

ZOOLOGIA DE VERTEBRADOS

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Castro***

Biólogo Dr. Hertz Figueiredo dos Santos

Monitores PAE: M.Sc. João Trevisan, José Haroldo Braga Jr.

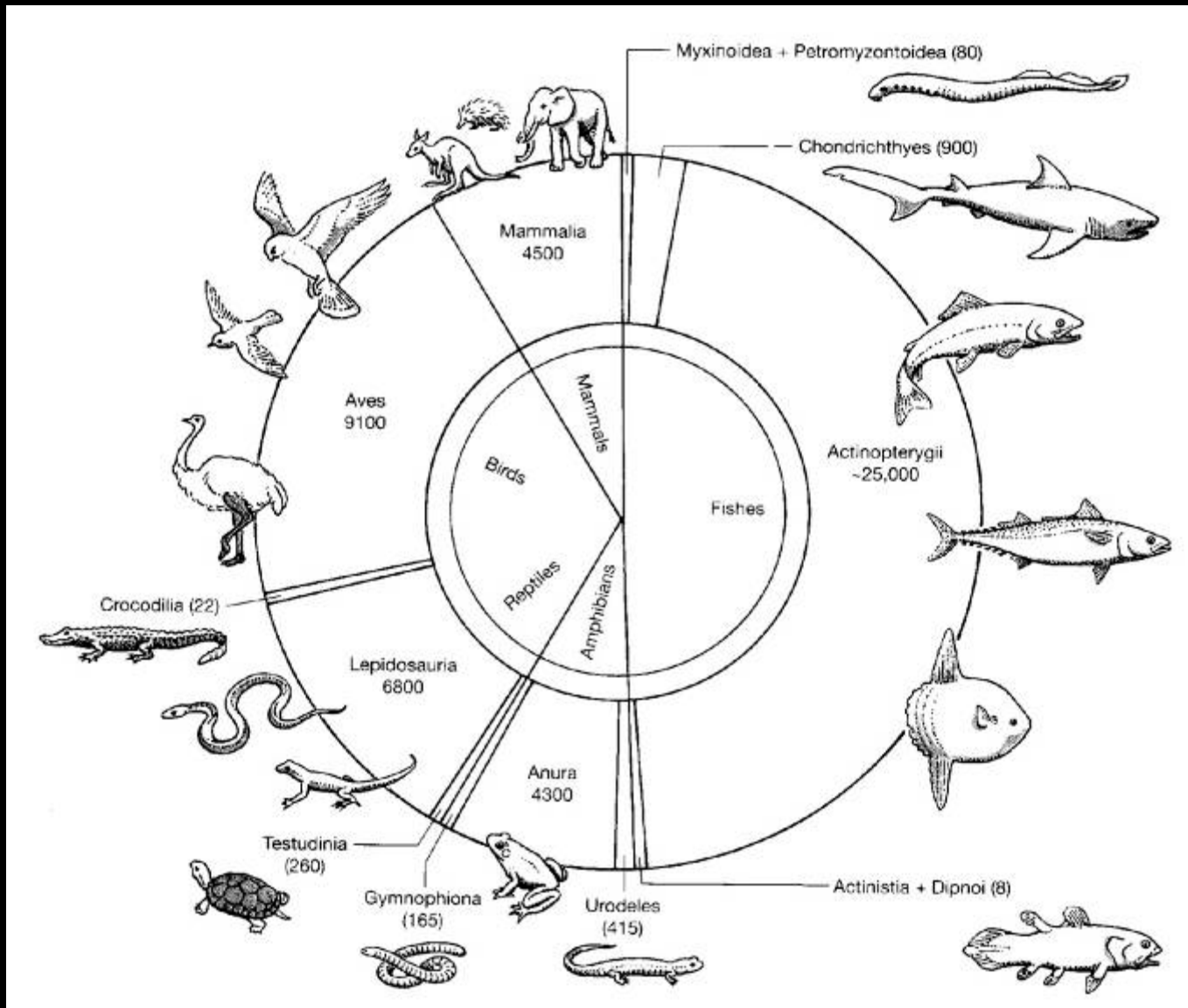
Monitor voluntário (graduação): Pedro Zani

2023

AULA 13

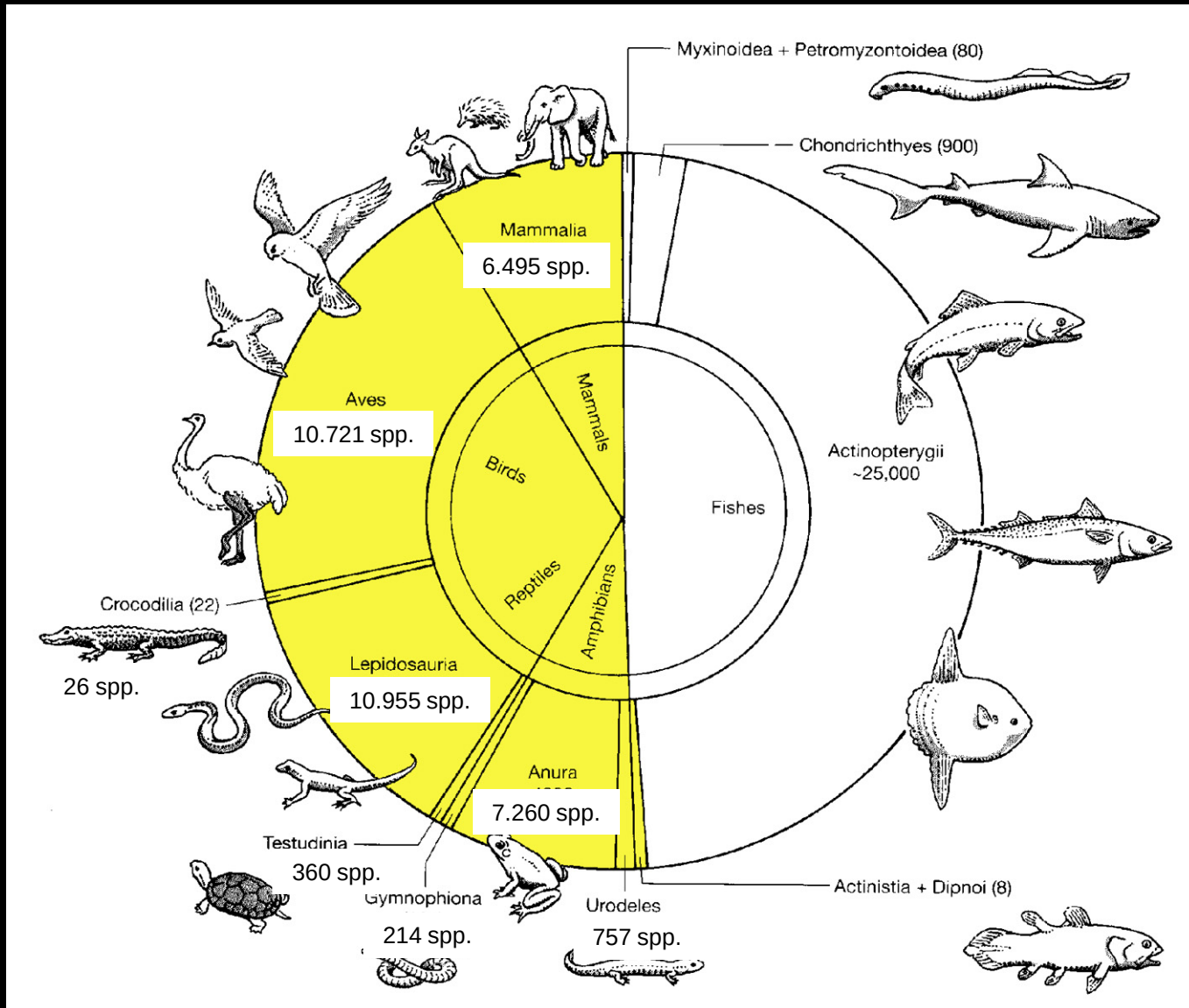
***-Evolução, anatomia, biologia e classificação de Diapsida
Archosauromorpha (Crocodylia e Aves)***





Diversidade dos vertebrados vivos (2002)

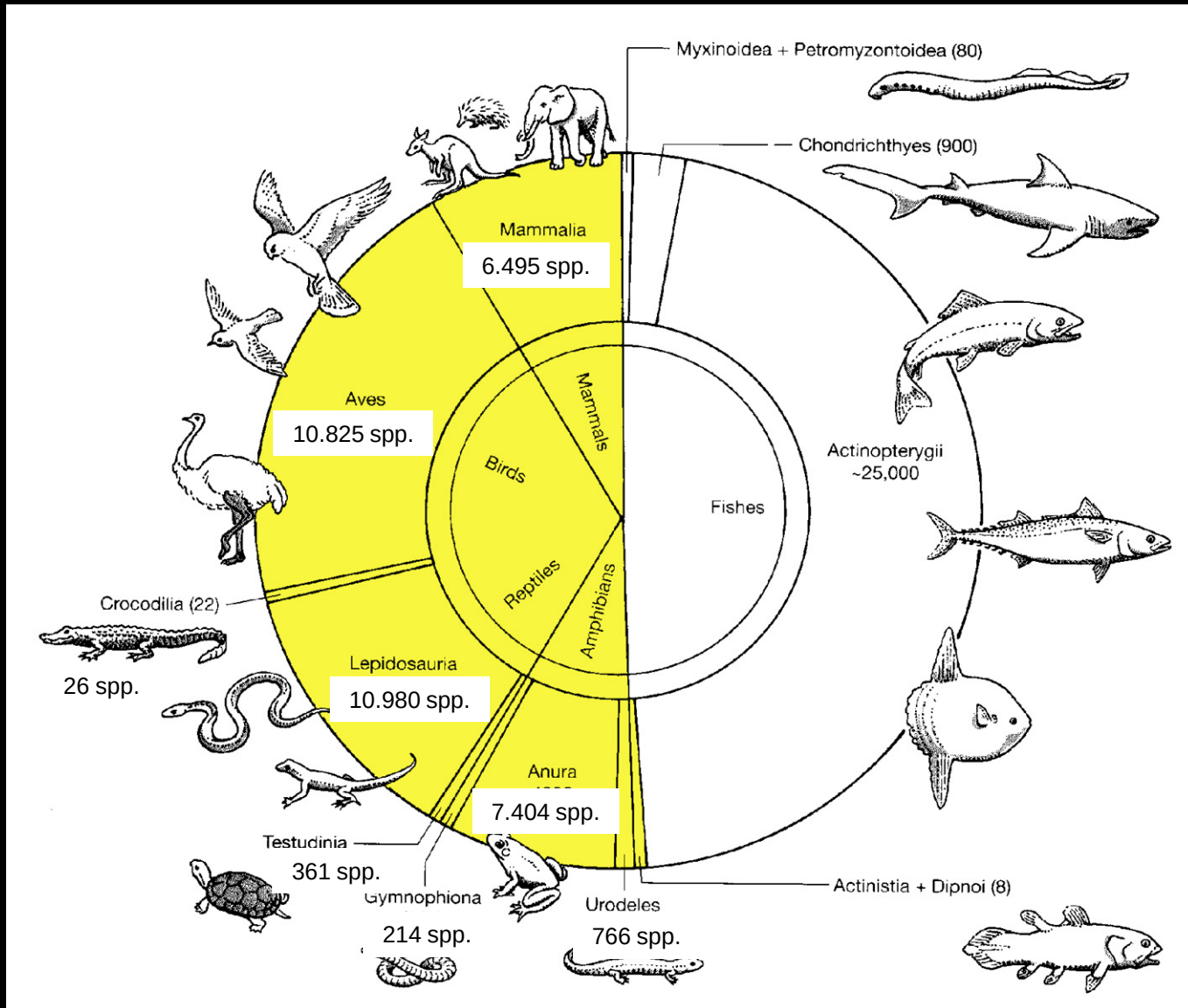
Fonte: Pough et al. (2002). Vertebrate Life. New Jersey, Prentice Hall.



Diversidade dos Sarcopterygii vivos (2020)

- Sarcopterygii: 36.796
espécies

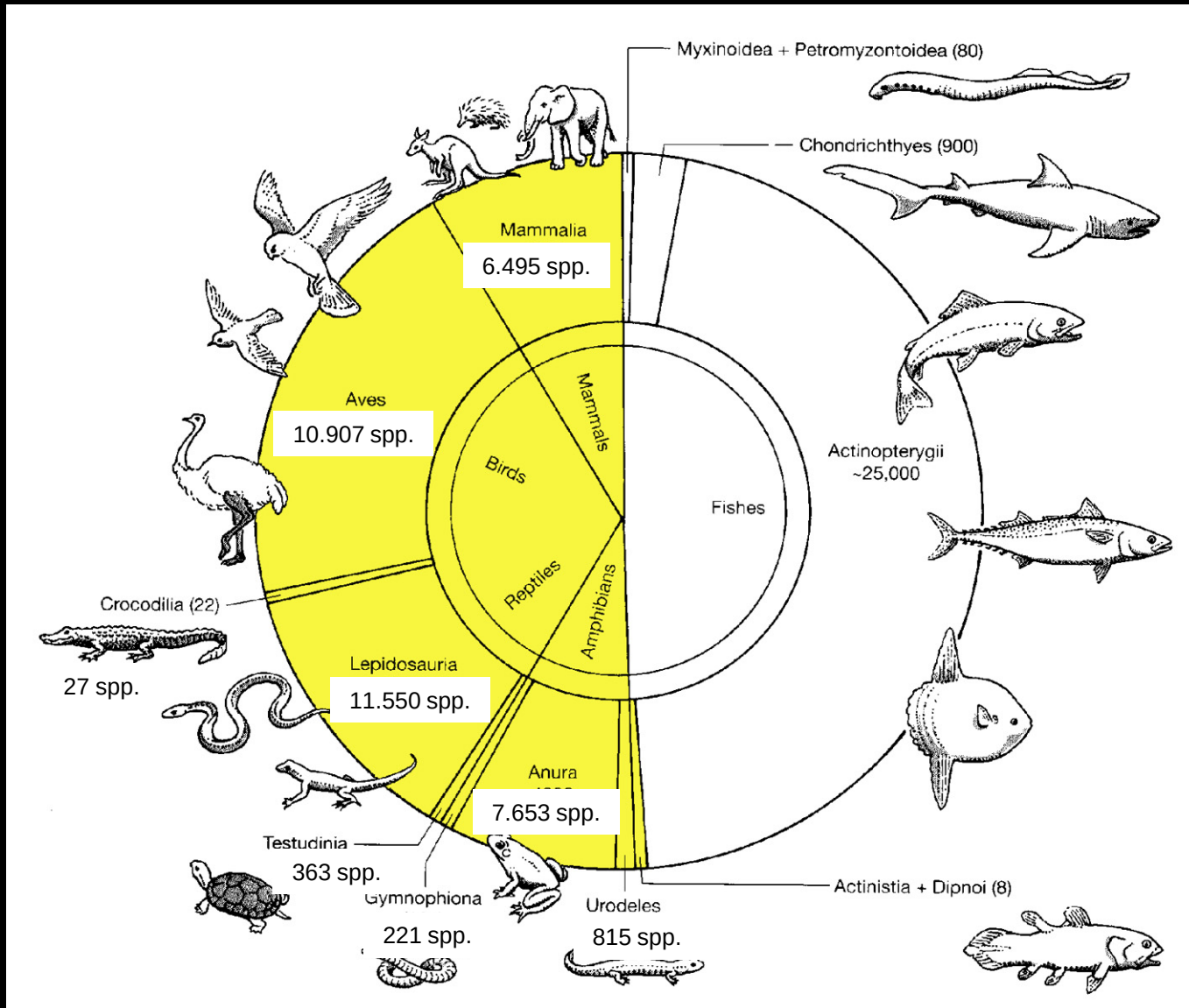
Fonte: Pough et al. (2002). Vertebrate Life. New Jersey, Prentice Hall.



Diversidade dos Sarcopterygii vivos (2021)

- Sarcopterygii: 37.080
espécies

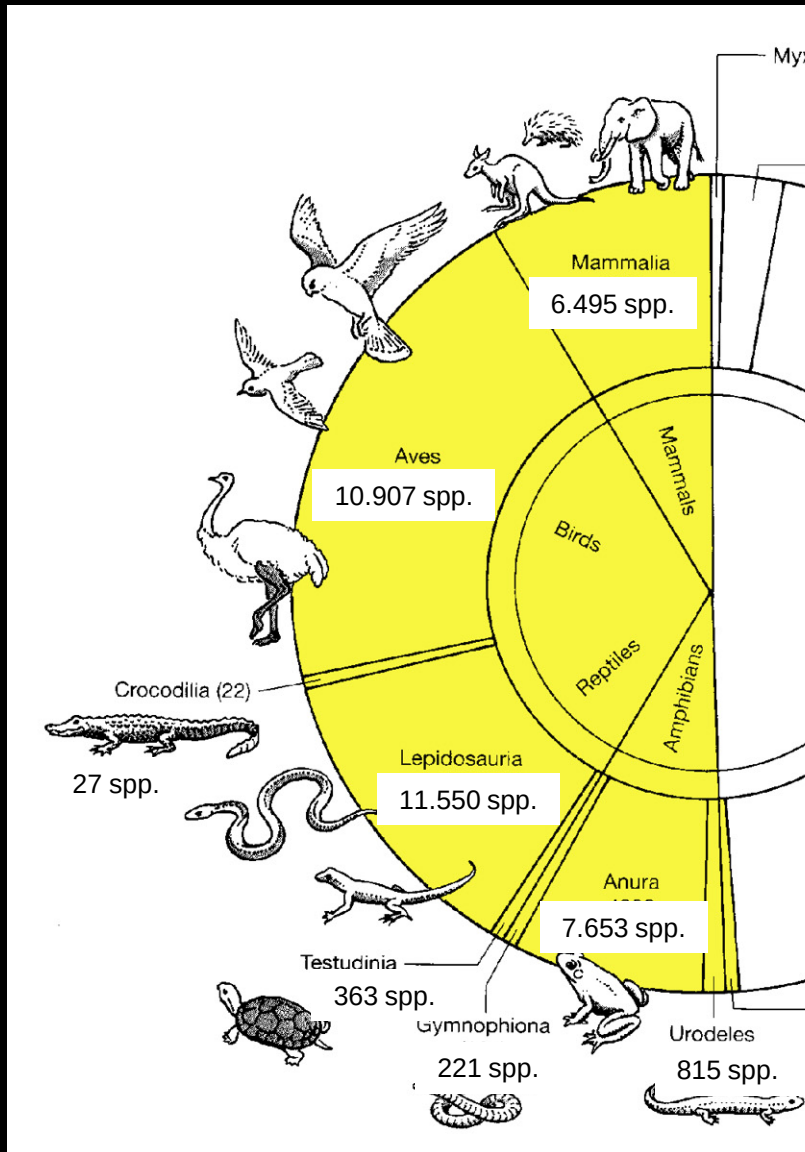
Fonte: Pough et al. (2002). Vertebrate Life. New Jersey, Prentice Hall.



Diversidade dos Sarcopterygii vivos (2023)

Fonte: Pough et al. (2002). Vertebrate Life. New Jersey, Prentice Hall.

- Sarcopterygii: 38.039
espécies



- Sarcopterygii: 38.039 espécies
- Actinistia: 2 spp.
- Dipnoi: 6 spp.
- Amphibia: 8.689 spp. (Anura 7.653 spp., Caudata ou Urodela: 815 spp., Gymnophiona: 221 spp.)
- Testudinia ou Chelonia: 363 spp.
- Squamata: 11.549 spp.
- Rhynchocephalia: 1 sp.
- **Crocodilia: 27 spp.**
- **Aves: 10.907 spp. (+18.022 subespécies!)**
- Mammalia: 6.495 spp.

AmphibiaWeb (2023) AmphibiaWeb: Information on Amphibian Biology and Conservation. University of California, Berkeley. Disponível em: <http://amphibiaweb.org/> (Acessado em 23/10/2023)

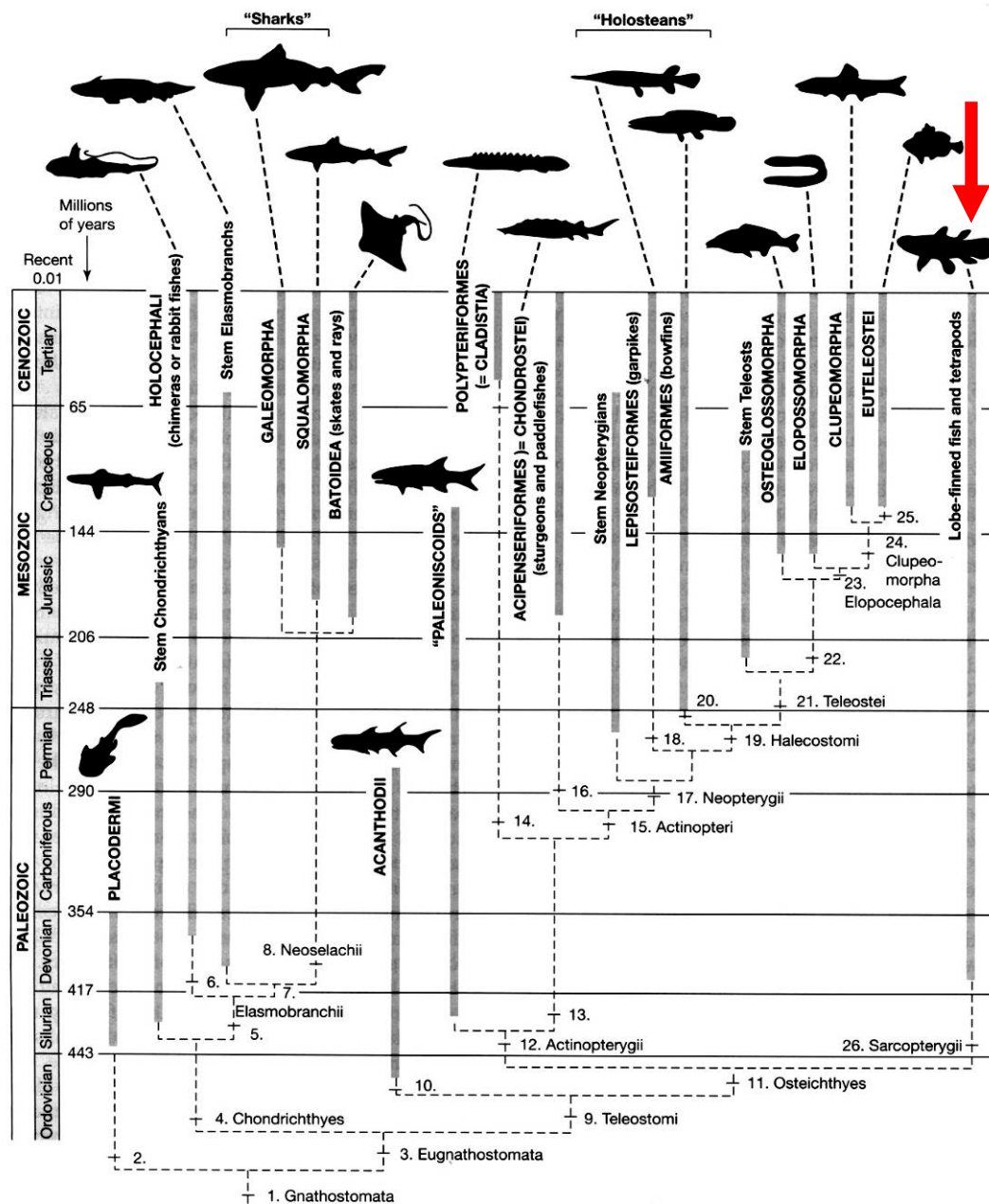
Burgin, C. J. et al. (2018) How many species of mammals are there? Journal of Mammalogy, 99 (1): 1–14.

Clements, J.F. et al. (2022) The eBird/Clements Checklist of Birds of the World: v2022. Cornell University, Ithaca. Disponível em: <http://www.birds.cornell.edu/clementschecklist/download/> (Acessado em 24/10/2023)

Uetz, P. (2023) The Reptile Database. Disponível em: <http://www.reptile-database.org/> (Acessado em 24/10/2023)

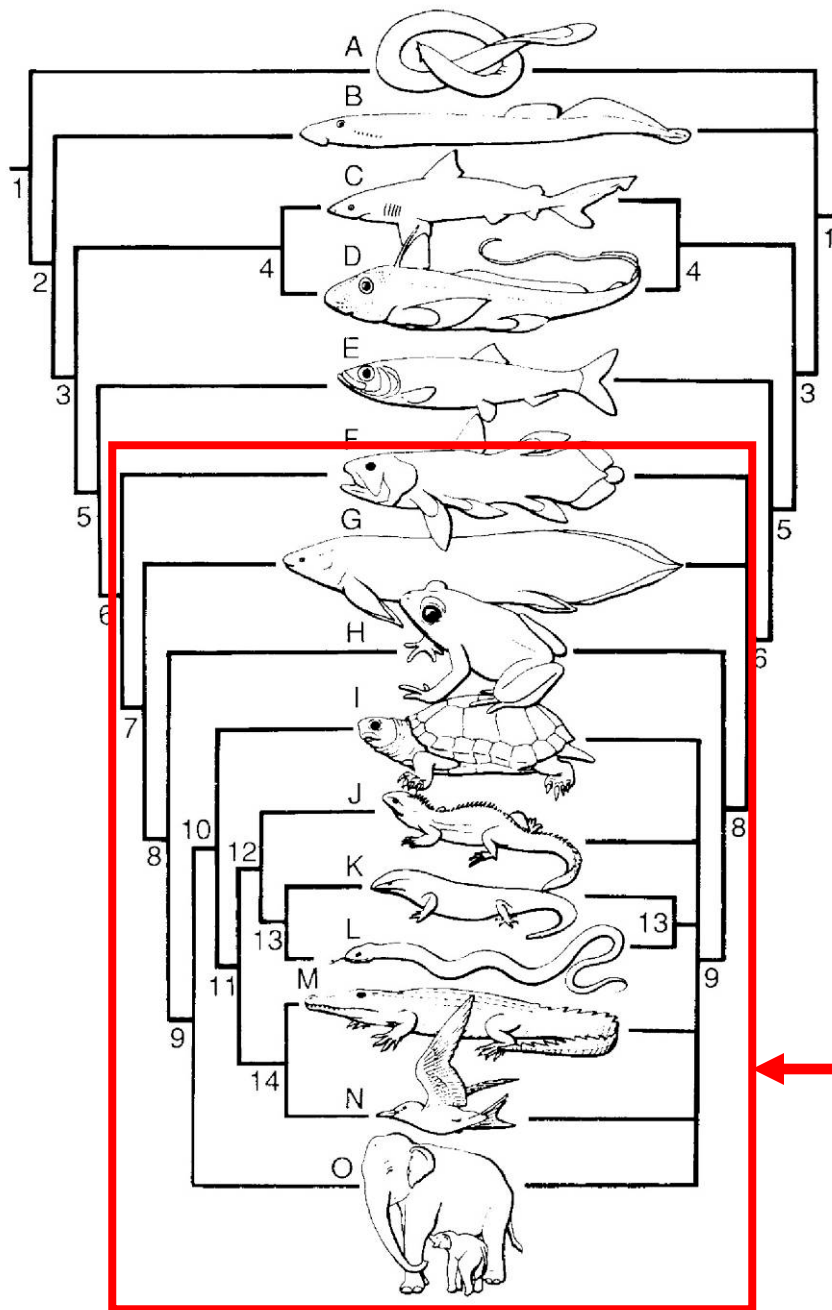
Diversidade dos Sarcopterygii viventes (2023)

Fonte: Pough et al. (2002). Vertebrate Life. New Jersey, Prentice Hall.



Posição Filogenética de
Crocodylia e Aves - Filogenia dos
Gnathostomata (vertebrados
com mandíbula).

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.



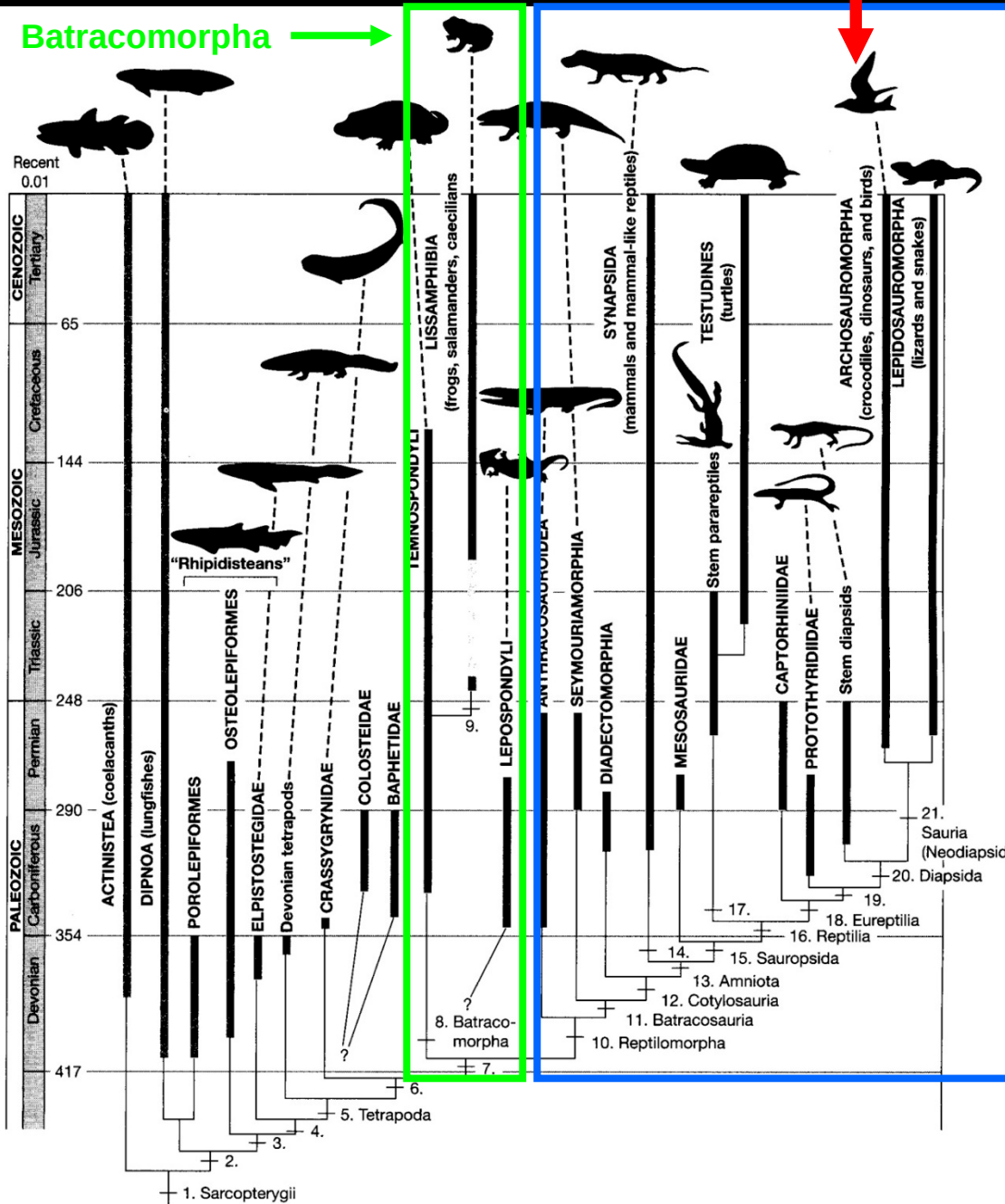
Filogenia dos Craniata.

Sarcopterygii

Fonte: Janvier, P. 1996. *Early Vertebrates*. New York, Oxford University Press.

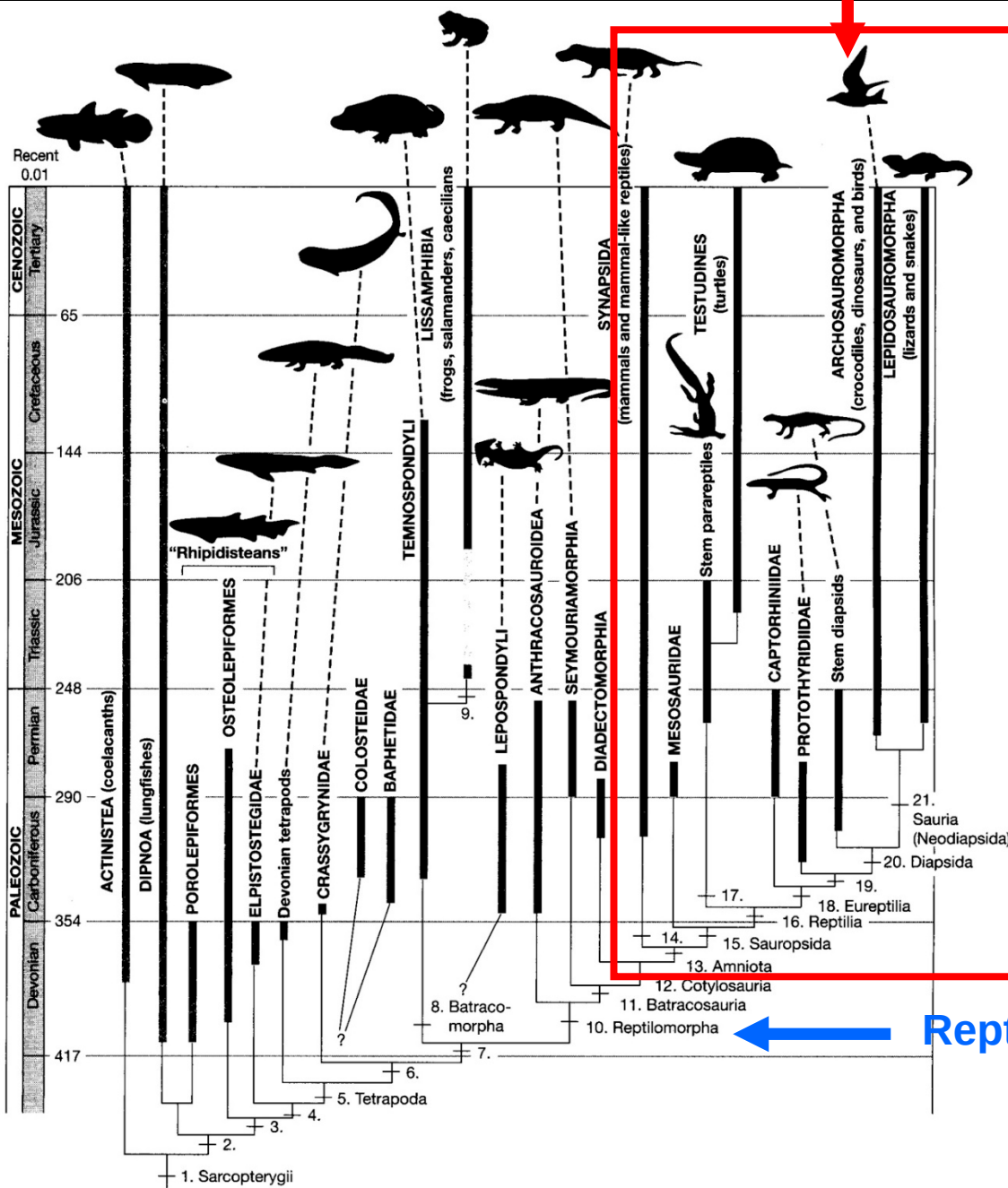
Batrachomorpha →

← Reptilomorpha

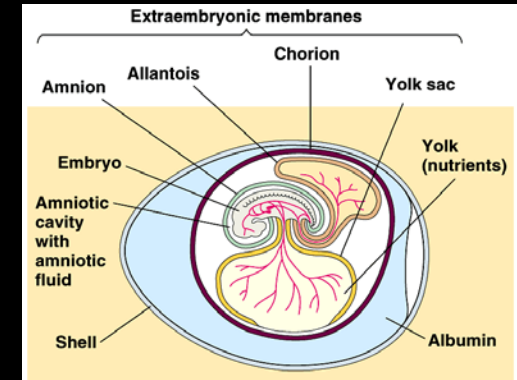


Posição Filogenética de Crocodylia e Aves - Filogenia dos Gnathostomata (vertebrados com mandíbula).

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



Amniota



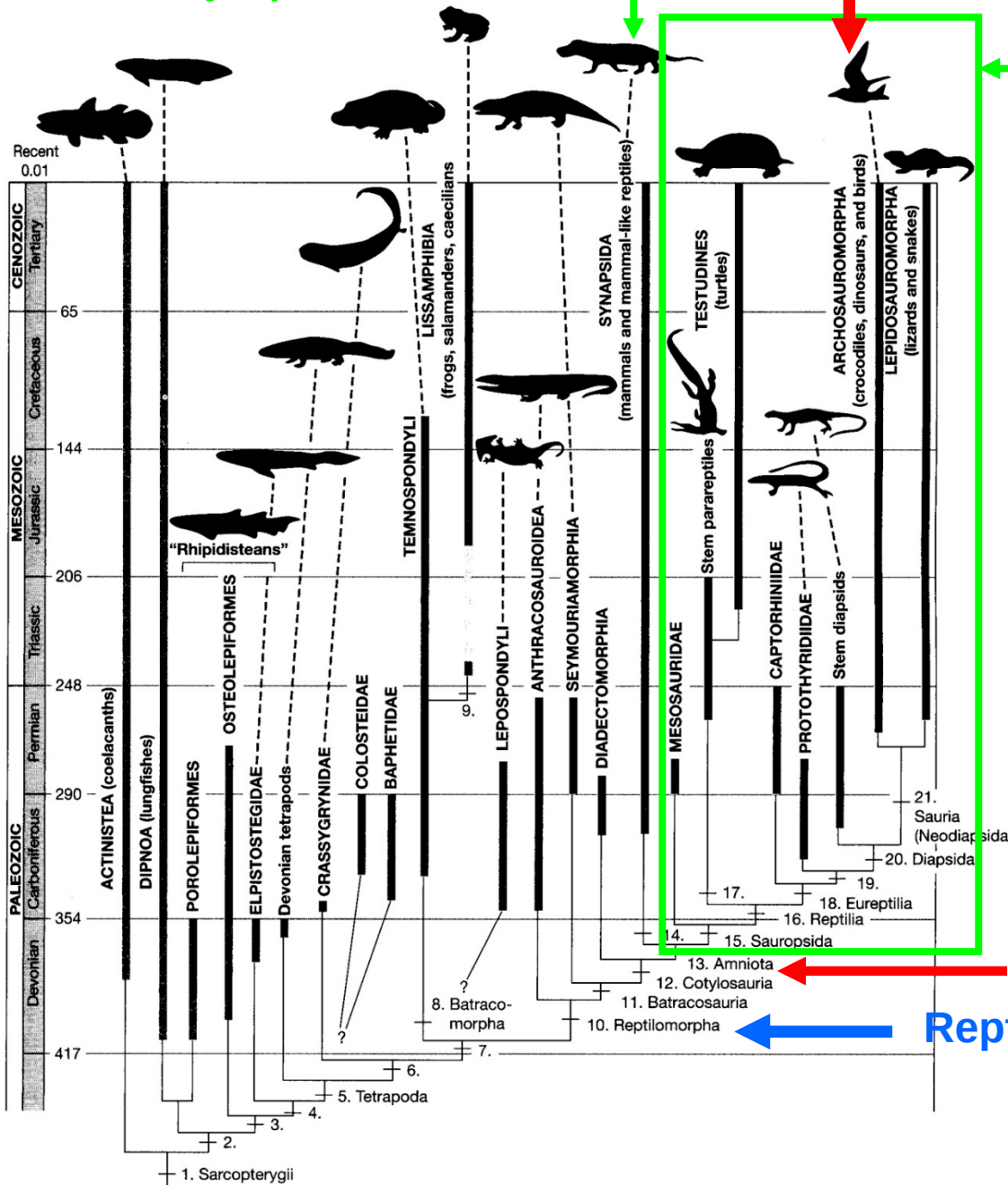
Posição Filogenética de Crocodylia e Aves - Filogenia dos Gnathostomata (vertebrados com mandíbula).

Reptilomorpha

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

Synapsida

Sauropsida



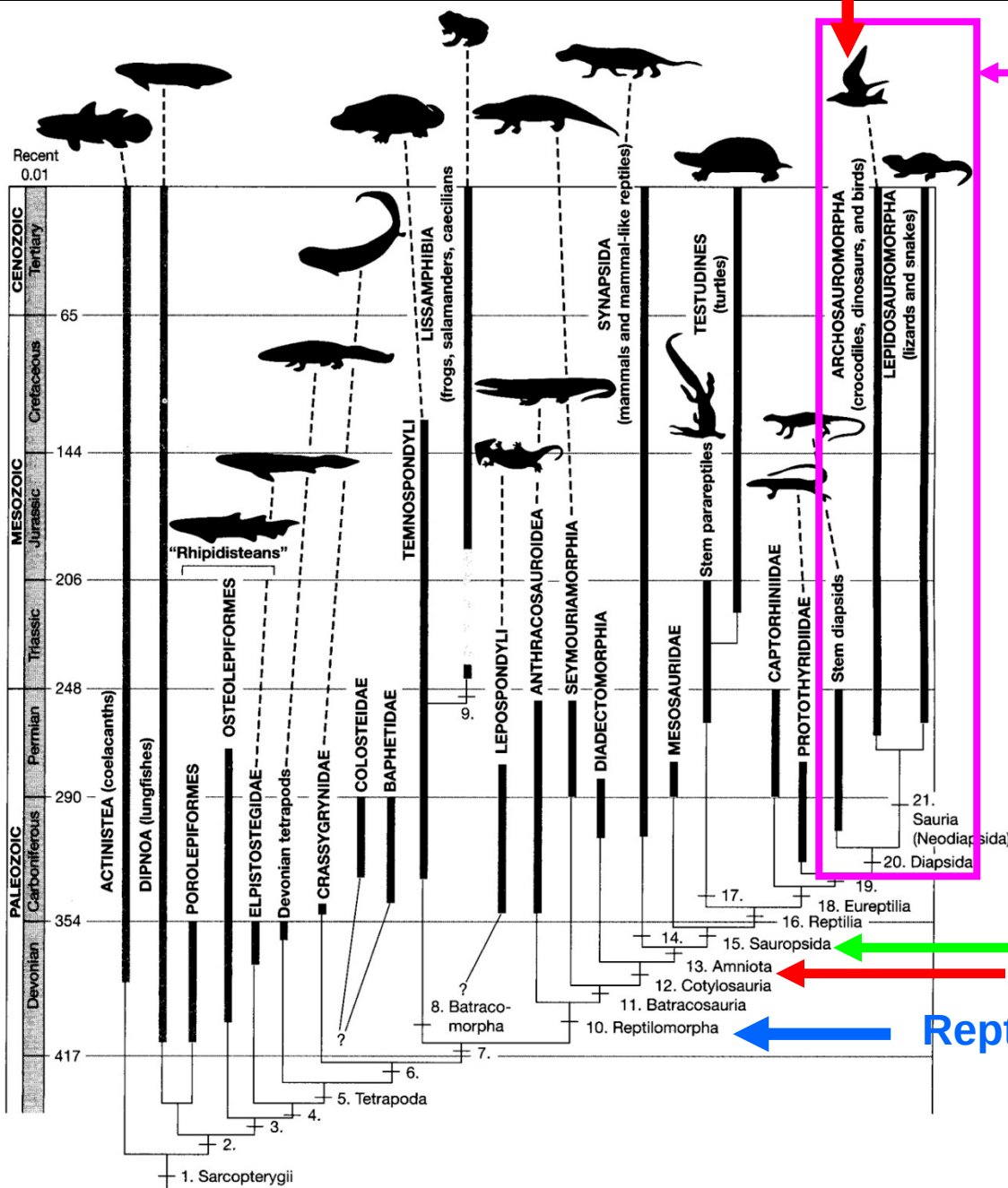
Posição Filogenética de Crocodylia e Aves - Filogenia dos Gnathostomata (vertebrados com mandíbula).

Fonte: Pough et al. 2002. *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

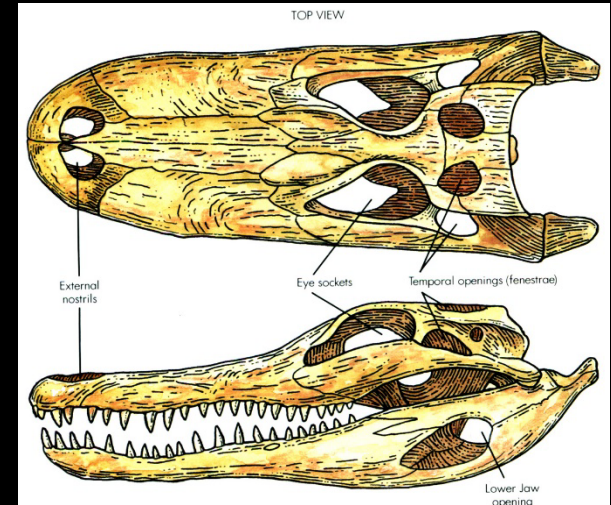
Amniota

Reptilomorpha

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



Diapsida



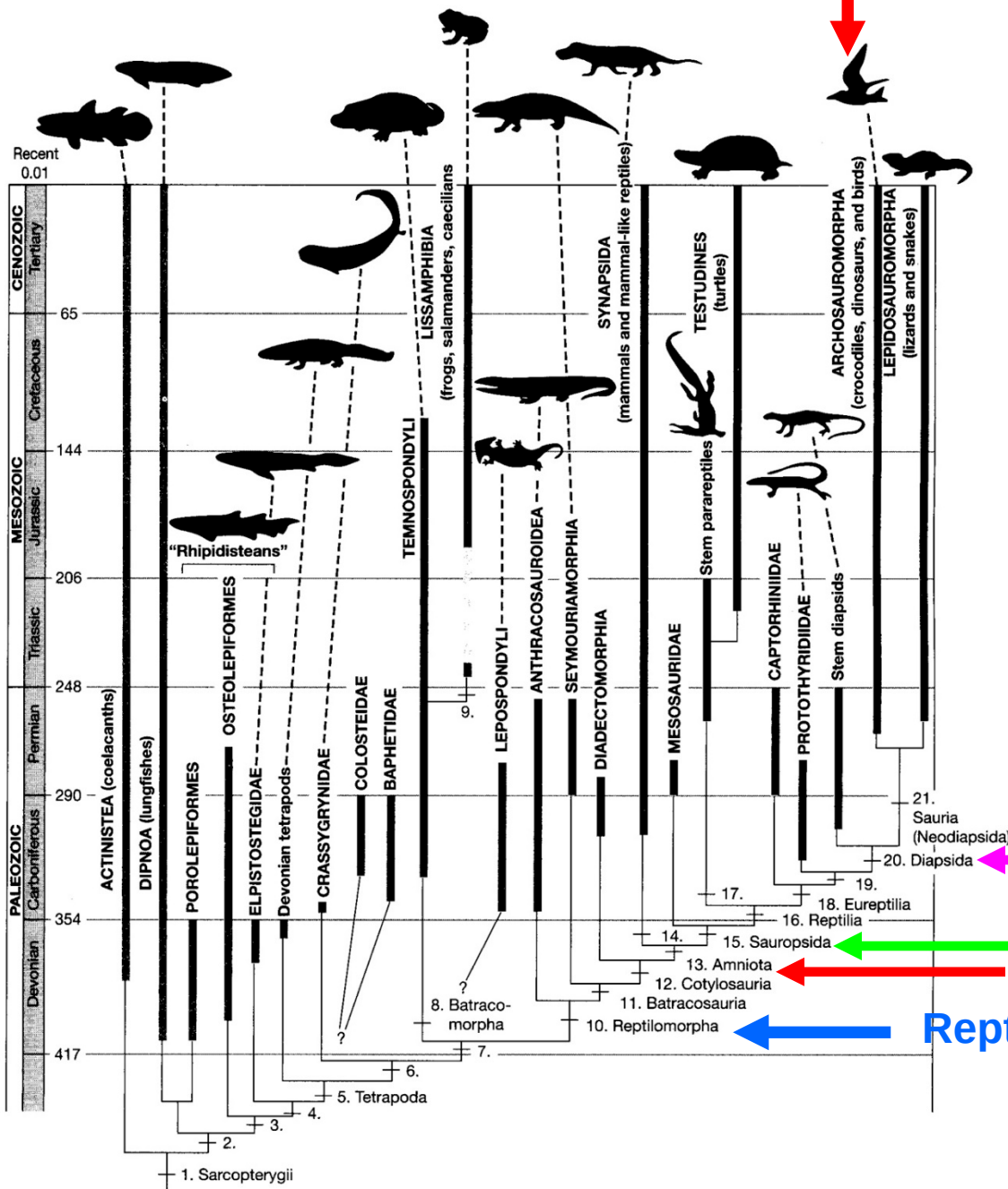
Posição Filogenética de Crocodylia e Aves - Filogenia dos Gnathostomata (vertebrados com mandíbula).

Sauropsida

Amniota

Reptilomorpha

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



Posição Filogenética de Crocodylia e Aves - Filogenia dos Gnathostomata (vertebrados com mandíbula).

Fonte: Pough et al. 2002. *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

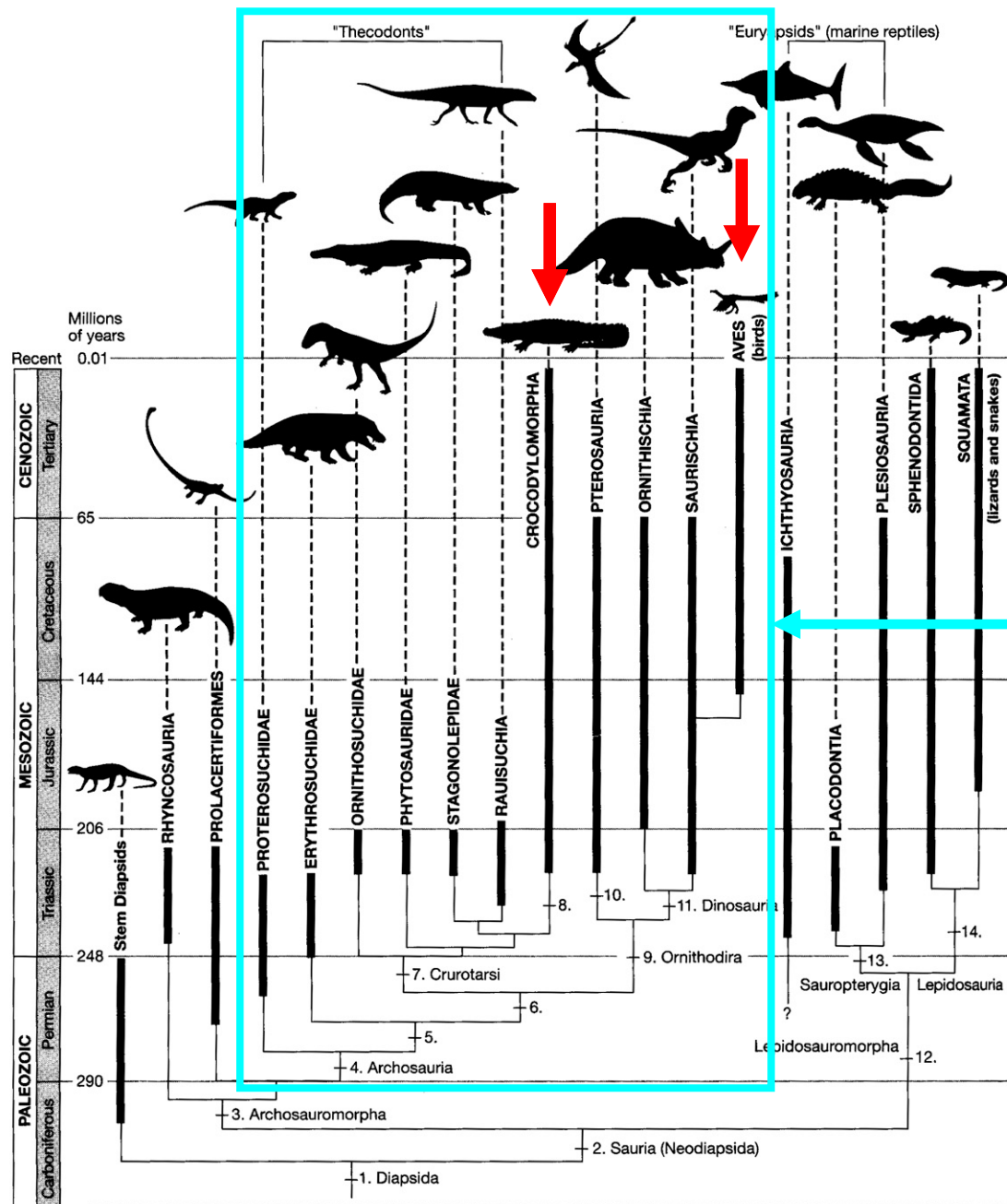
Diapsida

Sauropsida

Amniota

Reptilomorpha

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

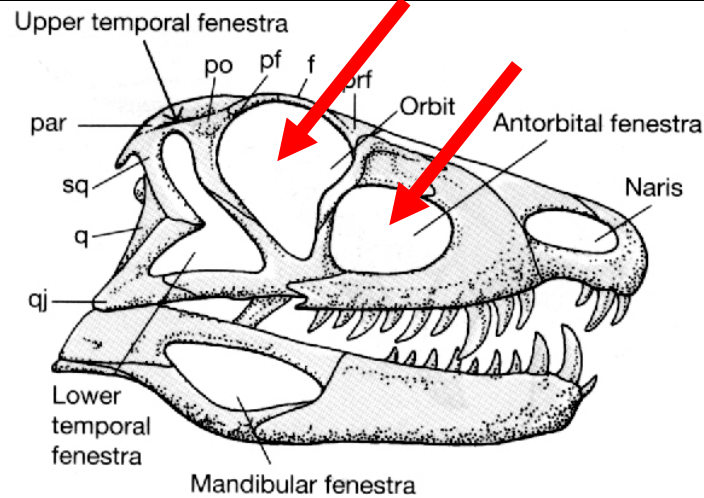


Filogenia dos Diapsida.

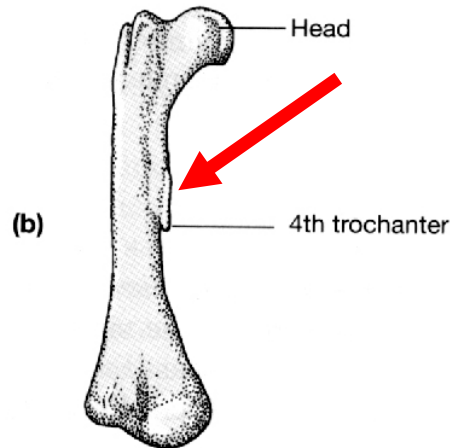
Posição Filogenética de Crocodylia e Aves - Filogenia dos Diapsida.

Archosauria

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



(a)



(b)

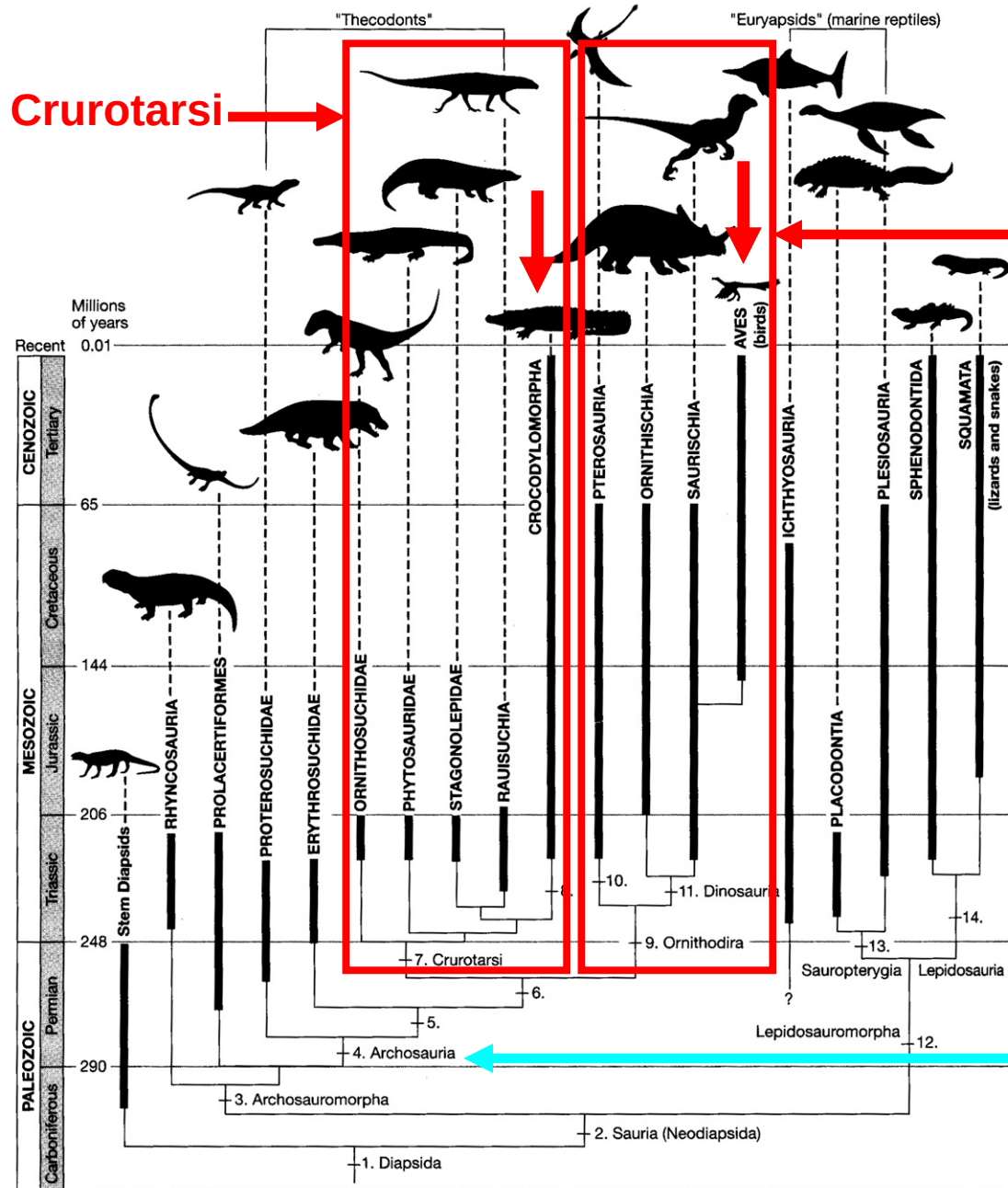
Legend: f, frontal; par, parietal; pf, postfrontal; po, postorbital; prf, prefrontal; sq, squamosal; q, quadrate; qj, quadratojugal.

Morphological features of diapsids. (a) Skull of *Ornithosuchus* showing the characteristic features of archosaurs: two temporal arches, a keyhole-shaped orbit, and an antorbital fenestra. (b) Femur of *Thescelosaurus* showing the fourth trochanter.

Archosauria – morfologia: (a) crânio de *Ornithosuchus*; (b) fêmur de *Thescelosaurus*.

Fonte: Pough *et al.* (2002). *Vertebrate Life*. New Jersey, Prentice Hall.

Fonte: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



Crurotarsi →

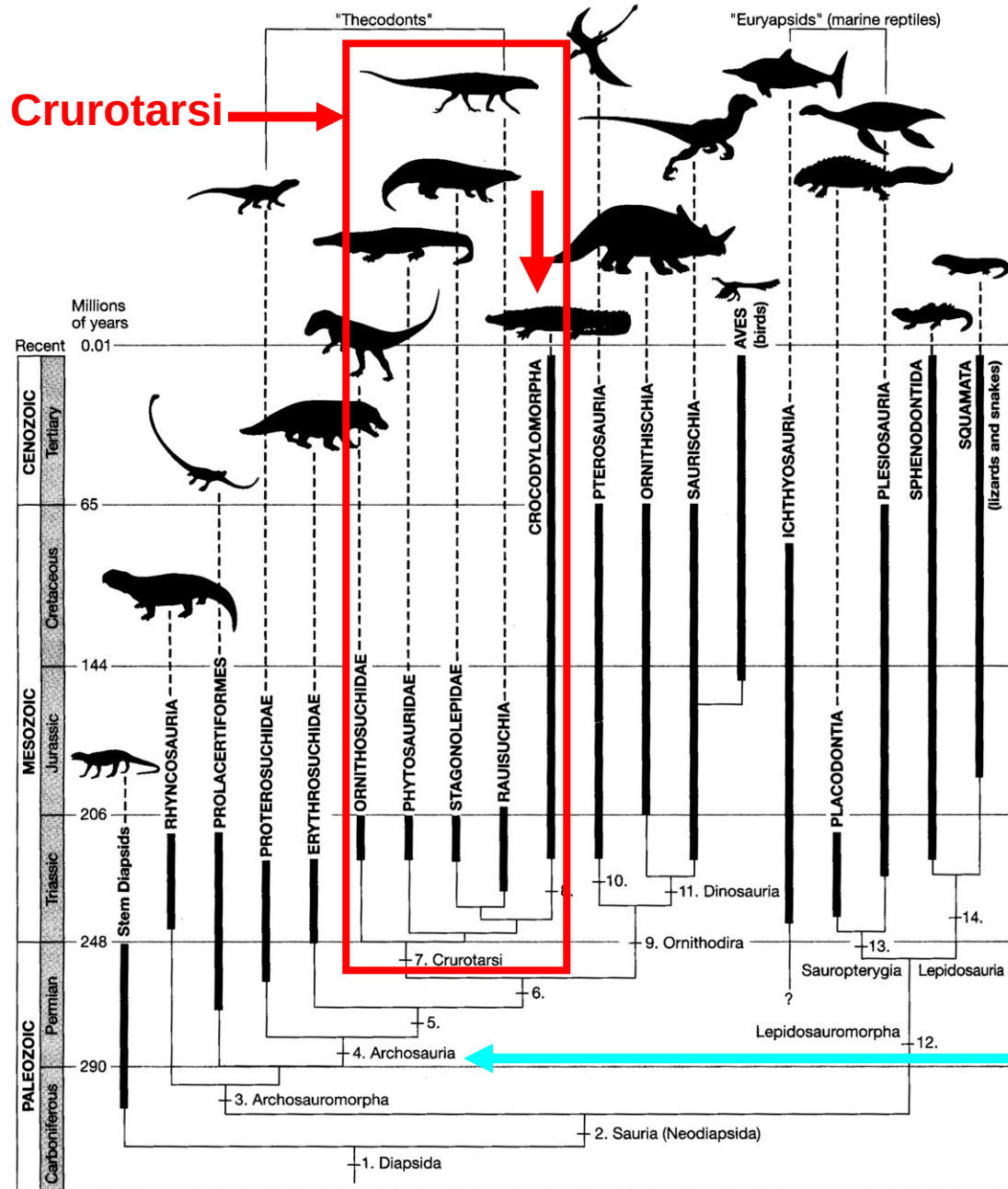
Ornithodira →

Posição Filogenética de Crocodylia e Aves - Filogenia dos Diapsida.

