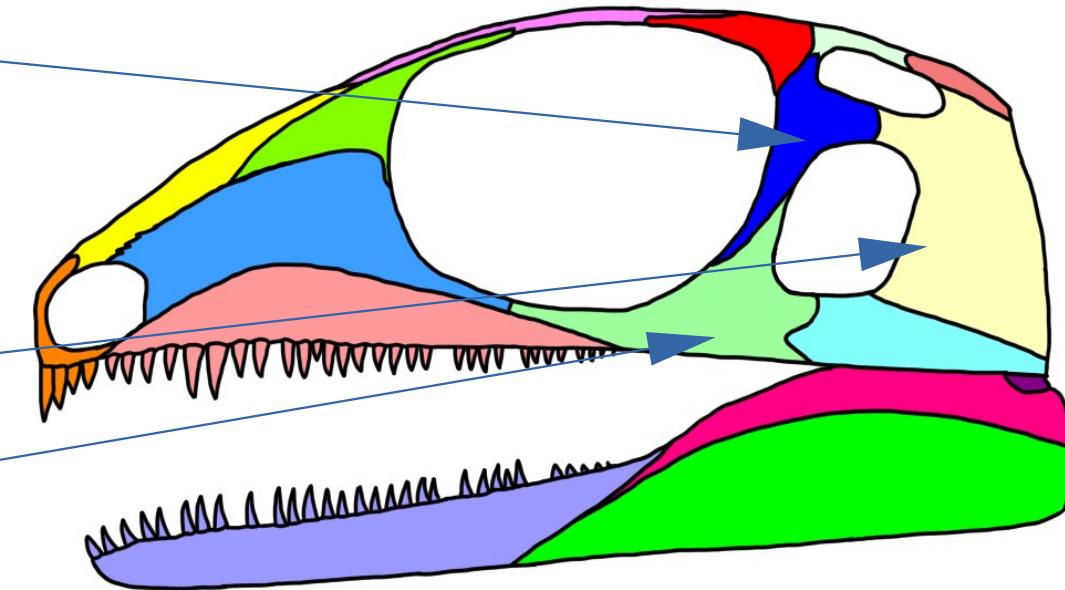
This term continues to be widely used today for «basal», or «non-therapsid» synapsids.

