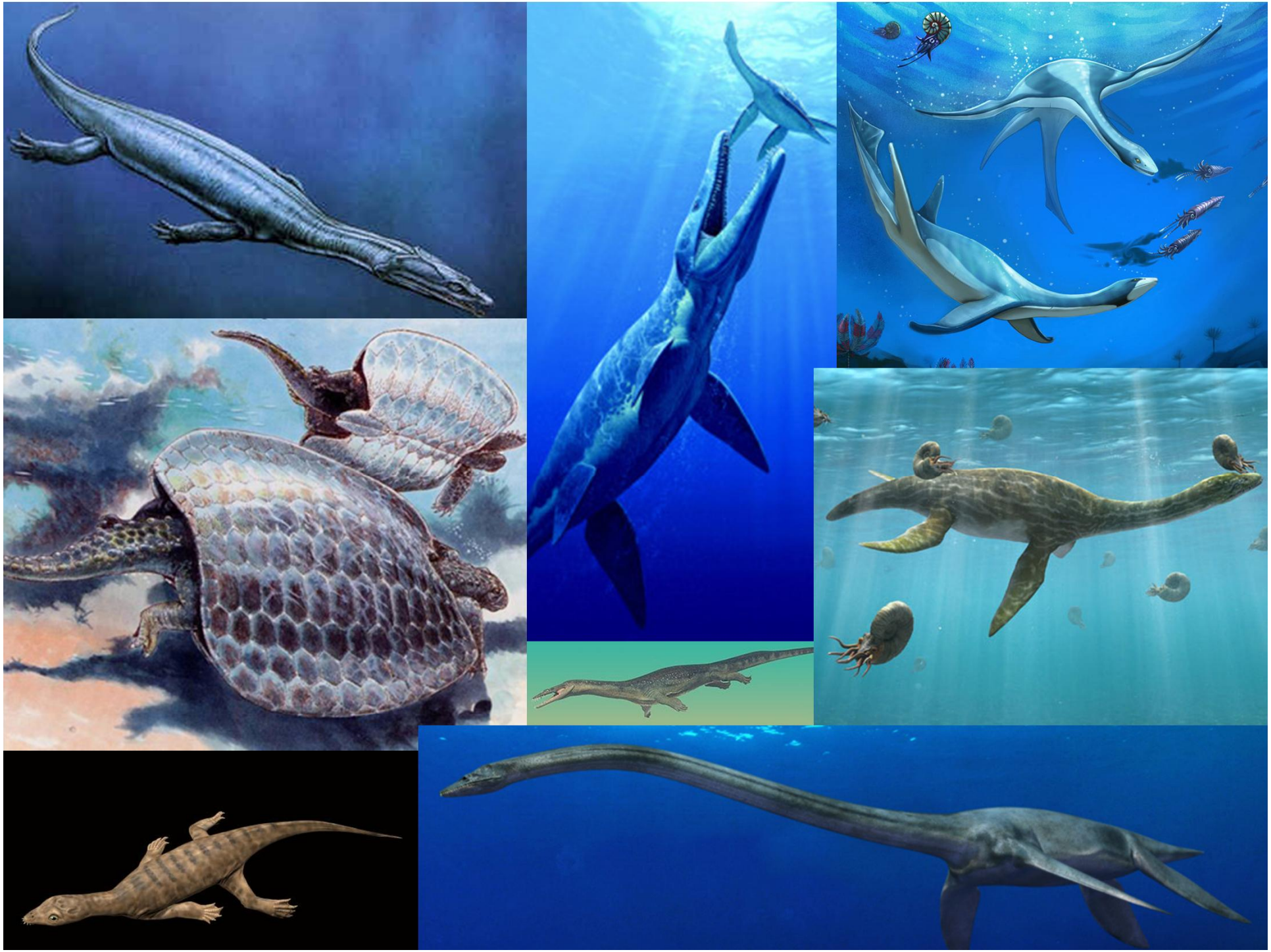
SAUROPTERYGIA

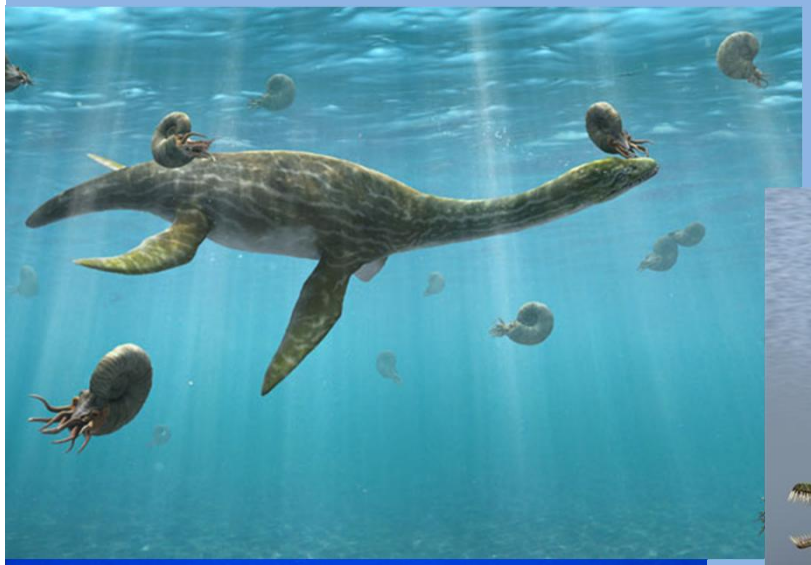
VargasLab 2018

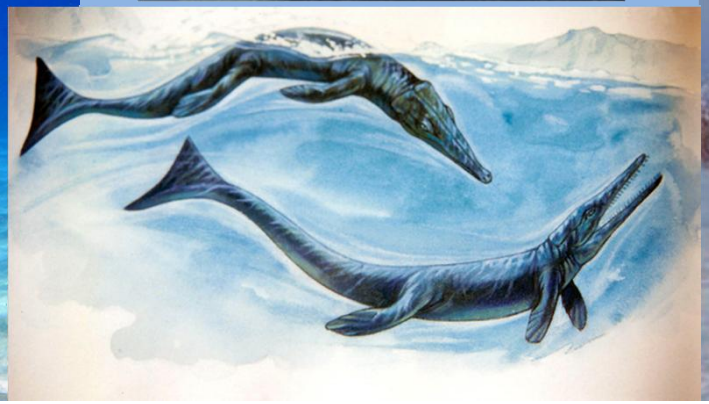


1) Introducción a Sauropterygia

-Sauropterygia: Concepto acuñado por Sir Richard Owen en 1860. Hace referencia a lagartos con aletas (del griego *saurus*, lagarto; *pterygion*; ala, aleta).

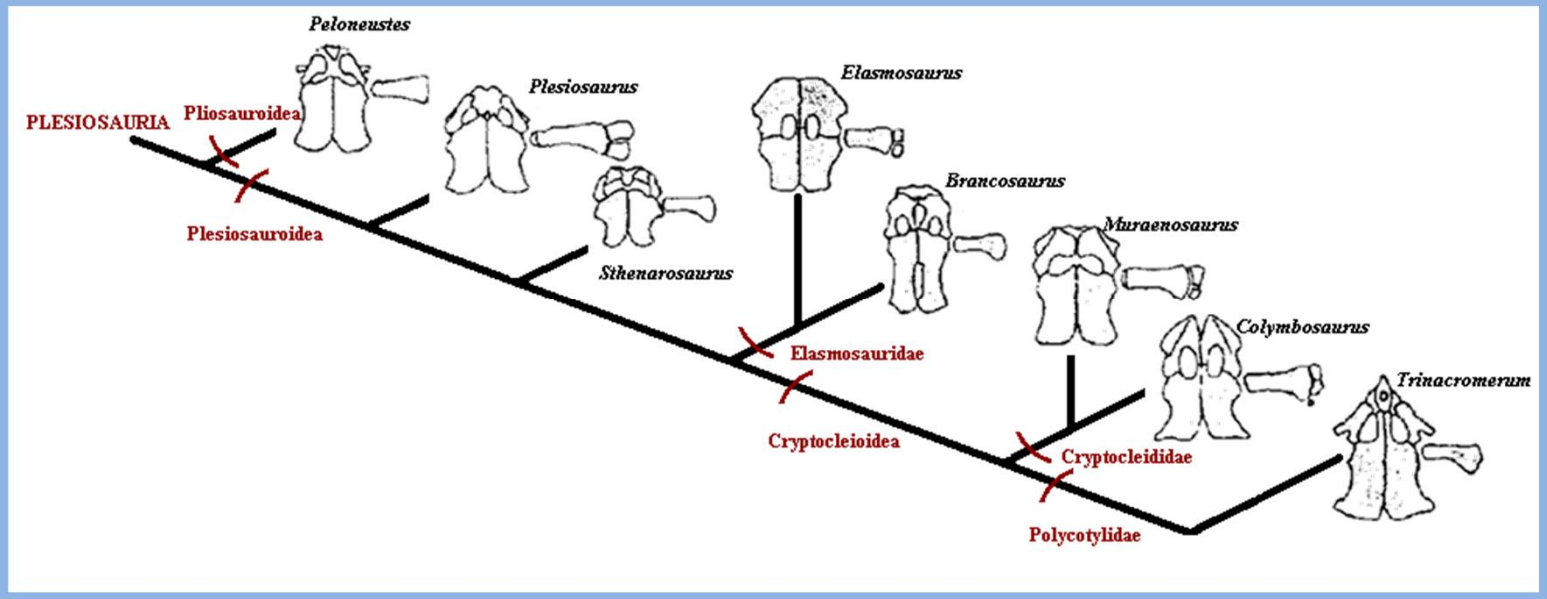
¿Qué nos dice la definición original?





1) Introducción a Sauropterygia

- Se distinguen de otros saurópsidos por una progresiva modificación de la cintura pectoral, asociada a una adaptación al ambiente acuático. Los huesos de la cintura pectoral se modifican a modo de plataformas óseas ventralizadas; junto con esto ocurre el ordenamiento de las gastralia a modo de parrilla ventral; la continuidad de este soporte óseo es dada por la ventralización de isquión y púbis en la cintura pélvica, también a modo de plataforma ósea.



- A diferencia de ictiosaurios y mosasaurios, se mantiene un bauplan en donde ni los miembros posteriores ni la cintura pélvica se reducen, llegando en algunos casos a ser las aletas posteriores más grandes que las anteriores (e.g., *Liopleurodon ferox*).

1) Introducción a Sauropterygia

Figure 12-4. SKELETON OF *PACHYPLEUROSAURUS*, A NOTHOSAUR FROM THE MIDDLE
ZERLAND. The joint surfaces of the limbs and girdles are poorly ossified and would probably not
continuous terrestrial locomotion. The limbs are otherwise little specialized for aquatic locomotion. T
force was probably produced by the tail, in which the anterior neural spines and haemal arches are
ventrally. The adult specimen is approximately 120 centimeters long. *From Carroll and Gaskill, 1985.*

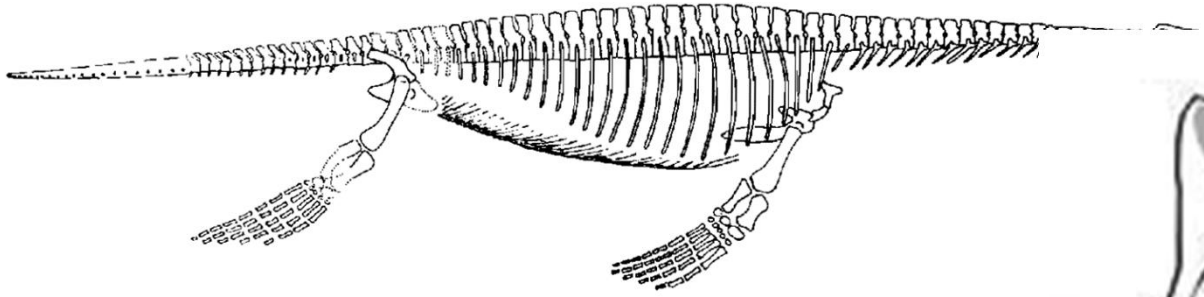
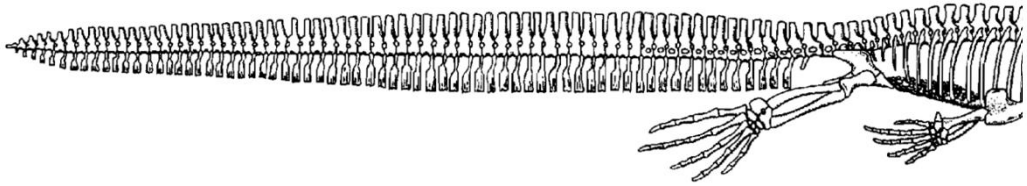


Figure 12-10. SKELETON OF *PISTOSAURUS*. The postcranial skeleton was found
the skull but not in direct articulation. If the association is correct, this genus combines
like that of typical nothosaurs with a skull similar to that of plesiosaurs. Length ap
From von Huene, 1948.



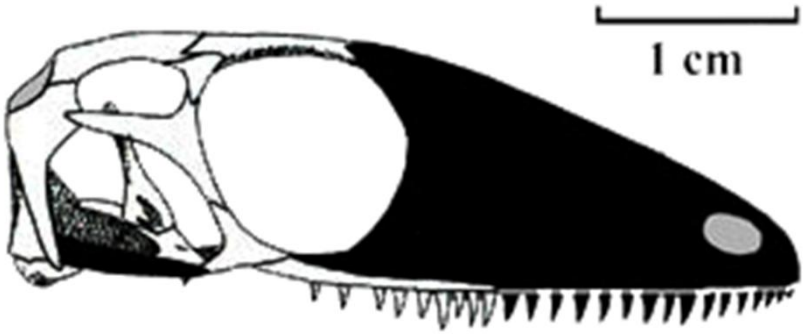
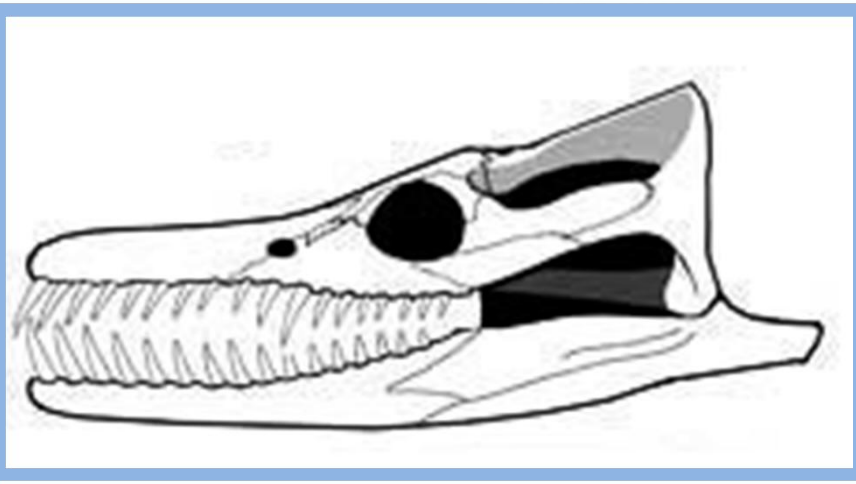
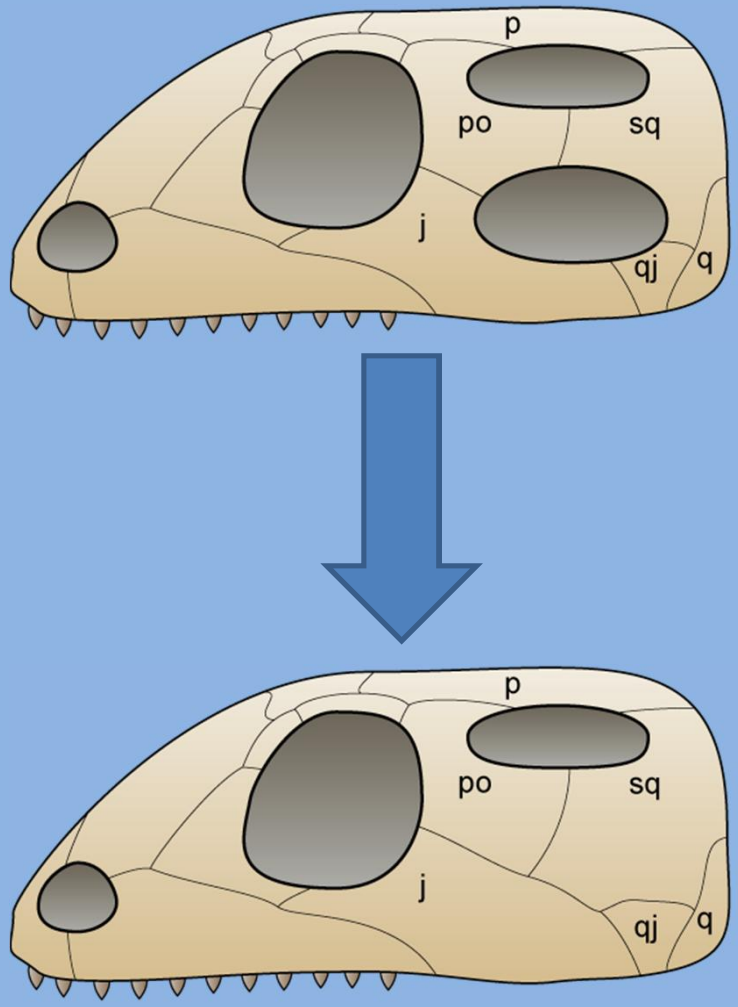


Figure 11-12. *HOVASAURUS*, AN AQUATIC EOSUCHIAN FROM THE UPPER PERMIAN OF
proximately 50 centimeters long. Most of the specimens of this genus have small stones in the abdon
have served as ballast. *From Currie, 1981.*

1) Introducción a Sauropterygia

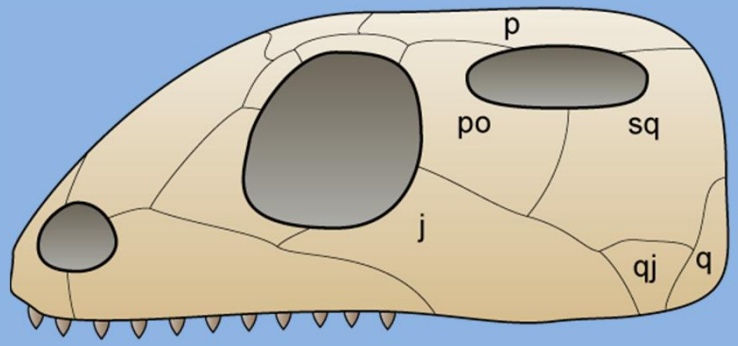


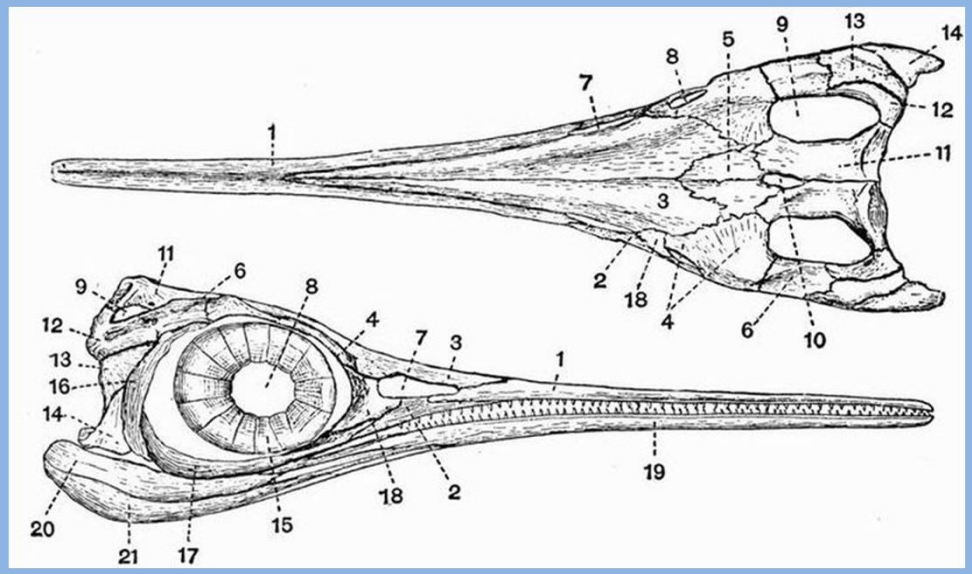


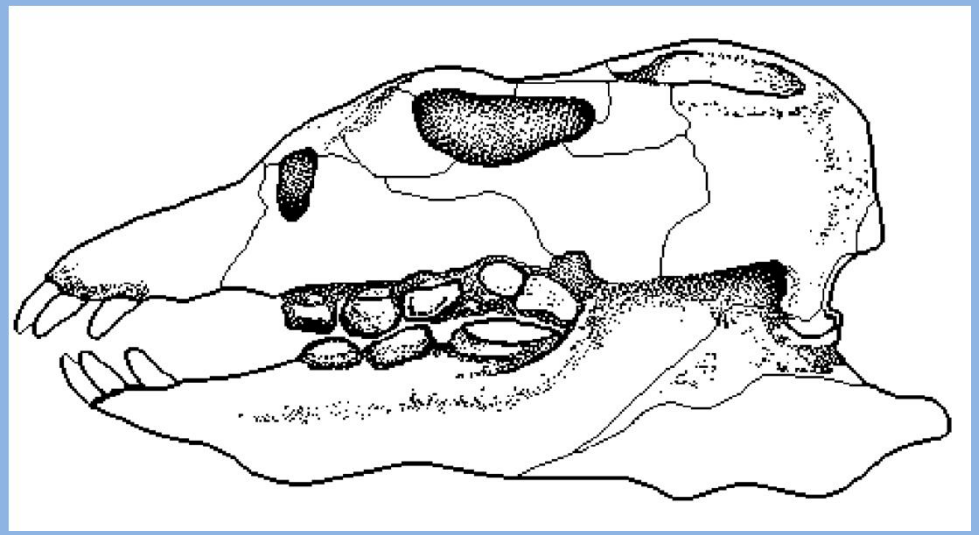
Cráneo euryápsido (diápsido derivado).

-Se pierde la barra cuadrato-yugal.
-Tendencia a la dorsalización y ampliación de la fosa temporal

1) Introducción a Sauropterygia







Sin embargo, el cráneo “euryápsido“ aparece independientemente en sauropterygios más derivados (Eosauropterygia) y en al menos otros dos linajes: Ichthyopterygia y Placodontia.

1) Introducción a Sauropterygia

En resumen:

-pérdida definitiva del bauplan tipo lagarto (cuello corto, tronco elongado y cola muy larga) en formas derivadas. La longitud de la cola se vuelve reducida en todos los representantes jurásicos y cretácicos, mientras que la longitud del cuello es variable en distintos taxa.

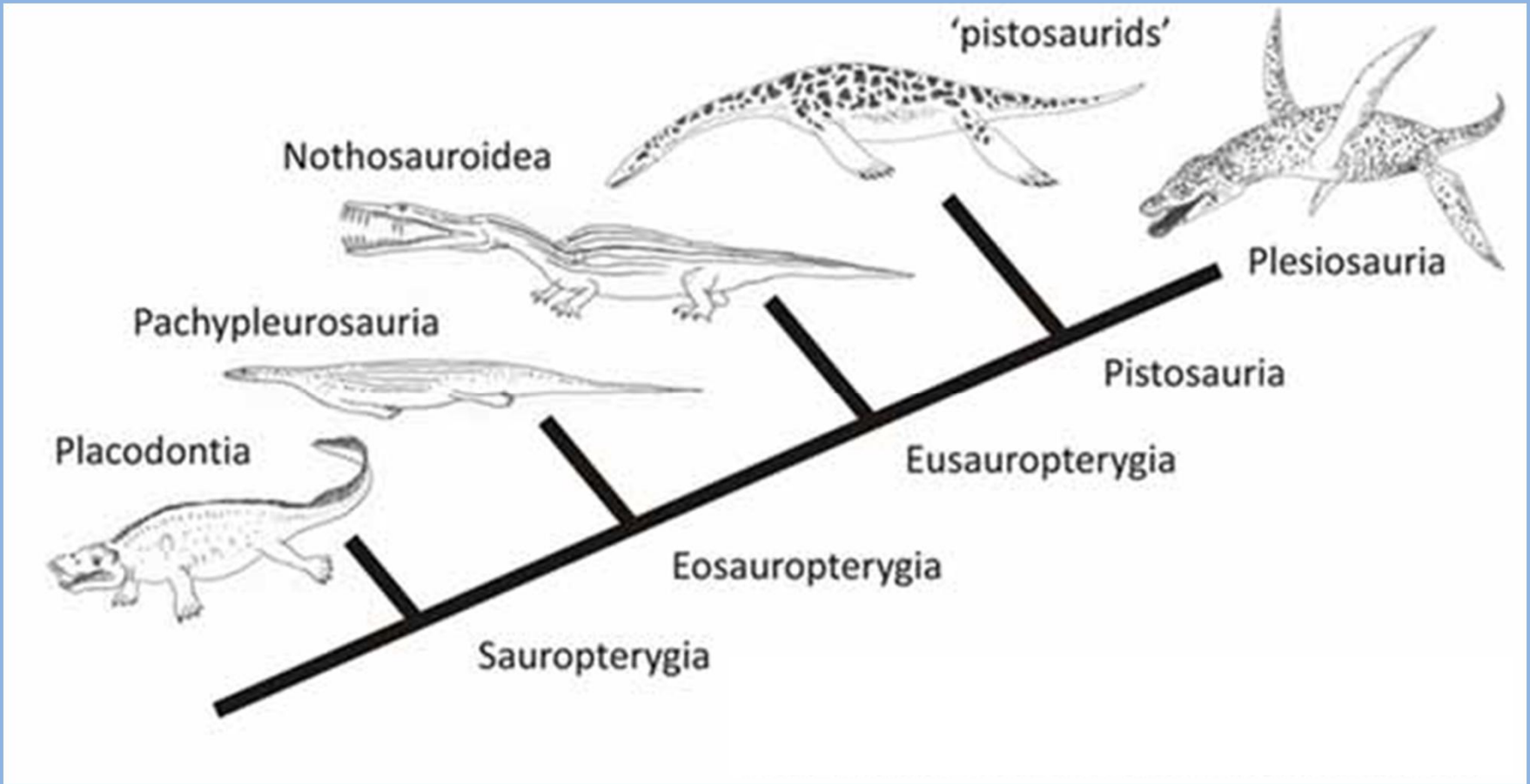
-Cráneo euryápsido (diápsido derivado). El cráneo presenta una solo fosas temporales, de ubicación dorsal y amplias.

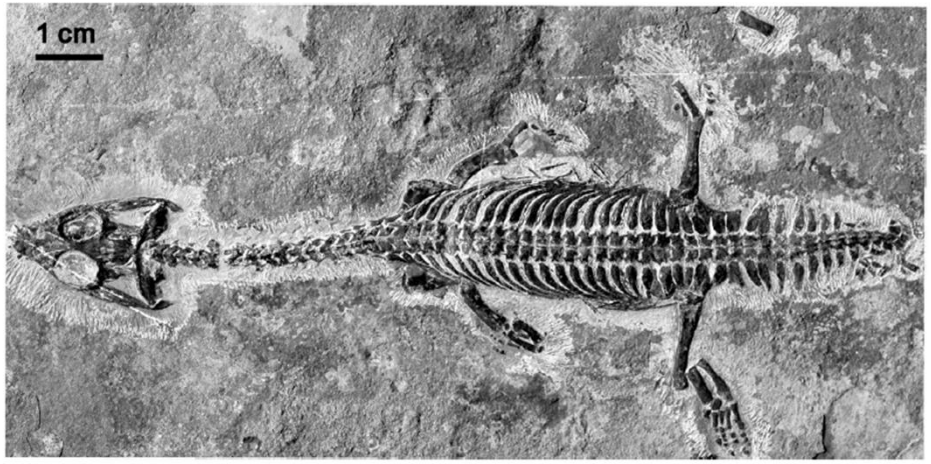
-los cuatro miembros se mantienen bien desarrollados en todos los representantes.

-parrilla ventral ósea conformada por cintura pectoral, gastralia y cintura pélvica.

1) Introducción a Sauropterygia

Actualmente hay un concenso creciente sobre las relaciones de ancestro-descendiente dentro del clado Sauropterygia, sin embargo, la ubicación filogenética del grupo dentro de Sauropsida sigue en discusión.





Liu et al., 2011. JVP.

FIGURE 2. Skeleton of the holotype of *Dianopachysaurus dingi* (LPV 31365).

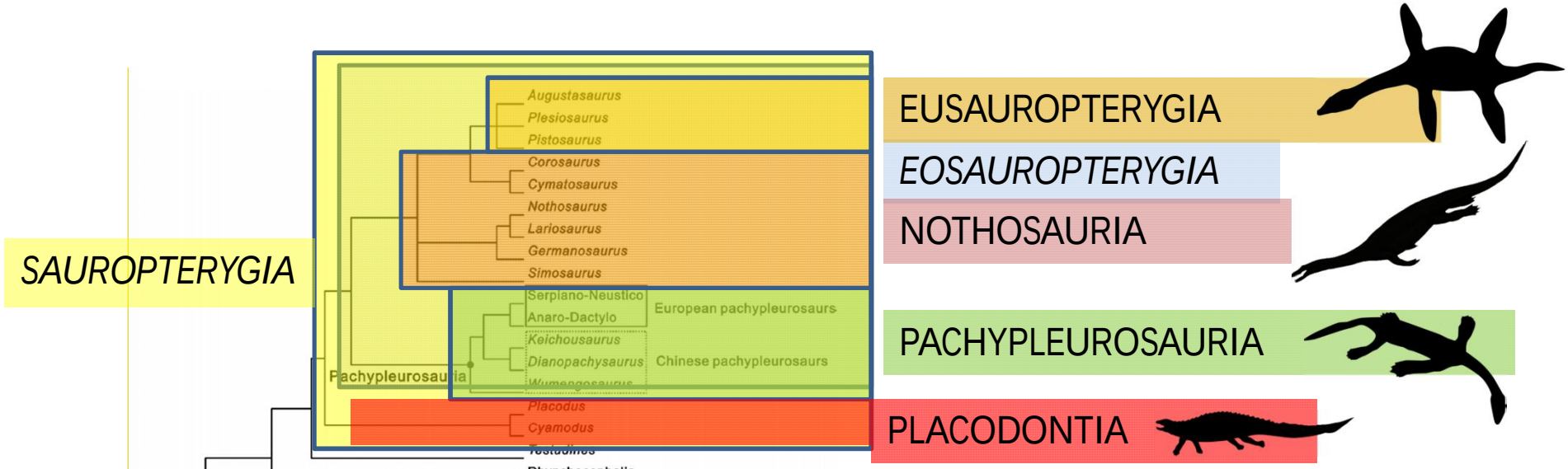


FIGURE 8. Strict consensus tree (8 MPTs, TL = 403, CI = 0.4367, HI = 0.5633, RI = 0.7093, RC = 0.3098) showing phylogenetic relationships of Chinese pachypleurosaurs.

Rieppel, 1994.

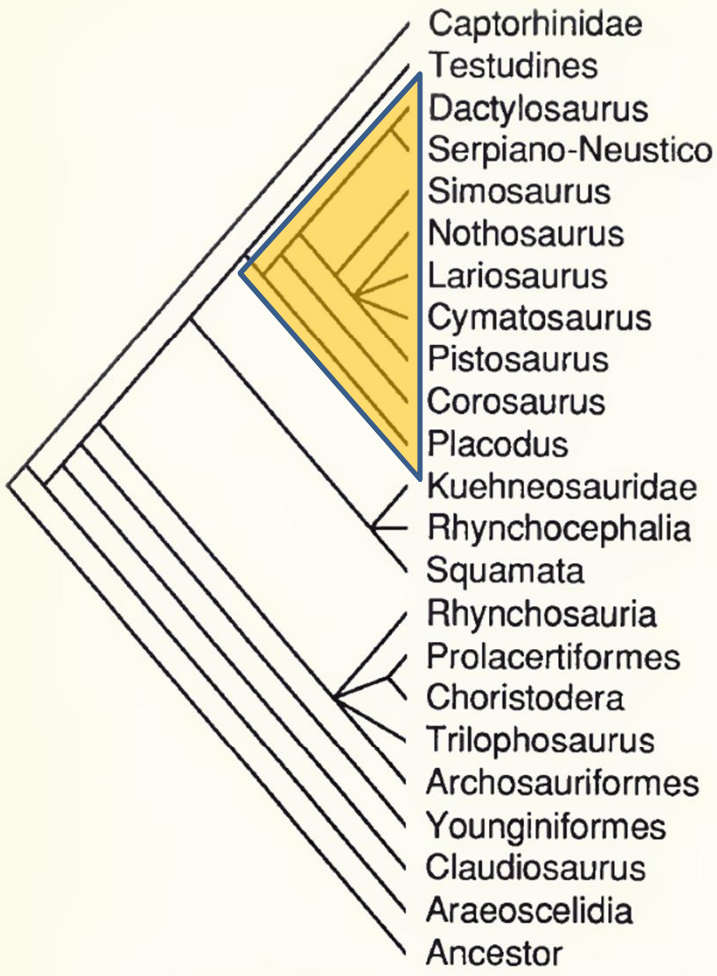


FIG. 68. Strict consensus tree (of 36 MPRs; TL = 351, CI = 0.650, RC = 0.471) for 22 reptile taxa rooted on an all-zero ancestor. For further discussion, see text.

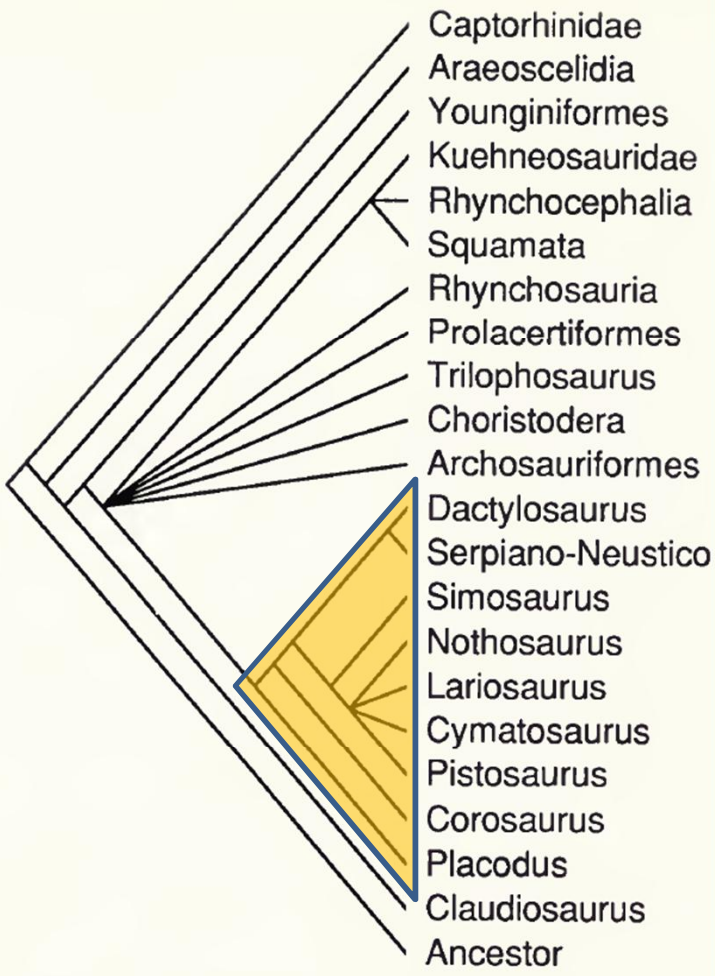


FIG. 69. Sauropterygian interrelationships among the Reptilia with the Testudines omitted from the analysis (strict consensus tree of 48 MPRs; TL = 323, CI = 0.633, RC = 0.491). For further discussion, see text.

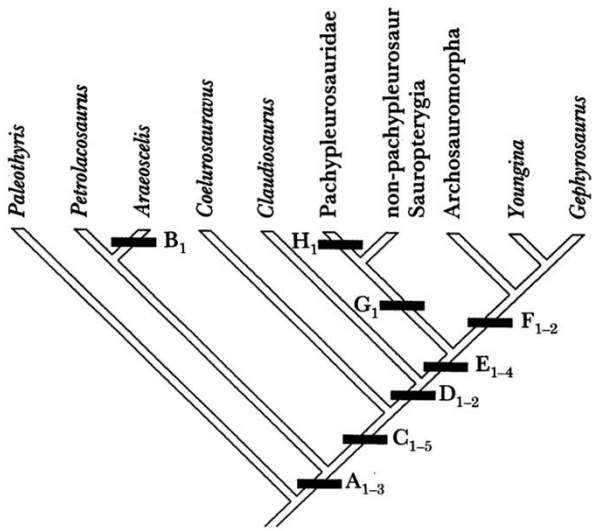


FIGURE 12. A cladogram of sauropterygian interrelationships (for further explanation see text).

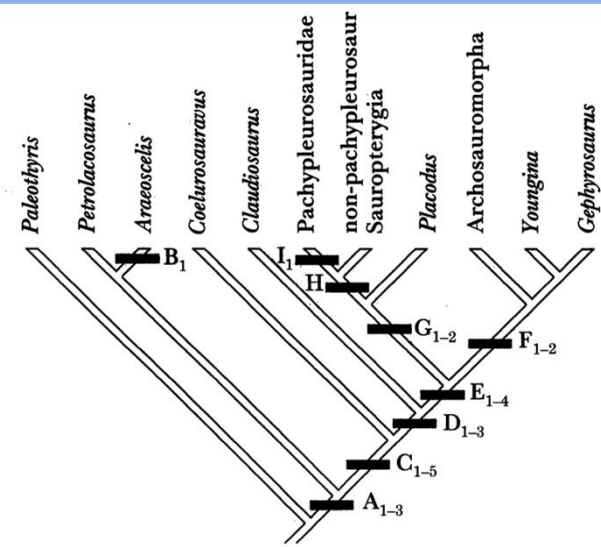


FIGURE 13. A cladogram of euryapsidan interrelationships (for further explanation see text).

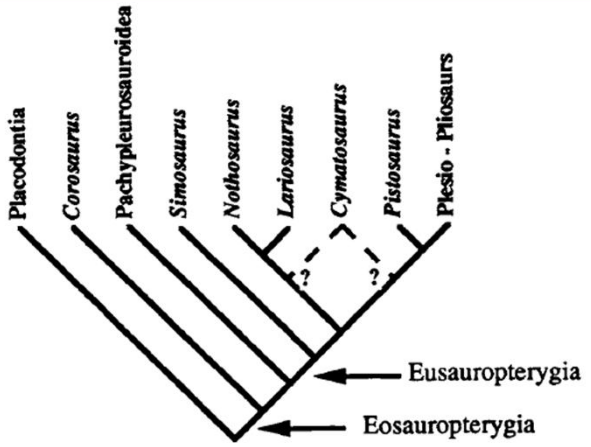


Figure 1. Hypothetical relationships of the Sauropterygia. See text for further discussion.

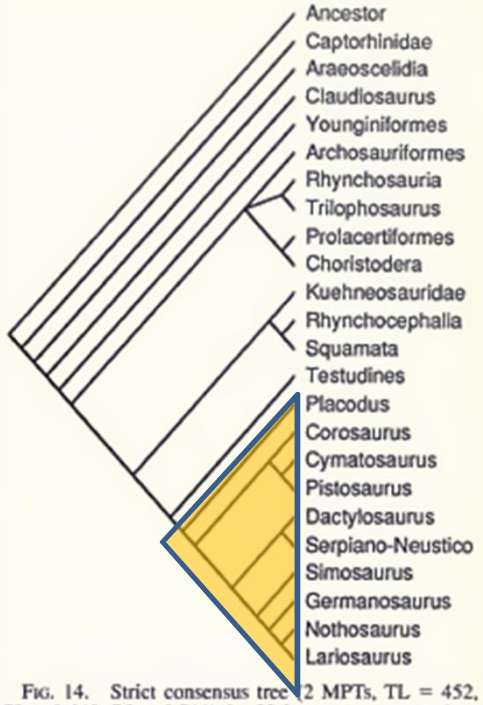


FIG. 14. Strict consensus tree (2 MPTs, TL = 452, CI = 0.648, RI = 0.711) for 23 ingroup taxa rooted on an all-0 ancestor. For further discussion see text.

Nuevos hallazgos y nuevos análisis filogenéticos están dando luces sobre la ancestría de sauropterygios y su relación con otros Sauria basales.