Archosauria – atualmente dividido em Pseudosuchia e Avemetatarsalia (ou Panaves)

Archosauria →

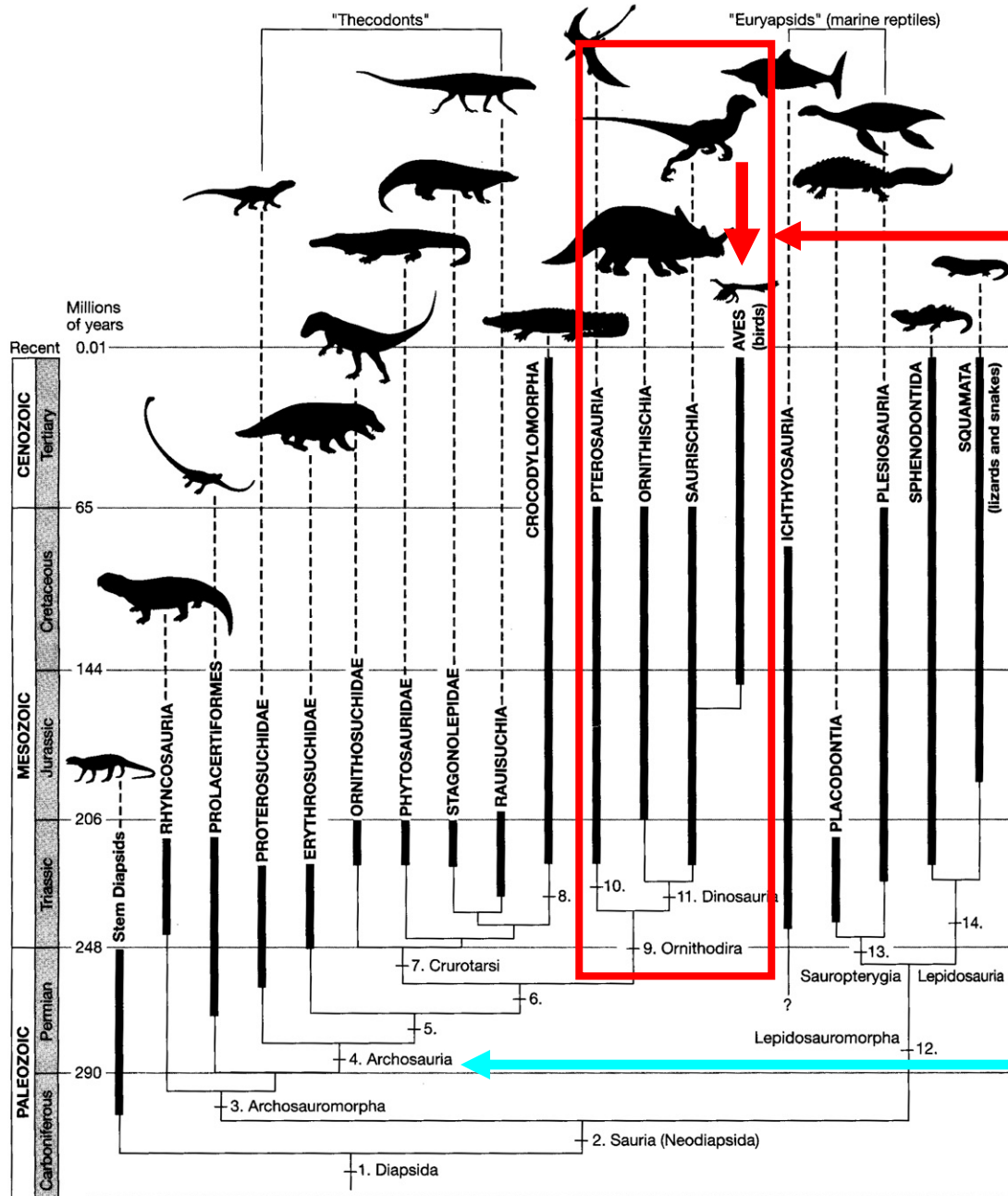
Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



Filogenia dos Diapsida.

Archosauria

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

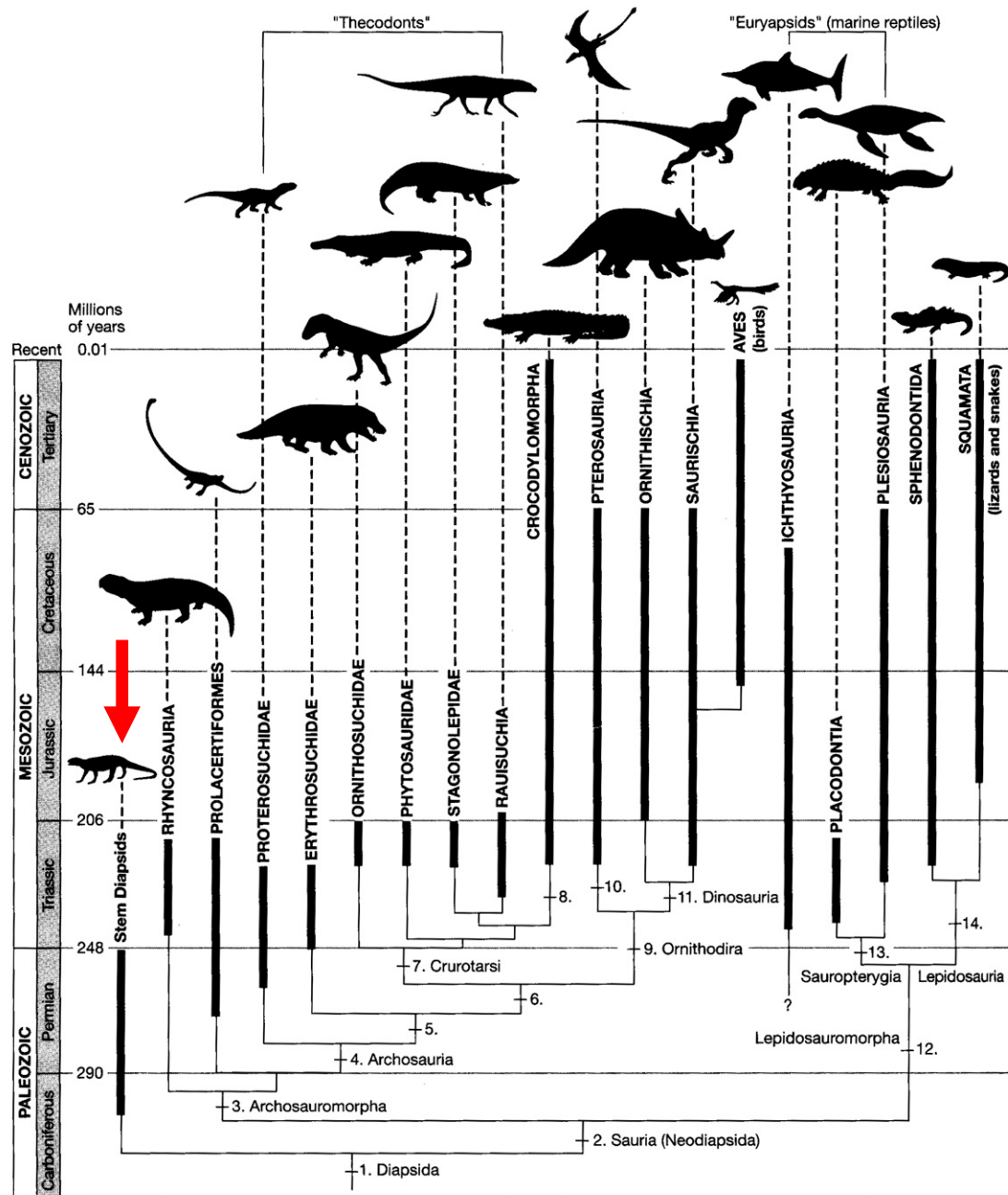


Ornithodira

Filogenia dos Diapsida.

Archosauria

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

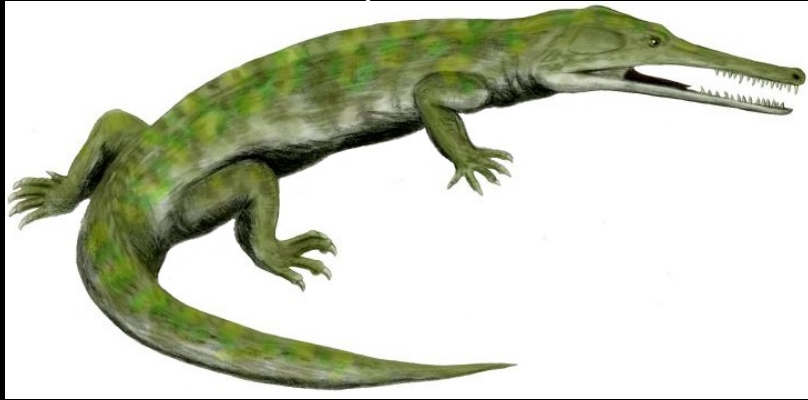


Filogenia dos Diapsida.

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

ORDEM CHORISTODERA: Diapsida basal ou Archosauromorpha basal?

- Jurássico Médio -> Mioceno Inferior.
- Semi-aquáticos.



Champsosaurus natator, Triássico Inferior, Montana, EUA.



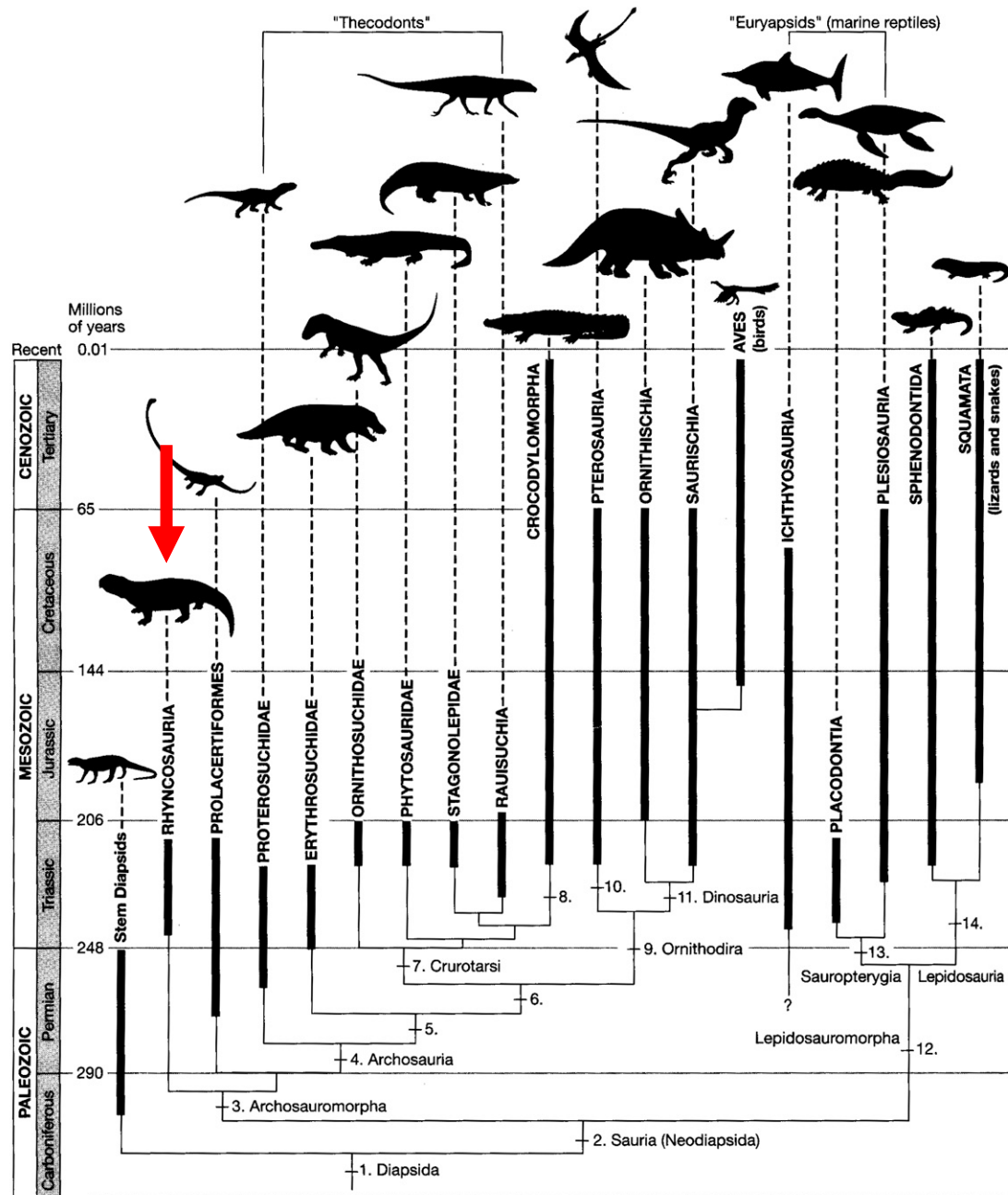
Hyphalosaurus lingyuanensis,
Cretáceo Inferior, China.



Embrião ou neonato não identificado,
Cretáceo Inferior, China.

Fontes: Buffetaut, E. *et al.* (2007) A two-headed reptile from the Cretaceous of China. *Biol. Lett.*, 3: 80–81.

Gao, K.-Q. & Ksepka, D. T. (2008) Osteology and taxonomic revision of *Hyphalosaurus* (Diapsida: Choristodera) from the Lower Cretaceous of Liaoning, China. *J. Anat.*, 212: 747–768.



Filogenia dos Diapsida.

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

RHYNCHOSAURIA: Morfologia e Diversidade



Rhynchosaurus articeps, Triássico, Brasil

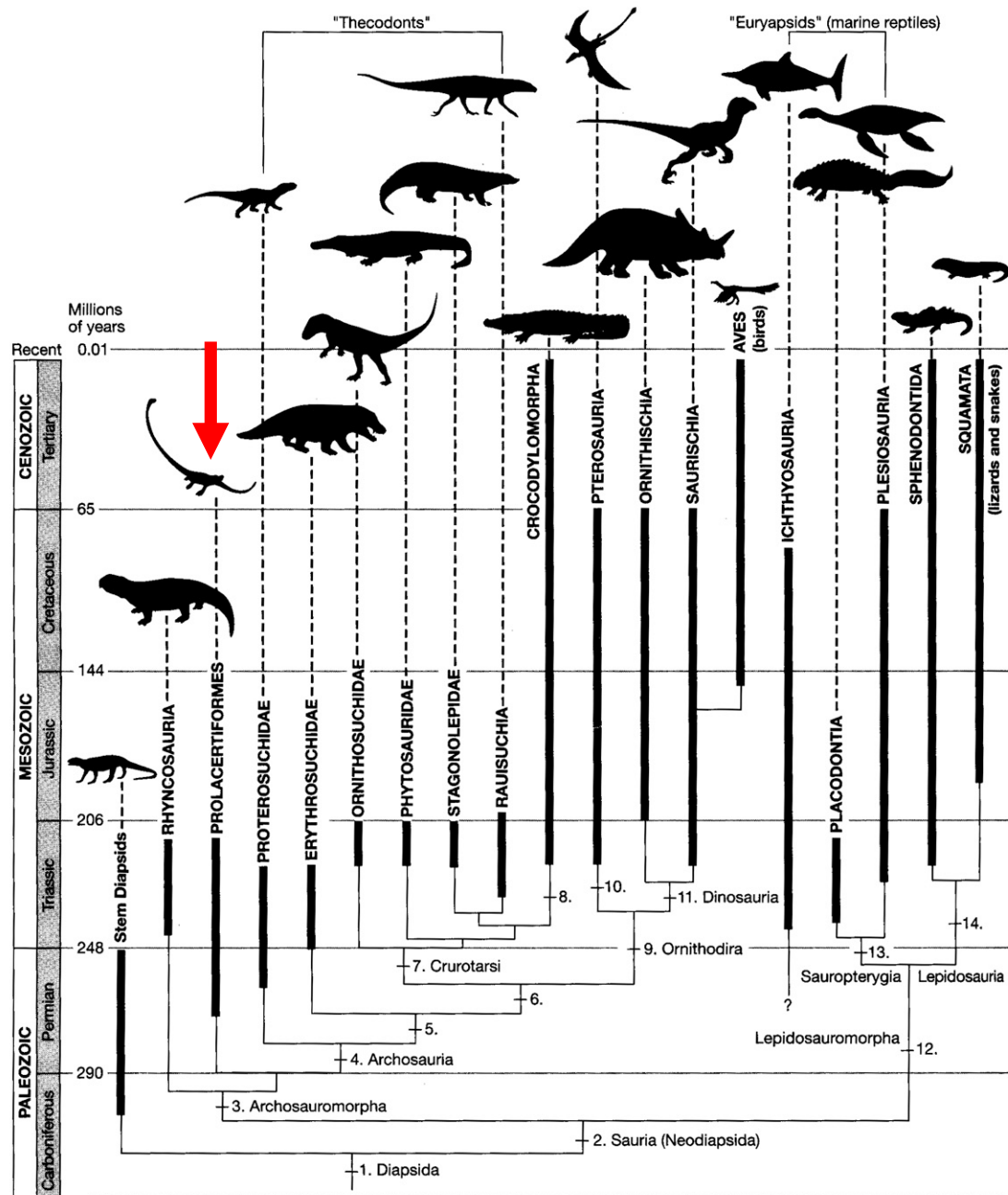
superfície ventral de placa dentária de
Hyperodapedon



Mesosuchus browni, Triássico Inf., África
do Sul



Hyperodapedon sanjuanensis,
Trássico, Argentina



Filogenia dos Diapsida

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

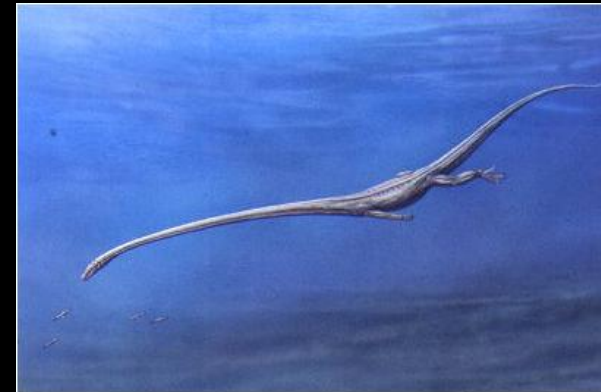
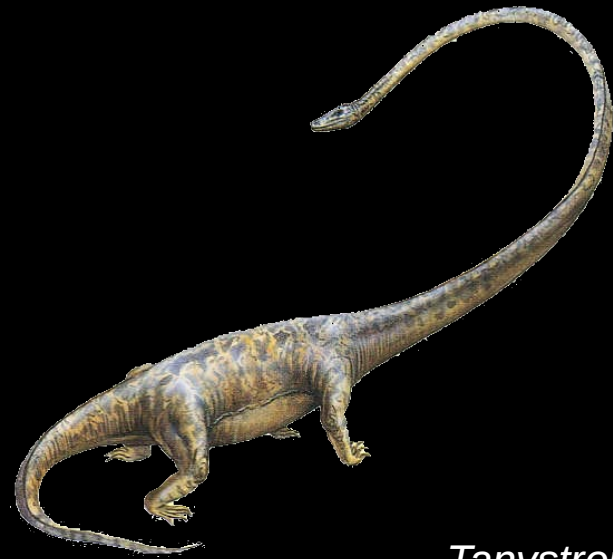
PROLACERTIFORMES (protossauros): Morfologia e Diversidade



Sharovipteryx mirabilis (2,5 cm sem cauda). Triássico Médio, Quirguistão

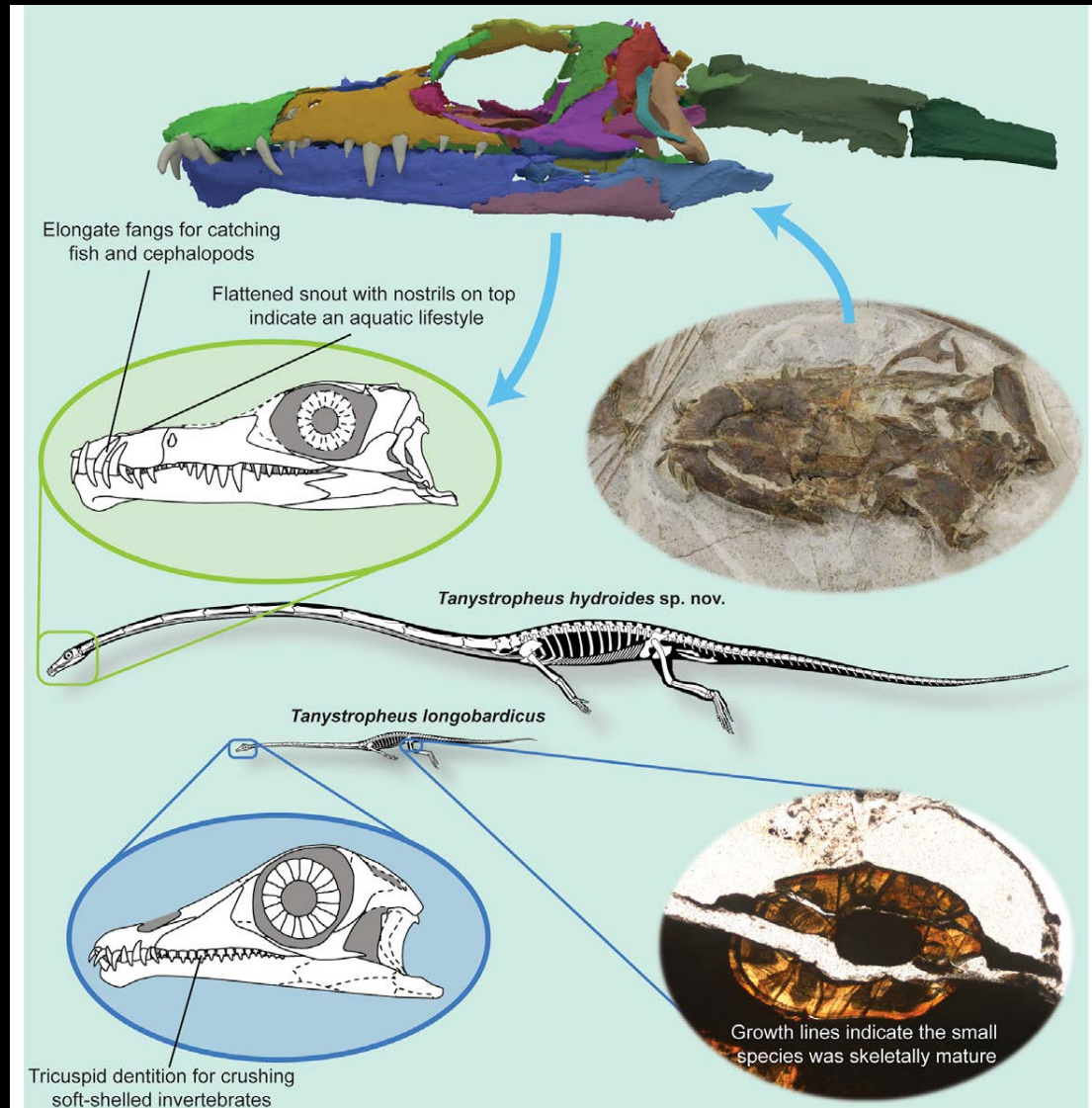


Macrocnemus. Trássico Médio, Europa e China

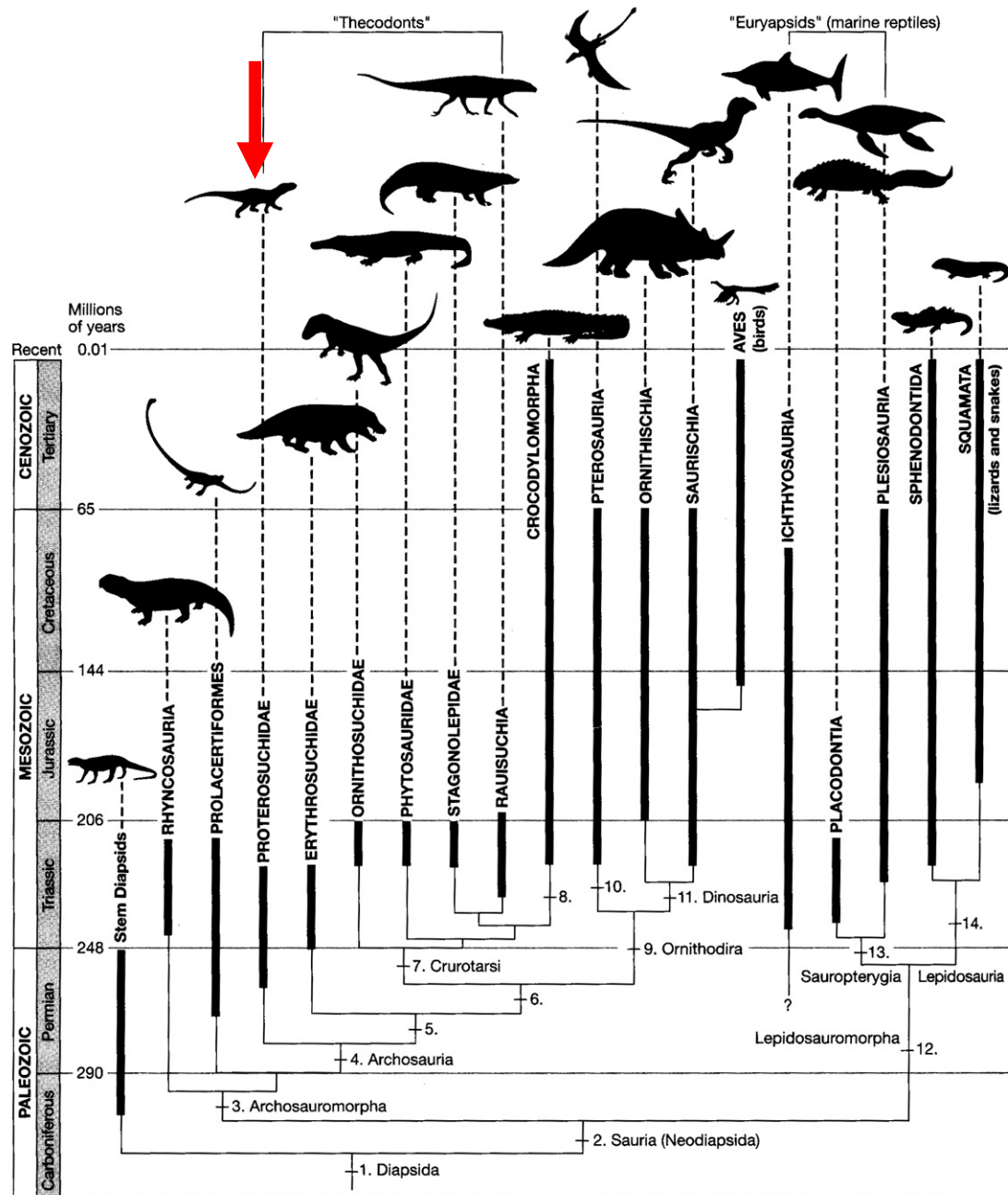


Tanystropheus. Triássico Médio, Europa, Oriente Médio, China

PROLACERTIFORMES (protossauros): Morfologia e Diversidade



Fonte: Spiekman, S.N.F. *et al.* (2020) Aquatic habits and niche partitioning in the extraordinarily long-necked Triassic reptile *Tanytropheus*. *Current Biology*, 30: 3889–3895.



Filogenia dos Diapsida

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

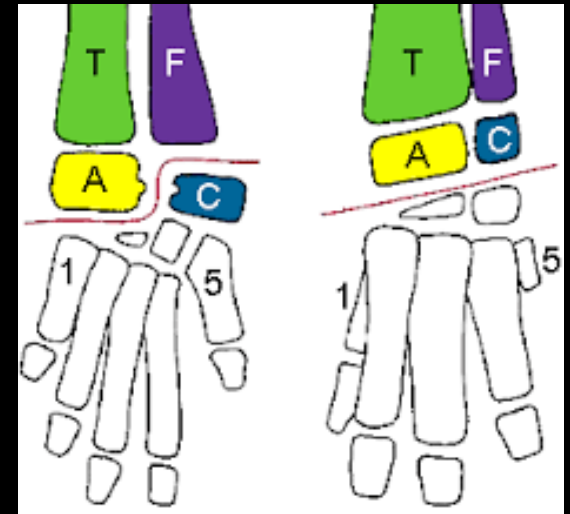
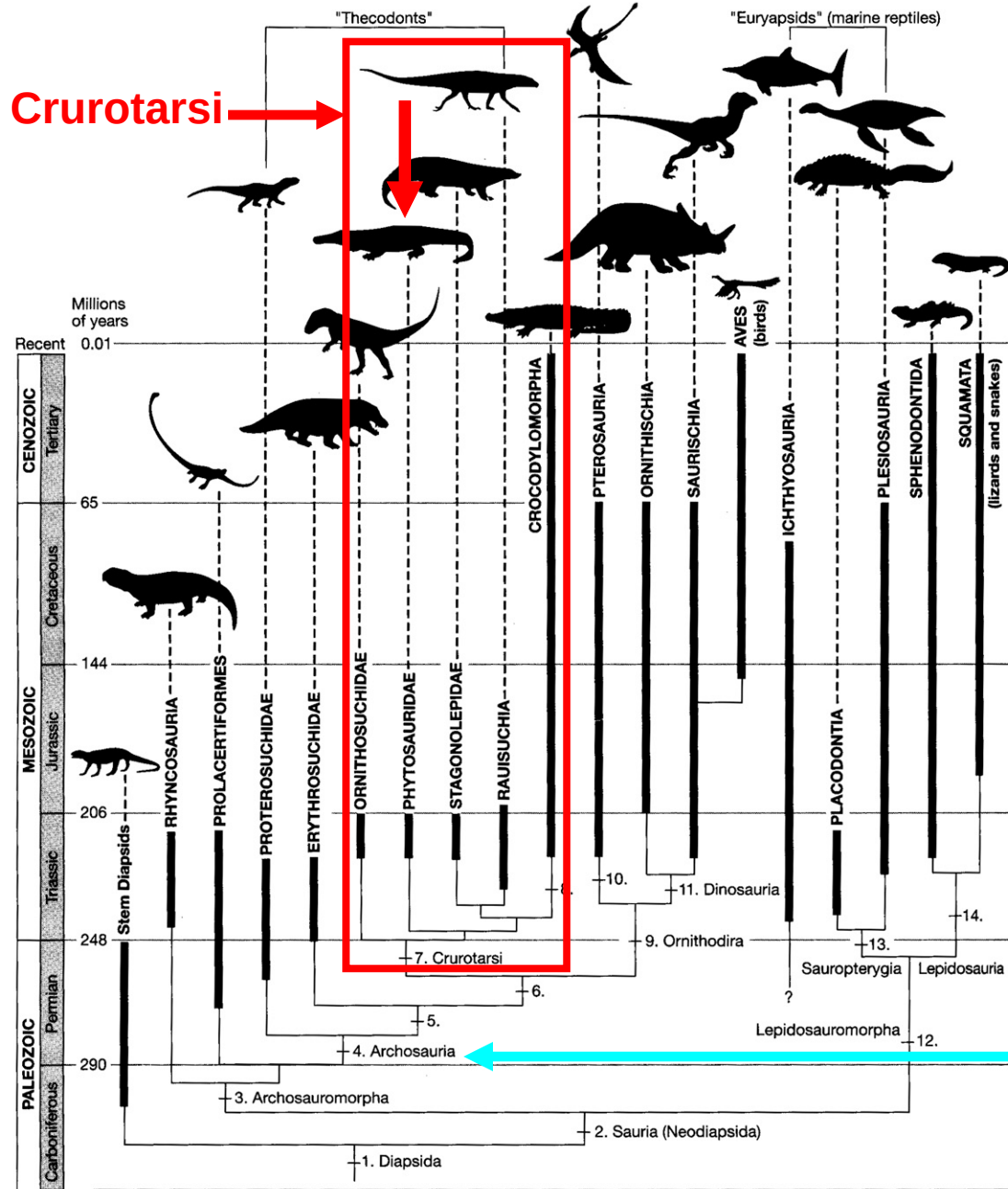
ARCHOSAURIA: PROTEROSUCHIA: Morfologia e Diversidade



Archosaurus rossicus. Rússia, Permiano Superior



Chasmatosaurus. África do Sul, Trássico Inferior



Tornozelo de Crocodylia

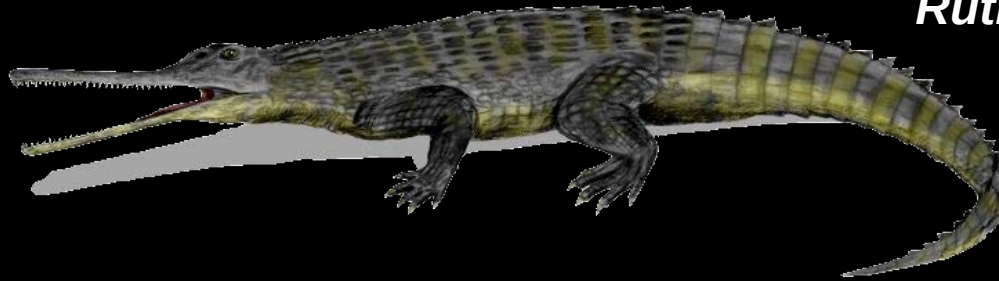
Tornozelo de Ornithodira

Filogenia dos Diapsida.

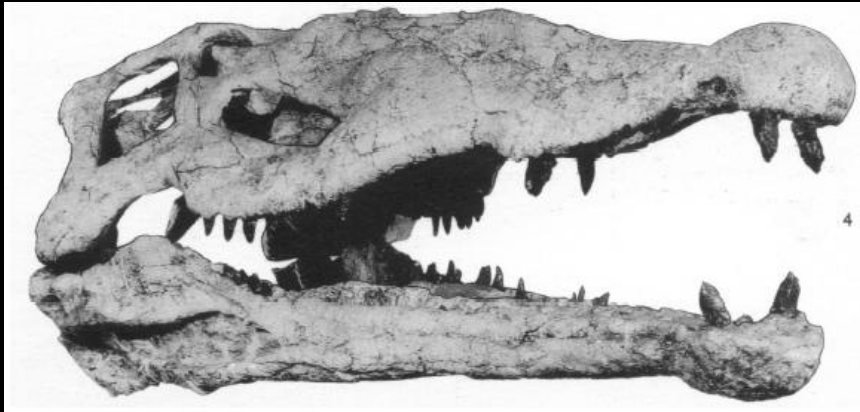
Archosauria

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

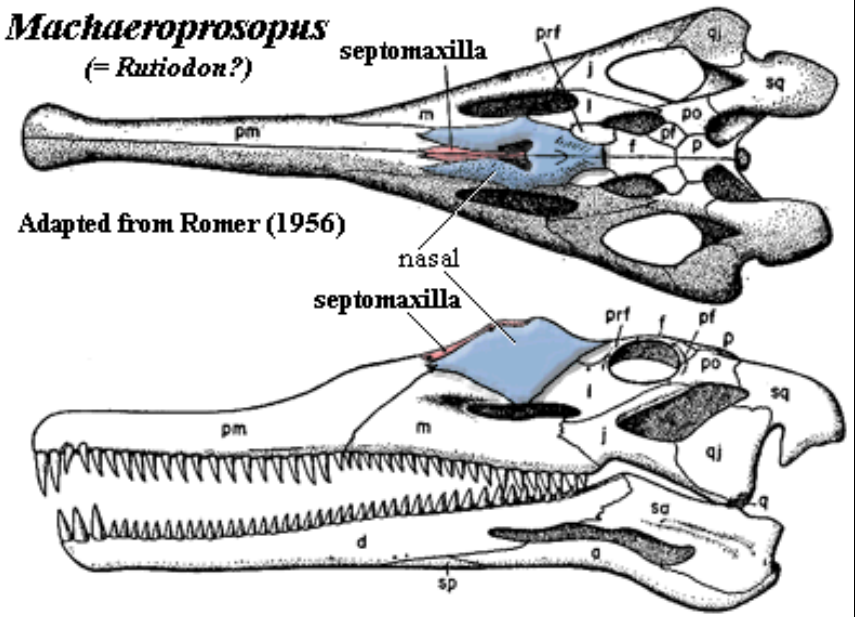
CRUROTARSI: PHYTOSAURIA: Morfologia e Diversidade



Rutiodon carolinensis (EUA, Triássico Superior)

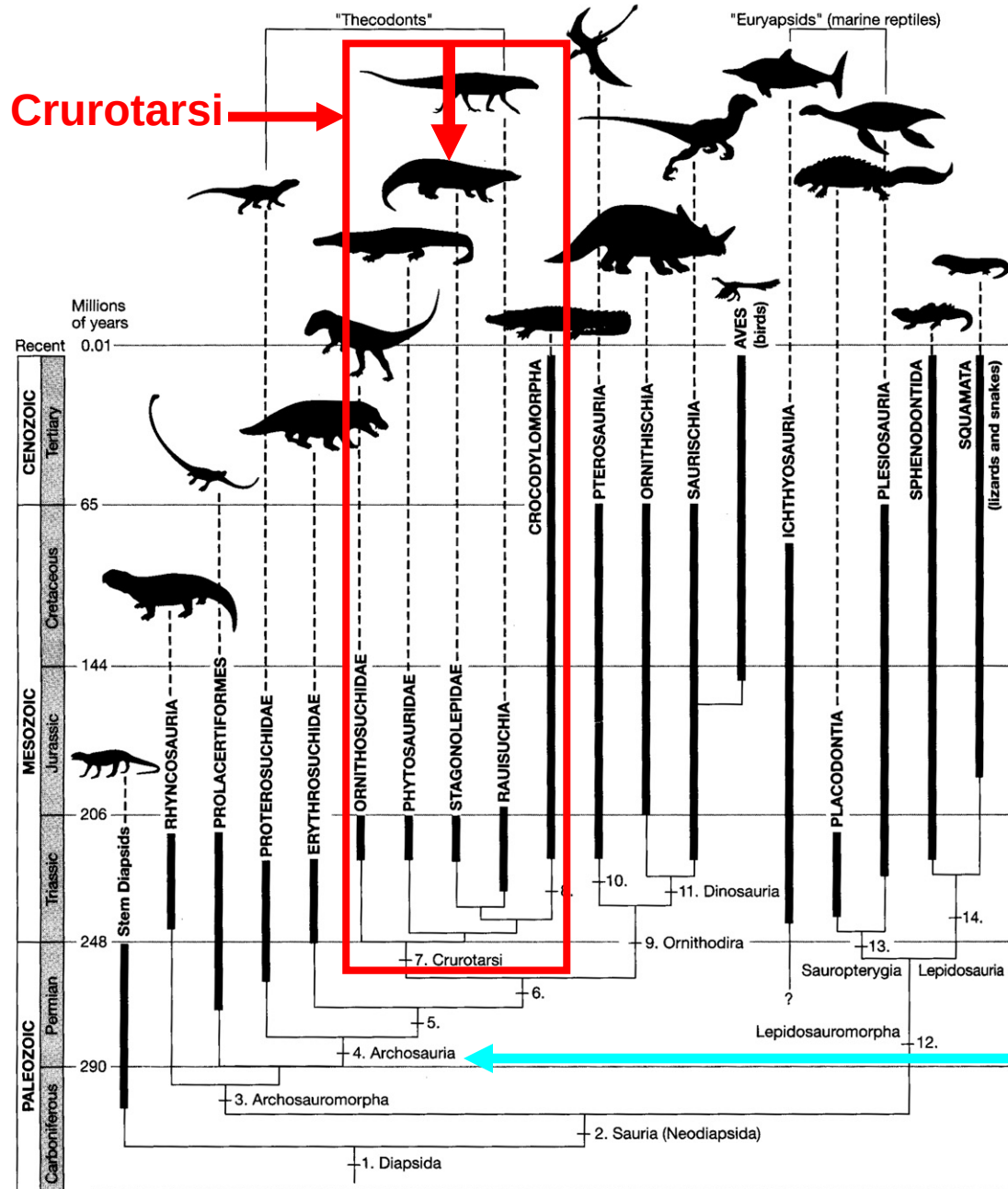


Machaeropsopos
(= *Rutiodon*?)



Adapted from Romer (1956)

Machaeropsopos gregorii. Novo México, EUA, Triássico Superior

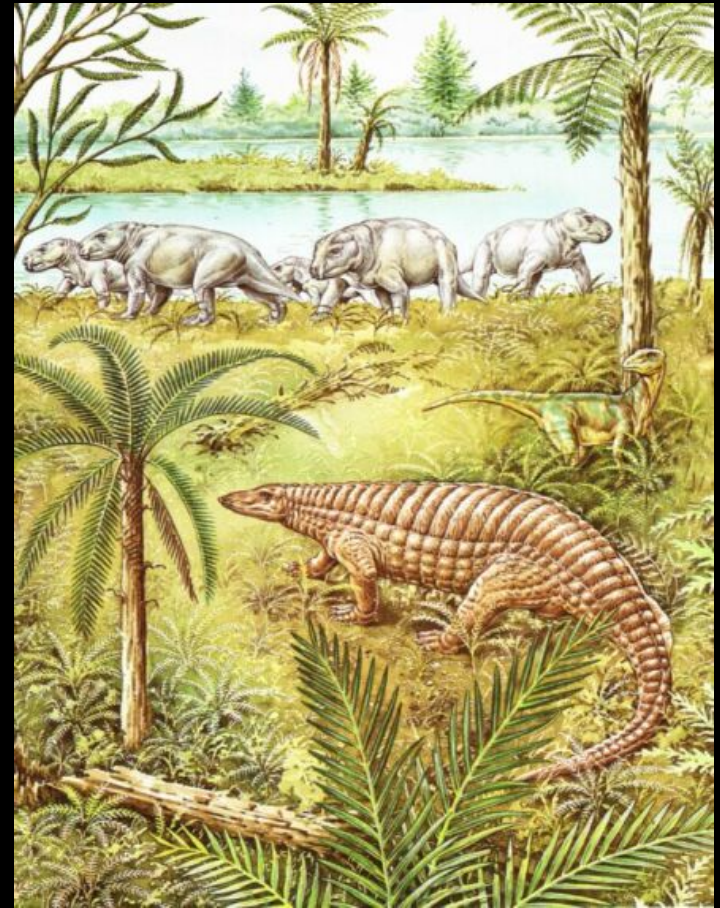


Filogenia dos Diapsida.

Archosauria

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

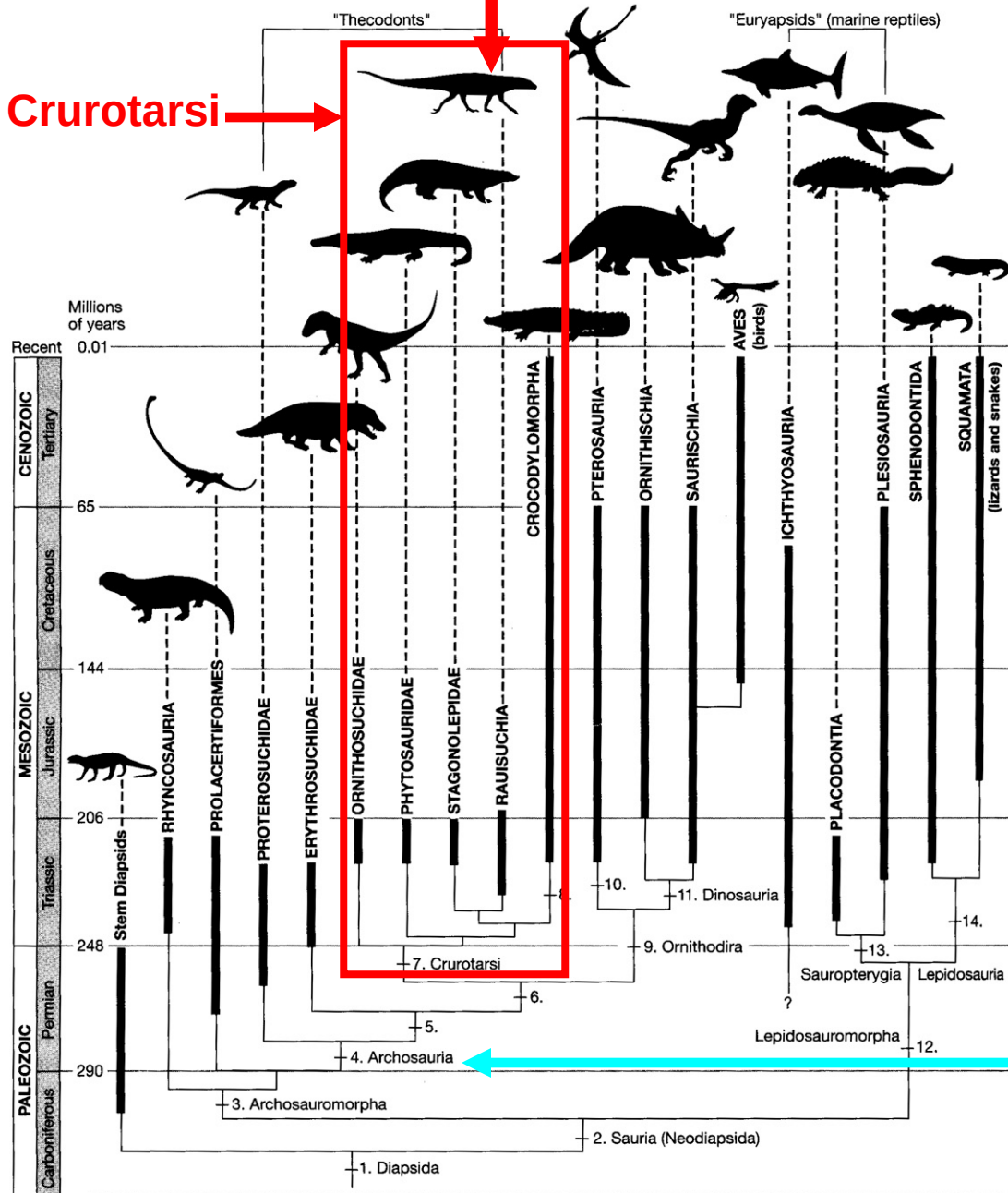
CRUROTARSI: AETOSAURIA: Morfologia e Diversidade



Stagonolepis robertsoni.
Tráássico Superior, Inglaterra

Desmatosuchus haplocerus. Triáássico
Superior, Texas

Crurotarsi

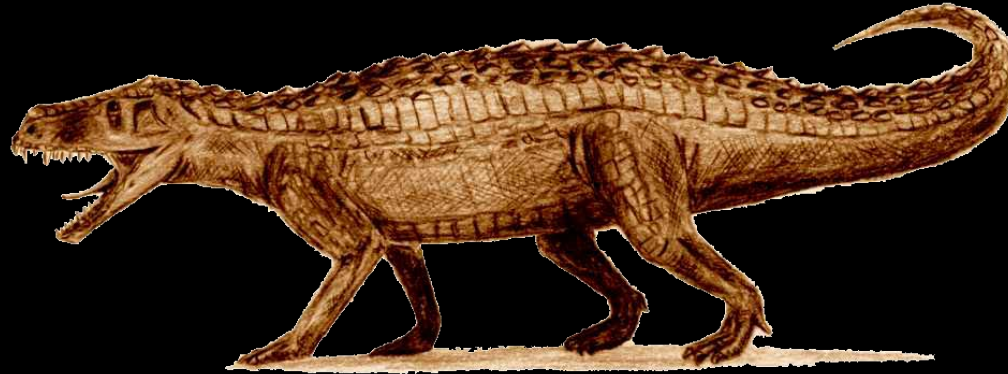


Filogenia dos Diapsida.

Archosauria

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

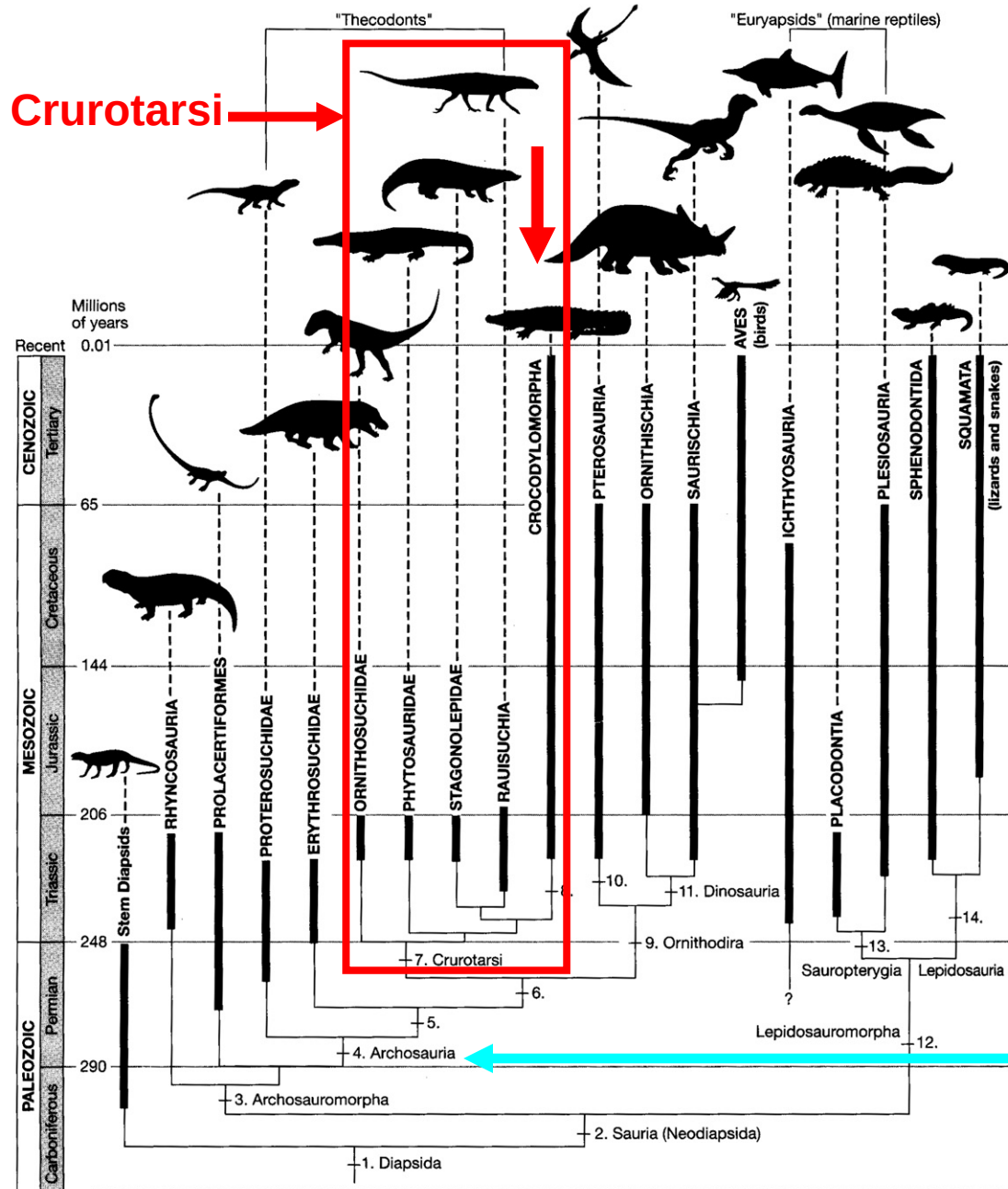
CRUROTARSI: RAUISUCHIA: Morfologia e Diversidade



Prestosuchus chiniquensis. Triássico Superior,
Rio Grande do Sul, Brasil. 6,7 m



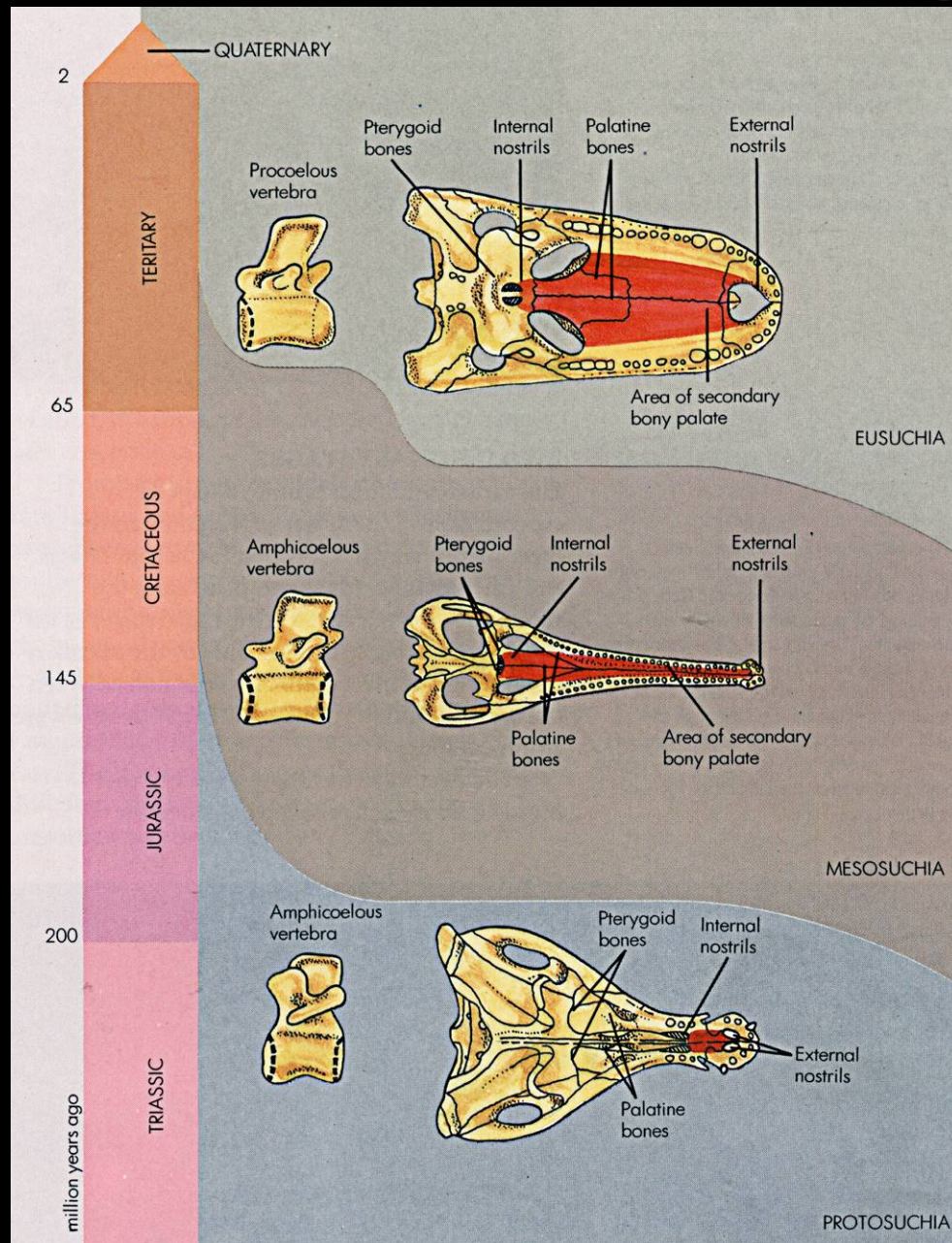
Qianosuchus mixtus. Triássico,
China. 3,0 m



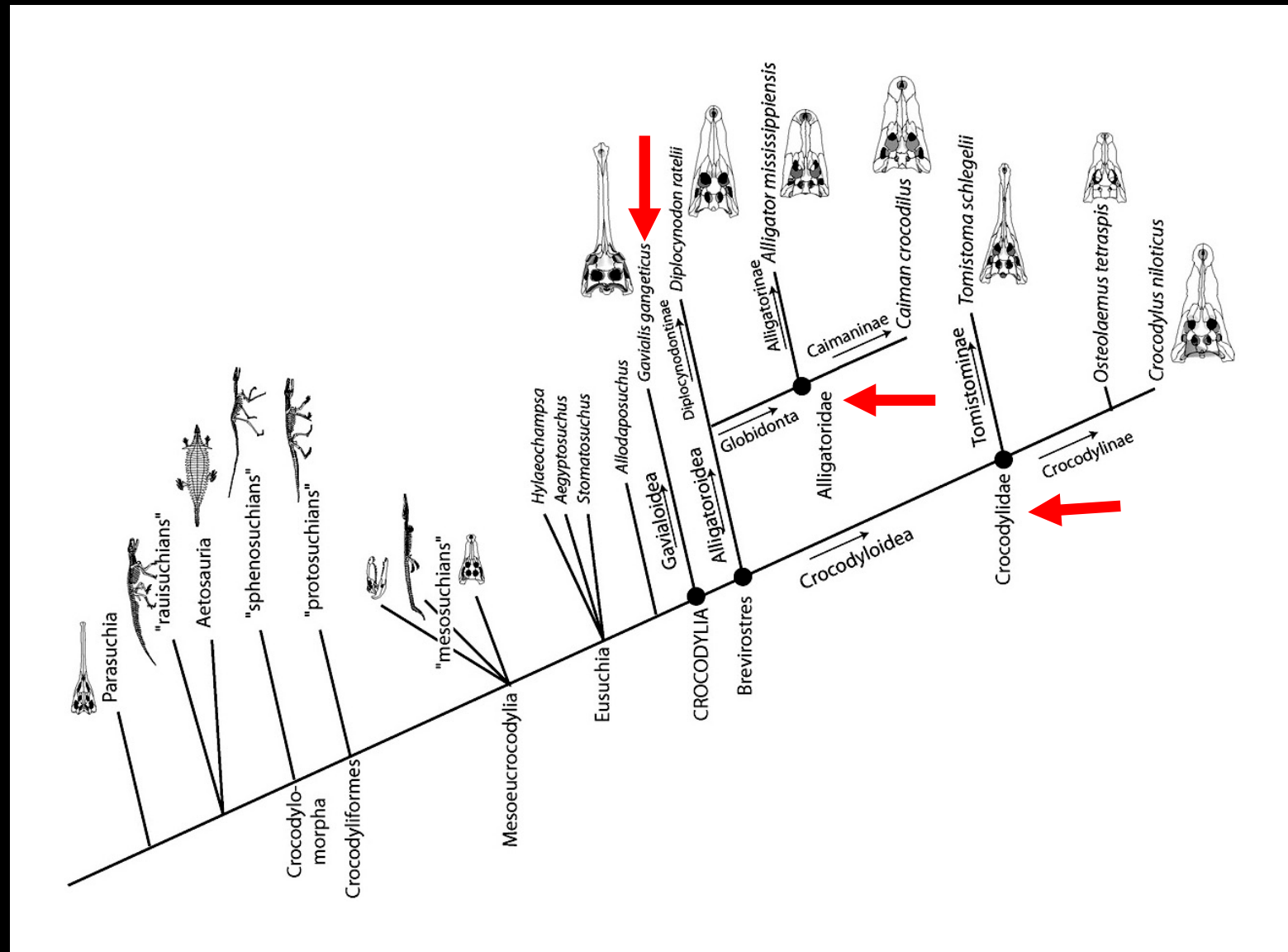
Filogenia dos Diapsida.

Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.

CRUROTARSI: CROCODYLOMORPHA: Morfologia e Diversidade

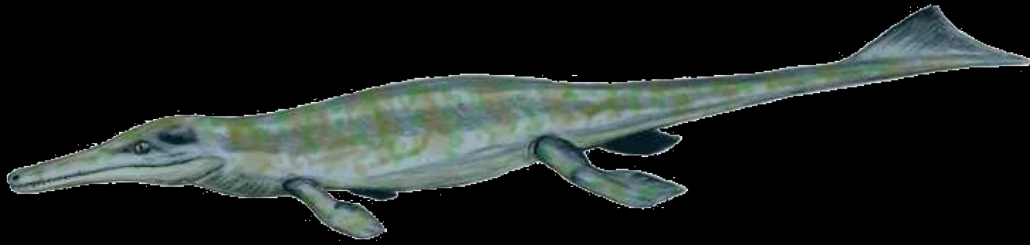


CRUROTARSI: CROCODYLOMORPHA: Filogenia

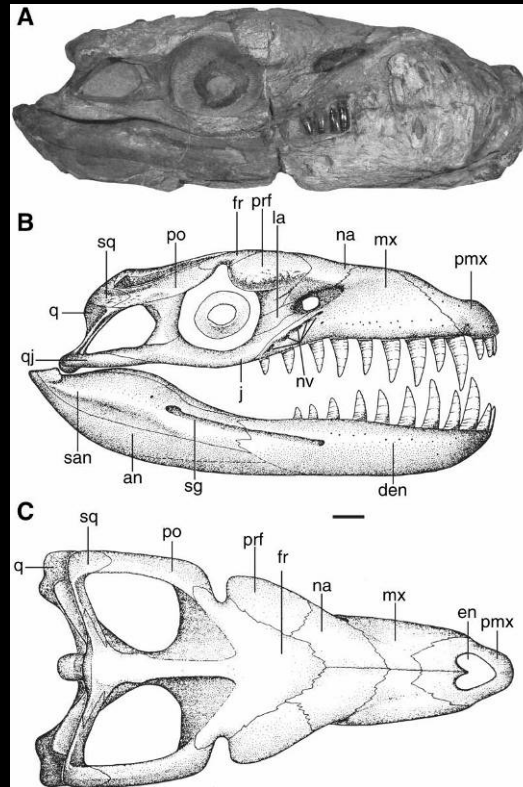


Filogenia de Crocodylia (Brochu, 2003)

CRUROTARSI: CROCODYLOMORPHA: Morfologia e Diversidade

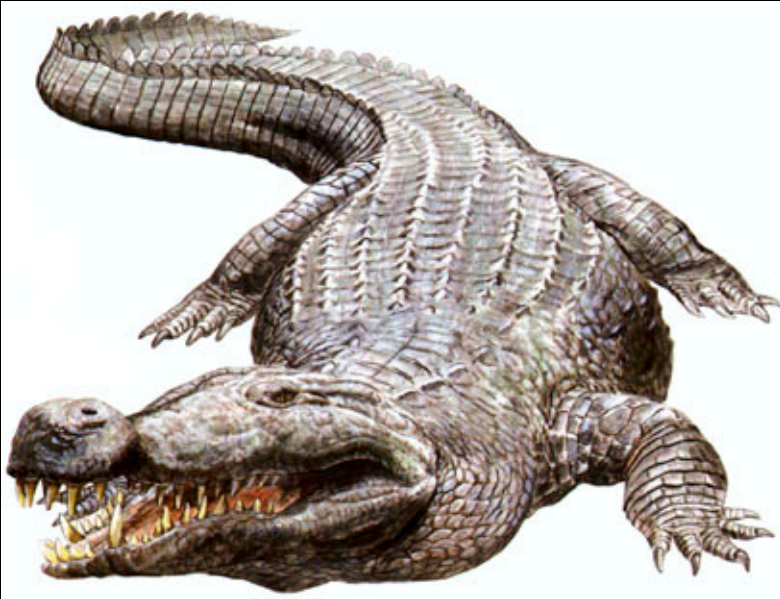


Metriorhynchus superciliosus.
Cerro Jaspe, Chile, Jurássico



Dakosaurus andinensis.
Chile, Jurássico Inferior

CRUROTARSI: CROCODYLOMORPHA: Morfologia e Diversidade

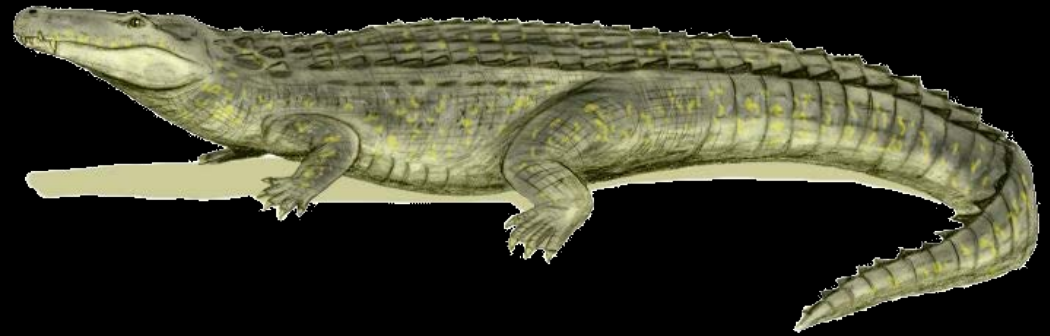


Deinosuchus riograndensis (Alligatoridae). Cretáceo, EUA. 10-12m.