I Pelycosauri



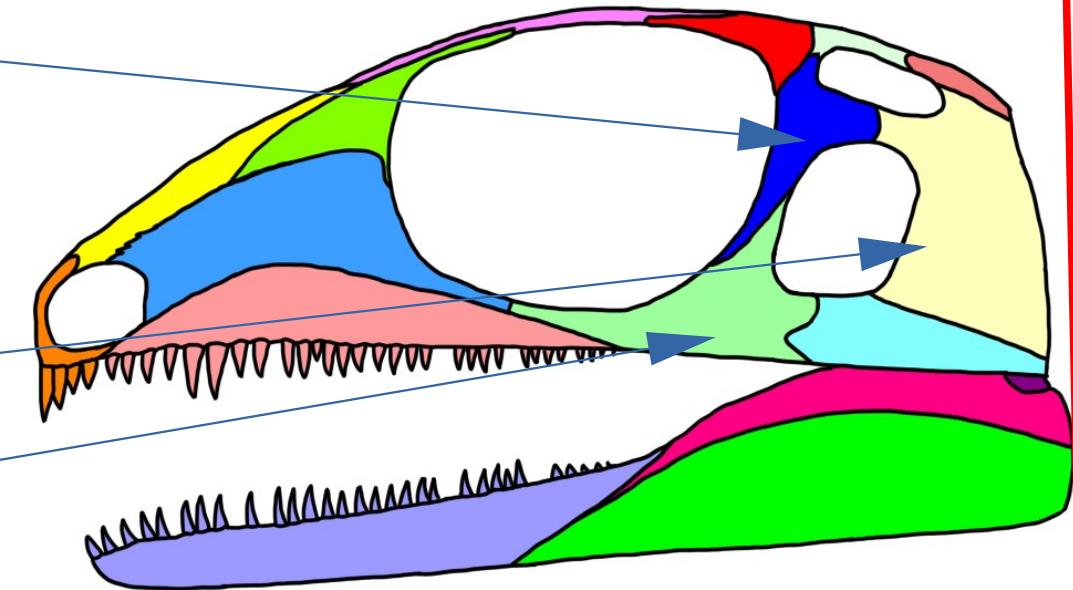
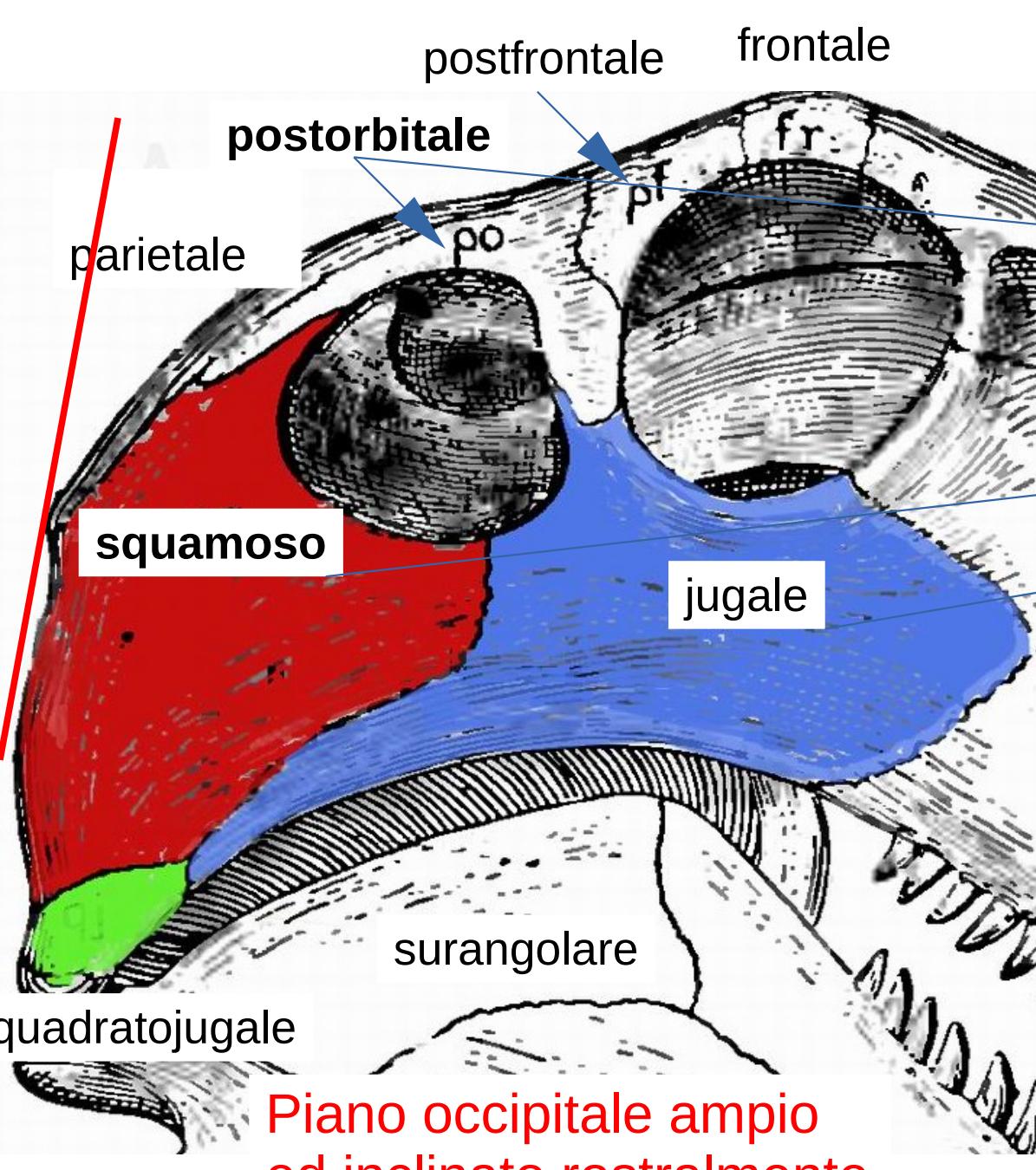


Una sola finestra temporale delimitata
dorsalmente dallo squamoso e dal postorbitale