Bever et al., 2015

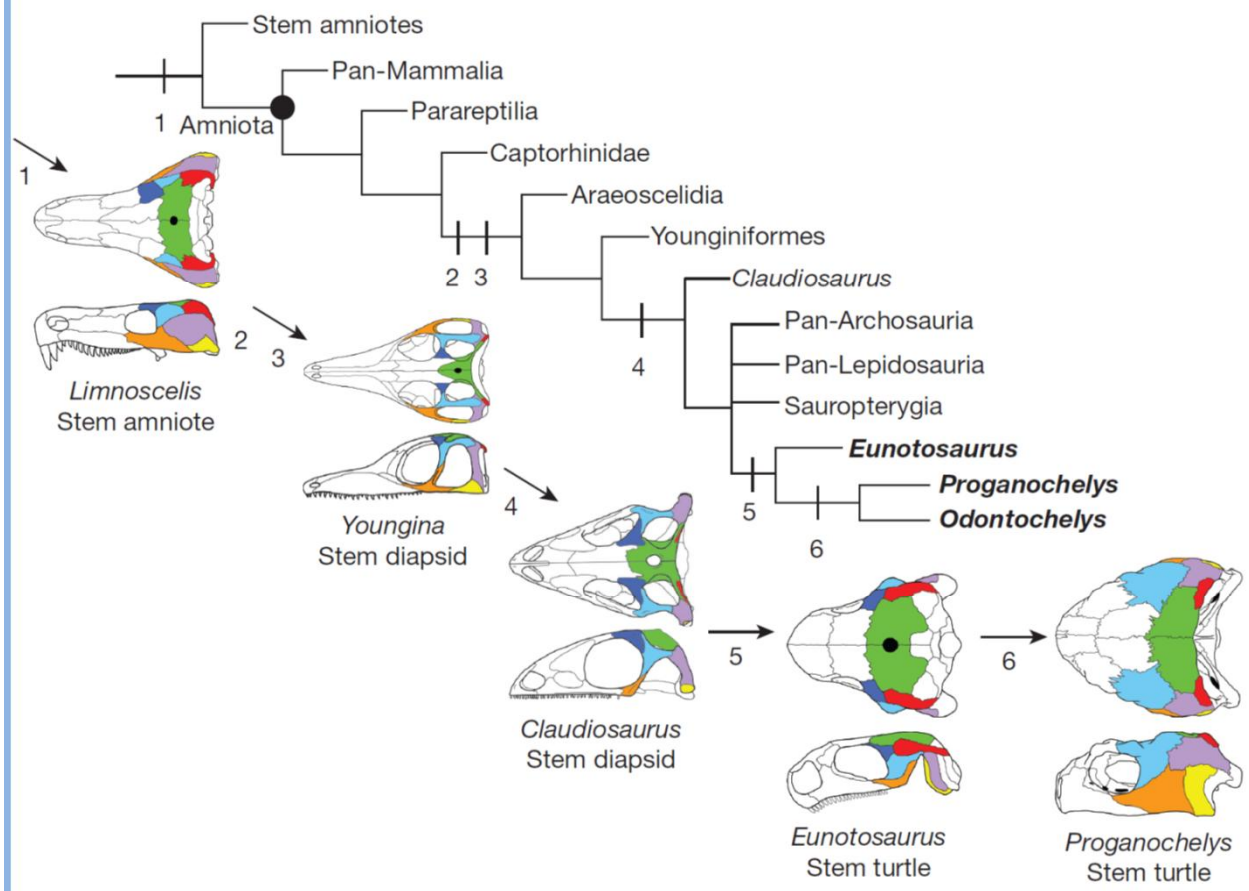
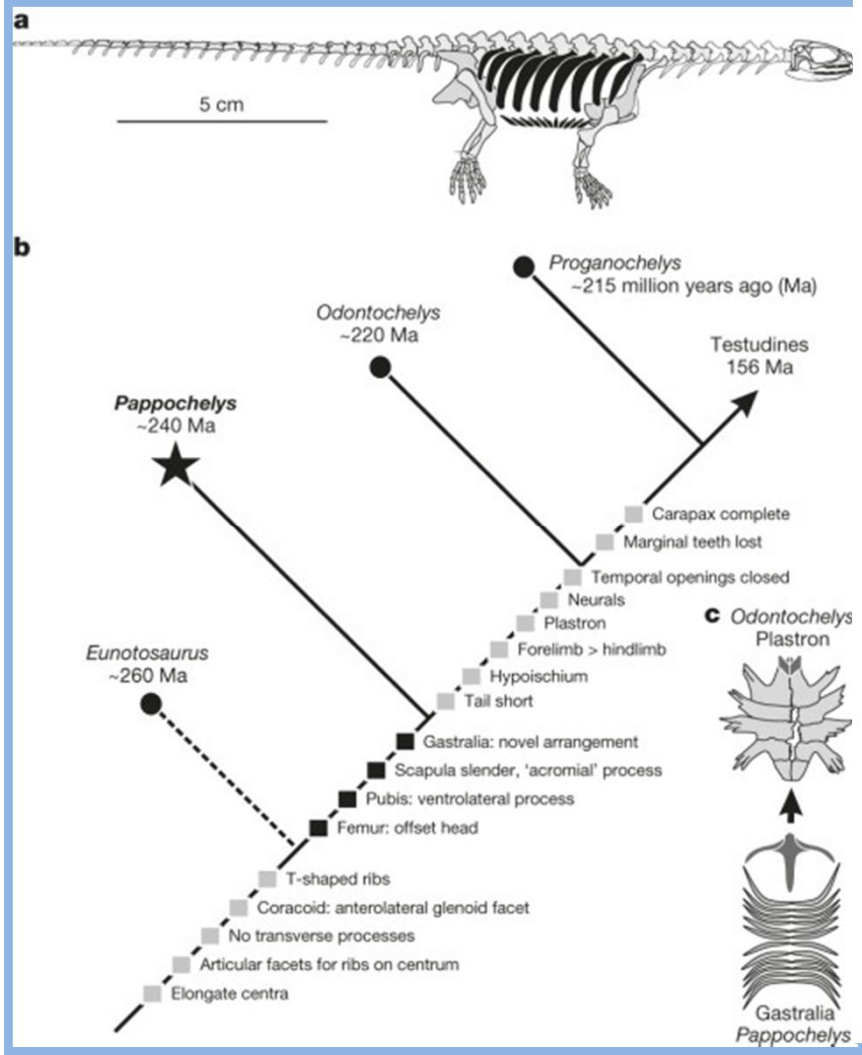
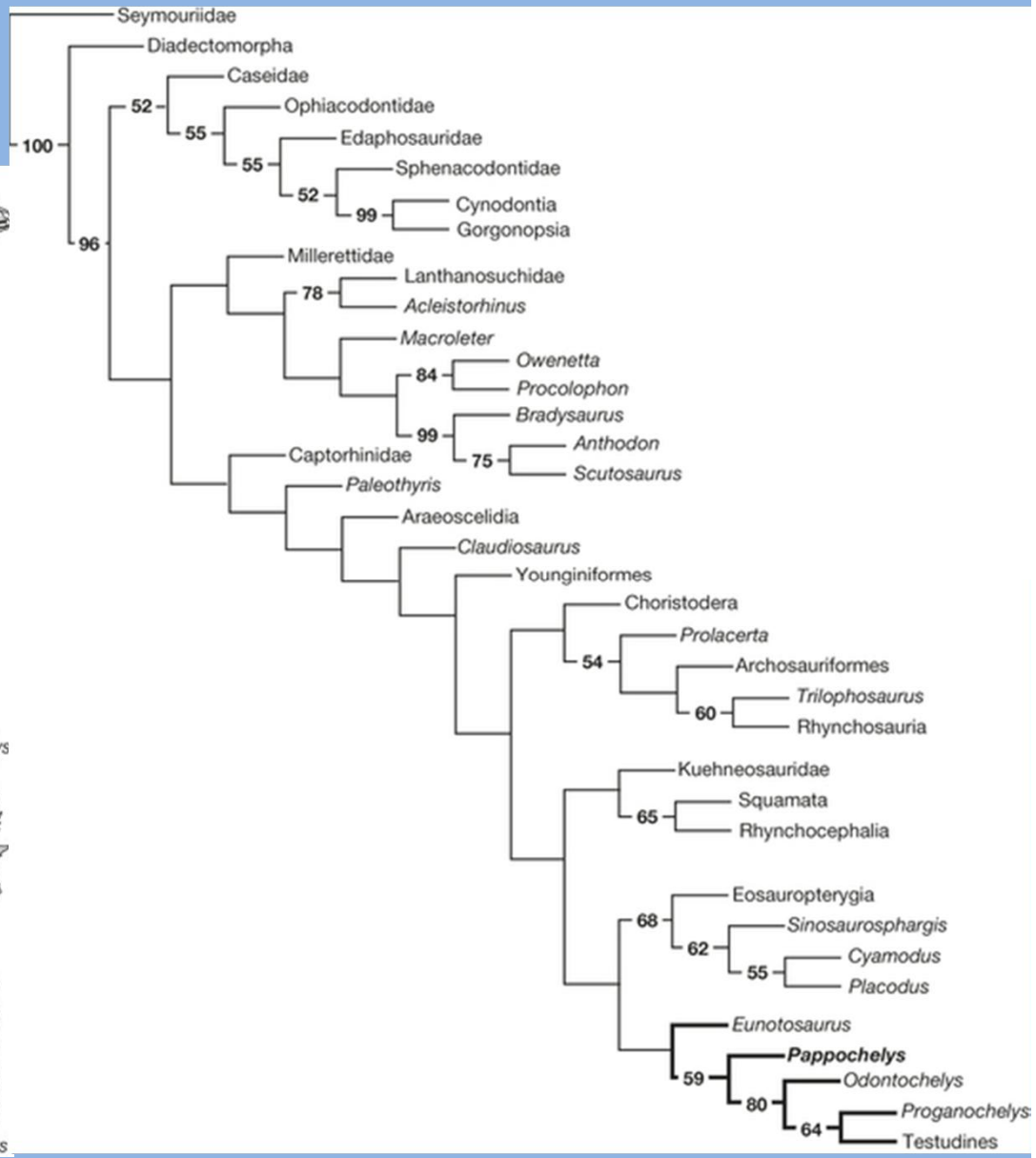
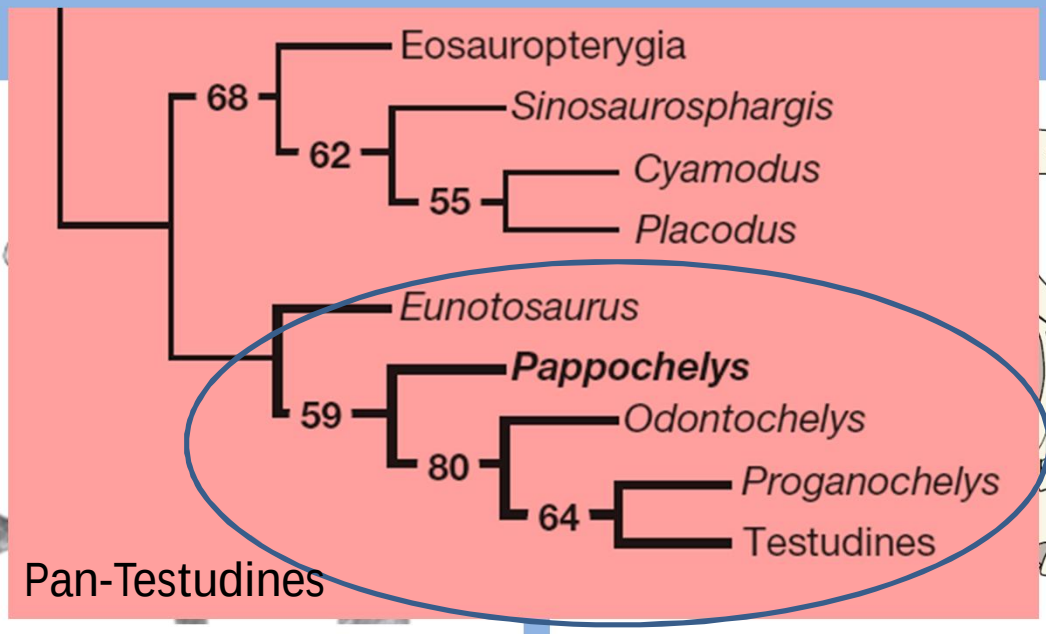


Figure 4 | Generalized amniote phylogeny showing sequence of major transformations in the origin of the turtle skull. (**1**) Ancestral crown amniote retains anapsid condition of amniote stem. (**2**) and (**3**) LTF and UTF appear, producing a fully diapsid skull. (**4**) Loss of lower temporal bar results in ventrally open LTF. (**5**) Size of UTF and LTF constricted through postnatal expansion of surrounding dermal elements (most notably postorbital and squamosal). Superficial covering of the UTF by the supratemporal, as expressed in *Eunotosaurus*, may or may not be ancestral to modern turtles. (**6**) Closure of LTF and UTF, perhaps involving a peramorphic shift in dermal bone growth. A secondary reduction of the supratemporal also may have occurred at this point.

Schoch & Sues, 2015







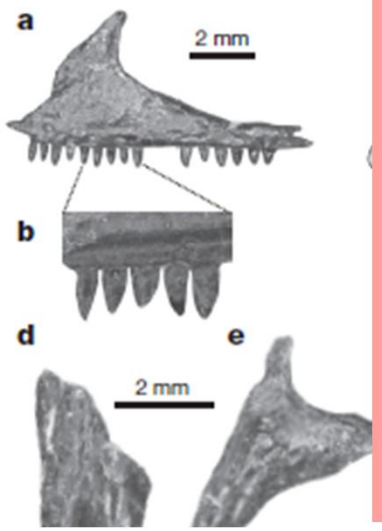
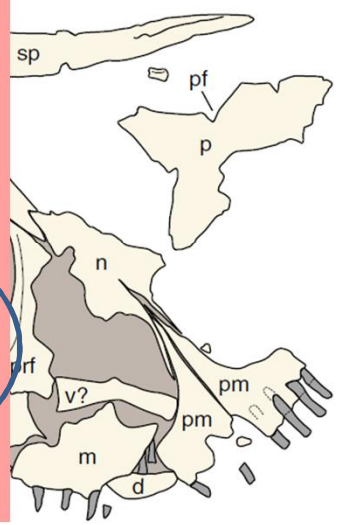


Figure 2 | Skull elements of *P. rosinae* (digitally extracted from surrounding matrix). **a**, **b**, Left maxilla (SMNS 91431; **a**, labial view; **b**, lingual view of marked section); **c**, skull reconstruction in lateral view, with preserved elements indicated in grey; **d**, right parietal (SMNS 91356); **e**, right postorbital (SMNS 91356); **f**, right squamosal (SMNS 90013); **g**, right quadrate (SMNS 90013); **h**, left jugal (SMNS 92066, broken into two segments and partly preserved as an impression); **i**, left dentary (SMNS 92066).



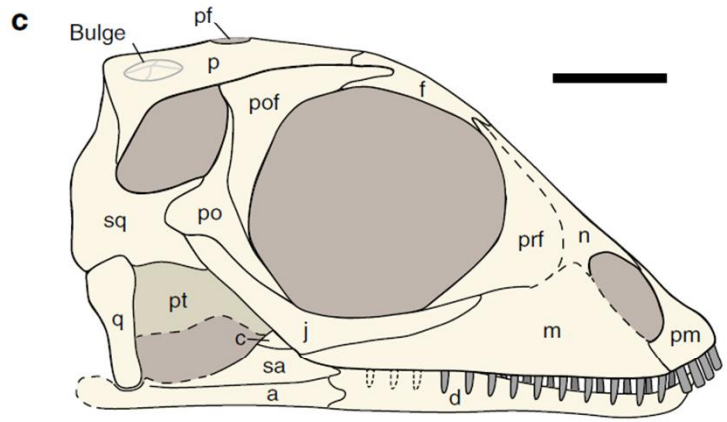
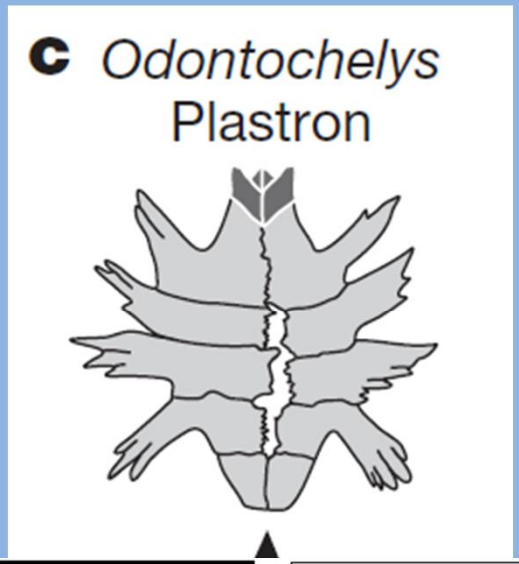
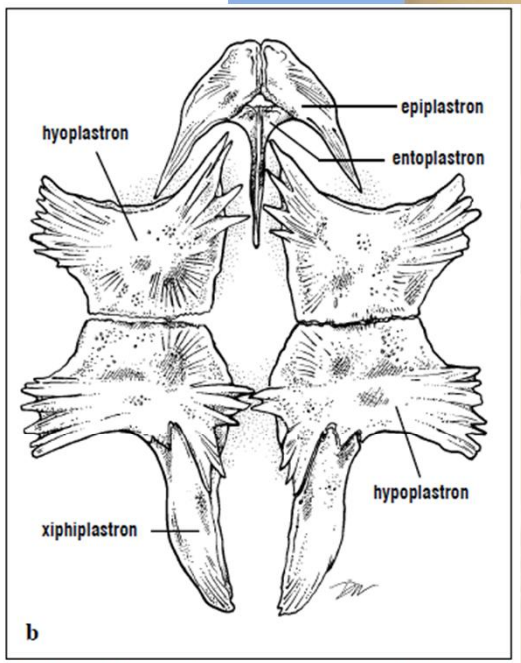
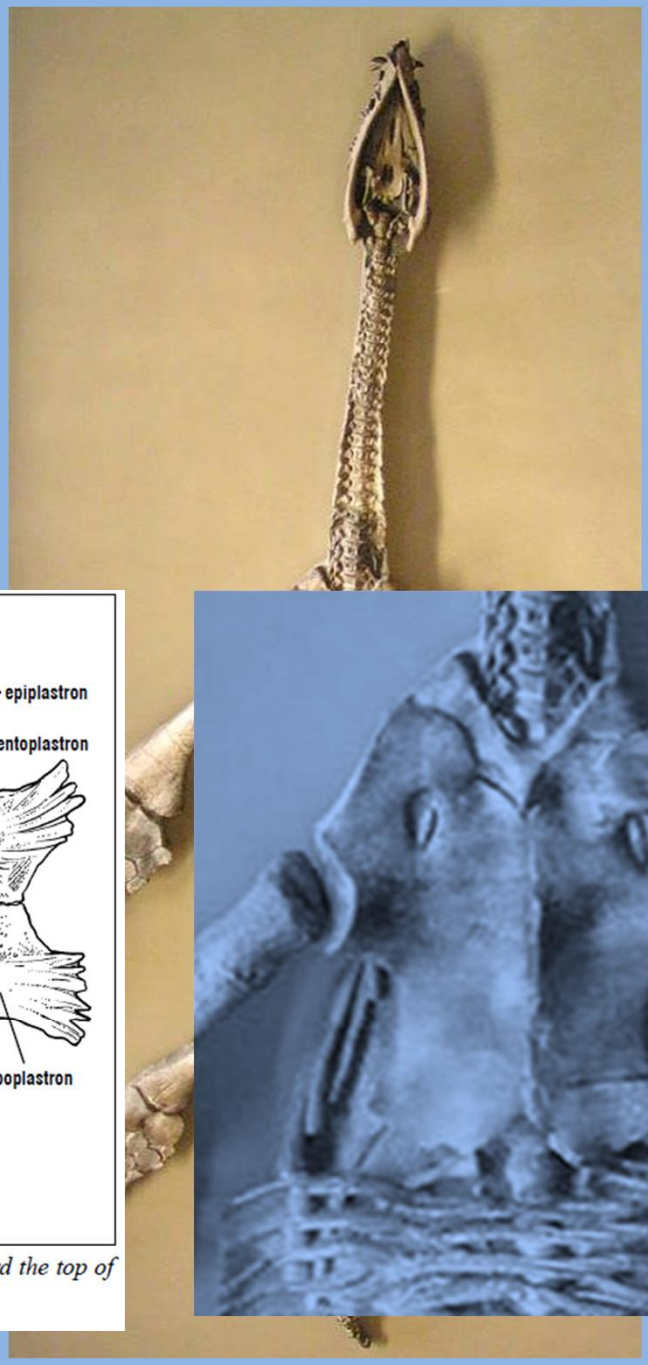


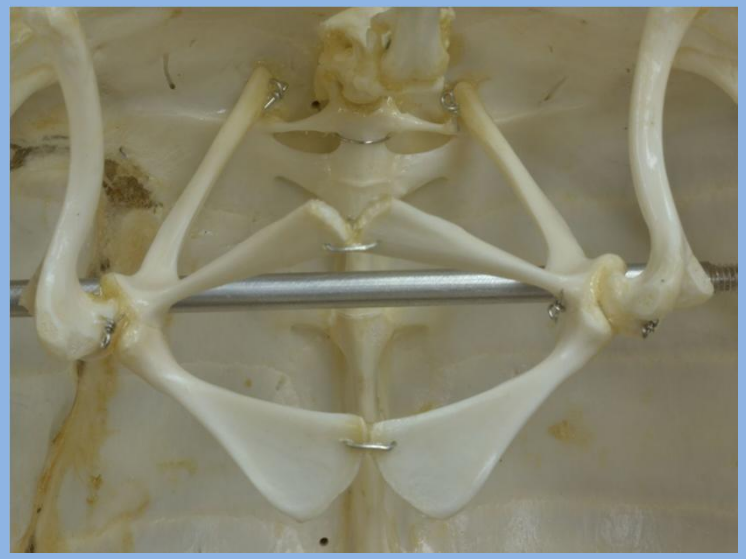
Figure 1 | *Palatodonta bleekeri* genus et species nova holotype (TW480000470). (**a**) Right lateral view of the specimen with disarticulated elements inset. (**b**) Labelled interpretation. (**c**) Reconstruction in lateral view. a, angular; c, coronoid; d, dentary; f, frontal; j, jugal; m, maxilla; n, nasal; p, parietal; pf, pineal foramen; pl, palatine; pm, premaxilla; po, postorbital; pof, postfrontal; prf, prefrontal; pt, pterygoid; q, quadrate; sa, surangular; sp, splenial; sq, squamosal; v, vomer. Scale bar, 3 mm.

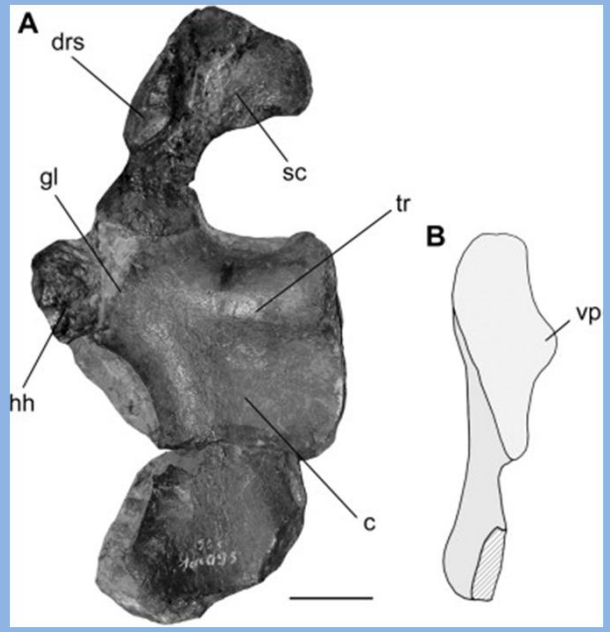




Figs. 97a and 97b. *The plastron is composed of 9 bones that are separate in hatchlings but become fused in older turtles. Anterior is toward the top of the picture.*



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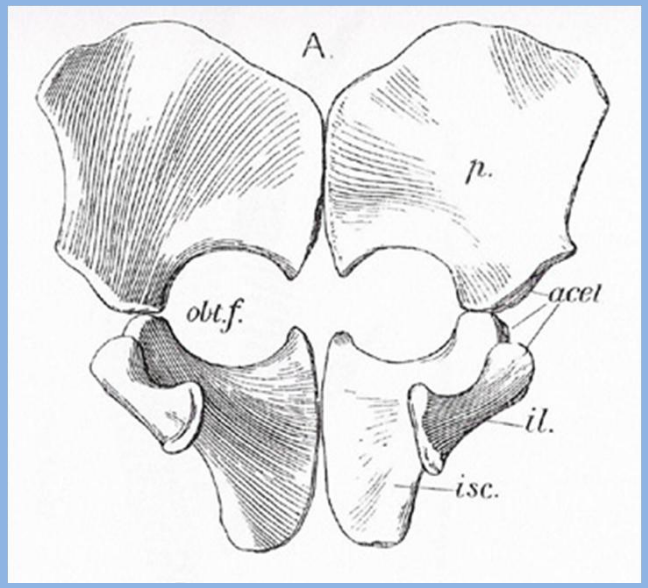
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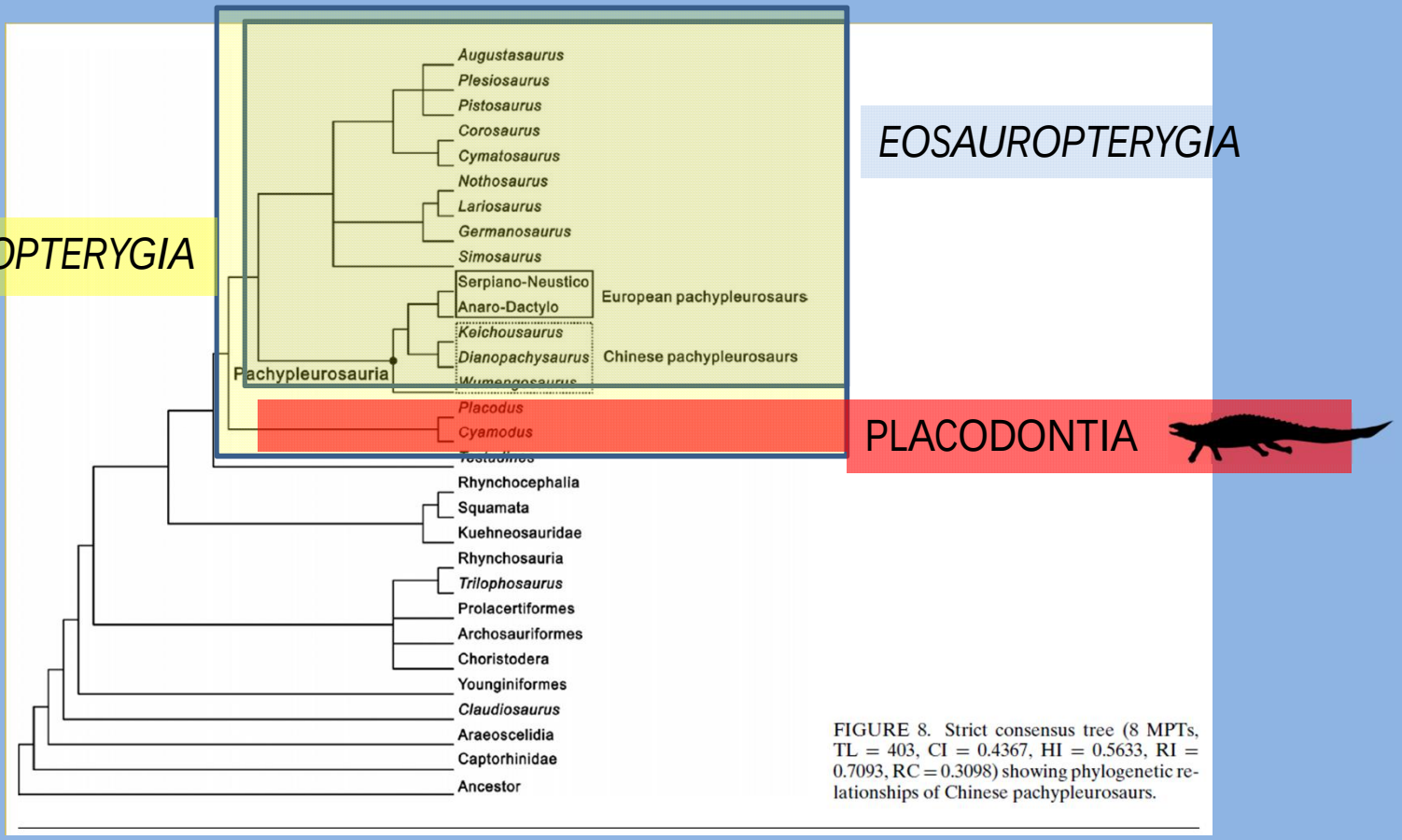
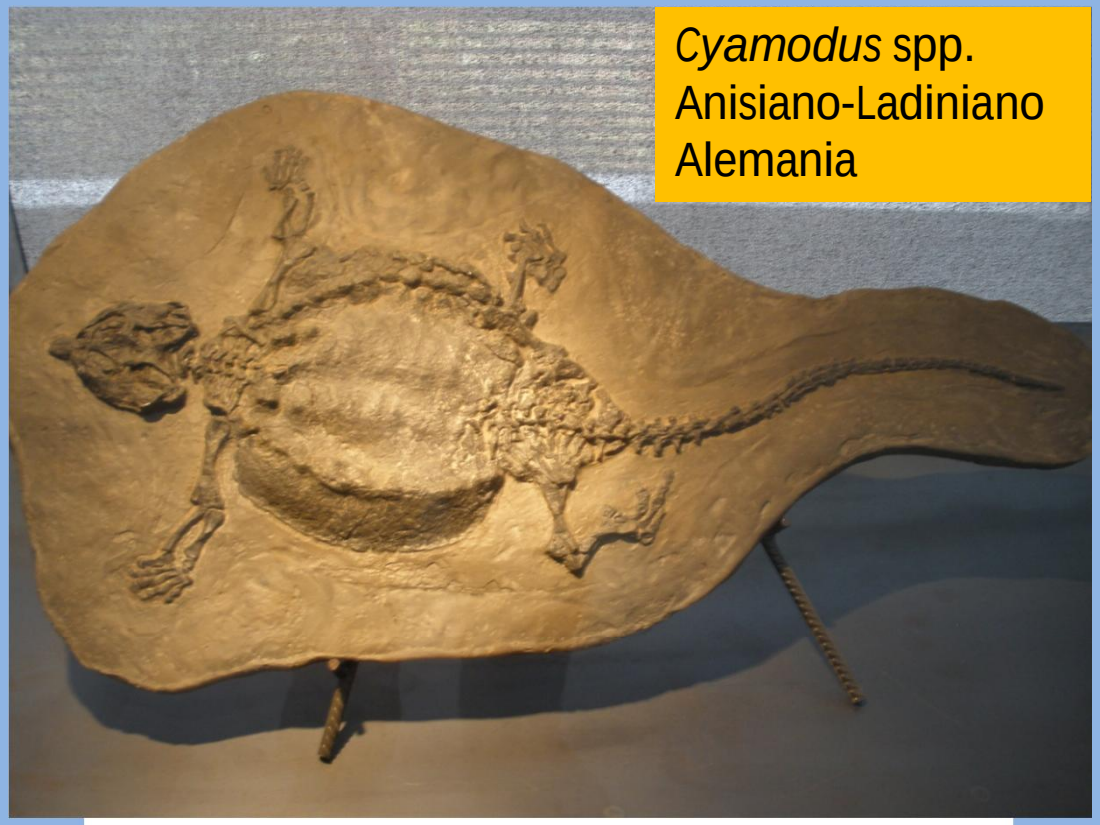


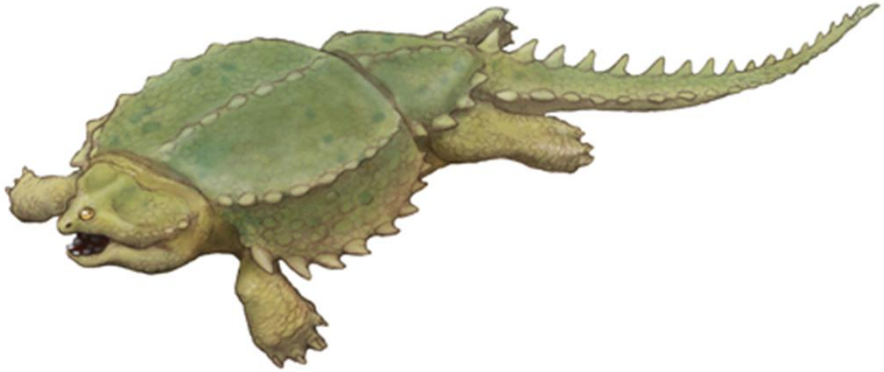
FIGURE 8. Strict consensus tree (8 MPTs, TL = 403, CI = 0.4367, HI = 0.5633, RI = 0.7093, RC = 0.3098) showing phylogenetic relationships of Chinese pachypleurosaurs.

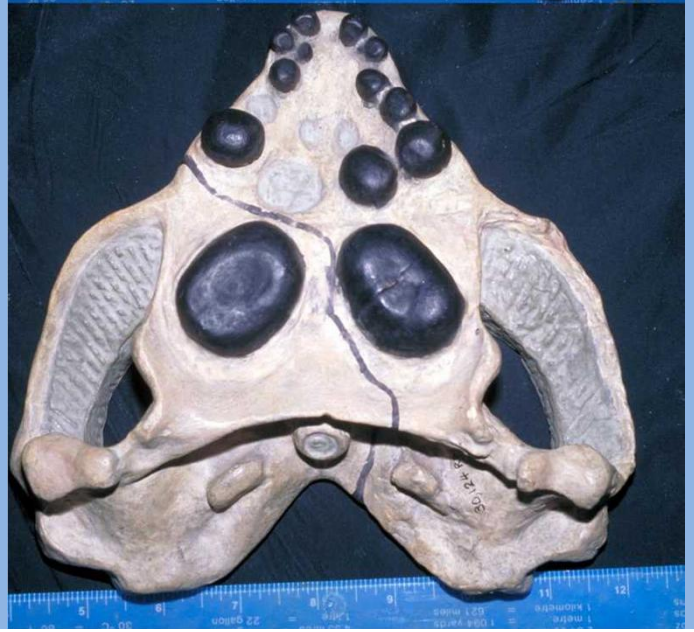
Sauropterygia Owen, 1860

Placodontia Cope, 1871, sensu Rieppel, 2000



Cyamodus spp.
Anisiano-Ladiniano
Alemania

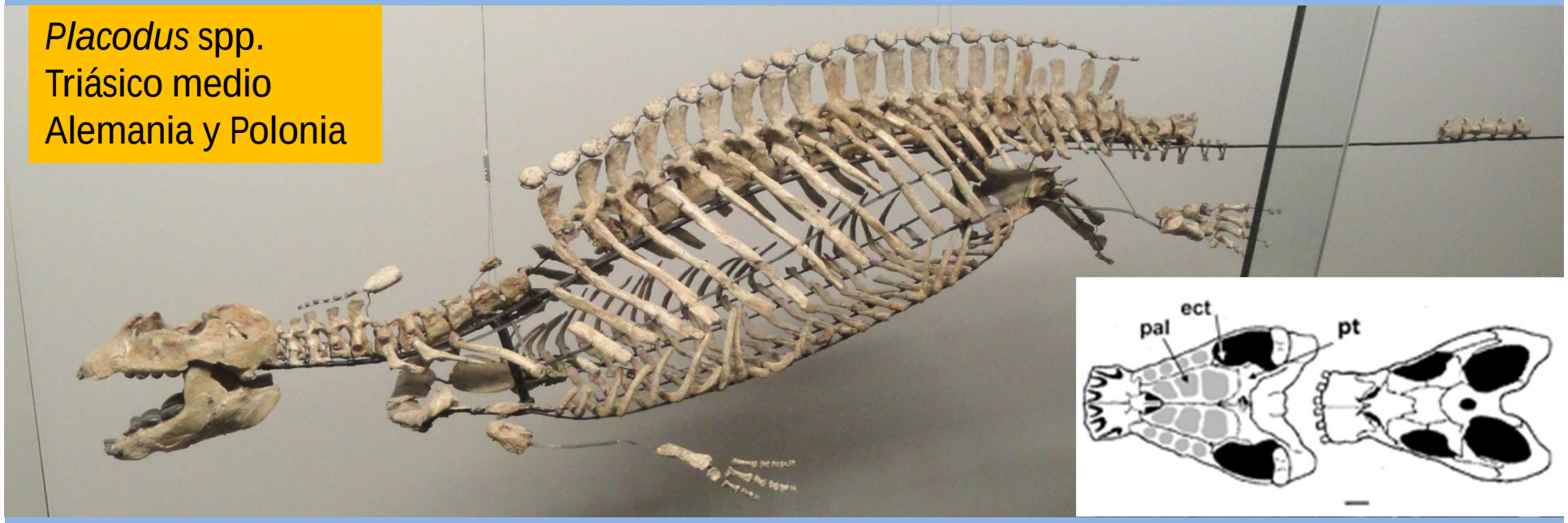


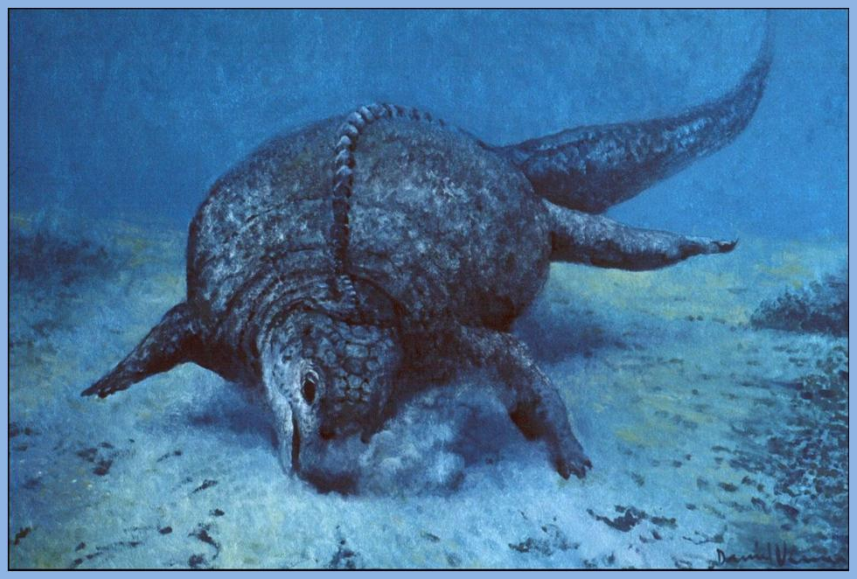


Sauropterygia Owen, 1860

Placodontia Cope, 1871, sensu Rieppel, 2000

Placodus spp.
Triásico medio
Alemania y Polonia





Sauropterygia Owen, 1860

Placodontia Cope, 1871, sensu Rieppel, 2000

Henodus chelyops Von Huene, 1936

Carniano (Triásico tardío)