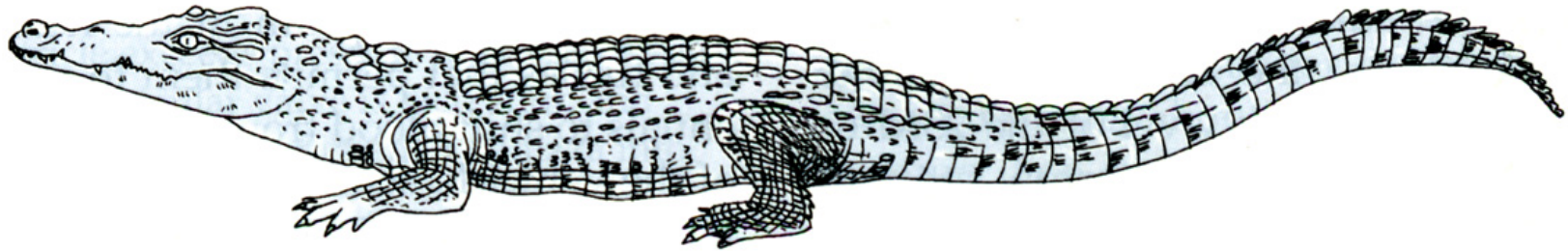
Sarcosuchus imperator (†Pholidosauridae). Cretáceo, África. 11-12m.

CRUROTARSI: CROCODYLOMORPHA: Morfologia e Diversidade

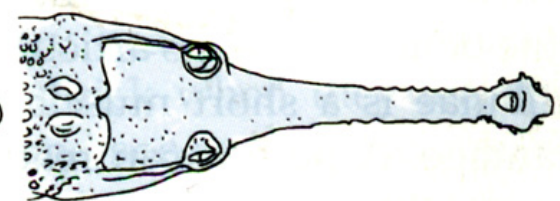
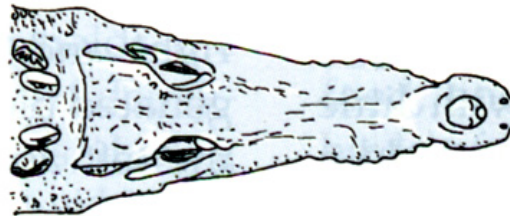
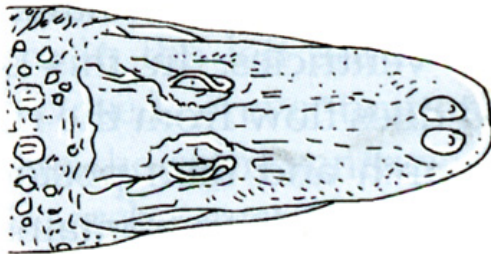
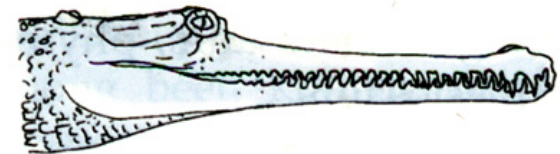
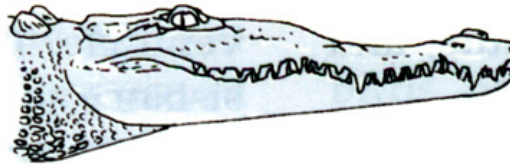
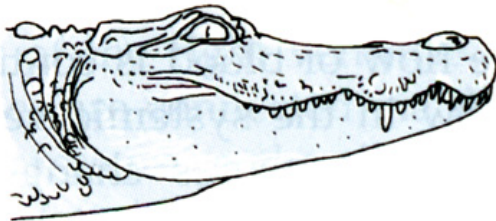


Purussaurus brasiliensis (Alligatoridae, Caimaninae).
Mioceno, Brasil (Acre) e Peru (20 m.a.). 10,9 m, +5ton

CROCODYLIA viventes: Morfologia geral



(a)



(b)

(c)

(d)

(a) crocodilo cubano; (b) aligador chinês; (c) crocodilo americano; (d) garial.

CROCODYLIA viventes: Morfologia geral



**Crocodylidae. *Crocodylus cataphractus*.
África.**

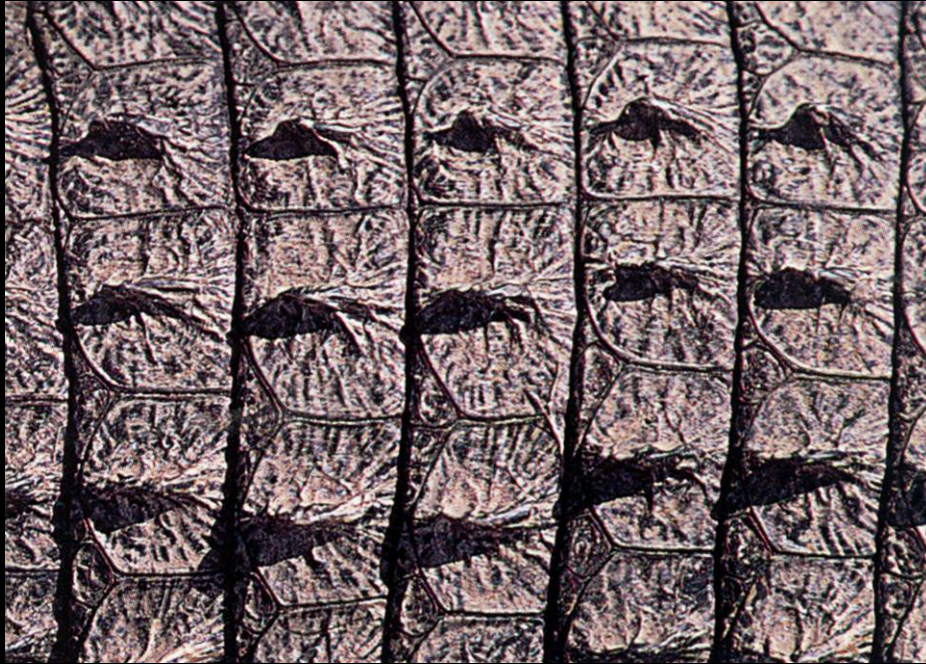


Alligatoridae. *Alligator mississippiensis*. E.U.A.

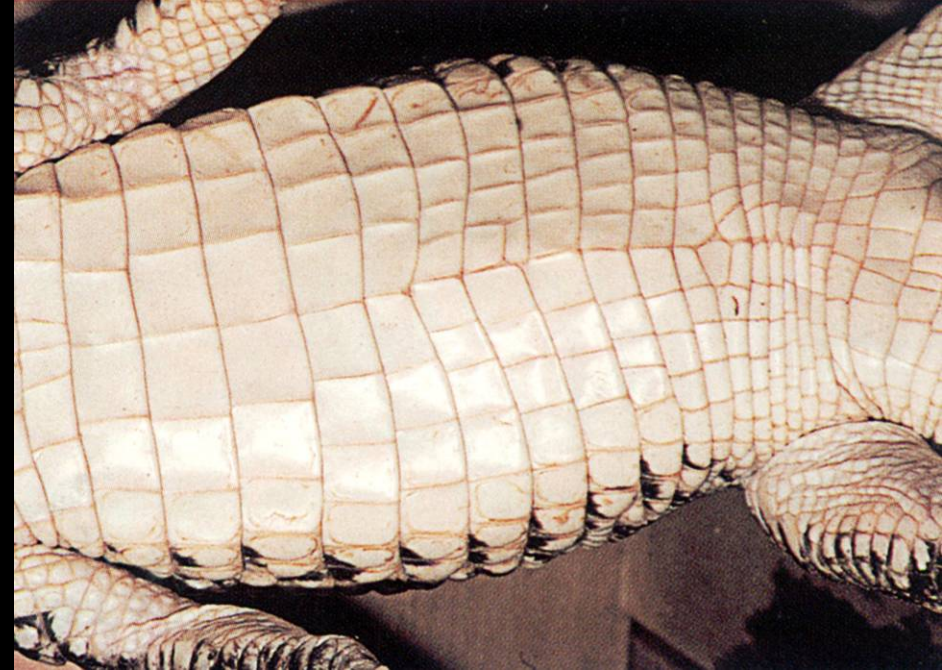


Gavialidae. *Gavialis gangeticus*. Índia.

CROCODYLIA viventes: Morfologia - Tegumento



Vista dorsal do tronco - osteodermos:
***Crocodylus niloticus*. África.**



Vista ventral do tronco – escamas sem osteodermos.

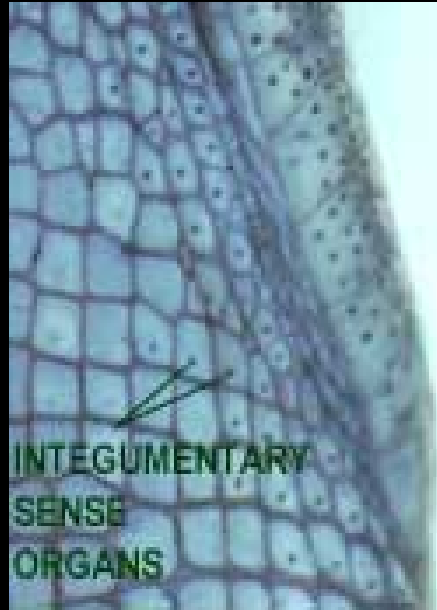
- Epiderme (proteína queratinizada) – camada germinativa e camada córnea (material morto acumulado);
- Derme (*corium*) – colágeno; forma osteodermos (altamente vascularizados) – carbonato de cálcio e fosfato de cálcio – proteção, controle de temperatura e fonte de Ca (lança íons alcalinos que neutralizam acidose - acúmulo de CO₂ no sangue devido ao mergulho);
- Sub-cútis – camada carnosa.

CROCODYLIA viventes: Morfologia - Tegumento

Órgãos sensoriais tegumentares



Alligator mississippiensis



Crocodylus acutus

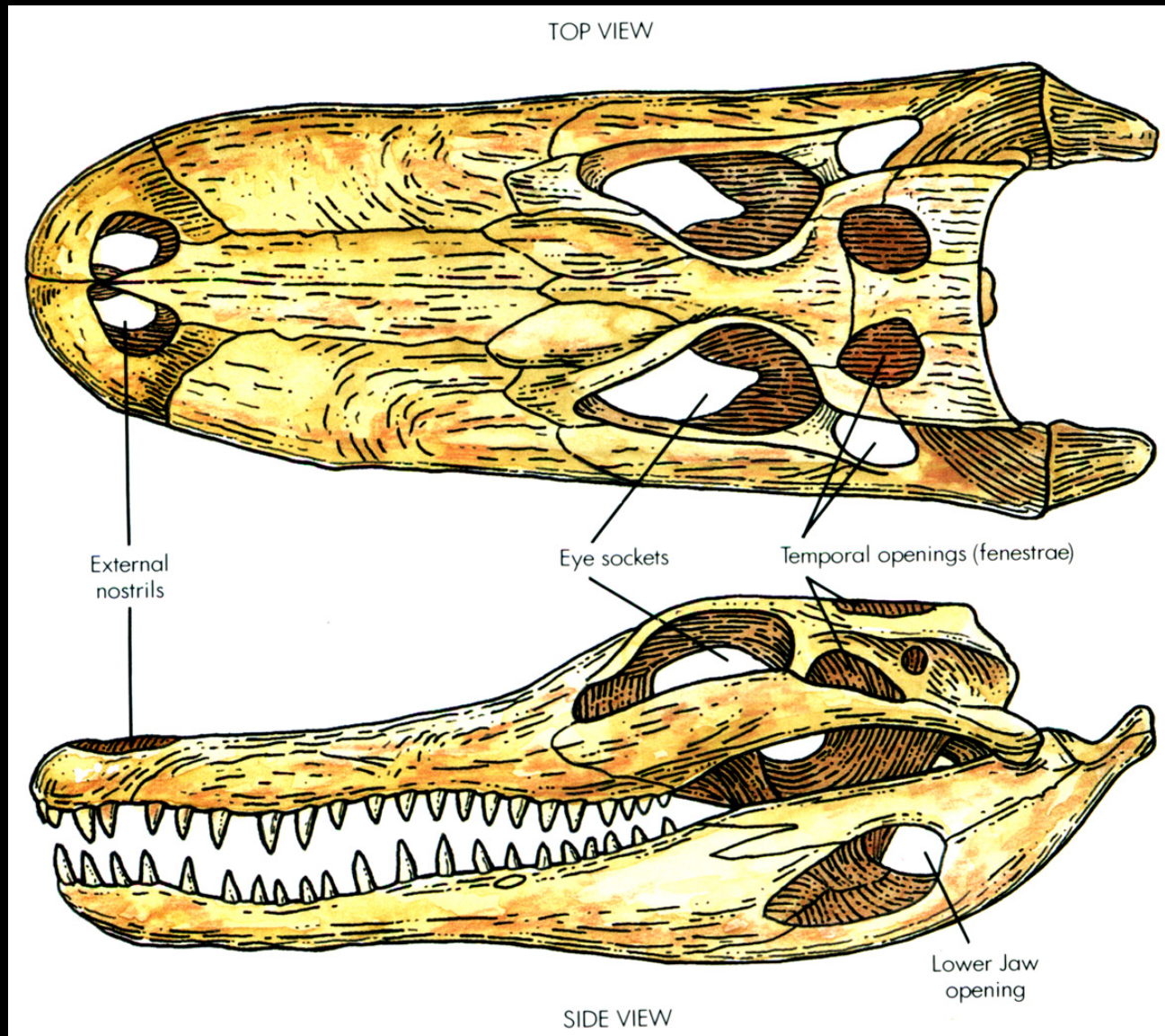
- Função pouco conhecida: detectam alterações de pressão, movimento de presas e mudanças na salinidade da água.

- Em Crocodylidae, presentes na cabeça, maxila, mandíbula, pescoço, tronco, cauda e parte interna dos membros.

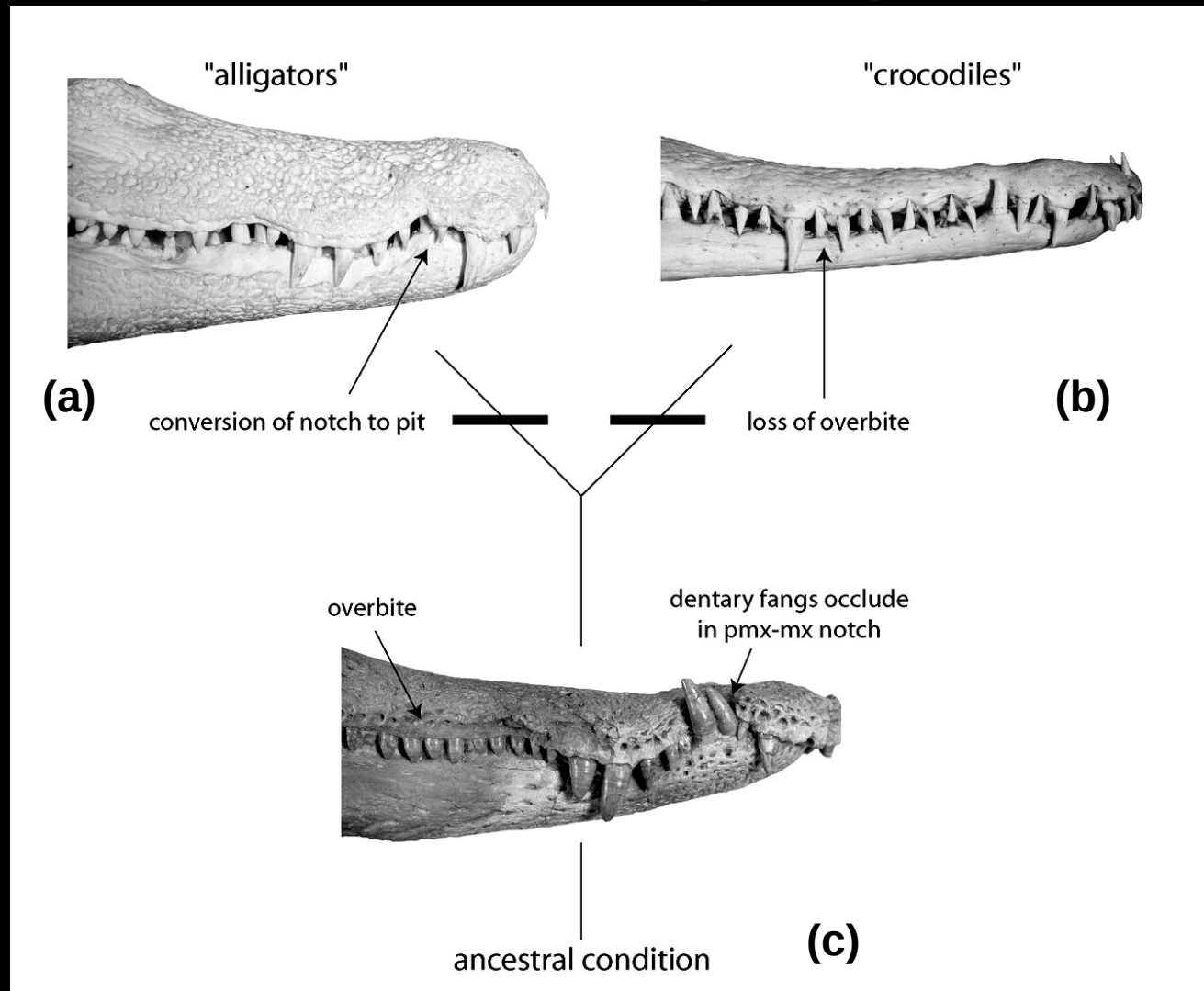
- Em Alligatoridae, presentes apenas na maxila, focinho, ao redor dos olhos, mandíbula e palato superior.



CROCODYLIA viventes: Morfologia – região cefálica

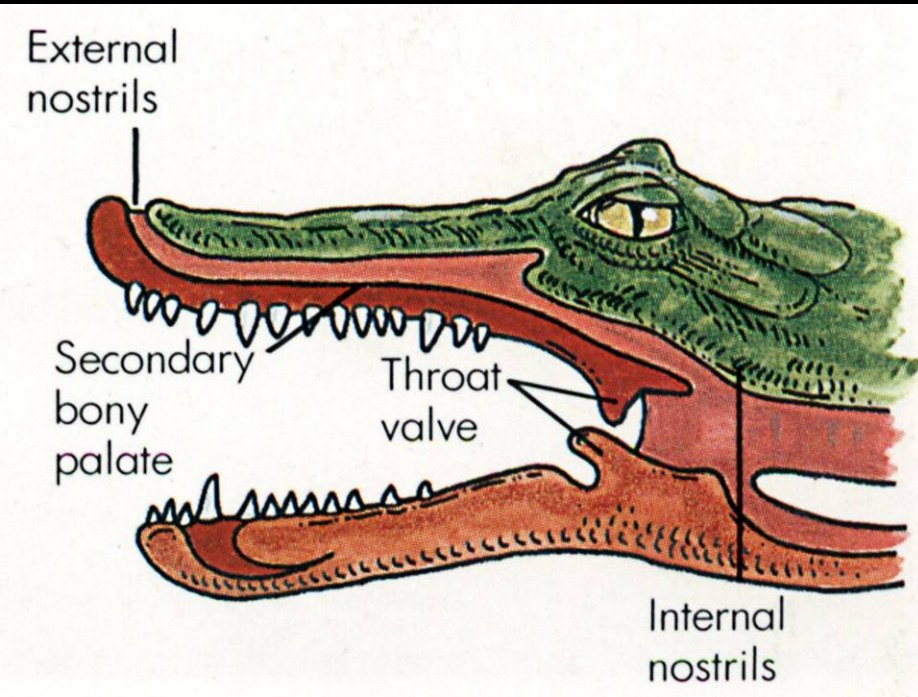


CROCODYLIA viventes: Morfologia – região cefálica

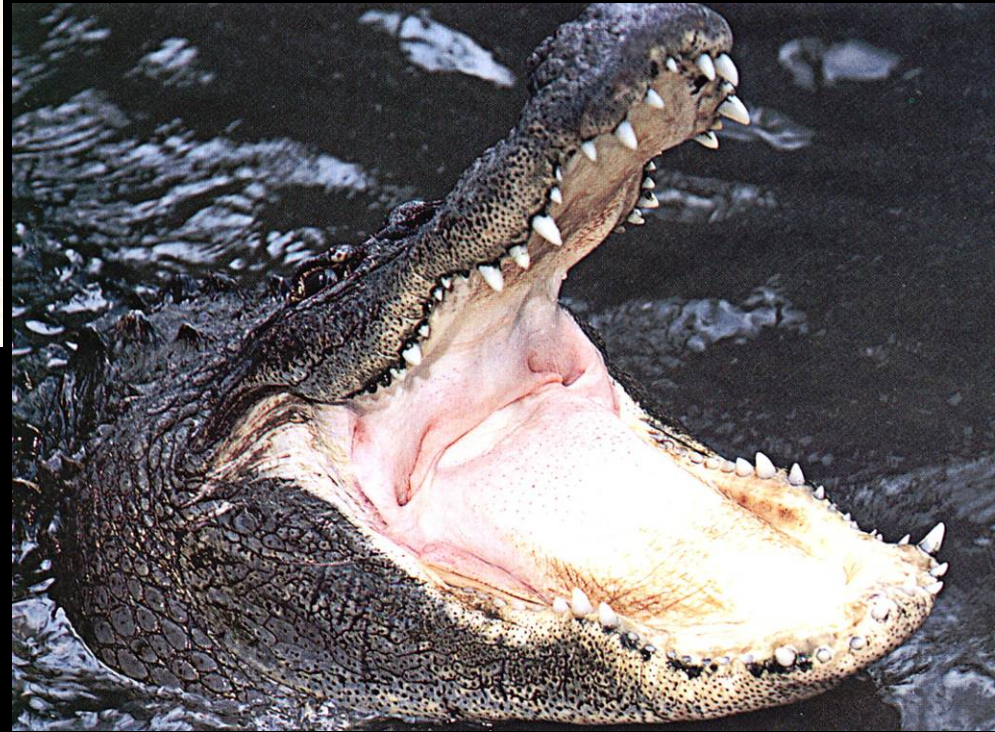


Evolução da oclusão dentária em Crocodylia (Brochu, 2003): (a) *Paleosuchus trigonatus* (Alligatoridae), Recente; (b) *Crocodylus intermedius* (Crocodylidae), Recente; (c) *Leidyosuchus canadensis* (Alligatoroidea), Cretáceo Superior.

CROCODYLIA viventes: Morfologia – região cefálica



- Palato secundário – formando pelas pré-maxilas, maxilas, palatos e pterigóides; narinas internas se abrem nos pterigóides.
- Selos carnosos no céu da boca (válvula palatal) e na base da língua, isolando a cavidade oral da traquéia.



***Crocodylus mississippiensis*. E.U.A.**

CROCODYLIA viventes: Morfologia – região cefálica



Narinas externas (anteriores) de *Crocodylus mississippiensis*. E.U.A. (em protuberâncias na extremidade do focinho – águas calmas)

- Olfato bem desenvolvido – detecção de presas e reprodução (gl. cloacais)
- Orgão vômero-nasal é pouco desenvolvido

CROCODYLIA viventes: Morfologia – região cefálica



Olho de *Crocodylus porosus*, durante o dia. Região Indo-Pacífica.

Olho de *Crocodylus johnsoni*, durante a noite. Austrália.

- Olhos esféricos;
- *Tapetum lucidium* - camada refletora atrás da retina – cristais de guanina;
- células receptoras de luz – cones, bastonetes (enxergam colorido);
- Membrana nictitante presente; recobre o olho durante o mergulho



CROCODYLIA viventes: Morfologia – região cefálica



Ouvido externo de *Crocodylus johnsoni*. Austrália.

- Ouvido externo coberto por aba dérmica;
- Audição bem desenvolvida – relacionada à vocalização

CROCODYLIA viventes: Morfologia – membros

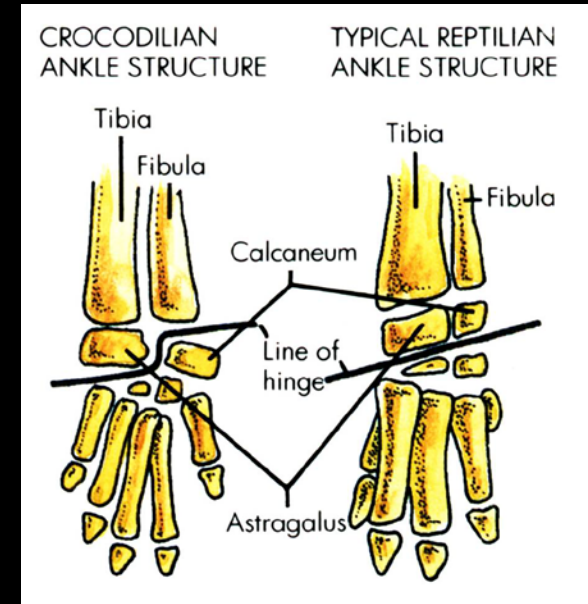
Locomoção na água



Membro posterior de Crocodylia, com membranas interdigitais



Salto (jovens): *Crocodylus cubensis*. Cuba.



Estrutura do tornozelo de Crocodylia (Crurotarsi) (permite movimentos giratórios e de torção)

CROCODYLIA viventes: Morfologia – membros

Locomoção em terra



Rastejamento: *Crocodylus*. África.



Marcha: *Crocodylus palustris*. Índia.



Galope: *Crocodylus johnsoni*. Austrália.

CROCODYLIA – Alimentação



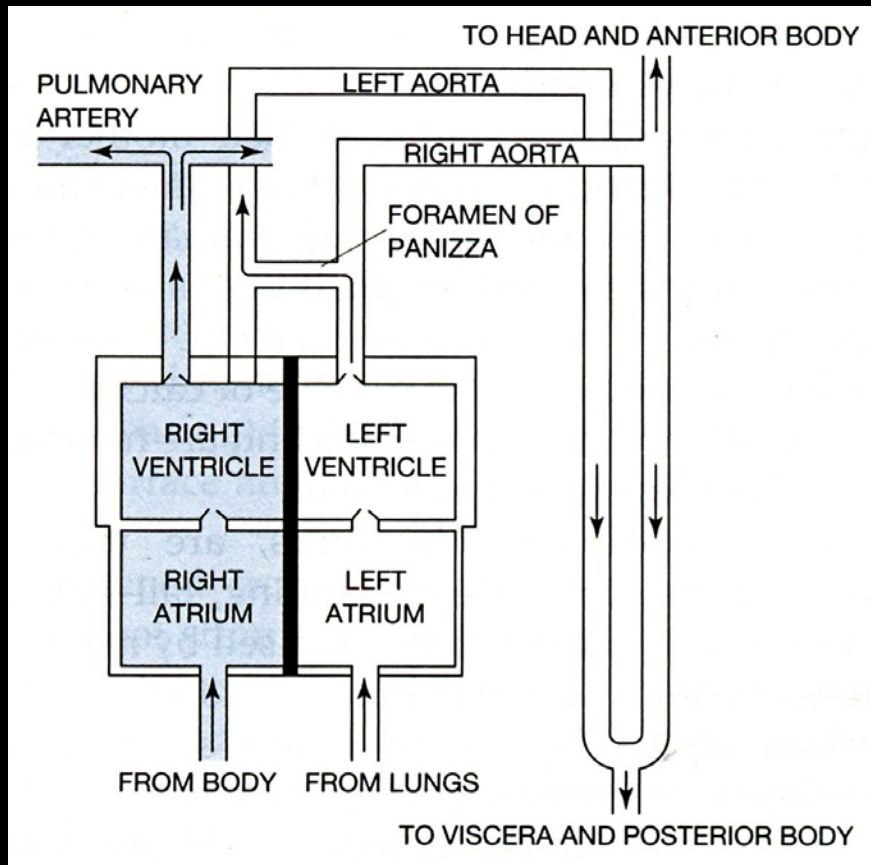
***Crocodylus cataphractus*. África.**

CROCODYLIA – Alimentação



Crocodylus porosus. Sumatra,
Indonésia.

CROCODYLIA viventes: Morfologia – sistema cardiovascular

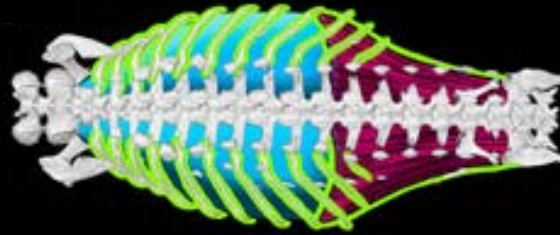
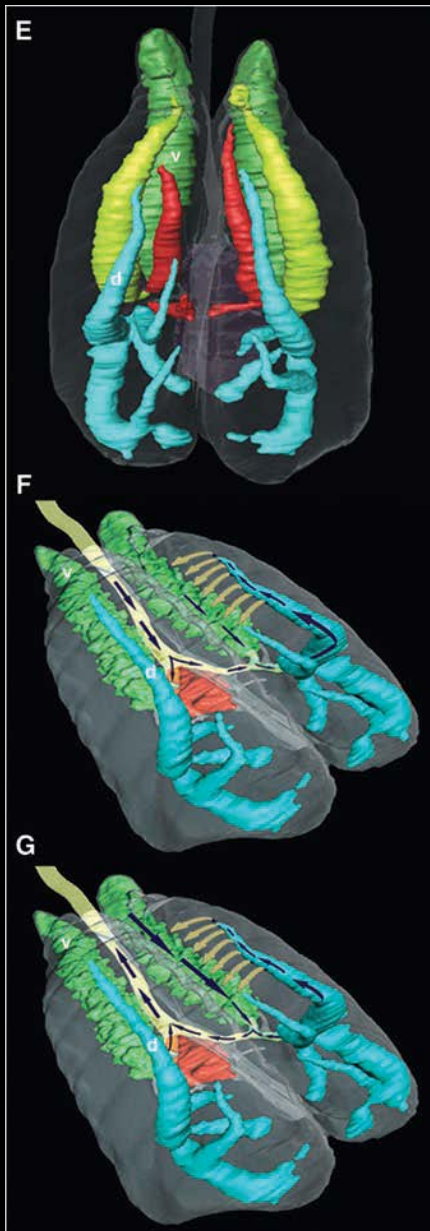


Pressão sistólica (= em contração) (quando crocodilo em repouso):

- **Circulação sistêmica:** endotérmicos: 87-216cm H₂O (pressão alta, para vencer a resistência periférica dos tecidos alt. vascularizados) X ectotérmicos: 30-80cm H₂O.
- **Circulação pulmonar:** endotérmicos: < 30cm H₂O (pressão baixa, para lidar com a delicada membrana pulmonar; altas taxas de liberação de O₂; pulmão “seco”) X ectotérmicos: 20-55cm H₂O (alta pressão; pulmão “úmido”, com membrana pulmonar produzindo 10-20X mais plasma que nos endotérmicos, constituindo uma barreira para o intercâmbio de gases).
- Ectotérmicos: todos permitem que sangue desoxigenado e oxigenado se misturem (desvio direita para esquerda).
- Crocodylia: pressão da circulação sistêmica ca. 3X pressão pulmonar (similar aos endotérmicos); sangue flui tanto pelo arco aórtico direito, como esquerdo (via forâmen de Panizza).

Esquema de coração e principais vasos de um Crocodylia (em atividade).

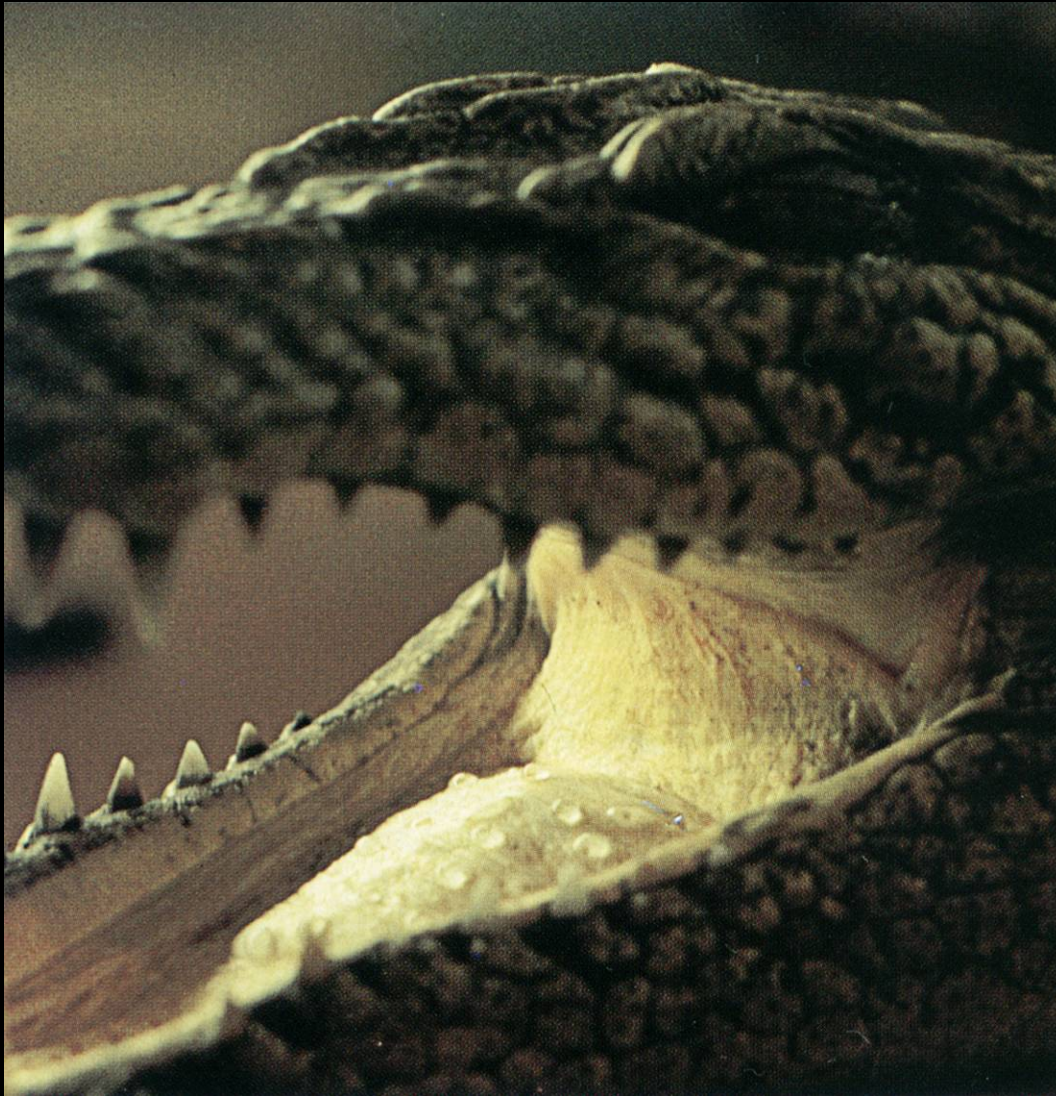
CROCODYLIA – Respiração e Circulação



- Pulmão multicameral.
- Respiração aérea; inspiração – expansão das costelas, diafragma funcional e pistão hepático (movimento da cintura pélvica e do fígado para trás).
- Fluxo de ar unidirecional durante inalação e exalação (vs. fluxo de ar “tidal”, alternando para fora e para dentro - Mammalia).
- Sacos aéreos ausentes.
- Brônquios intrapulmonares similar aos de Aves:
 - 1 par de **brônquios cervicais** similar aos brônquios ventrais de Aves que se conectam com sacos aéreos cervicais.
 - 1 par de pequenos **brônquios paracardíacos**.
 - 3 pares de **brônquios caudais** originados de uma câmara intrabronquial terminal.

Estrutura tridimensional do pulmão de um crocodilo e fluxo de ar [visão dorsal oblíqua (E), movimentos de inspiração (F) e de expiração (G)] (Farmers & Sanders, 2010)

CROCODYLIA – Excreção e Osmorregulação



- Crocodilos de água doce (**hipertônicos** em relação ao meio) – mecanismos comportamentais e fisiológicos para conservação de solutos (Na, K) (na cloaca) e excreção de excesso de água (epitélio da boca e trato respiratório);

- Crocodilos estuarinos e marinhos (**hipotônicos** em relação ao meio) – mecanismo comportamentais e fisiológicos para excreção de solutos (gl. de sal na boca em Crocodylidae), para evitar entrada de solutos e obtenção de água (bebem apenas água doce).

Boca de *Crocodylus porosus* com gotículas salinas secretadas pelas glândulas de sal. Região Indo-Pacífica.

CROCODYLIA – Controle de temperature e ecologia

Efficiency of biomass conversion by ectotherms and endotherms. These are net conversion efficiencies calculated as (energy converted/energy assimilated) $\times 100$

<i>Ectotherms</i> <i>Species</i>	<i>Efficiency(%)</i>	<i>Endotherms</i> <i>Species</i>	<i>Efficiency(%)</i>
Red-backed salamander (<i>Plethodon cinereus</i>)	48	Kangaroo rat (<i>Dipodomys merriami</i>)	0.8
Mountain salamander (<i>Desmognathus ochrophaeus</i>)	76–98	Field mouse (<i>Peromyscus polionotus</i>)	1.8
Panamanian anole (<i>Anolis limifrons</i>)	23–28	Meadow vole (<i>Microtus pennsylvanicus</i>)	3.0
Side-blotched lizard (<i>Uta stansburiana</i>)	18–25	Red squirrel (<i>Tamiasciurus hudsonicus</i>)	1.3
Hognose snake (<i>Heterodon contortrix</i>)	81	Least weasel (<i>Mustela rixosa</i>)	2.3
Python (<i>Python curtus</i>)	6–33	Savanna sparrow (<i>Passericulus sandwichensis</i>)	1.1
Adder (<i>Vipera berus</i>)	49	Marsh wren (<i>Telmatodytes palustris</i>)	0.5
Average of 12 species	50	Average of 19 species	1.4

- Demanda metabólica de endotérmicos excede em 15-20 vezes aquela dos ectotérmicos com massa corporal similar (mais O₂ e nutrientes por unidade de tempo).

CROCODYLIA – Comportamento Social e Reprodução



Crocodylus novaguineae. Nova Guiné.

CROCODYLIA – Comportamento Social e Reprodução

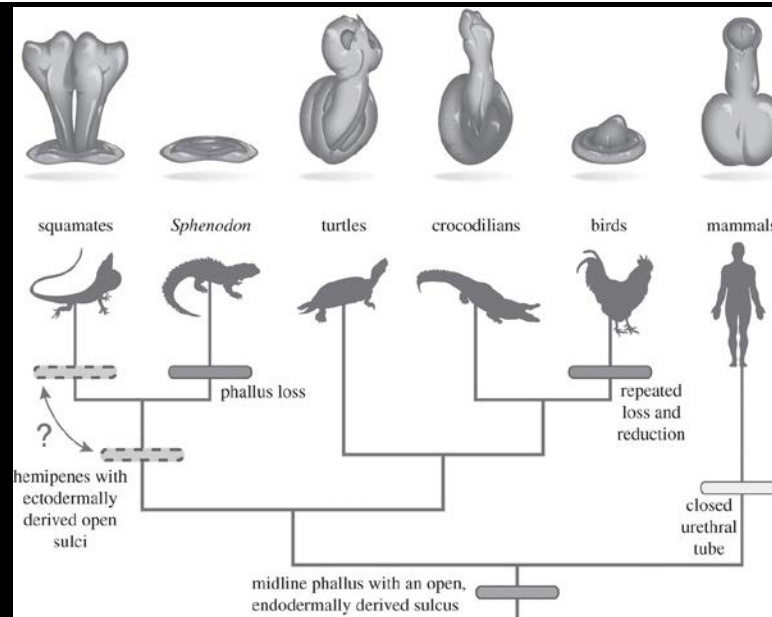


Desova de *Crocodylus palustris*. Índia.

CROCODYLIA – Comportamento Social e Reprodução

Table 1. Variation among amniote phalluses. *, this study.

	external genital swellings number and position	phallus number and position	open sulcus or closed urethra	germ layer contributing to sulcus/urethra	primary erectile mechanism
<i>Sphenodon</i>	paired, lateral buds*	no mature phallus			
Squamata	paired, lateral buds	paired, lateral hemipenes	open sulcus	ectoderm	blood/lymph
Chelonia	paired, lateral buds	single, midline phallus	open sulcus	endoderm	blood
Crocodylia	paired, lateral buds	single, midline phallus	open sulcus	endoderm	muscle/blood
Mammalia	paired, lateral buds	single, midline phallus	tubular urethra	endoderm	blood
Aves (Palaeognathae, Anseriformes)	paired, lateral buds	single, midline phallus	open sulcus	endoderm	lymph
Aves (Neoaves, Galiformes)	paired, lateral buds	no mature intromittent phallus			



Fonte: Sanger, T. J. et al. (2015) Resurrecting embryos of the tuatara, *Sphenodon punctatus*, to resolve vertebrate phallus evolution. *Biol. Lett.* 11: 20150694.

CROCODYLIA – Comportamento Social e Reprodução



Grupo de ovos de *Paleosuchus trigonatus*, próximo a termiteiros. Brasil.

CROCODYLIA – Comportamento Social e Reprodução



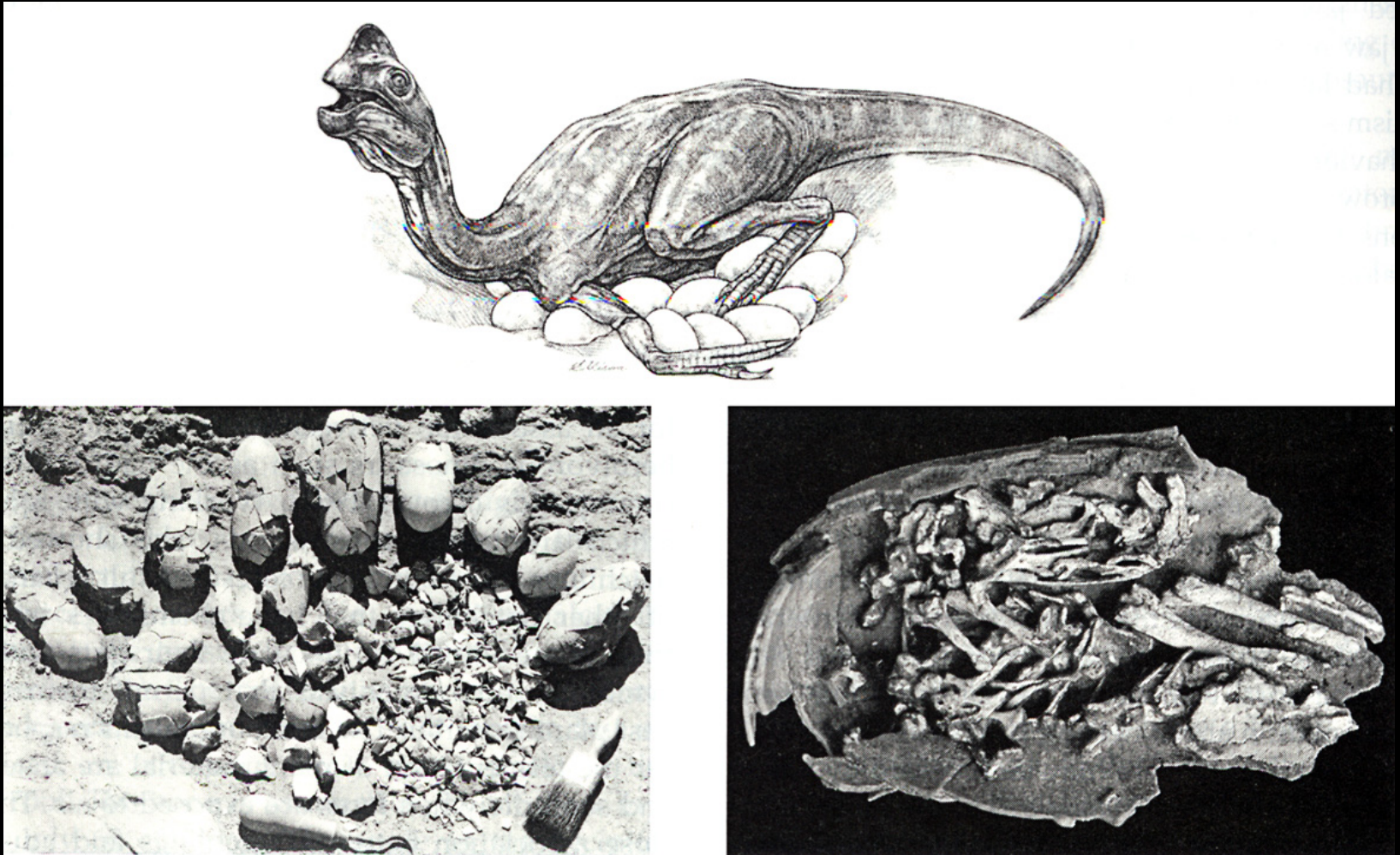
Cuidado parental – fêmea de *Crocodylus niloticus* carregando ovos. África.

CROCODYLIA – Comportamento Social e Reprodução

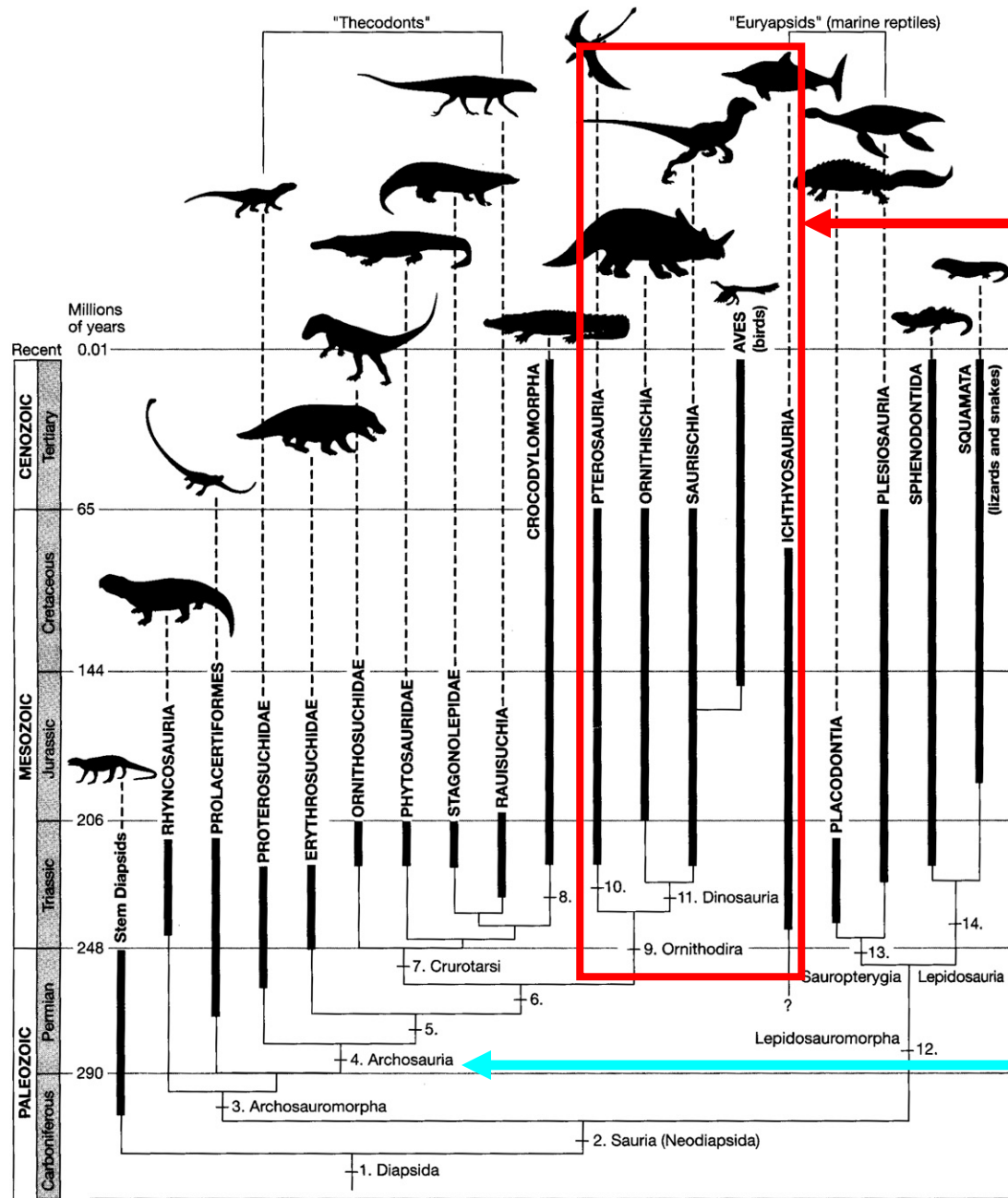


Cuidado parental – fêmea de *Crocodylus palustris* auxiliando recém-nascido. Índia.

CROCODYLIA – Comportamento Social e Reprodução



Ninhos de Dinosauria e ovos: (a) Oviraptorídeo chocando ovos; (b) ninho fossilizado de oviraptorídeo; (c) embrião fossilizado de oviraptorídeo.

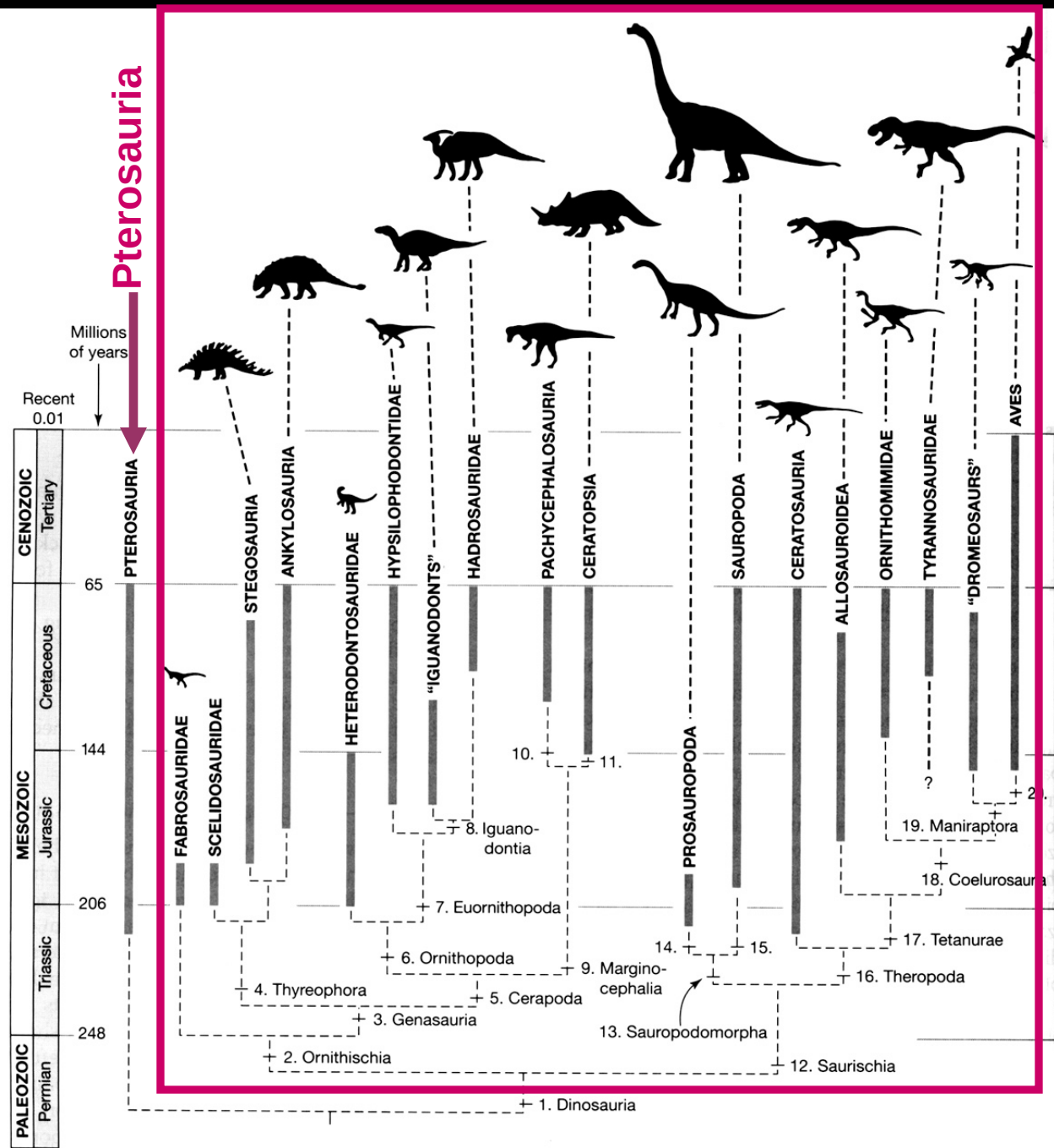


Ornithodira

Filogenia dos Diapsida.

Archosauria

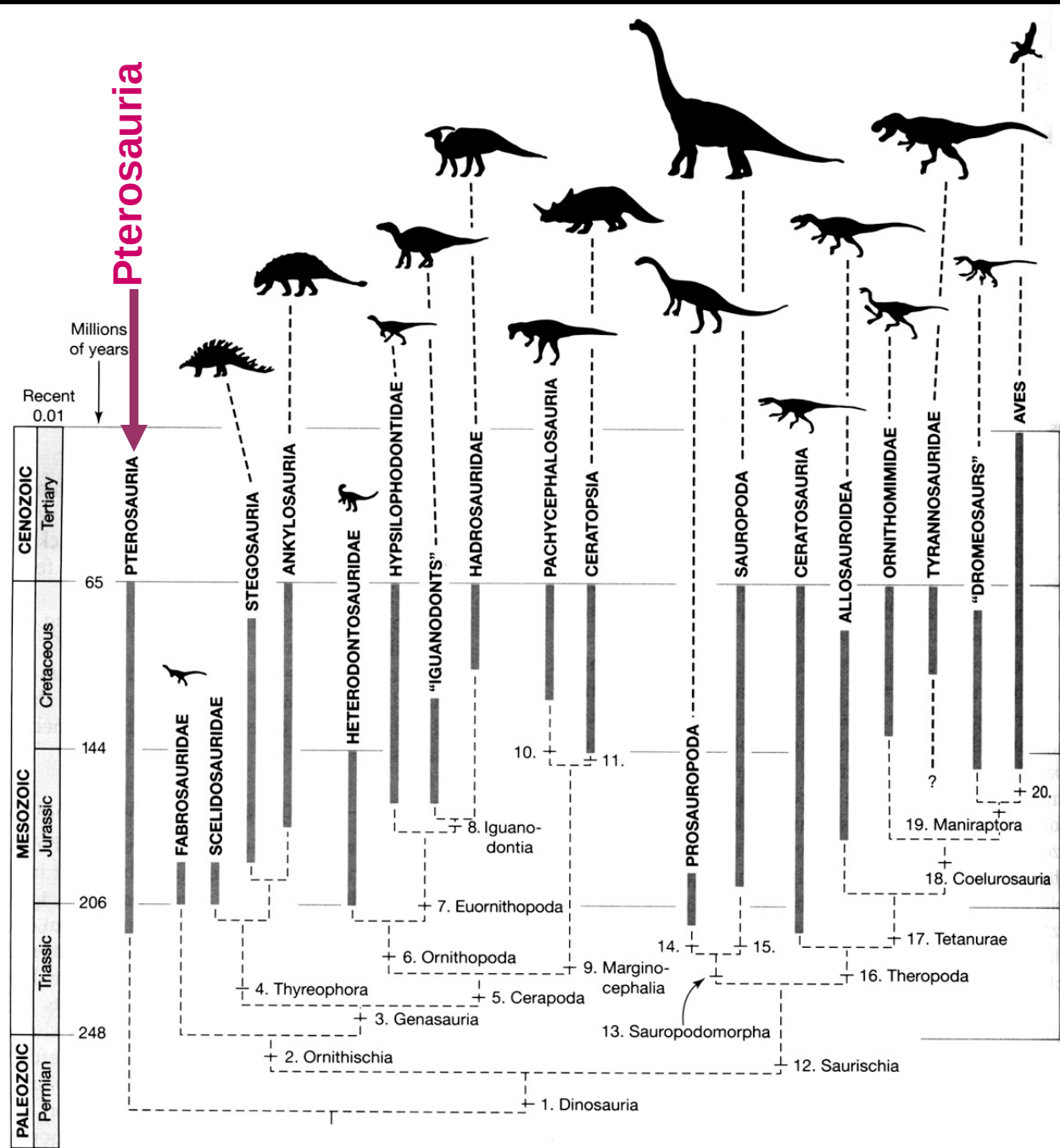
Fonte: Pough et al. (2002) *Vertebrate Life*.
6 Ed. New Jersey, Prentice Hall.



← Dinosauria

Filogenia dos Ornithodira.

Fonte: Pough et al. 2002. *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

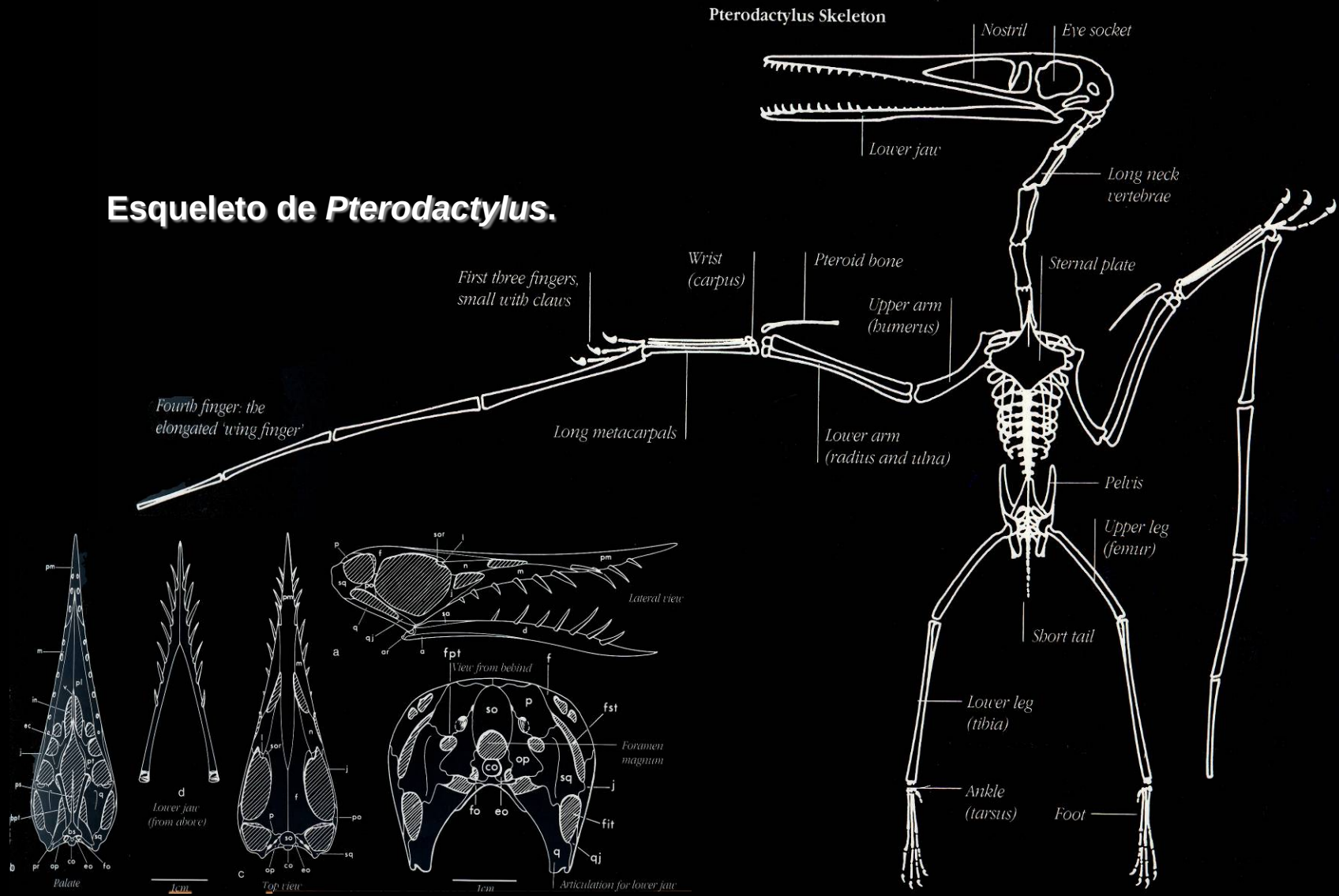


Filogenia dos Ornithodira.

Fonte: Pough et al. 2002. *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

PTEROSAURIA: Morfologia

Esqueleto de *Pterodactylus*.



Crânio de *Rhamphorhynchus*.

Fonte: Wellnhofer, P. (1991) *The illustrated Encyclopedia of Prehistoric Reptiles*. New York, Barnes & Noble Books.