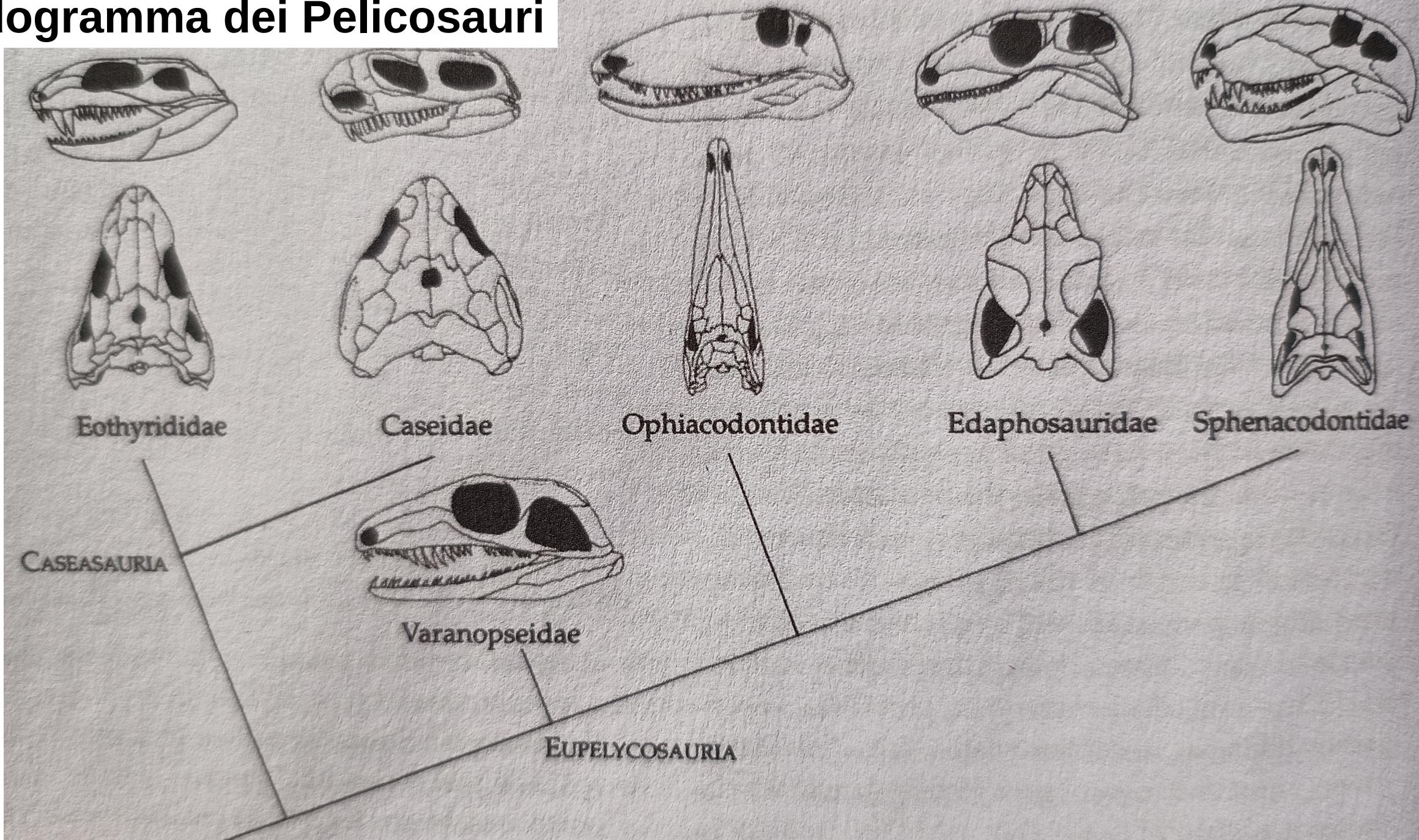
Premaxilla	Frontal	Quadratojugal
Nasal	Postfrontal	Quadratojugale
Maxilla	Parietal	Quadratojugale
Prefrontal	Postorbital	Dentary
Lacrimal	Squamosal	Surangular
Jugal	Angular	Surangular
	Supratemporal	Angular