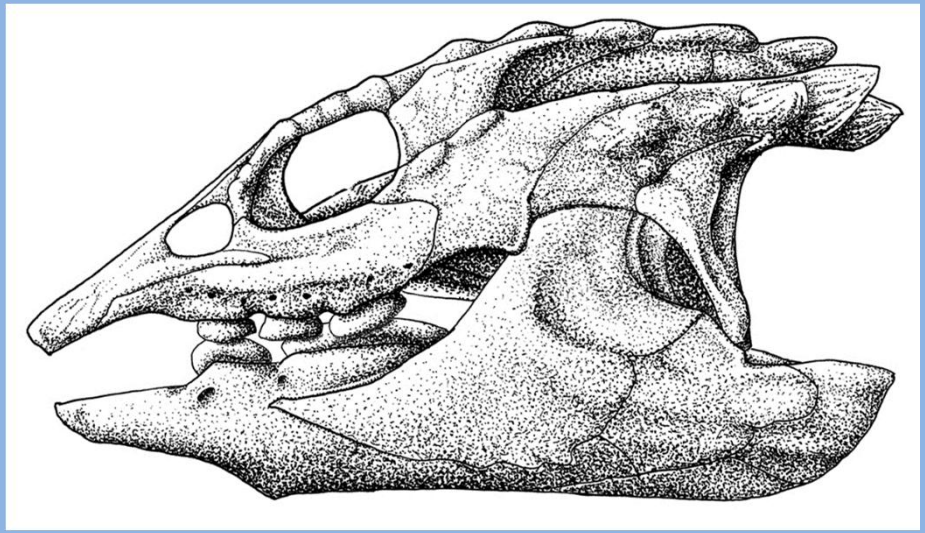
Alemania

Sauropterygia Owen, 1860
Placodontia Cope, 1871, sensu Rieppel, 2000

Henodus chelyops Von Huene, 1936
Carniano (Triásico tardío)
Alemania

Sauropterygia Owen, 1860

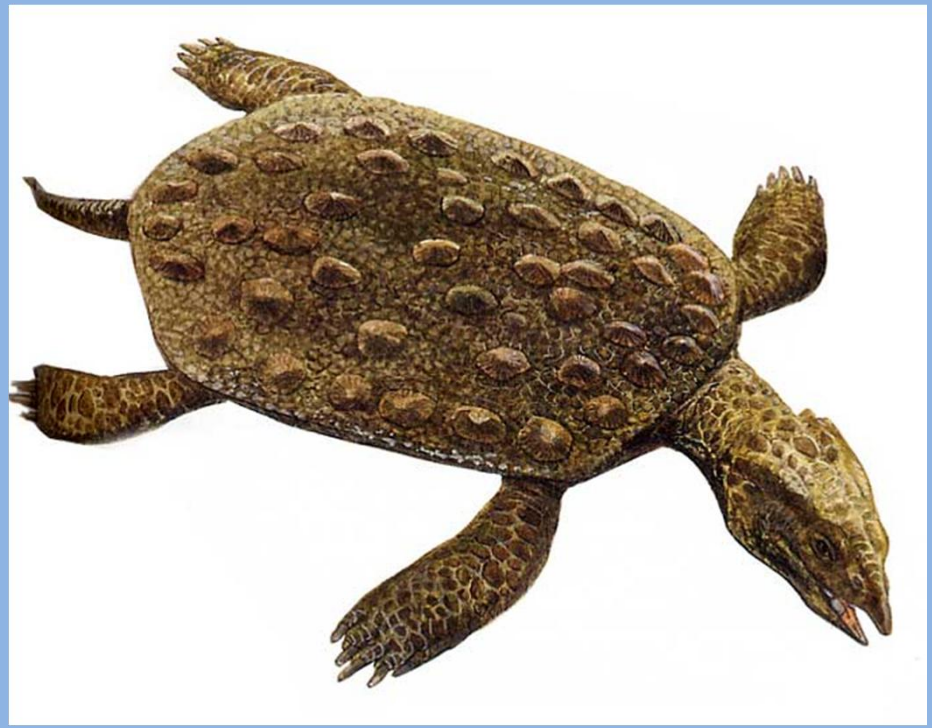
Placodontia Cope, 1871, sensu Rieppel, 2000

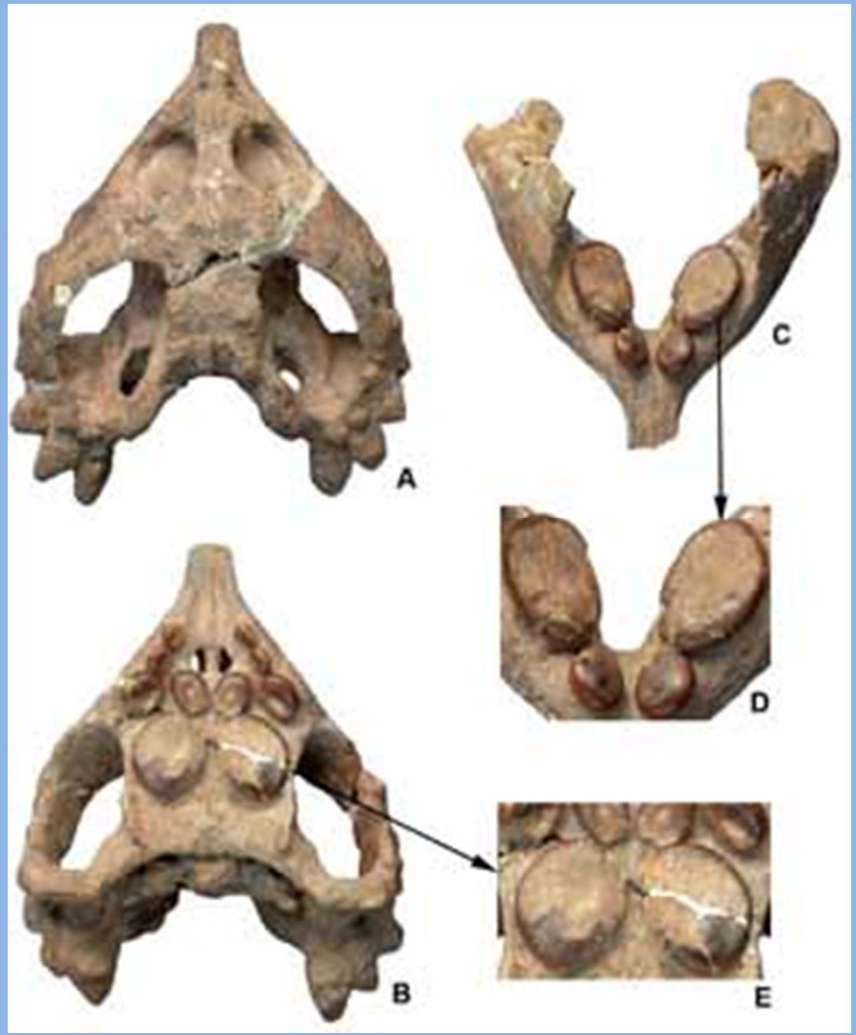


Placochelys placodonta Jaeckel, 1902

Carniano (Triásico tardío)

Alemania





Sauropterygia Owen, 1860

Placodontia Cope, 1871, sensu Rieppel, 2000

Palatodonta bleekeri Neenan et al., 2013

Anisiano temprano

Alemania

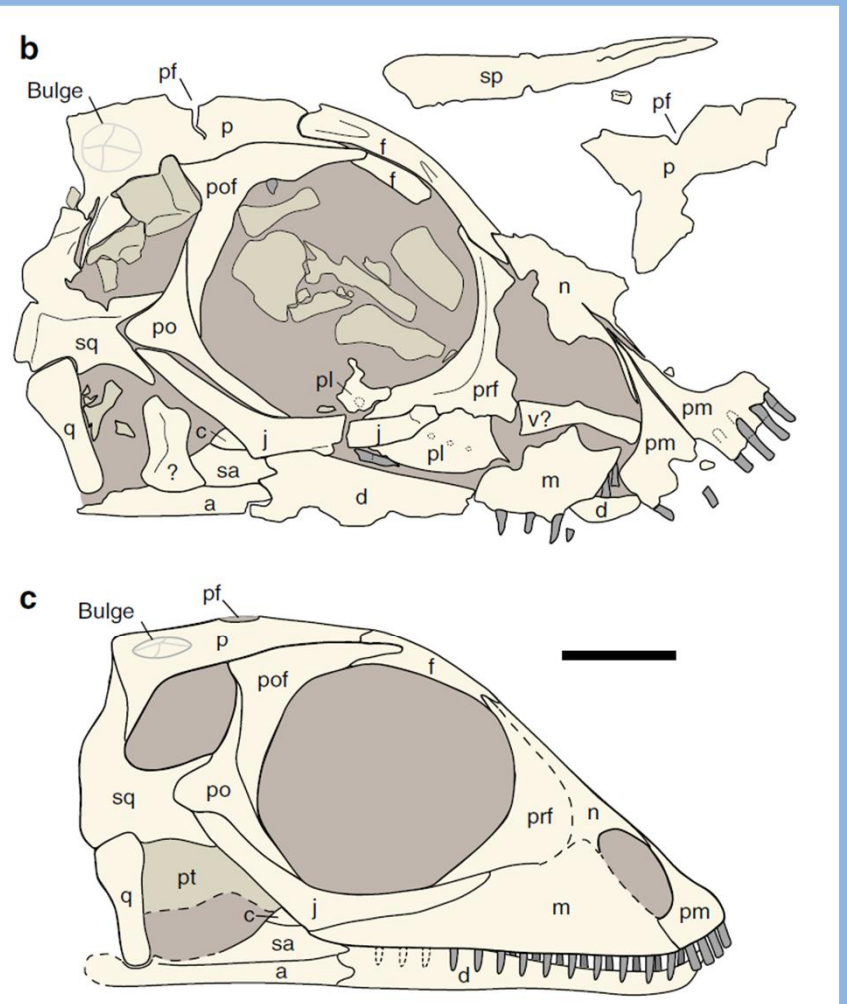
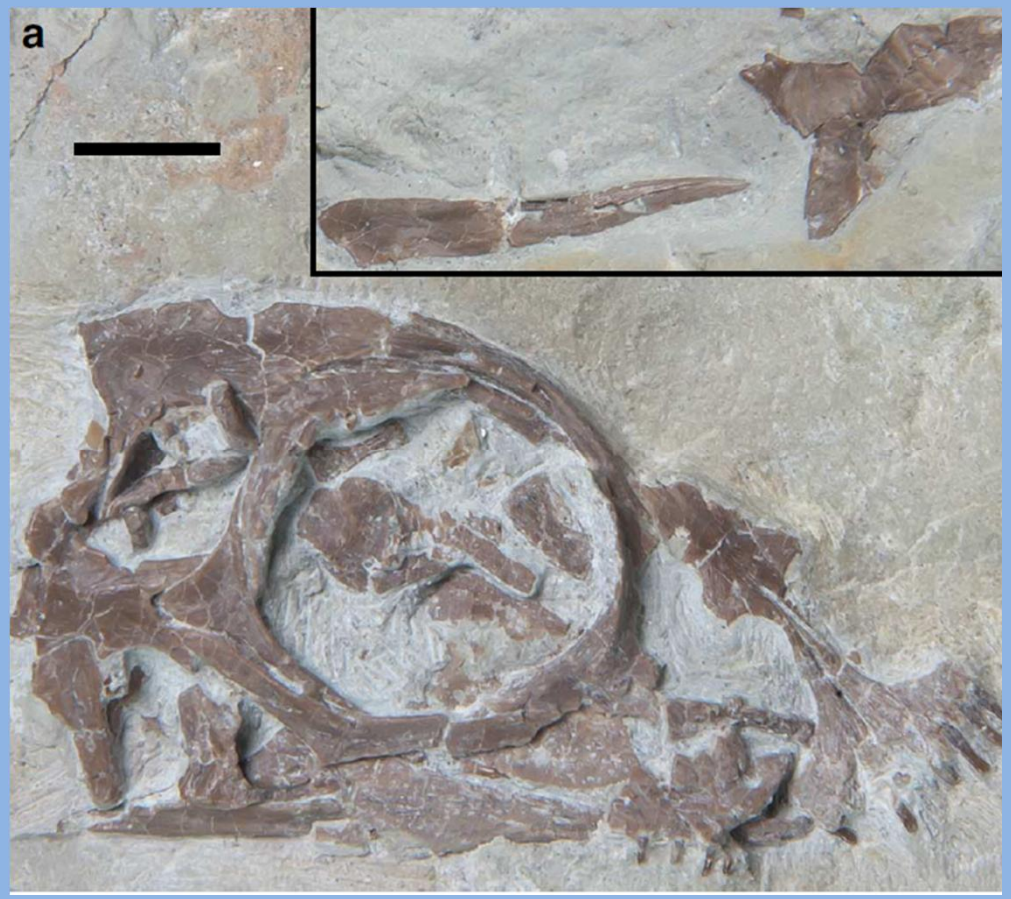


Figure 1 | *Palatodonta bleekeri* genus et species nova holotype (TW480000470). (**a**) Right lateral view of the specimen with disarticulated elements inset. (**b**) Labelled interpretation. (**c**) Reconstruction in lateral view. a, angular; c, coronoid; d, dentary; f, frontal; j, jugal; m, maxilla; n, nasal; p, parietal; pf, pineal foramen; pl, palatine; pm, premaxilla; po, postorbital; pof, postfrontal; prf, prefrontal; pt, pterygoid; q, quadrate; sa, surangular; sp, splenial; sq, squamosal; v, vomer. Scale bar, 3 mm.



Sauropterygia Owen, 1860
Placodontia Cope, 1871, sensu Rieppel, 2000

Palatodonta bleekeri Neenan et al., 2013
Anisiano temprano
Alemania

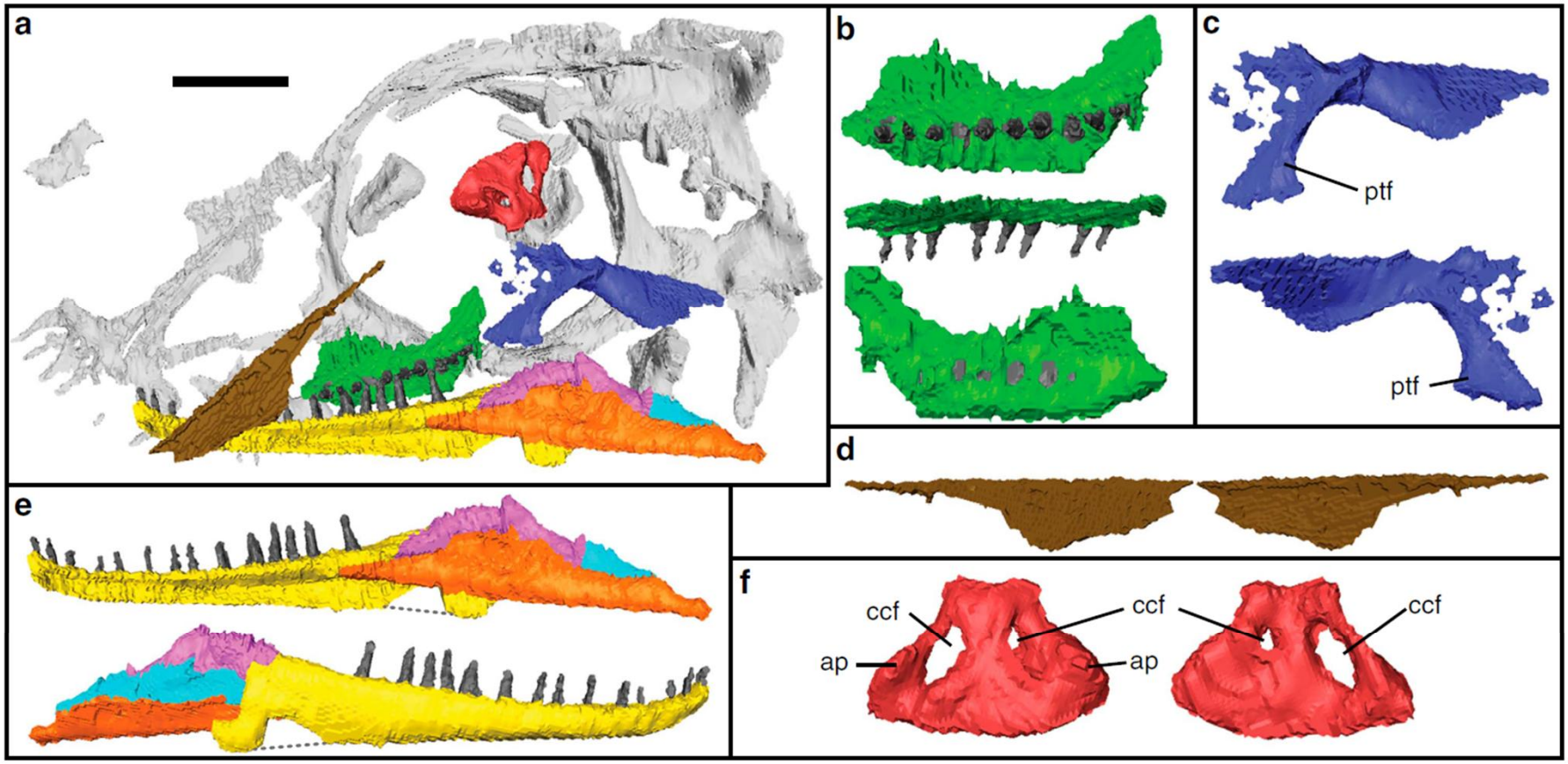


Figure 2 | Three-dimensional reconstruction of μCT data showing obscured elements. (**a**) Skull interior with obscured elements highlighted. red, basisphenoid; dark blue, pterygoid; green, palatine; brown, right splenial; yellow, dentary; pink, coronoid; light blue, surangular; orange, angular. (**b**) Palatine in ventral (top), lateral (middle) and dorsal (bottom) views. (**c**) Pterygoid in medial (top) and lateral (bottom) views. (**d**) Right splenial in lateral (left) and medial (right) views. (**e**) Right mandible in medial (top) and lateral (bottom) views. (**f**) Basisphenoid in dorsal (left) and ventral (right) views. ap, ascending process; ccf, cerebral carotid foramen; ptf, pterygoid flange. Scale bar, 3 mm, **b–f** not to scale.

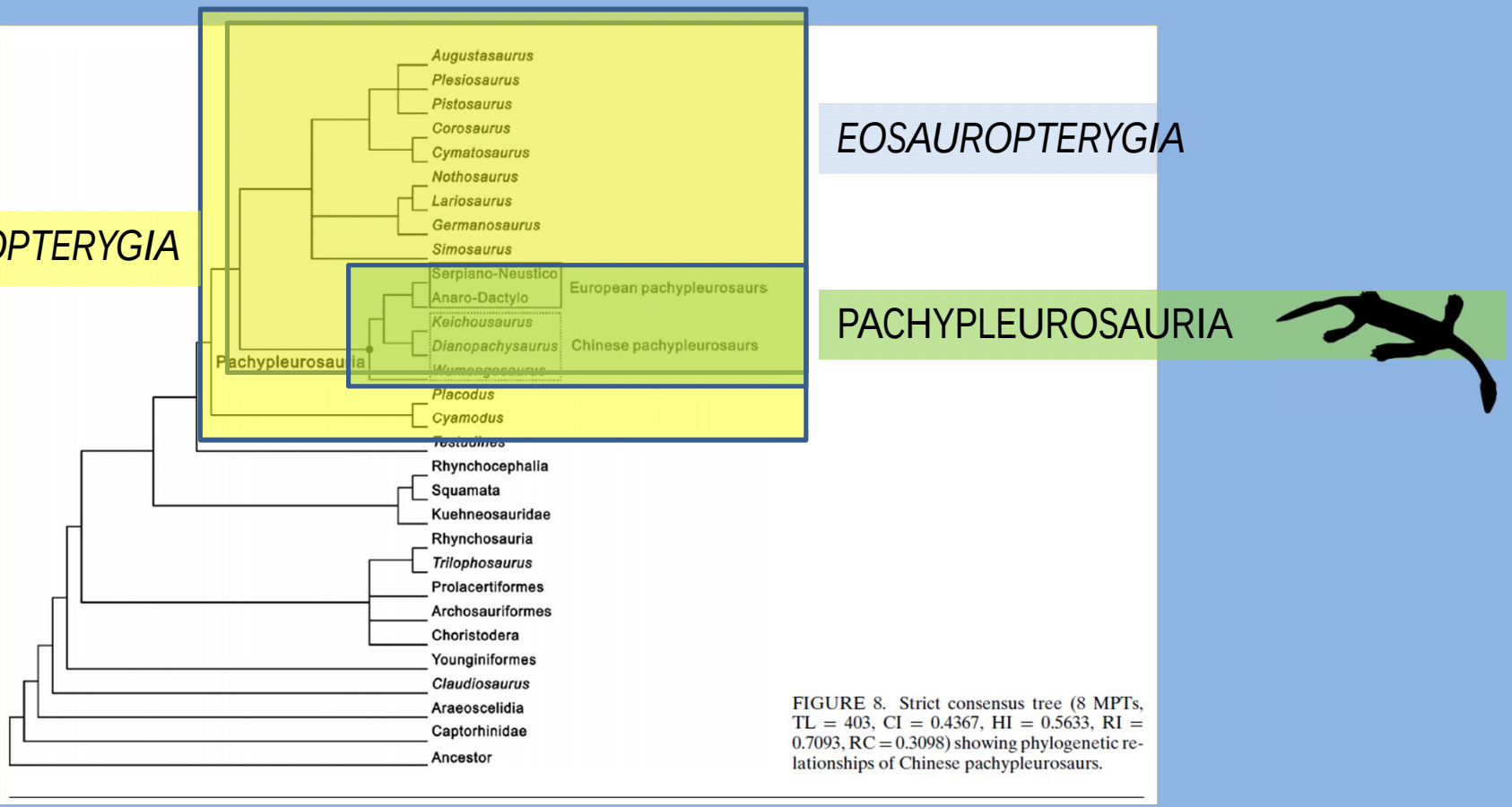


FIGURE 8. Strict consensus tree (8 MPTs, TL = 403, CI = 0.4367, HI = 0.5633, RI = 0.7093, RC = 0.3098) showing phylogenetic relationships of Chinese pachypleurosaurs.

Sauropterygia Owen, 1860

Eosauropterygia Rieppel, 1994

Nothosauroidea Baur, 1889

Pachypleurosauroidea Von Huene, 1956

Pachypleurosauridae Nopcsa, 1928

Figure 12-4. SKELETON OF *PACHYPLEUROSAURUS*, A NOTHOSAUR FROM THE MIDDLE TRIASSIC OF SWITZERLAND. The joint surfaces of the limbs and girdles are poorly ossified and would probably not support the body for continuous terrestrial locomotion. The limbs are otherwise little specialized for aquatic locomotion. The primary propulsive force was probably produced by the tail, in which the anterior neural spines and haemal arches are expanded dorsally and ventrally. The adult specimen is approximately 120 centimeters long. *From Carroll and Gaskill, 1985.*

Nothosauria Baur, 1889

Nothosauridae Baur, 1889

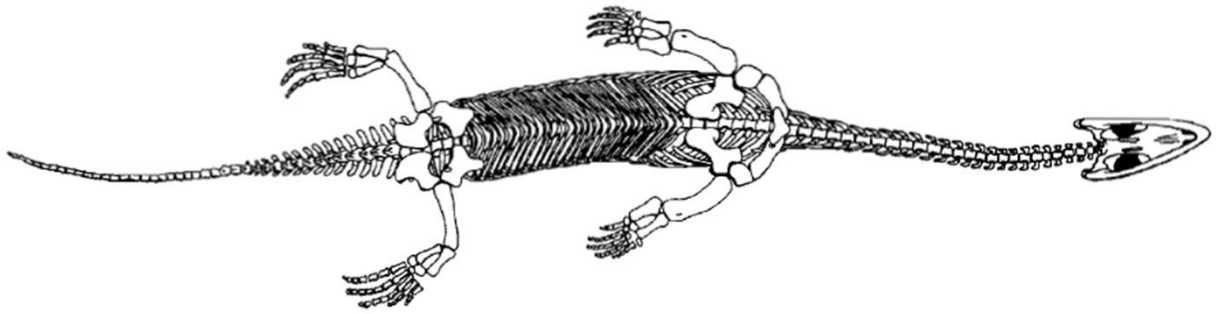


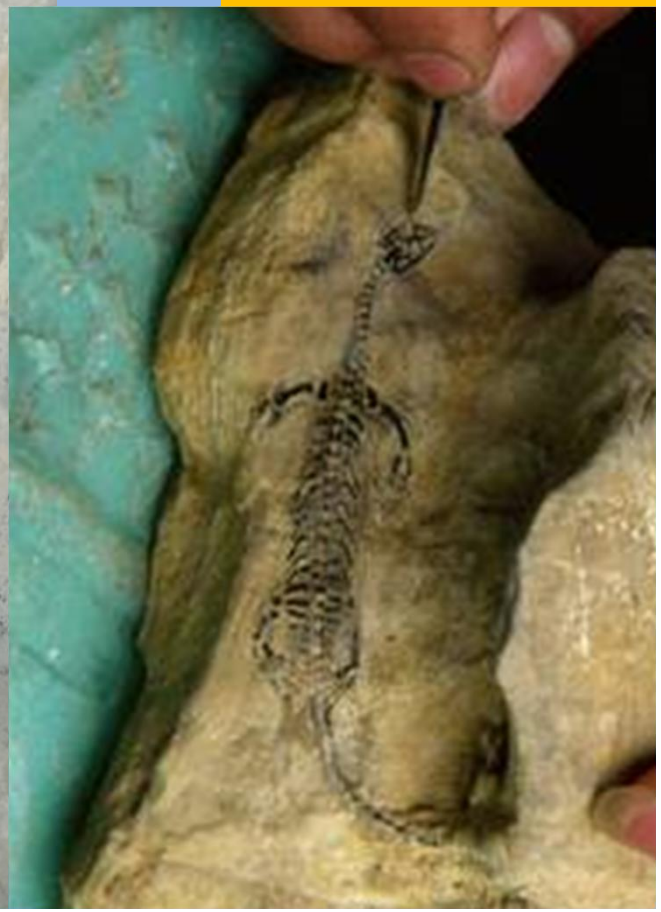
Figure 12-7. SKELETON OF THE NOTHOSAUR CERESIOSAURUS IN VENTRAL VIEW. This genus reached 4 meters in length. *From Kuhn-Schnyder, 1963. By permission of the Archivio Storico Ticinese.*

Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Pachypleurosauroidea Von Huene, 1956
Pachypleurosauridae Nopcsa, 1928

Keichousaurus spp.
Triásico tardío
China

Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Pachypleurosauroidea Von Huene, 1956
Pachypleurosauridae Nopcsa, 1928

Keichousaurus spp.
Triásico tardío
China



Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Pachypleurosauroidea Von Huene, 1956
Pachypleurosauridae Nopcsa, 1928

Pachypleurosaurus spp.
Triásico medio
Suiza

***Serpianosaurus mirigiolensis* Rieppel, 1989.**
Pachypleurosáurido altamente informativo:
-Dimorfismo sexual (tamaño general, tamaño de miembros anteriores)

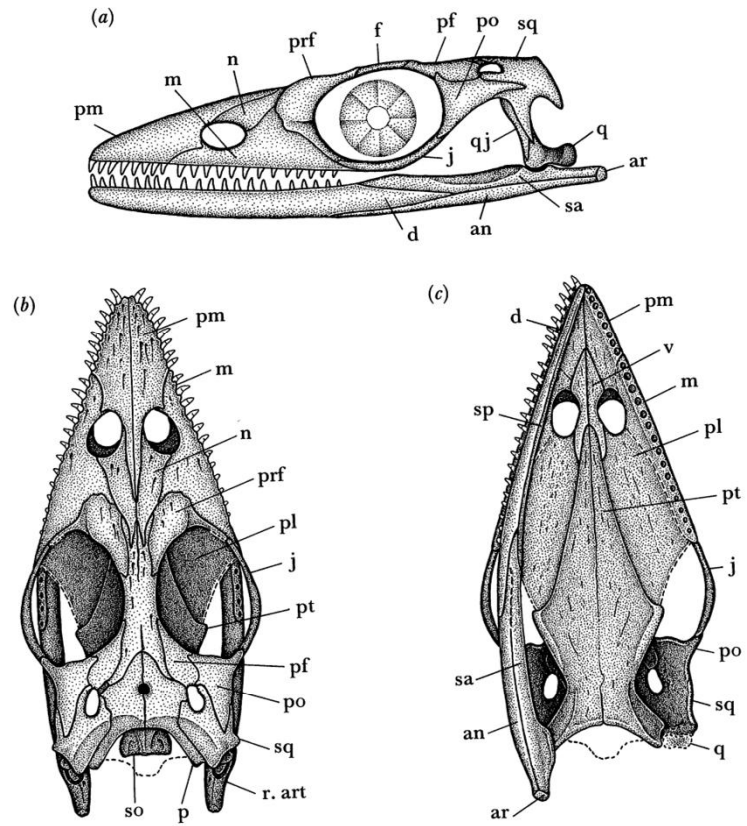
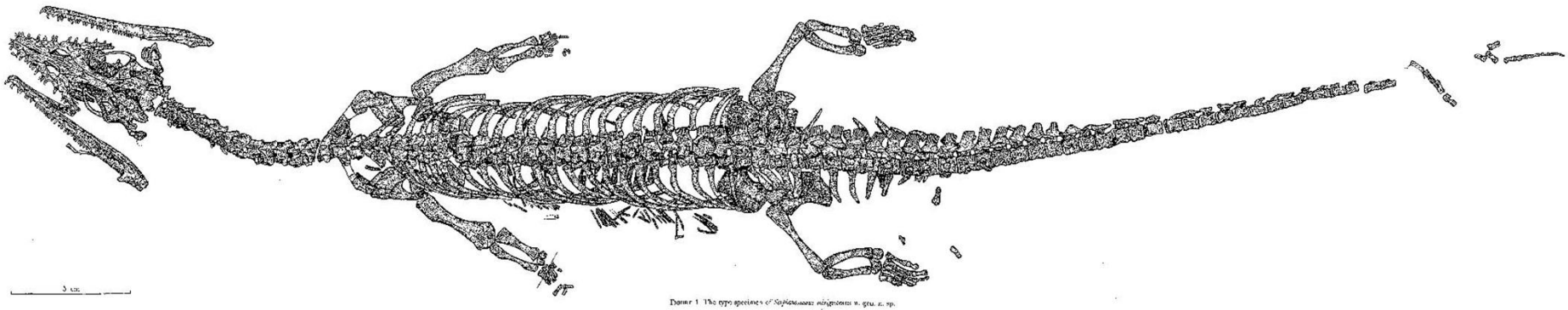


FIGURE 2. *Serpianosaurus mirigiolensis*, reconstruction of the skull in (*a*) left lateral view, (*b*) dorsal view and (*c*) ventral view. The left side of the skull table is reconstructed on the basis of specimen T 3686, the right side on specimen T 1071. The left side of the palate is reconstructed on the basis of specimen T 3689, the right side on specimen T 96.

Phil. Trans. R. Soc. Lond. B, volume 323



Donnet 1. The type specimen of *Serpianosaurus mirigiolensis* n. gen. n. sp.

Donnet fr. S.

SAUROPTERYGIA

EOSAUROPTERYGIA

NOTHOSAURIA

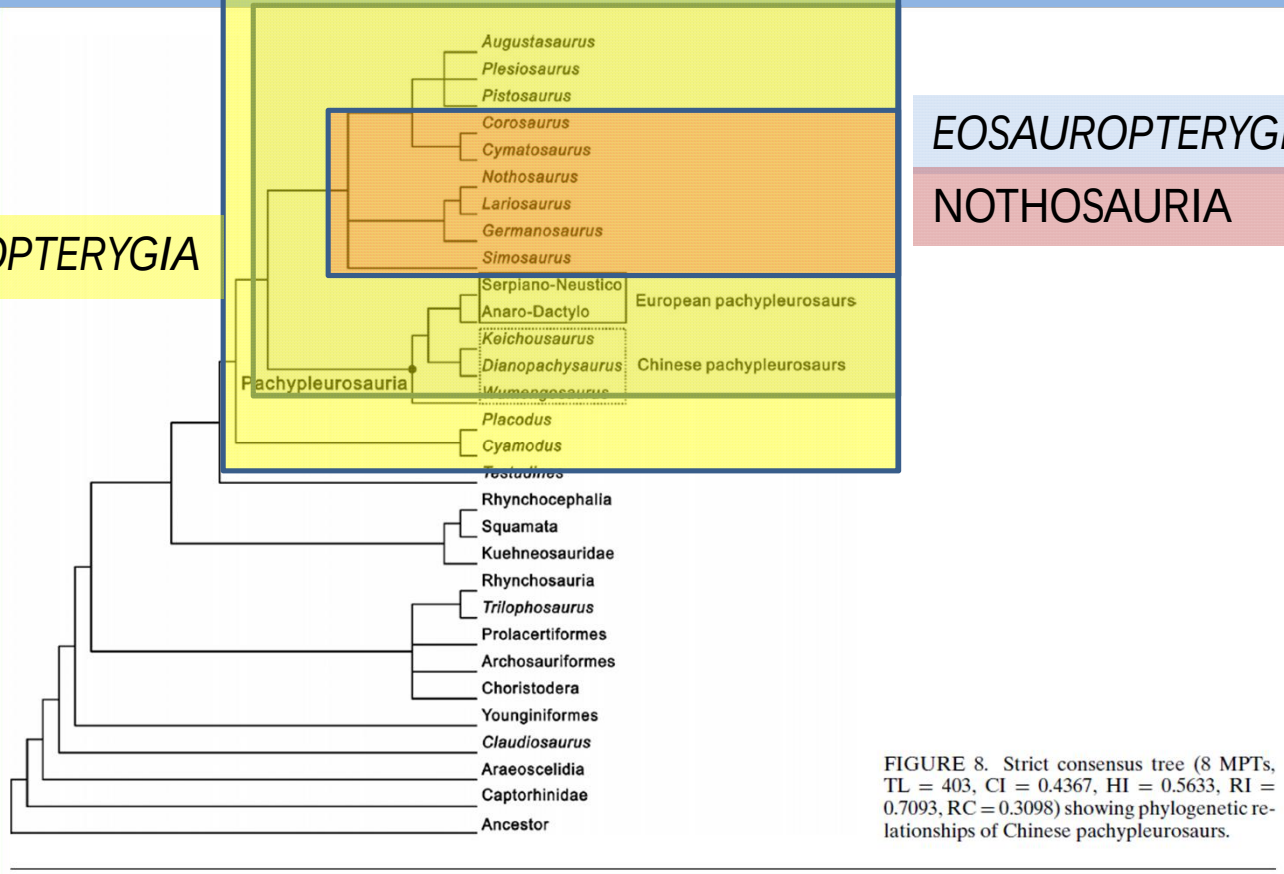


FIGURE 8. Strict consensus tree (8 MPTs, TL = 403, CI = 0.4367, HI = 0.5633, RI = 0.7093, RC = 0.3098) showing phylogenetic relationships of Chinese pachypleurosaurs.

Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Nothosauria Baur, 1889
Nothosauridae Baur, 1889

Nothosaurus spp.
Triásico
Europa, norte de África y China

Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Nothosauria Baur, 1889
Nothosauridae Baur, 1889

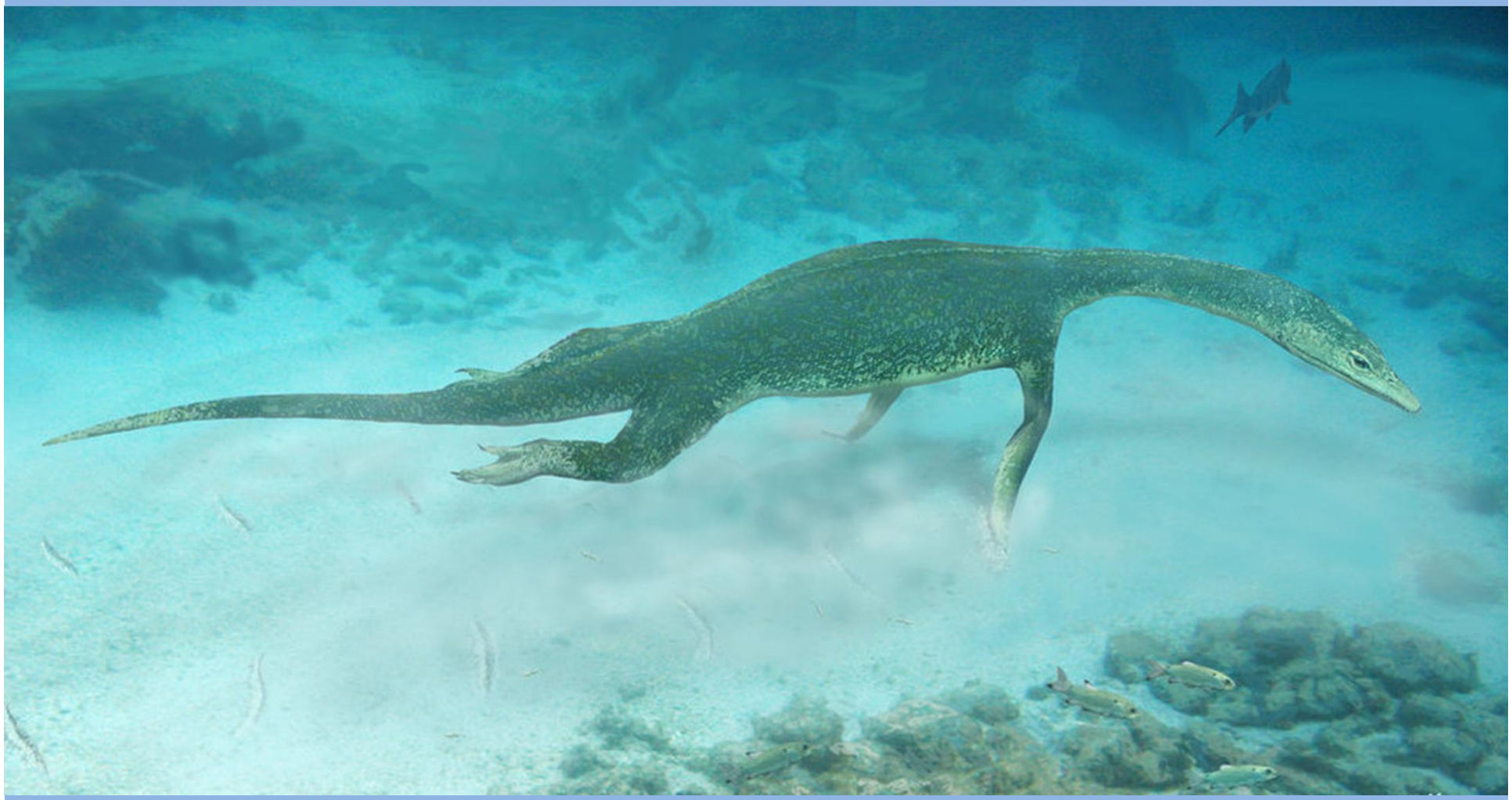
Nothosaurus spp.
Triásico
Europa, norte de África y China

Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Nothosauria Baur, 1889
Nothosauridae Baur, 1889

Lariosaurus spp.
Triásico
Italia

Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Nothosauria Baur, 1889
Nothosauridae Baur, 1889

Lariosaurus spp.
Triásico
Italia



Sauropterygia Owen, 1860
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Nothosauria Baur, 1889
Nothosauridae Baur, 1889

Simosaurus spp.
Triásico medio
Europa

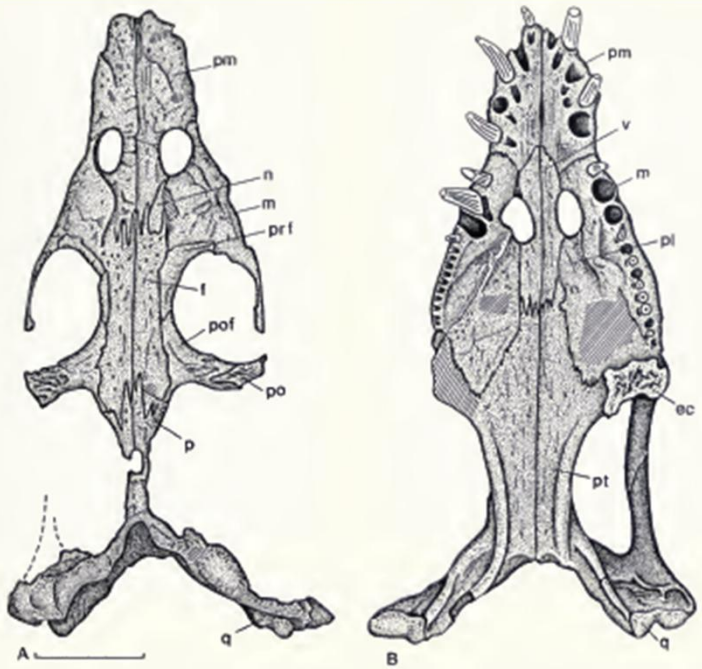


FIG. 6. The skull of the neotype of *Cymatosaurus latifrons* (Gürich, 1884) (SMNS 10109) from the lower Muschelkalk of Krapkowice, Upper Silesia. **A**, Dorsal view; **B**, ventral view. Scale bar = 20 mm. Abbreviations: ec, ectopterygoid; f, frontal; m, maxilla; n, nasal; p, parietal; pl, palatine; pm, premaxilla; po, postorbital; pof, postfrontal; prf, prefrontal; pt, pterygoid; q, quadrate; v, vomer.