PTEROSAURIA: Morfologia



Fig. 4 | Reconstruction of one of the studied anurognathid pterosaurs. This pterosaur exhibits diverse types of pycnofibres distributed in different body parts. Credit: Yuan Zhang

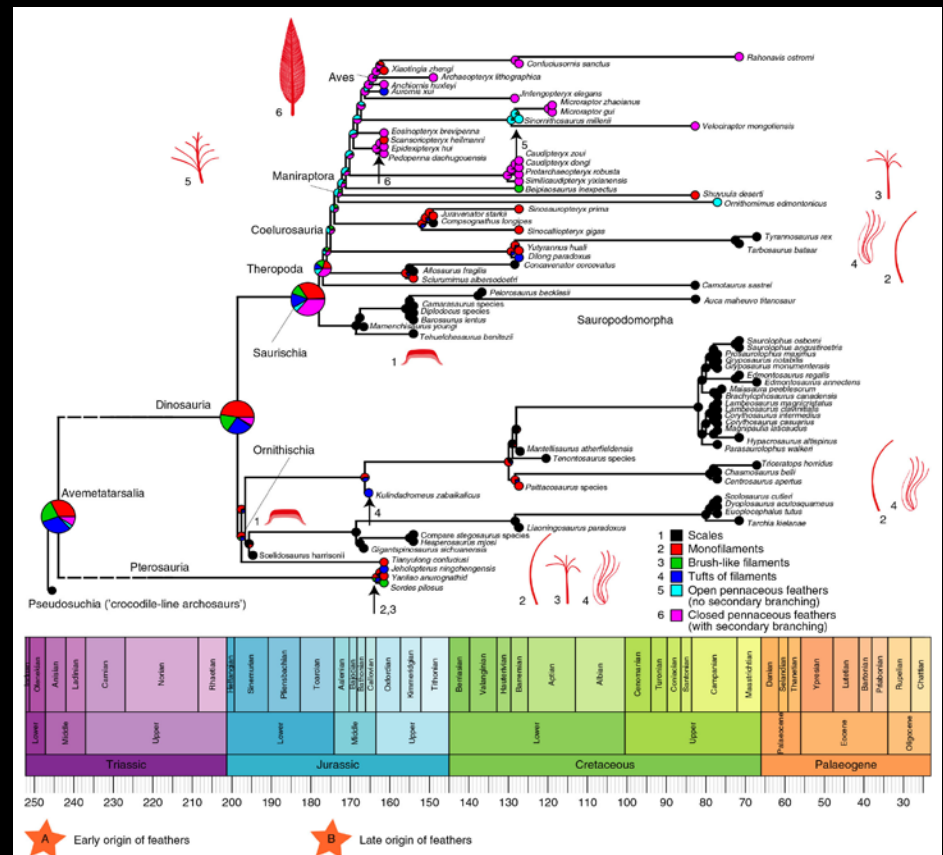
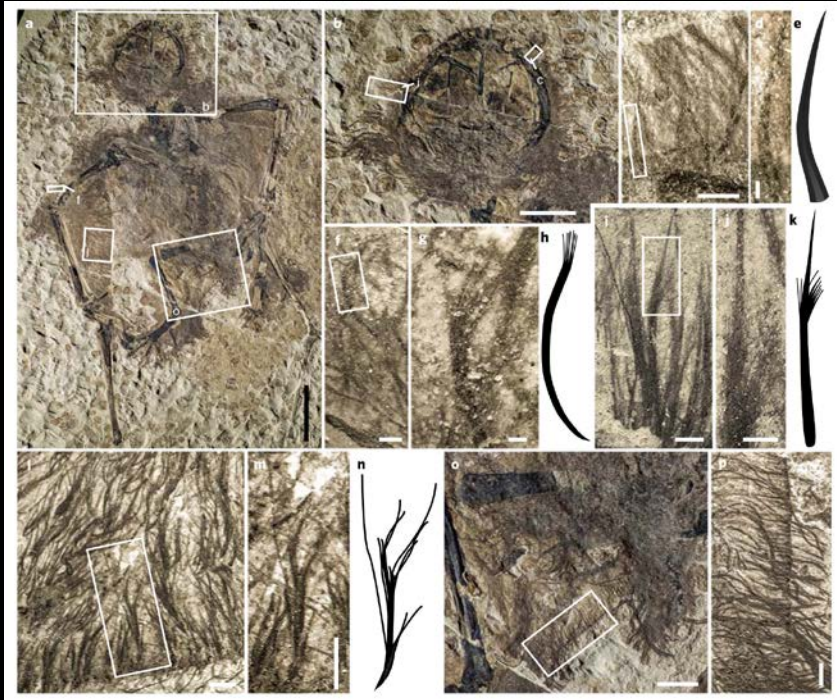
ARTICLES

<https://doi.org/10.1038/s41559-018-0728-7>

nature
ecology & evolution

Pterosaur integumentary structures with complex feather-like branching

Zixiao Yang¹, Baoyu Jiang ^{1*}, Maria E. McNamara ², Stuart L. Kearns³, Michael Pittman ⁴, Thomas G. Kaye ⁵, Patrick J. Orr⁶, Xing Xu⁷ and Michael J. Benton ^{3*}

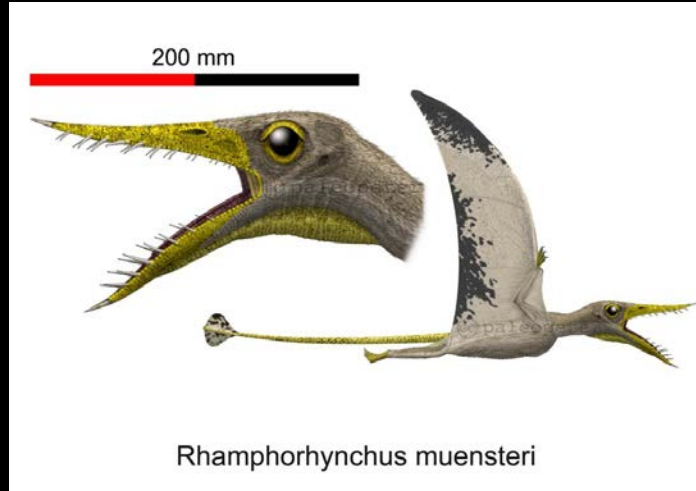


Fonte: Yang, Z. *et al.* (2019) Pterosaur integumentary structures with complex feather-like branching. *Nature Ecology & Evolution*, 3: 24-30.

PTEROSAURIA: Diversidade



Pterodactylus

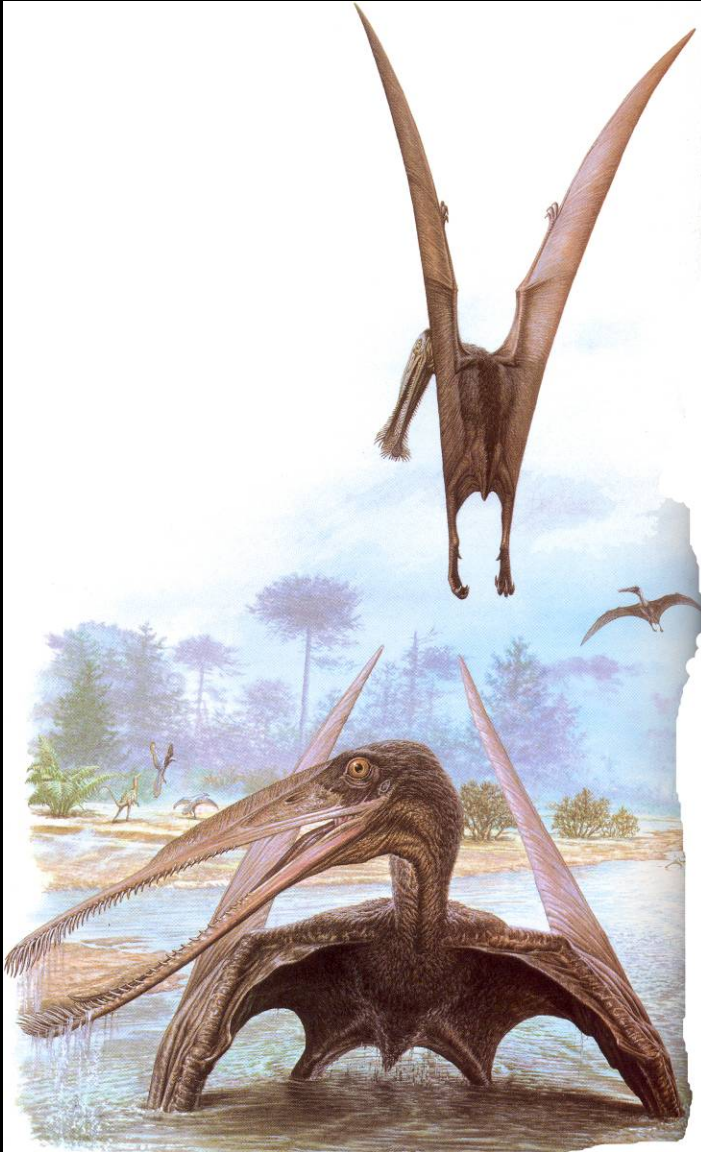


Rhamphorhynchus muensteri

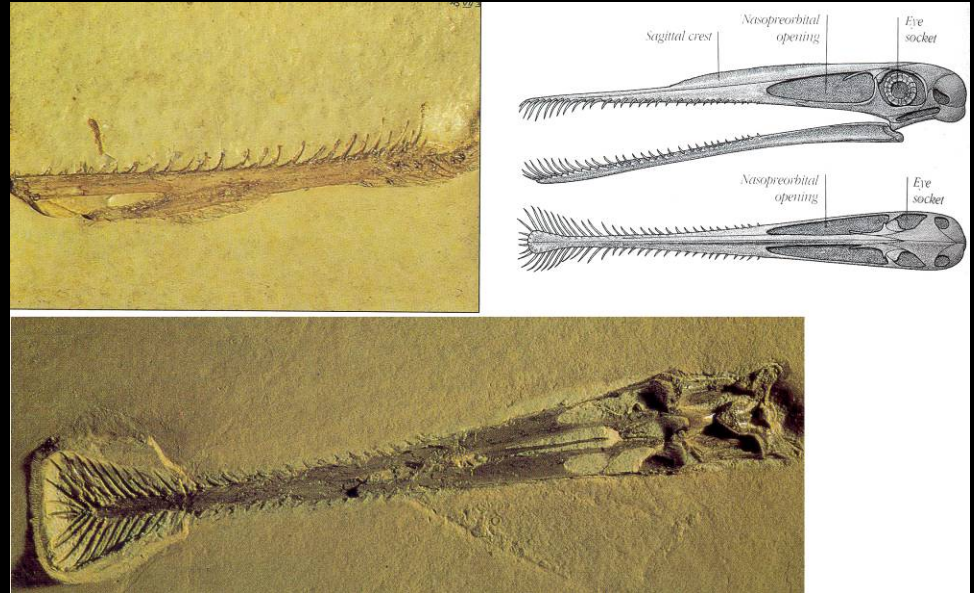


Rhamphorhynchus

PTEROSAURIA: Diversidade

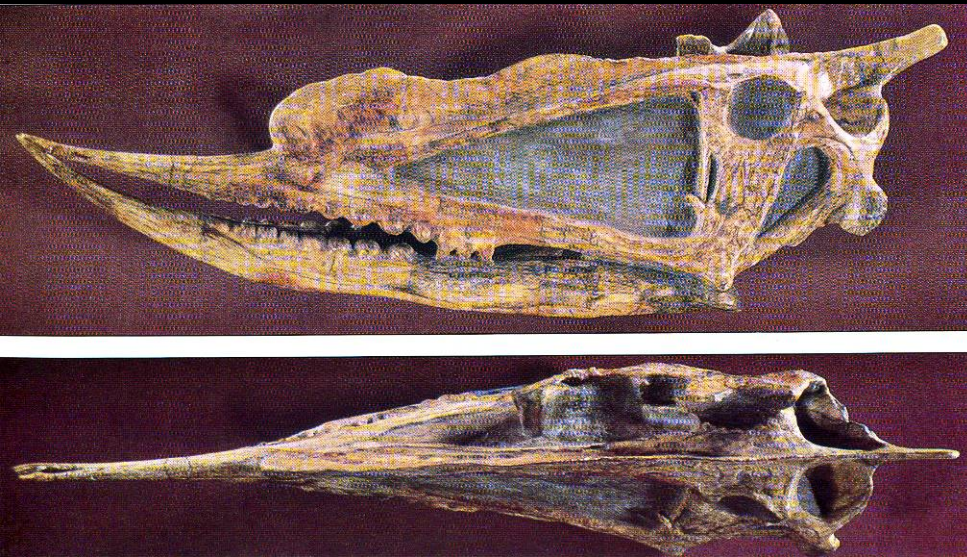


Ctenochasma: filtrador

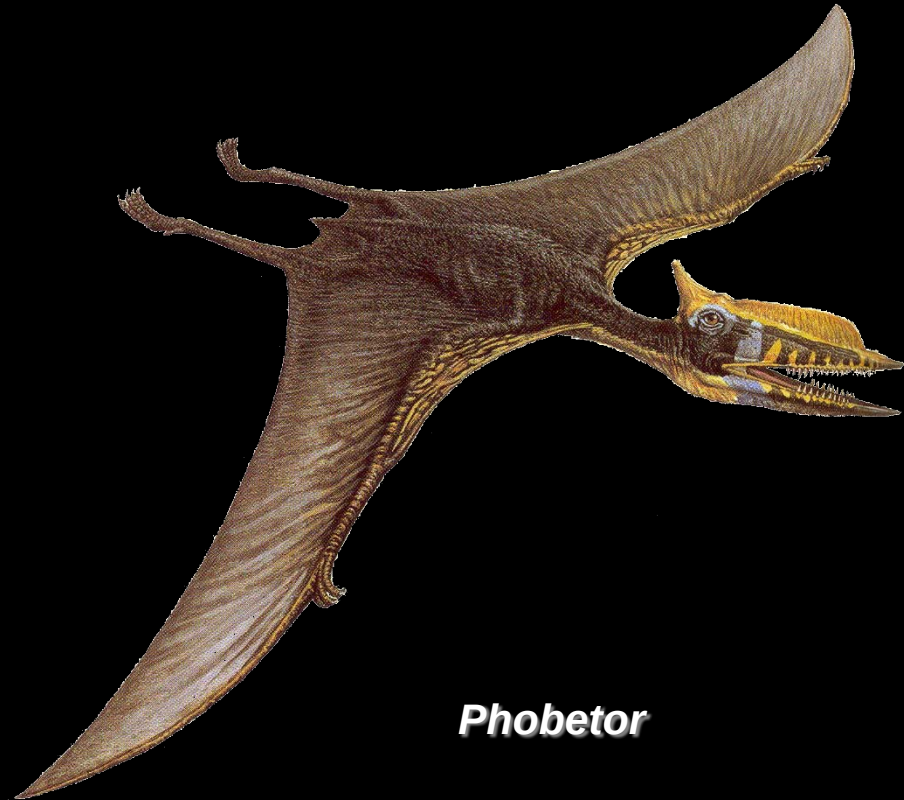


Gnathosaurus: filtrador?

PTEROSAURIA: Diversidade

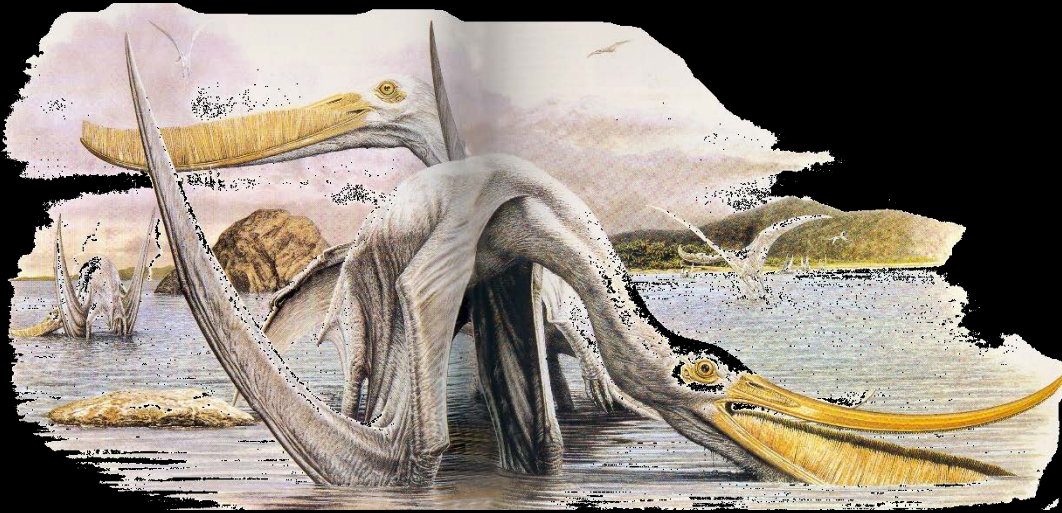


Crânio de *Dsungaropterus*: durófago

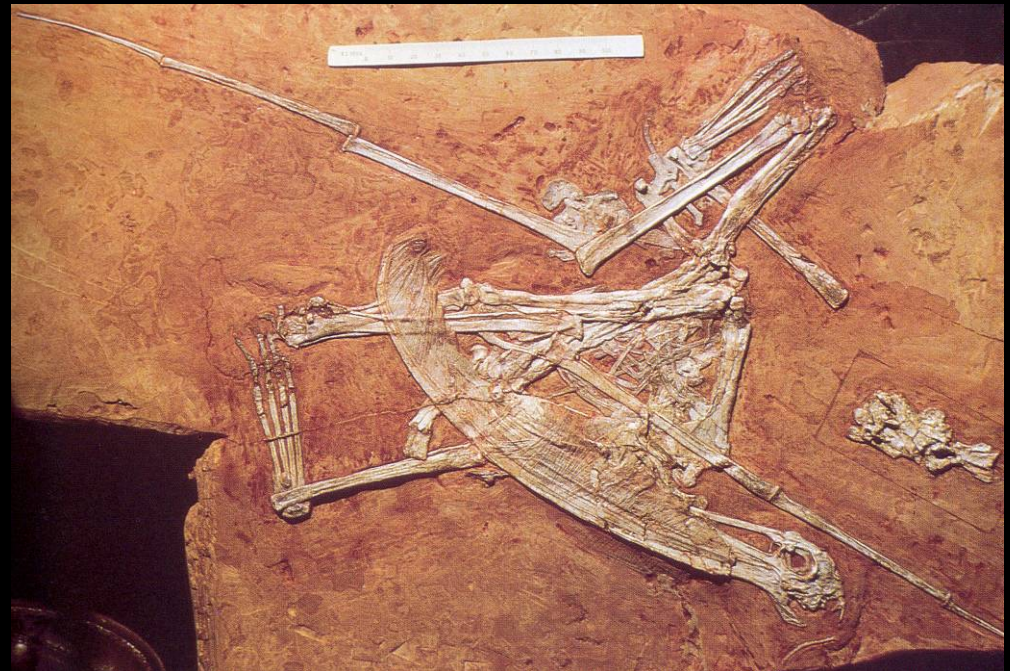


Phobosopterus

PTEROSAURIA: Diversidade



Reconstrução e crânio de
Pterodaustro: filtrador



PTEROSAURIA: Diversidade (Brasil)



†*Thalassodromeus sethi*, Cretáceo Inferior
(110 m.a.), bacia do Araripe



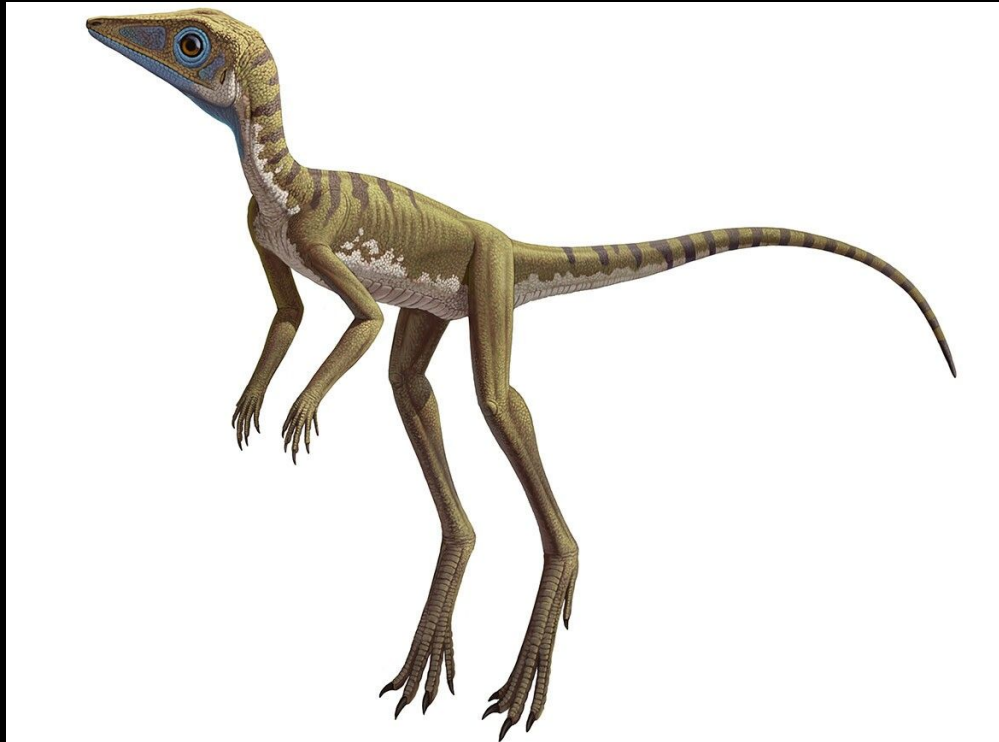
†*Caiuajara dobruskii* (Tapejaridae), Cretáceo
Superior (85 m.a.), Cruzeiro do Oeste, bacia
de Bauru

PTEROSAURIA: Diversidade (Brasil)



†*Keresdrakon wilsoni* (~Tapejaridae),
Cretáceo Superior (85 m.a.), Cruzeiro do
Oeste, bacia de Bauru

PTEROSAURIA: Relações Filogenéticas

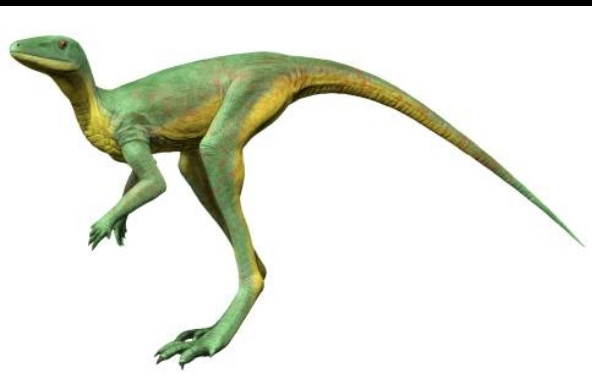


†*Scleromochlus taylori* (Scleromochlidae, Avemetatarsalia),
Triássico Superior (220 m.a.), Escócia, 18 cm.

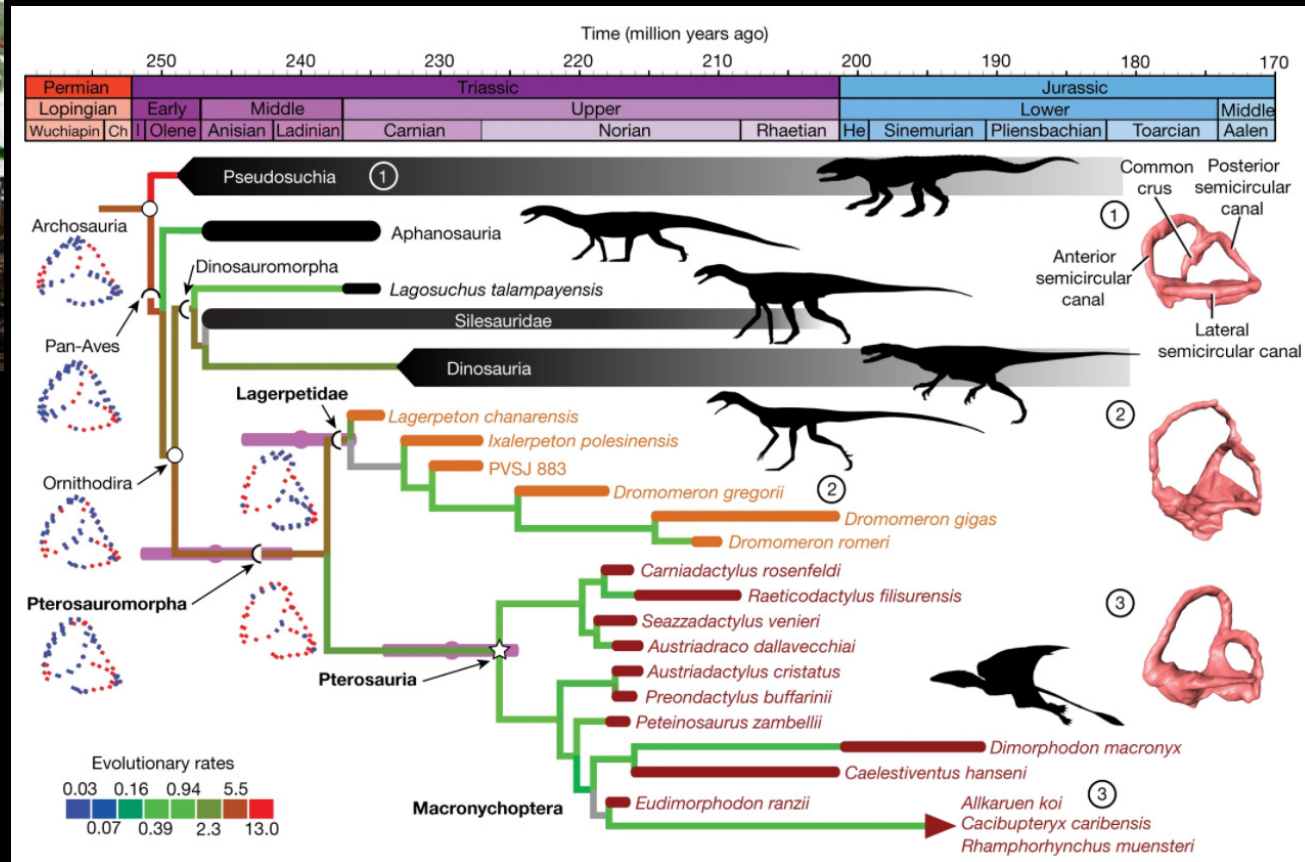
PTEROSAURIA: Relações Filogenéticas - Lagerpetidae

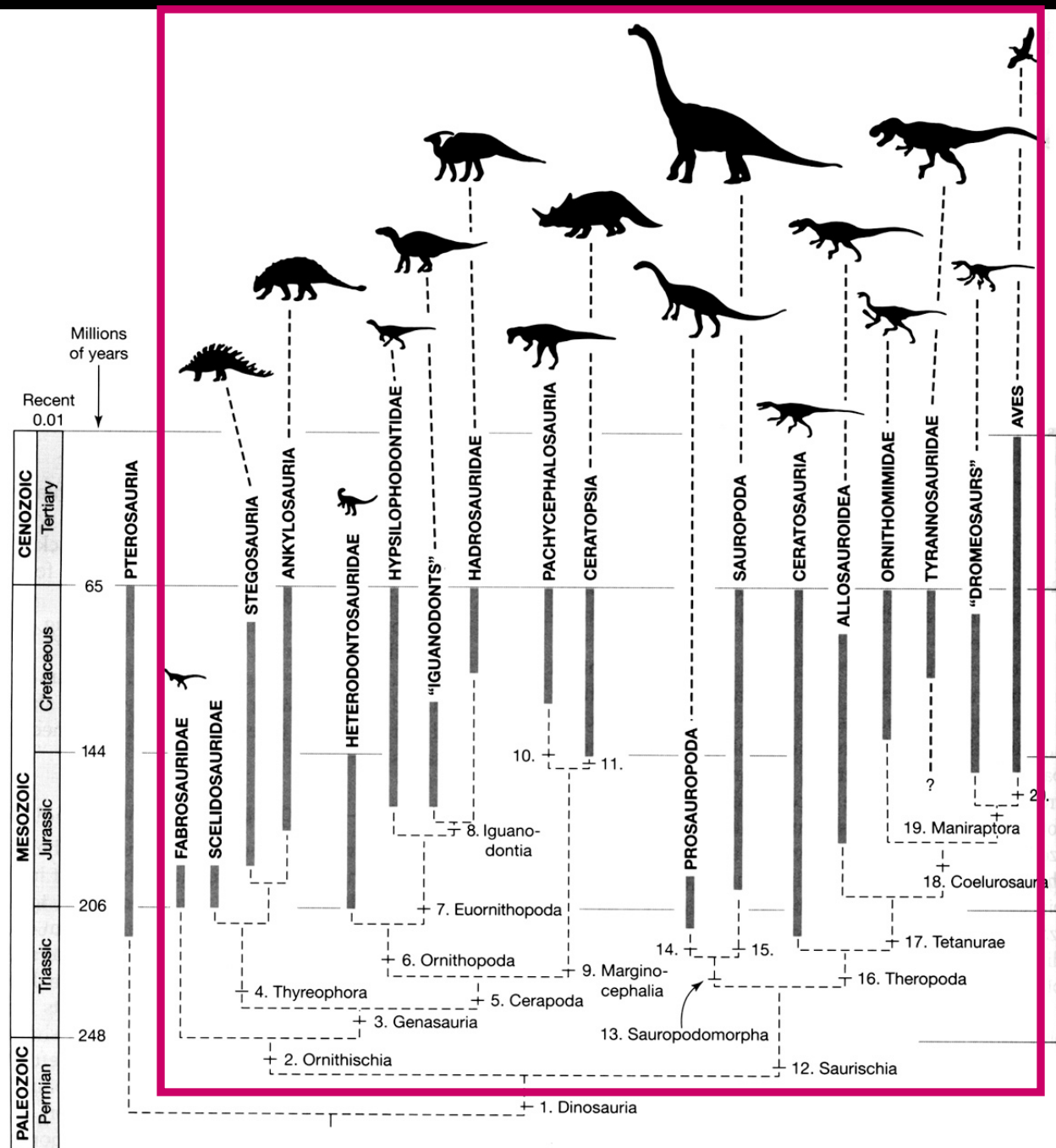


†*Ixalerpeton polesinensis*,
Brasil, Triássico Superior
(~237–228 M.a.), 40 cm



†*Lagerpeton chanarensis*,
Formação Chañares, Província
La Rioja, Argentina, Triássico
Superior (~236–234 M.a.), 70 cm



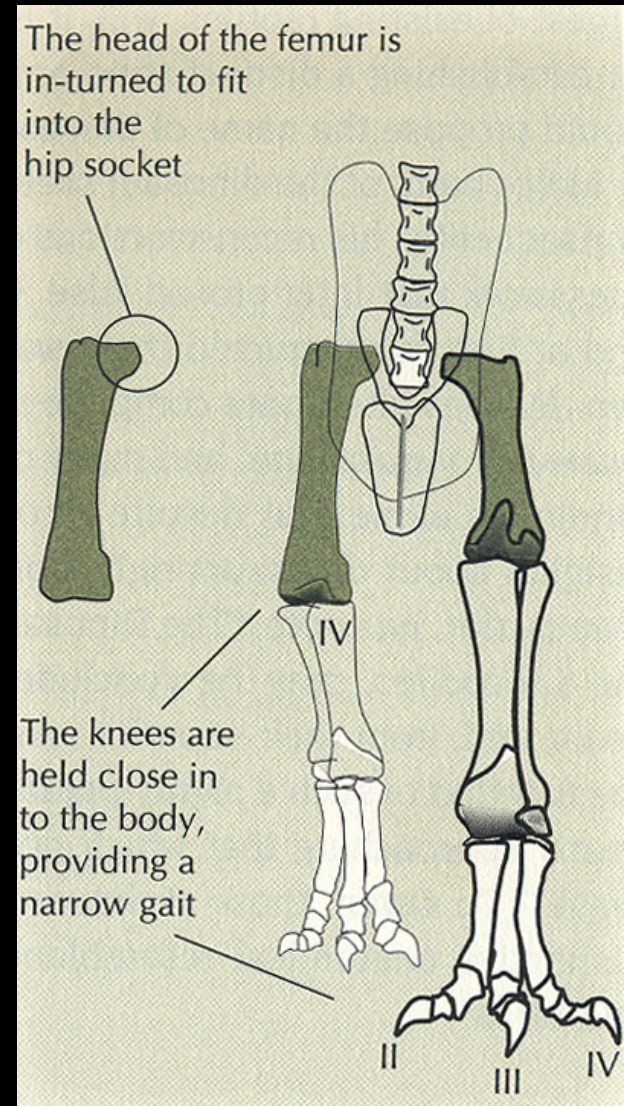
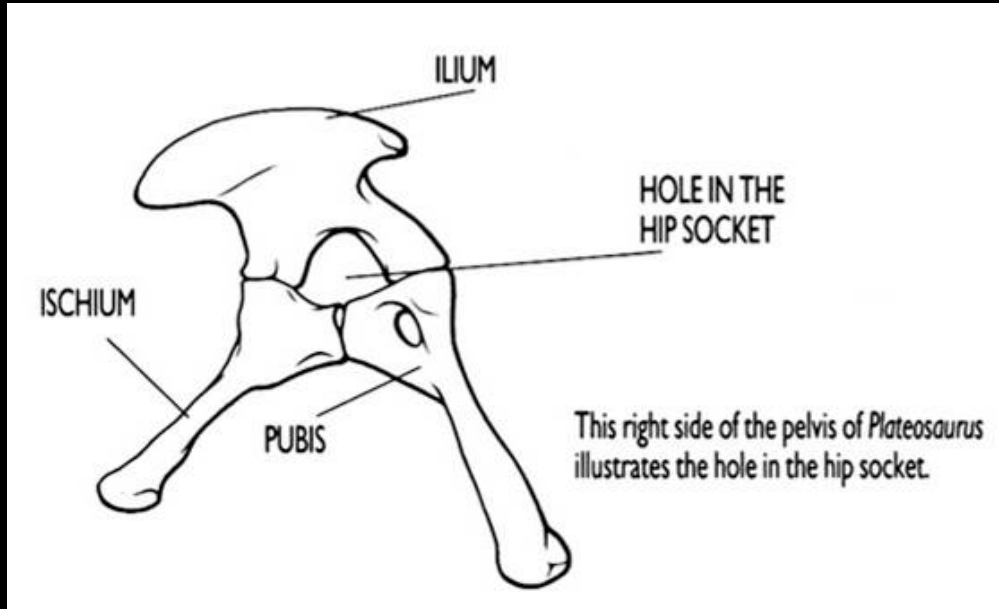


← Dinosauria

Filogenia dos Ornithodira.

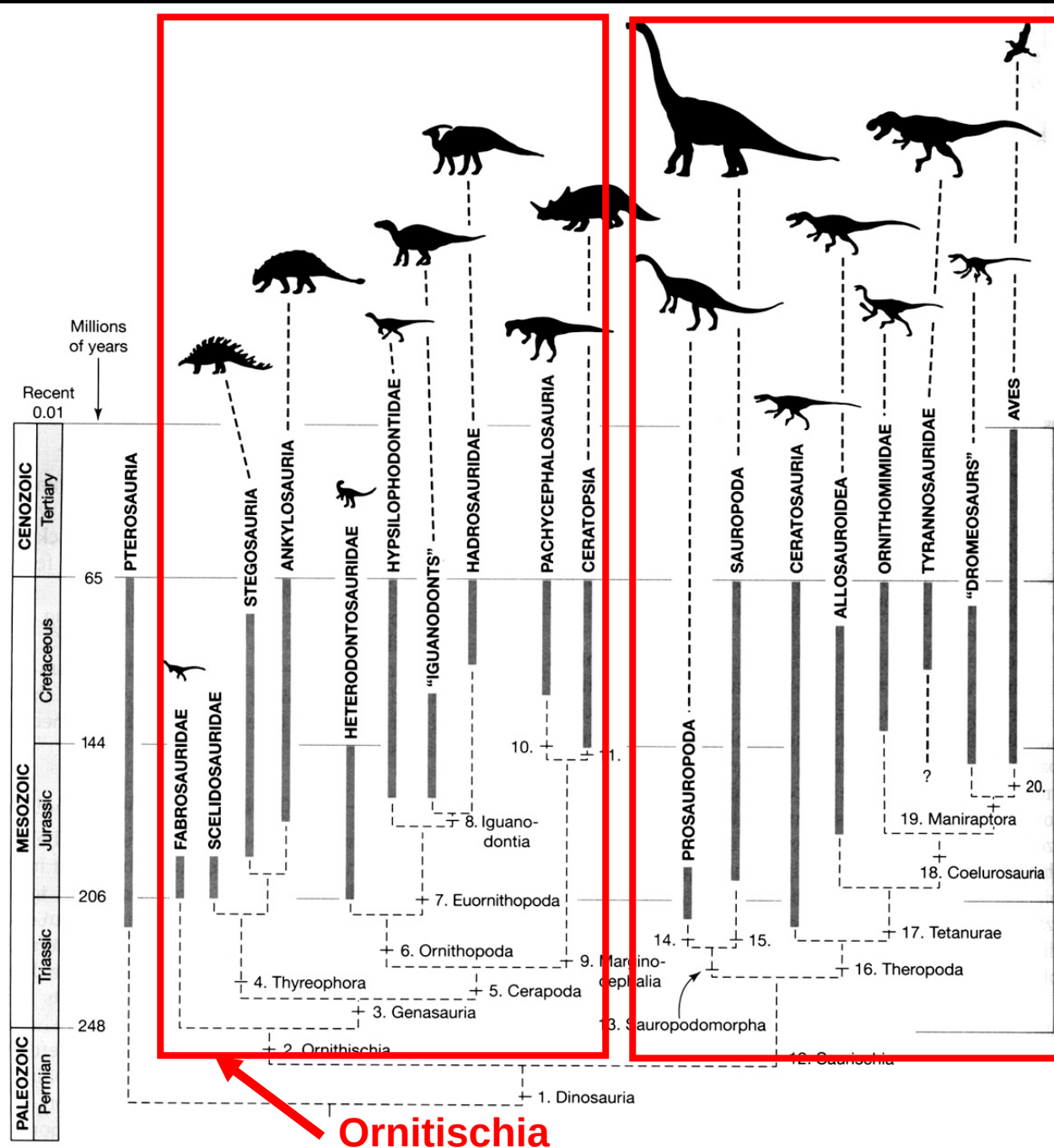
Fonte: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: Sinapomorfias



Fonte: Dingus, L. et al. (1995) *The Halls of Dinosaurs. A Guide to Saurischians and Ornithischians*. New York, American Museum of Natural History.

Dingus, L. & Rowe, T. (1997) *The Mistaken Evolution. Dinosaur Evolution and the Origin of Birds*. New York, W.H. Freeman and Company.

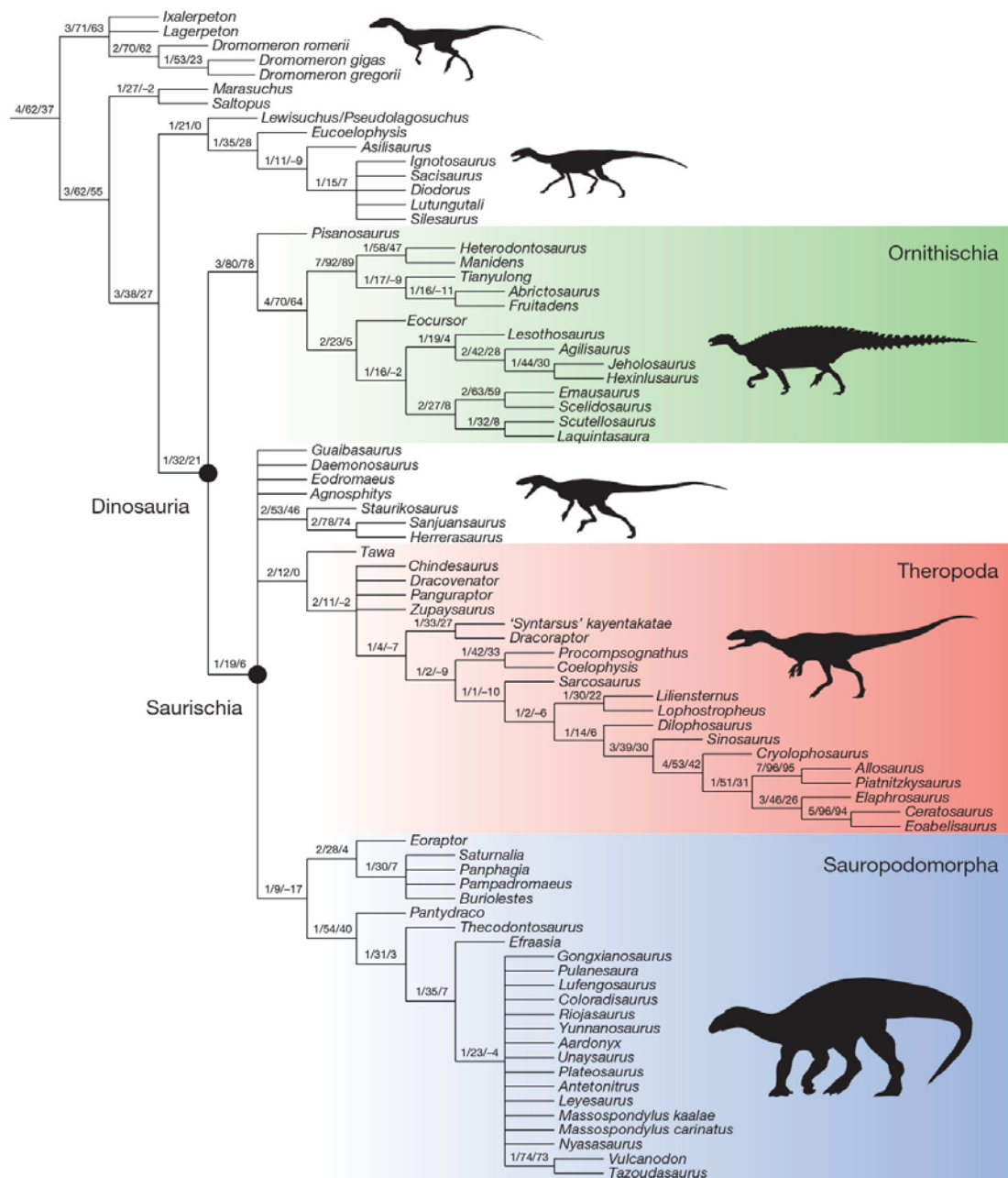


Saurischia

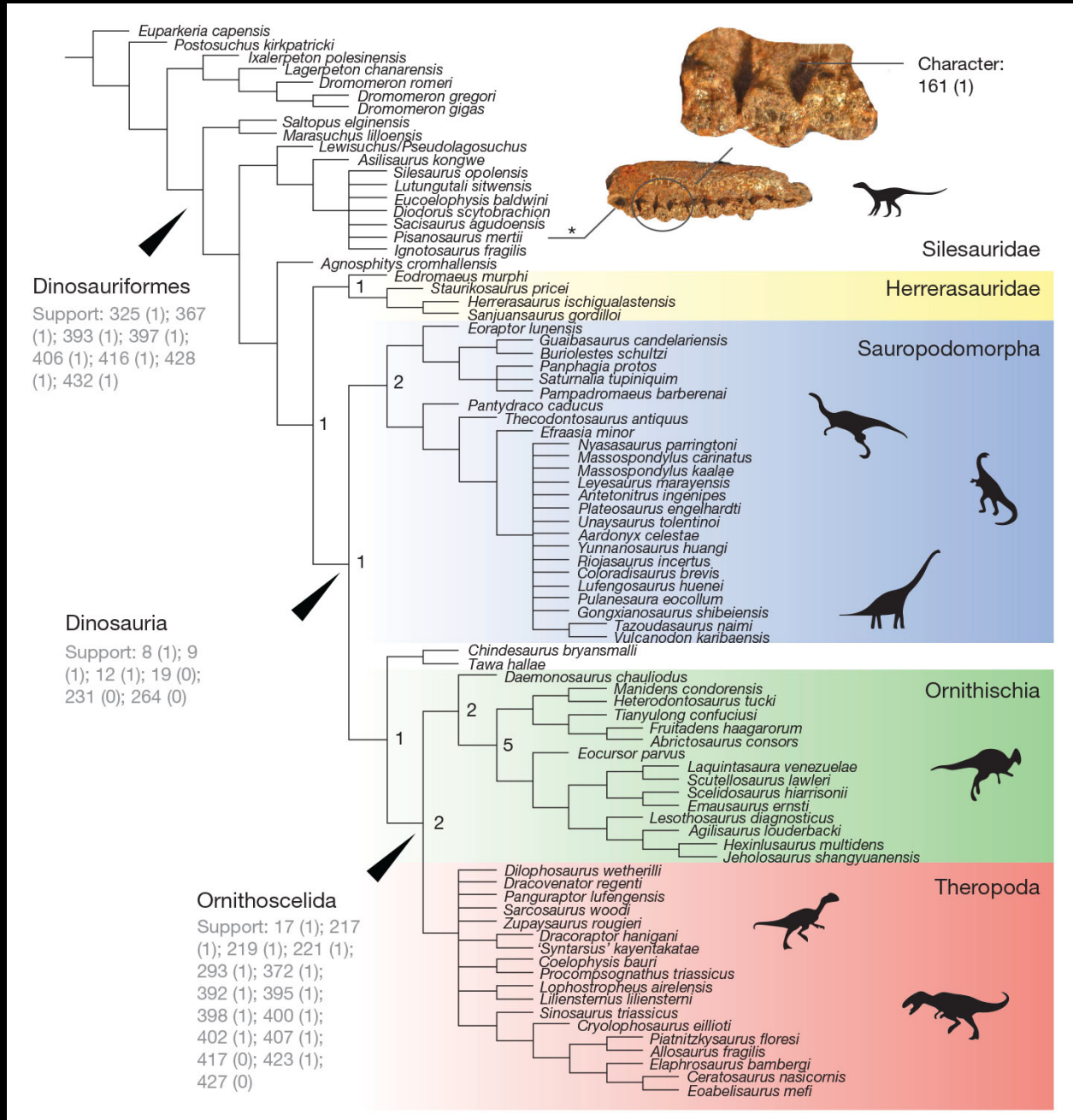
Filogenia dos Ornithodira.

Ornithischia

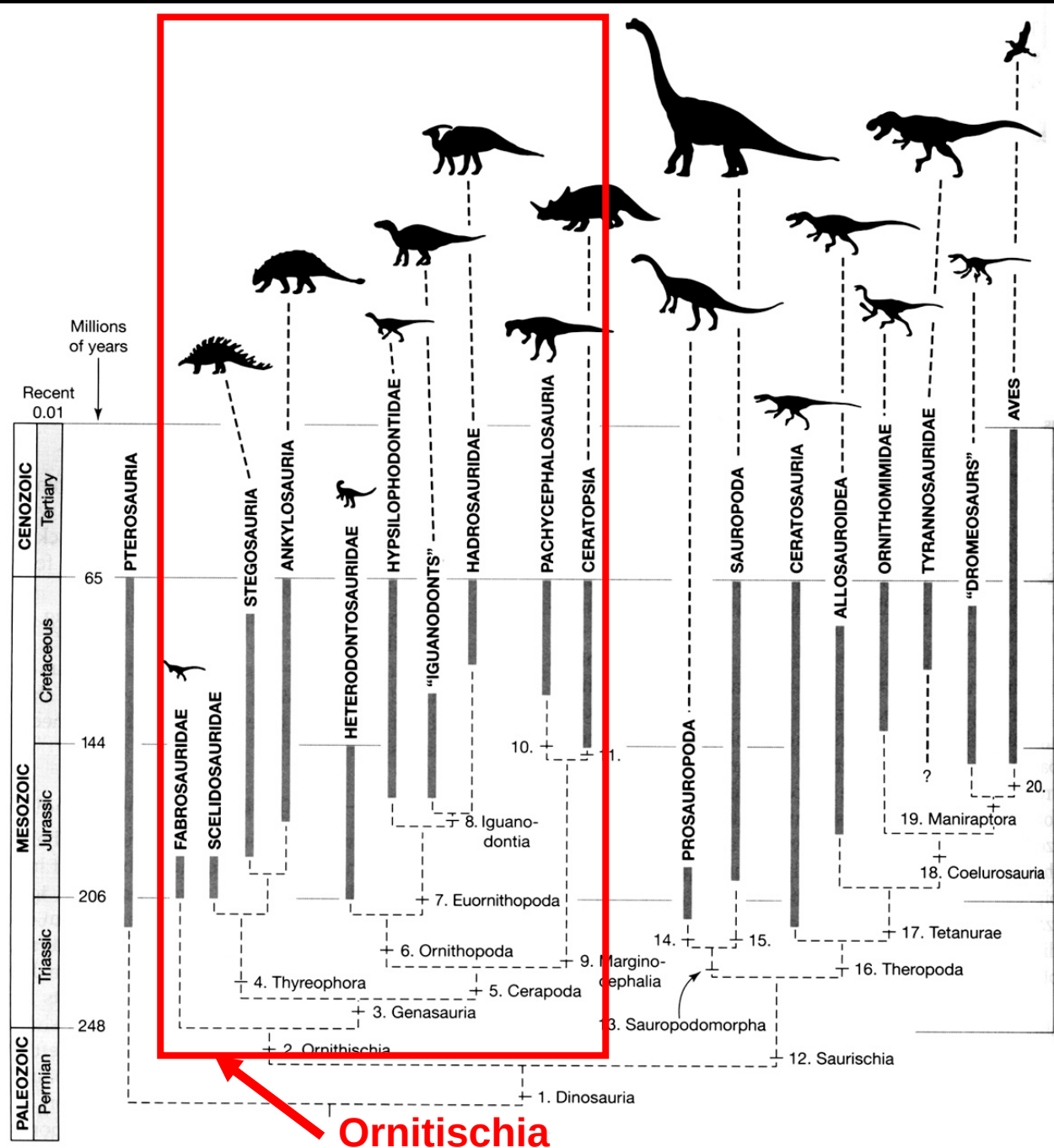
Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.



Fontes: Baron, M.G. et al. (2017) A new hypothesis of dinosaur relationships and early dinosaur evolution. *Nature*, 543, 501–506.
 Langer, M.C. et al. (2017) Untangling the dinosaur family tree. *Nature*, 551, E1-E3.



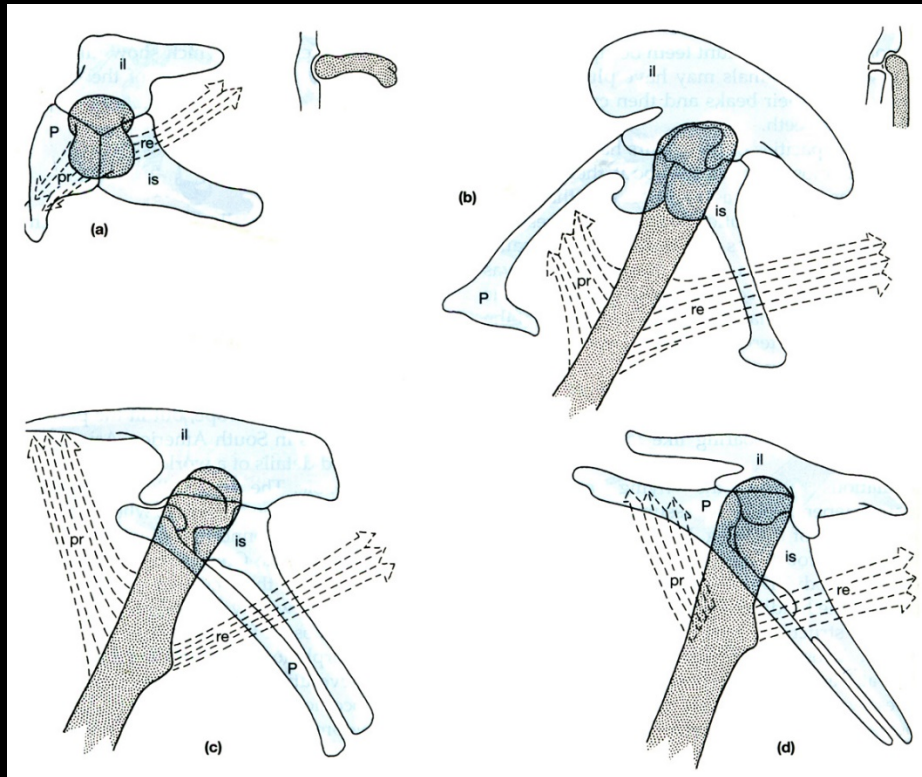
Fontes: Baron, M.G. *et al.* (2017) A new hypothesis of dinosaur relationships and early dinosaur evolution. *Nature*, 543, 501–506.
 Langer, M.C. *et al.* (2017) Untangling the dinosaur family tree. *Nature*, 551, E1–E3.



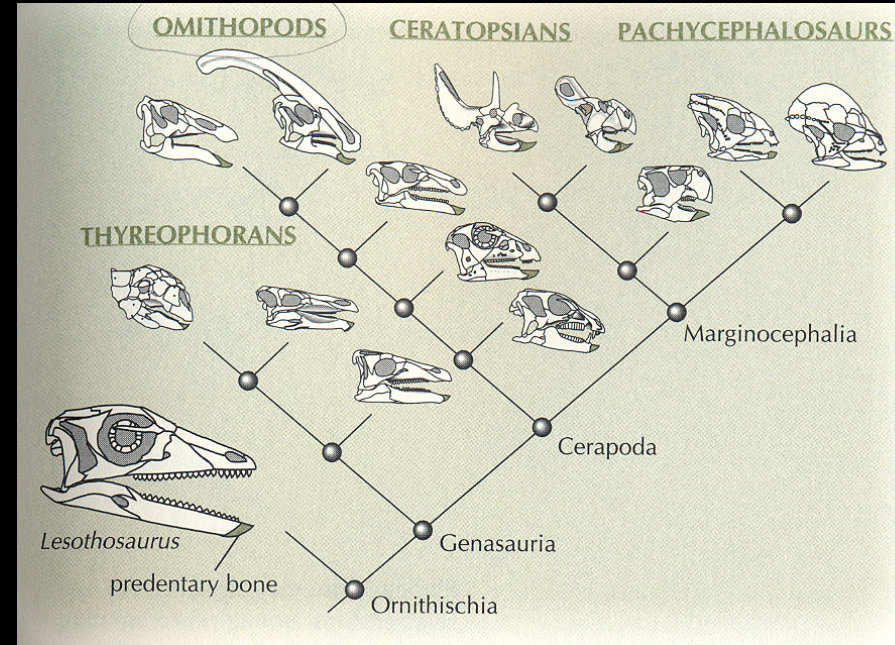
Filogenia dos Ornithodira.

Fonte: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: ORNITISCHIA: Sinapomorfias

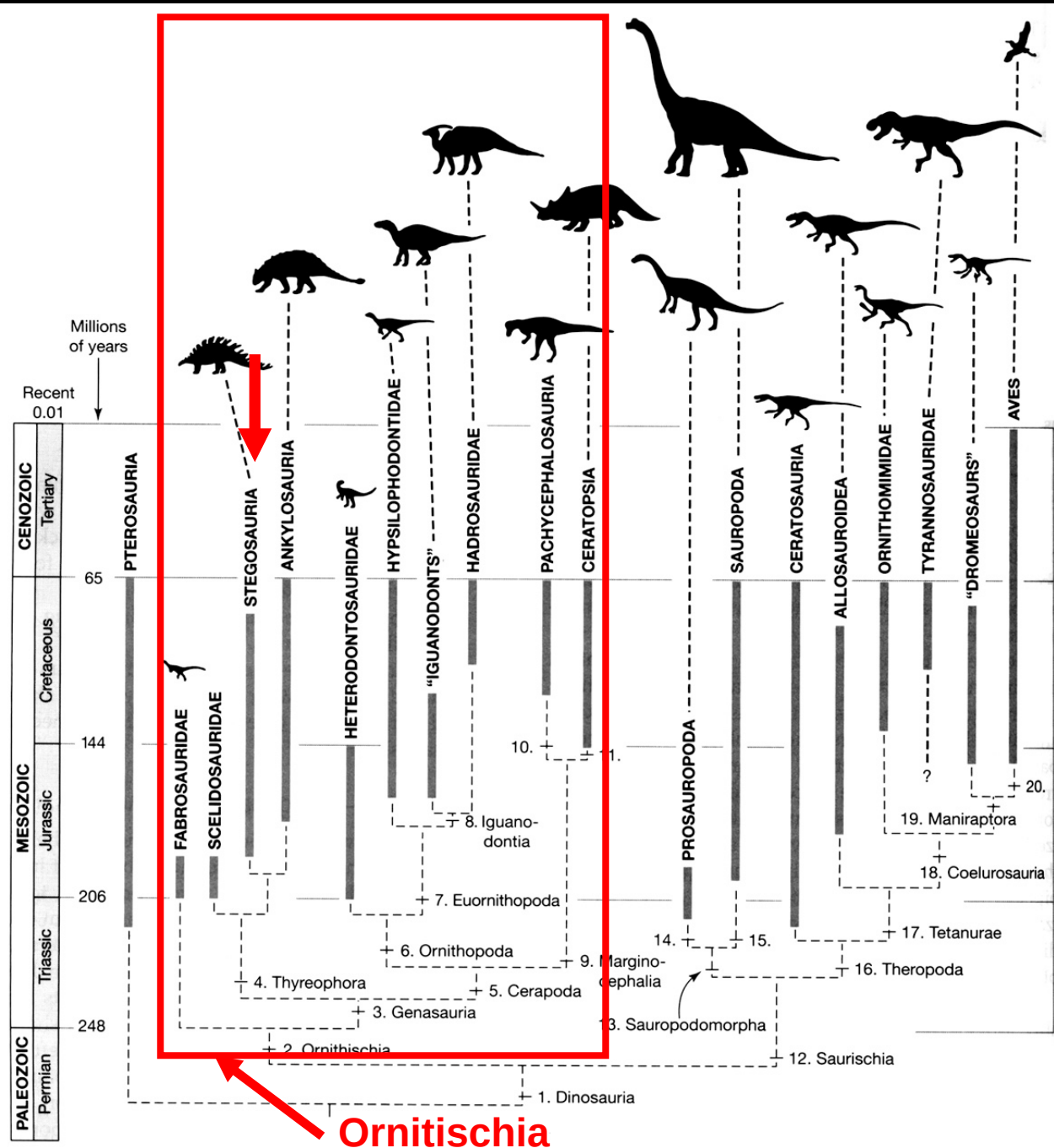


(a) *Euparkeria*; (b) *Ceratosaurus* (Saurischia); (c) *Scelidosaurus* (Ornithischia); (d) *Thescelosaurus* (Ornithischia).



Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

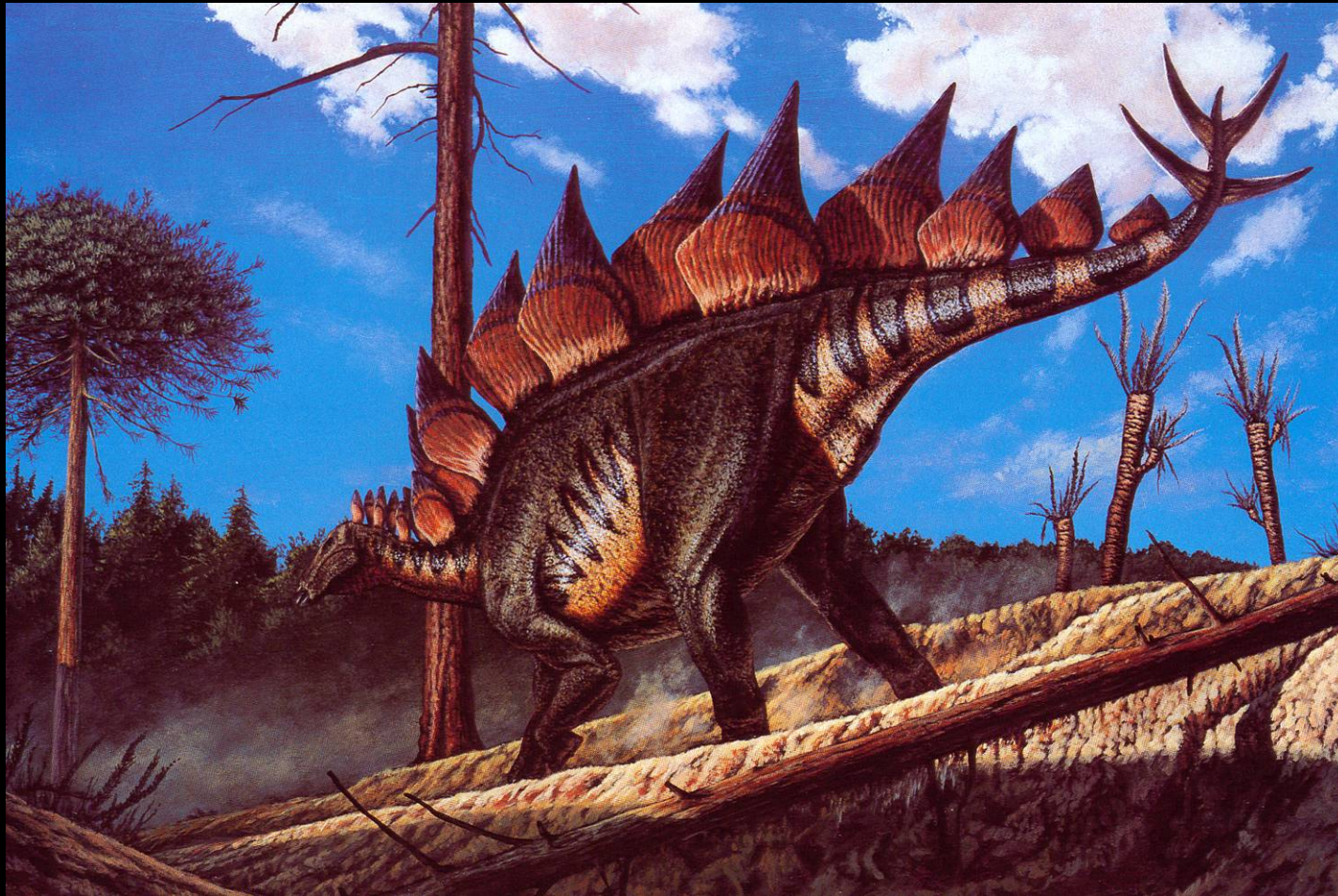
Dingus, L. & Rowe, T. (1997) *The Mistaken Evolution. Dinosaur Evolution and the Origin of Birds*. New York, W.H. Freeman and Company.