Due finestre temporali

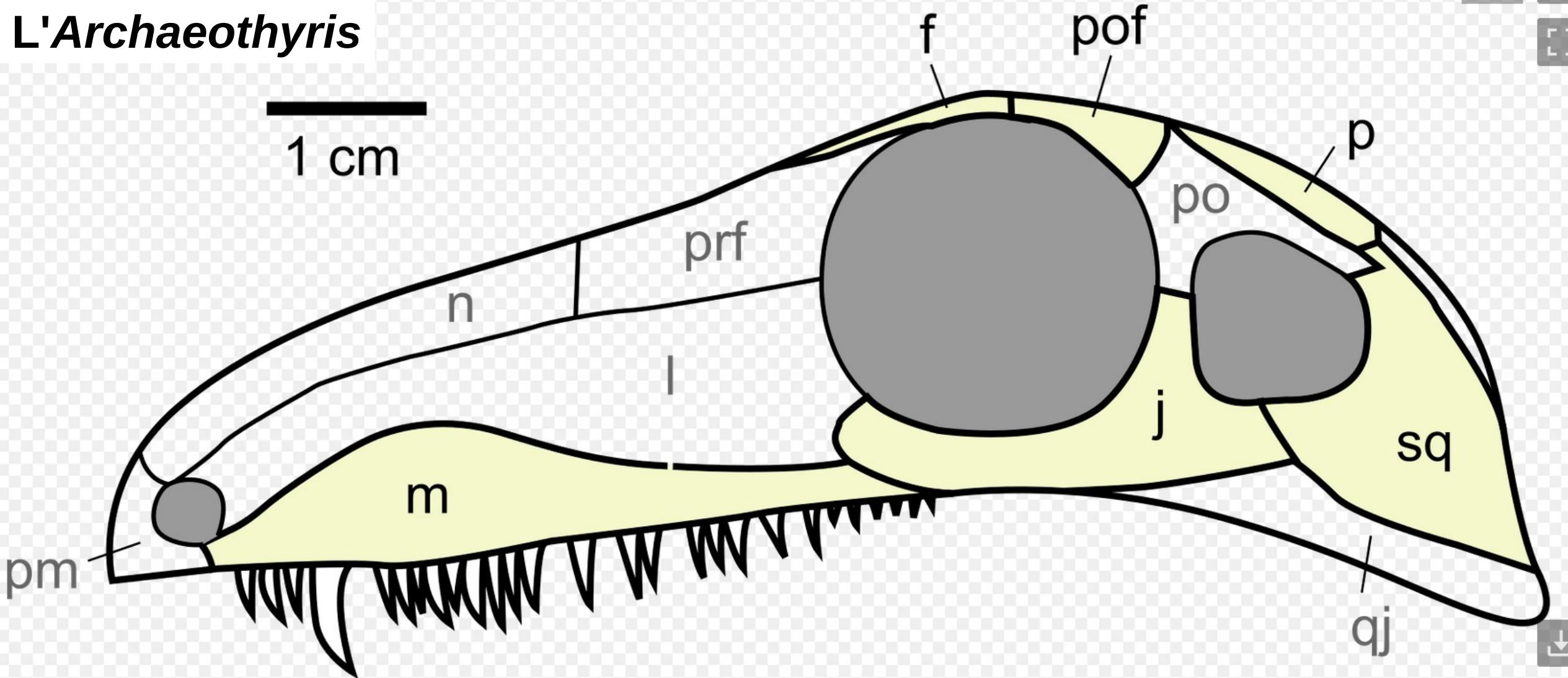


Premaxilla	Frontal	Quadratojugal
Nasal	Postfrontal	Quadrate
Maxilla	Parietal	Dentary
Prefrontal	Postorbital	Surangular
Lacrimal	Squamosal	Angular
Jugal	Supratemporal	

Il cladogramma dei Pelicosauri



L'Archaeothyris



Skull reconstruction of *Archaeothyris florensis*, the oldest known synapsid amniote. Known bones are indicated in light yellow, as yet unknown bones appear in white. f = frontal, j = jugal, l = lacrimal, m = maxilla, n = nasal, p = parietal, pm = premaxilla, po = postorbital, pof = postfrontal, prf = prefrontal, qj = quadratojugal, sq = squamosal.