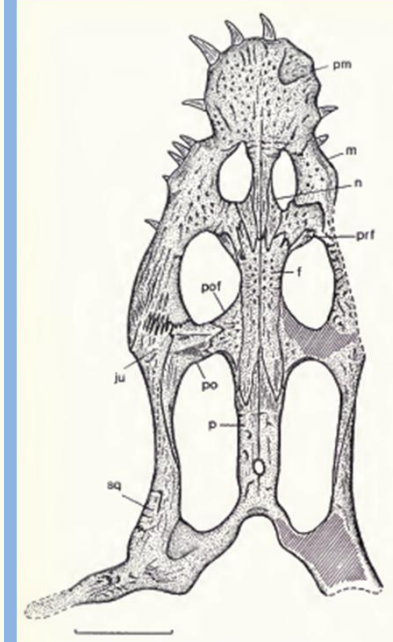
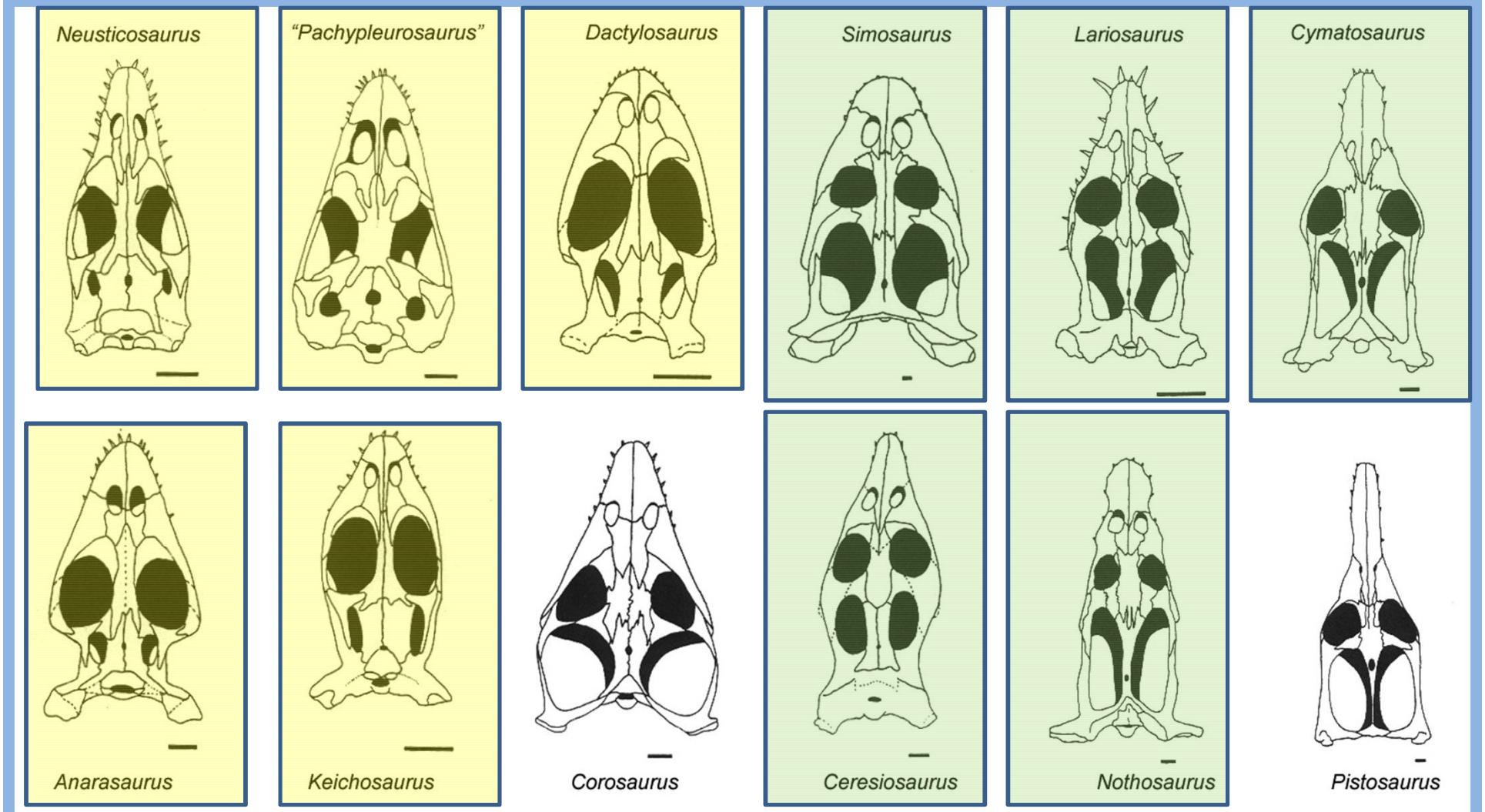


FIG. 11. The skull of the holotype of *Germanosaurus schafferi* (Arthaber, 1924) (NHMW, uncatalogued), from the lower Muschelkalk of Gogolin, Upper Silesia, in dorsal view. Scale bar = 50 mm. Abbreviations: f, frontal; ju, jugal; m, maxilla; n, nasal; p, parietal; pm, premaxilla; po, postorbital; pof, postfrontal; prf, prefrontal; sq, squamosal.

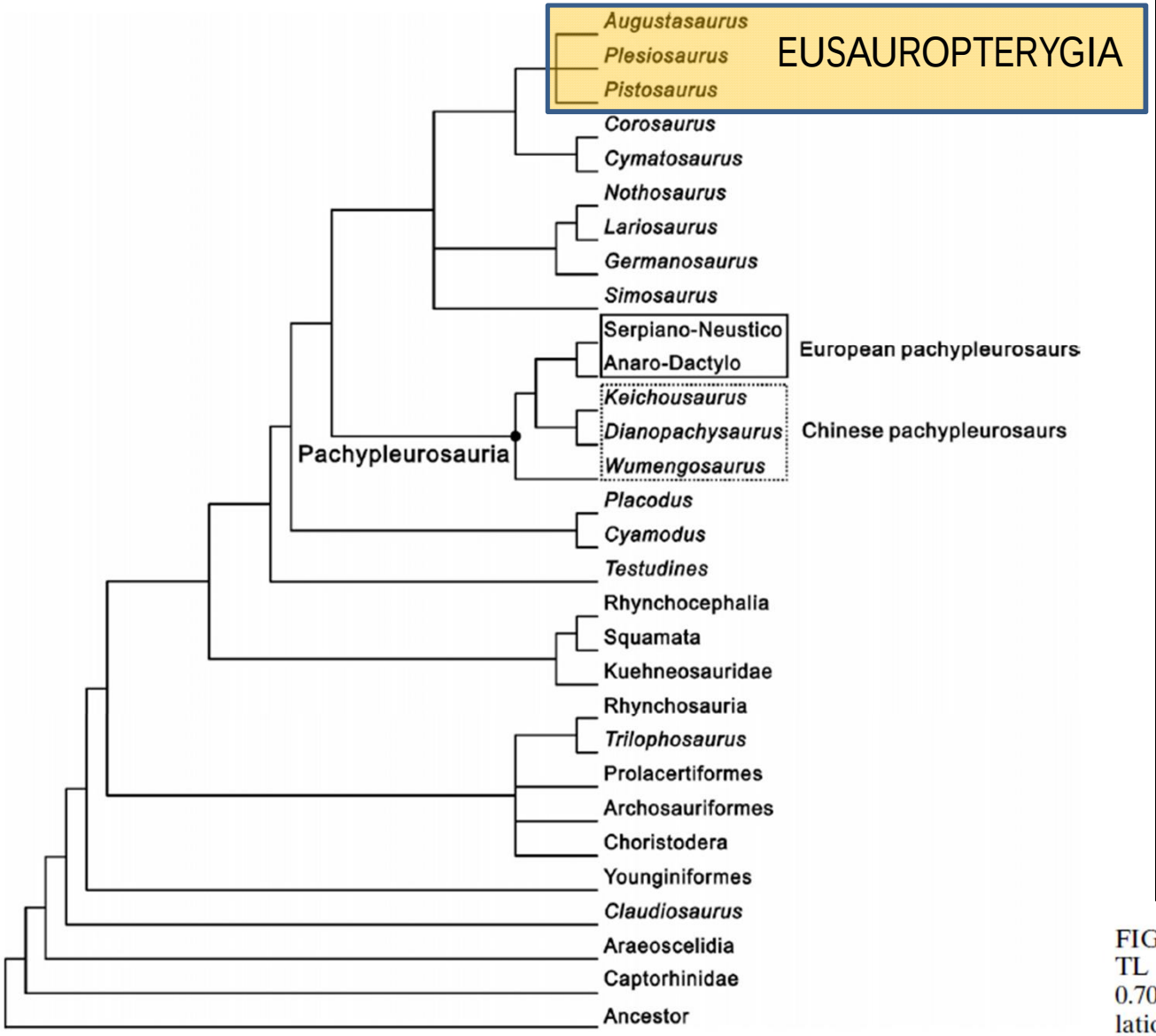
Sauropterygia Owen, 1860

Eosauropterygia (del griego *Eos*, amanecer; y sauropterygia, lagarto con aletas)



Cráneos de algunos Eosauropterygia

Sauropterygia Owen, 1860
Eusauropterygia Rieppel, 1994



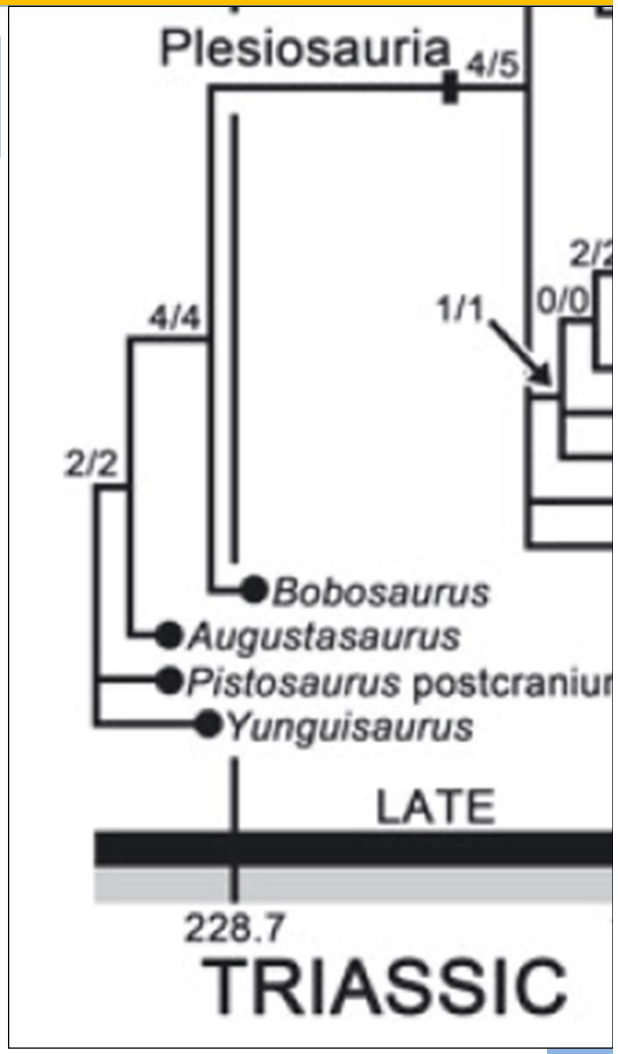
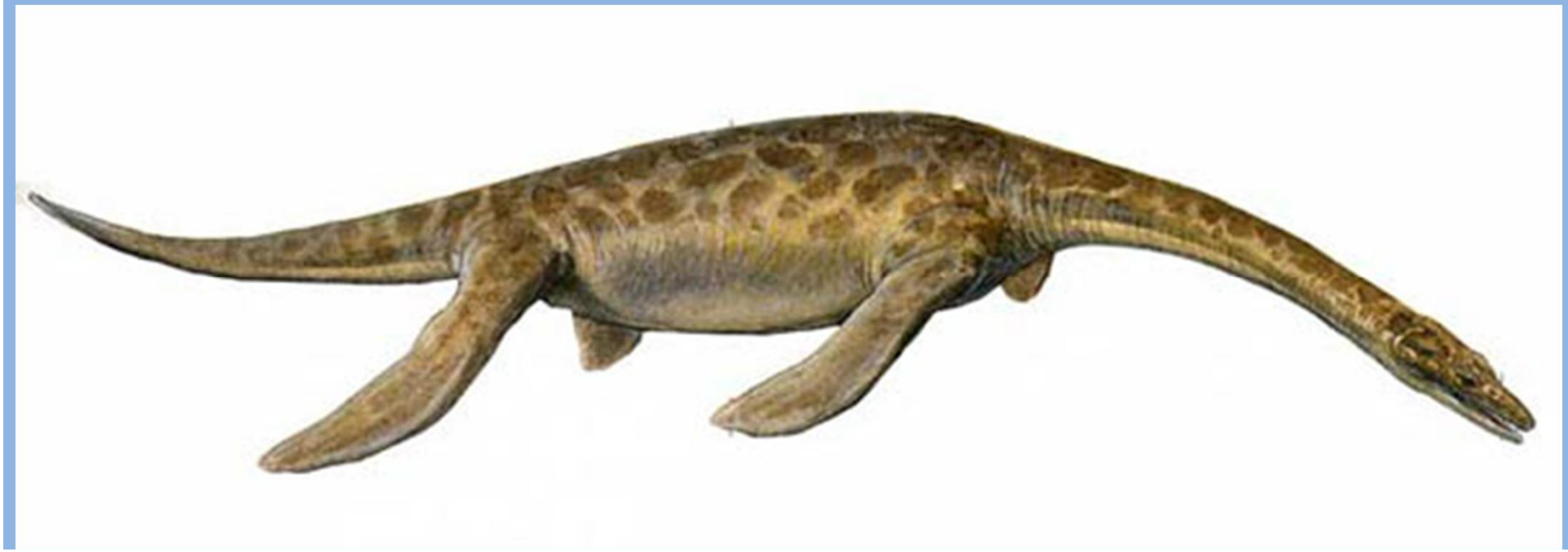


FIGURE 8. Strict consensus tree (8 MPTs, TL = 403, CI = 0.4367, HI = 0.5633, RI = 0.7093, RC = 0.3098) showing phylogenetic relationships of Chinese pachypleurosaurs.

Sauropterygia Owen, 1860
Eusauropterygia Rieppel, 1994

Pistosaurus longaevus Meyer, 1839
Triásico medio
Alemania y Francia



Sauropterygia Owen, 1860
Eusauropterygia Rieppel, 1994

Augustasaurus hagdorni Sander et al., 1997
Anisiano
Nevada, US.

Sauropterygia Owen, 1860

Eusauropterygia Rieppel, 1994

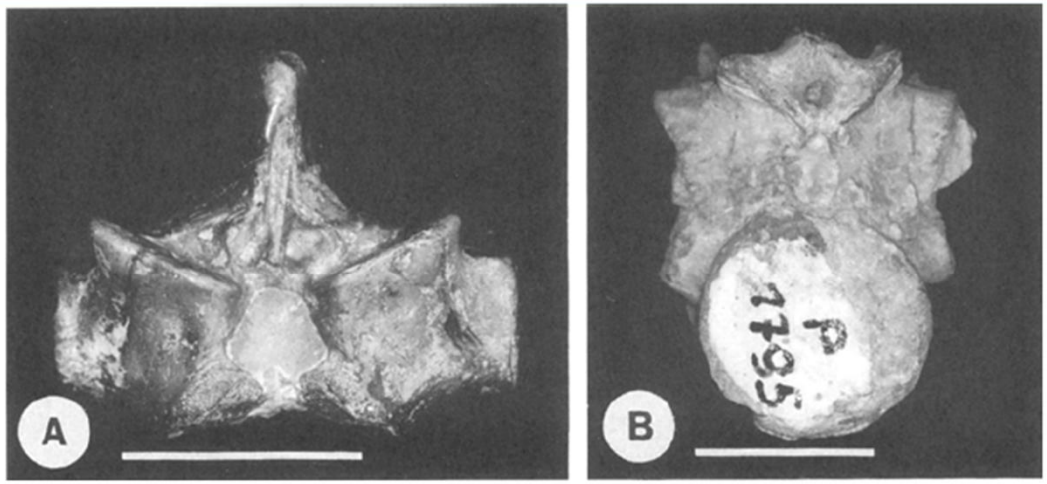
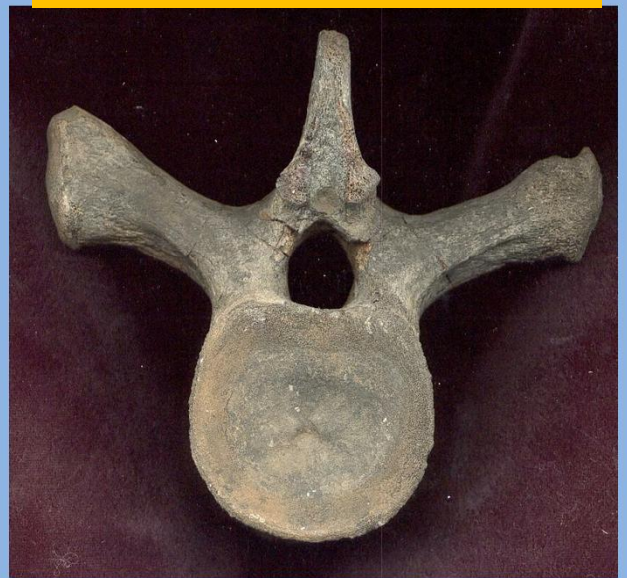


Figure 5. A) Eusauropterygian neural arch from the lower Muschelkalk (mu_1) of Halle/Saale (Halle, uncatalogued). **B)** Sacral vertebra from the Schaumkalk (upper lower Muschelkalk, mu_2) of Freyburg/Unstrut (Jena, P 1795). Scale bar = 20 mm.

Augustasaurus hagdorni

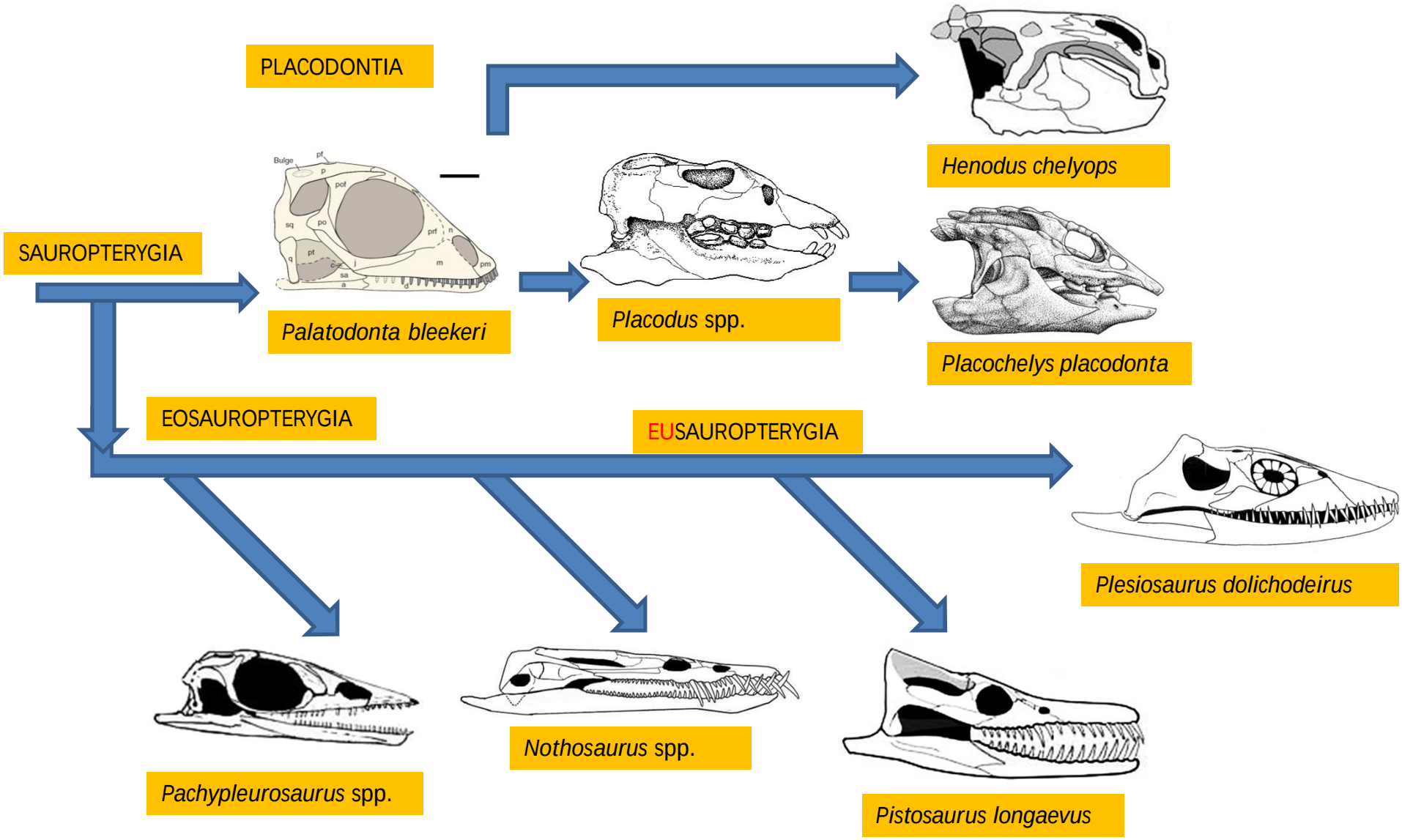
Cryptoclidus eurymerus



Elasmosauridae

Pistosaurus longaevus

Sauropterygia Owen, 1860



Plesiosauria de Blainville, 1835

2) Reseña histórica

2.1. Primeros hallazgos

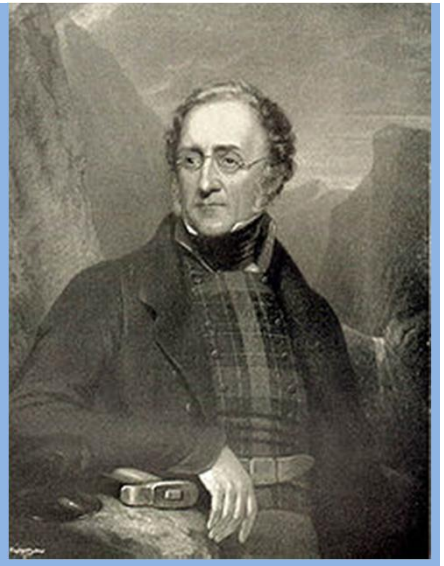
William Conybeare & Henry De La Beche, 1821

Primera descripción de restos de un nuevo reptil con aletas.

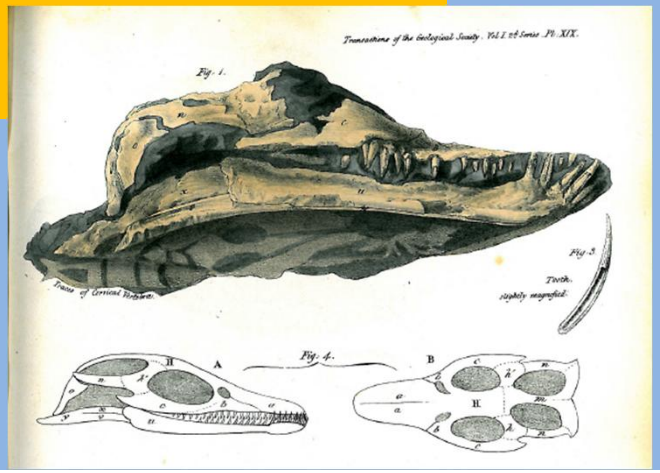
Para entonces ya se conocía al *Ichthyousaurus,* “reptil-pez” de aspecto similar a un delfín.

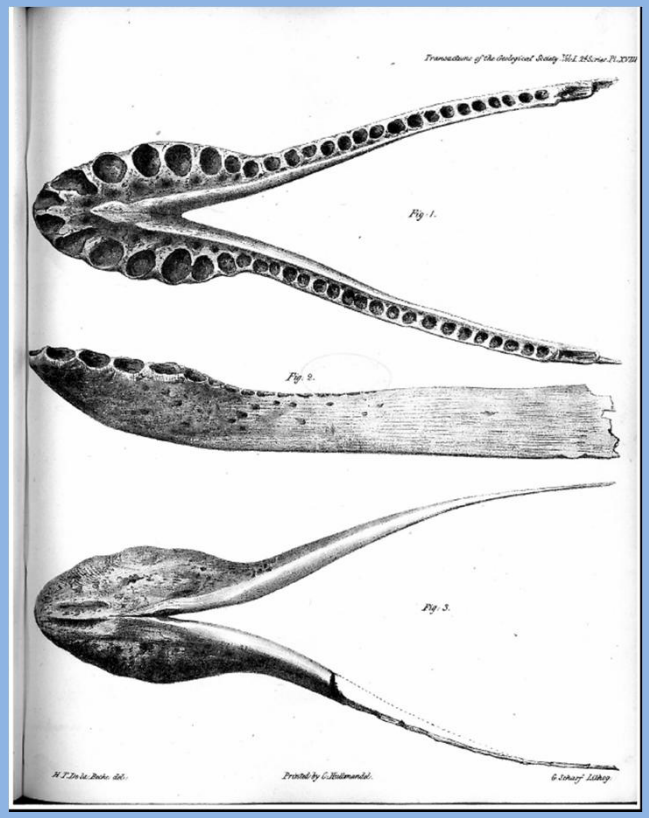
El nuevo reptil de Conybeare & De La Beche poseía una forma “más cercana” a un lagarto que a un *Ichthyosaurus*. De esto deriva el nombre *plesiosaurus*, lagarto cercano.

Conybeare



De la Beche





Reseña histórica

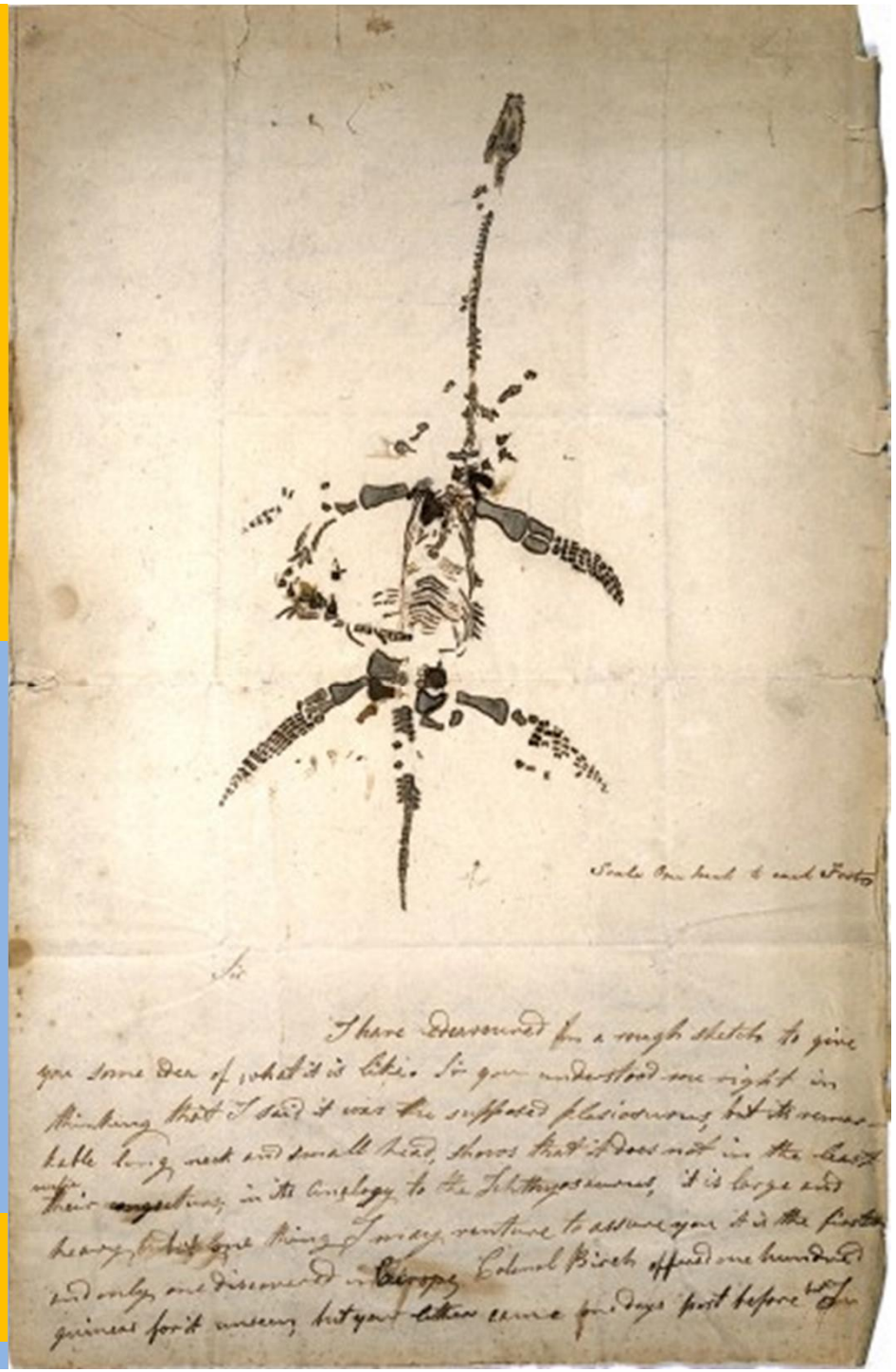
Primeros hallazgos

William Conybeare, 1824

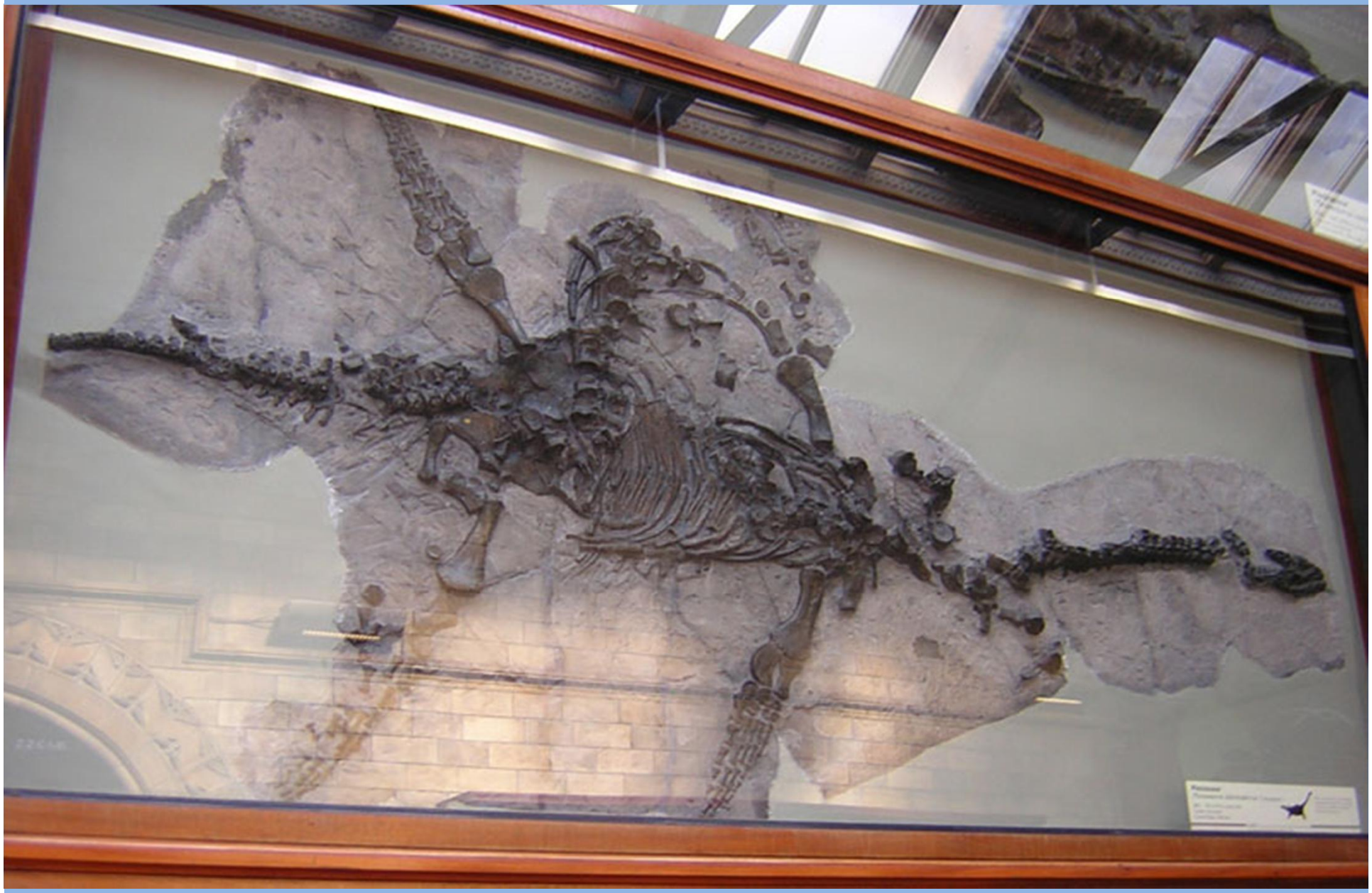
Se describe el primer esqueleto relativamente completo de un plesiosaurio conocido hasta la fecha. Corresponde a un espécimen proveniente del Jurásico Inferior de Lyme Regis, y colectado por Mary Anning.

Se propone la especie tipo, *Plesiosaurus dolichodeirus*.

Mary Anning



Primera descripción de *Plesiosaurus dolichodeirus* por Conybeare, 1824.



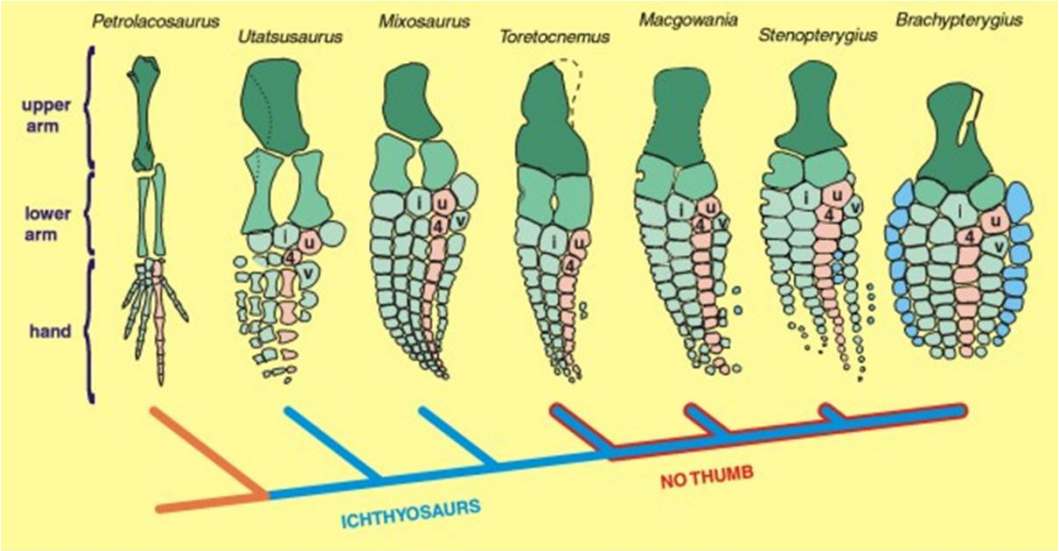
¿Qué es entonces un plesiosaurio?

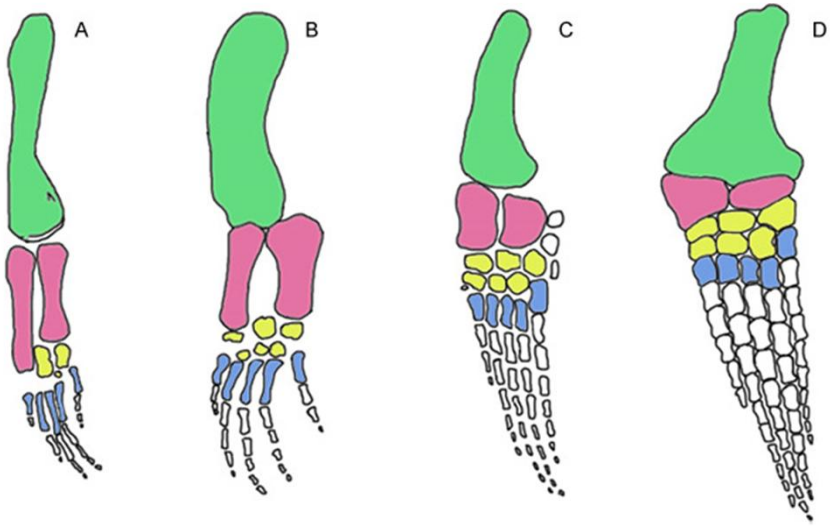
-Arquetipo: *Plesiosaurus dolichodeirus* Conybeare, 1824.

-Reptiles marinos diferentes a los ictiosaurios, “con un tronco relativamente corto, cinturas pectorales y pélvicas bien desarrolladas y ventrales, cola relativamente corta, una excepcional parrilla ventral de gastralia, y la transformación permanente de los miembros en aletas, caracterizado por un acortamiento de los huesos proximales plesiomórficamente largos, y por una hiperfalangia notoria” (Rieppel, 1997).

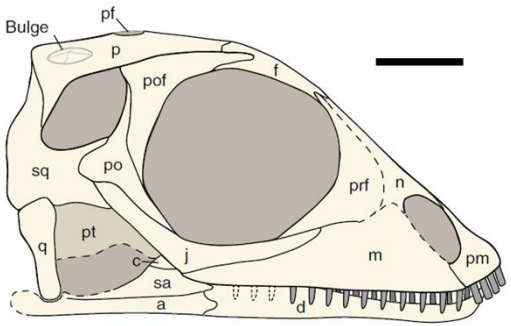
¿Qué es entonces un plesiosaurio?

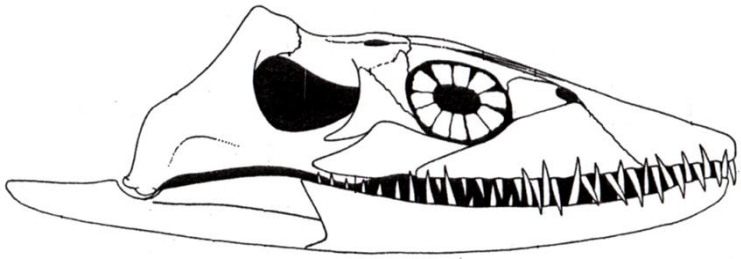
-Aletas mantienen los 5 dedos en todos los representantes conocidos del grupo.





-Migración posterior de las narinas externas.





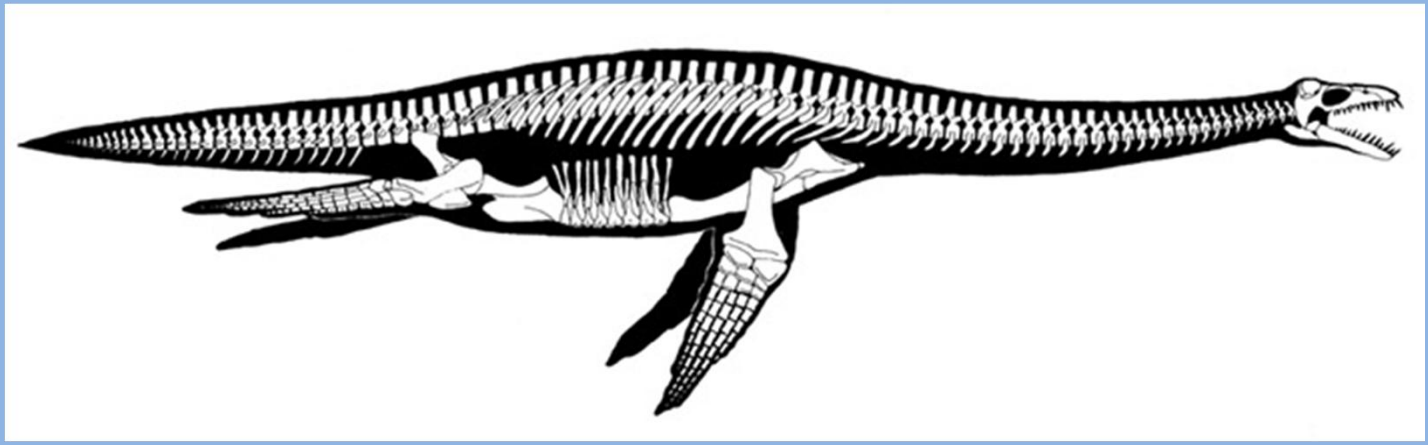
Palatodonta bleekeri

Pachypleurosaurus spp.

Plesiosaurus dolichodeirus

¿Qué es entonces un plesiosaurio?

-esqueleto poscraneal formado por una sección axial + costillas y una parrilla ventral que sostiene las aletas. Cintura pectoral ventralizada, formada por escápulas, coracoides, interclaviculares . Cintura pélvica ventralizada, pubis e isquión ventralizados; iléón dispuesto en sentido dorsoventral, con contacto al esqueleto axial muy reducido. No existe sacro fusionado.



-Cráneo eminentemente sauropterygio (euryápsido—diápsido derivado). Fosas temporales son las únicas fenestras del cráneo; se disponen dorsalmente y son grandes.