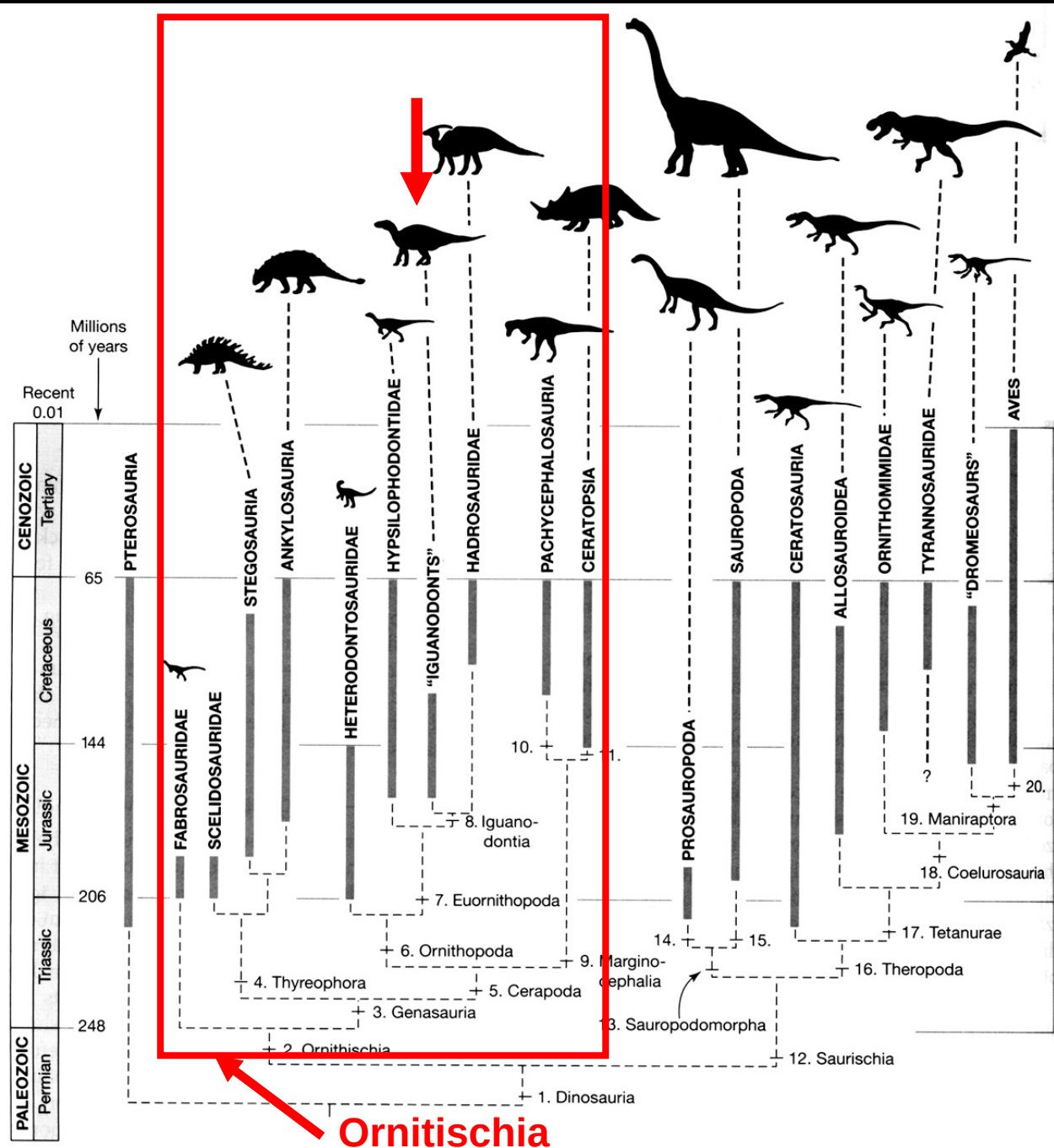
Filogenia dos Ornithodira.

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: ORNITISCHIA: THYREOPHORA: Morfologia e Diversidade



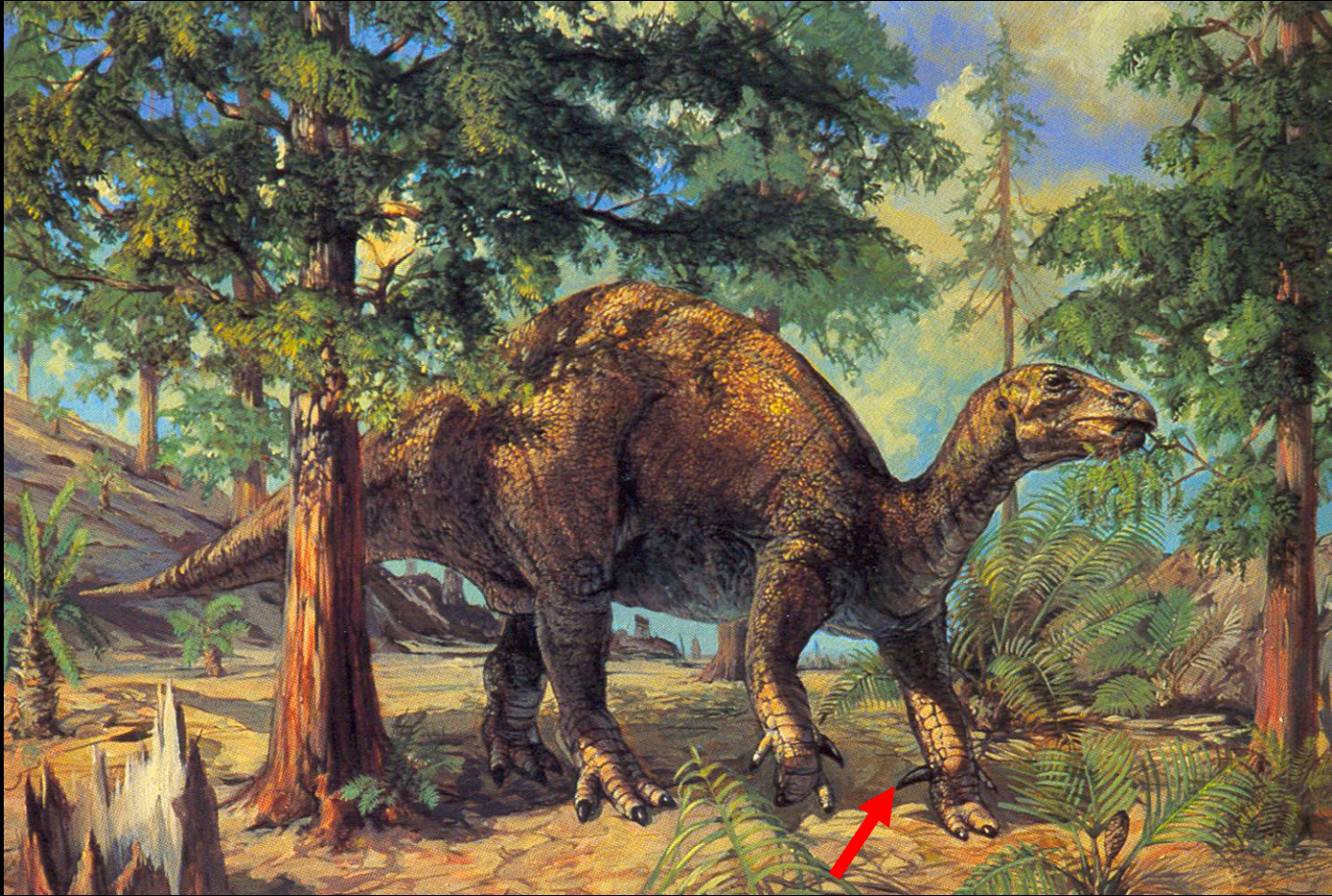
***Stegosaurus stenops* (Stegosauria):
Colorado, EUA, Jurássico.**



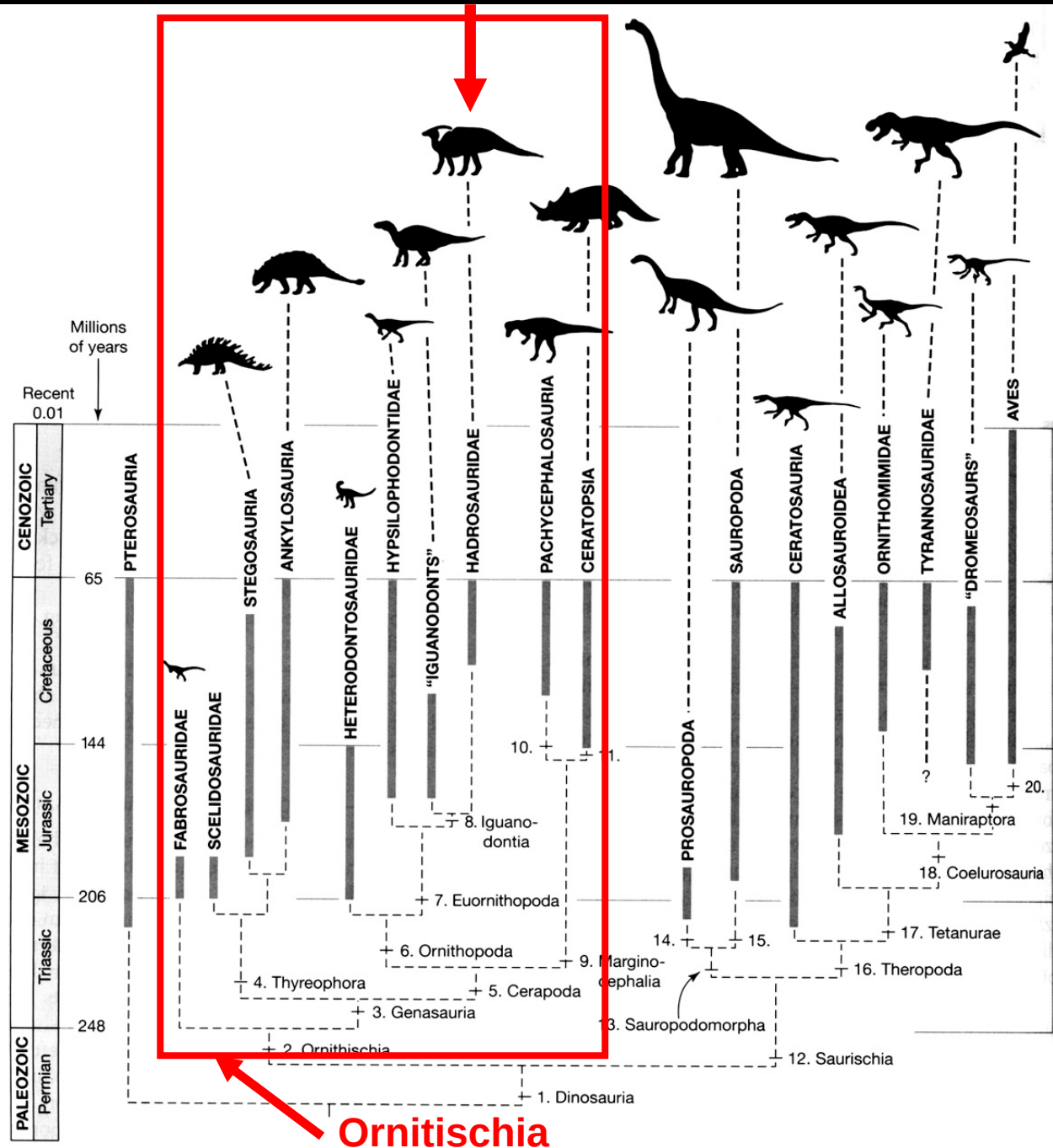
Filogenia dos Ornithodira.

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: ORNITISCHIA: ORNITHOPODA: Morfologia e Diversidade



***Iguanodon mantelli* (Iguanodontidae):
Sussex, Inglaterra, Cretáceo.**



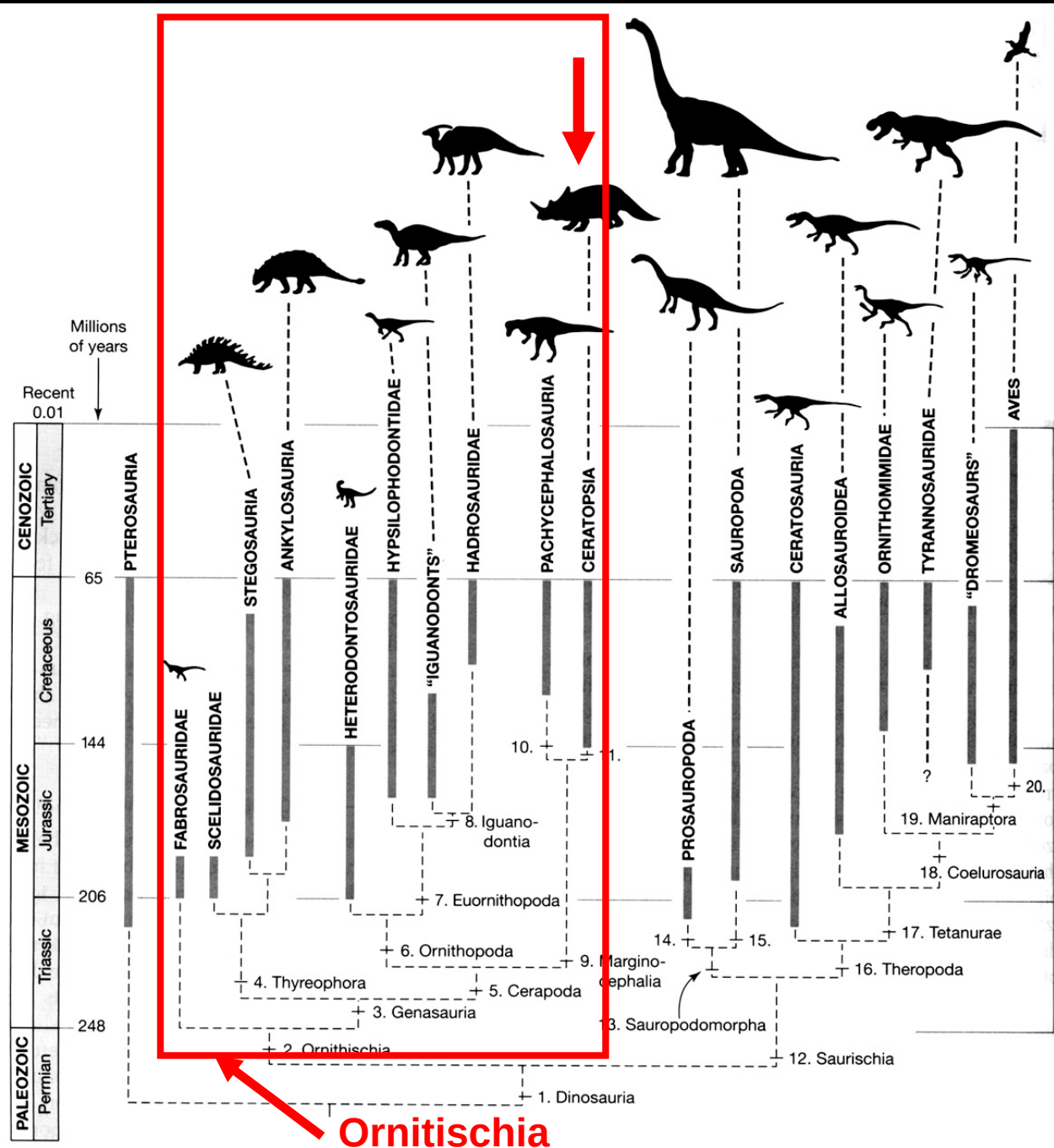
Filogenia dos Ornithodira.

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: ORNITISCHIA: ORNITHOPODA: Morfologia e Diversidade



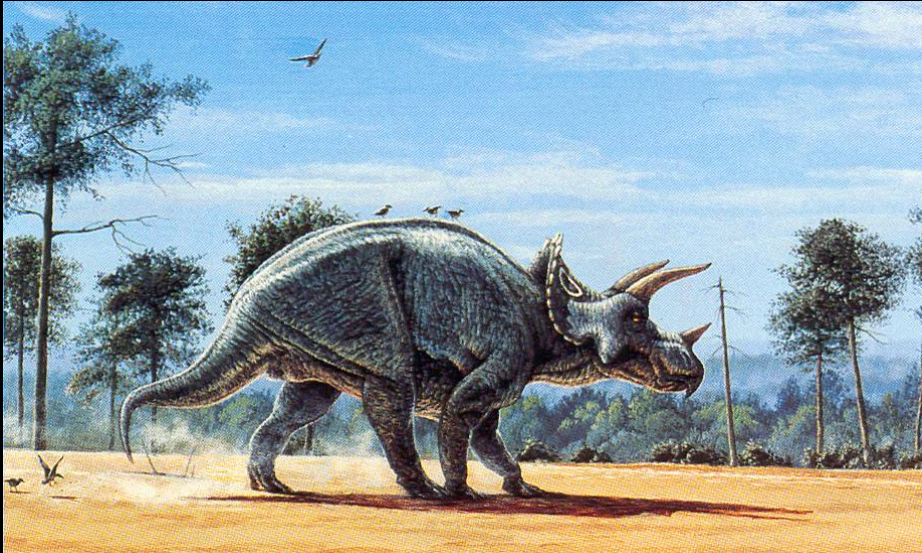
***Parasaurolophus walkeri* (Hadrosauridae):
Alberta, Canadá, Cretáceo Superior.**



Filogenia dos Ornithodira.

Fonte: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: ORNITISCHIA: CERATOPSIA: Morfologia e Diversidade



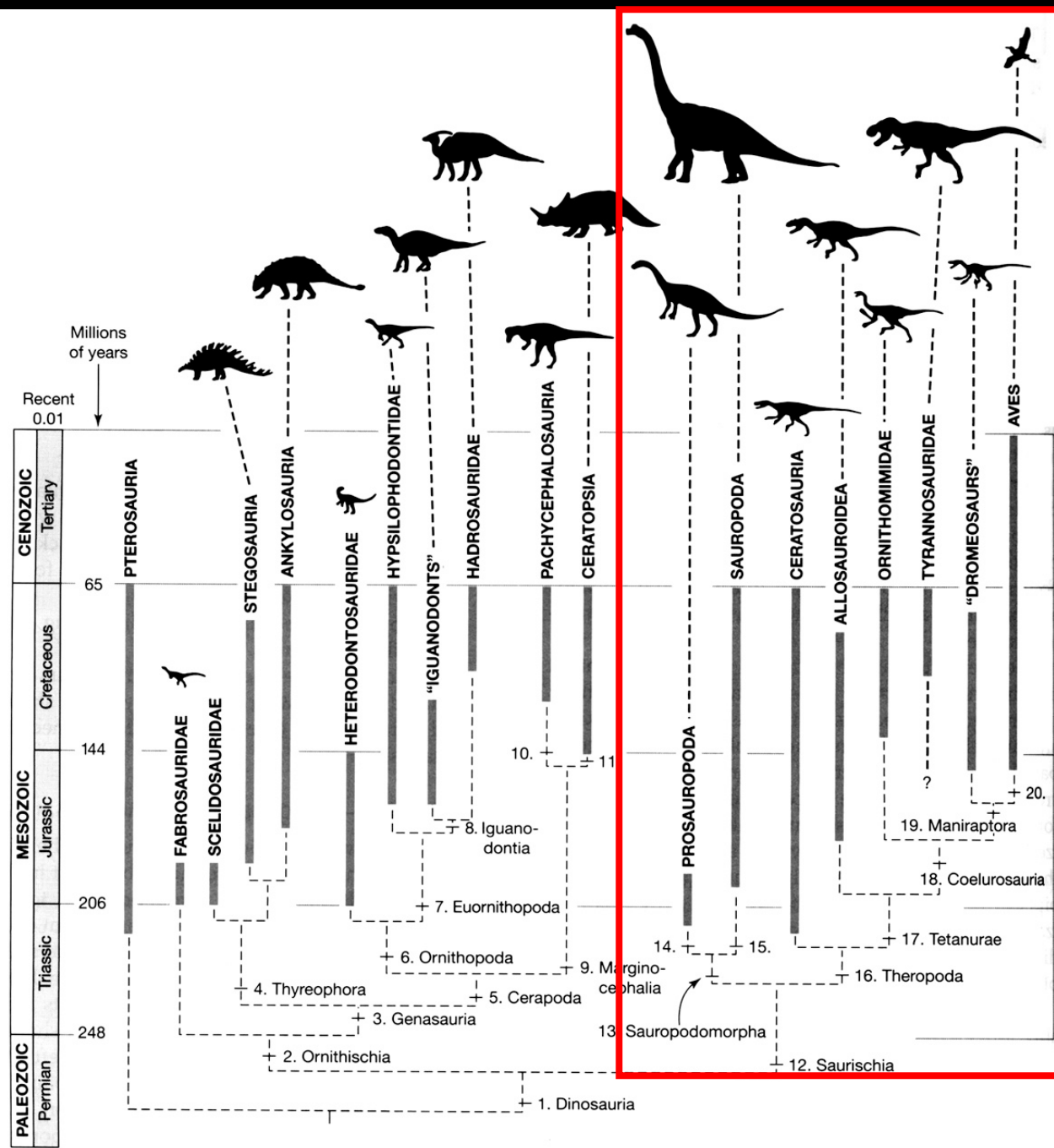
***Triceratops* (Ceratopsidae): Alberta, Canadá, Cretáceo Superior.**



Centrosaurus

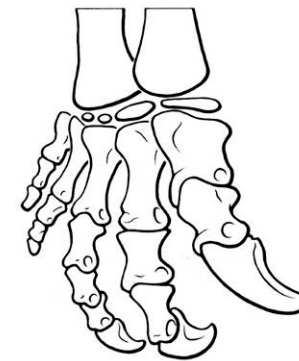


Arrhinoceratops



Saurischia

Filogenia dos Ornithodira.



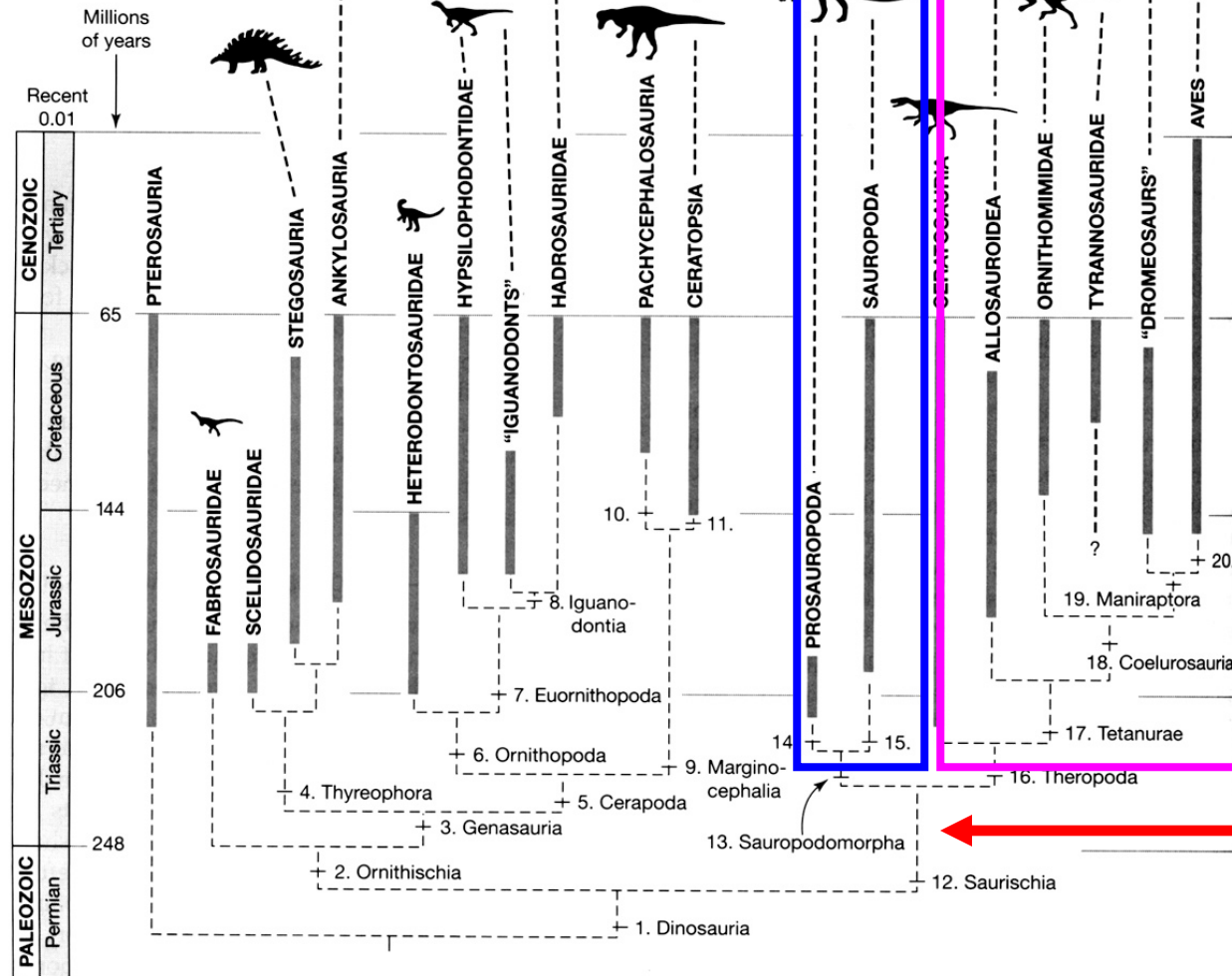
This portion of the right arm of *Plateosaurus* illustrates the grasping hand.

Fontes: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

Dingus, L. *et al.* (1995) *The Halls of Dinosaurs. A Guide to Saurischians and Ornithischians*. New York, American Museum of Natural History.

Sauropodomorpha

Theropoda

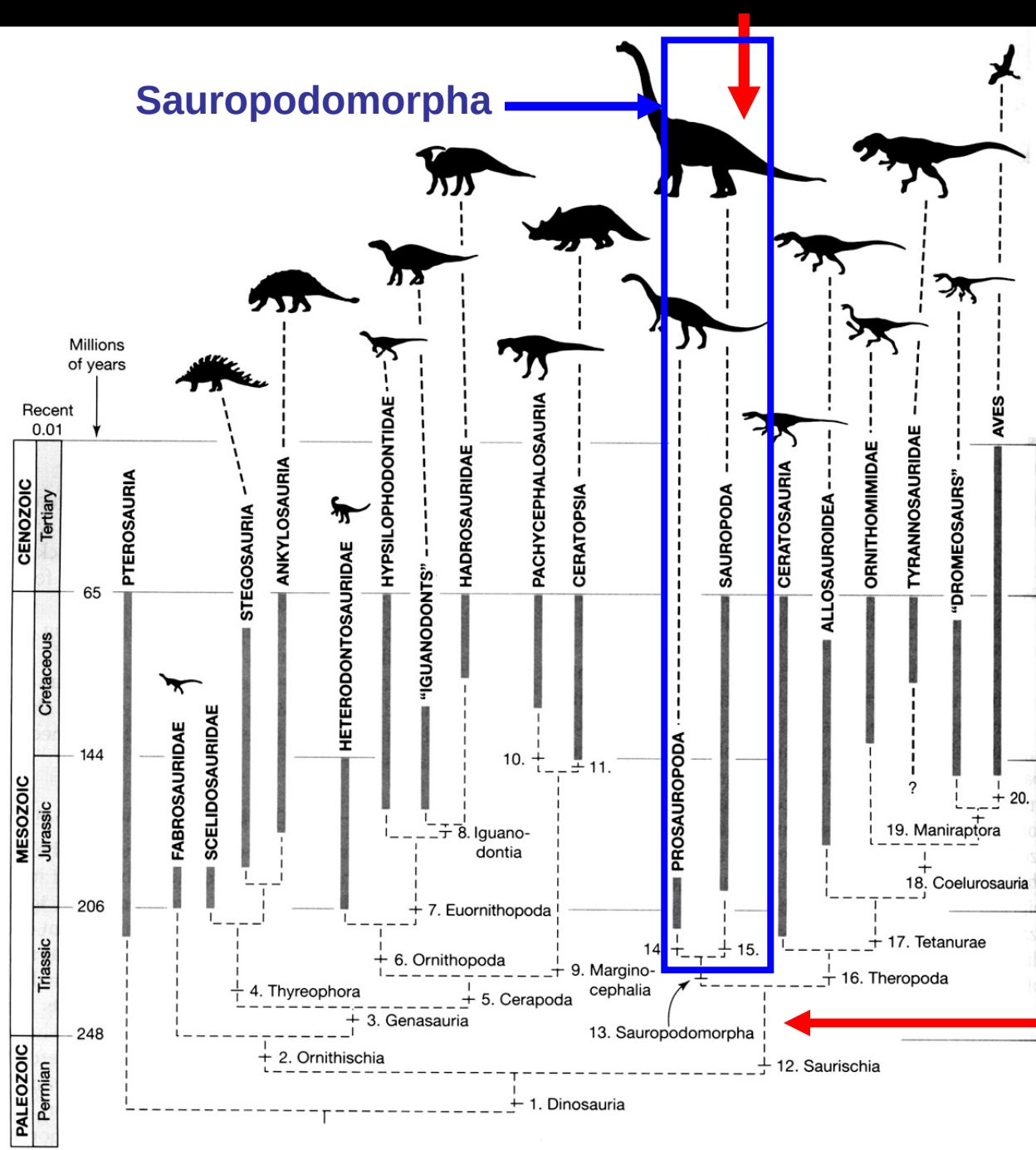


Filogenia dos Ornithodira.

Saurischia

Fonte: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

Sauropodomorpha



Filogenia dos Ornithodira.

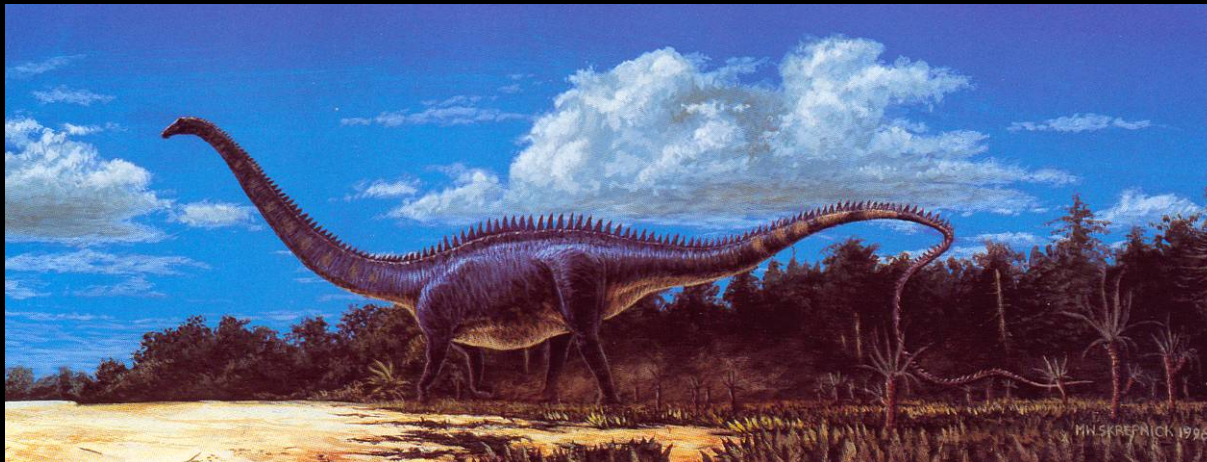
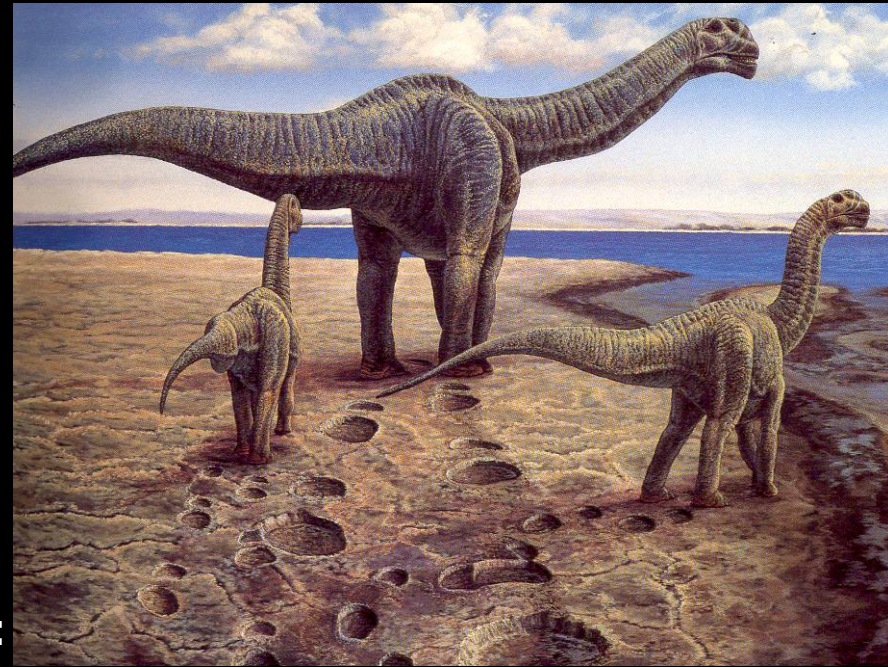
Saurischia

Fonte: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

DINOSAURIA: SAURISCHIA: SAUROPODA: Morfologia e Diversidade

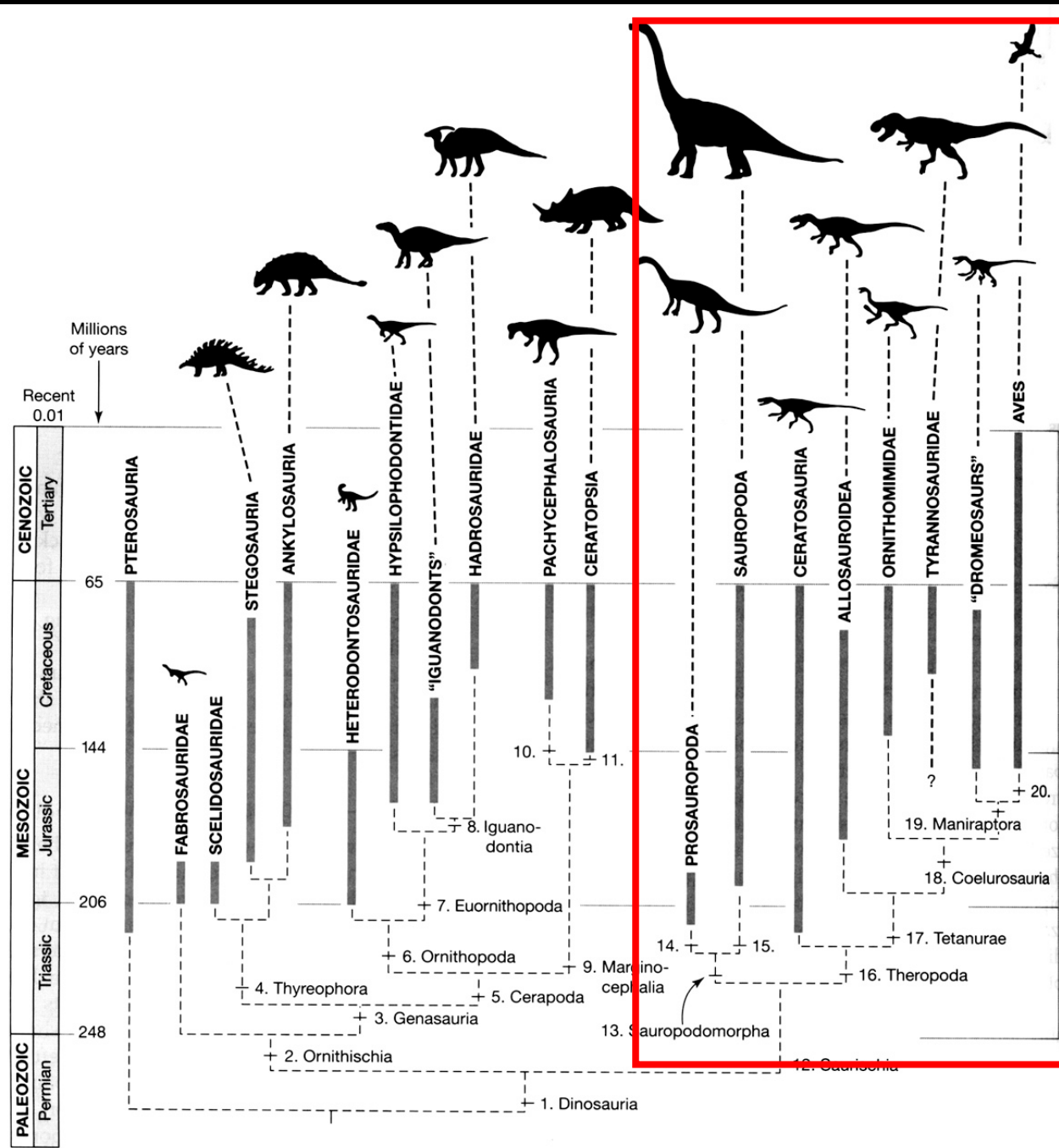


***Camarasaurus supremus* (Camarasauridae):**
Colorado, EUA, Jurássico Superior.



***Diplodocus carnegii* (Diplodocidae):** EUA, Jurássico Superior.

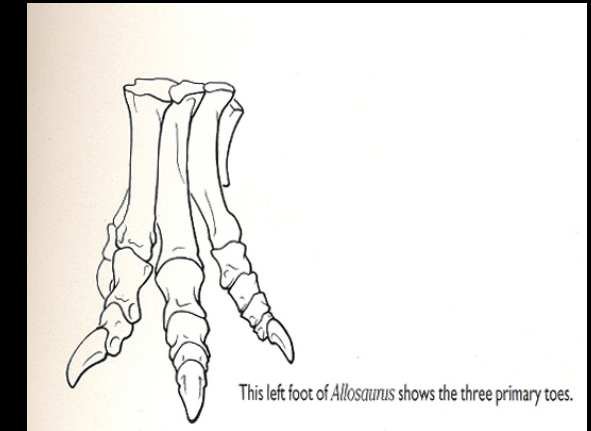
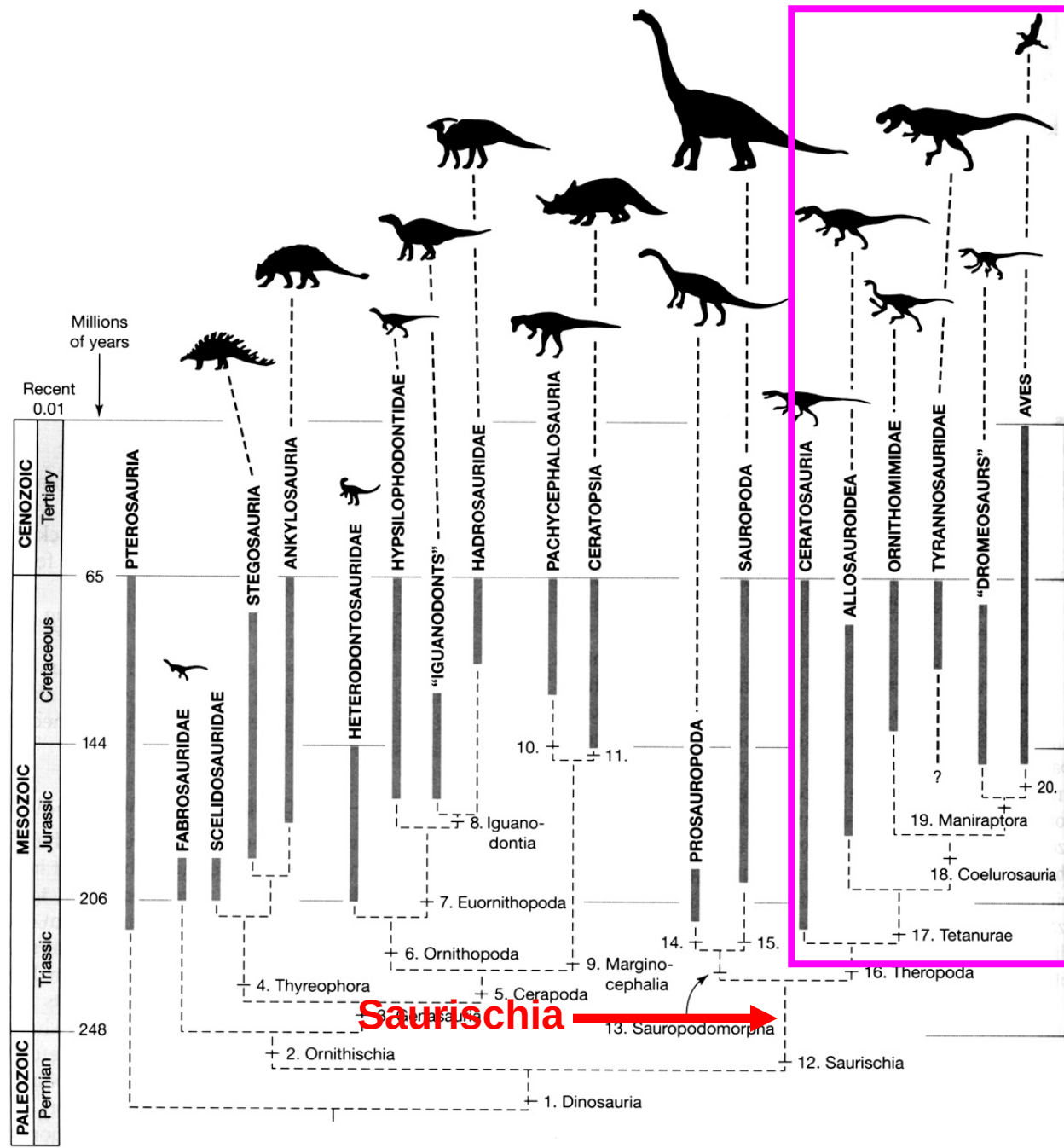
Fonte: Currie, P. J., & K. Padian (Ed.). (1997) *Encyclopedia of Dinosaurs*. San Diego, Academic Press.



Saurischia

Filogenia dos Ornithodira.

Fonte: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

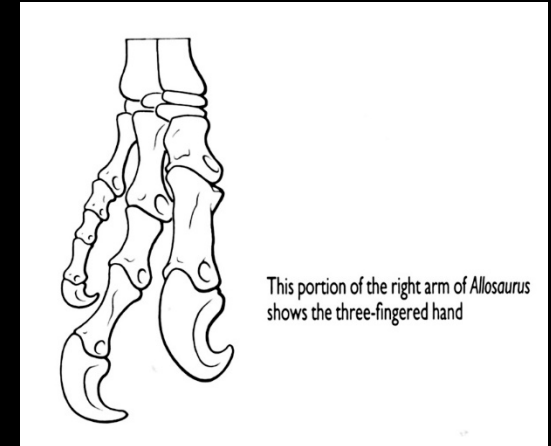


Filogenia dos Ornithodira.

Fontes: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

Dingus, L. et al. (1995) *The Halls of Dinosaurs. A Guide to Saurischians and Ornithischians*. New York, American Museum of Natural History.

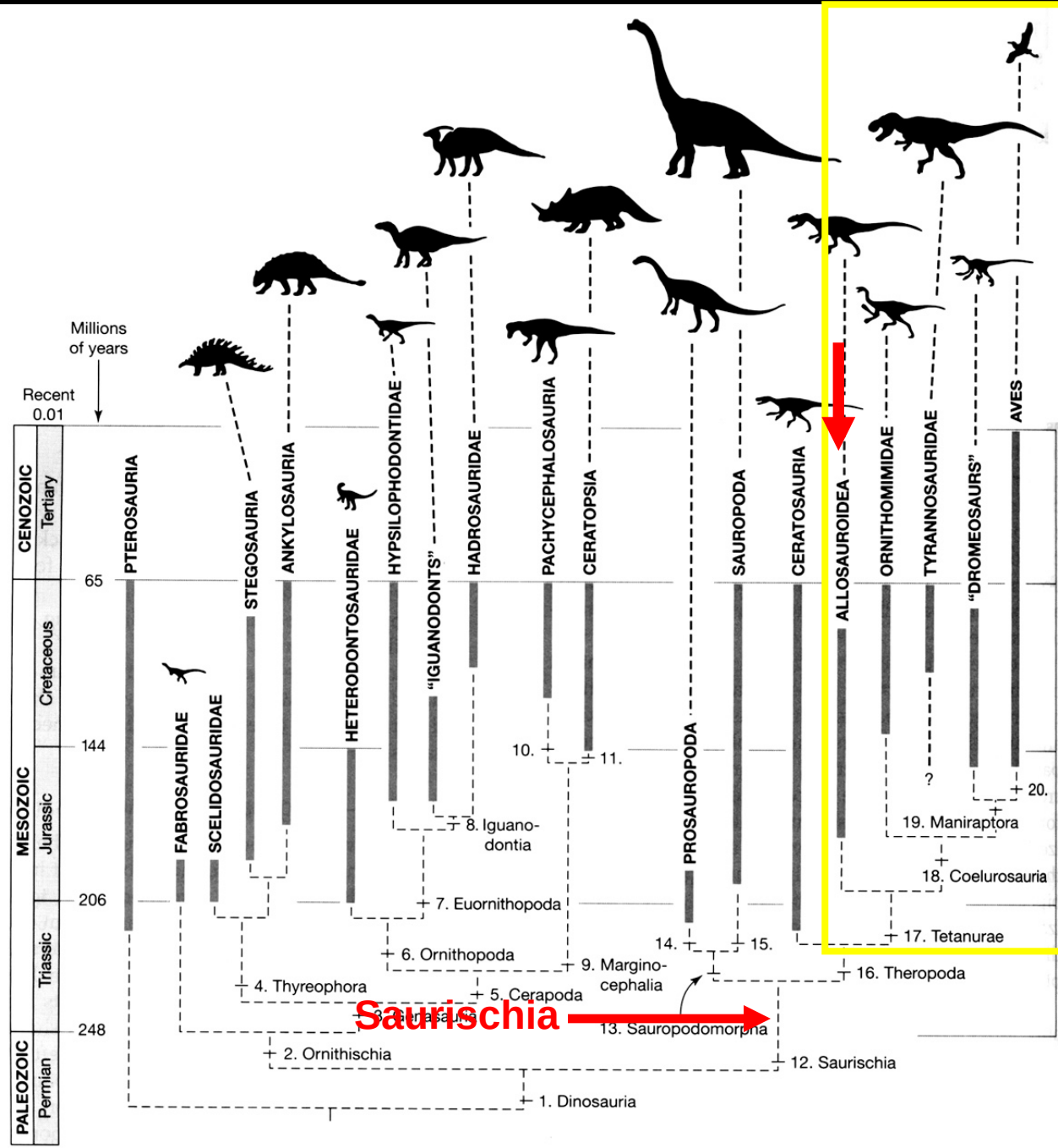
Tetanurae



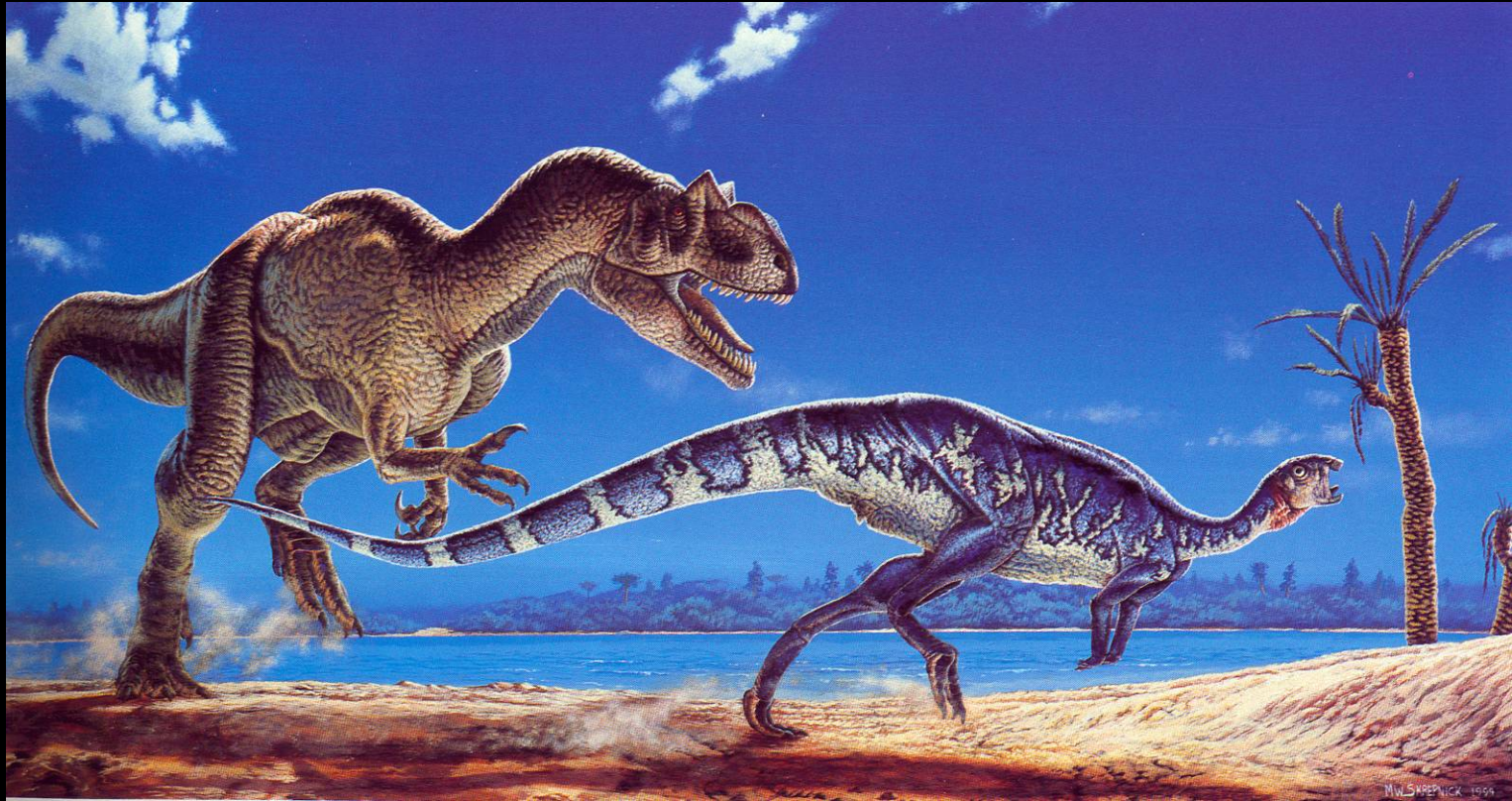
Filogenia dos Ornithodira.

Fontes: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

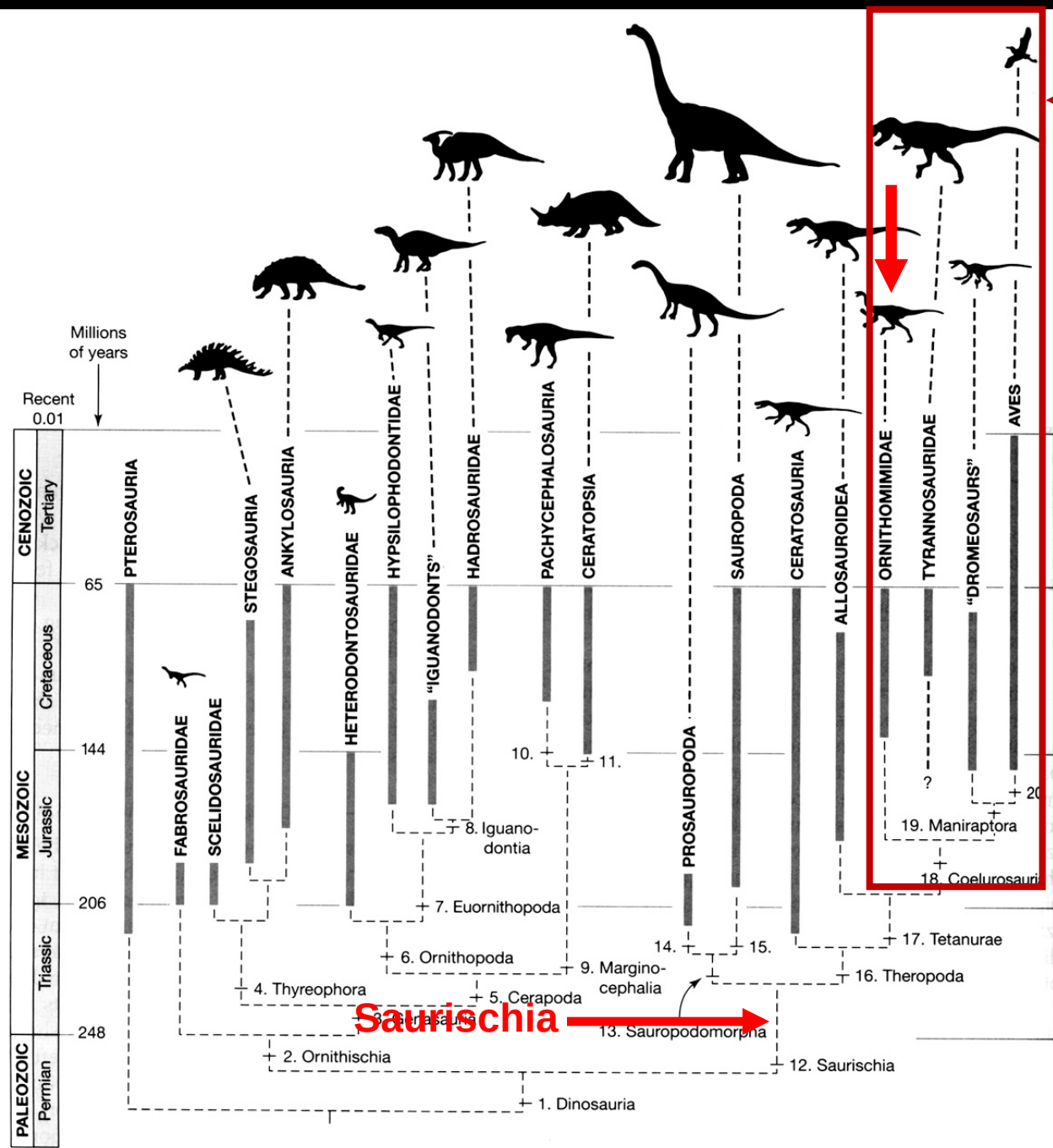
Dingus, L. et al. (1995) *The Halls of Dinosaurs. A Guide to Saurischians and Ornithischians*. New York, American Museum of Natural History.



DINOSAURIA: SAURISCHIA: THEROPODA: Morfologia e Diversidade



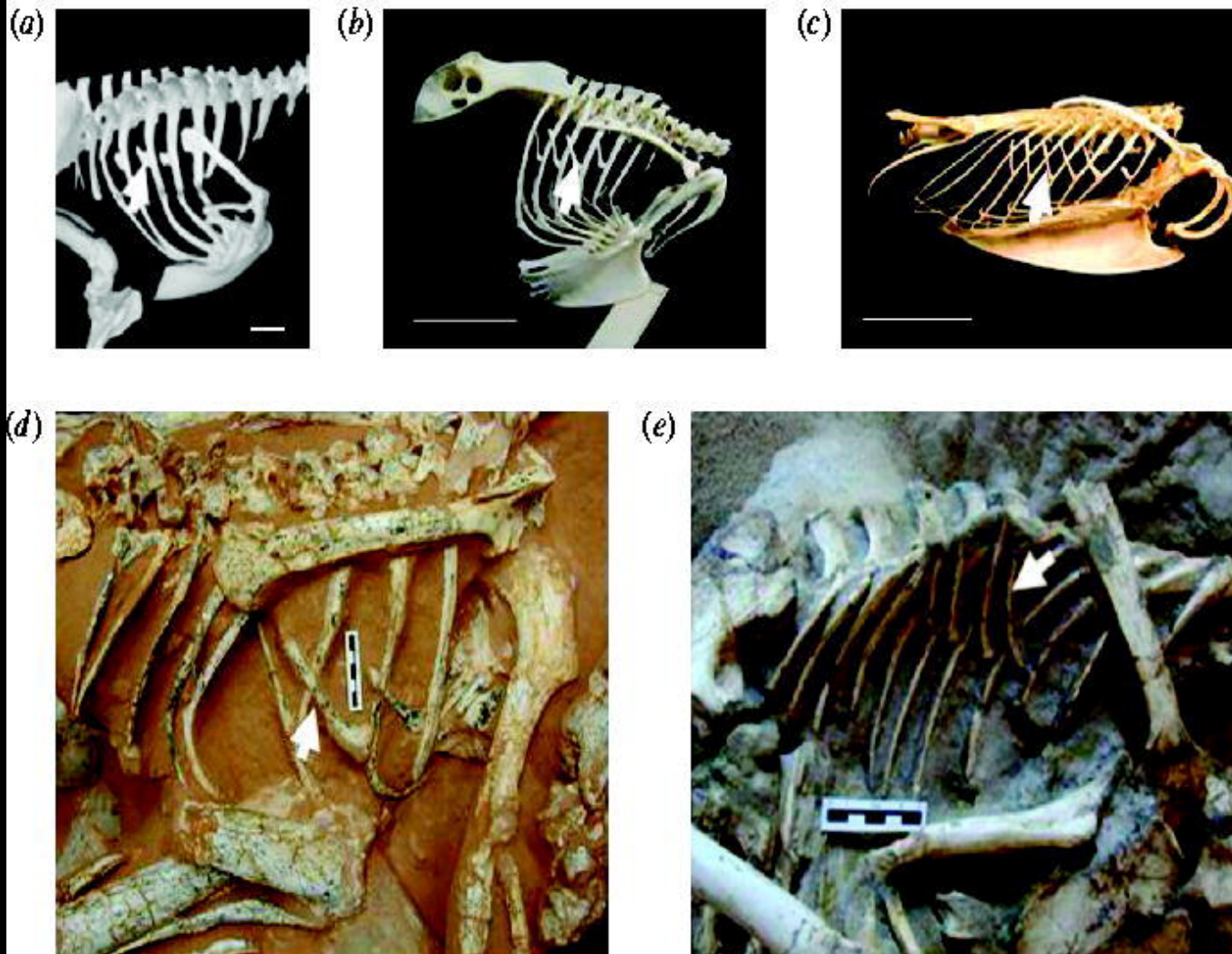
***Allosaurus fragilis* (Allosauridae). EUA, Jurássico Superior.**



Filogenia dos Ornithodira.

Fontes: Pough et al. (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

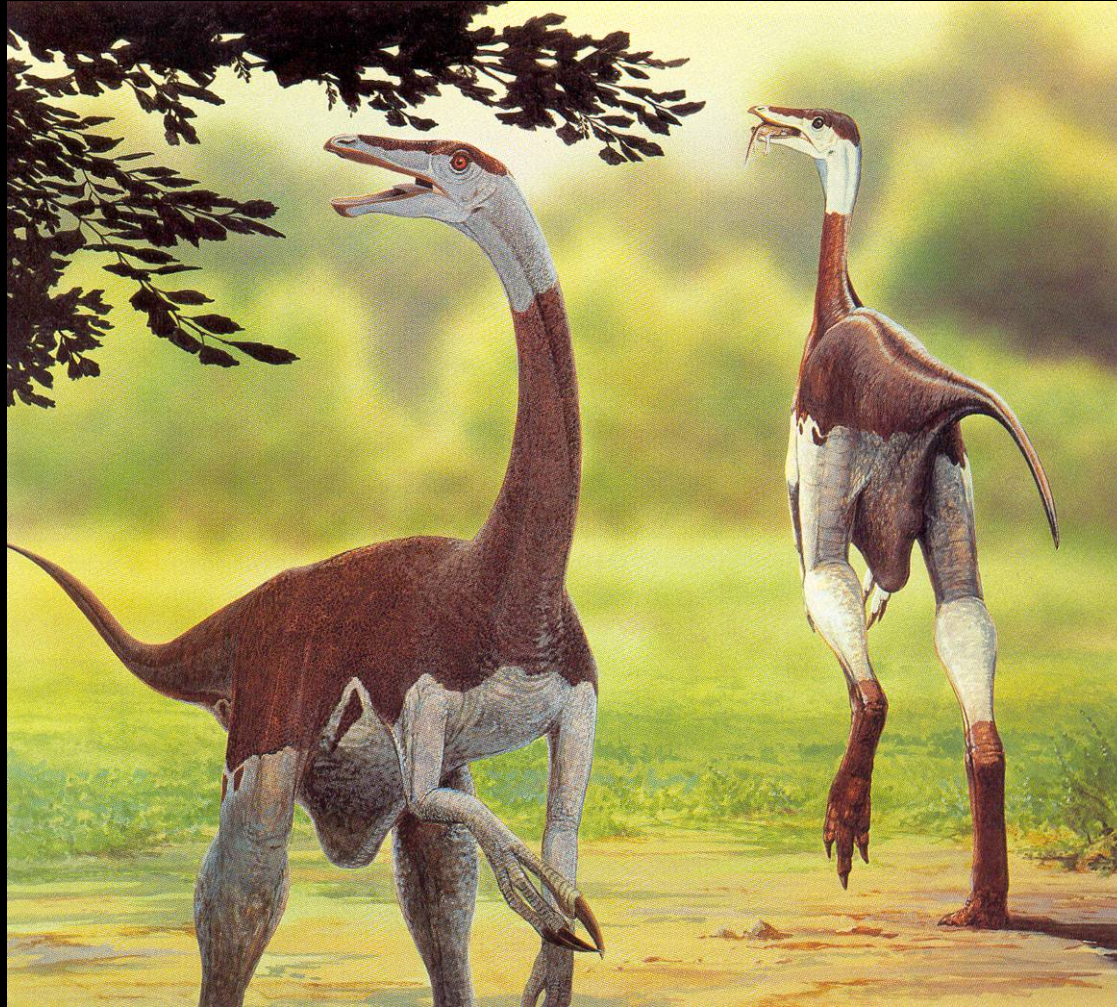
Dingus, L. et al. (1995) *The Halls of Dinosaurs. A Guide to Saurischians and Ornithischians*. New York, American Museum of Natural History.



Processo uncinado em Coelurosauria – Dromeosauridae seriam Aves?