L'Archaeothyris



Classificazione dell'Archaeothyris

Domain: Eukaryota

Kingdom: Animalia

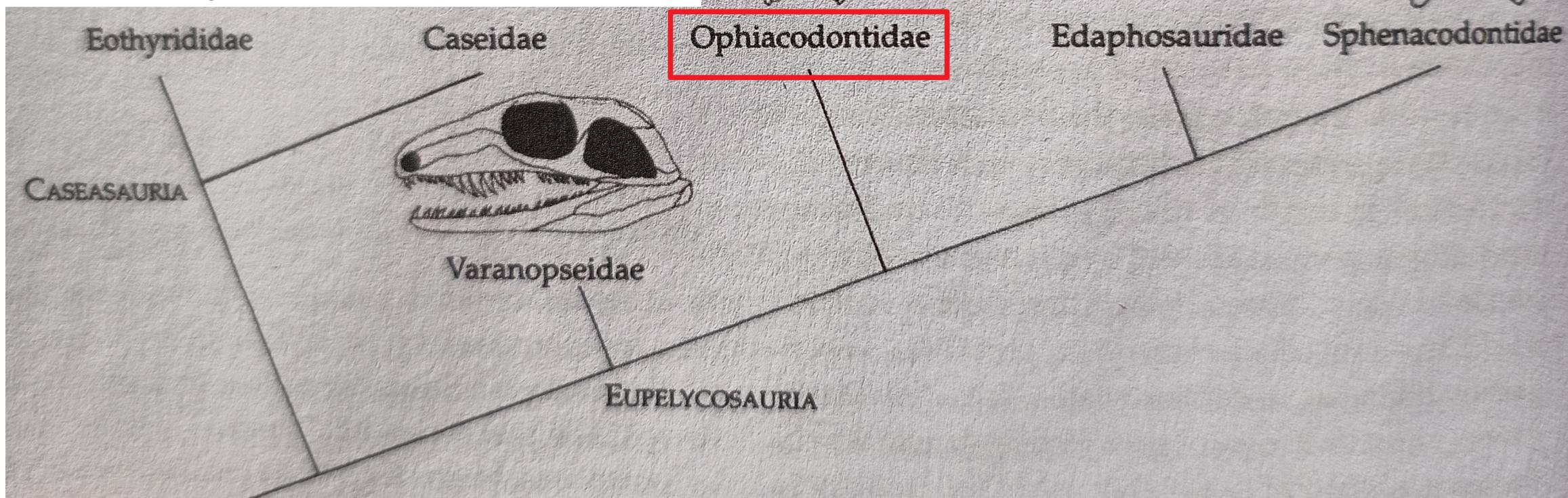
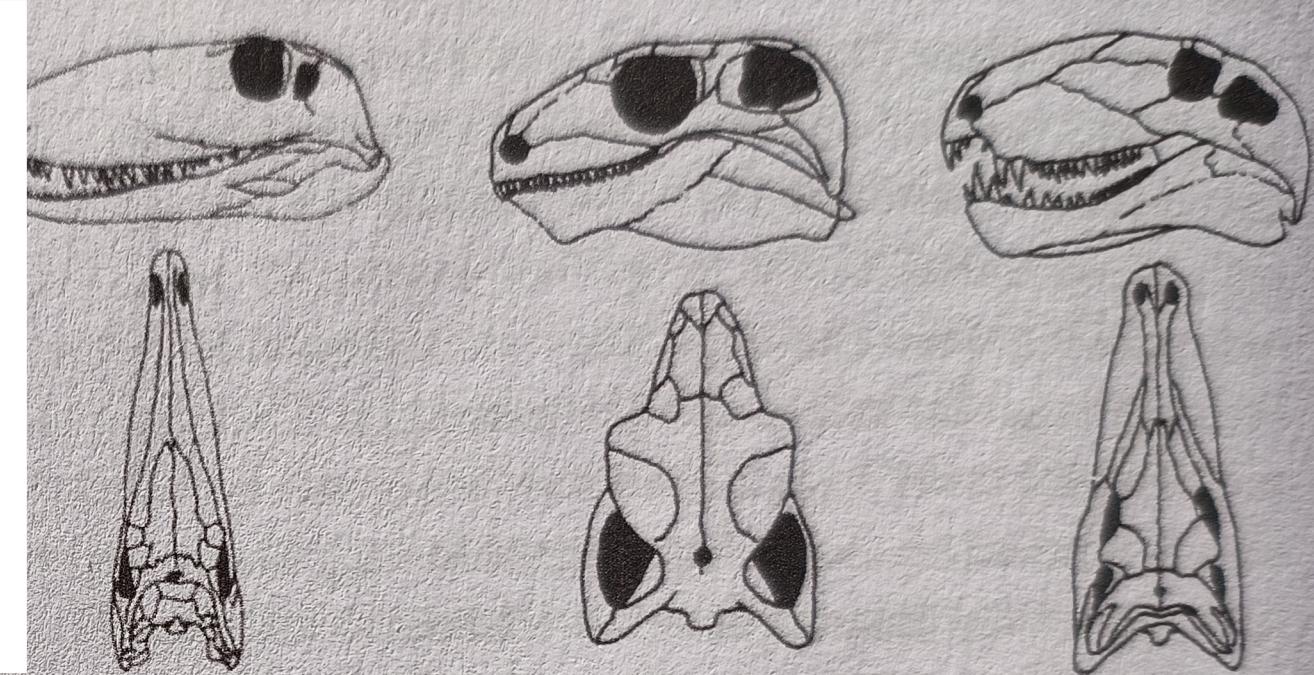
Phylum: Chordata

Clade: *Synapsida*

Order: *Pelycosauria*

Family: *Ophiacodontidae*

Genus: *Archaeothyris*



II *Dimetrodon* (299÷273 Mya)