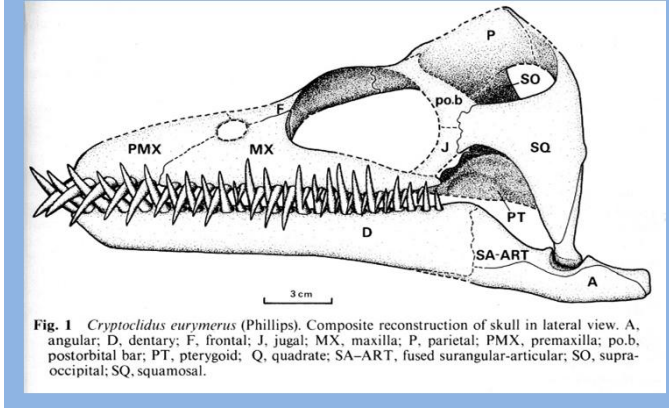
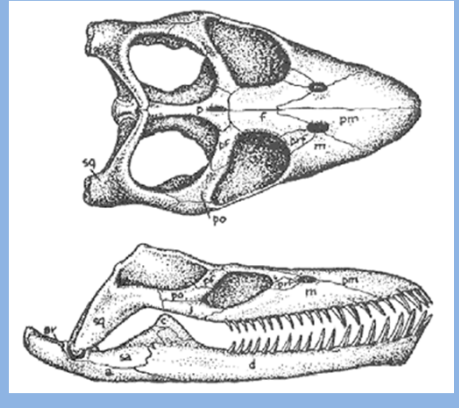


Fig. 1 *Cryptoclidus eurymerus* (Phillips). Composite reconstruction of skull in lateral view. A, angular; D, dentary; F, frontal; J, jugal; MX, maxilla; P, parietal; PMX, premaxilla; po.b, postorbital bar; PT, pterygoid; Q, quadrate; SA–ART, fused surangular-articular; SO, supraoccipital; SQ, squamosal.



RESEÑA HISTÓRICA

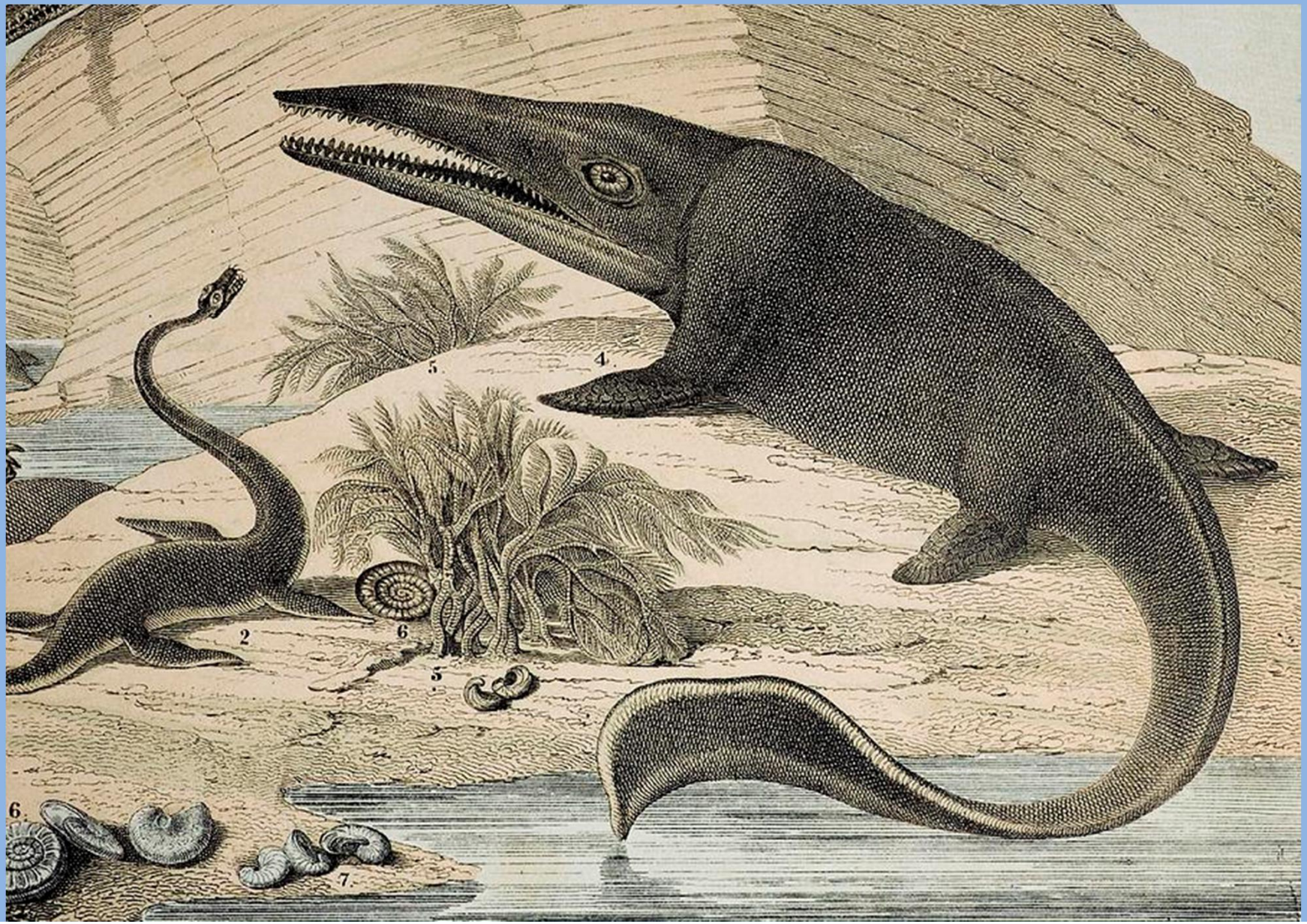
Conceptos victorianos

Duria Antiquior (antiguo Dorset): Acuarela realizada por De La Beche en 1830, que constituye la primera reconstrucción paleoambiental basada en fósiles.

RESEÑA HISTÓRICA

Conceptos victorianos

Ichythyosaur & Plesiosaur: Dibujo de Thomas Hawkins (1862).

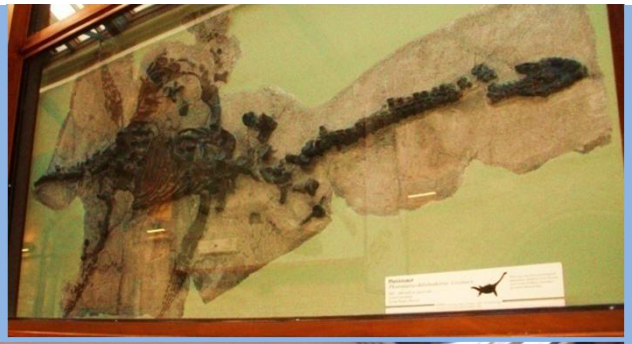


SEQUENCE OF UPPER BLUE LIAS LIMESTONE BEDS AT EAST CLIFF, LYME REGIS.

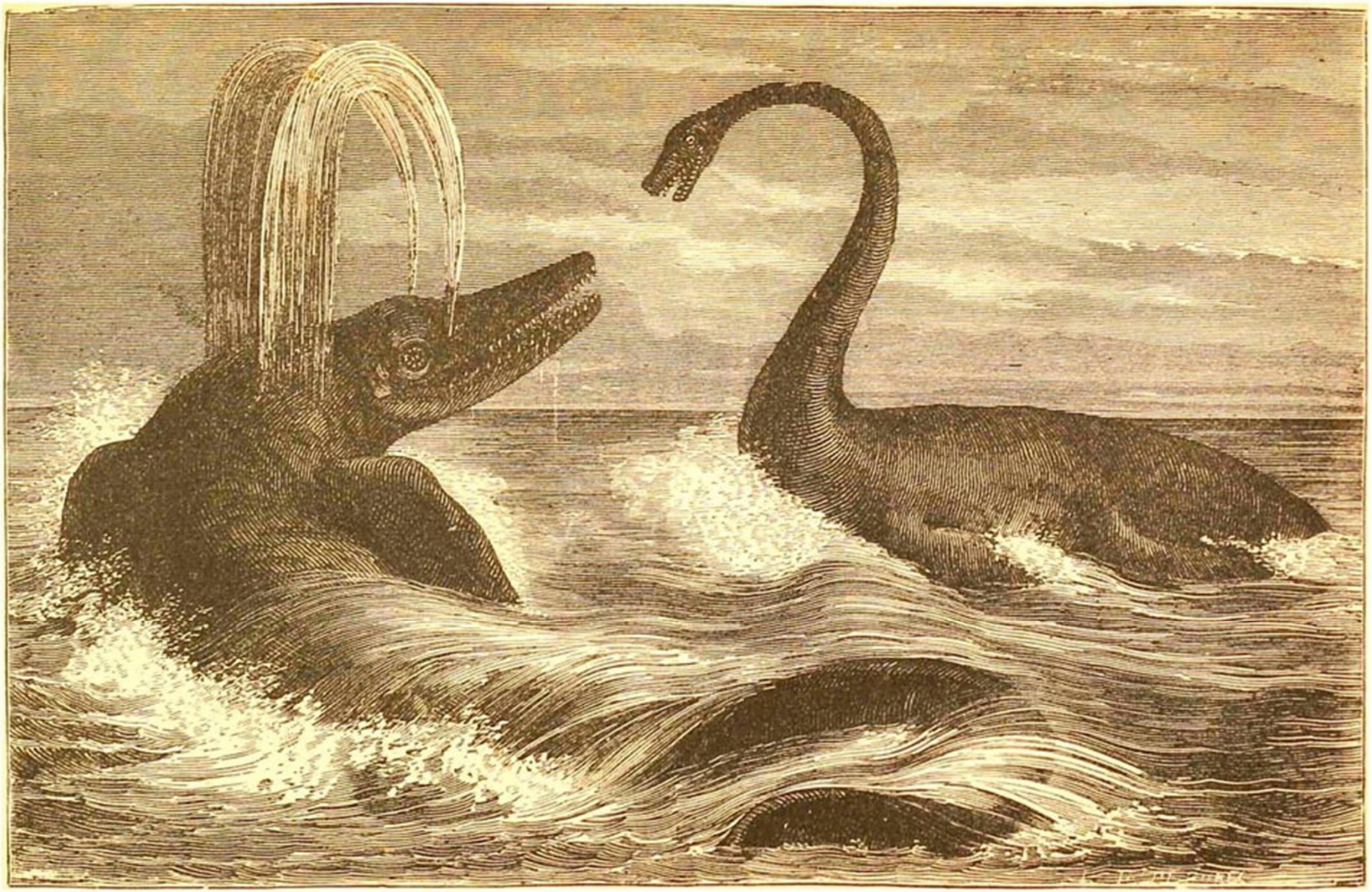
This is an interesting cliff of mostly Sinemurian strata. To see older Blue Lias, including all of the Hettangian go west of Lymoe Regis (see webpage on Lyme Regis - Westward). All cliffs carry some risk and the geologist should try to minimise this. The risk here is higher than normal. There is no accumulation of beach pebbles, the cliff is retreating rapidly, it is vertical, and there is an obvious accumulation of large slabs on the shore and a shale dribble (a warning sign). No one should linger at the cliff base and the hazard is greater at high tide when the available beach is narrow. Photograph 2006, with Daniel Bentley. Ian West (c) 2011.

RESEÑA HISTÓRICA

Conceptos victorianos



Jules Verne, Journey to the centre of the earth, 1864

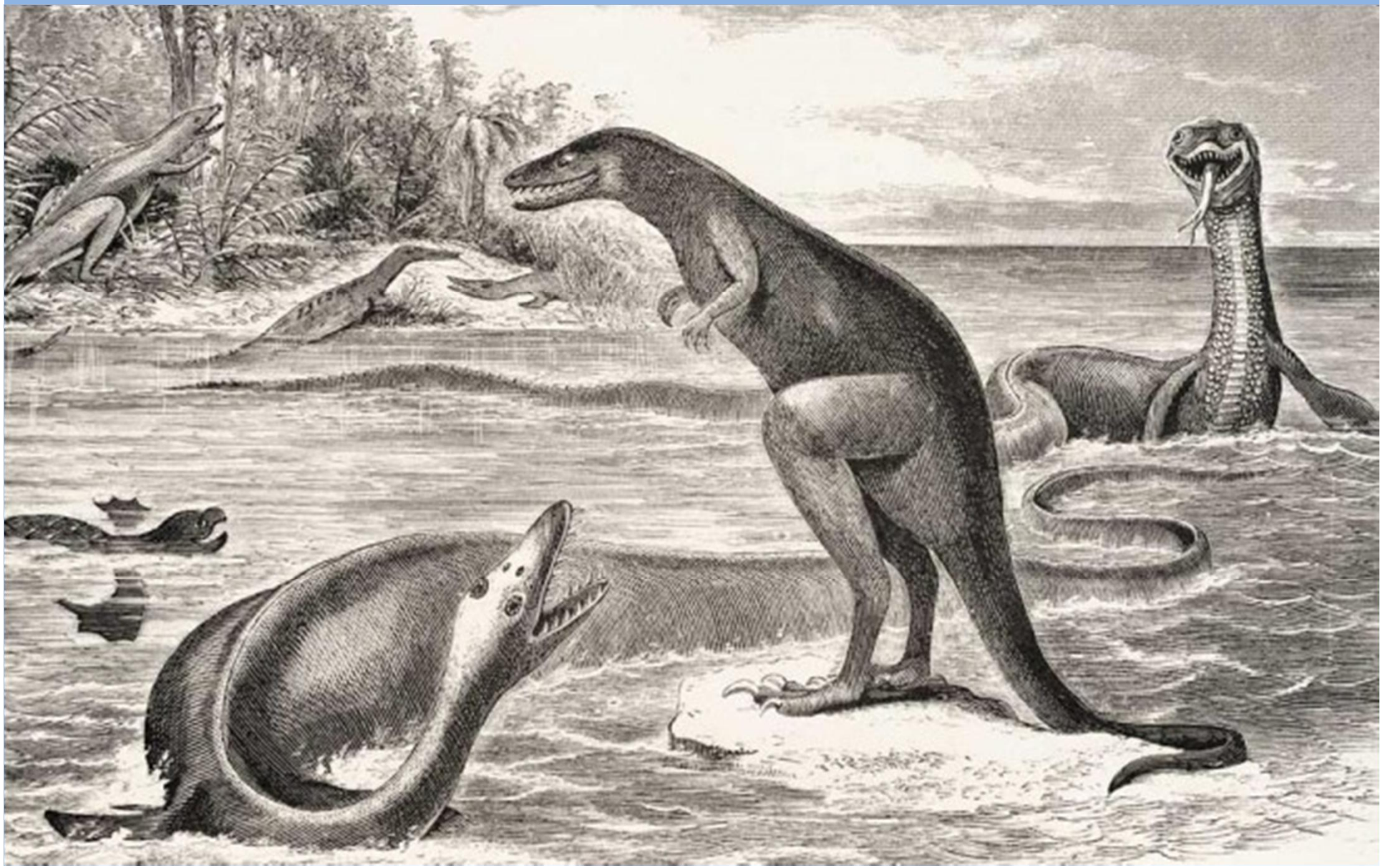


XV.—Ideal scene of the Lias with Ichthyosaurus and Plesiosaurus.

Reseña histórica

Conceptos victorianos

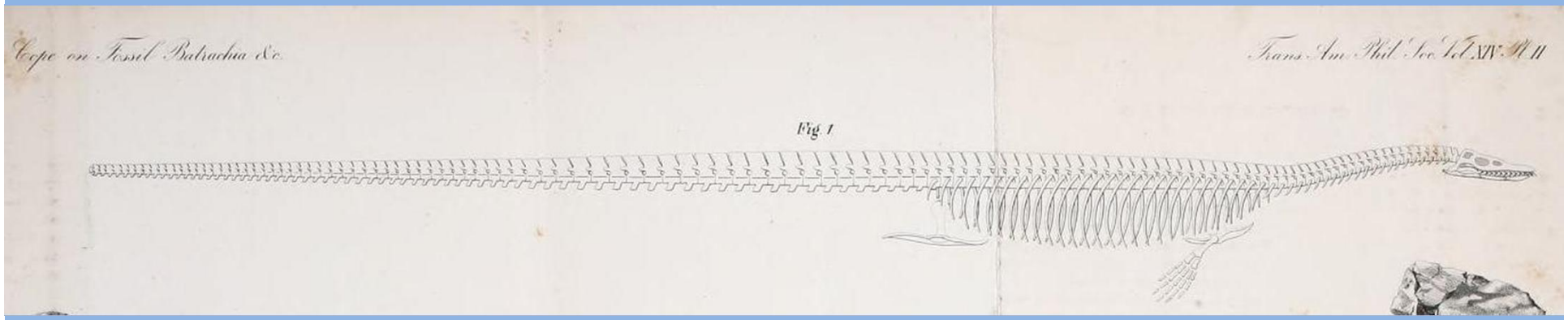
Del otro lado del Atlántico:
Reconstrucción ambiental por Edward Drinker Cope (1869). Se observan dos *Elasmosaurus platyurus* en la playa, uno de ellos enfrentando un *Dryptosaurus.* Una tortuga marina (*Archelon ischiros*) y dos hadrosaurios complementan el cuadro que interpreta el ambiente durante el Campaniano en las costas del Mar interior del Oeste de USA (WIS)

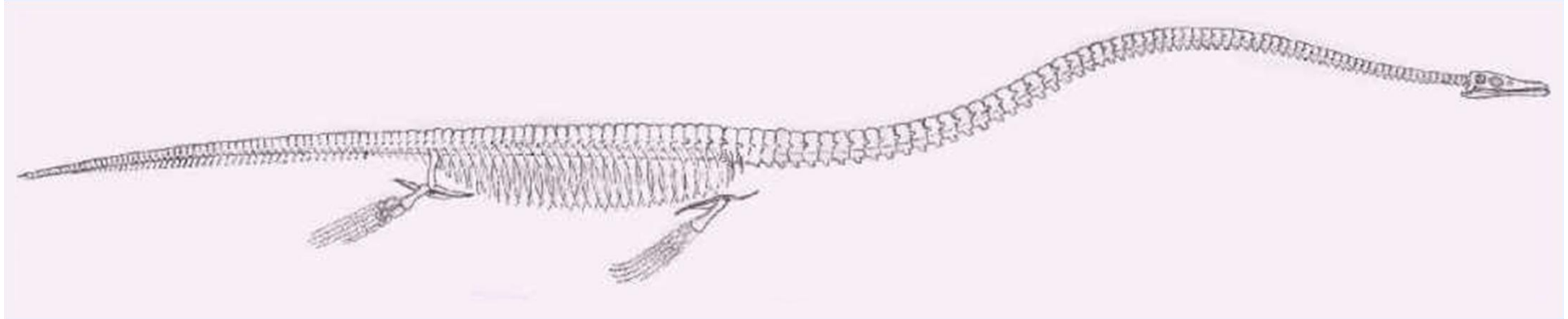


Reseña histórica

Conceptos victorianos

Elasmosaurus platyurus, “the tale of a tail”.





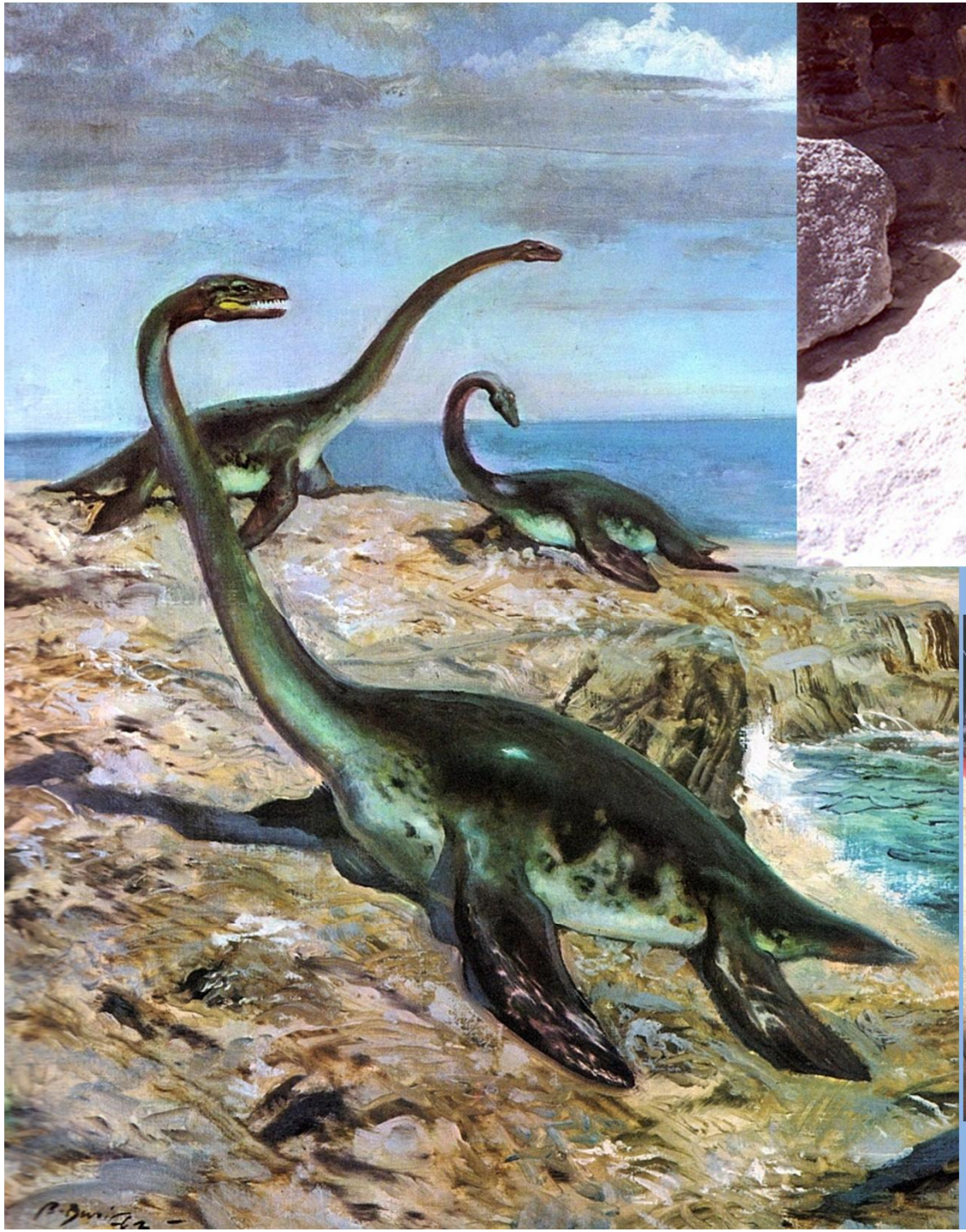
RESEÑA HISTÓRICA

Conceptos victorianos

THE SECONDARY ISLAND.

1. Mososaurus.
2, 3. Pterodactyles.
4, 5. Iguanodon.
6. Hylæosaurus.
7. Megalosaurus
8, 9. Pterodactyles of Oolite.
10, 11. Teleosaurus.
12—14. Ichthyosaurus.
15—17. Plesiosaurus.
18—20. Labyrinthodo.
21—22. Dikynodon.

Figure 5. A possibly diagrammatic sketch of "The Secondary [i.e., Mesozoic] Island" of c. 1855 at the Crystal Palace, south London; far from being confined to dinosaurs, these reconstructions included a much fuller range of fossil saurians, including several marine reptiles. Original in Anonymous (1877:27); photograph courtesy of the Trustees of the National Museums of Scotland.

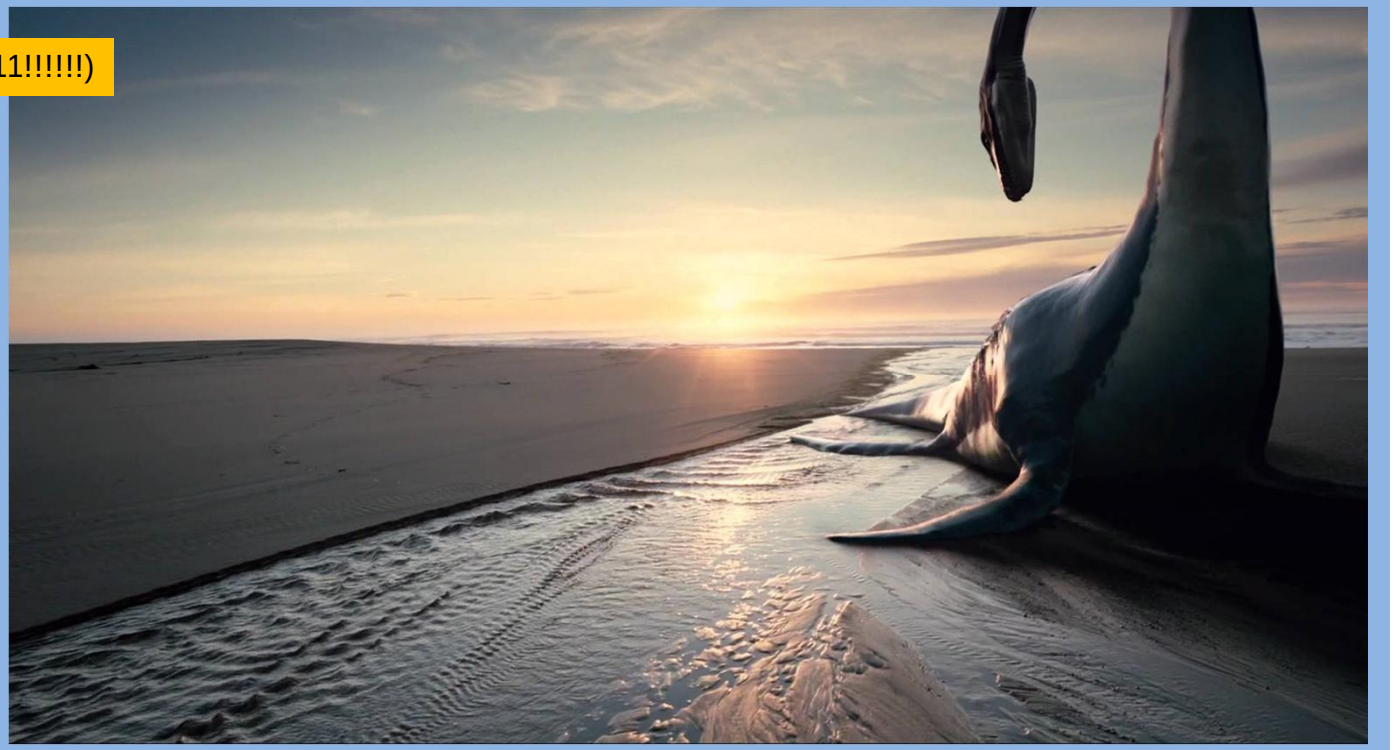


Concepto de Ray Harryhausen, años 60's

Burian, 1962!!!

BBC: Walking with dinosaurs, 1999!!!!

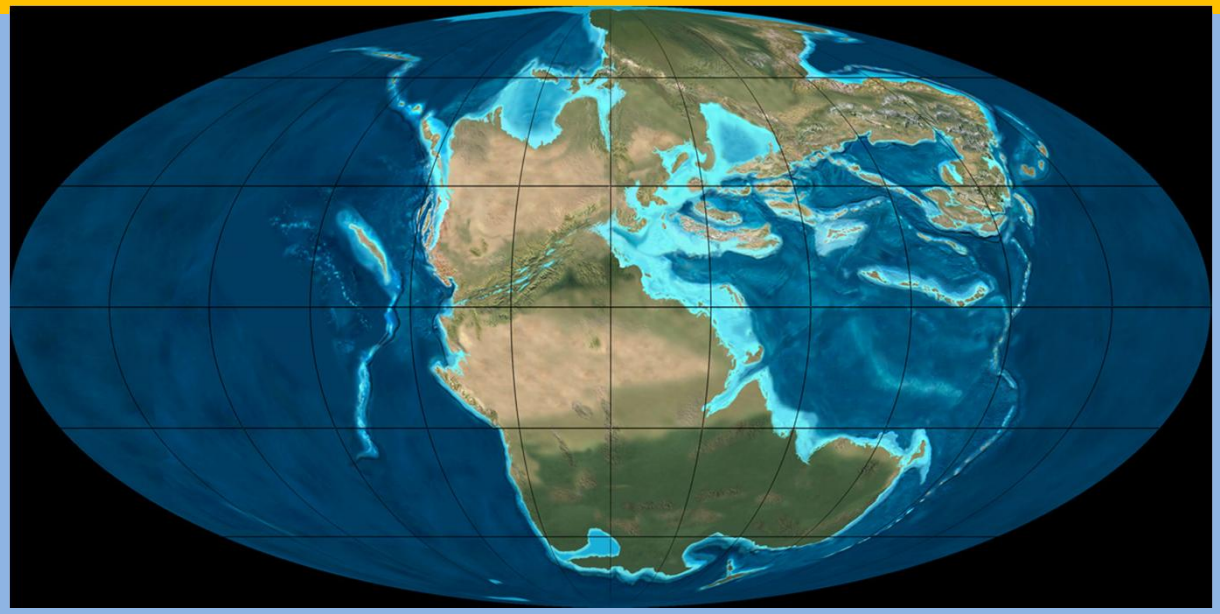
The Tree of Life (Terrance Malick, 2011!!!!!!)



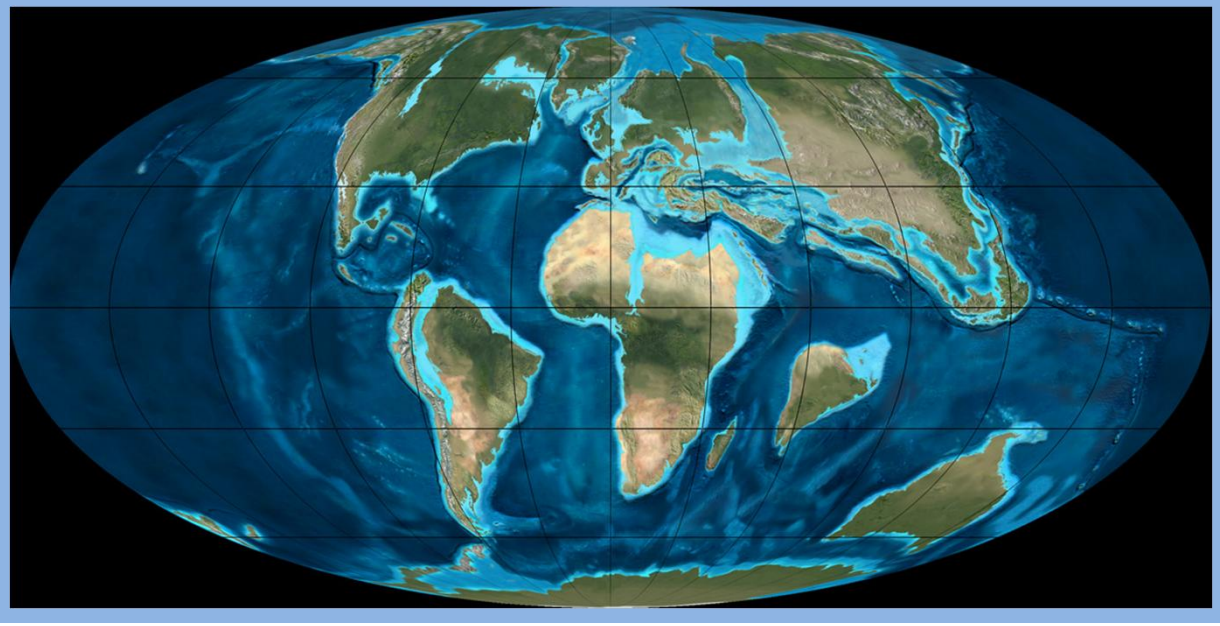
DIVERSIDAD EN PLESIOSAURIA

Rango temporal del grupo: Jurásico Inferior – Cretácico Superior (ca. 135 millones de años)

Triásico-Jurásico



Cretácico Superior

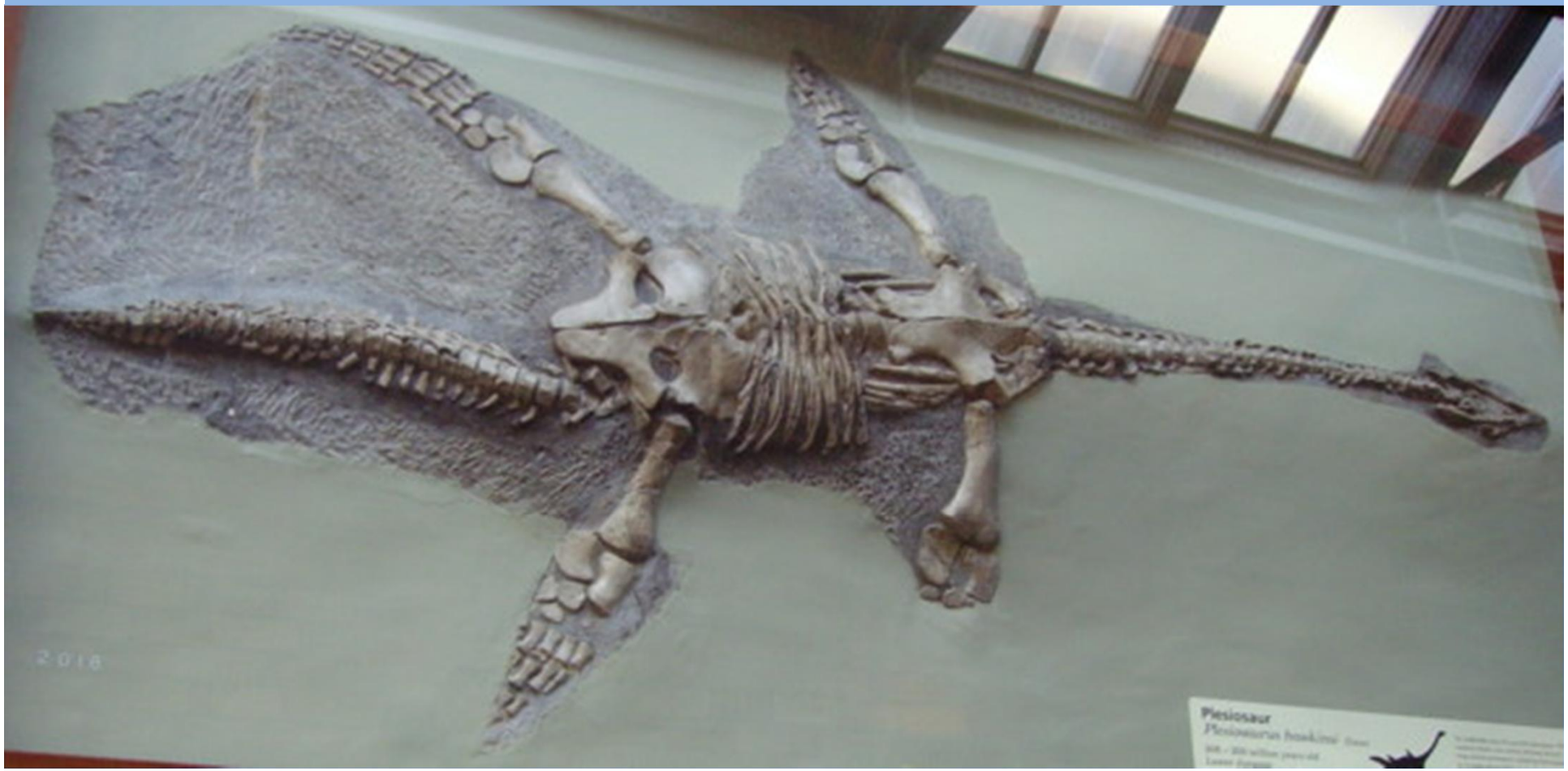


3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

Formas basales
Incertae Sedis

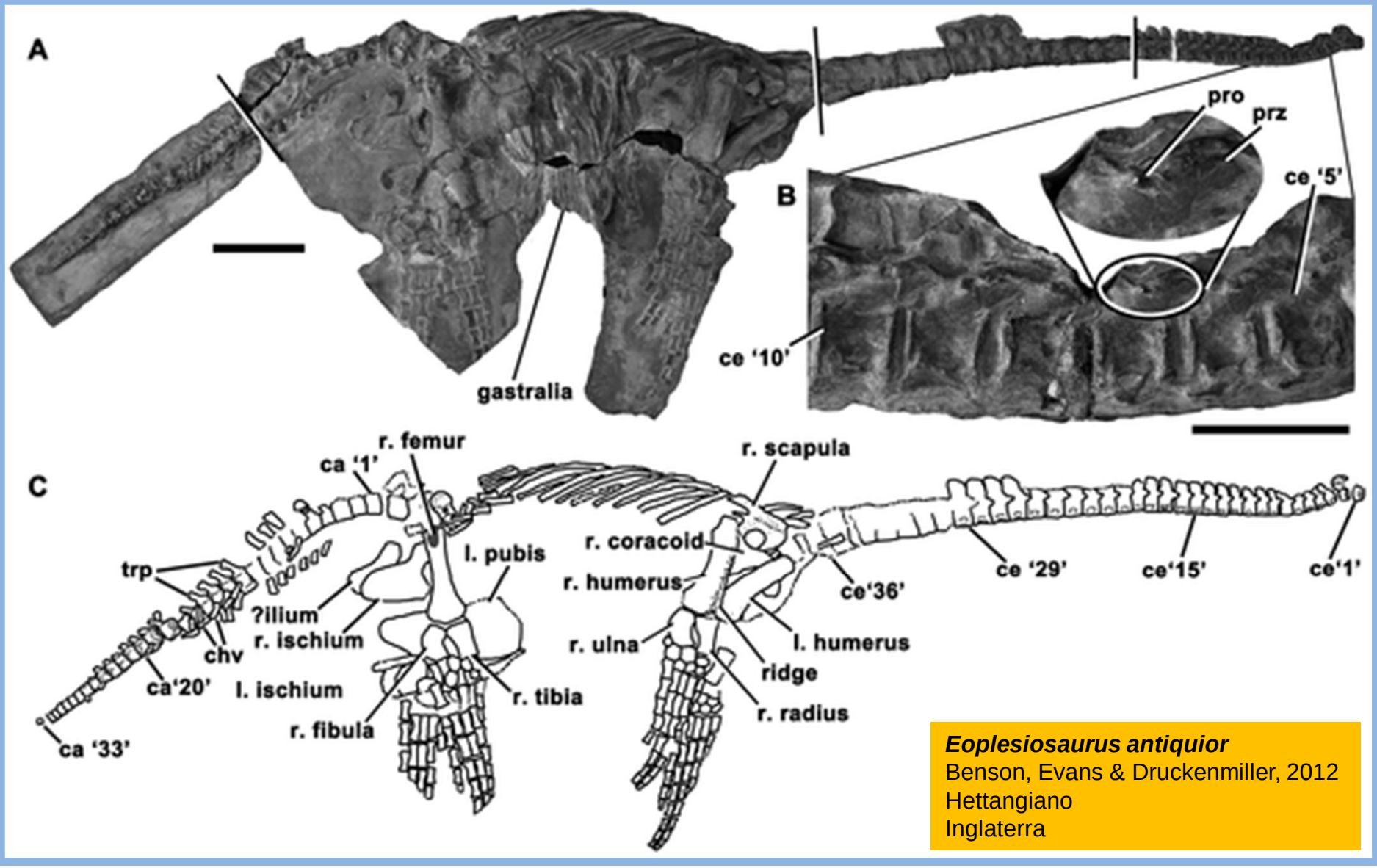
Thalassiodracon hawkinsi (Storrs & Taylor, 1996)
Rhaetiano - Hettangiano
Inglaterra