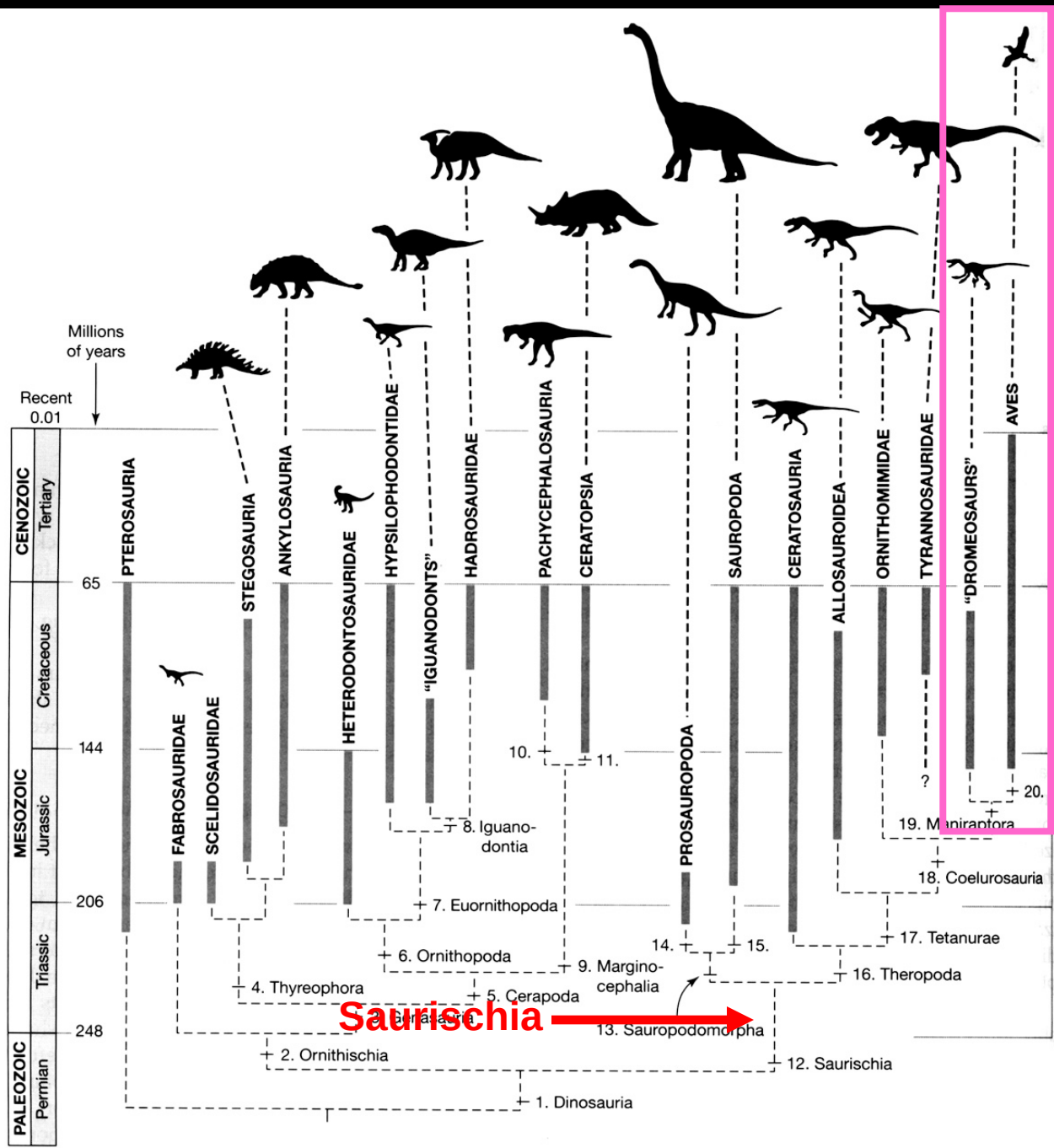
(a) Uma ave corredora, o casuar (*Casuaris casuaris*), (b) uma ave voadora, o mocho-real (*Bubo bubo*), (c) uma ave mergulhadora, a alca (*Alca torda*); estudos indicam que os processo uncinados são curtos nas corredoras, longos nas mergulhadoras e de tamanho intermediário nas demais aves, (d) *Oviraptor philoceratops*, (e) *Velociraptor mongoliensis*. Escala=5 cm

DINOSAURIA: SAURISCHIA: THEROPODA: Morfologia e Diversidade

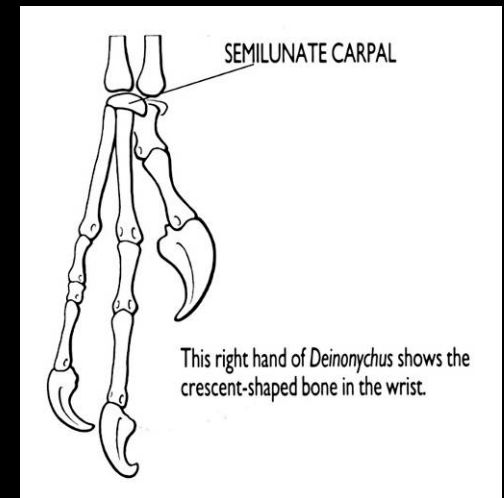


***Ornithomimus* (Ornithomimidae) – Coelurosauria – braços longos e fúrcula**

Fonte: Currie, P. J., & K. Padian (Ed.). (1997) *Encyclopedia of Dinosaurs*. San Diego, Academic Press.



Maniraptora

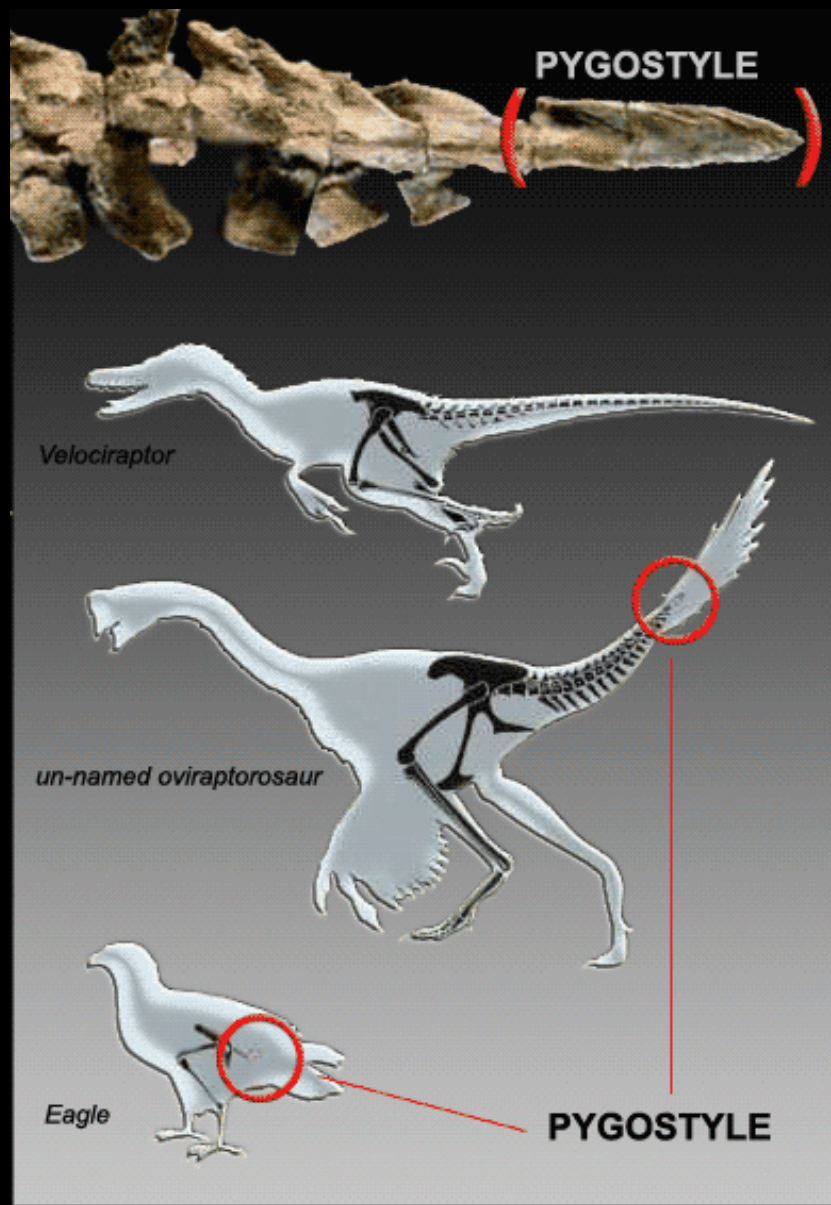


Filogenia dos Ornithodira.

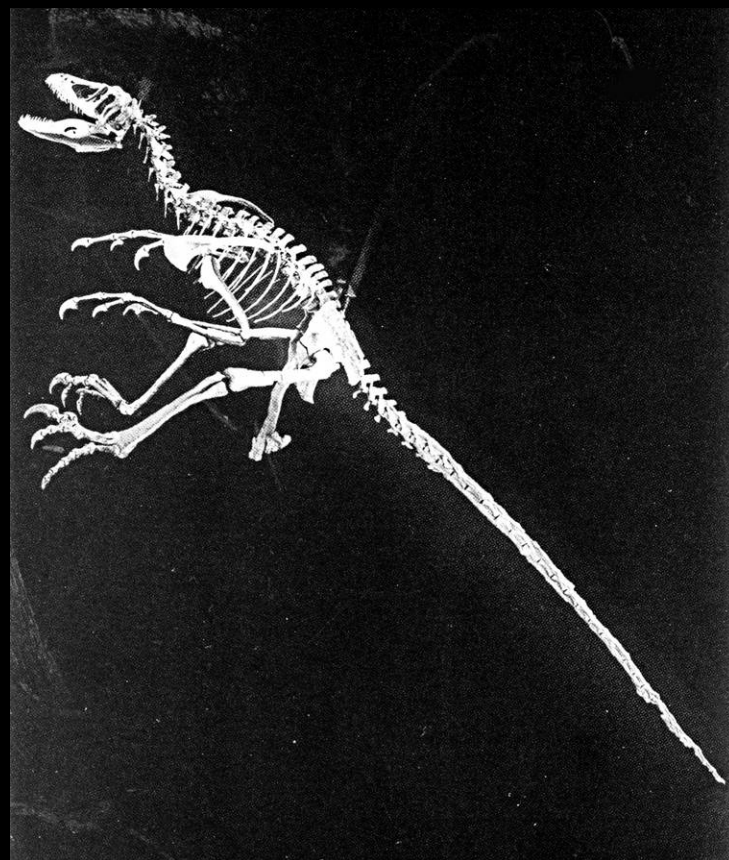
- carpal semilunado;
- púbis voltado para trás;
- 1º. dedo do pé (hálux) voltado para trás;
- pigóstilo?

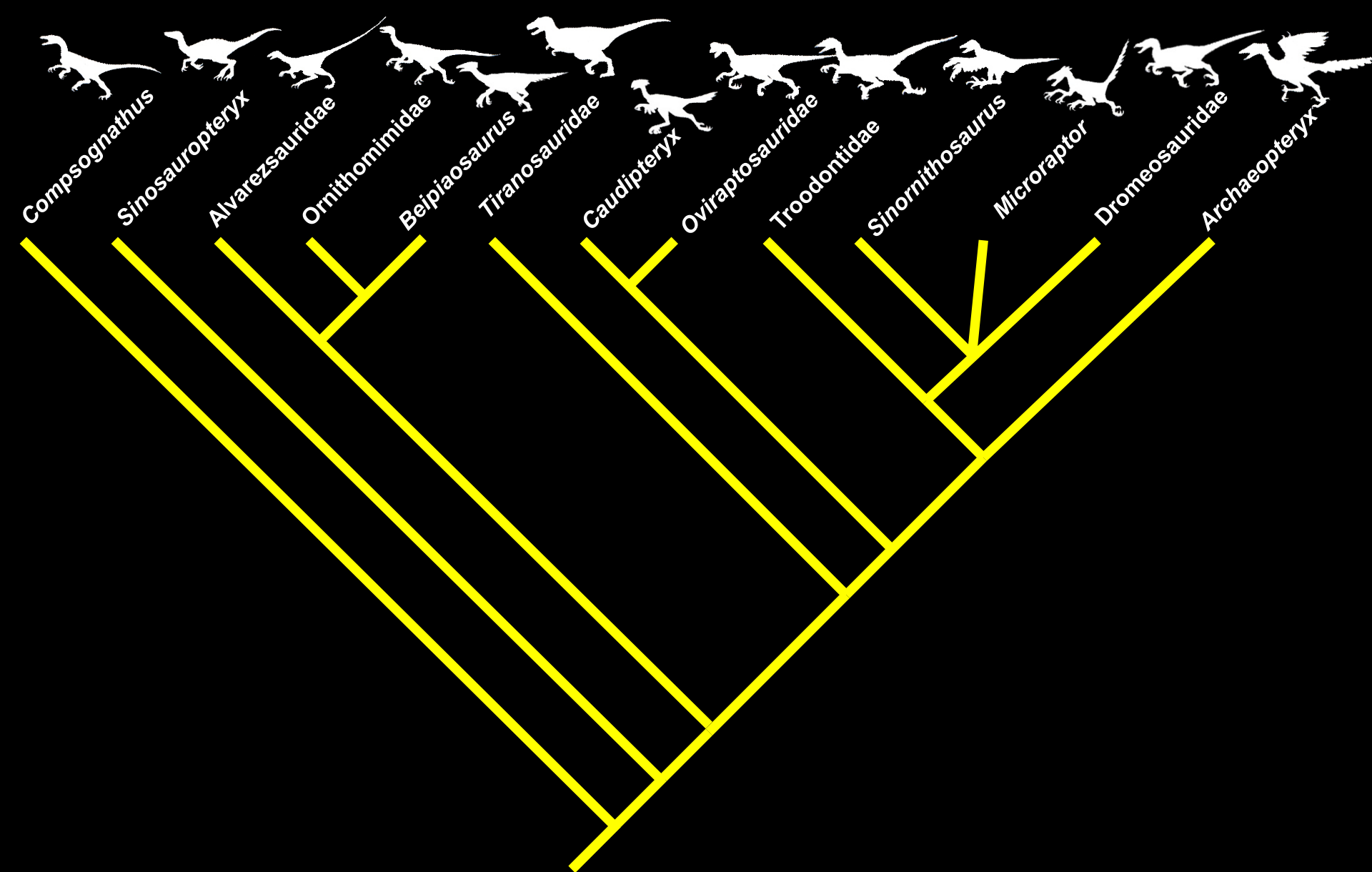
Fontes: Pough *et al.* (2002) *Vertebrate Life*. 6 Ed. New Jersey, Prentice Hall.

Dingus, L. *et al.* (1995) *The Halls of Dinosaurs. A Guide to Saurischians and Ornithischians*. New York, American Museum of Natural History.



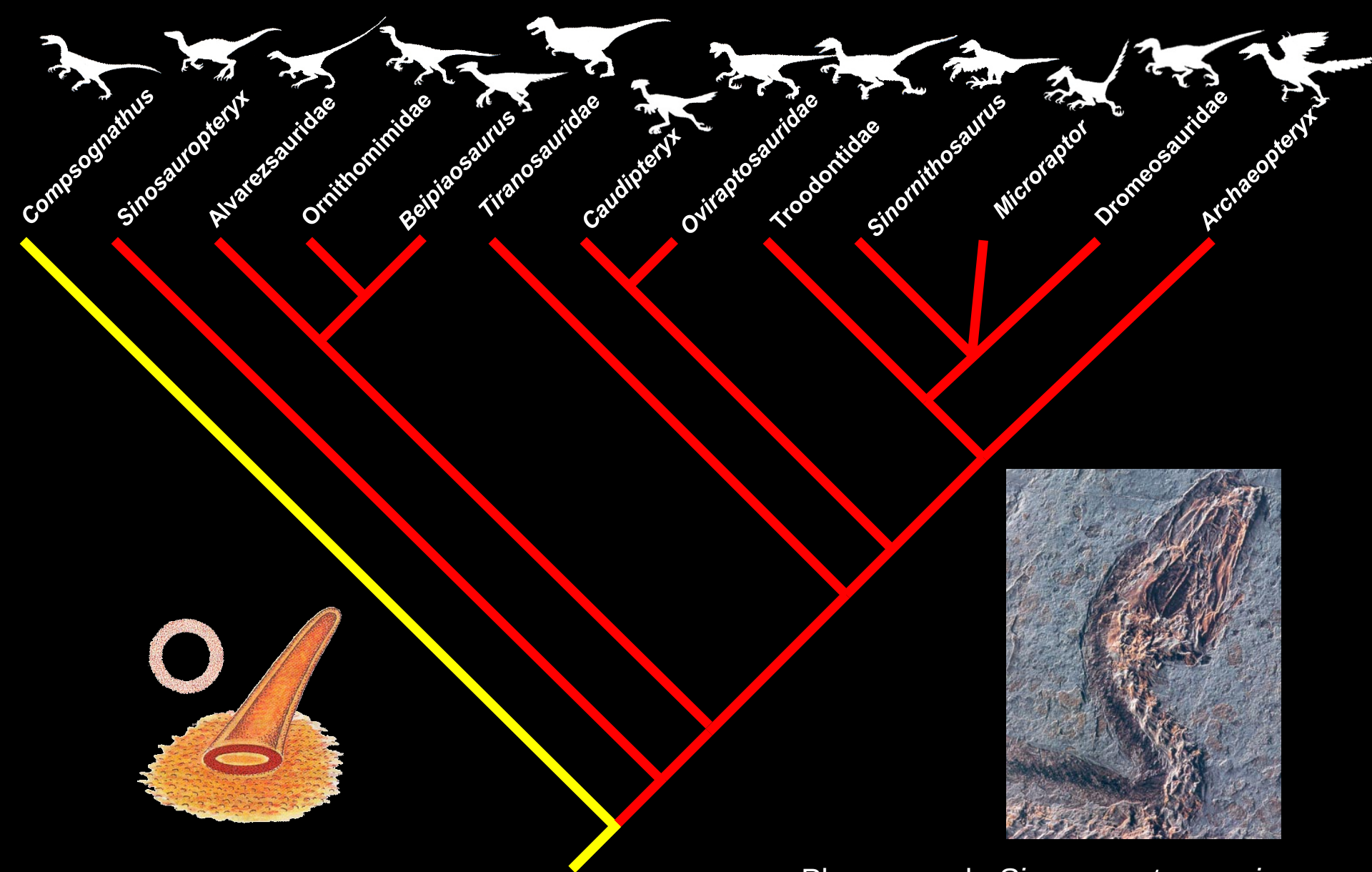
Precursor do pigóstilo em Maniraptora – Dromeosauridae seriam Aves?





Filogenia dos Coelurosauria – Evolução das Penas

Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.



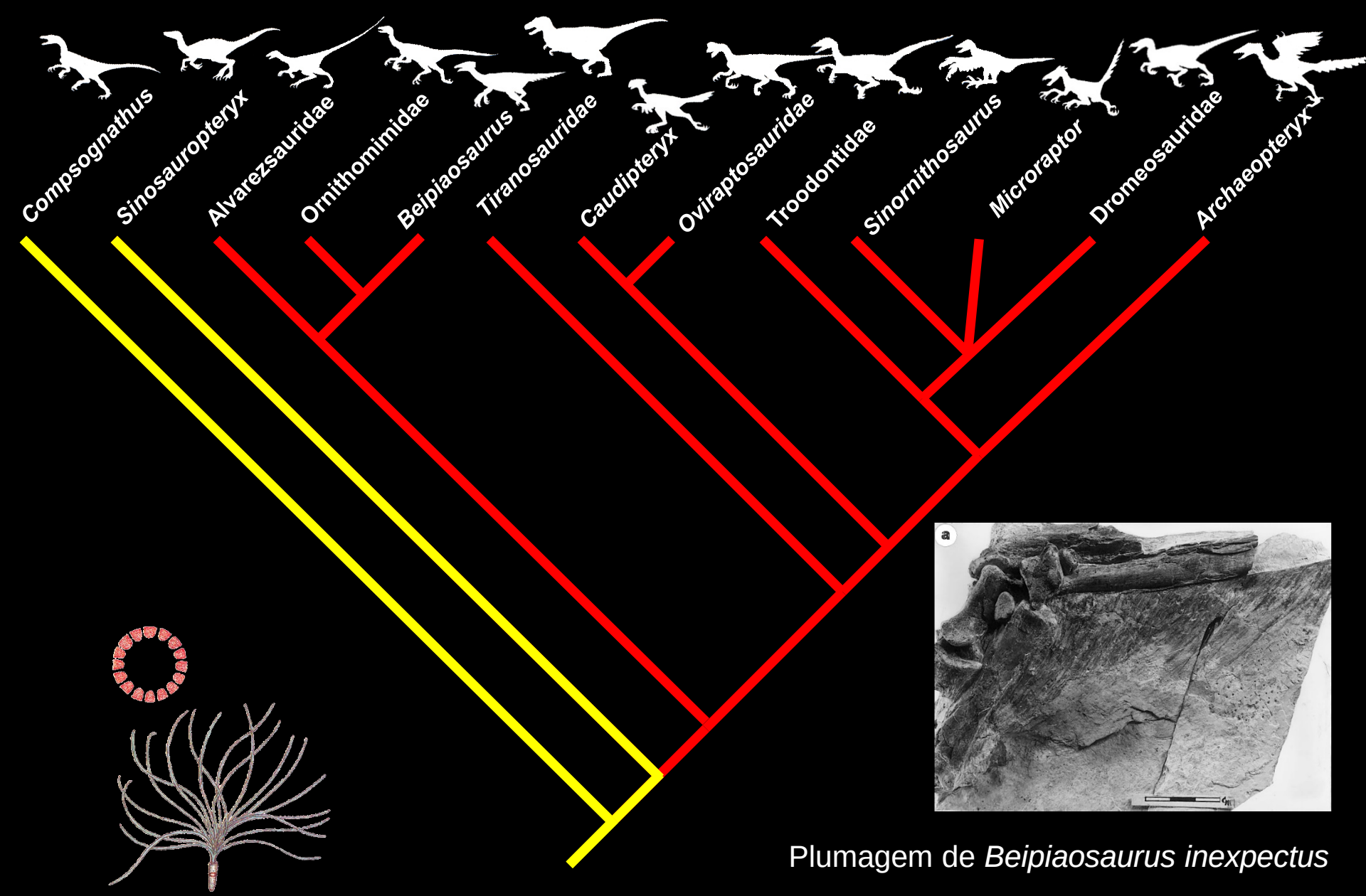
Plumagem de *Sinosauroptryx prima*

Filogenia dos Coelurosauria – Evolução das Penas

Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.

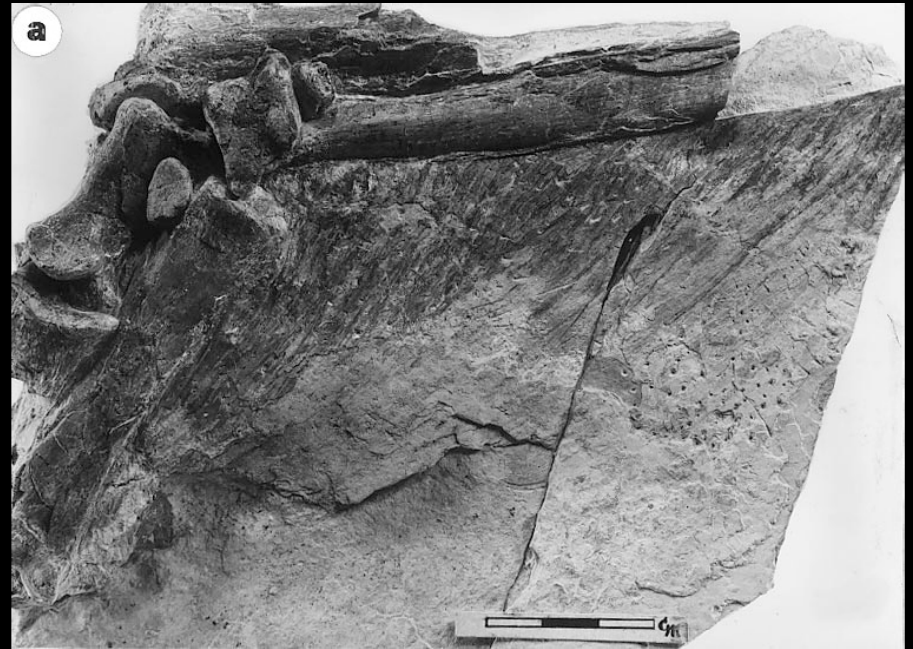
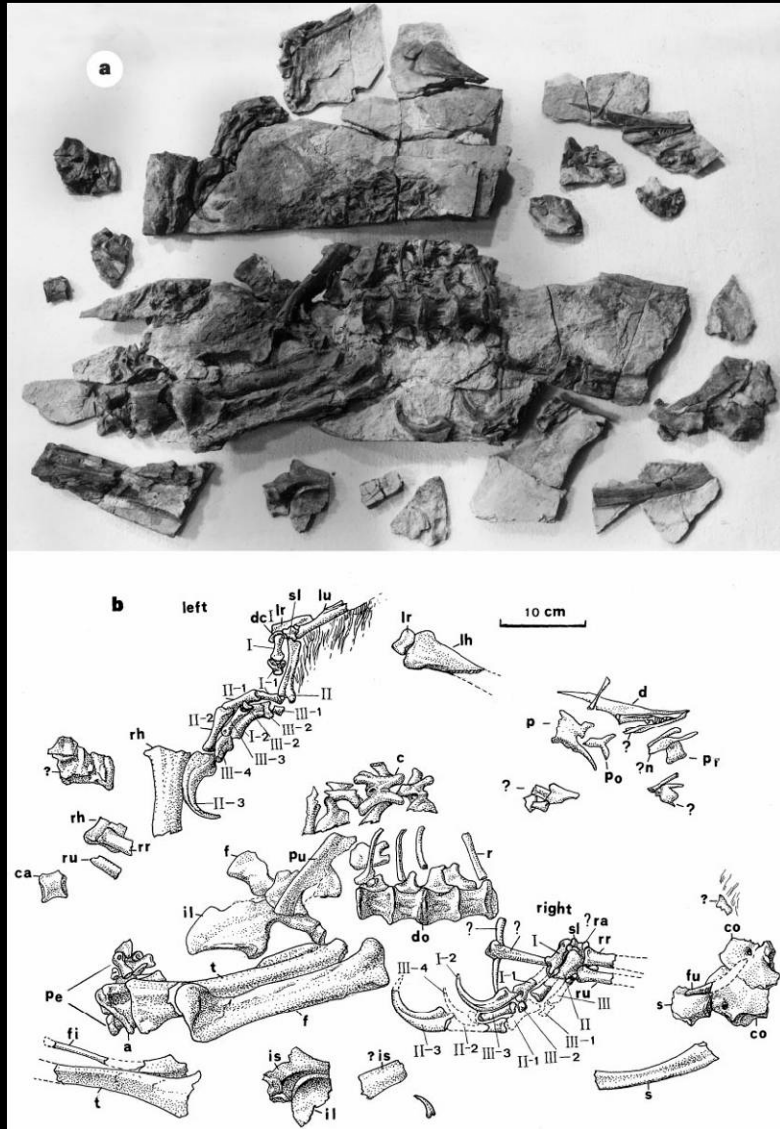


Sinosauropteryx prima, China, Província Liaoning, Cretáceo Inferior: reconstrução e holótipo, mostrando plumagem.



Filogenia dos Coelurosauria – Evolução das Penas

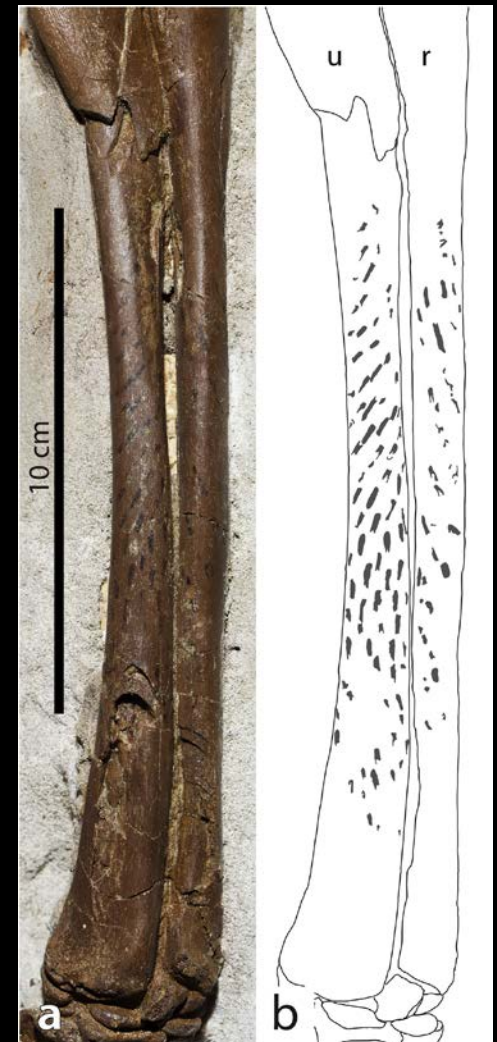
Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.



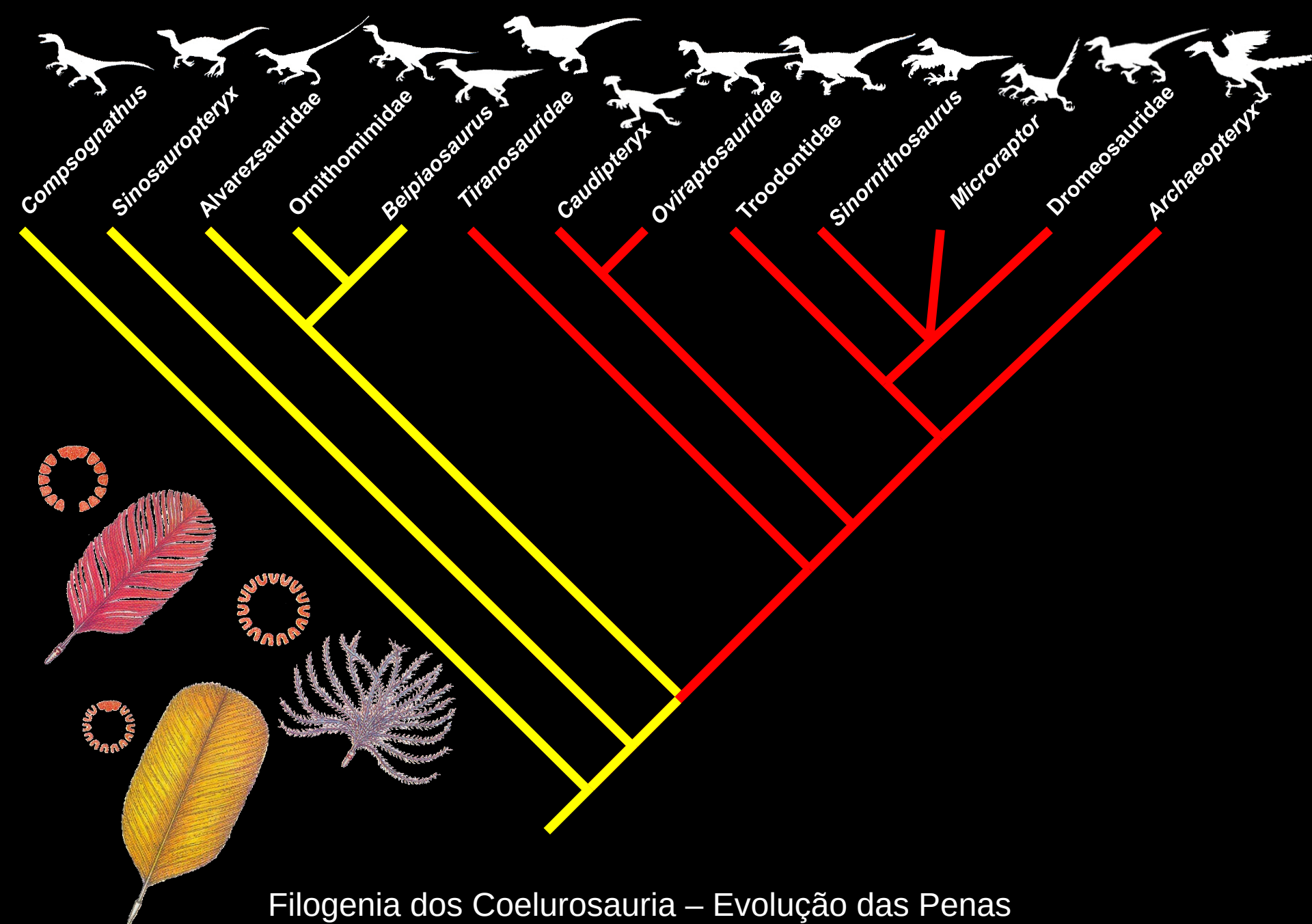
Beipiaosaurus inexpectus (Therizinosauroida), China, Província Liaoning, Cretáceo Inferior e detalhe do antebraço, mostrando plumagem.

Fonte: Xu et al. (1999) A therizinosauroid dinosaur with integumentary structures from China. *Nature*, 399:350-354.

Rádio e ulna de *Ornithomimus* (Ornithomimidae),
mostrando marcas de penas.

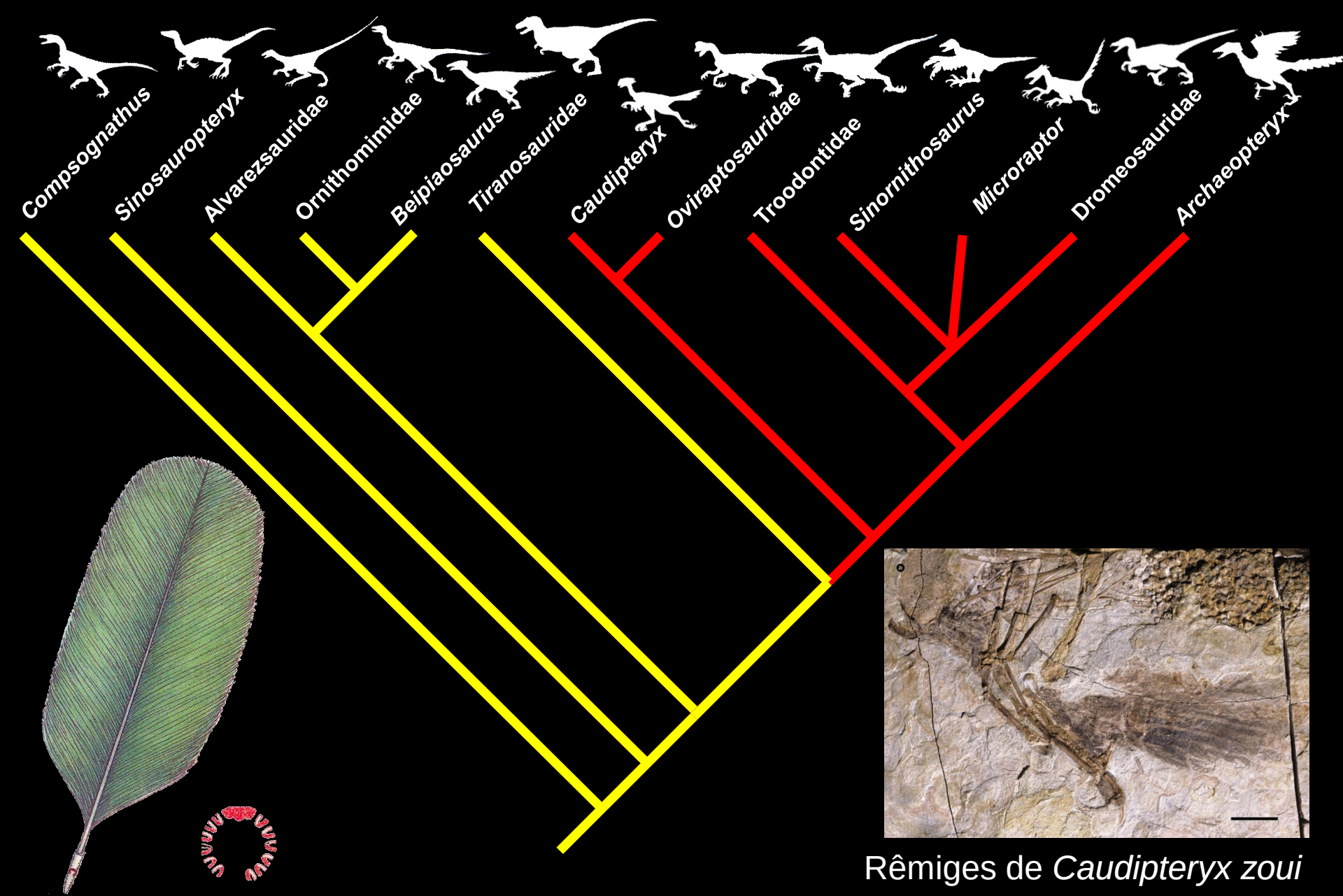


Ornithomimus (Ornithomimidae), Canadá, Alberta, Cretáceo Superior.



Filogenia dos Coelurosauria – Evolução das Penas

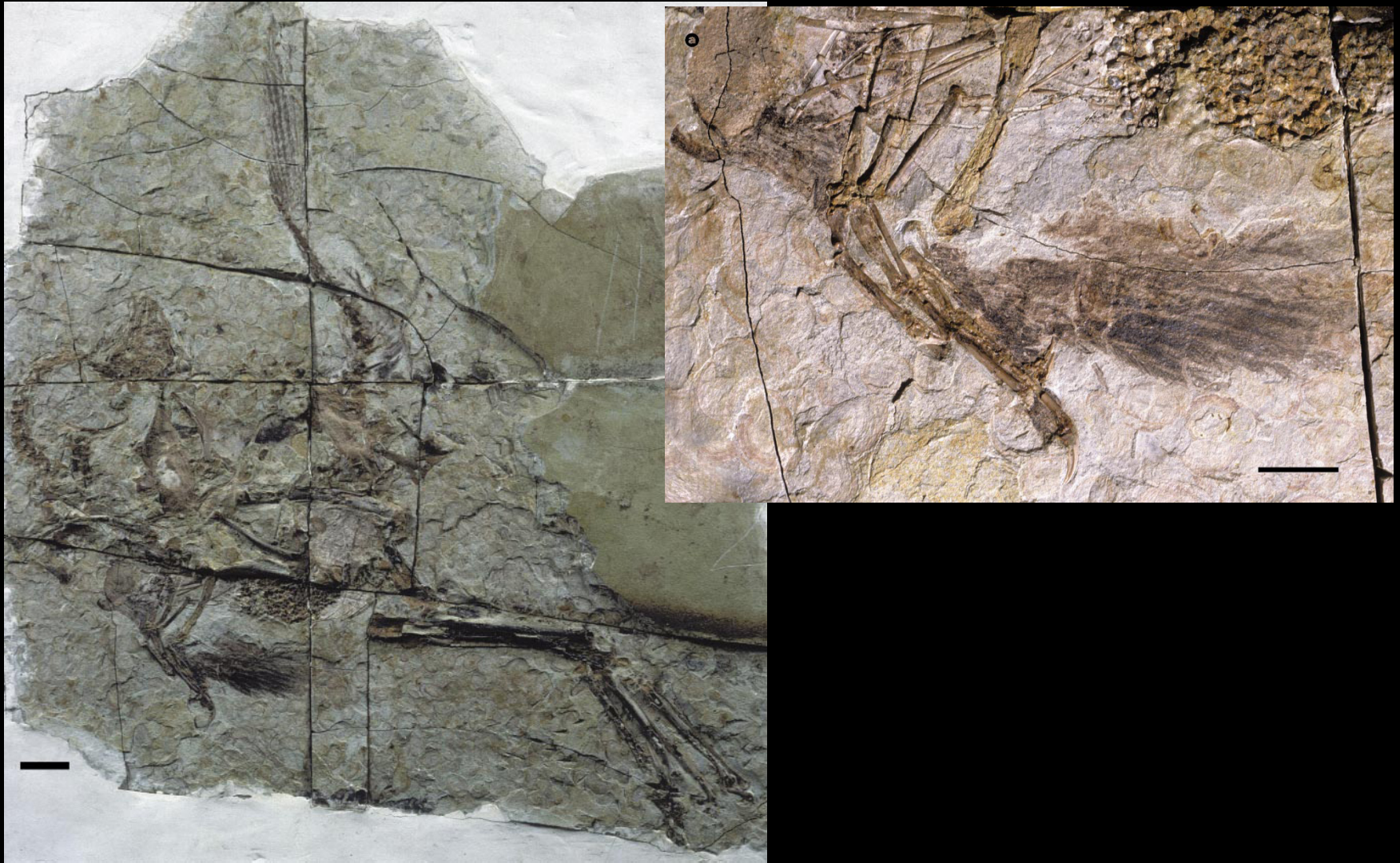
Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.



Rêmiges de *Caudipteryx zoui*

Filogenia dos Coelurosauria – Evolução das Penas

Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.



Caudipteryx zoui, China, Província Liaoning, Jurássico Sup.-Cretáceo Inf., holótipo, e detalhe do braço esquerdo, mostrando as rêmiges.



Microraptor gui, China, Província de Liaoning, Cretáceo Inferior, holótipo, e detalhes do braço e perna, mostrando as rêmiges.

Fonte: Xu *et al.* (2003) Four-winged dinosaurs from China. *Nature*, 421:335-340.



Microraptor gui, China, Província de Liaoning, Cretáceo Inferior, reconstrução e detalhes do braço e perna, mostrando as rêmiges.



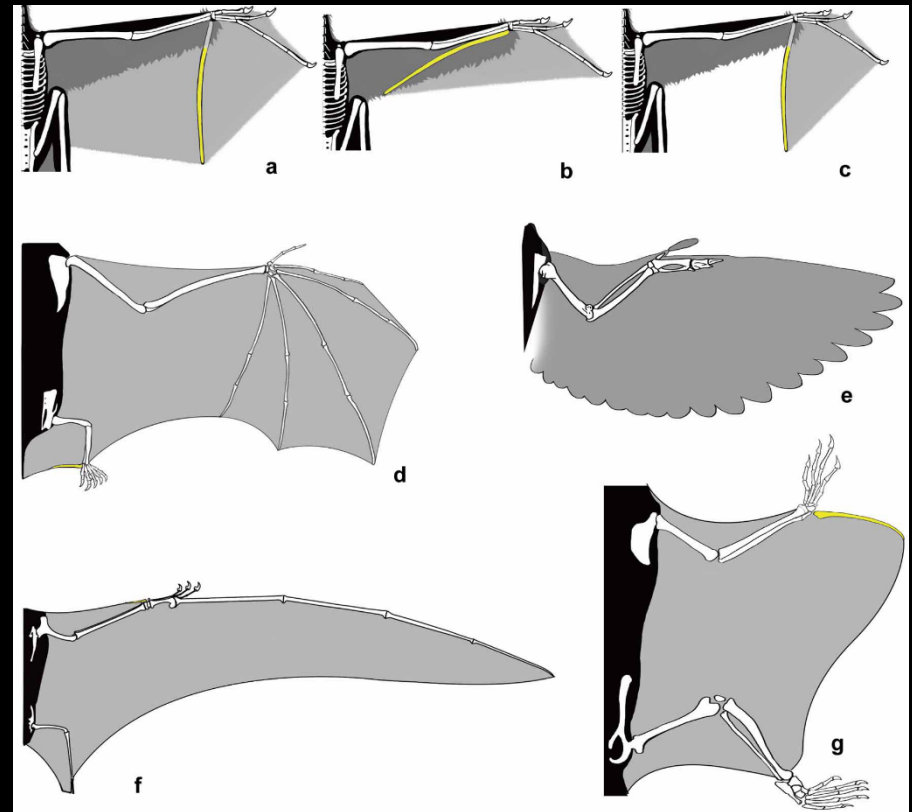
Cryptovolans pauli (possível sinônimo de *Microraptor gui*), China, Jiufotang, Cretáceo Inferior, reconstrução.

Fonte: Czerkas, S.A. et al. (2002) Flying dromeosaurs. Pp. 16-26. In: Czerkas, S.A. *Feathered Dinosaurs and the Origin of Flight: The Dinosaur Museum Journal 1*. Blanding, The Dinosaur Museum.



Deinonychus, reconstrução com penas.

Fonte: Czerkas, S.A. et al. (2002) Flying dromeosaurs. Pp. 16-26. In: Czerkas, S.A. *Feathered Dinosaurs and the Origin of Flight: The Dinosaur Museum Journal 1*. Blanding, The Dinosaur Museum.



Fonte: Xu, S.A *et al.* (2015) A bizarre Jurassic maniraptoran theropod with preserved evidence of membranous wings. *Nature*,

A new Jurassic scansoriopterygid and the loss of membranous wings in theropod dinosaurs

Min Wang^{1,2*}, Jingmai K. O'Connor^{1,2}, Xing Xu^{1,2} & Zhonghe Zhou^{1,2}

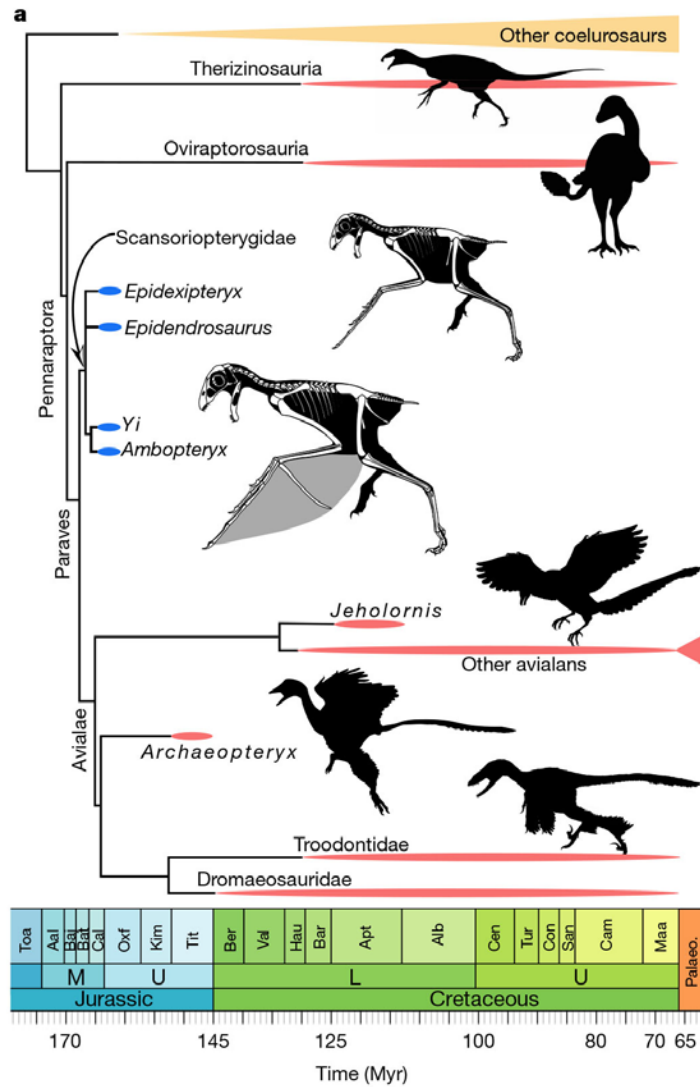
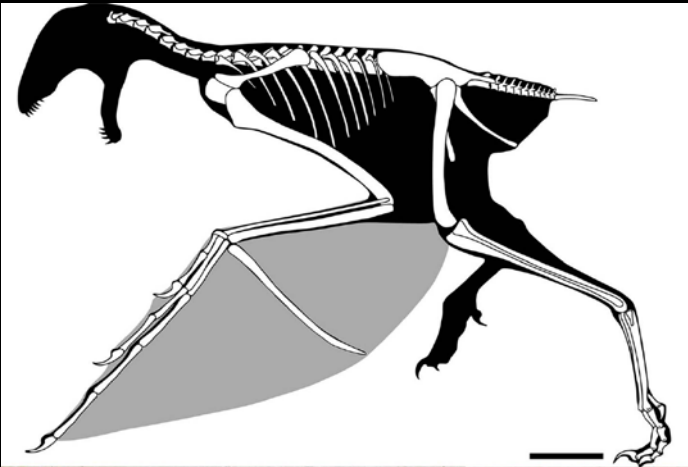
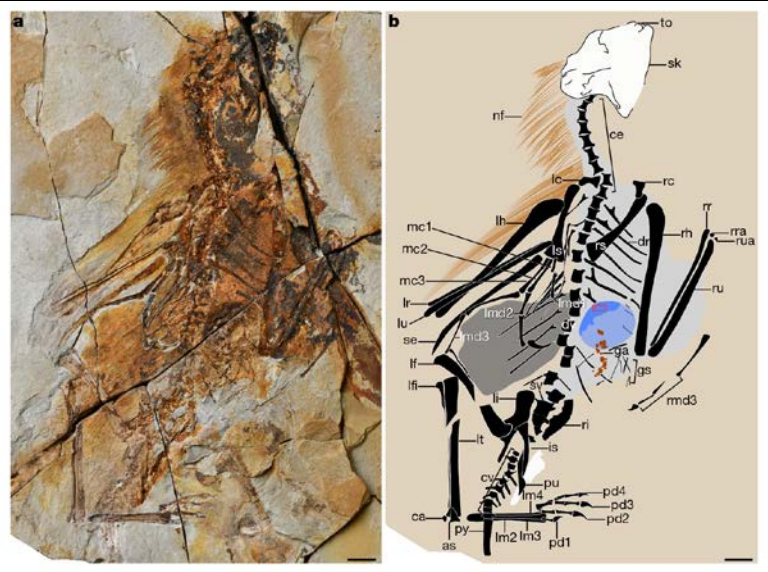
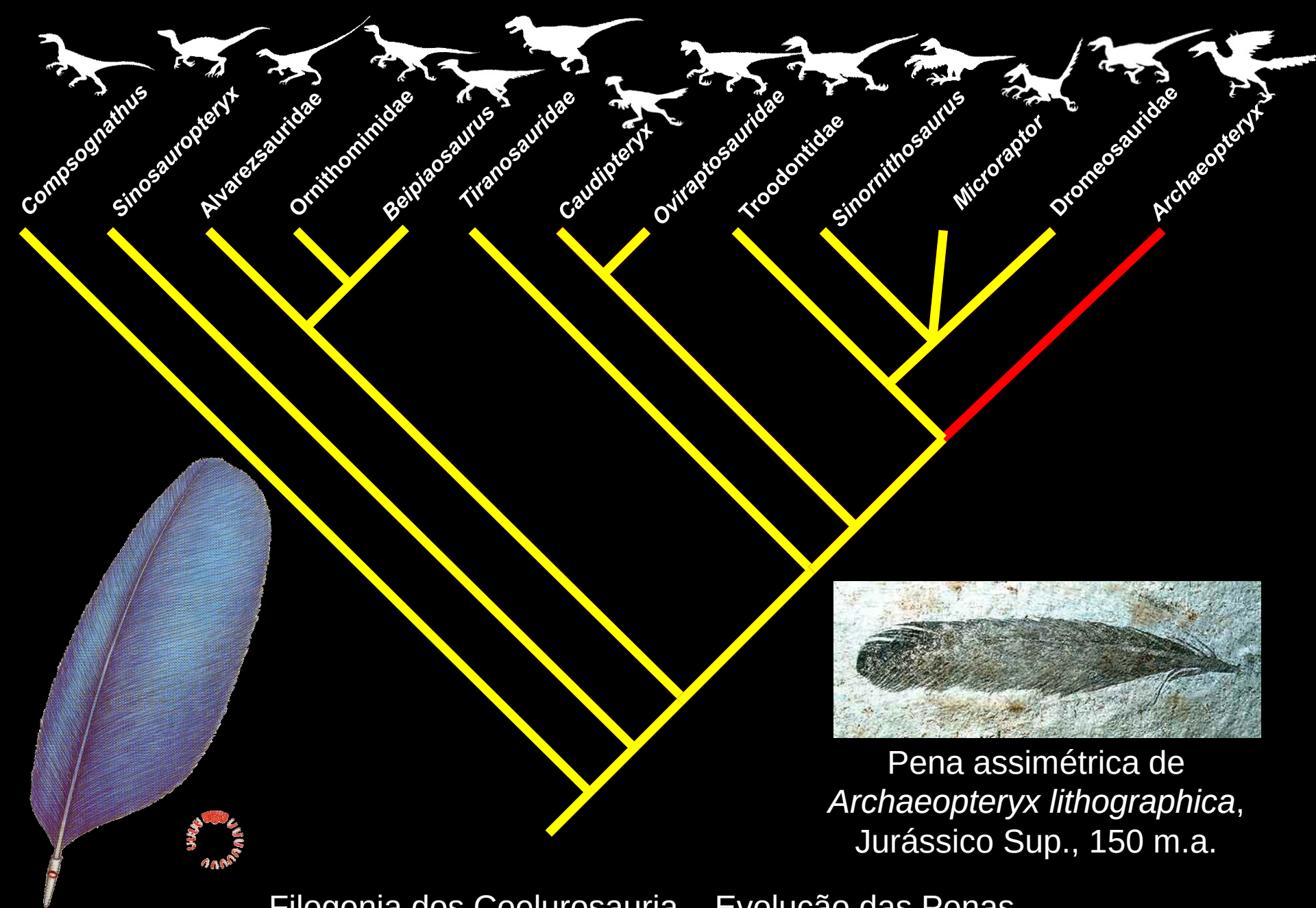


Fig. 3 | Phylogeny and phylomorphospace of Mesozoic coelurosaurs. **a**, Simplified phylogeny showing the position of *Ambopteryx* (see Extended Data Fig. 7 for complete results, and full names for age and stage abbreviations). Myr, million years. **b**, **c**, Phylomorphospace based on principal component (PC)1 and PC2 (57 taxa) when both fore- and hindlimbs are included (**b**), and on PC1 and PC2 when only the

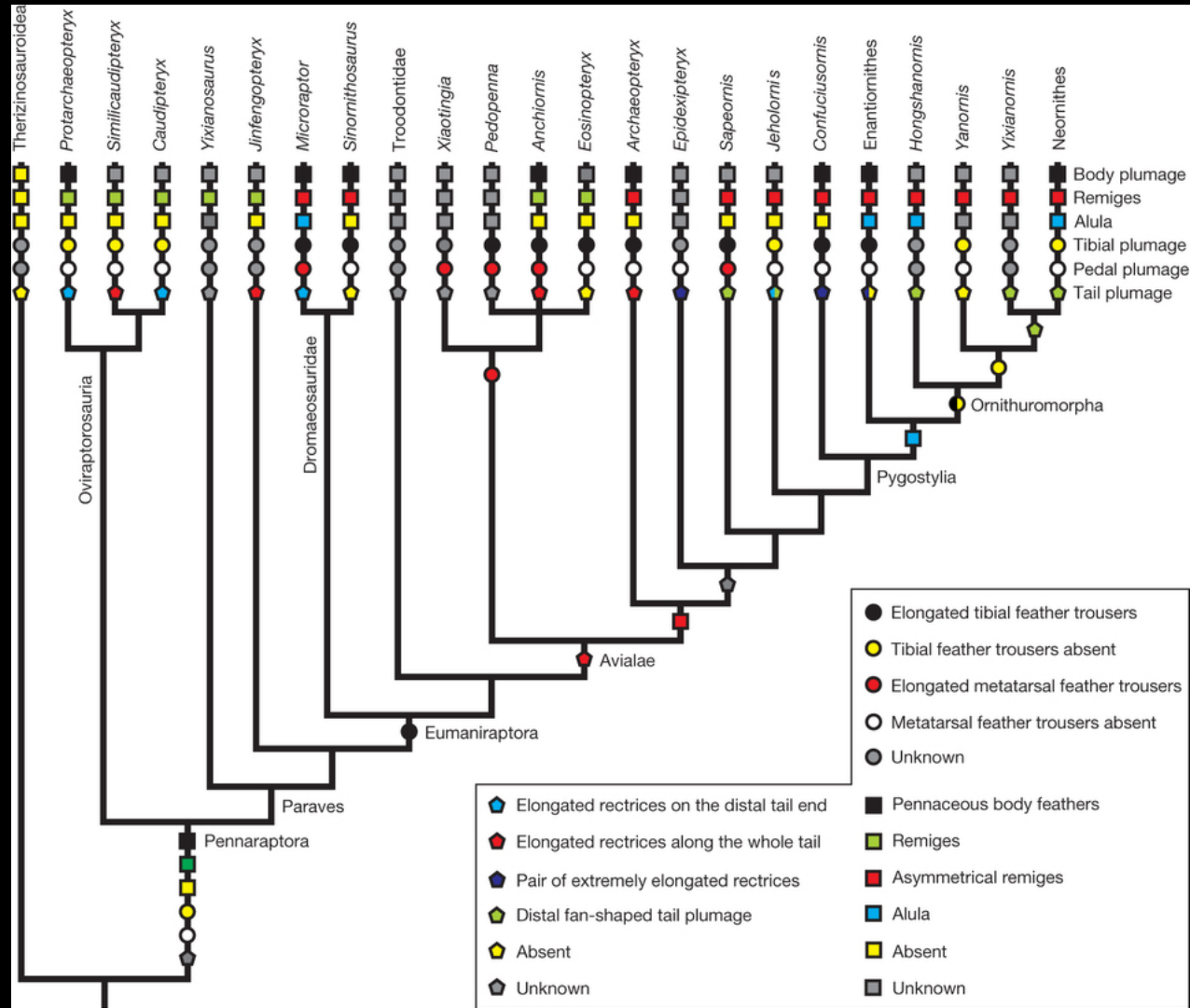


Pena assimétrica de
Archaeopteryx lithographica,
Jurássico Sup., 150 m.a.

Filogenia dos Coelurosauria – Evolução das Penas

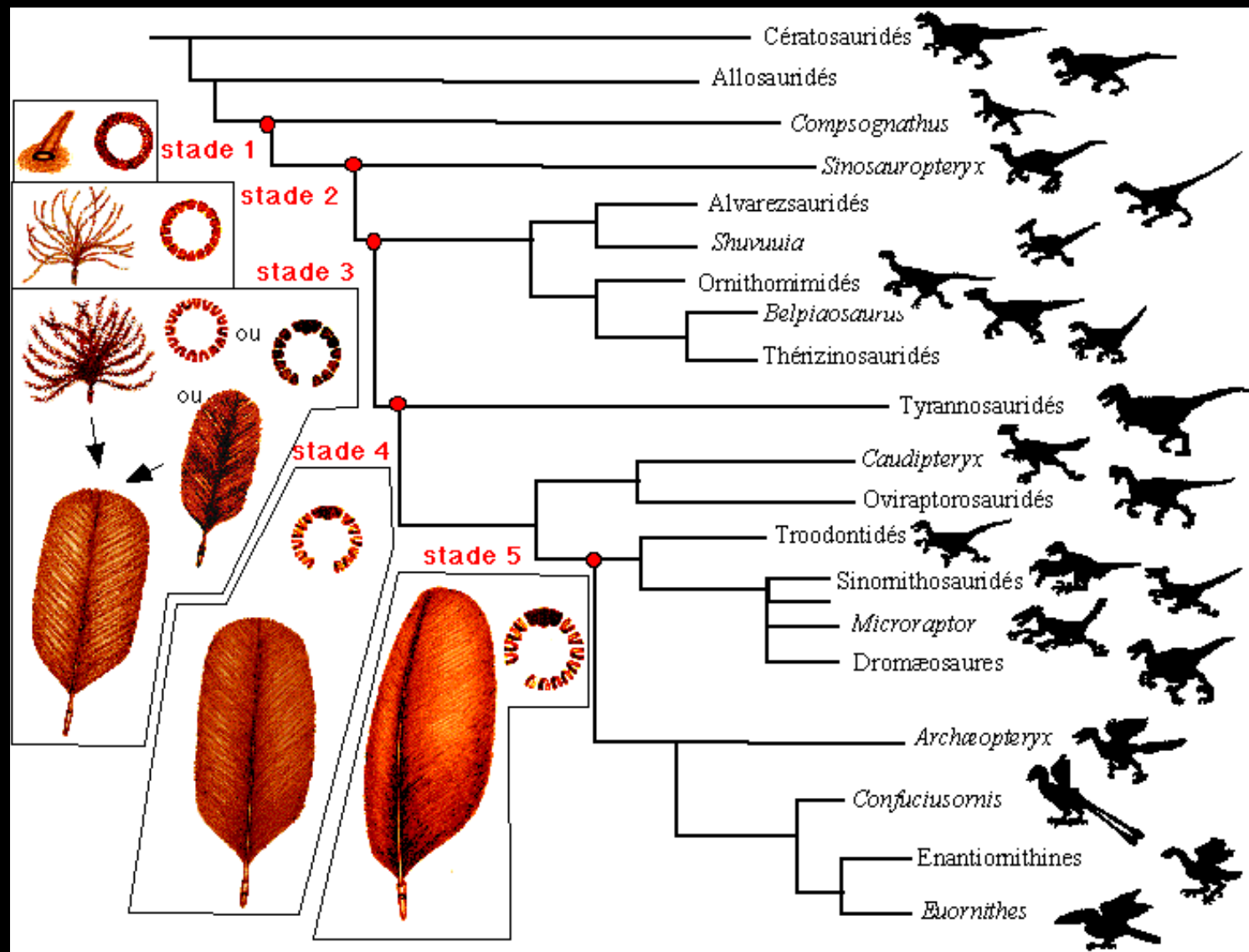
Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.

Evolução das penas penáceas em terópodes maniraptorianos.



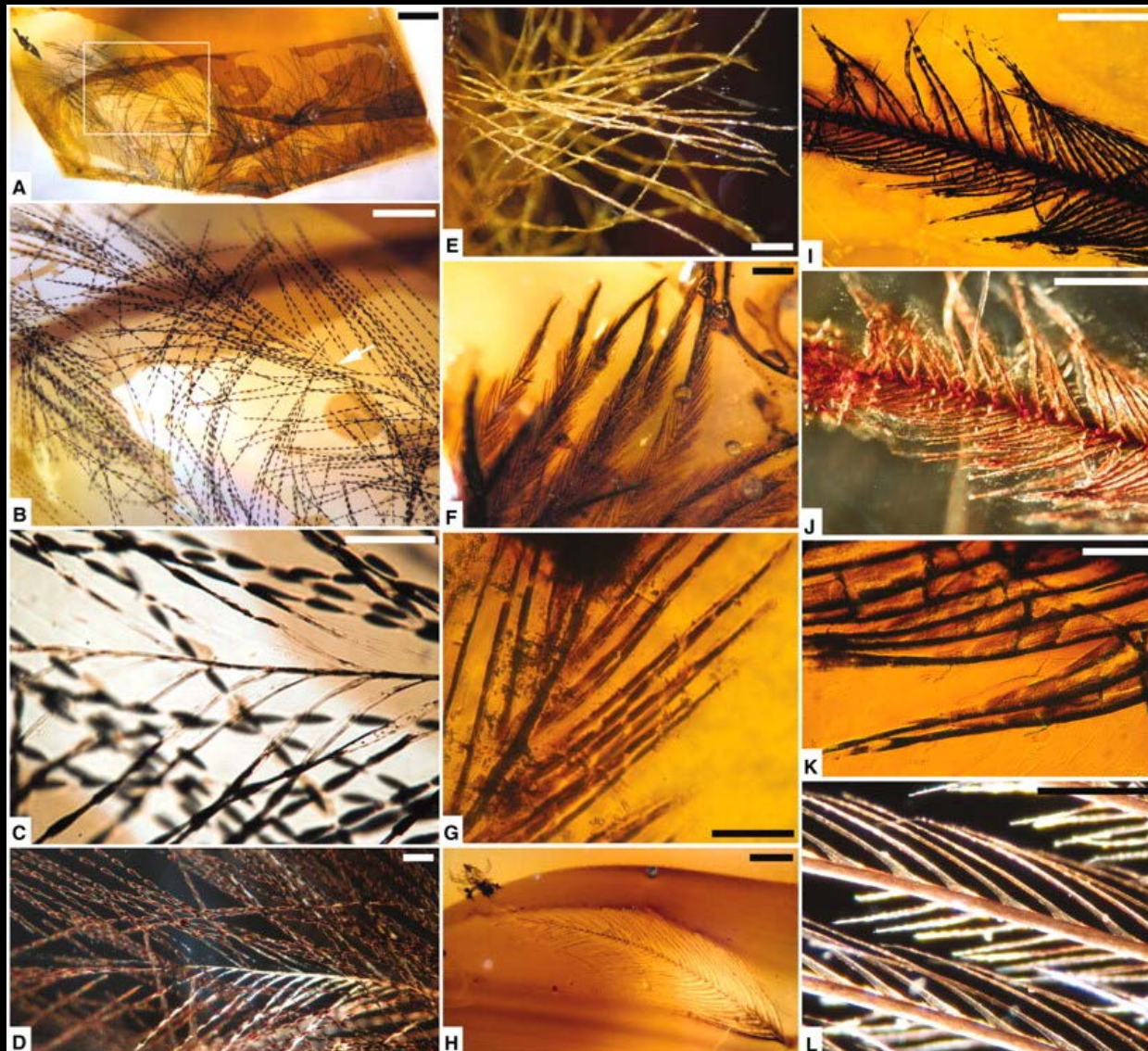
Foth, C., Tischlinger, H. & Rauhut, O. W. M. 2014. New specimen of *Archaeopteryx* provides insights into the evolution of pennaceous feathers. *Nature*, 511: 79-82+suppl.