Domain: Eukaryota

Kingdom: Animalia

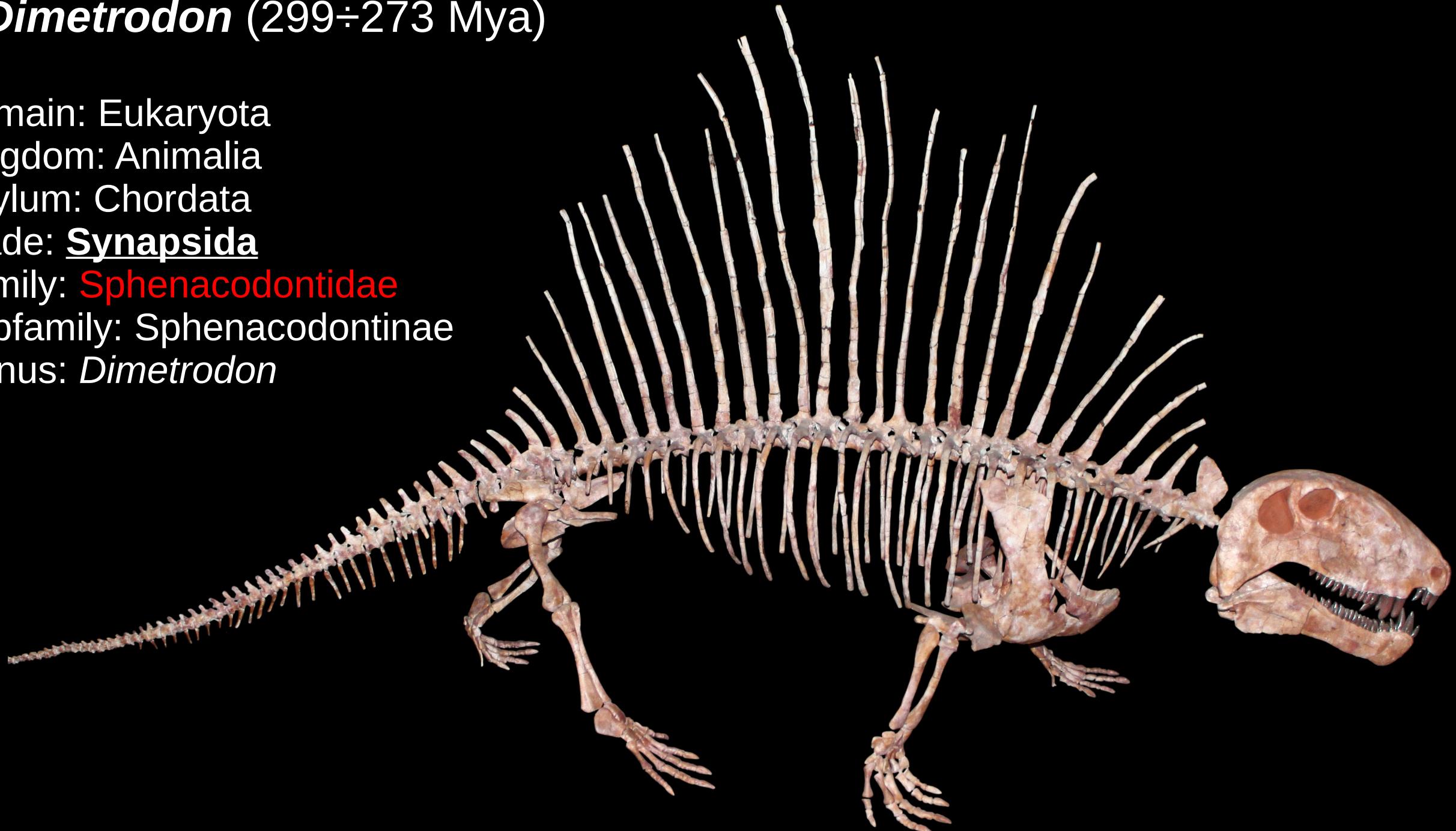
Phylum: Chordata

Clade: **Synapsida**

Family: **Sphenacodontidae**

Subfamily: Sphenacodontinae

Genus: *Dimetrodon*



II *Dimetrodon*

Dimetrodon is an extinct genus of non-mammalian synapsid belonging to the family Sphenacodontidae that lived during the Early Permian period, around 295÷272 million years ago.

With most species measuring 1.7÷4.6 m long and weighing 28÷250 kg, the most prominent feature of *Dimetrodon* is the **large neural spine sail on its back formed by elongated spines extending from the vertebrae**.

It was an obligate quadruped and had a tall, curved skull with large teeth of different sizes set along the jaws. Most fossils have been found in the Southwestern United States, the majority of these coming from a geological deposit called the Red Beds of Texas and Oklahoma.

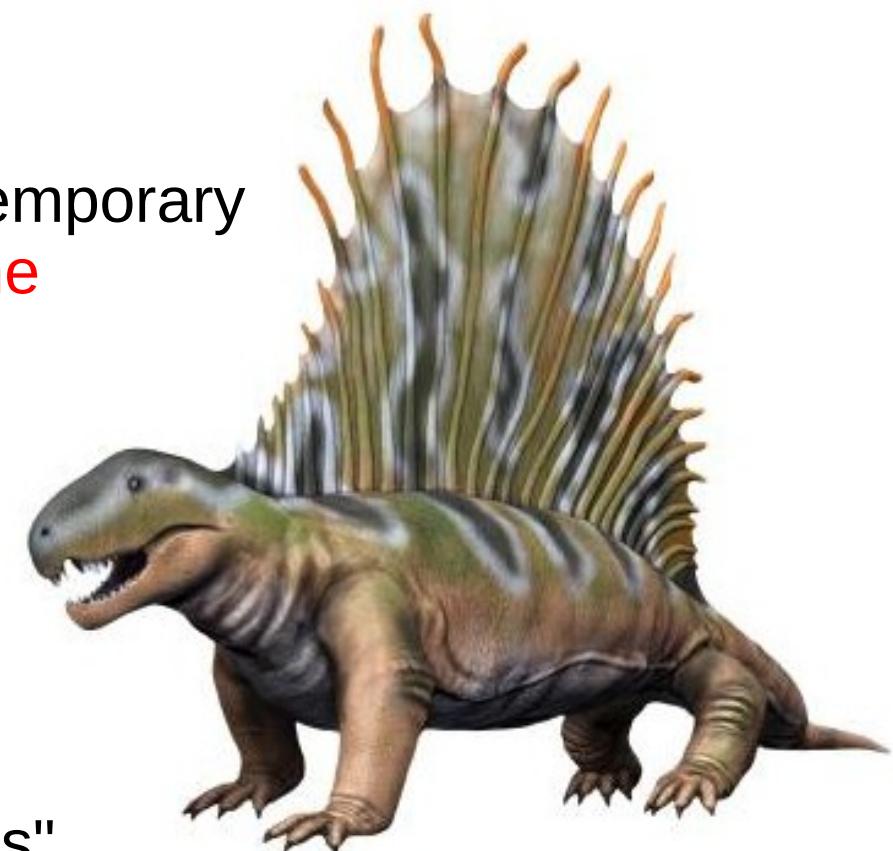
II *Dimetrodon*

Dimetrodon is often mistaken for a dinosaur or as a contemporary of dinosaurs in popular culture, but it became extinct some 40 million years before the advent of dinosaurs.