3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

Formas basales
Incertae sedis



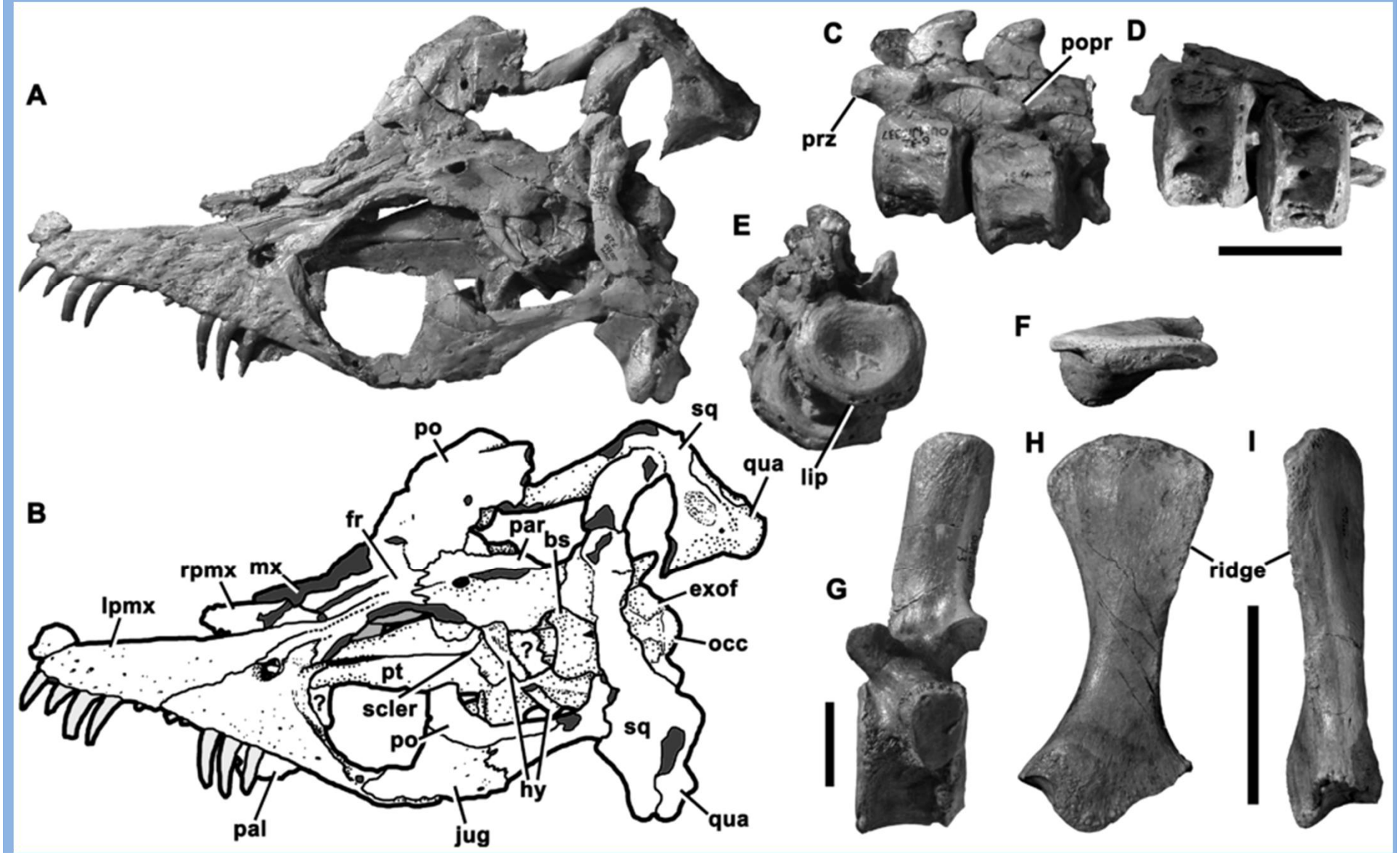
Eoplesiosaurus antiquior
Benson, Evans & Druckenmiller, 2012
Hettangiano
Inglaterra

3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

Formas basales
Incertae sedis

Stratesaurus taylori
Benson, Evans & Druckenmiller, 2012
Hettangiano
Inglaterra

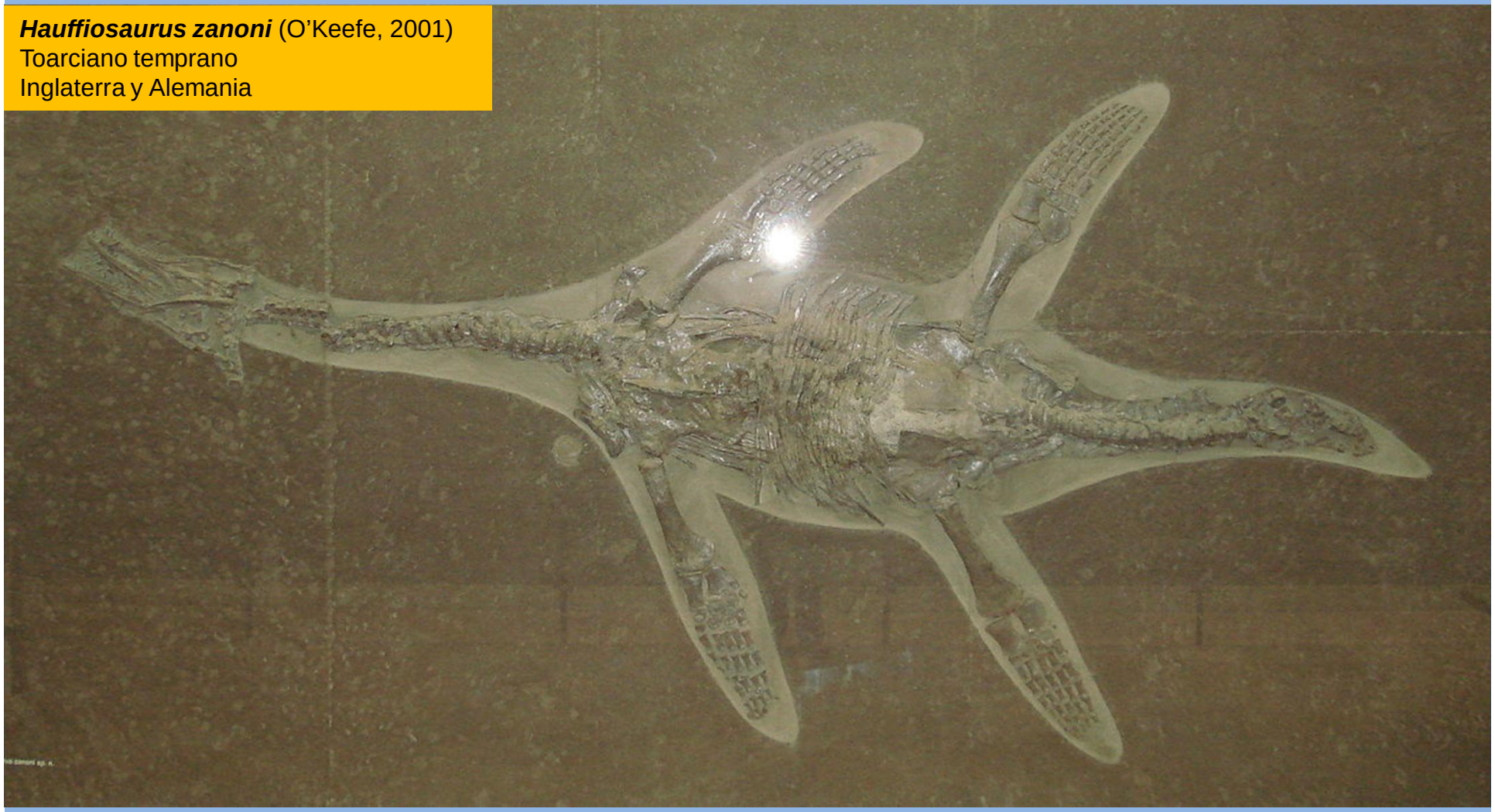


3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

Pliosauridae
Formas basales

Hauffiosaurus zanoni (O'Keefe, 2001)
Toarciano temprano
Inglaterra y Alemania



3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

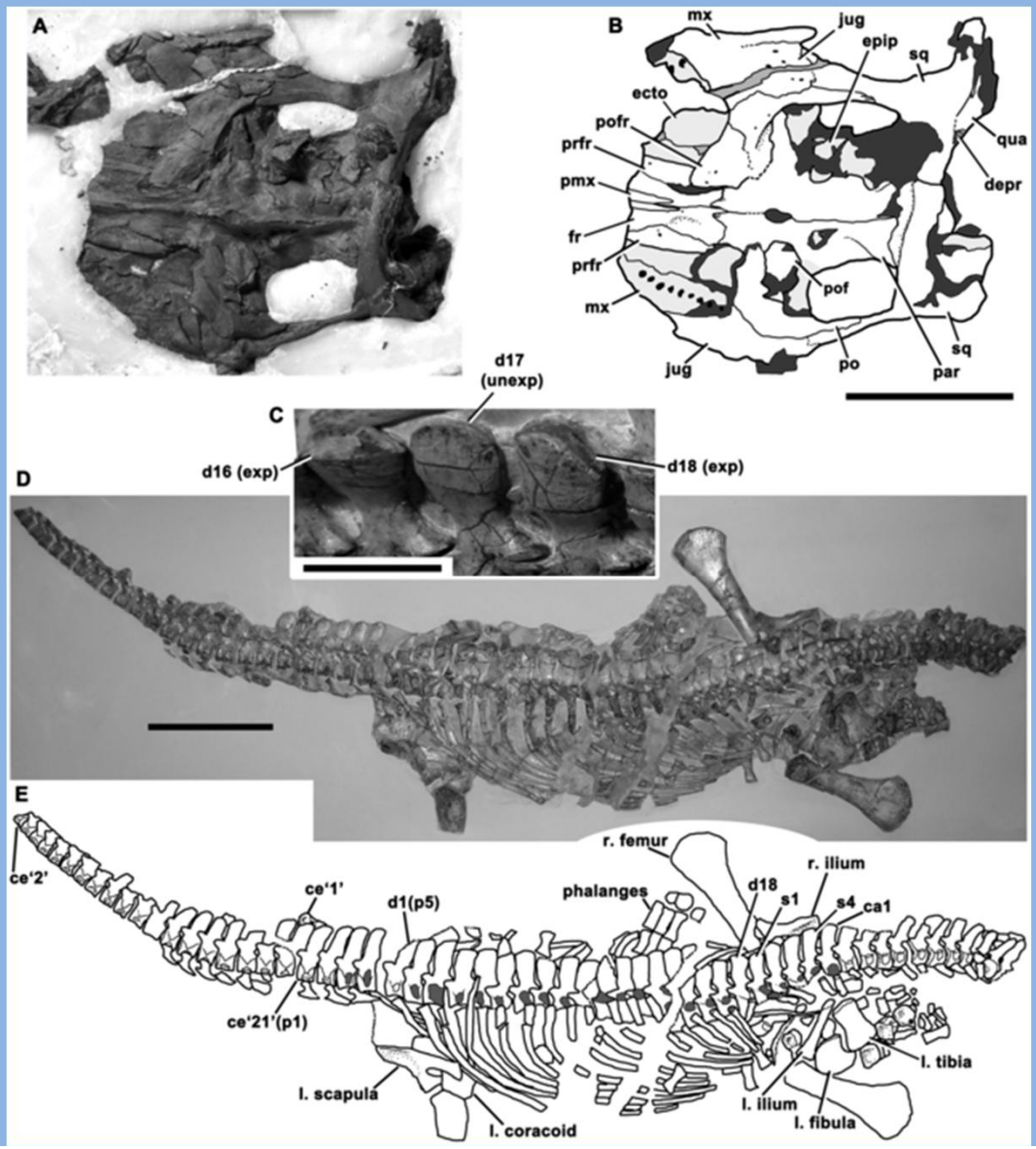
Pliosauridae
Formas basales

Attenborosaurus conybeari (Sollas, 1881)
'Lias inferior'
Inglaterra

3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

Rhomaleosauridae

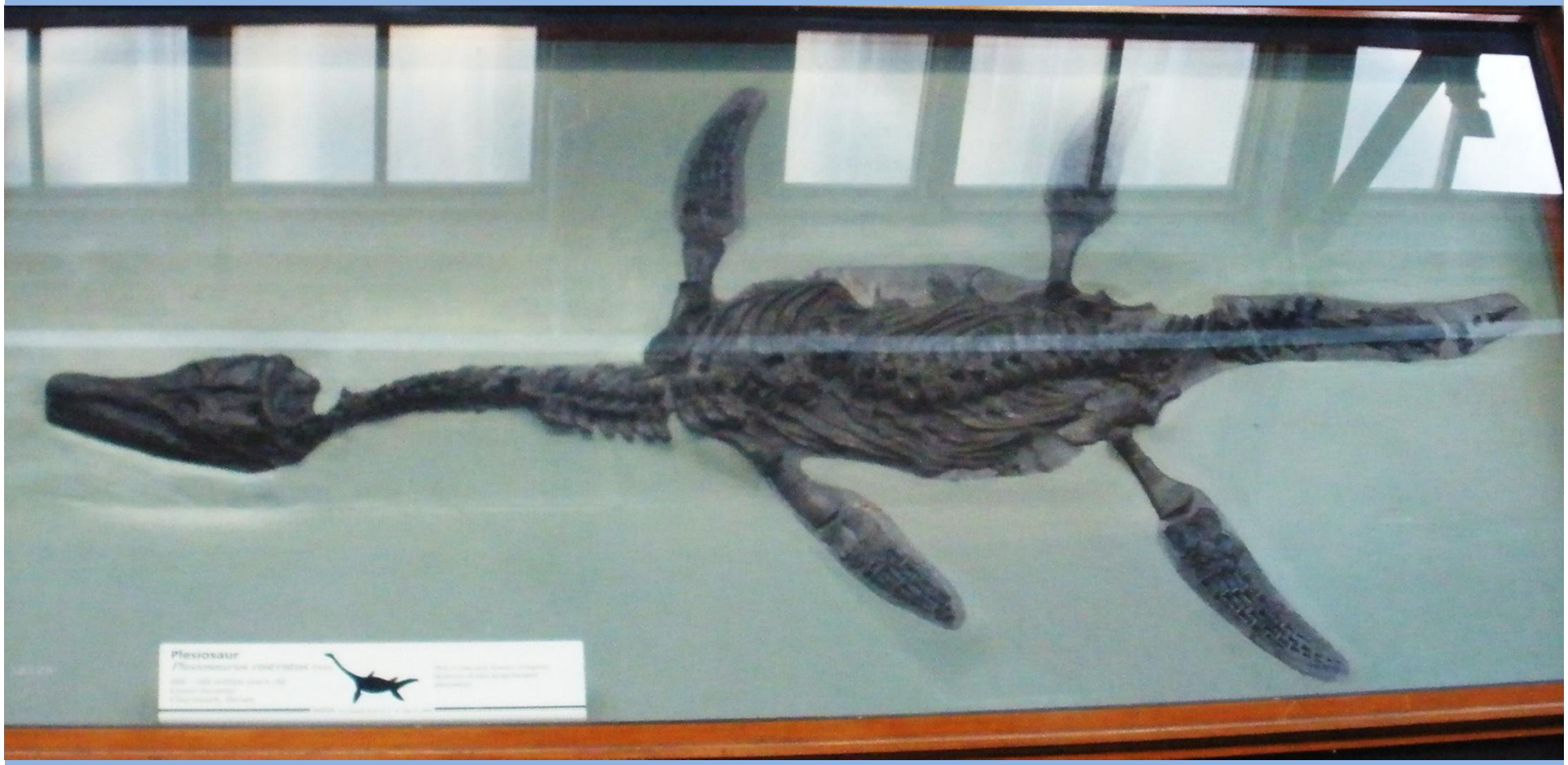


Avalonnectes arturi
Benson, Evans & Druckenmiller, 2012
Hettangiano
Inglaterra

3) Diversidad en Plesiosauria

Rhomaleosauridae?

3.2. Jurásico Inferior

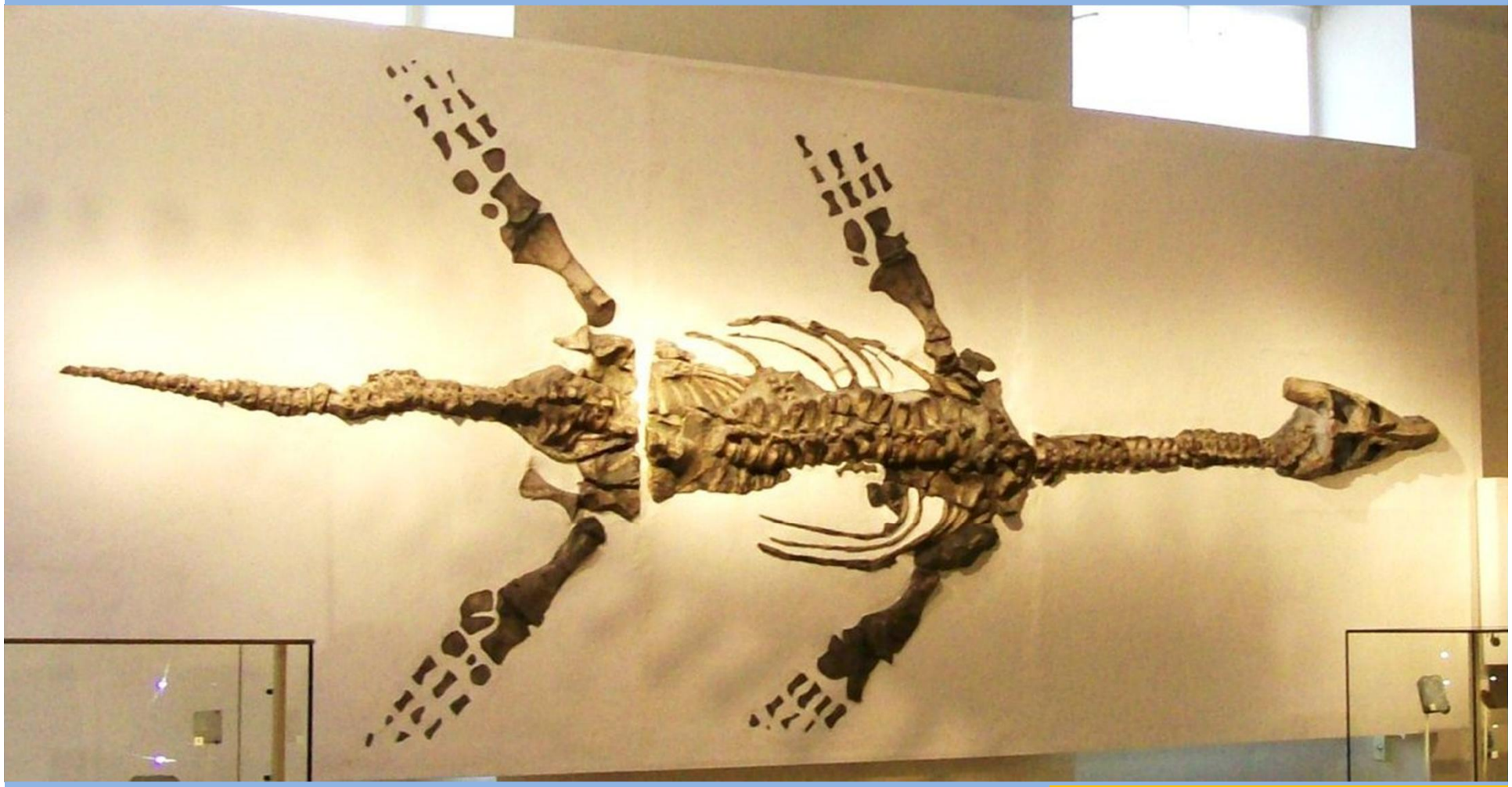


Archaeonectrus rostratus Owen, 1865
Toarciano
Inglaterra

3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

Rhomaleosauridae

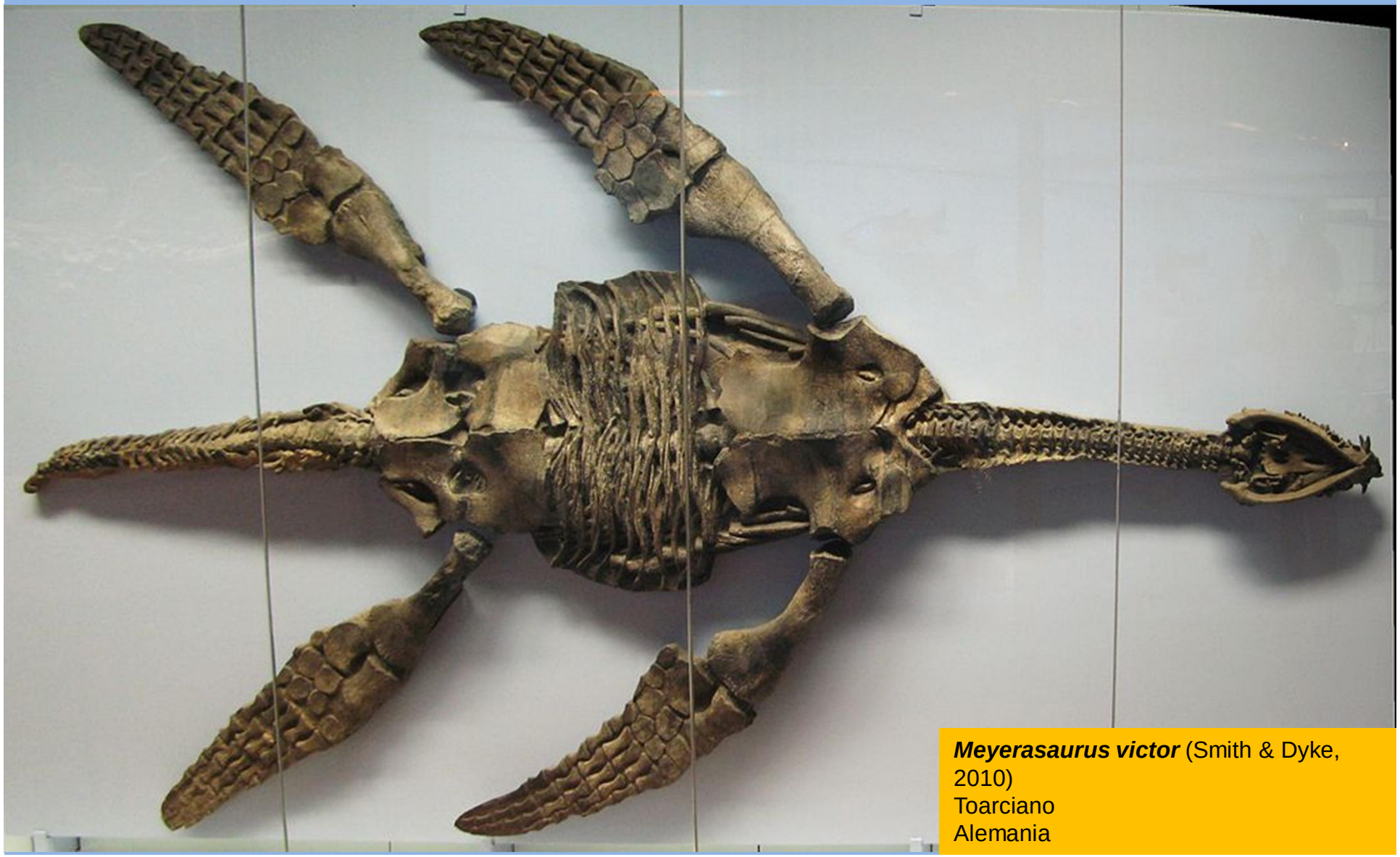


"Rhomaleosaurus" megacephalus
Seeley, 1874
Toarciano
Inglaterra

3) Diversidad en Plesiosauria

Rhomaleosauridae

3.2. Jurásico Inferior



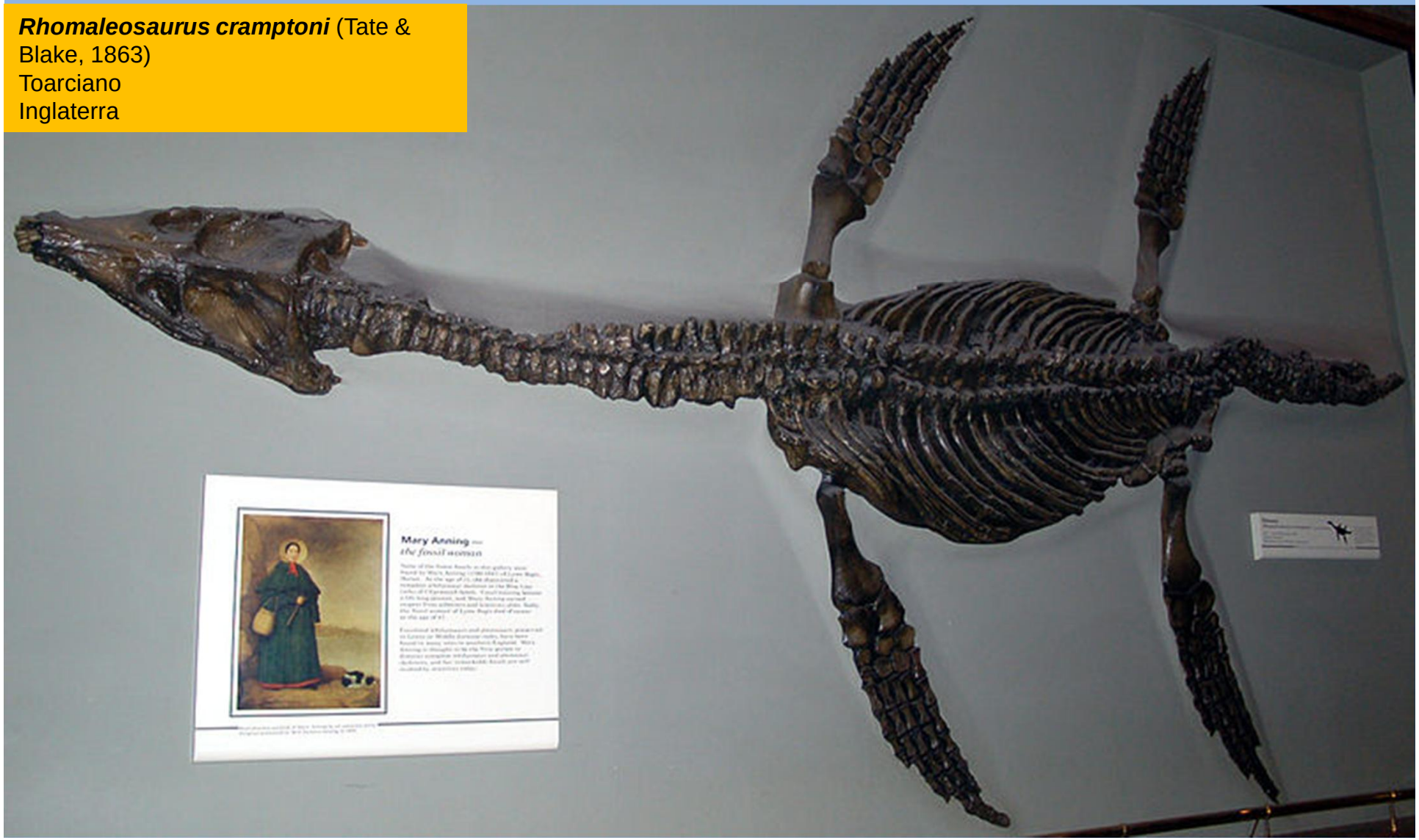
Meyerasaurus victor (Smith & Dyke, 2010)
Toarciano
Alemania

3) Diversidad en Plesiosauria

Rhomaleosauridae

3.2. Jurásico Inferior

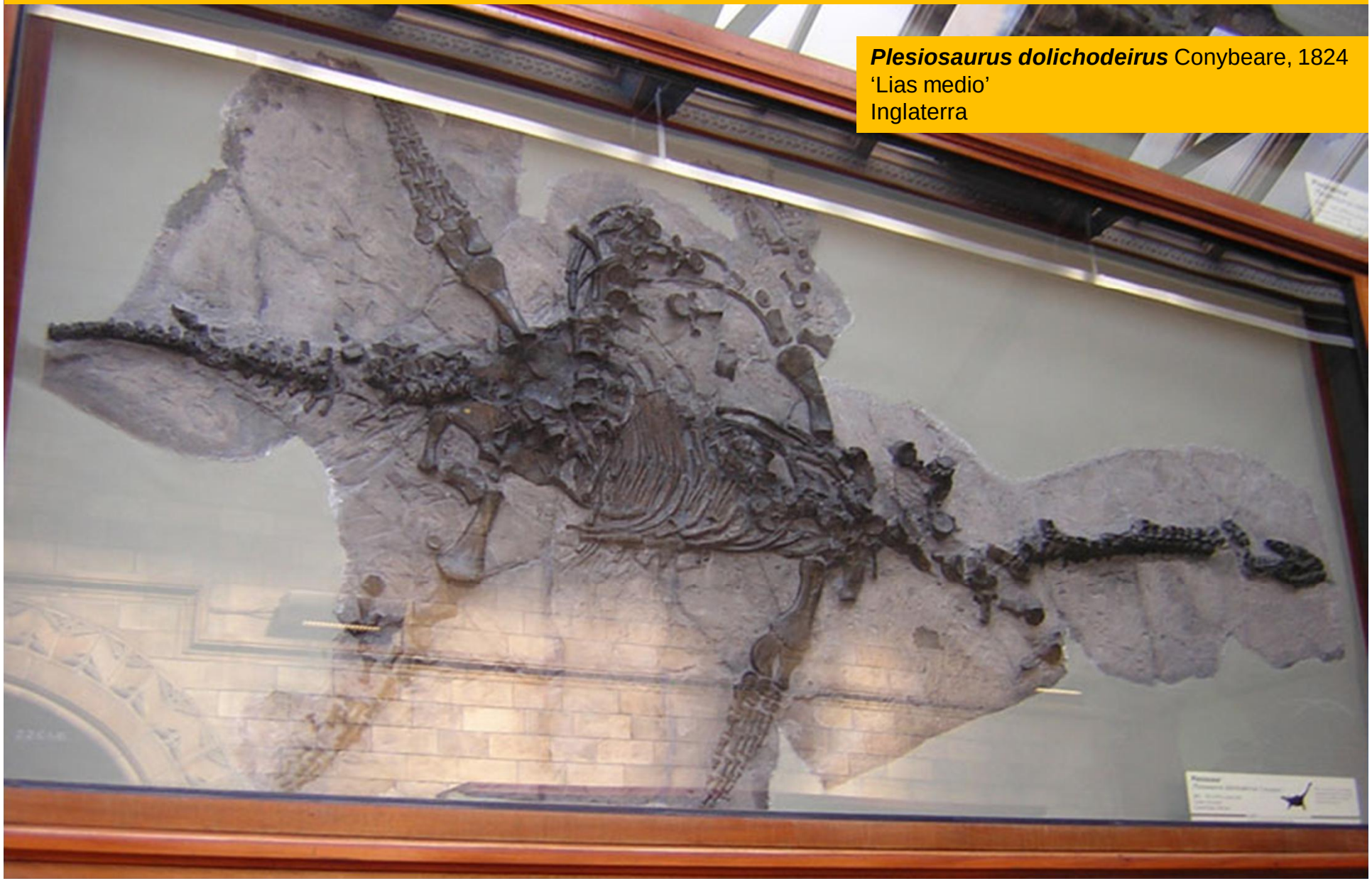
Rhomaleosaurus cramptoni (Tate & Blake, 1863)
Toarciano
Inglaterra



3) Diversidad en Plesiosauria

Plesiosauroidea

3.2. Jurásico Inferior



Plesiosaurus dolichodeirus Conybeare, 1824
'Lias medio'
Inglaterra

3) Diversidad en Plesiosauria

Plesiosauroidea

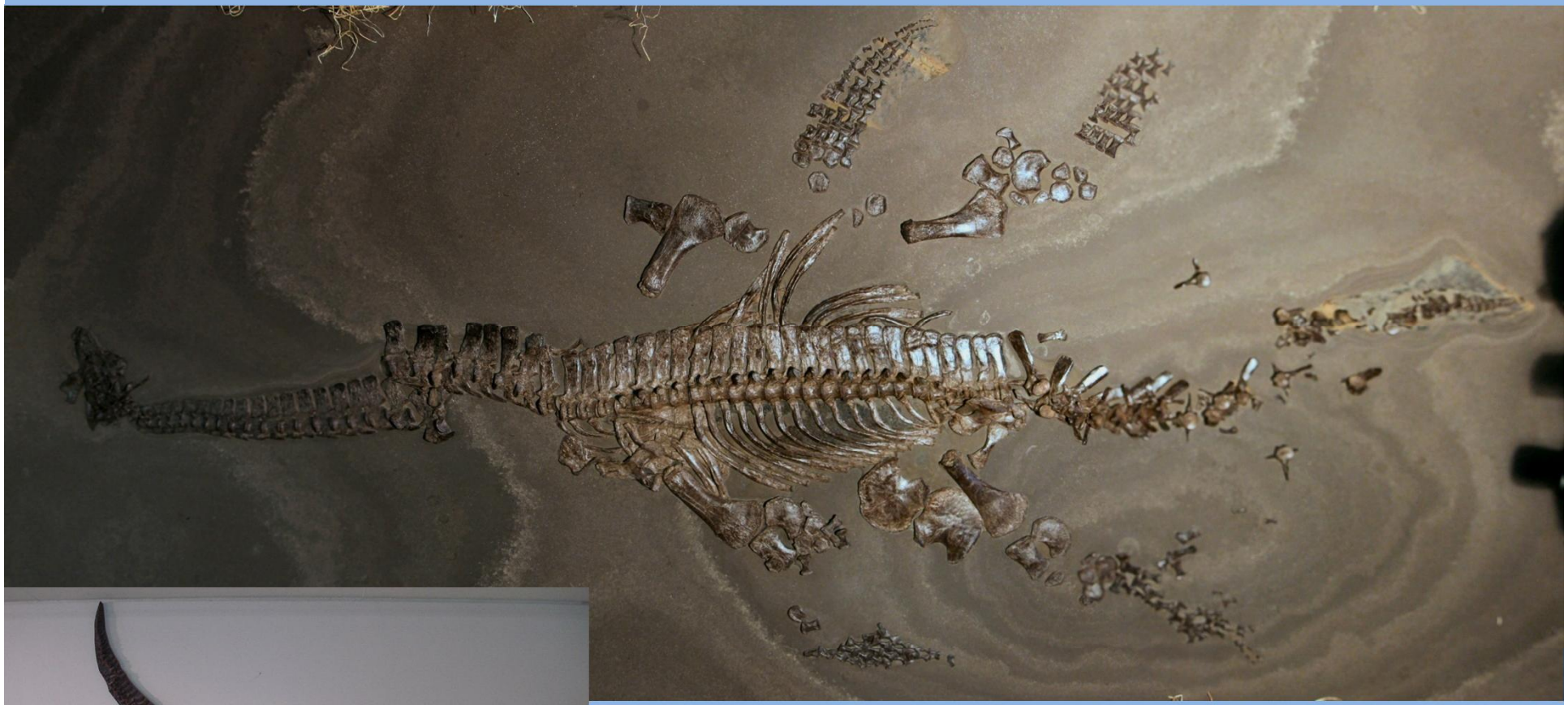
3.2. Jurásico Inferior

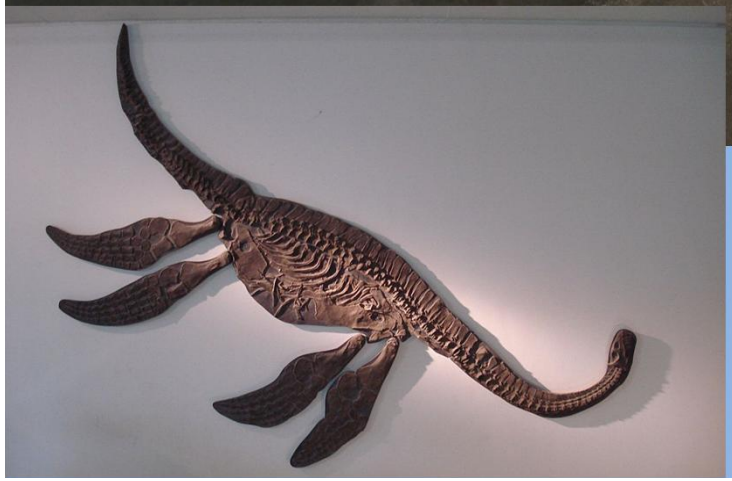
Eretmosaurus rugosus
(Owen, 1840)
'Lias medio'
Inglaterra

3) Diversidad en Plesiosauria

Plesiosauroidea

3.2. Jurásico Inferior





Seeleyosaurus guilhelmimperatoris (Owen, 1840)
Toarciano
Alemania

3) Diversidad en Plesiosauria

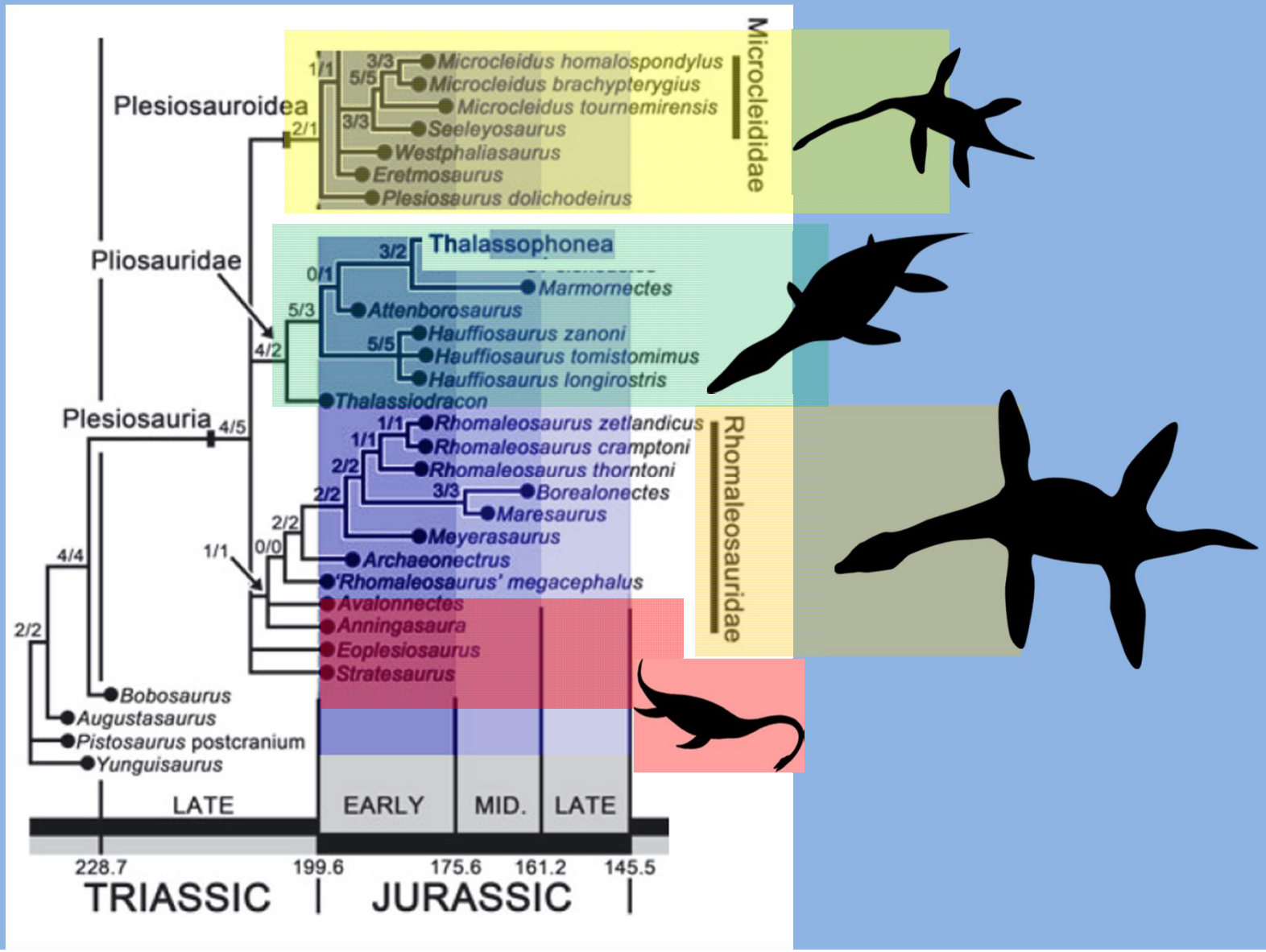
Plesiosauroidea

3.2. Jurásico Inferior

***Microcleidus* spp.**
Toarciano tardío
Francia

3) Diversidad en Plesiosauria

3.2. Jurásico Inferior

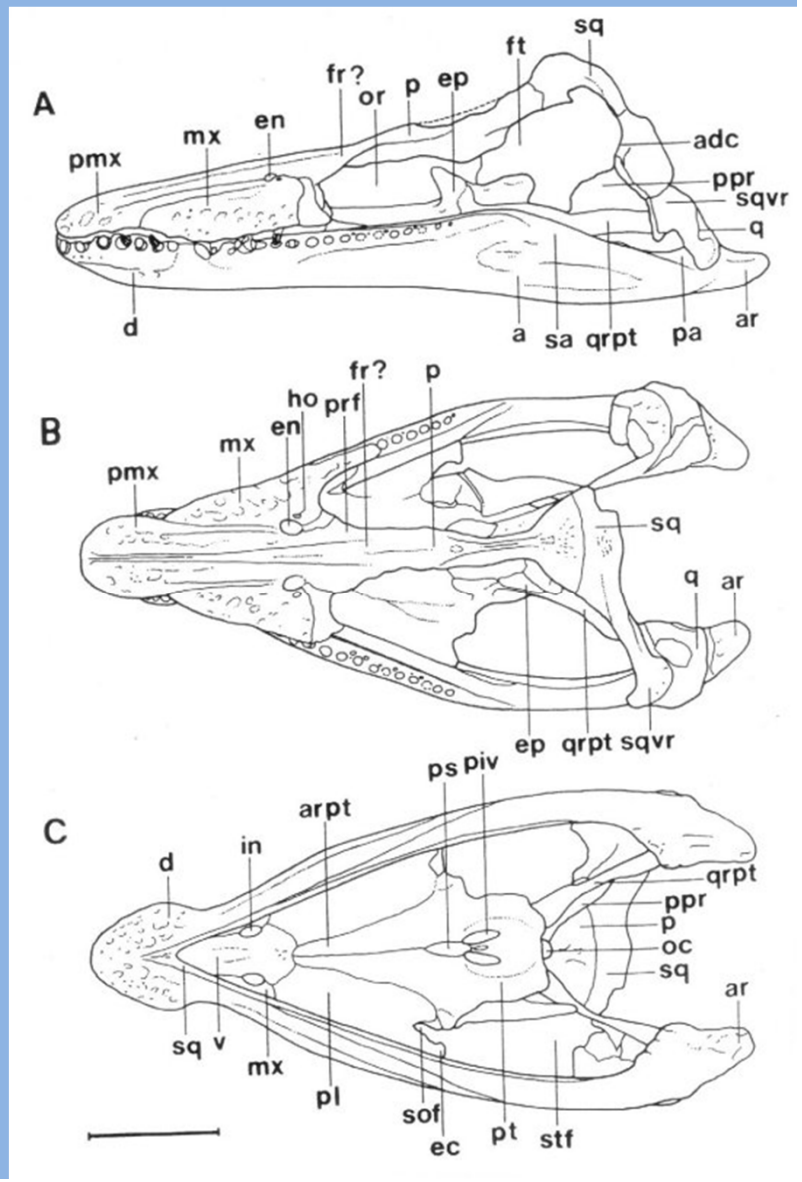


3) Diversidad en Plesiosauria

Rhomaleosauridae

3.3. Jurásico Medio

Maresaurus coccai Gasparini, 1997
Bajociano
Argentina



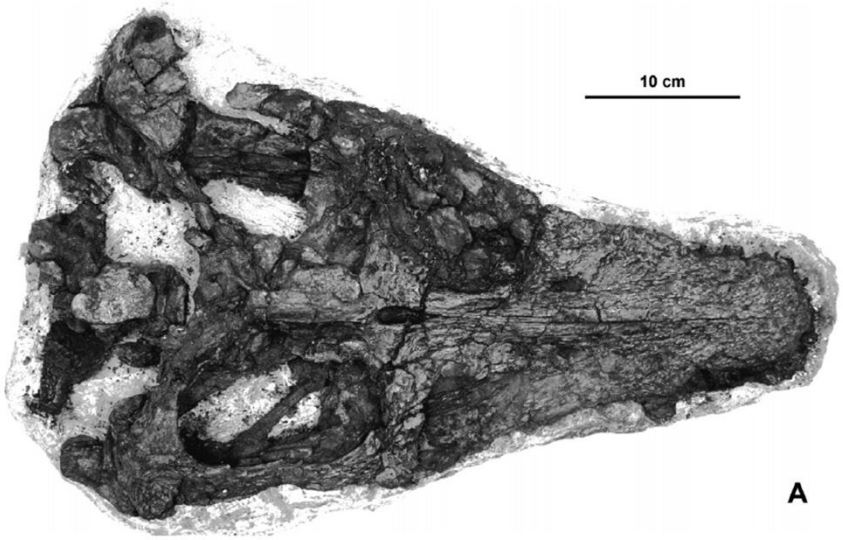
3) Diversidad en Plesiosauria

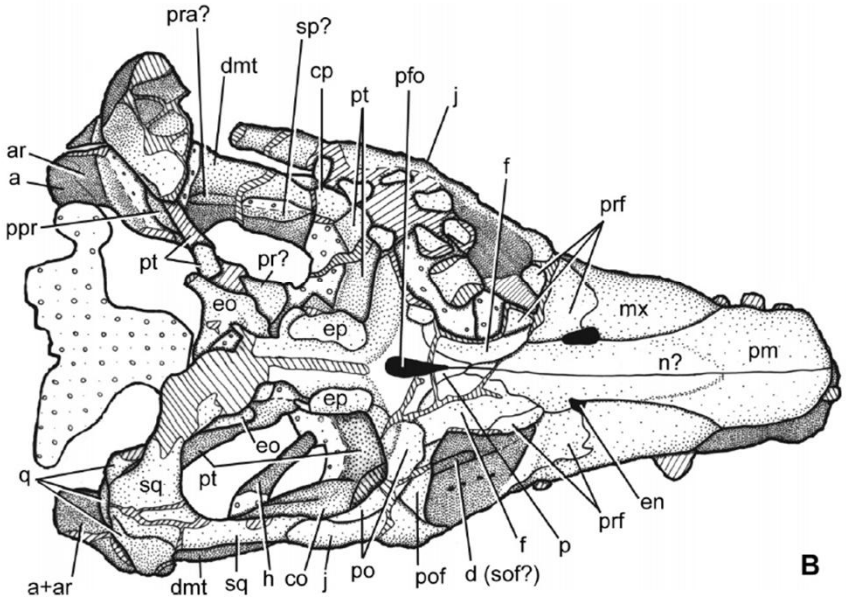
Rhomaleosauridae

3.3. Jurásico Medio

Borealonectes russelli Sato & Wu, 2008
Caloviano
Canada

Fig. 1. *Borealonectes russelli* gen. et sp. nov.: dorsal view of the skull (A) and interpretation (B). Abbreviations for Figs. 1–5: a, angular; ar, articular; boc, basioccipital; co, coronoid; cp, coronoid process; d, dentary; dmt, dorsomedian trough; en, external naris; eo, exoccipital–opisthotic; ep, epipterygoid; f, frontal; h, hyoid; in, internal naris; iptv, interpterygoid vacuity; j, jugal; mx, maxilla; n, nasal; oc, occipital condyle; p, parietal; pfo, pineal foramen; pm, premaxilla; po, postorbital; pof, postfrontal; ppr, paroccipital process; pr, prootic; pra, prearticular; prf, prefrontal; ps, parasphenoid; pt, pterygoid; ptb, pterygoid boss; q, quadrate; qrpt, quadrate ramus of pterygoid; rg, ridge; sa, surangular; so, supraoccipital; sof, suborbital fenestra; sp, splenial; sq, squamosal; ste, subtemporal emargination.