AVES - Vôo



Evolução da pena em Coelurosauria (Dinosauria: Theropoda) (Prum & Brush, 2004)

Fonte: Prum, R.O. & Brush, A.H. (2004) A controvérsia sobre o que veio primeiro: penas ou pássaros? *Scientific American Brasil*, 5: 64-73.



Pigmentação de penas em âmbar, Canadá, Cretáceo Superior (80 m.a.).

Fonte: McKellar, R.C. *et al.* (2011) *Science*, 333:1619-1622



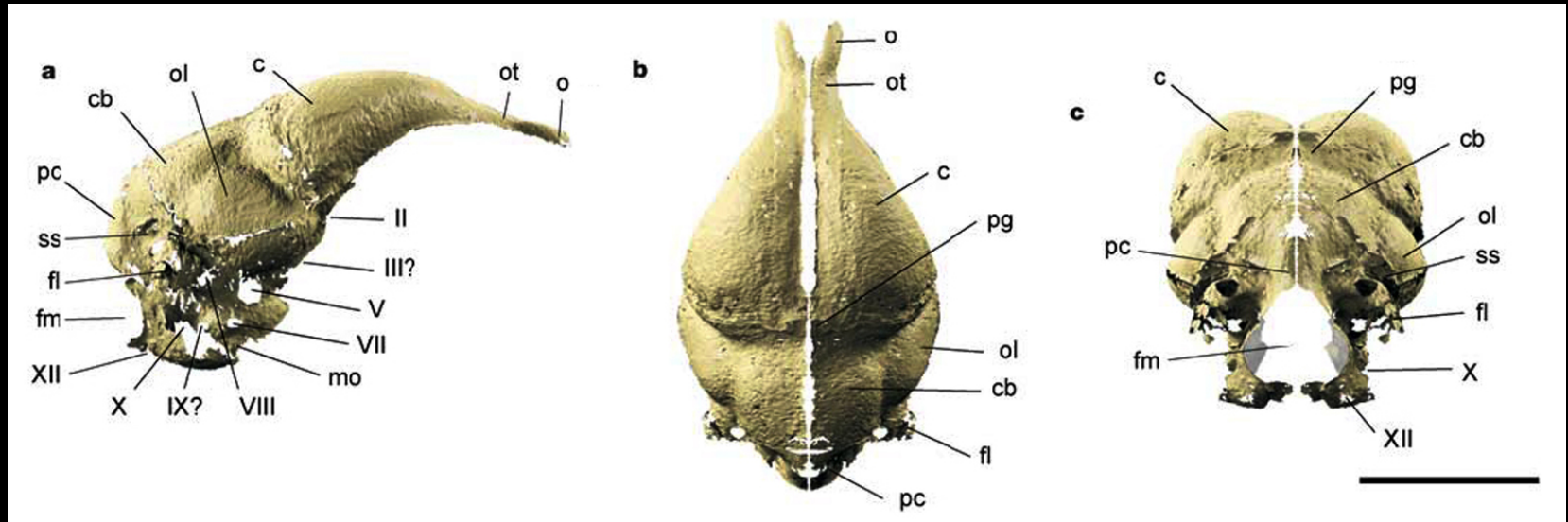
Archaeopteryx lithographica, Alemanha, Solhoffer, Jurássico Superior (150 m.a.): reconstrução e exemplar do Museu de Berlim, mostrando plumagem.



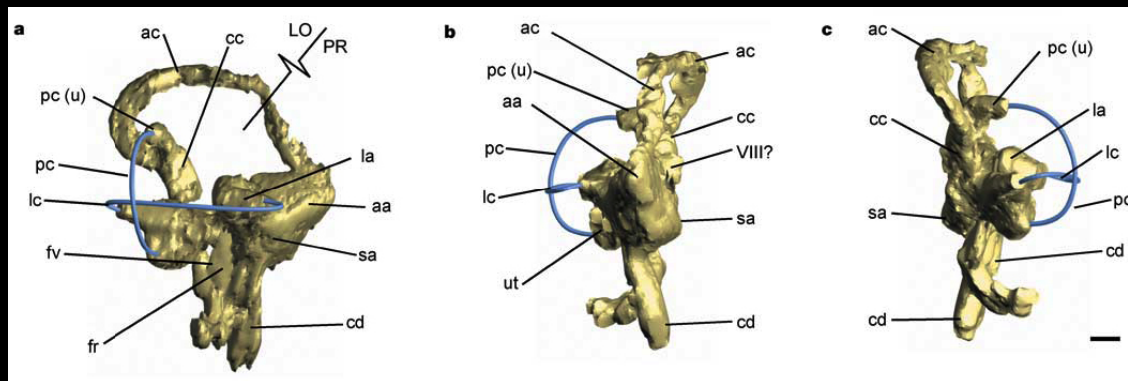
Archaeopteryx lithographica



Image Credit: Todd Marshall

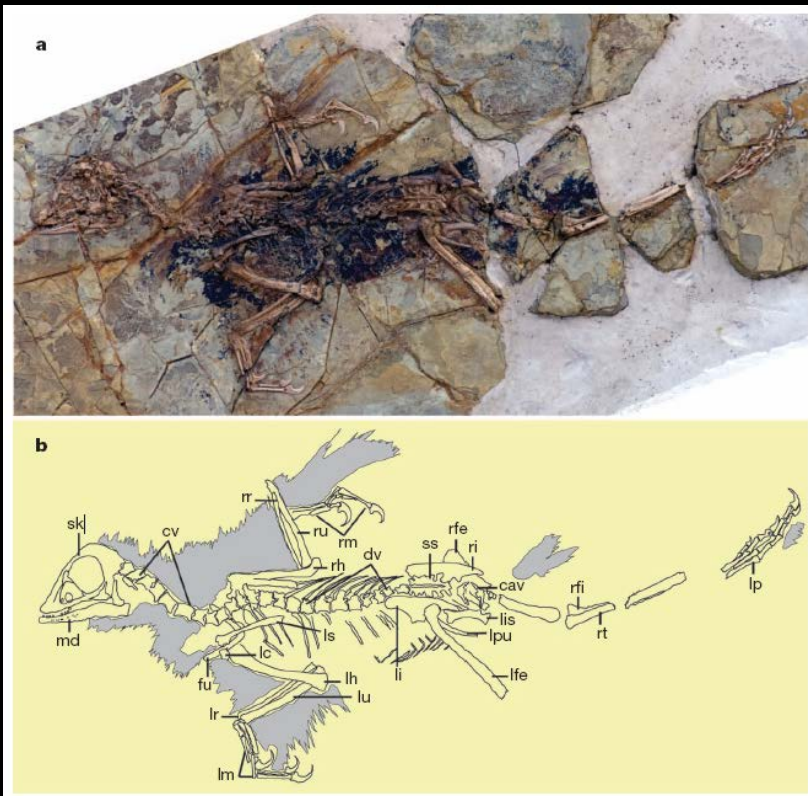


Molde do encéfalo de *Archaeopteryx lithographica*.

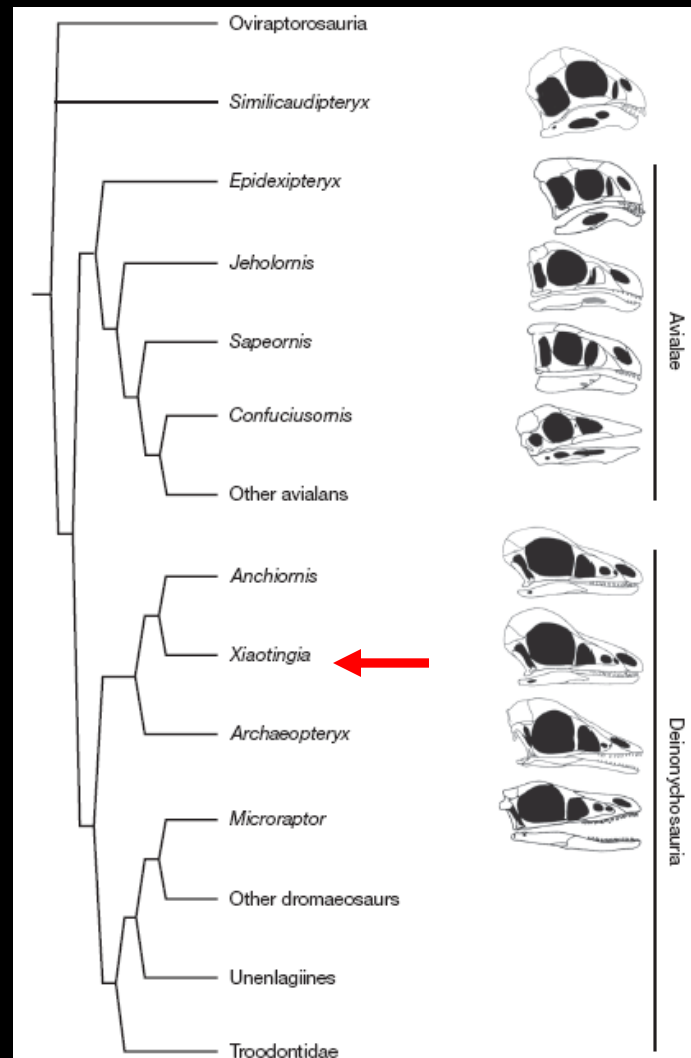


Ouvido interno direito de *Archaeopteryx lithographica*.

***Archaeopteryx* como Deinonychosauria?**



Xiaotingia zhengi, China, Jurássico Superior
(160 m.a.) (Xu *et al.*, 2011)



Filogenia de Coelurosauria, indicando posição de *Xiaotingia* (Xu *et al.*, 2011)

Fonte: Xu *et al.* (2011) An *Archaeopteryx*-like theropod from China and the origin of Avialae. *Nature*, 475:465-470.

Article

Hummingbird-sized dinosaur from the Cretaceous period of Myanmar

<https://doi.org/10.1038/s41586-020-2068-4> Lida Xing^{1,2,3}, Jingmai K. O'Connor^{3,4,5,6,7}, Lars Schmitz^{5,6,11}, Luis M. Chiappe⁵, Ryan C. McKellar^{1,8}, Qiru Yi⁹ & Gang Li^{10,11}

Received: 12 September 2019
Accepted: 22 January 2020
Published online: 11 March 2020

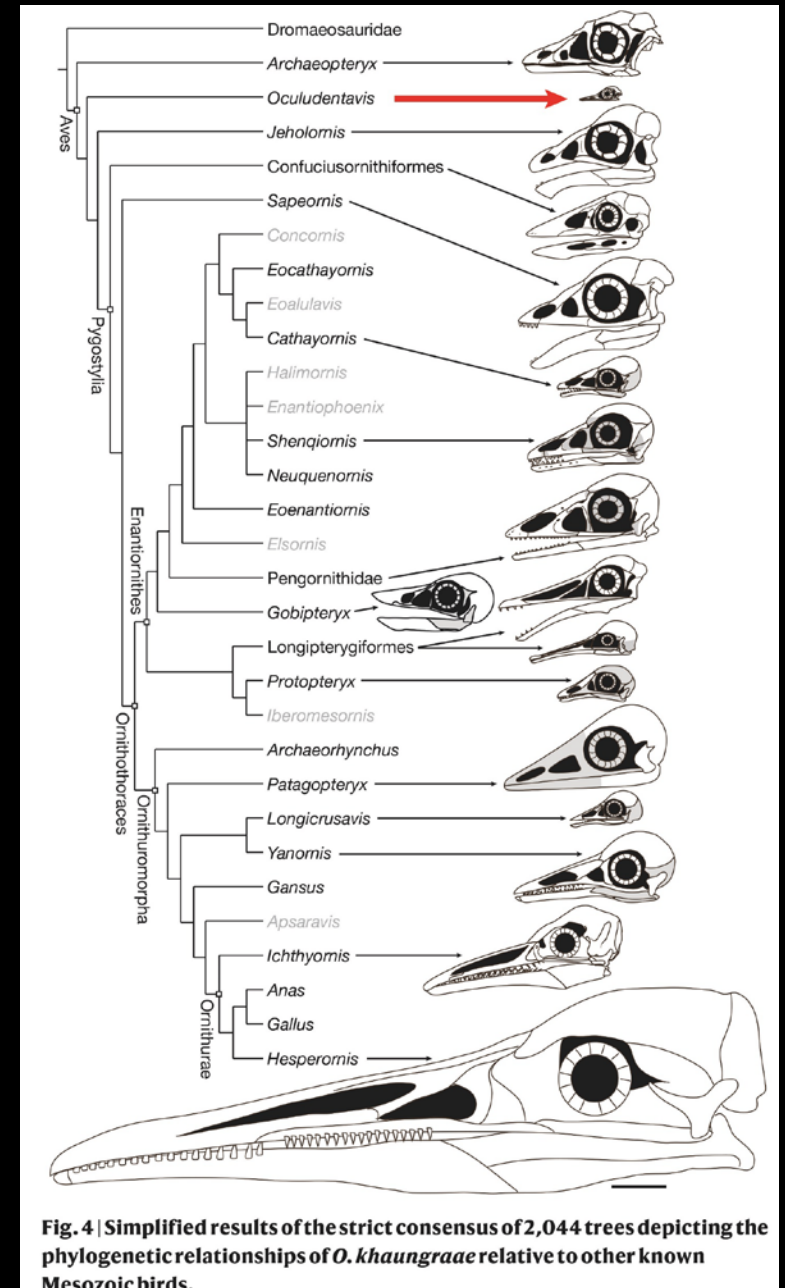
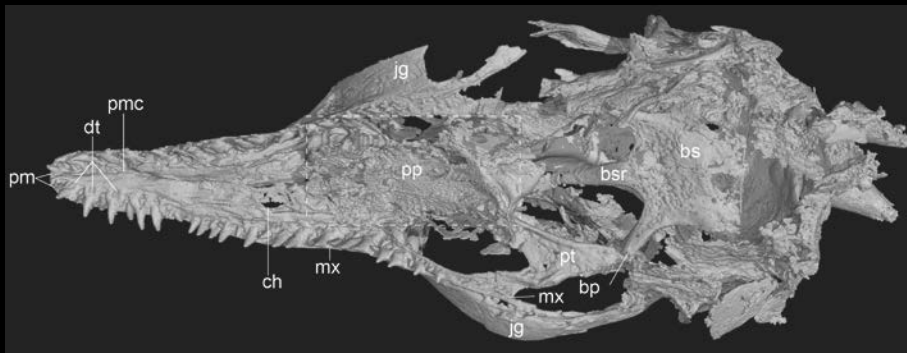
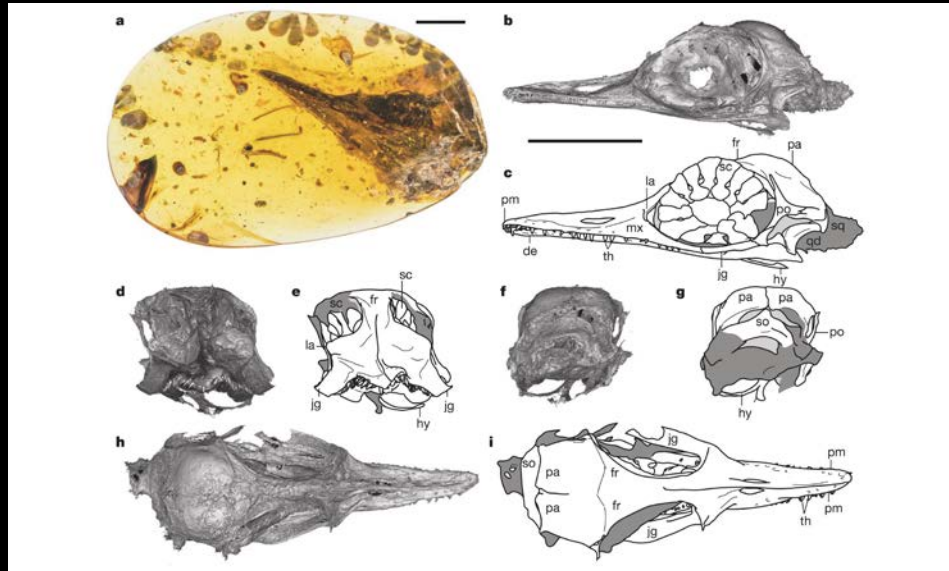


Fig. 4 | Simplified results of the strict consensus of 2,044 trees depicting the phylogenetic relationships of *O. khaungraae* relative to other known Mesozoic birds.

Article

Unusual morphology in the mid-Cretaceous lizard *Oculudentavis*

Arnaud Bolet,^{1,2} Edward L. Stanley,^{3,14} Juan D. Daza,^{4,12,13,*} J. Salvador Arias,⁵ Andrej Černiansky,⁶ Marta Vidal-García,⁷ Aaron M. Bauer,⁸ Joseph J. Bevitt,⁹ Adolf Peretti,¹⁰ and Susan E. Evans¹¹

*Correspondence: juand.daza@gmail.com
<https://doi.org/10.1016/j.cub.2021.05.040>

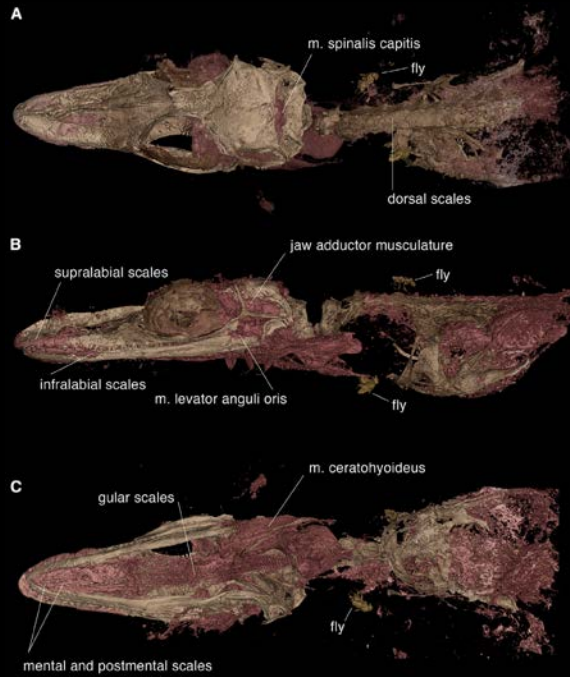


Figure 1. *Oculudentavis naga* (GRS-Ref- 286278) displaying the superb preservation of bone and soft tissue

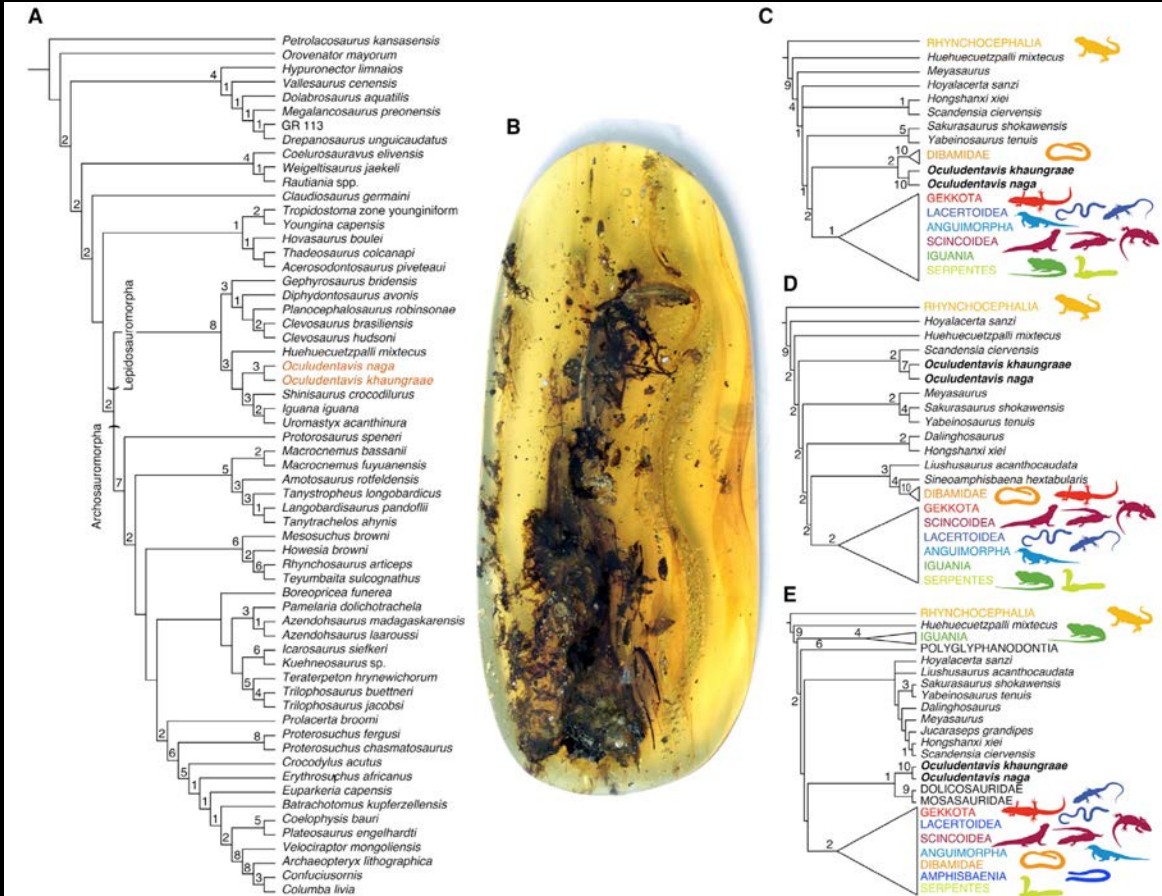
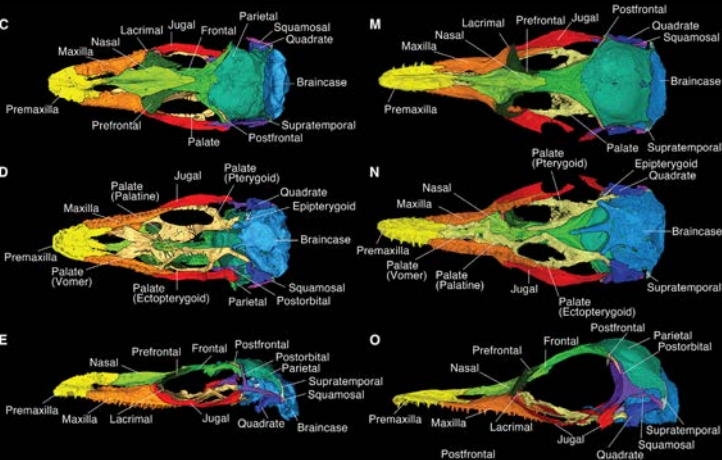
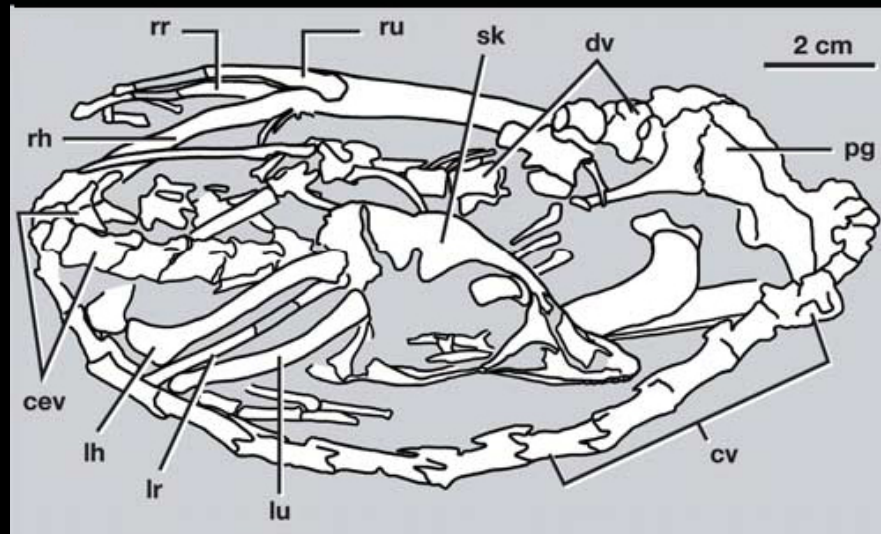


Figure 5. Phylogenetic trees showing the position of *Oculudentavis*

(A) Phylogenetic tree showing the position of *Oculudentavis* using an amniote dataset;⁵ (B) photograph of the holotype of *O. naga*; (C) simplified phylogenetic tree showing the position of *Oculudentavis* using a squamate dataset⁷ combined with a molecular dataset¹⁵ treating some morphological characters as ordered; (D) simplified phylogenetic tree showing the position of *Oculudentavis* using the same dataset as in (C) but with all characters unordered; (E) simplified phylogenetic tree showing the position of *Oculudentavis* using the same dataset as in (C) but removing molecular data.

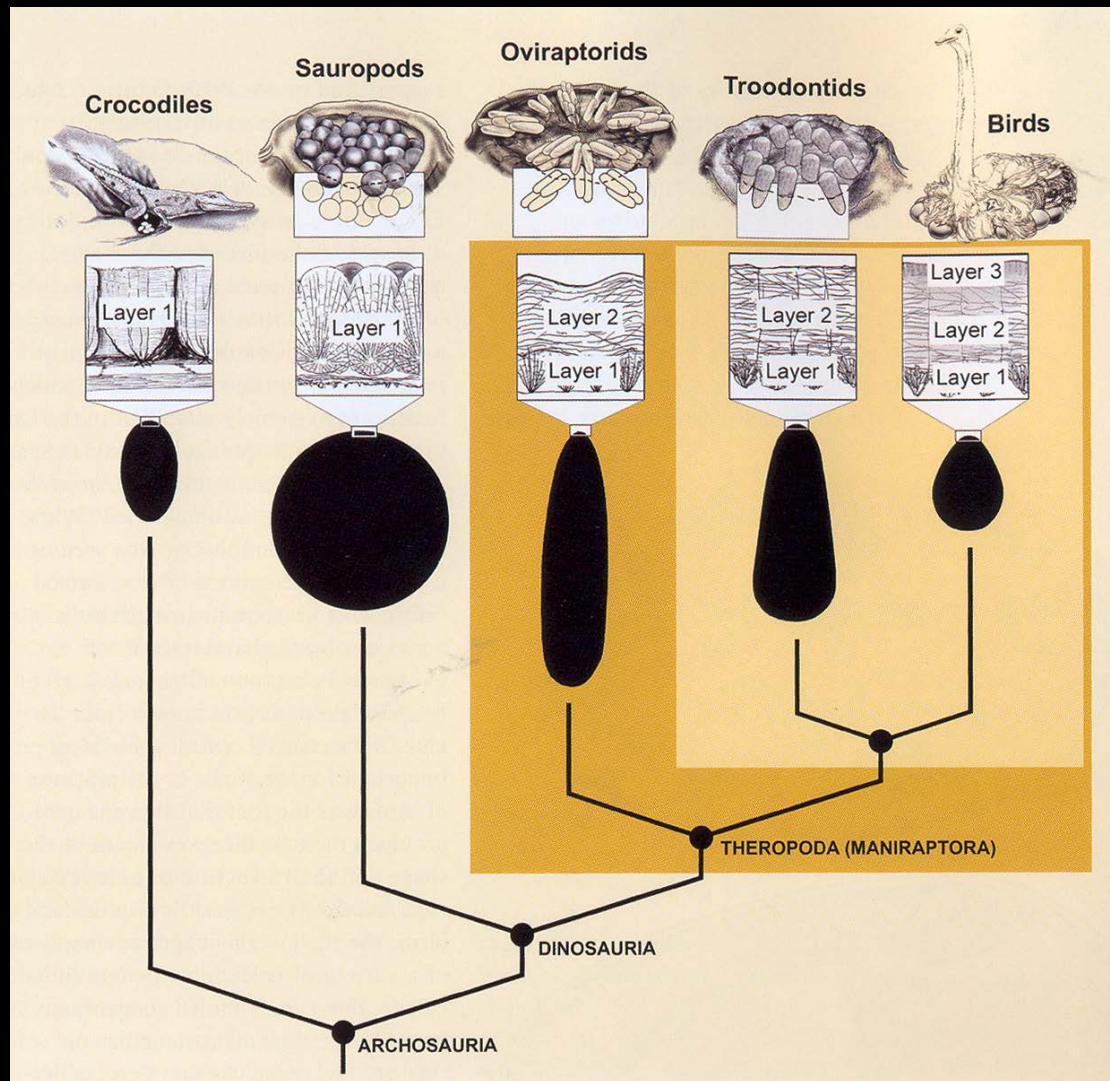
Evidências reunindo Crocodylia e Dinosauria (incluindo Aves)



Mei long (Troodontidae), Província Liaoning, Cretáceo Inferior: em posição de ave dormindo ou em repouso.

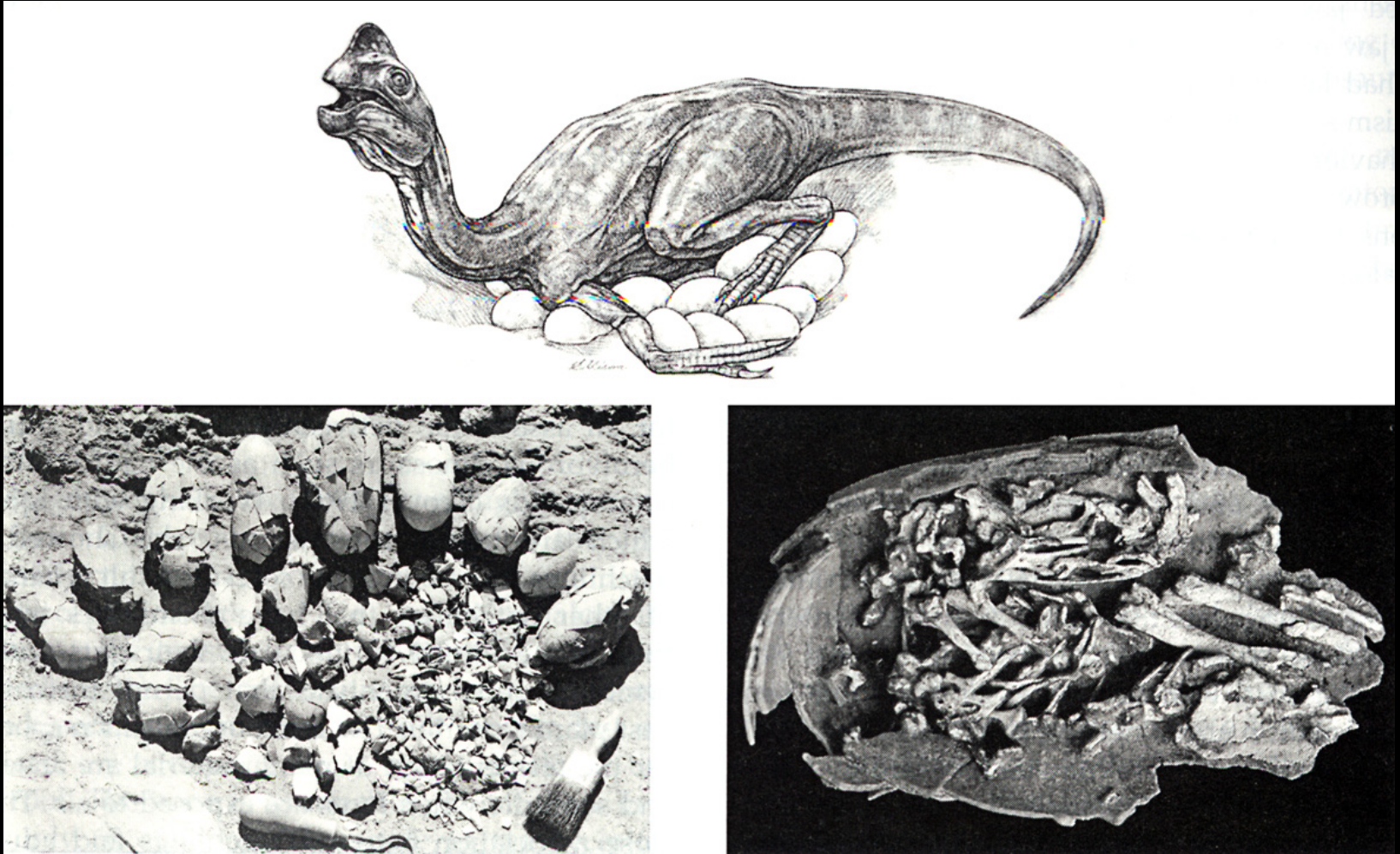
Fonte: Xu & Norell. (2004) A new troodontid dinosaur from China with avian-like sleeping posture. *Nature*, 431:838-841.

Evidências reunindo Crocodylia e Dinosauria (incluindo Aves)



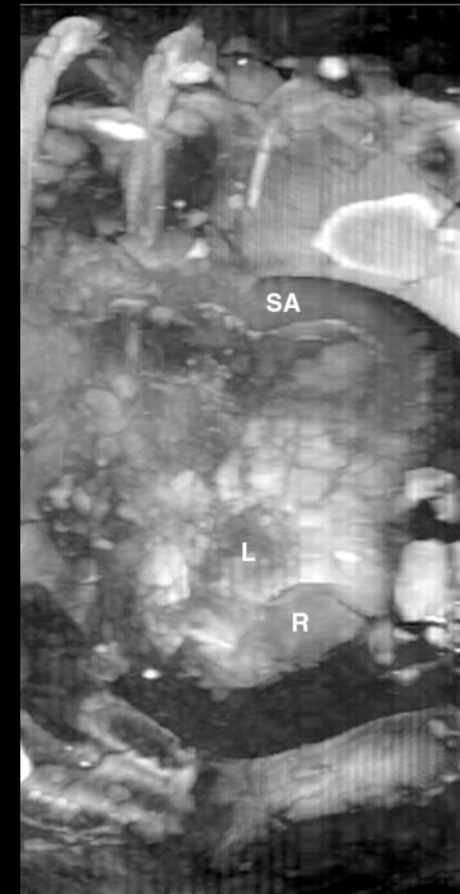
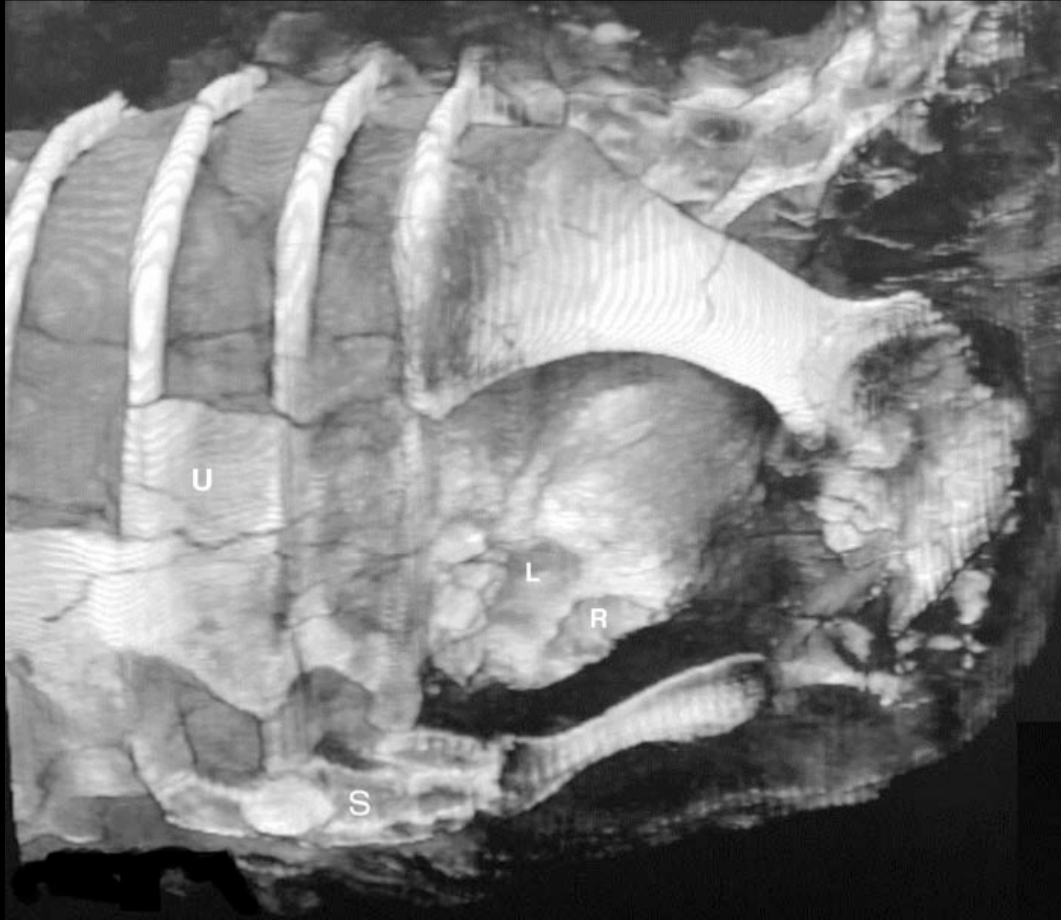
Características de ovos e ninhos de Archosauria: ninho, camadas cristalográficas da casca e simetria do ovo.

Evidências reunindo Crocodylia e Dinosauria (incluindo Aves)



Ninhos de Dinosauria e ovos: (a) Oviraptorídeo chocando ovos; (b) ninho fossilizado de oviraptorídeo; (c) embrião fossilizado de oviraptorídeo.

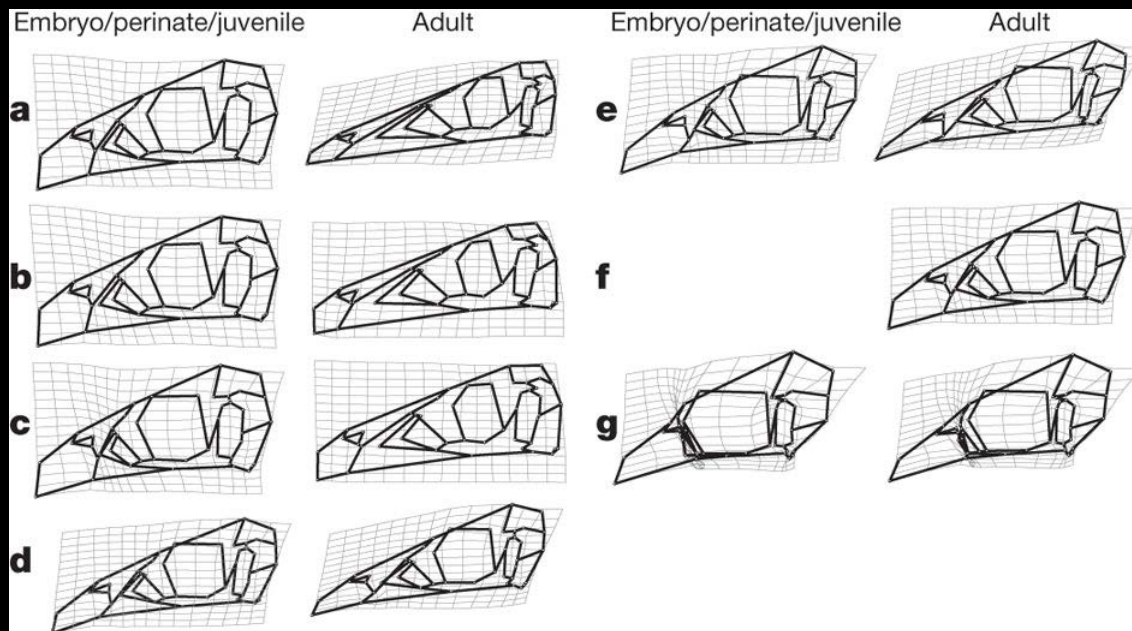
Evidências reunindo Crocodylia e Dinosauria (incluindo Aves)



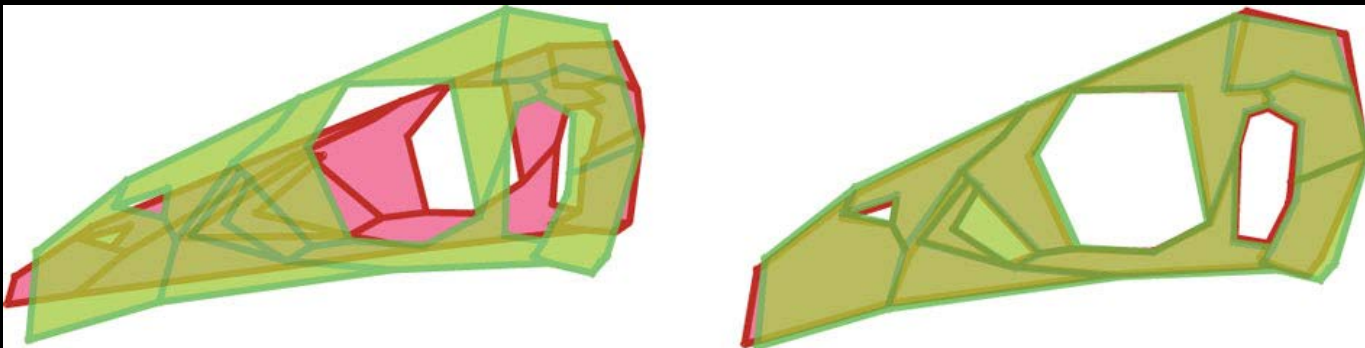
Vista lateral direita de uma reconstrução tridimensional de *Thescelosaurus*. L-cavidade ventricular esquerda; R-cavidade ventricular direita; S-costelas externas; SA-arco sistêmico; U-processo uncinado.

Fonte: Fisher, P.E. *et al.* (2004) Cardiovascular evidence for an Intermediate or higher metabolic rate in an ornithischian dinosaur. *Science*, 288:503-505.

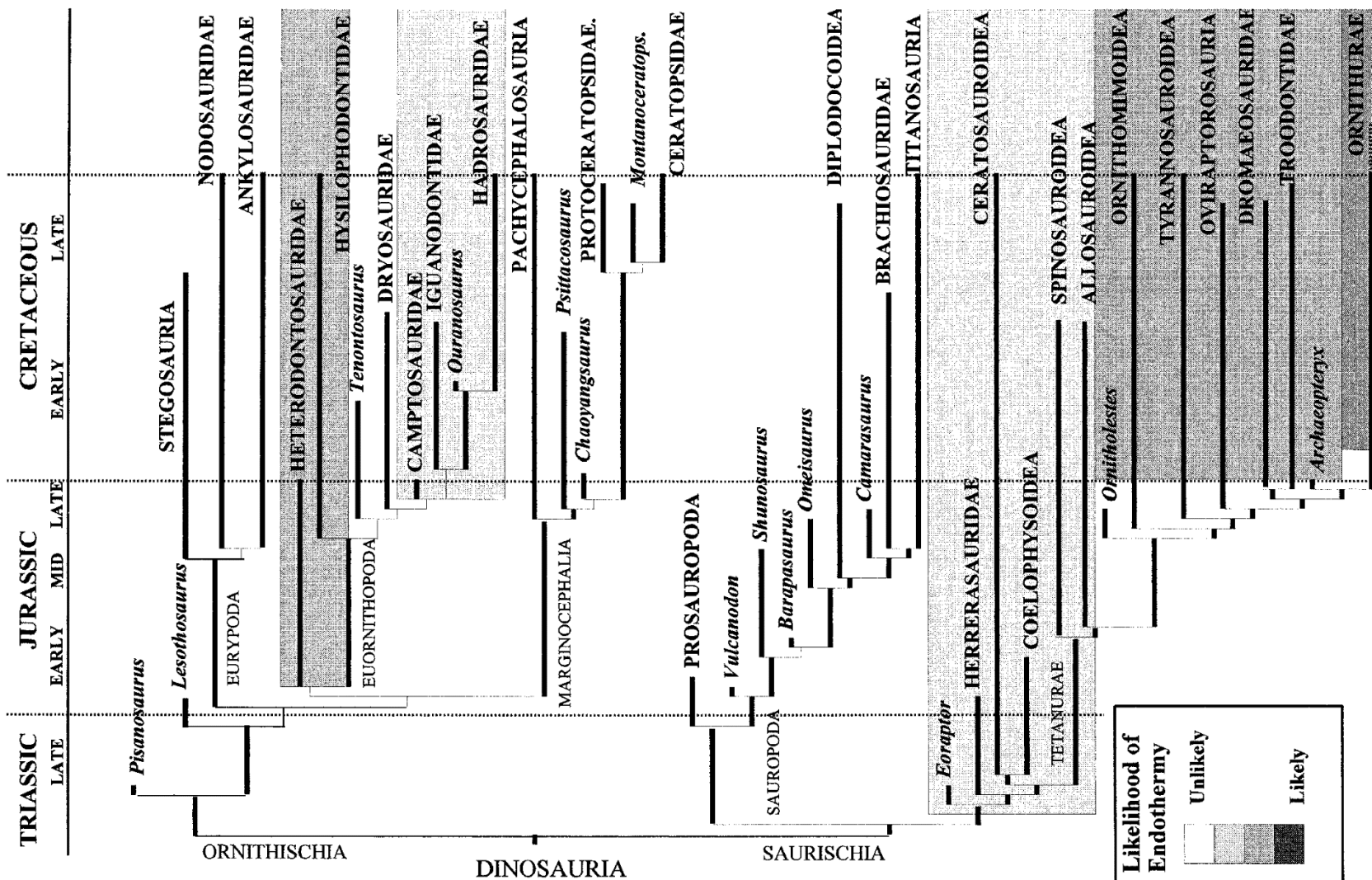
Evidências reunindo Crocodylia e Dinosauria (incluindo Aves)



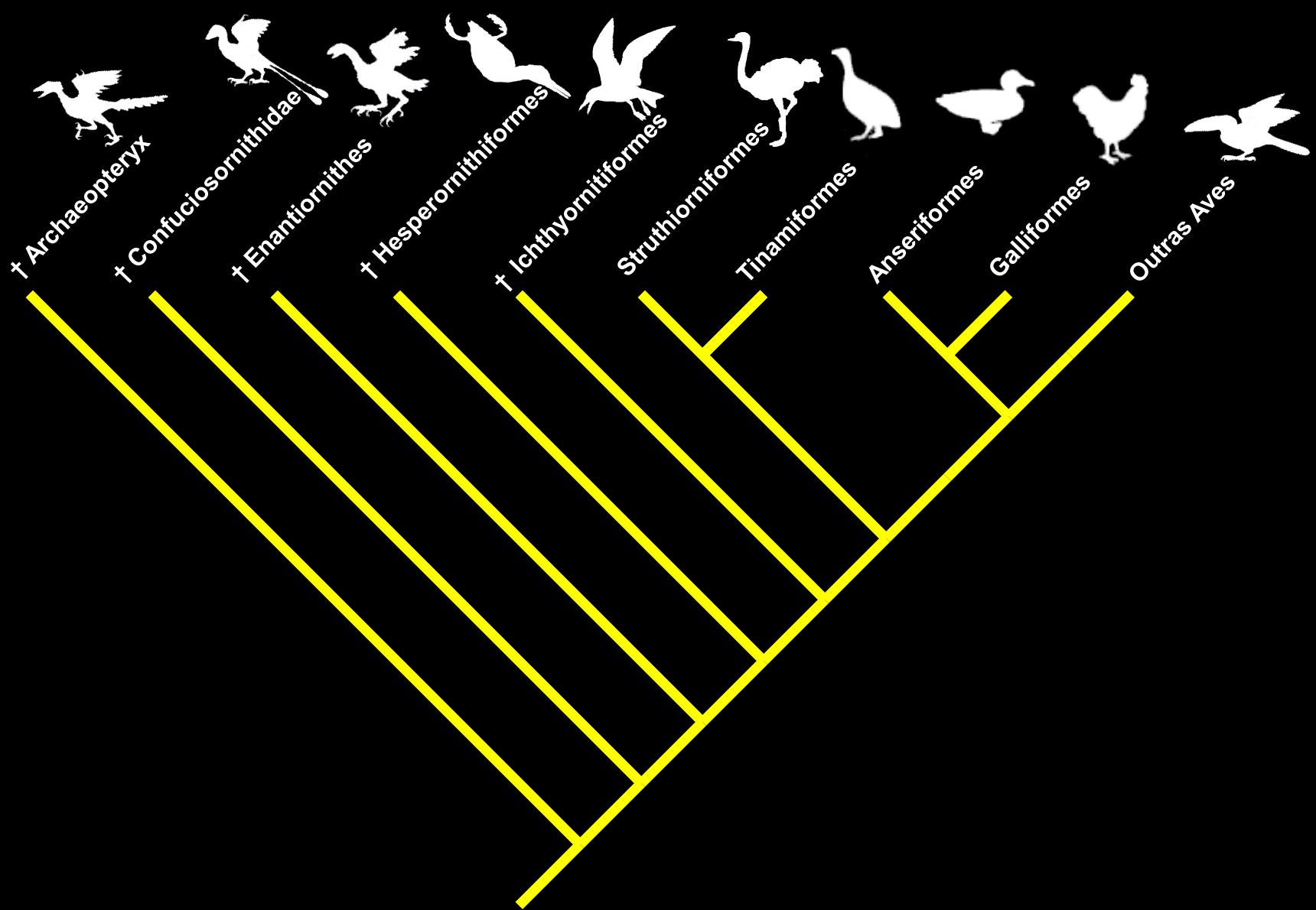
Mudanças ontogenéticas em crânios de Archosauria: a, *Alligator*; b, *Compsognathidae*; c, *Therizinosauridae*; d, *Archaeopteryx*; e, *Enantiornithes*; f, *Confuciusornis*; g, *Avestruz (Struthio)*.



Similaridade entre crânios de embrião (verde) e adulto (vermelho) de aligador, à esquerda, e de um adulto de *Confuciusornis* (vermelho) sobreposto por um jovem de aligador (verde), à direita.



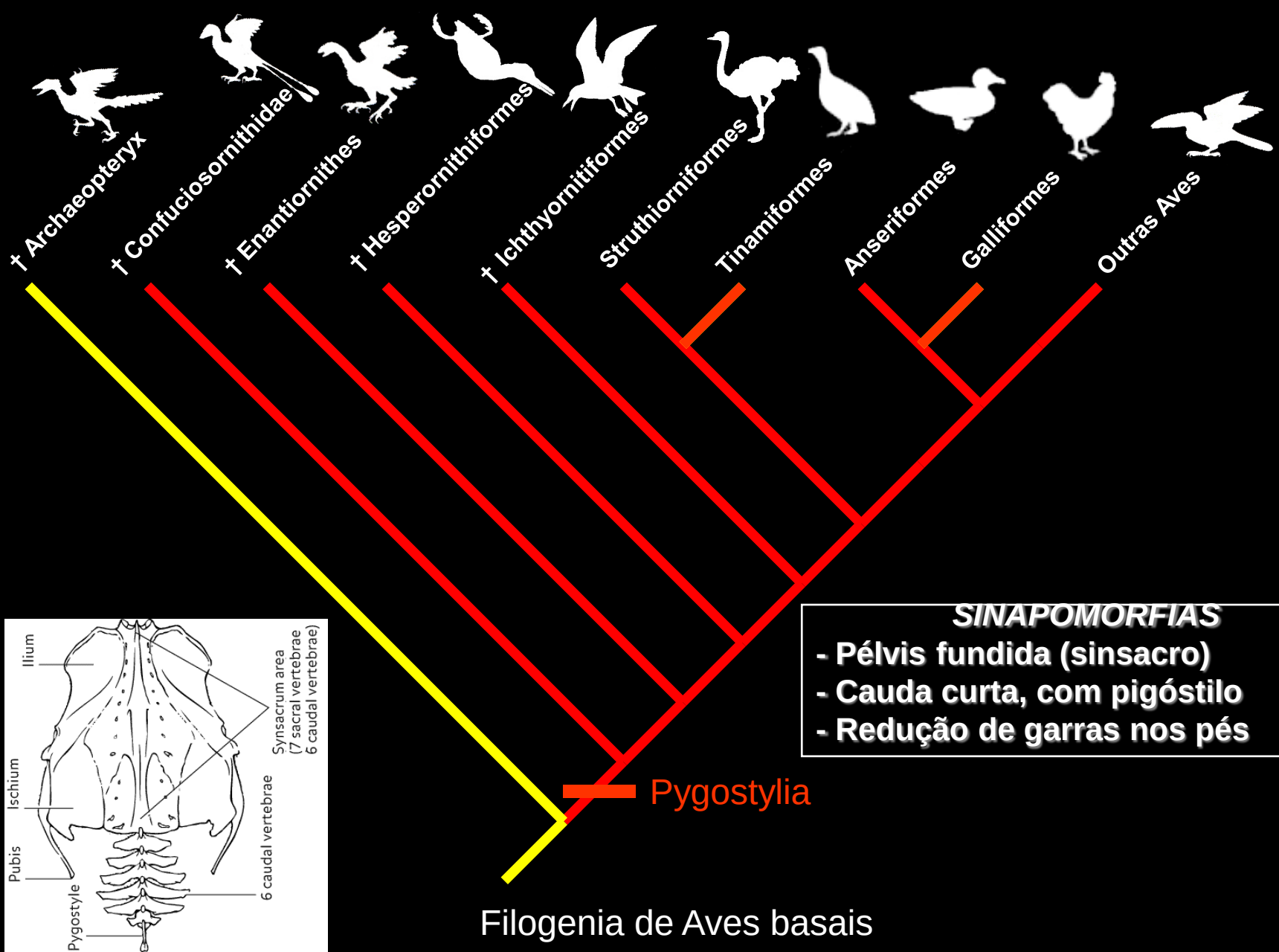
Termorregulação em Dinosauria (Seebacher, 2003)



Filogenia de Aves basais

Fontes: Clarke, J.A. (2004) Morphology, phylogenetic taxonomy, and systematics of *Ichthyornis* and *Apatornis* (Avialae: Ornithurae). *Bull. Am. Mus. Nat. Hist.*, 286:1-179.

Clarke, J.A. et al. (2005) Definitive fossil evidence of the extant avian radiation in Cretaceous. *Nature*, 433: 305-308.

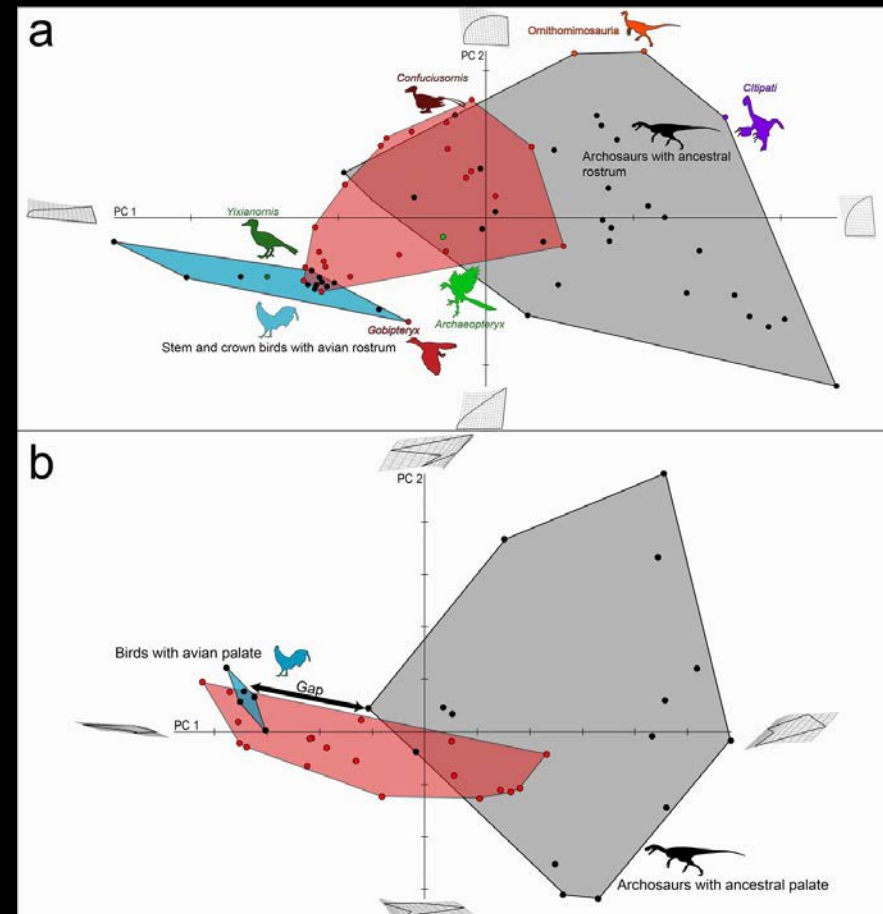
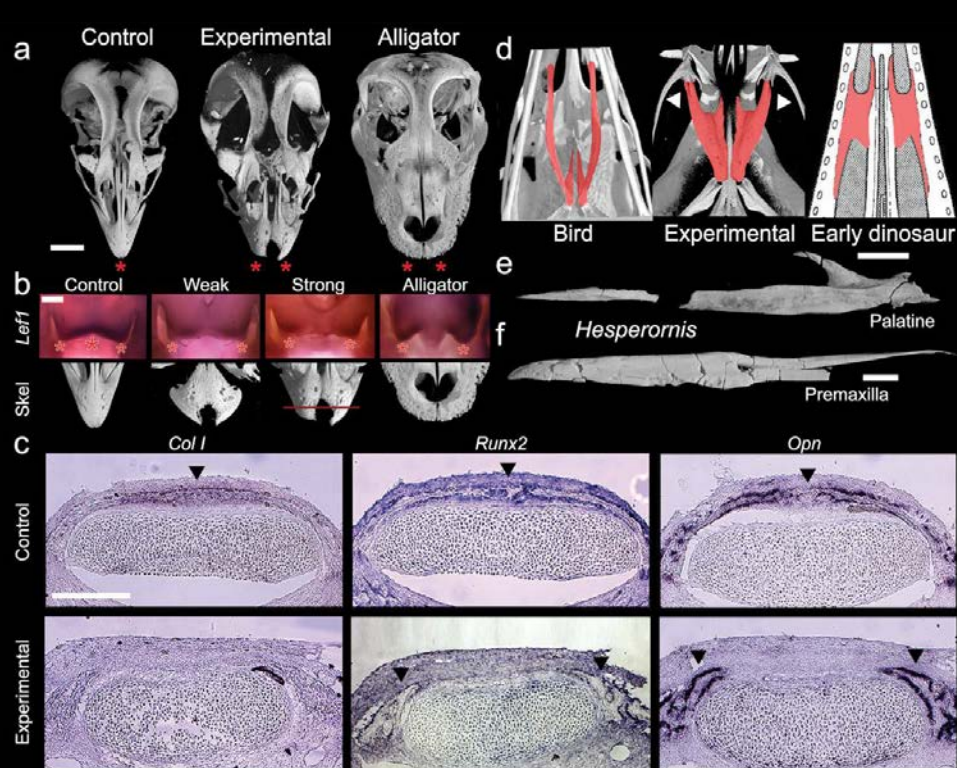


Fontes: Clarke, J.A. (2004) Morphology, phylogenetic taxonomy, and systematics of *Ichthyornis* and *Apatornis* (Avialae: Ornithurae). *Bull. Am. Mus. Nat. Hist.*, 286:1-179.