Although reptile-like in appearance and physiology, ***Dimetrodon* is much more closely related to mammals than to reptiles**, though **it is not a direct ancestor of mammals**.

Dimetrodon is assigned to the "non-mammalian synapsids". This groups *Dimetrodon* together with mammals in the clade Synapsida, while reptiles are placed in a separate clade, Sauropsida.

Single openings in the skull behind each eye, known as temporal fenestrae, and other skull features distinguish *Dimetrodon* and true mammals from most of the earliest sauropsids.



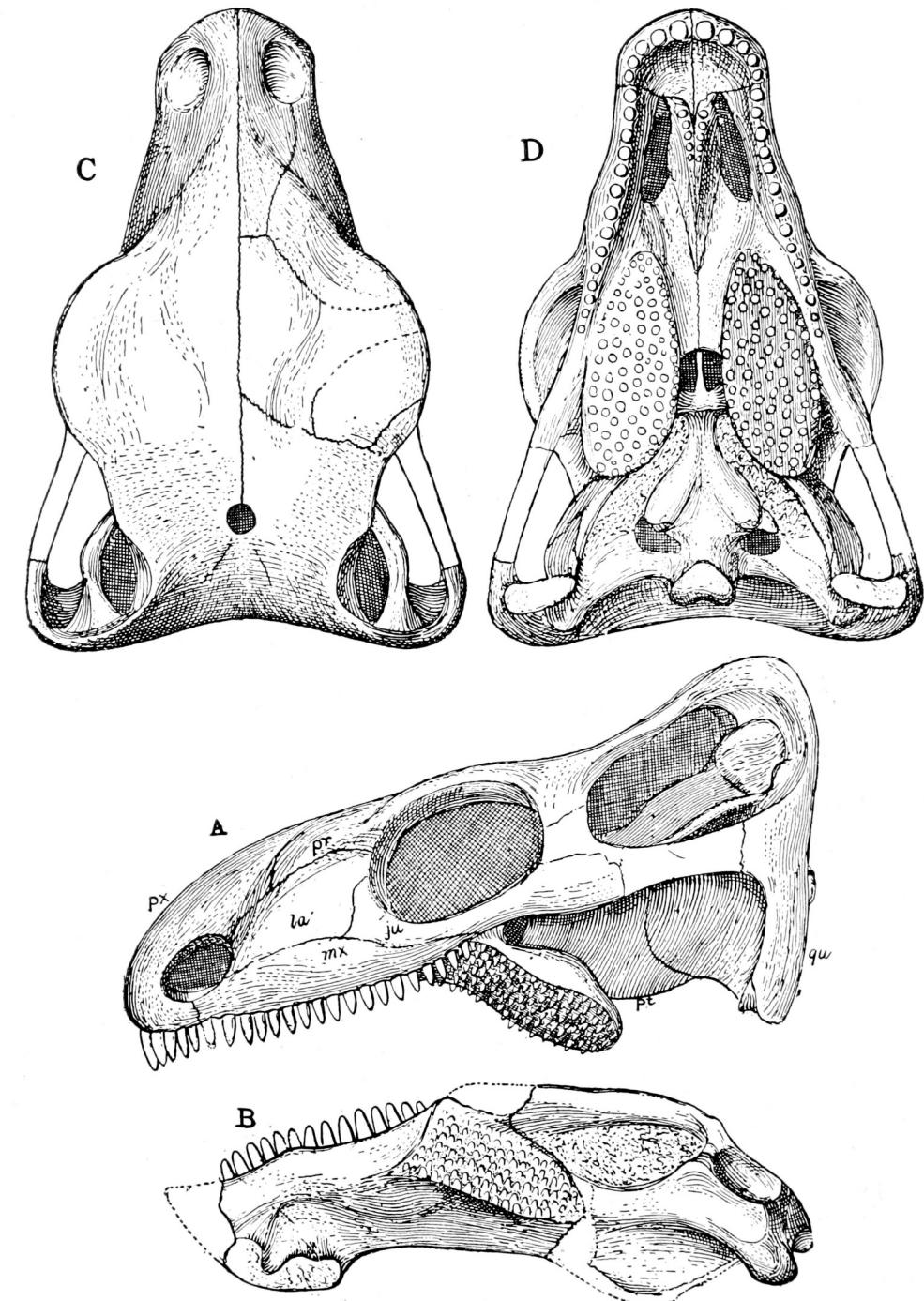
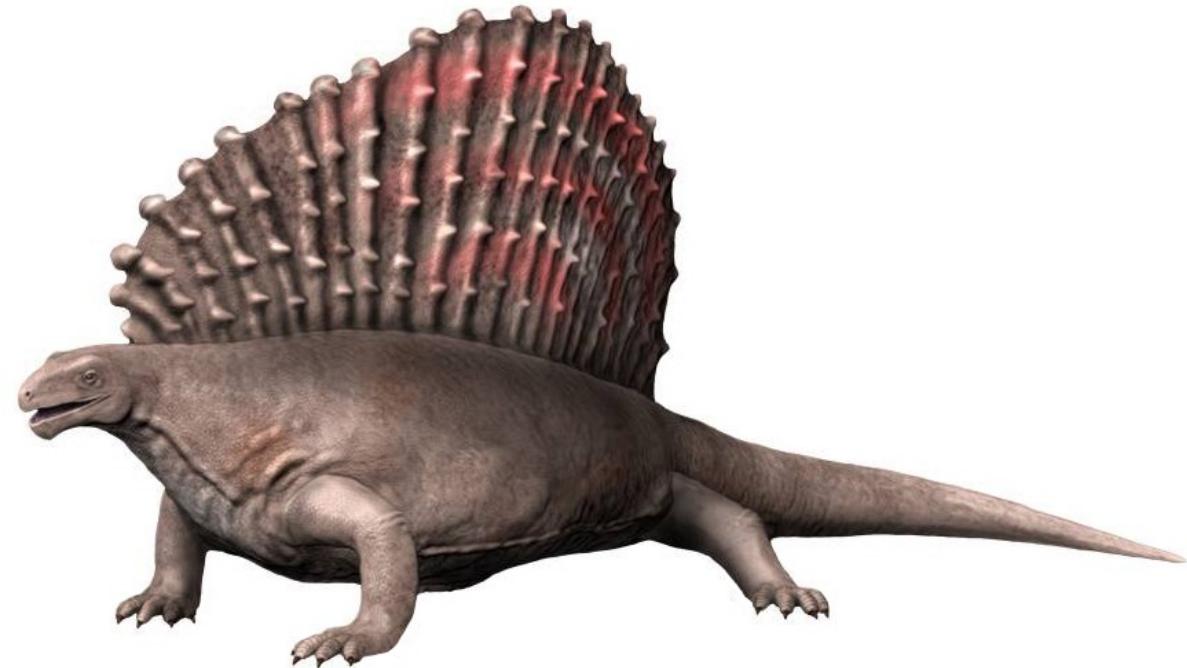
II *Dimetrodon*