3) Diversidad en Plesiosauria

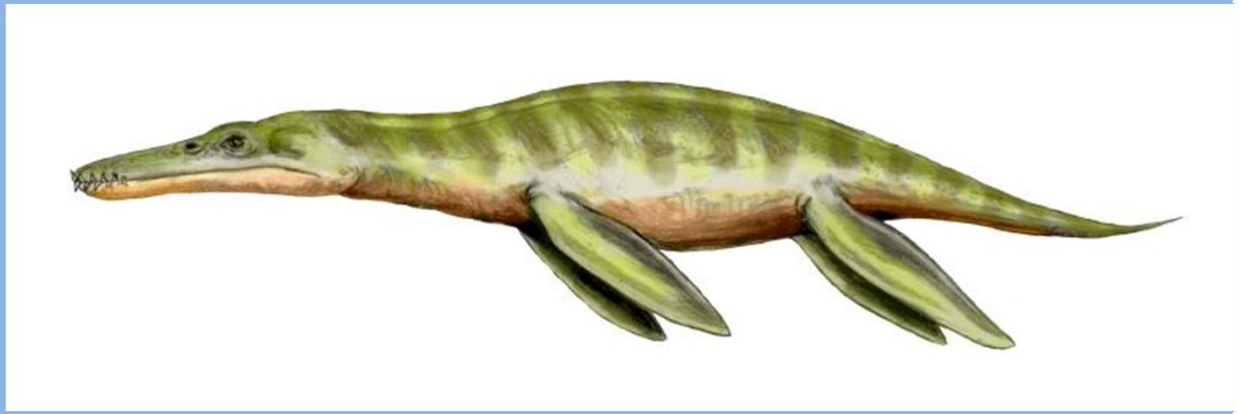
Pliosauridae
Thalassophonea

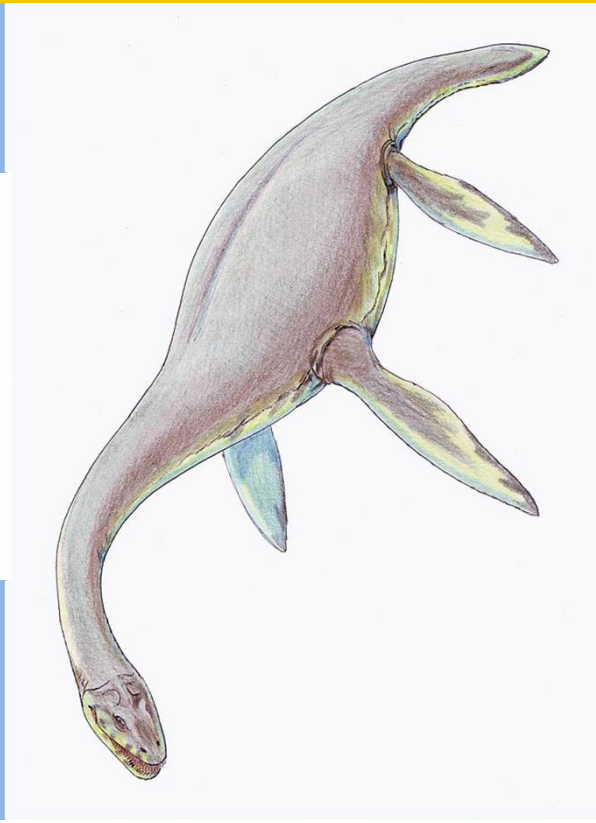
3.3. Jurásico Medio

Existe un importante gap en el registro global entre el Aaleniano – Bathoniano.

Se conocen abundantes especímenes desde el Caloviano en ambos hemisferios.

A partir del Caloviano, se destaca la diversificación de dos grupos: Pliosauridae (clado Thalassophonea), y Cryptoclididae





3) Diversidad en Plesiosauria

Pliosauridae
Thalassophonea

3.3. Jurásico Medio

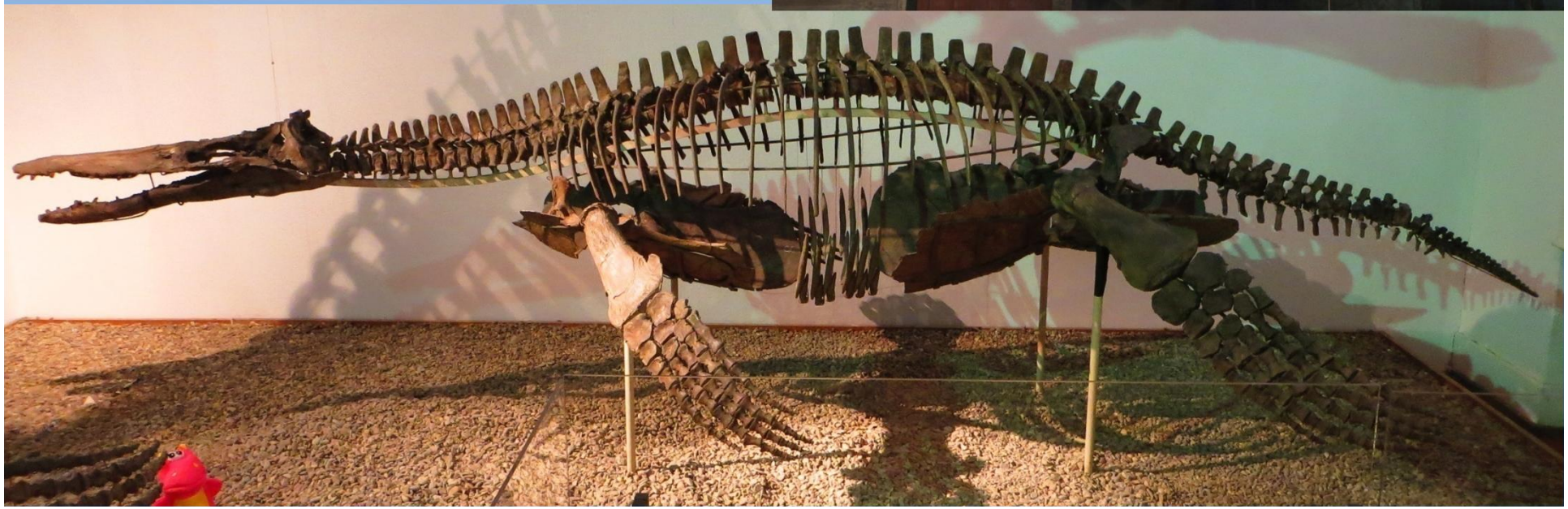
***Liopleurodon* spp.**
Caloviano
Europa

3) Diversidad en Plesiosauria

Pliosauridae
Thalassophonea

3.3. Jurásico Medio

Peloneustes philarchus Seeley, 1869
Caloviano
Inglaterra



3) Diversidad en Plesiosauria

3.3. Jurásico Medio

Pliosauridae
Thalassophonea

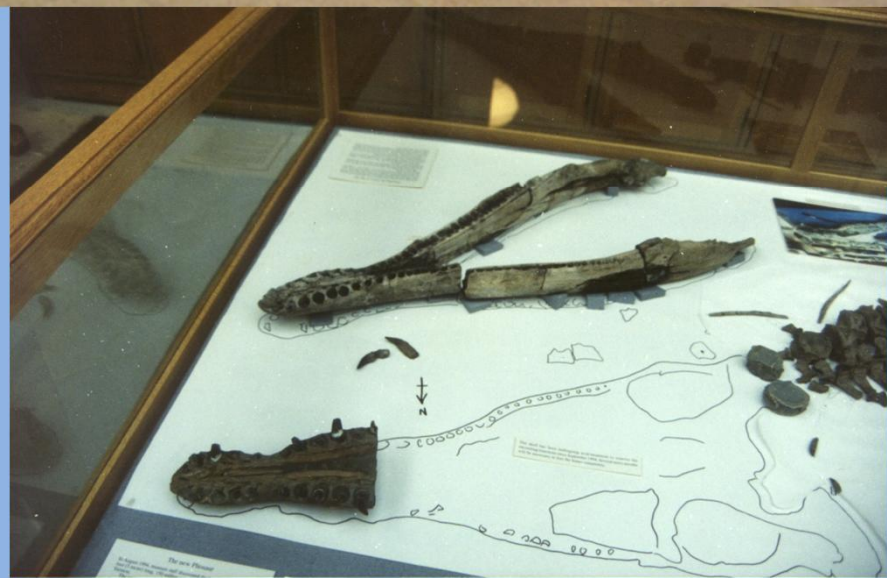
Gallardosaurus iturraldei Gasparini, 2009
Caloviano
Cuba

3) Diversidad en Plesiosauria

3.3. Jurásico Medio

Pliosauridae
Thalassophonea

Simolestes vorax Andrews, 1909
Caloviano-Oxfordiano
Inglaterra



3) Diversidad en Plesiosauria

3.3. Jurásico Medio

Plesiosauroidea
Cryptoclidia
Cryptoclididae

Cryptoclidus eurymerus (Phillips, 1871)
Caloviano-Oxfordiano
Inglaterra

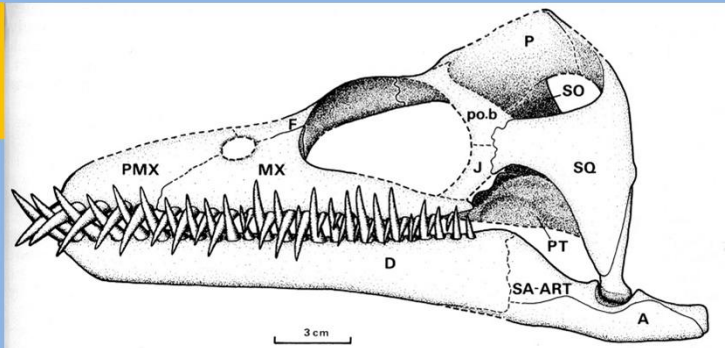


Fig. 1 *Cryptoclidus eurymerus* (Phillips). Composite reconstruction of skull in lateral view. A, angular; D, dentary; F, frontal; J, jugal; MX, maxilla; P, parietal; PMX, premaxilla; po.b, postorbital bar; PT, pterygoid; Q, quadrate; SA–ART, fused surangular-articular; SO, supra-occipital; SQ, squamosal.

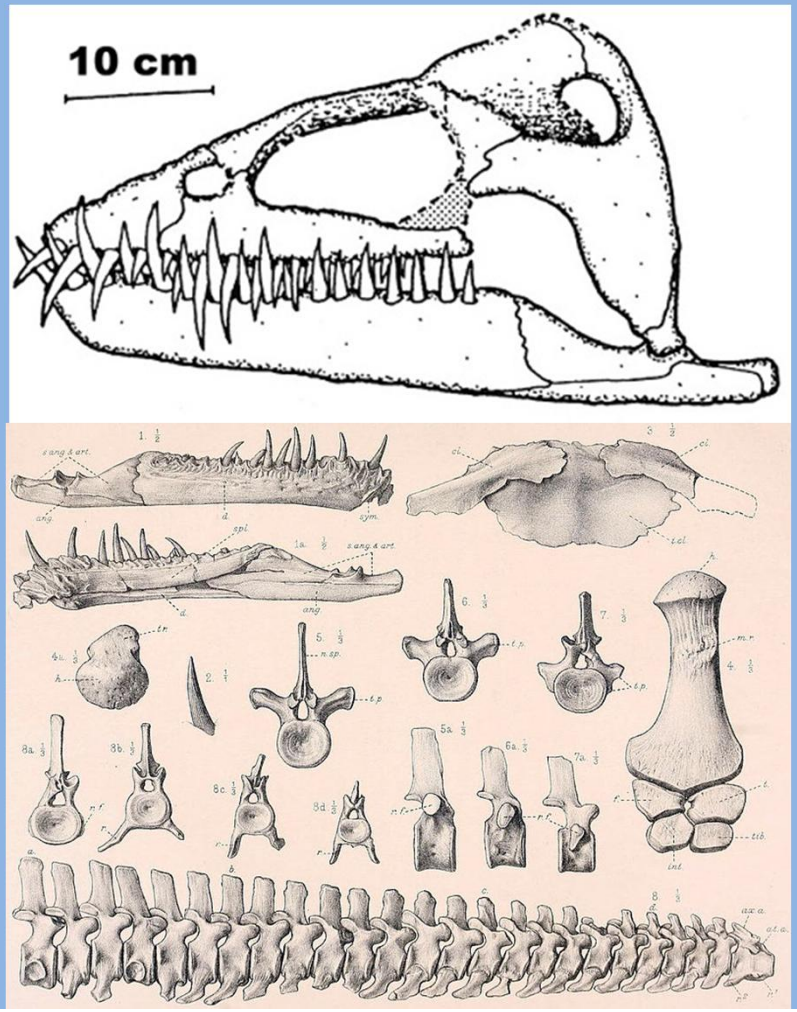
Cryptoclidus oxioniensis (Phillips, 1871)
Caloviano-Oxfordiano
Inglaterra

3) Diversidad en Plesiosauria

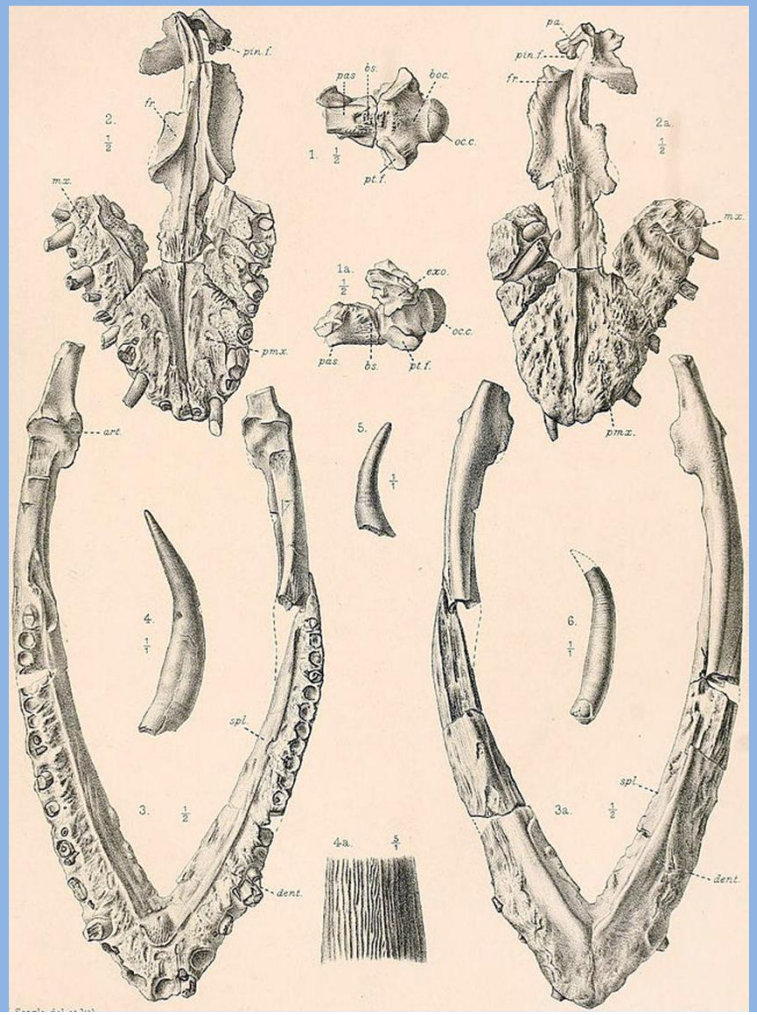
3.3. Jurásico Medio

Plesiosauroidea
Cryptoclidia
Cryptoclididae

Tricleidus seeleyi Andrews, 1909
Caloviano-Oxfordiano
Inglaterra



Muraenosaurus leedsi Seeley, 1874
Caloviano-Oxfordiano
Inglaterra y Francia



3) Diversidad en Plesiosauria

3.4. Jurásico Superior

Pliosauridae
Thalassophonea

Pliosaurus kevani Benson et al., 2013
Kimmeridgiano
Inglaterra

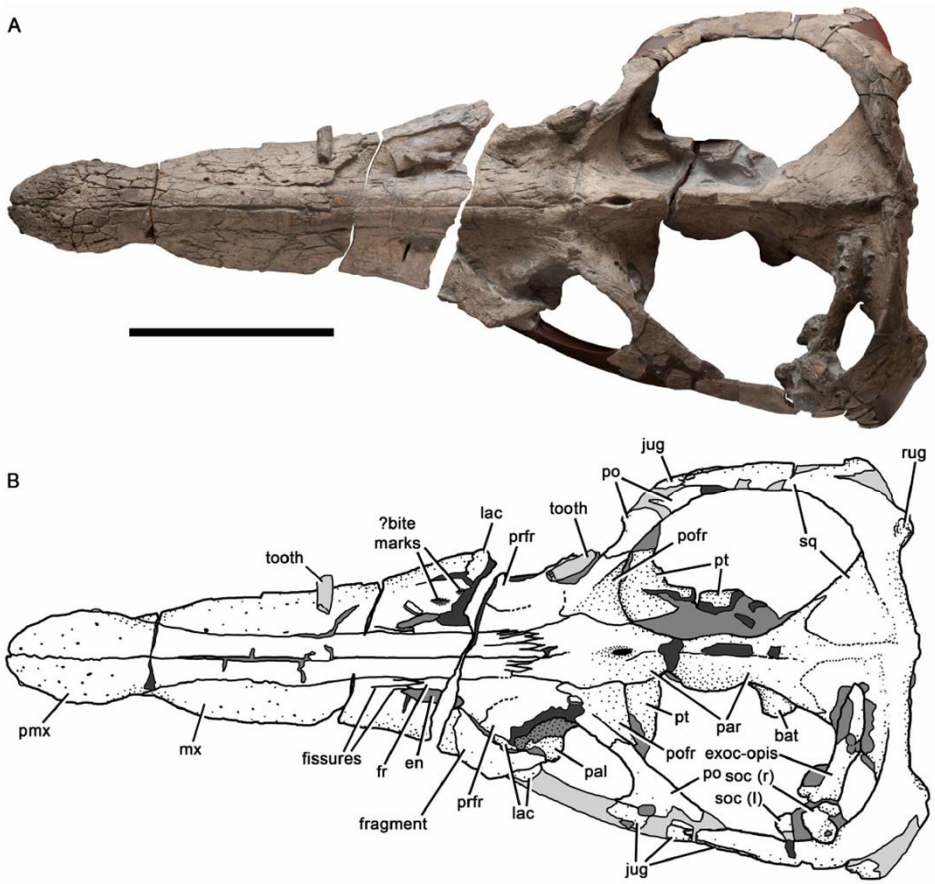


Figure 2. Cranium of *Pliosaurus kevani* **n. sp. DORCM G.13,675 in dorsal view** (A–B). In line drawing (B) dark grey tone represents broken bone surface, mid grey represents matrix, and light grey represents tooth or artificial restoration. Abbreviations: bat, basal tuber; en, external naris; exoc-opis, exoccipital-opisthotic; fr, frontal; jug, jugal; lac, 'lacrimal'; mx, maxilla; pal, palatine; par parietal; pmx, premaxilla; po, postorbital; pofr, postfrontal; prfr, prefrontal; pt, pterygoid; rug, rugose eminence; soc (l), left portion of supraoccipital; soc (r), right portion of supraoccipital; sq, squamosal. Ss
doi:10.1371/journal.pone.0065989.g002

Pliosaurus almanzaensis O'Gorman et al., 2018
Titoniano
Argentina

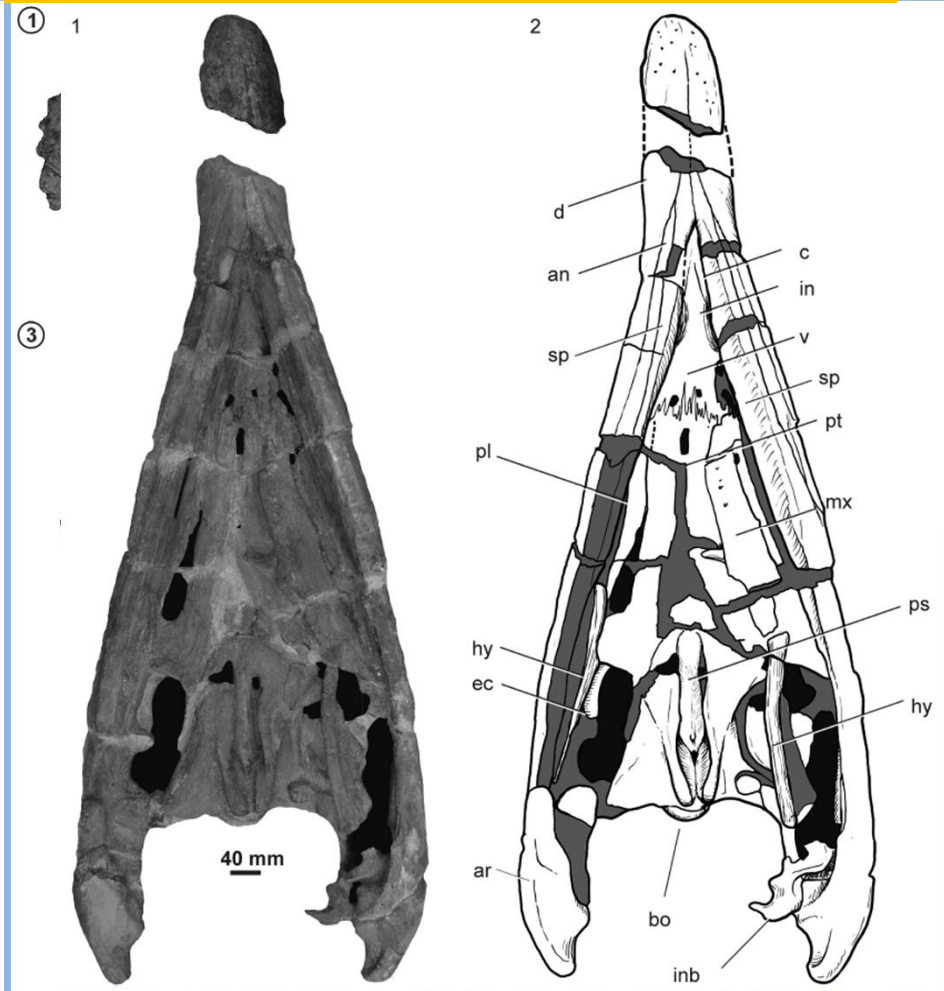


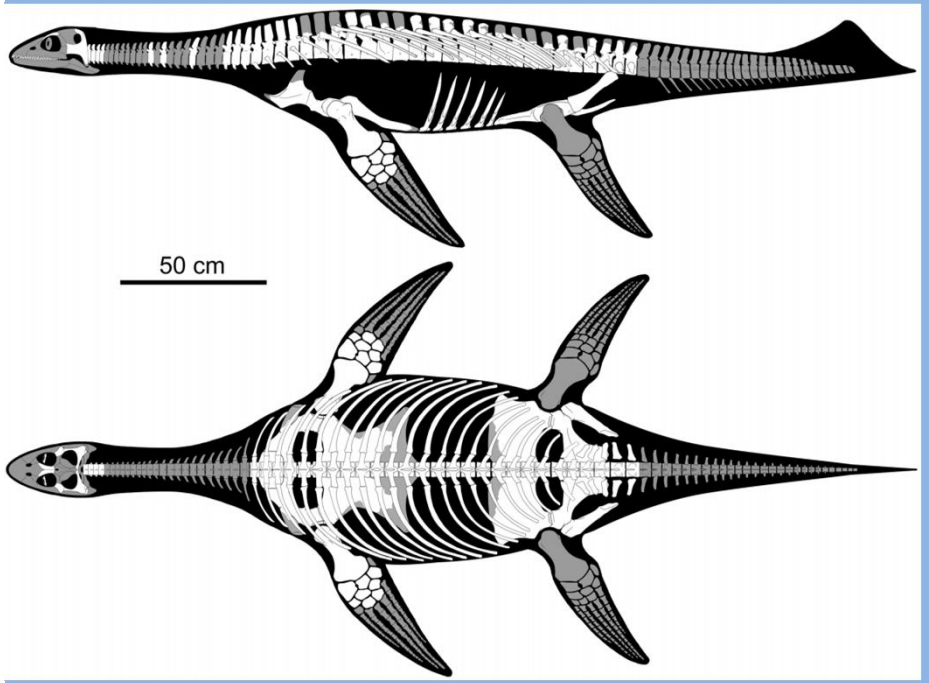
Figure 3. *Pliosaurus almanzaensis* n. sp. (MOZ 3728P), Vaca Muerta Formation, Cajón de Almanza, Neuquén Province, skull and mandible in ventral view: (1) photograph; (2) interpretive drawing. an = angular; ar = articular; bo = basioccipital; c = coronoid; d = dentary; ec = ectopterygoid; hy = hyoid element; in = internal naris; inb = indeterminate bone; mx = maxilla; pl = palatine; ps = parasphenoid; pt = pterygoid; sp = splenial; v = vomer.

3) Diversidad en Plesiosauria

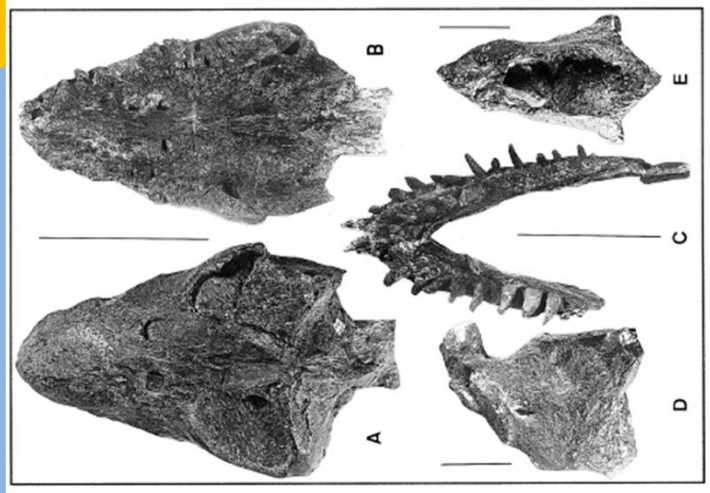
3.4. Jurásico Superior

Plesiosauroidea
Cryptoclidia
Cryptoclididae

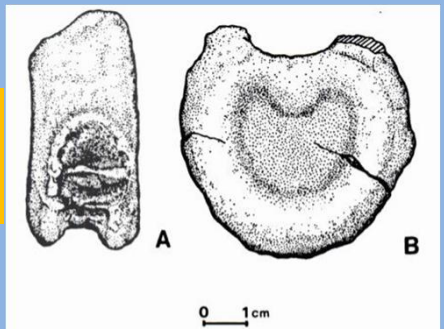
Tatenectes laramiensis (Knight, 1900)
Oxfordiano
Wyoming, US

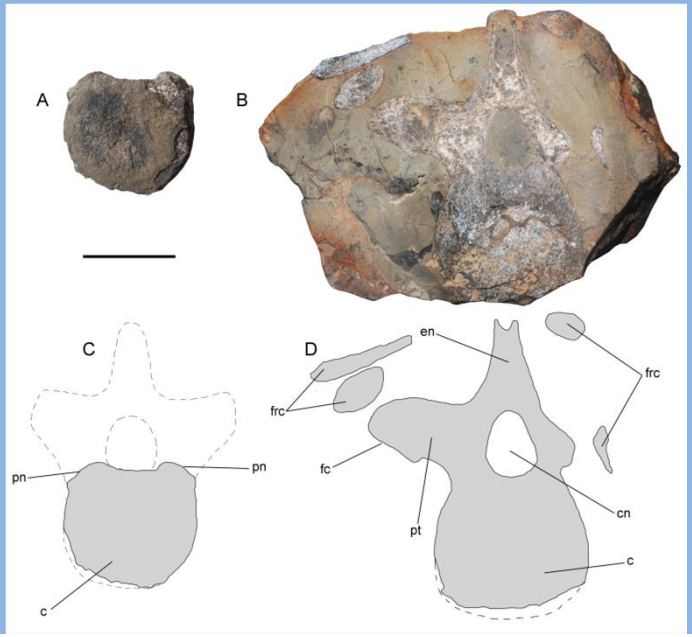


Vinialesaurus caroli Gasparini et al., 2002
Oxfordiano
Cuba



Cryptoclididae indet.
Oxfordiano
Argentina y Chile

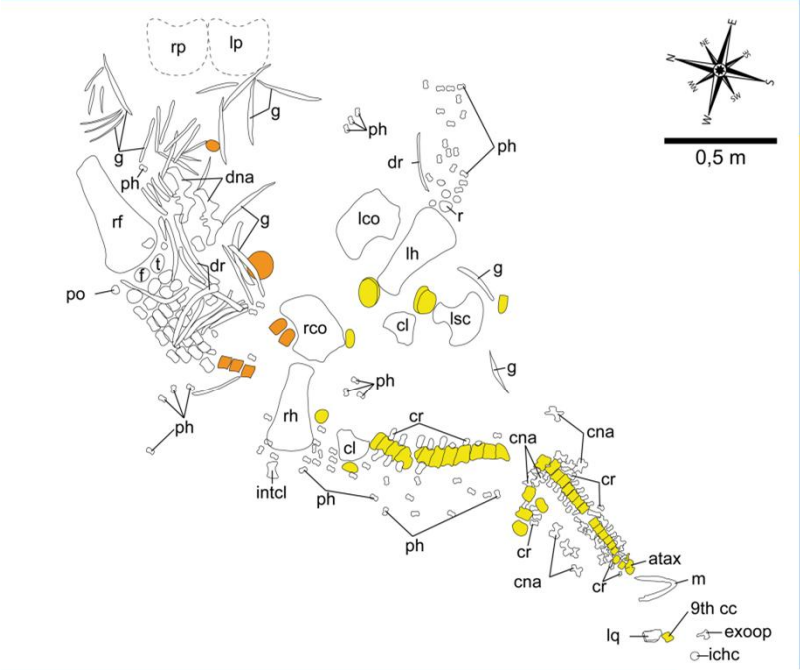




3) Diversidad en Plesiosauria

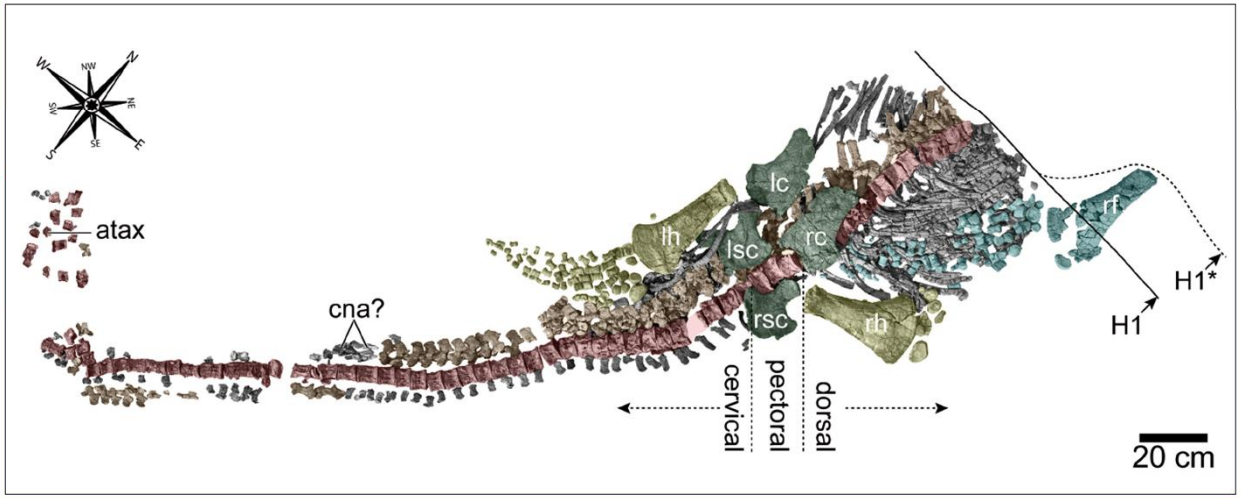
3.4. Jurásico Superior

Plesiosauroidea
Cryptoclidia
Cryptoclididae



Djupedalia engeri Knutsen et al., 2012
Titoniano
Noruega

***Spitrasaurus* spp.**
Titoniano
Noruega



3) Diversidad en Plesiosauria

Límite Jurásico - Cretácico

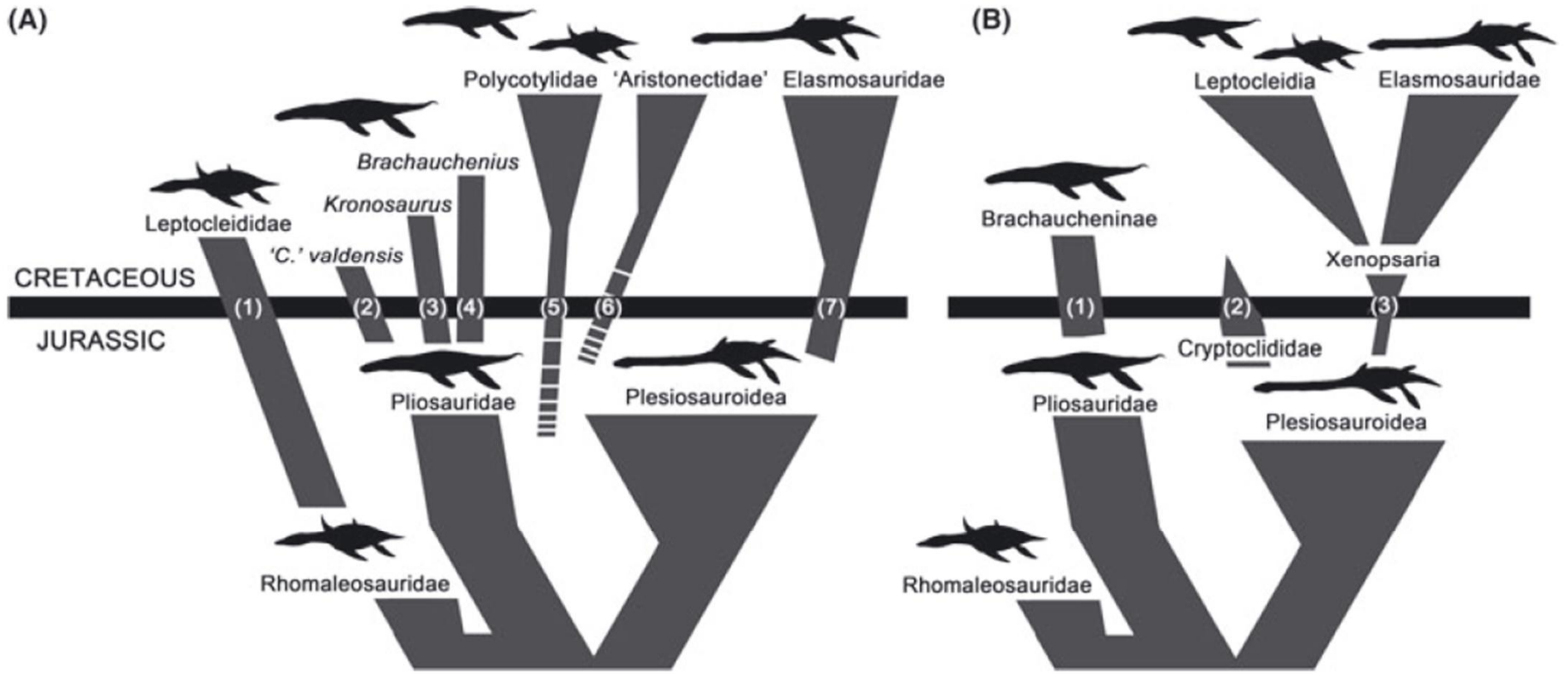


Fig. 1. Hypotheses of plesiosaurian lineages crossing the Jurassic–Cretaceous boundary. (A) Schematic depiction of previous hypotheses showing the maximum number of lineages hypothesised as crossing the boundary (seven lineages); (B) simplified depiction of the tree recovered from our dataset in which only three lineages crossed the boundary (see Figs 2 and 3).