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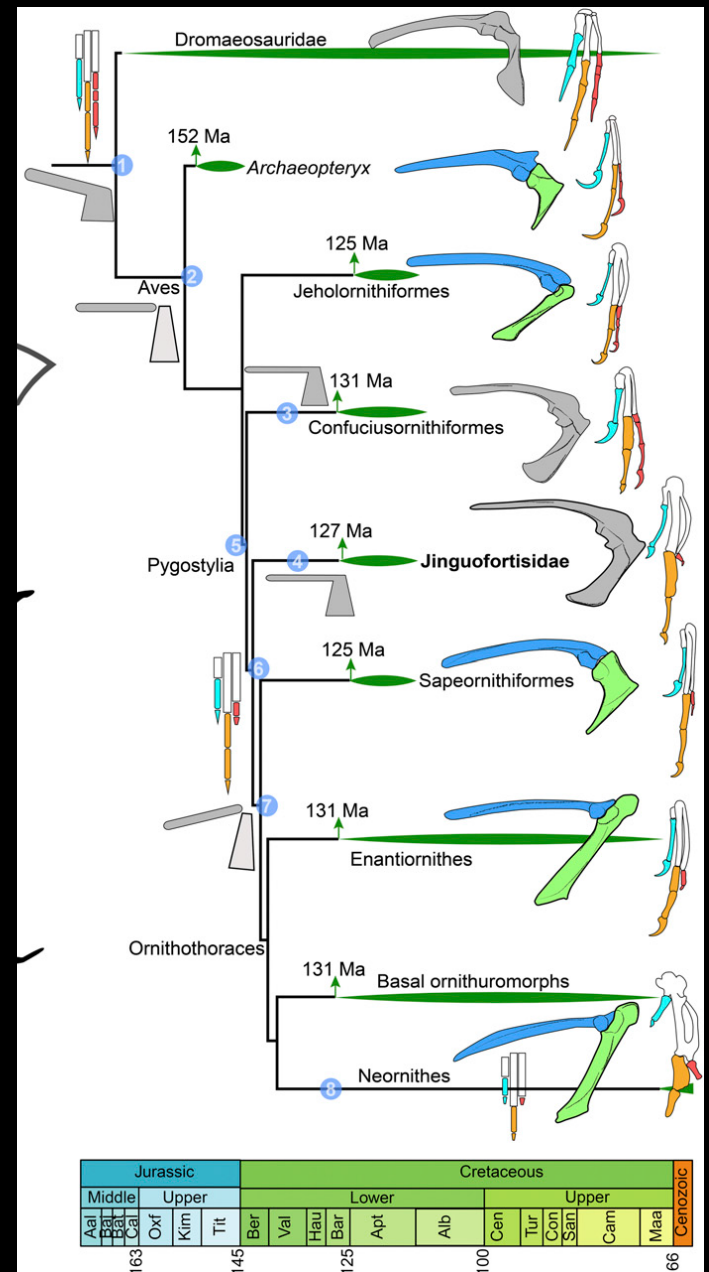
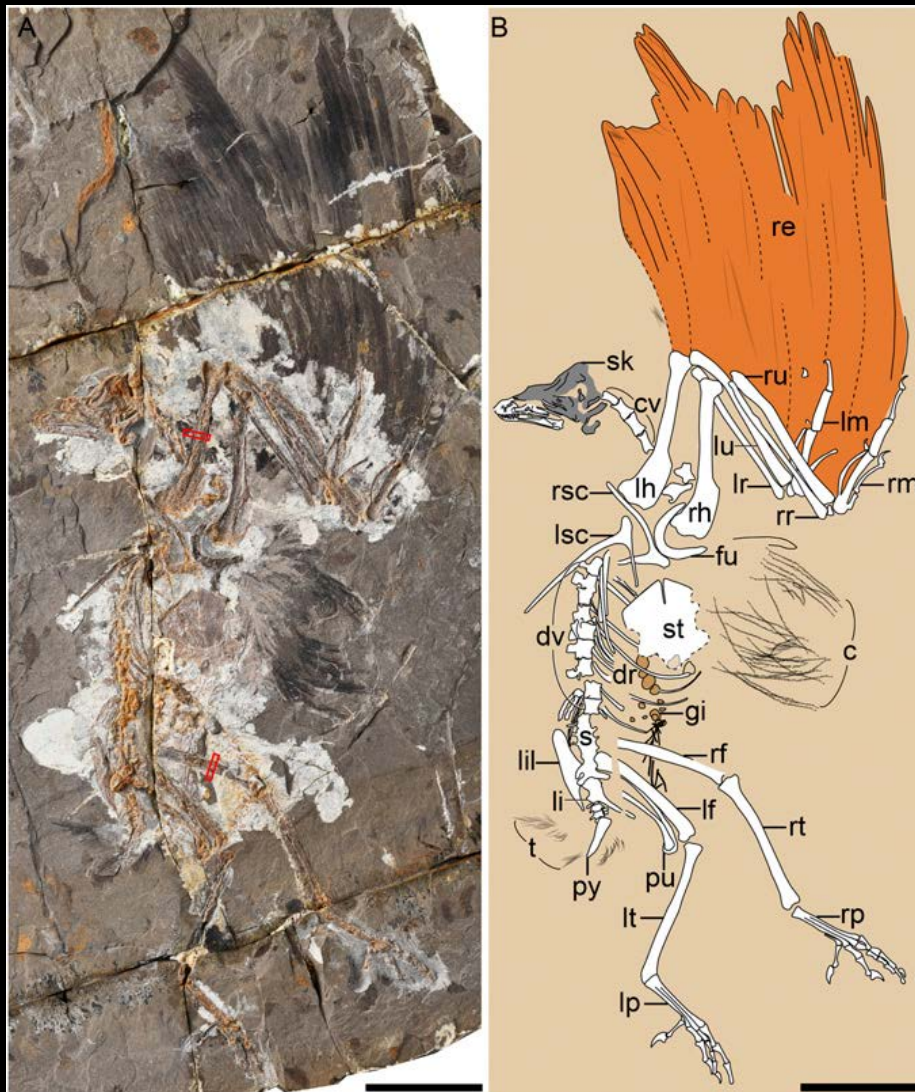


Membro basal de Pygostylia: *Confuciusornis sanctus*, China, Província Liaoning, Cretáceo Inferior

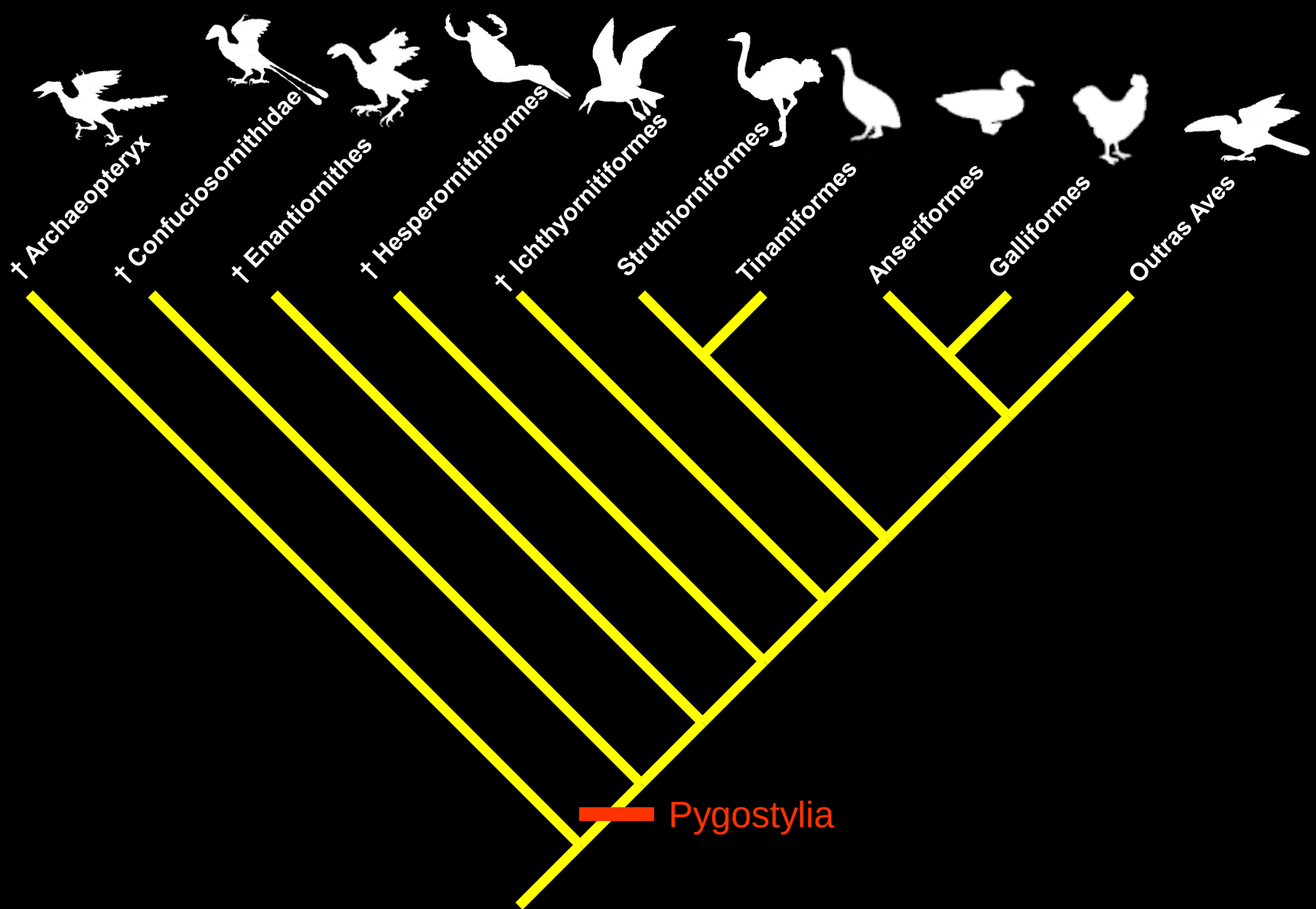


O uso de inibidores da região de expressão gênica autapomórfica em Aves com relação aos domínios de expressão da região facial embrionária (zona precoce ectodérmica frontonasal e região Wnt-responsiva mesofacial tardia) levou à expressão amniota ancestral da pré-maxila e do palato em galinhas.

Fonte: Bhullar, B.-A.S. *et al.* (2015). A molecular mechanism for the origin of a key evolutionary innovation, the bird beak and palate, revealed by an integrative approach to major transitions in vertebrate history. *Evolution*, 69 (7): 1665-1677.



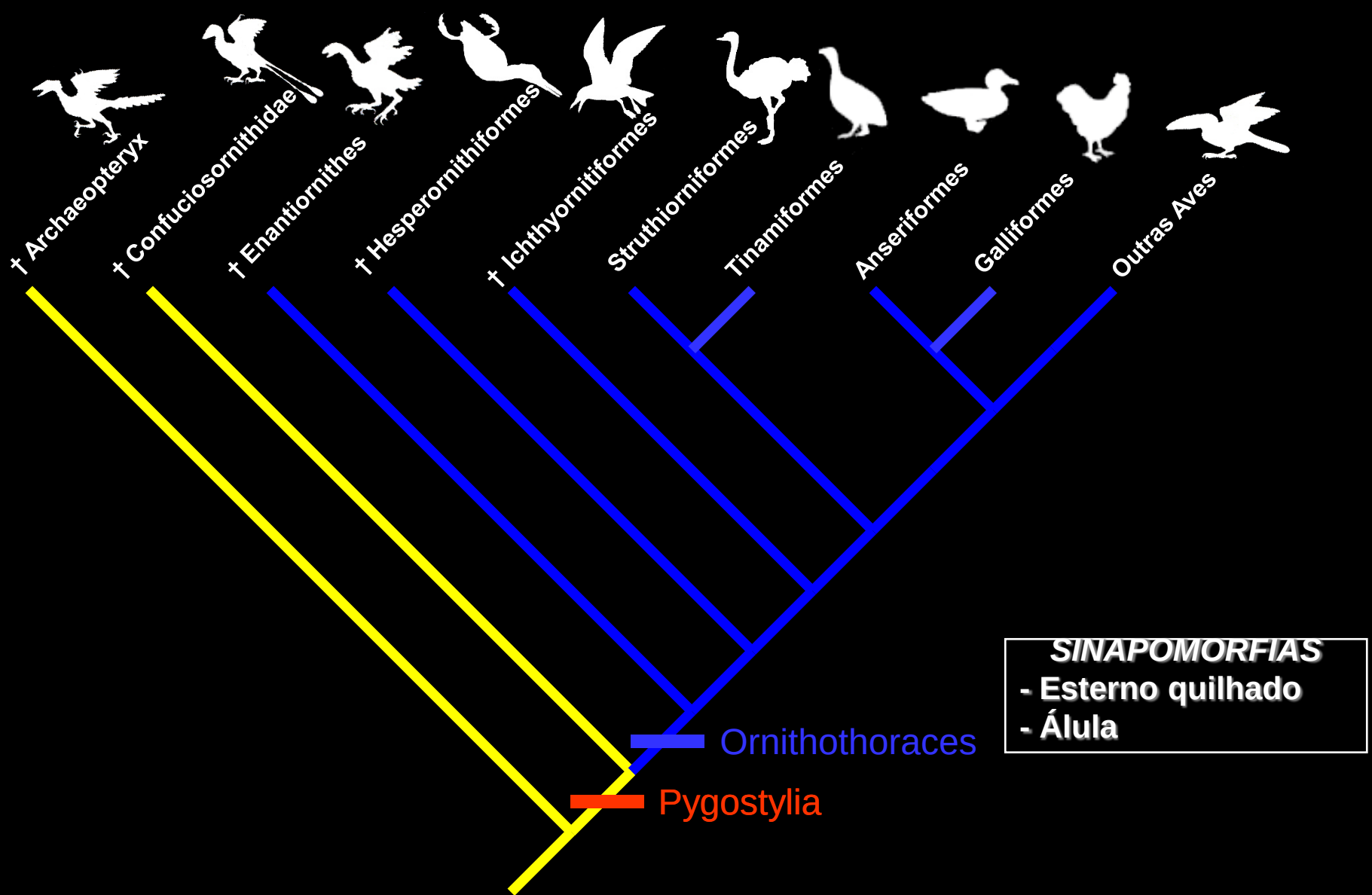
Fonte: Wang, M. et al. (2018) A new clade of basal Early Cretaceous pygostylian birds and developmental plasticity of the avian shoulder girdle. *Proceedings of the National Academy of Sciences*, 115 (42) 10708-10713.



Filogenia de Aves basais

Fontes: Clarke, J.A. (2004) Morphology, phylogenetic taxonomy, and systematics of *Ichthyornis* and *Apatornis* (Avialae: Ornithurae). *Bull. Am. Mus. Nat. Hist.*, 286:1-179.

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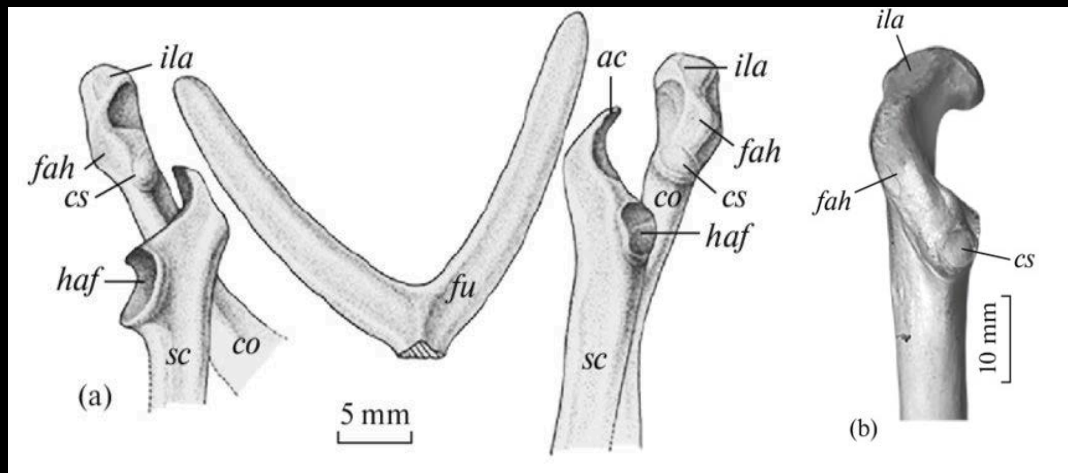
Membros basais de Ornithothoraces: Enanthiornithes



Iberomesornis romerali, Espanha, Las Hoyas, Cretáceo Inferior



Sinornis santensis, China, Liaoning, Cretáceo Inferior



(a) *Pengornis* sp. (Enanthiornithes), (b) *Crax rubra*. Abreviações: co- coracóide; cs - côndilo articular no coracóide para a escápula (cotyla scapularis); sc- escápula. Zelenkov (2017)



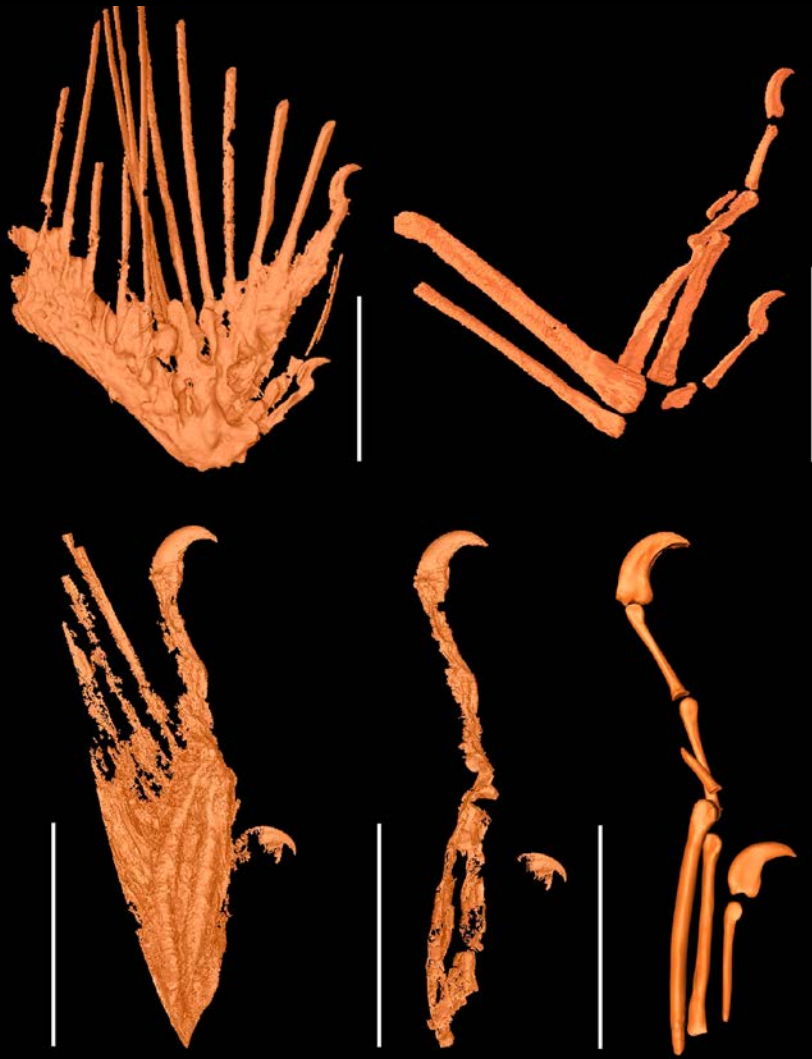
Enantiornis, Argentina, Cretáceo Superior

Membros basais de Ornithothoraces: Enanthiornithes



Cratoavis cearensis (Enanthiornithes). Brasil, Ceará, Cretáceo Inferior

Membros basais de Ornithothoraces: Enanthiornithes



Membros basais de Ornithothoraces: Enanthiornithes

A New Enantiornithine (Aves) Preserved in Mid-Cretaceous Burmese Amber Contributes to Growing Diversity of Cretaceous Plumage Patterns

OPEN ACCESS

Lida Xing^{1,2,3*}, Jingmai K. O'Connor^{4,5,6*}, Kecheng Niu³, Pierre Cockx^{6,7}, Huijuan Mai^{8,9}
and Ryan C. McKellar^{6,7,10}

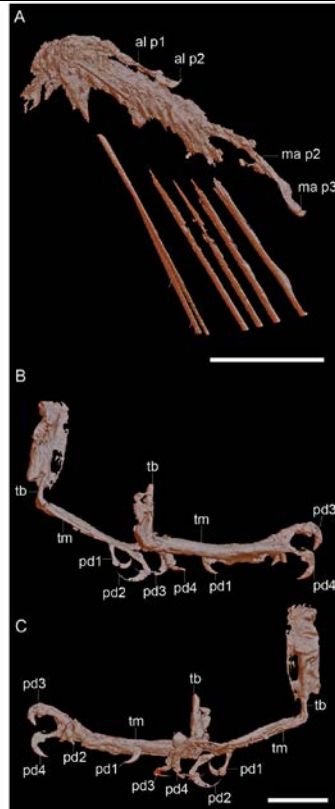


FIGURE 2 | Raw CT data of the right hand (A) and the feet viewed from the right (B) and viewed from the left (C). Scale bars equal 5 mm. Anatomical abbreviations: al p1, alular digit phalanx 1; al p2, alular digit phalanx 2; ma p2, major digit phalanx 2; ma p3, major digit phalanx 2; pd1-4, pedal digits 1-4; tb, tibiotarsus; tm, tarsometatarsus.

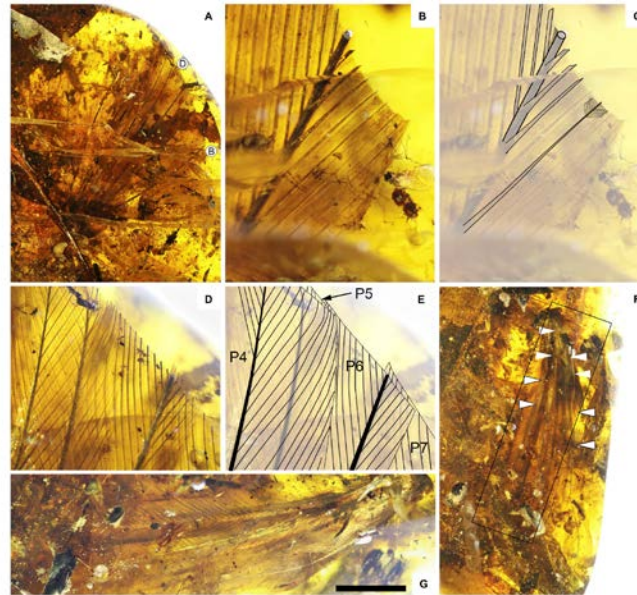


FIGURE 4 | Plumage of YLSNH-M00813. (A) Overview of the left wing; (B) close-up of a barb truncated at the amber surface; (C) interpretive diagram of (B) with examples of barb ram position and barbu position; (D) close-up of remiges superimposed and truncated by the surface of amber; (E) interpretive diagram of (D) highlighting the outline of the vanes as well as the position of the rami and the rachises; (F) overview of the right wing with arrowheads (white and white with a black contour) highlighting the position of two white bands; (G) close-up of the left wing. Scale bars = A: 10 mm; B: 1 mm; D: 3 mm; F, G: 5 mm.

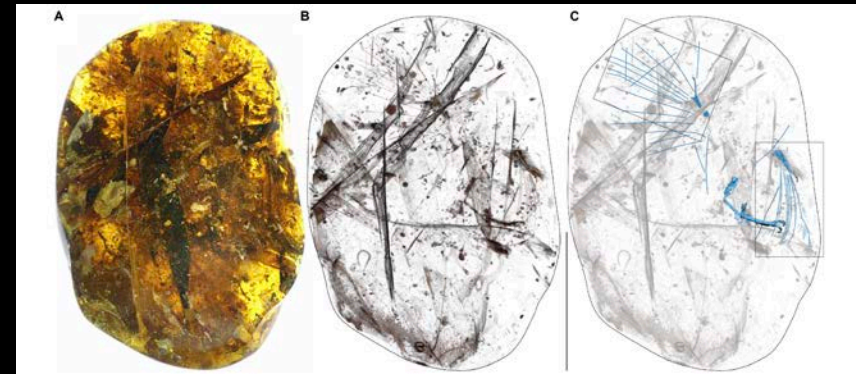


FIGURE 1 | Photograph of the amber specimen (A), X-ray (B) and CT scan (C). In the CT scan the bird bones and primary rachises are indicated in blue. Scale bar equals 50 mm. Boxes indicate areas enlarged in Figures 4A,F.

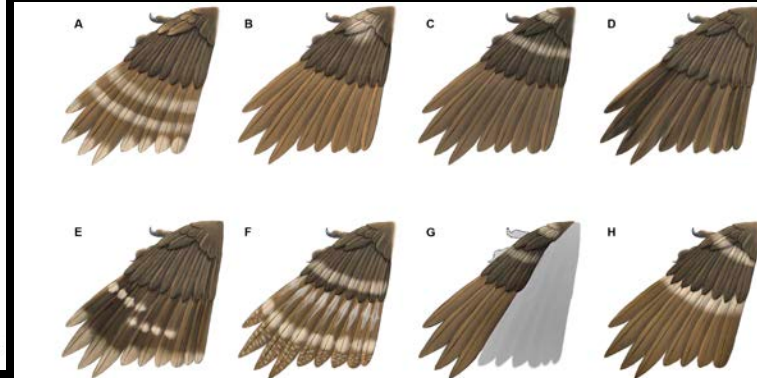


FIGURE 5 | Reconstructions of primary plumage color patterns known so far in enantiornithines from Burmese Amber. (A) HPG-15-1; (B) DIP-V-15100; (C) DIP-V-15101; (D) DIP-V-15105; (E) HPG-15-2; (F) LV-0321; (G) DIP-V-15102; (H) YLSNH-M00813.

Membros basais de Ornithothoraces: Enantiornithes

Geological Magazine

Rapid Communication

Cite this article: Xu L, Buffetaut E, O'Connor J, Zhang X, Jia S, Zhang J, Chang H, and Tong H. A new, remarkably preserved, enantiornithine bird from the Upper Cretaceous Qiupa Formation of Henan (central China) and convergent evolution between enantiornithines and modern birds.
Geological Magazine <https://doi.org/10.1017/S0016756821000807>

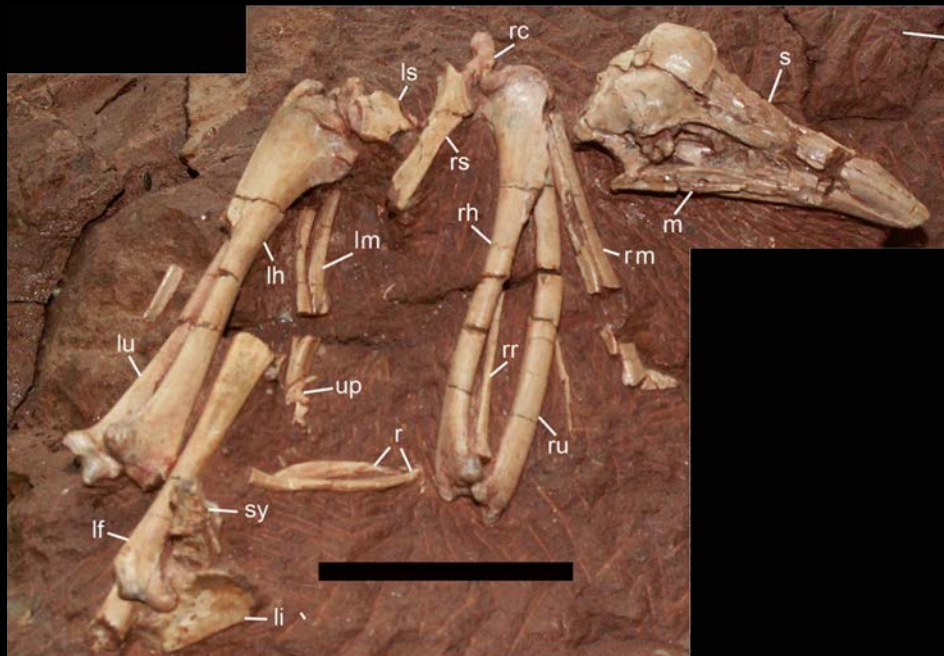
Received: 23 March 2021

Revised: 14 June 2021

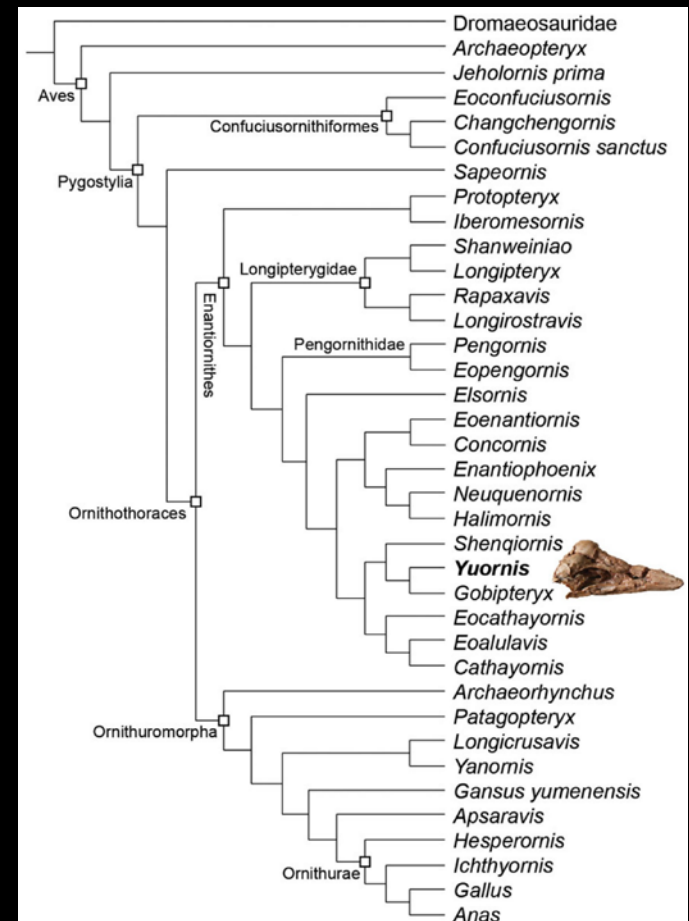
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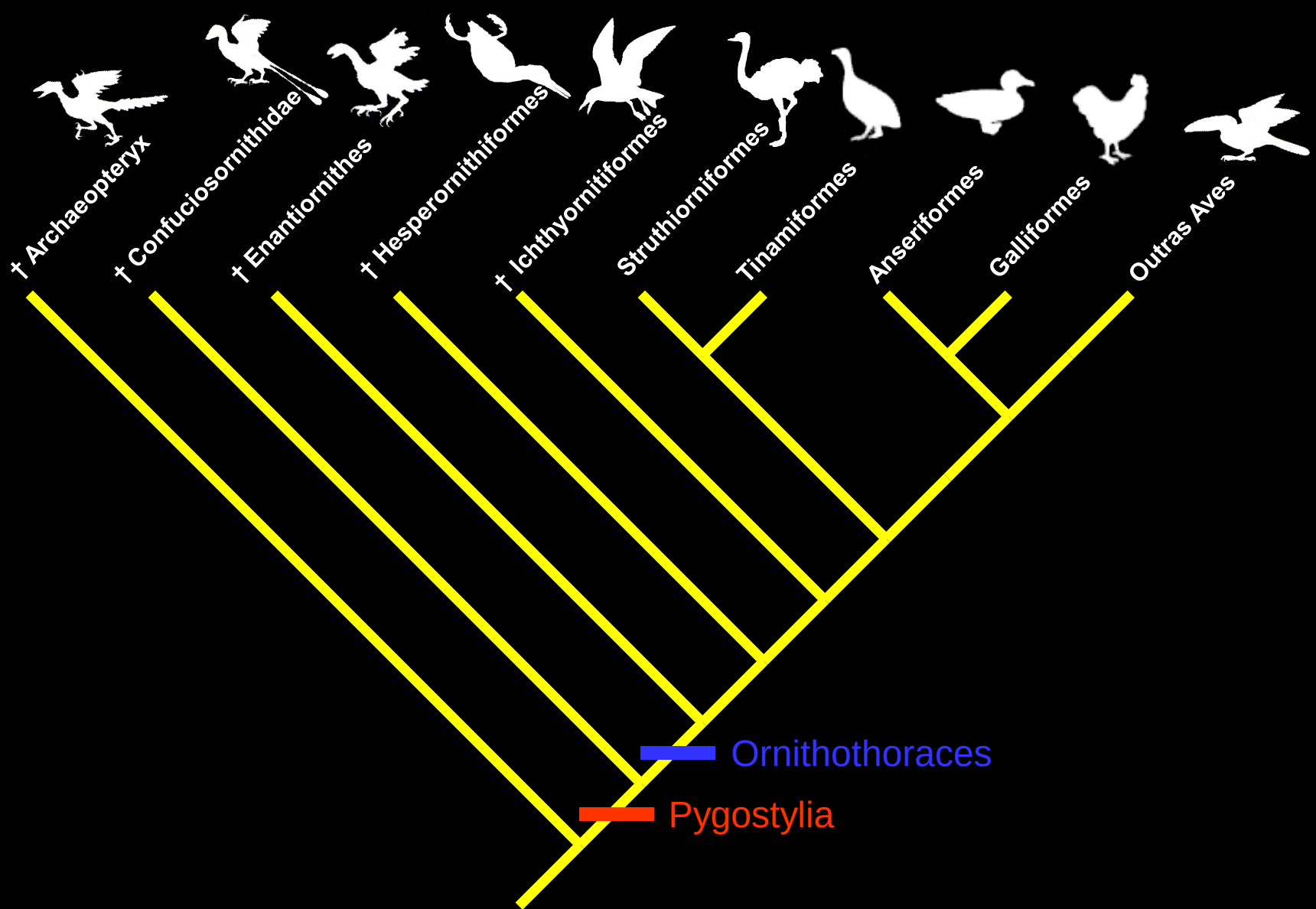
A new, remarkably preserved, enantiornithine bird from the Upper Cretaceous Qiupa Formation of Henan (central China) and convergent evolution between enantiornithines and modern birds

Li Xu¹, Eric Buffetaut^{2,3} , Jingmai O'Connor⁴, Xingliao Zhang¹, Songhai Jia¹, Jiming Zhang¹, Huali Chang¹ and Haiyan Tong^{3,5} 



Yuornis junchangi, China, Luanchuan, Cretáceo Superior

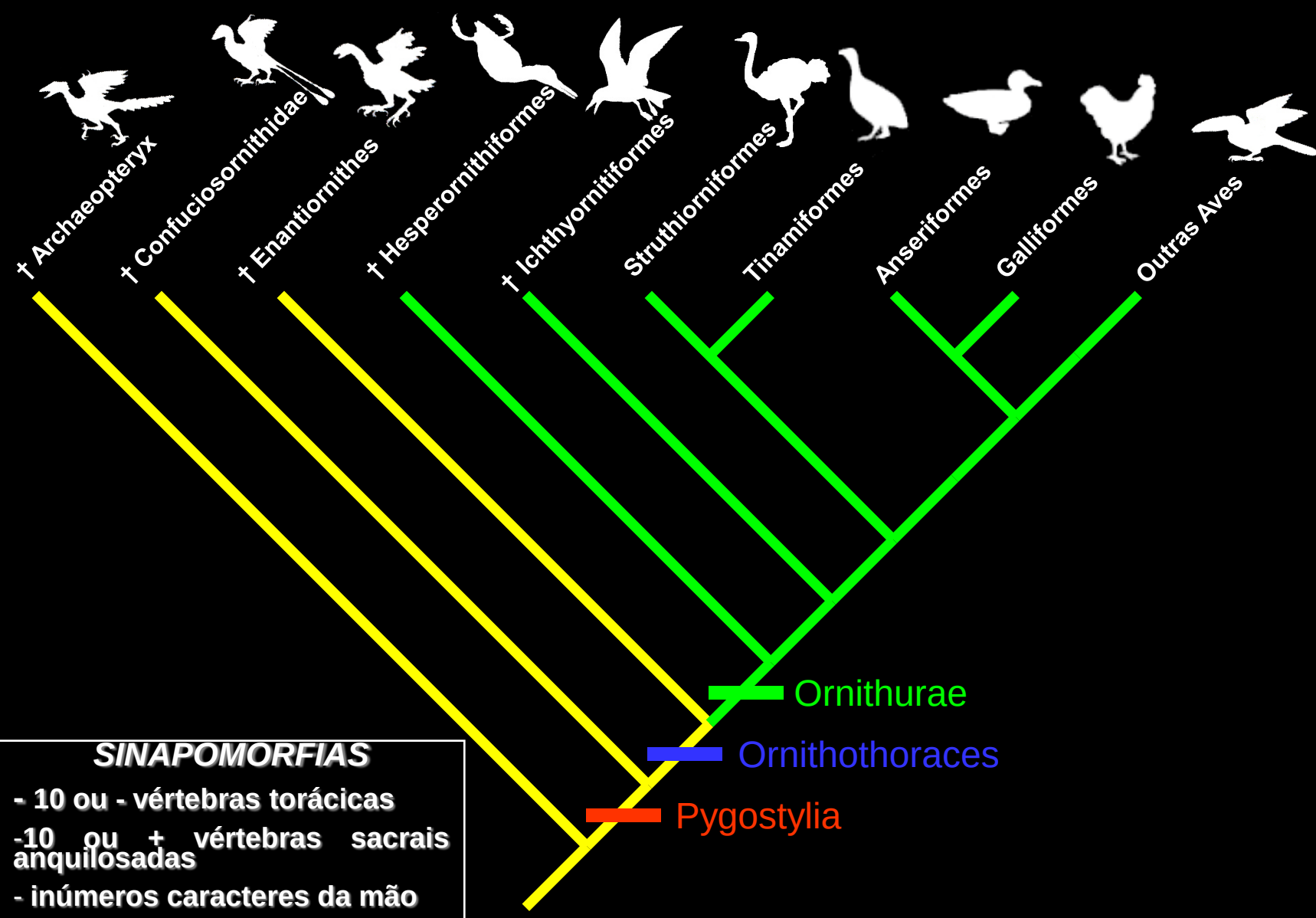




Filogenia de Aves basais

Fontes: Clarke, J.A. (2004) Morphology, phylogenetic taxonomy, and systematics of *Ichthyornis* and *Apatornis* (Avialae: Ornithurae). *Bull. Am. Mus. Nat. Hist.*, 286:1-179.

Clarke, J.A. et al. (2005) Definitive fossil evidence of the extant avian radiation in Cretaceous. *Nature*, 433: 305-308.



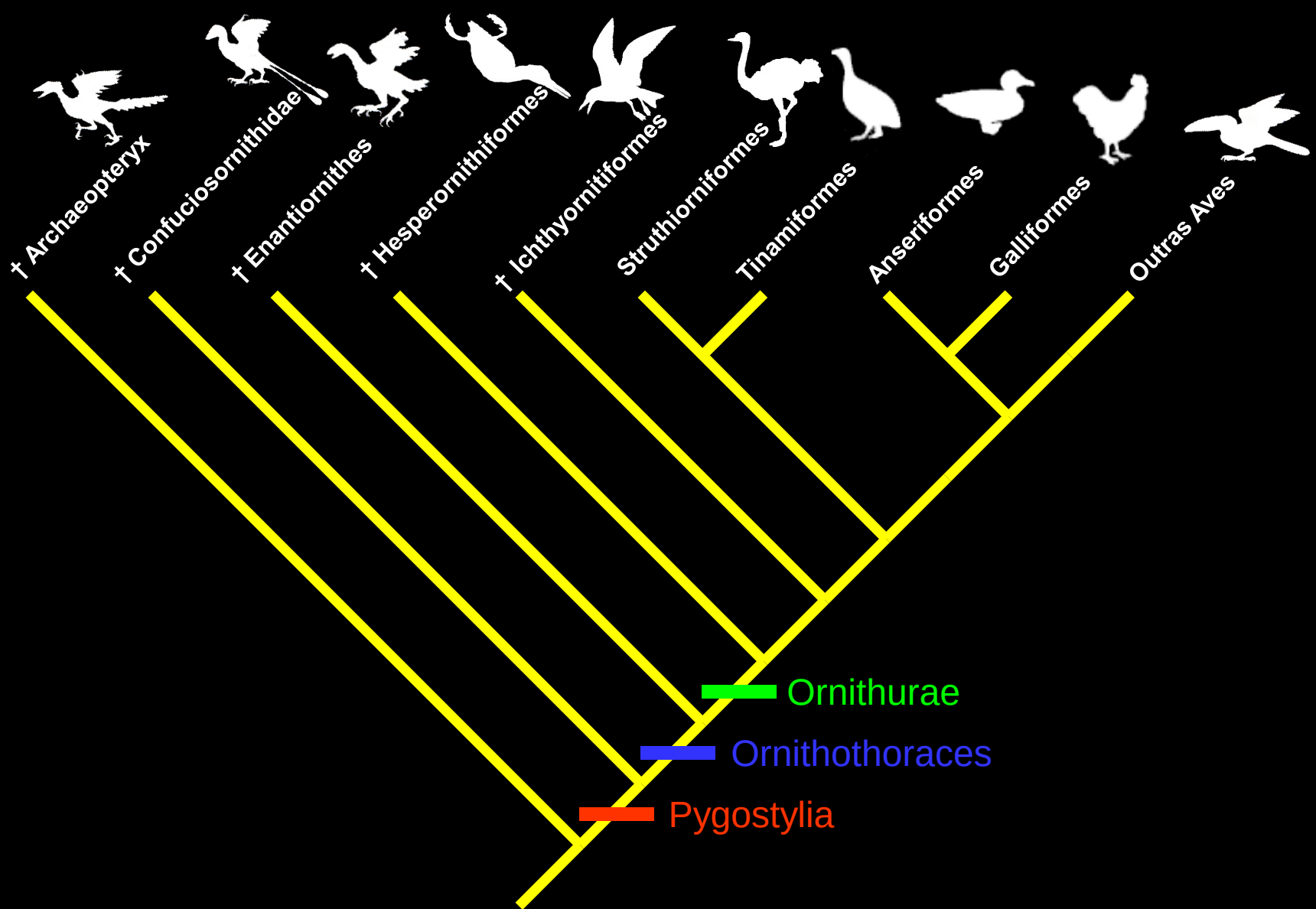
Filogenia da Aves basais

Ordem Hesperornithiformes - membro basal de Ornithurae

- Laurásia - Cretáceo
- Aquáticas, adaptadas à vida marinha



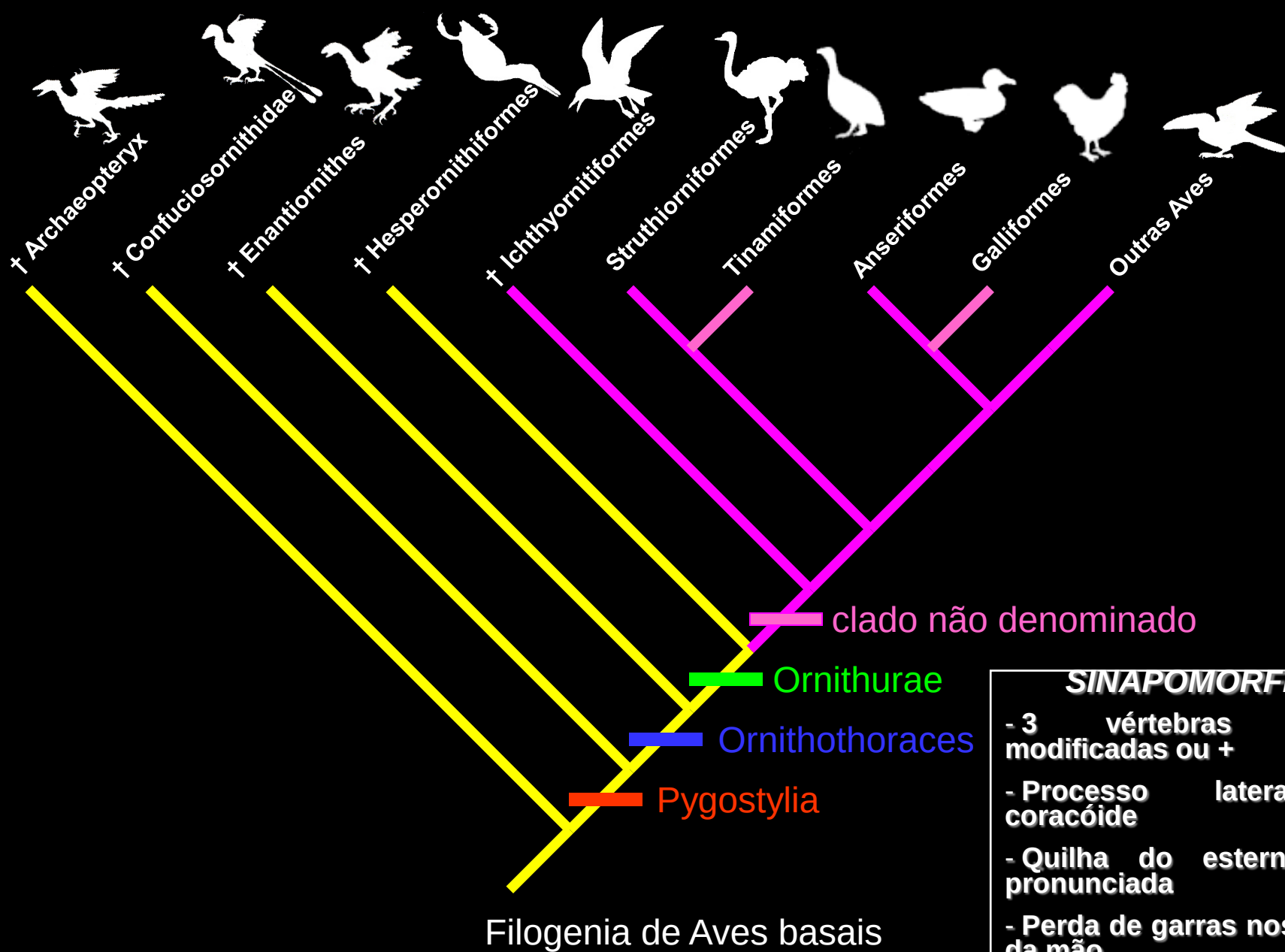
Hesperornis regalis. EUA, Kansas, Cretáceo Superior



Filogenia de Aves basais

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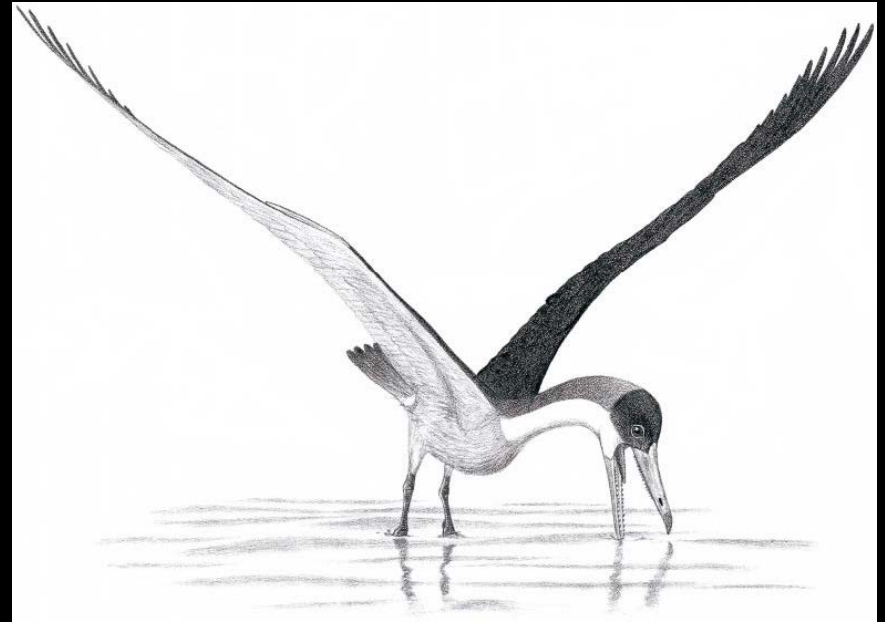


Filogenia de Aves basais

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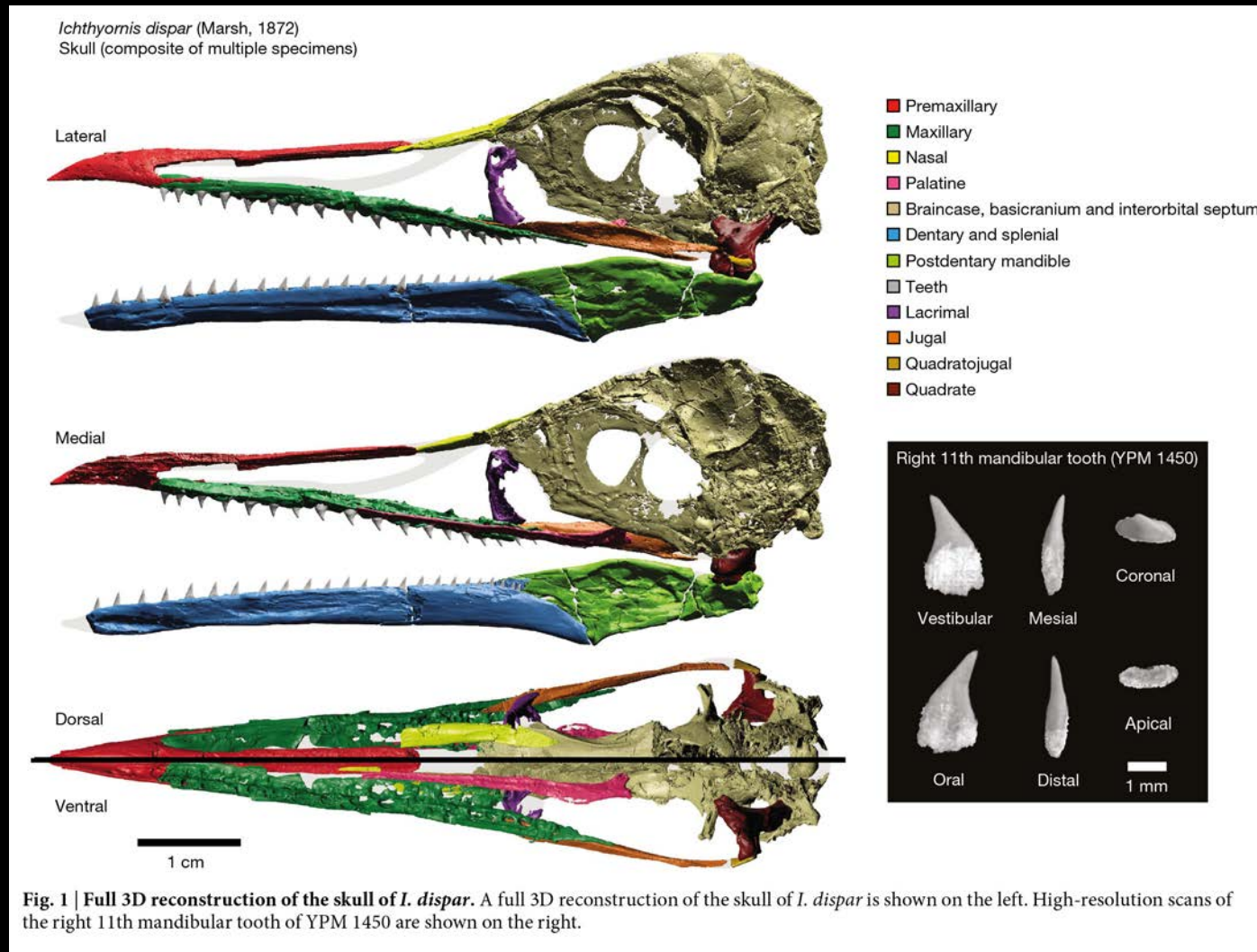
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Ordem Ichthyornithiformes - membro basal do clado não denominado



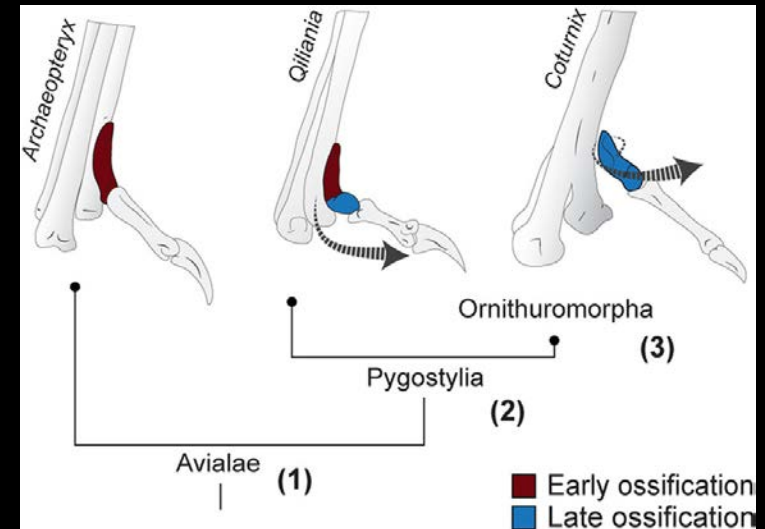
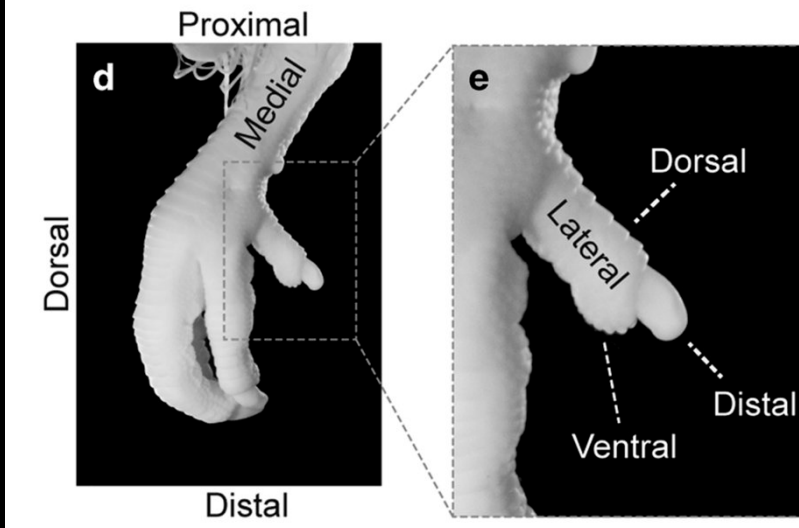
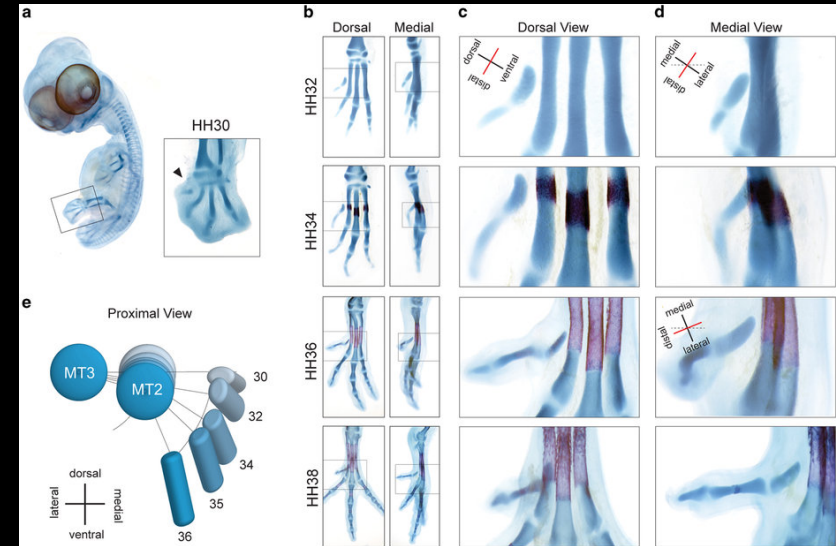
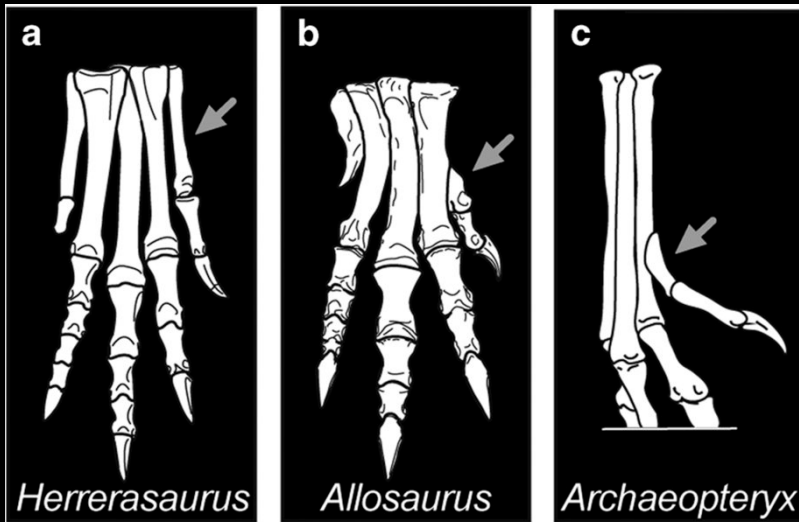
Ichthyornis dipar. EUA, Kansas, Cretáceo Superior

Ordem Ichthyornithiformes - membro basal do clado não denominado

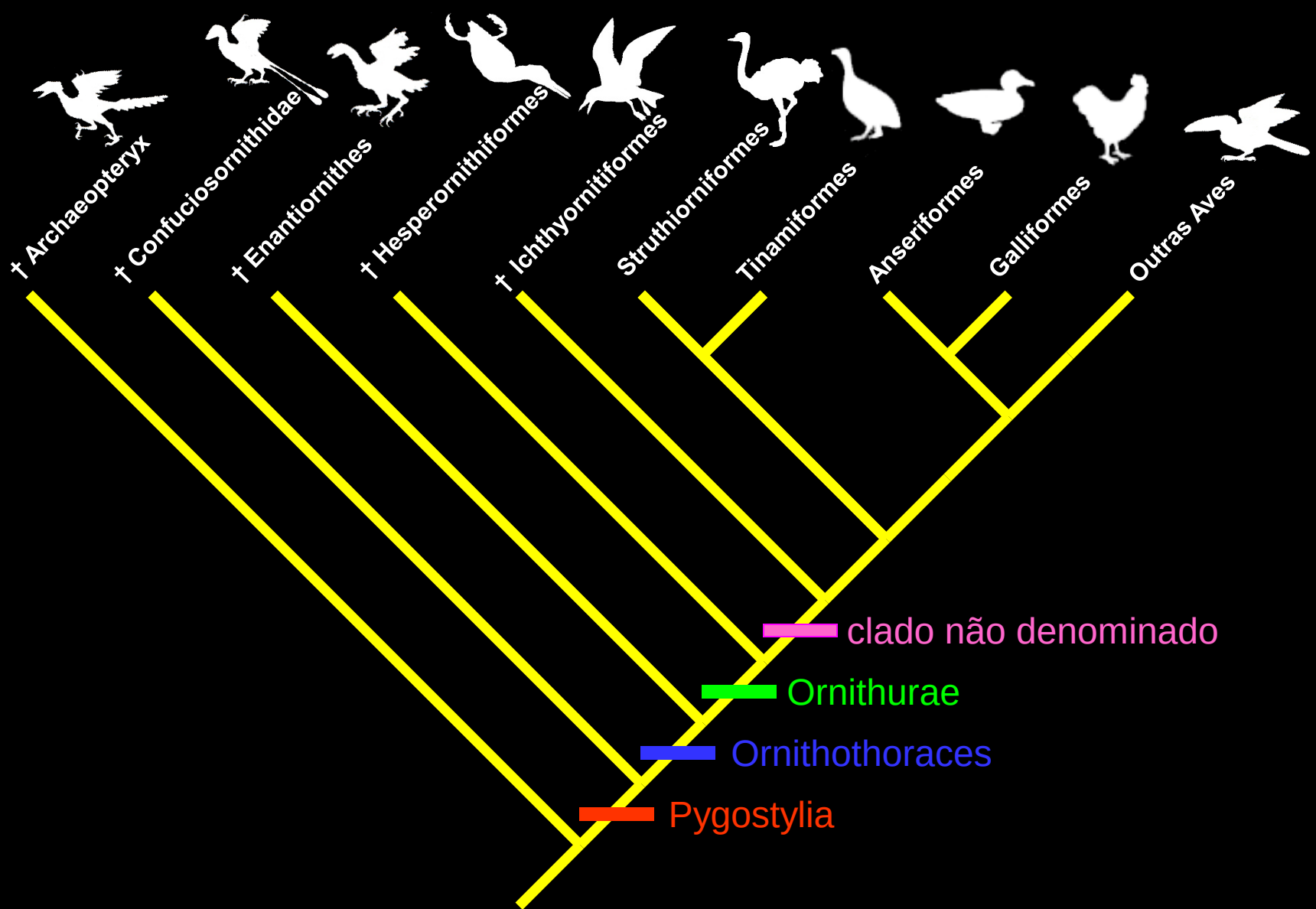


Fonte: Field, D.J. *et al.* (2018) Complete *Ichthyornis* skull illuminates mosaic assembly of the avian head. *Nature*, 557: 96–100.

Ordem Ichthyornithiformes - membro basal do clado não denominado



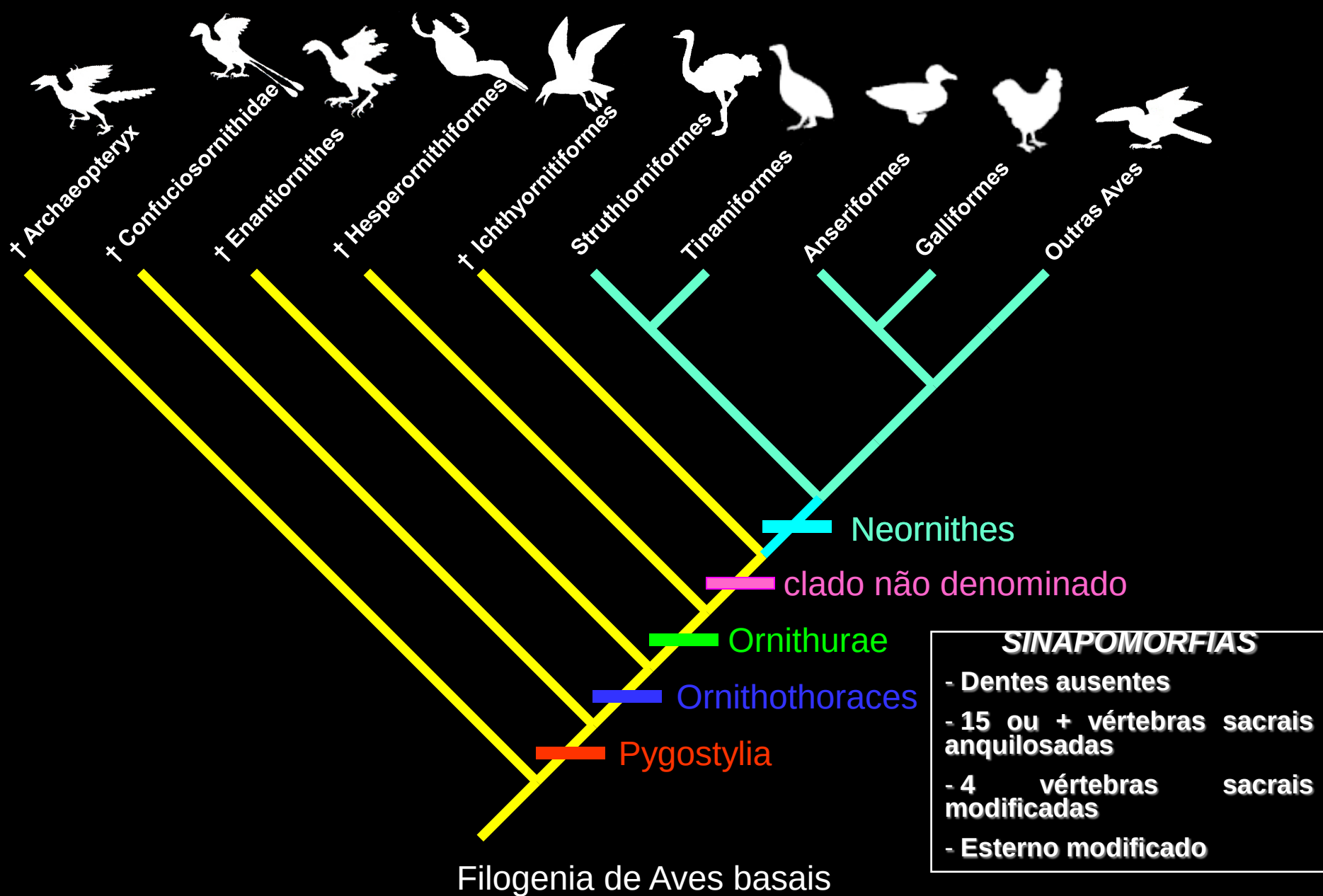
Fontes: Botelho, J.F. (2015) Skeletal plasticity in response to embryonic muscular activity underlies the development and evolution of the perching digit of birds. *Nature, Scient. Rep.*, 5 (9840):1-11.



Filogenia de Aves basais

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