Dimetrodon was probably one of the apex predators of the Cisuralian ecosystems, feeding on fish and tetrapods, including reptiles and amphibians.

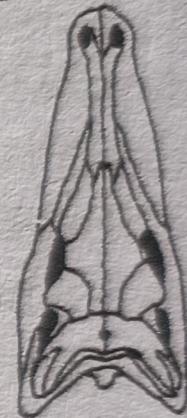
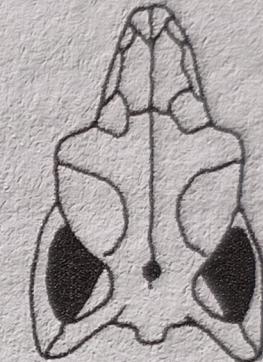
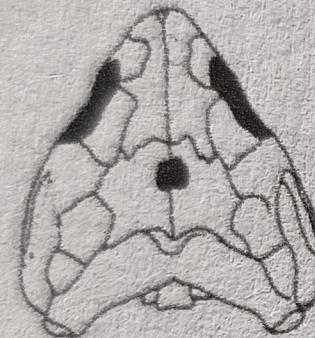
The sail of *Dimetrodon* may have been used in courtship display, including threatening away rivals or showing off to potential mates.

L'*Edaphosaurus*

Una delle prede del *Dimetrodon* era, probabilmente, l'*Edaphosaurus*, un pelicosauro erbivoro dotato di piccola vela dorsale e di denti triangolari, oltre ad una serie di denti più piatti localizzati sul palato e sulla superficie interna della mandibola



L'Edaphosaurus



Eothyrididae

Caseidae

Ophiacodontidae

Edaphosauridae

Sphenacodontidae

CASEASURIA



Varanopseidae

EUPELYCOSURIA

Classificazione dell'*Edaphosaurus*

Domain: Eukaryota

Kingdom: Animalia

Phylum: Chordata

Clade: **Synapsida**

Clade: **Sphenacomorpha**

Family: **Edaphosauridae**

Genus: *Edaphosaurus*

Il *Cotylorhynchus*: erbivoro o predatore?