3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Pliosauridae
Thalassophonea
Brachaucheninae

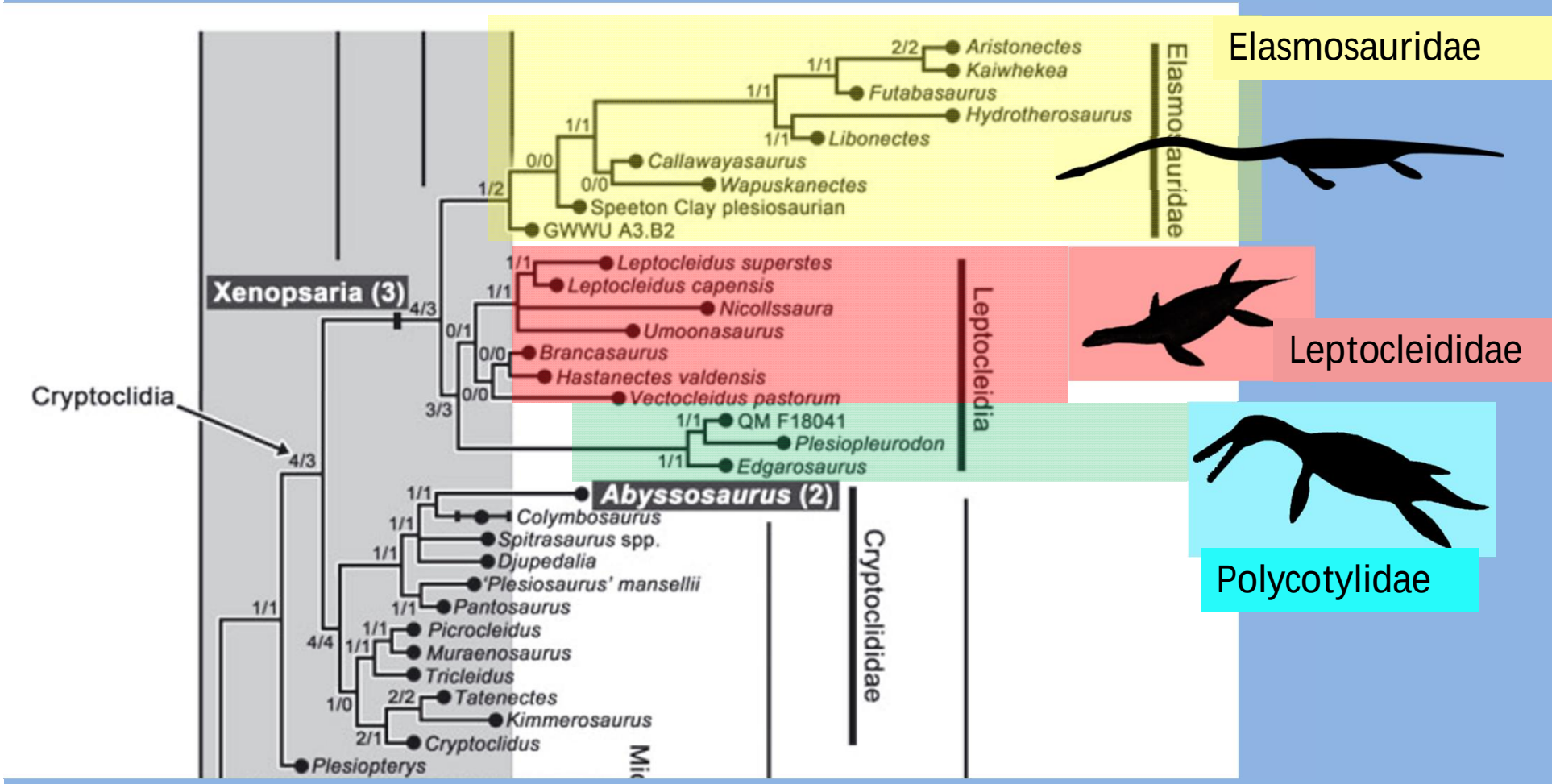
Kronosaurus queenslandicus Longman, 1924
Aptiano-Albiano
Australia

Kronosaurus boyacencis Hampe, 1992
Aptiano
Colombia

3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria



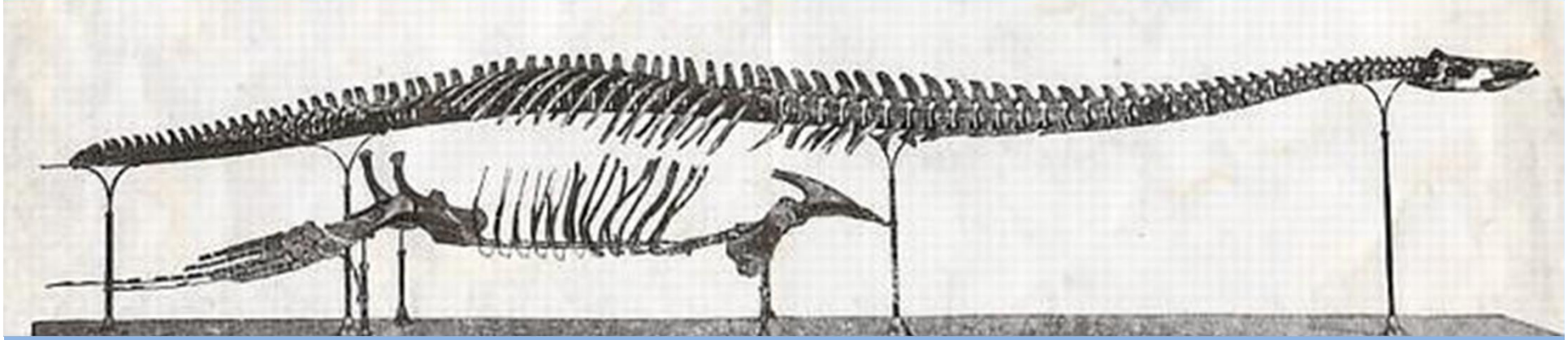
Xenopsaria:
-Clado más exitoso durante el Cretácico. Incluye a los **Leptocleidia** y **Elasmosauridae**
-Debió divergir a durante el Jurásico.

3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria
Leptocleidia

Brancasaurus brancai Wegner, 1914
Hauteriviano
Alemania



3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria
Leptocleidia

Nichollsaura borealis Druckenmiller & Russell, 2008
Aptiano
Canada

3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria
Leptocleidia

Umoonasaurs demoscyllus Kear et al., 2006
Aptiano-Albiano
Australia

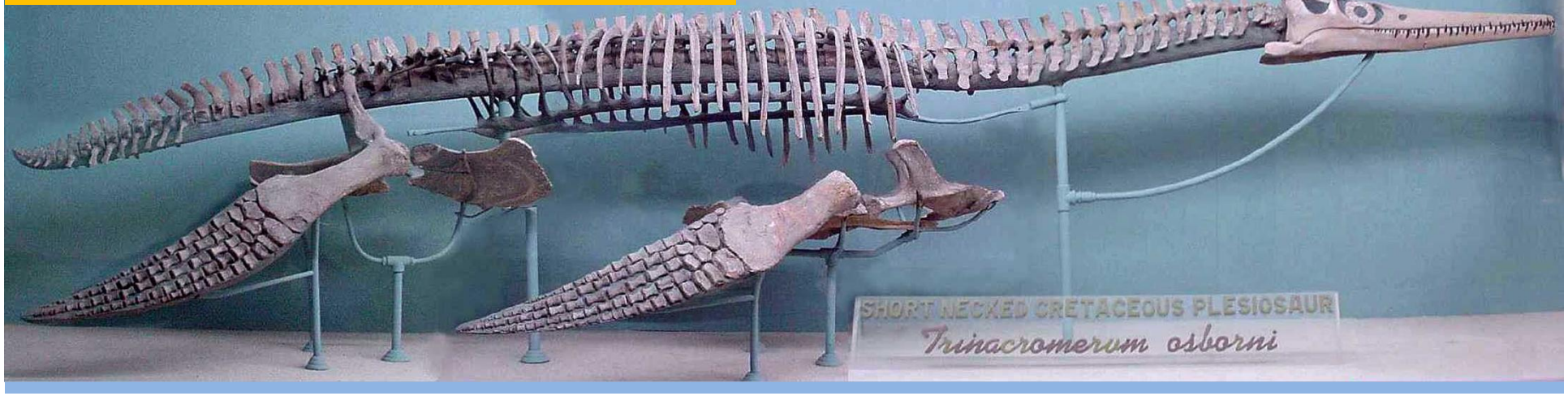
3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria
Leptocleidia
Polycotylidae

Polycotylus latipinnis Cope, 1869
Turoniano
Estados Unidos

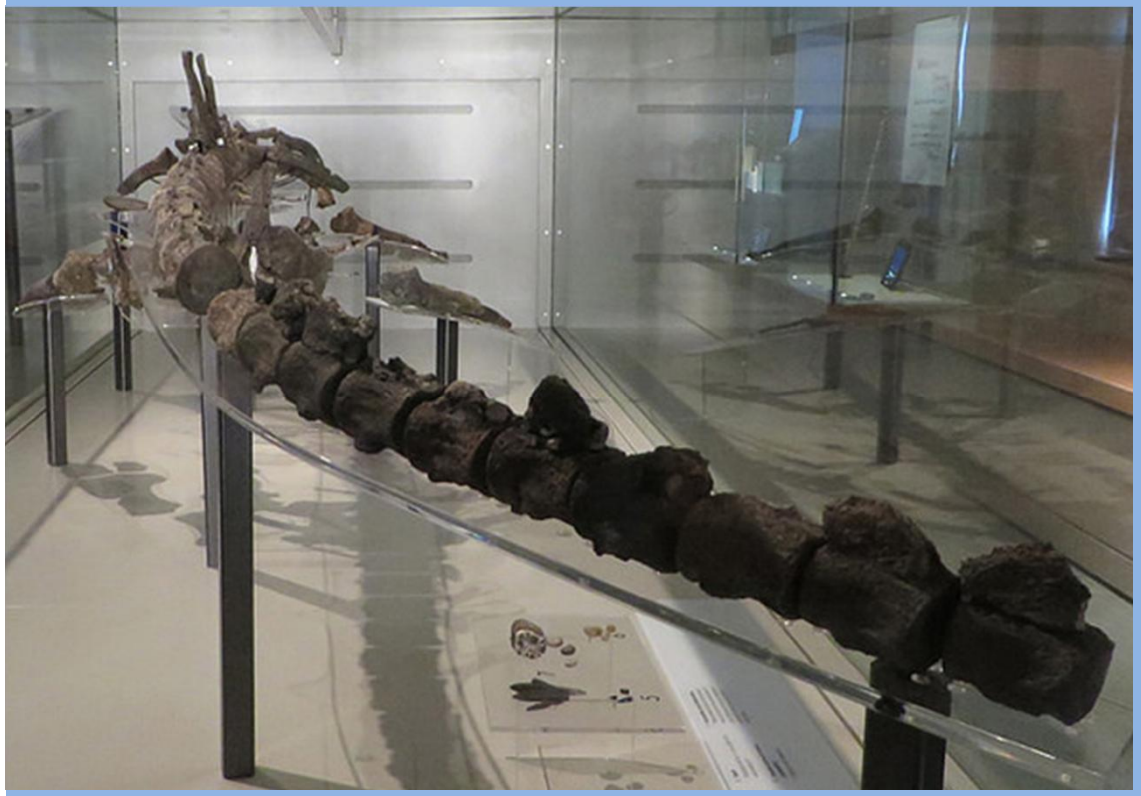
Dolychorhynchops osborni (Williston, 1902)
Campaniano
Estados Unidos



3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria
Elasmosauridae



Speeton Clay plesiosaur
Hauteriviano
Inglaterra

GWWU A3.B2 (sin descripción formal)
Berriasiano
Alemania

Tentativemente el elasmosáurido más antiguo conocido

?

3) Diversidad en Plesiosauria

3.5. Cretácico Inferior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Callawayasaurus colombiensis (Welles, 1962)
Aptiano
Colombia

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Thalassomedon hanningtoni Welles, 1943
Cenomaniano
Estaods Unidos

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Pliosauridae
Thalassophonea
Brachaucheninae

Brachauchenius lucasi Williston, 1903
Turoniano temprano
Utah, US.

***Brachauchenius* sp.**
Barremiano
Colombia

Fig. 2. Uncovered skeleton of *Brachauchenius* sp. VL from the late Barremian Formación Paja of Loma La Cabrera, Villa de Leyva area, in dorsal view. The far posterior part (ischia, tail) and the right hind limb are not preserved.

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Figure 1. Original site photographs (reproduced from Shuler, 1950) of the holotype skeleton of *Libonectes morgani* (SMU SMP 69120) as it occurred *in situ* during excavation. The image on the left also shows the discoverer T. W. Tidwell.

Libonectes morgani (Welles, 1949)
Cenomaniano-Turoniano
Colombia

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Futabasaurus suzukii Sato et al., 2006
Santoniano
Japón

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

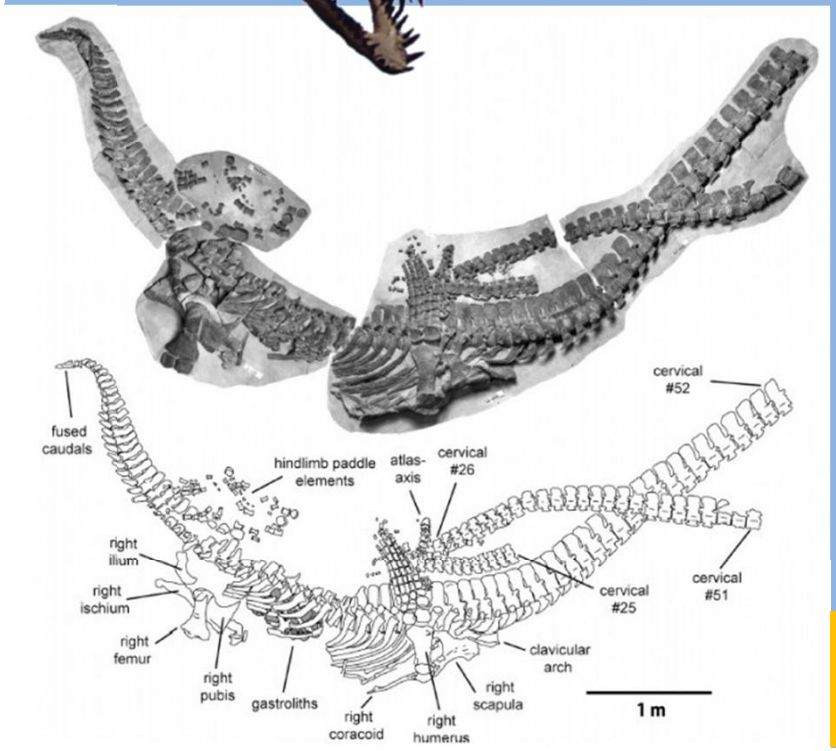
Styxosaurus snowii (Williston, 1890)
Santoniano-Campaniano
Estados Unidos

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Elasmosaurus platyurus Cope, 1868
Campaniano
Estados Unidos

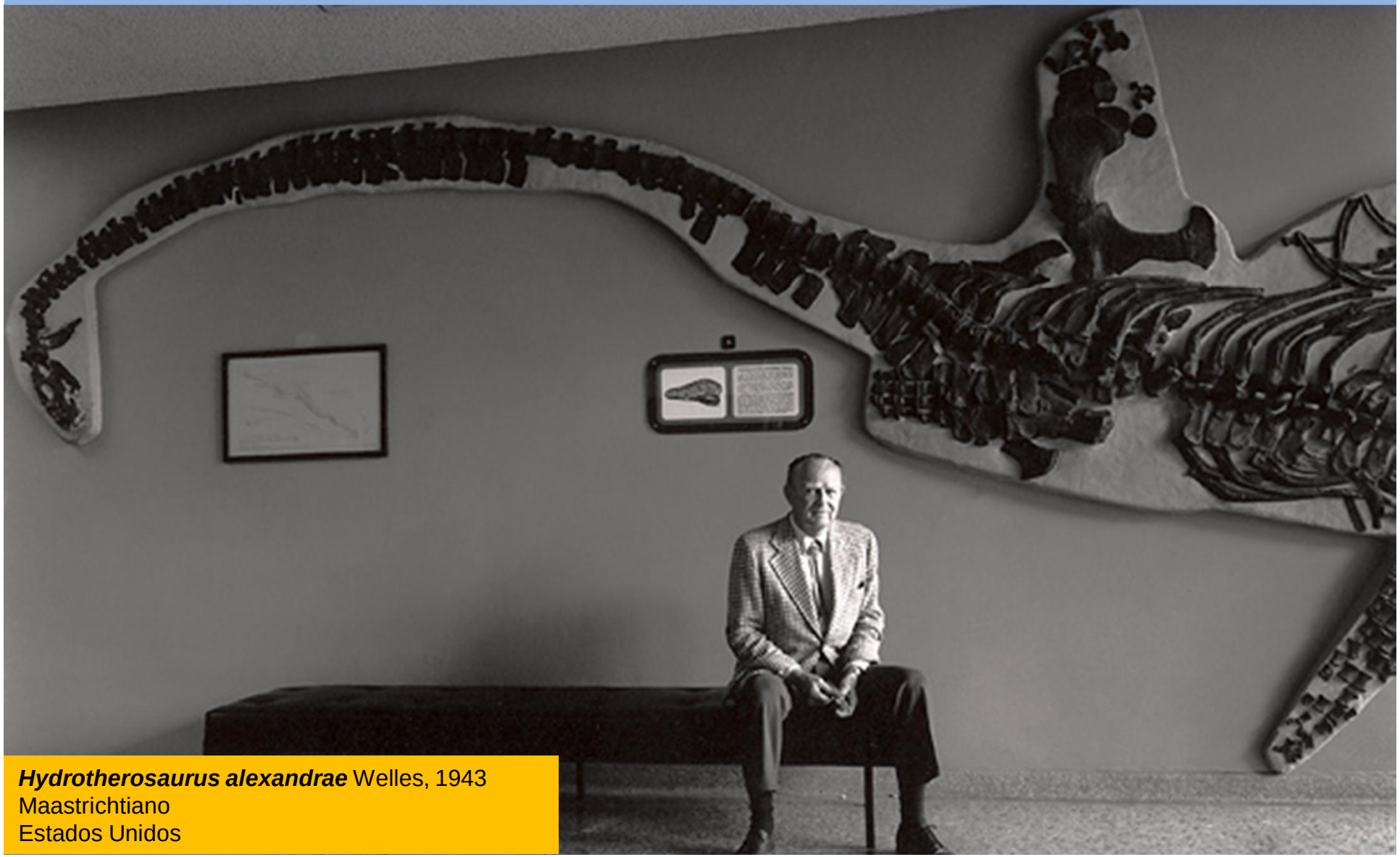


Albertonectes vanderveldei Kubo et al., 2012
Campaniano tardío
Canada

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae



Hydrotherosaurus alexandrae Welles, 1943
Maastrichtiano
Estados Unidos

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Mauisaurus haasti Hector, 1874
Campaniano tardío
Nueva Zelanda

FIGURE 5. Photograph of Hector's display of *Mauisaurus haasti* in the old Dominion Museum, Wellington, New Zealand, showing his reconstruction of the pelvis and hind paddle, and a separate dorsal centrum (upper left).

3) Diversidad en Plesiosauria

Plesiosauroidea
Xenopsaria
Polycotylidae

3.6. Cretácico Superior

Sulcusuchus erraini Gasparini, & Spaletti, 1990
Maastrichtiano temprano
Argentina

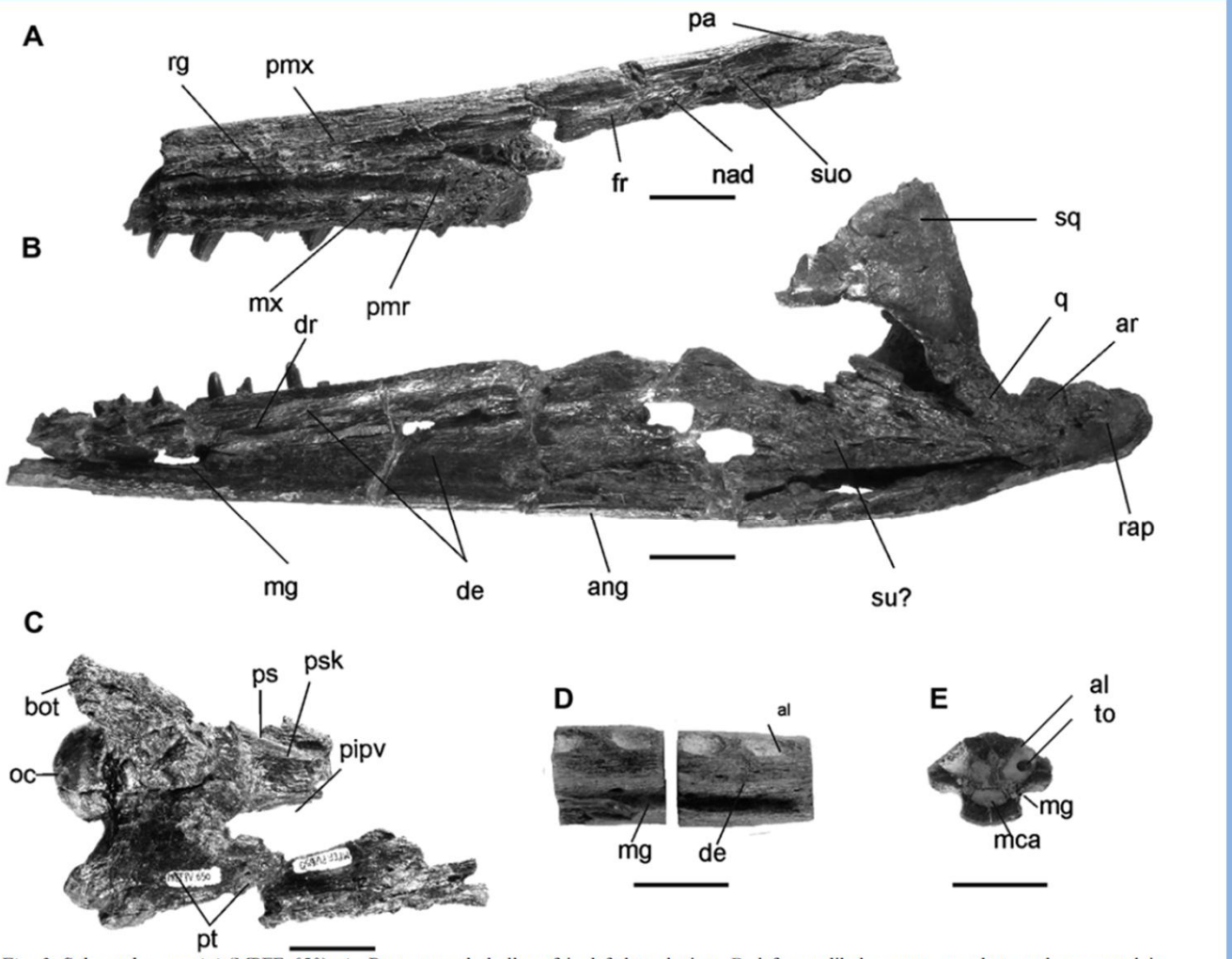


Fig. 2. Sulcusuchus erraini (MPEF 650). **A**, Rostrum and skull roof in left lateral view; **B**, left mandibular ramus, quadrate and squamosal in lateral view; **C**, basicranium and posterior part of palate in ventral view; **D**, **E**, mandibular symphysis of *Sulcusuchus erraini* (holotype: MLP 88-IV-10-1). **D**, Right lateral view and **E**, cross-sections in posterior view. Scale bars = 20 mm.

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

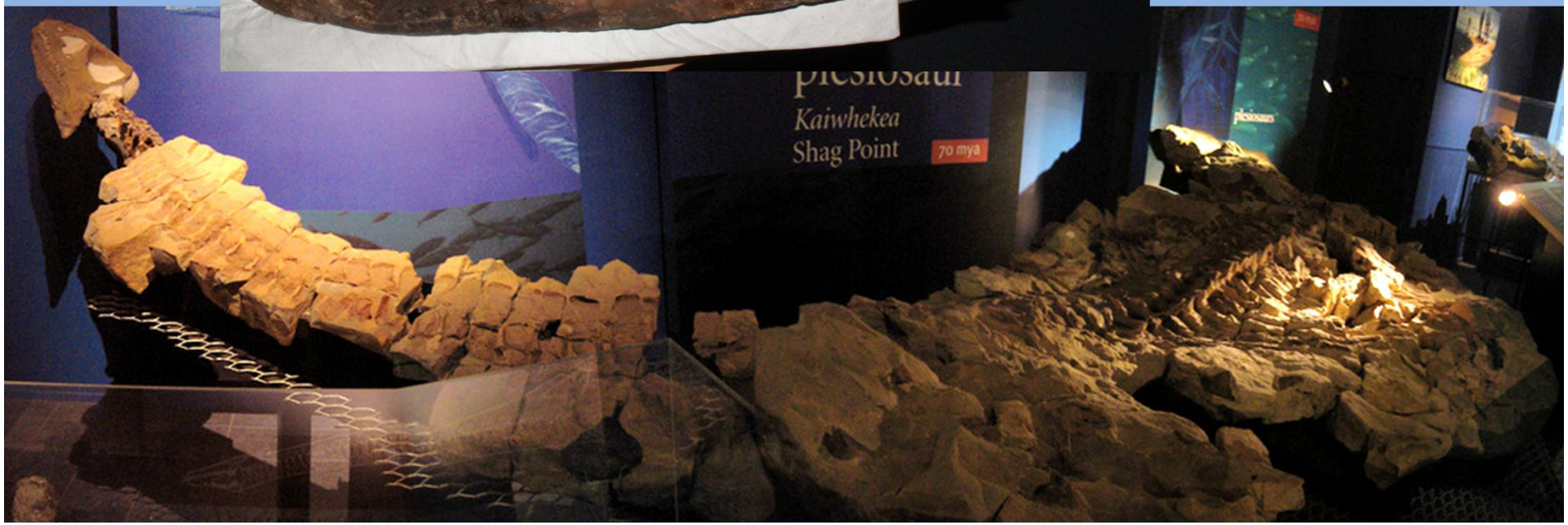
Tuarangisaurus keyesi Wiffen & Moisley, 1986
Maastrichtiano temprano
Nueva Zelanda

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Kaiwhekea katiki Cruickshank & Fordyce, 2002
Maastrichtiano temprano
Nueva Zelanda



3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Zarafasaura oceanis Vincent et al., 2010
Mastrichtiano tardío
Marruecos

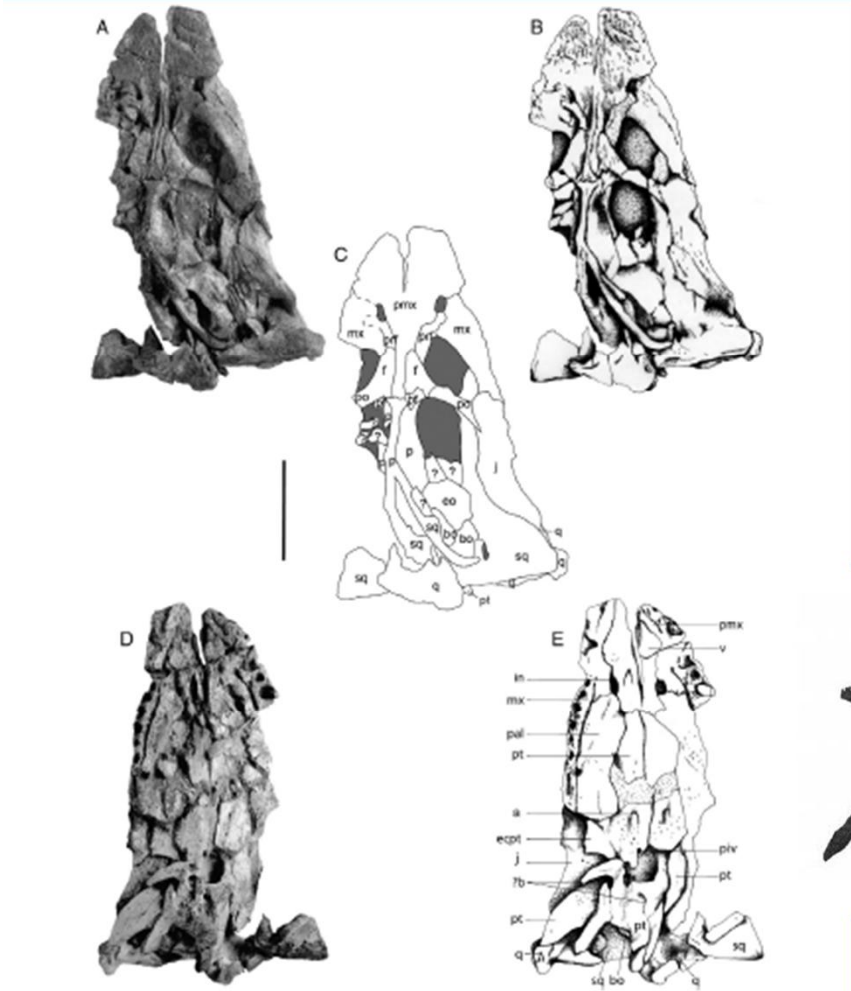
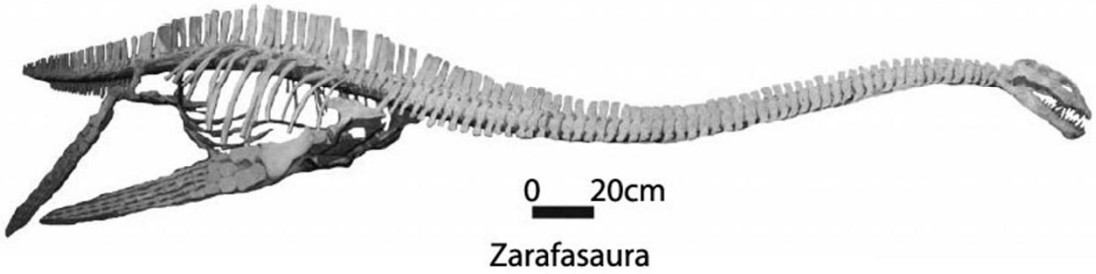


Fig. 2. *Zarafasaura oceanis* n. gen. and sp., OCP DEK/GE 315, holotype, skull. Sidi Daoui area, Oulad Abdoun Basin, Morocco, Upper Cell level, Upper Maastrichtian, Upper Cretaceous. Dorsal view: A, photograph; B, drawing; C, interpretative drawing with sutures. Ventral view: D, photograph; E, interpretative drawing with sutures. Abbreviations: a, pterygoid ingrowth; b, pterygoid cavity; bo, basioccipital; ecpt, ectopterygoid; eo, exoccipital; f, frontal; in, internal nares; j, jugal; mx, maxilla; p, parietal; pal, palatine; pf, postfrontal; pty, posterior interpterygoid vacuity; pmx, premaxillae; po, postorbital; prf, prefrontal; pt, pterygoid; q, quadrate; sq, squamosal; v, vomer; ?, undetermined bone. Scale bar = 10 cm.



3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Aristonectes parvidens Cabrera, 1941
Mastrichtiano tardío
Argentina

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Morturneria seymourensis (Chatterjee & Small, 1989)
Mastrichtiano tardío
Antártica

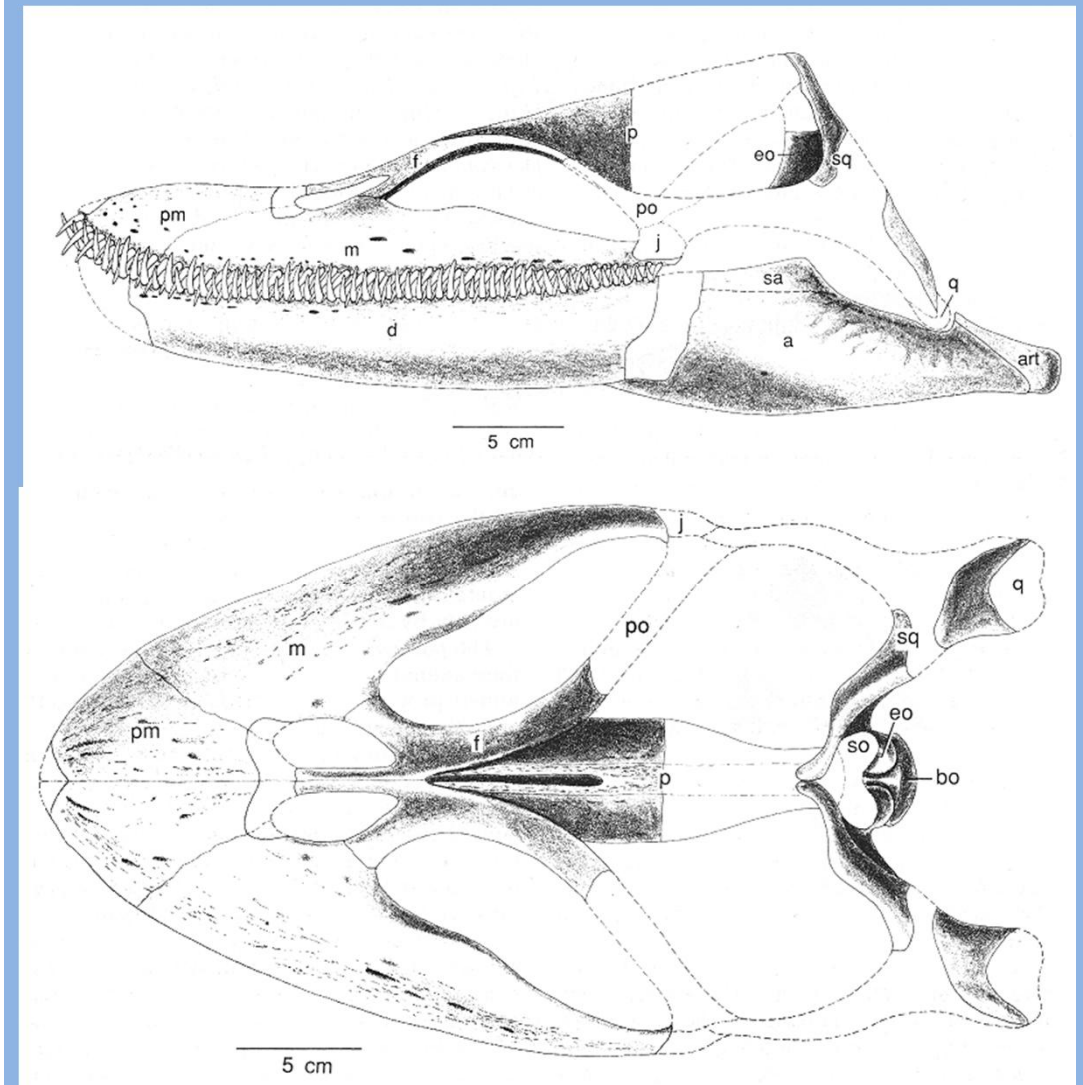


Fig. 3. *Turneria seymourensis*, n. gen., n. sp., skull in dorsal view, TTU P 9219, holotype. Abbreviations as for Fig. 2.

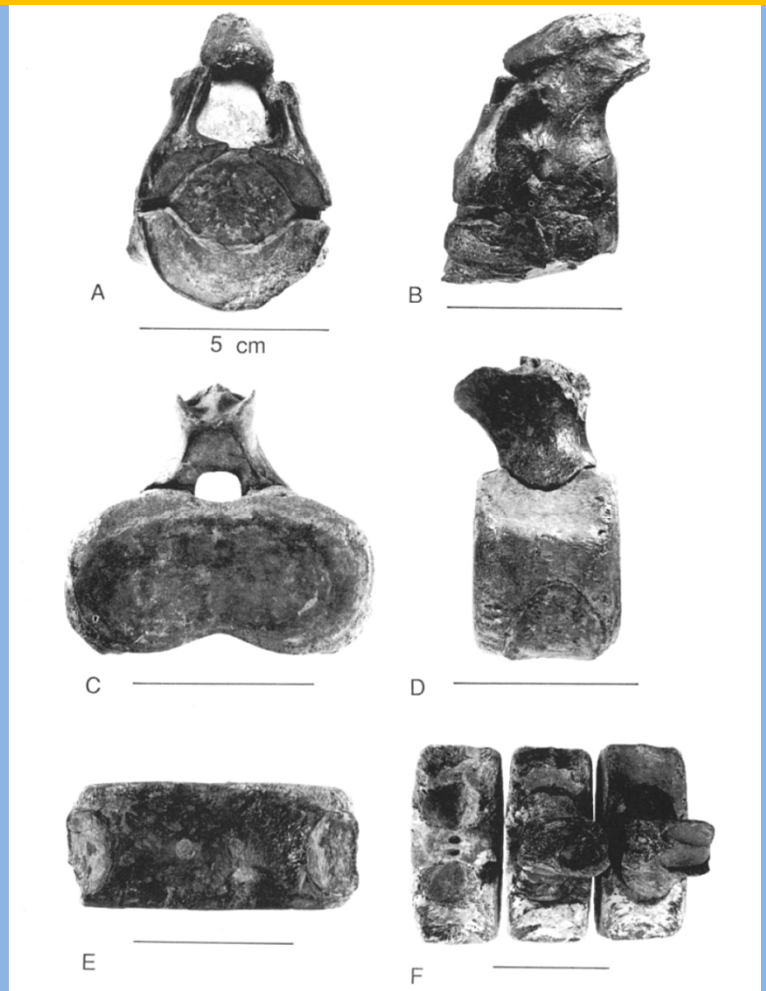


Fig. 10. *Turneria seymourensis*, n. gen., n. sp., A: atlas-axis complex in anterior view; B: atlas-axis in lateral view; C: a middle cervical in anterior view; D: the same in lateral view; E: the same in ventral view; F: three middle cervicals in anterior view; TTU P 9219, holotype; all scales 5 cm.

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

Antártica: Formas de cuello intermedio (Campaniano tardío), *Aristonectes* sp., *Mauisaurus* sp. (Maastrichtiano tardío)

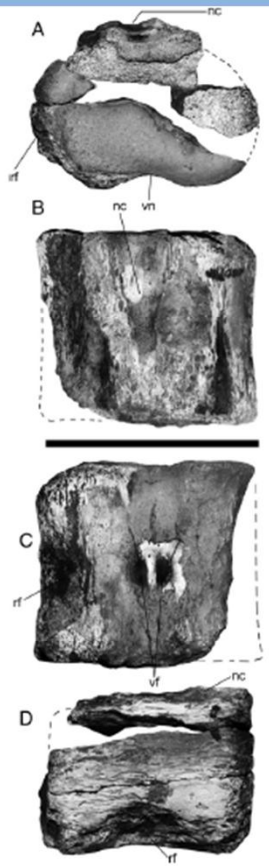


Fig. 5. Elasmosauridae indet. (SGO.PV.6508), James Ross Island, Antarctica, Santa Marta Formation, Gamma member, late Campanian. Cervical vertebra of a very long-necked individual. A, anterior view. B, dorsal view. C, ventral view. D, right lateral view. Scale bar equals 50 mm.

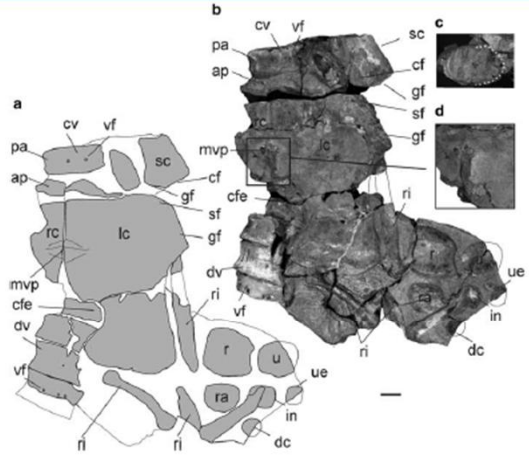


Fig. 2. *Aristonectes* cf. *parvidens*, MLP 89-III-3-2. Partial postcranial skeleton in ventral view. **a.** Interpretative drawing, **b.** photograph, **c.** first pre-pectoral vertebra in anterior view, and **d.** detail of the mid-ventral process. Scale bar equals 40 mm.

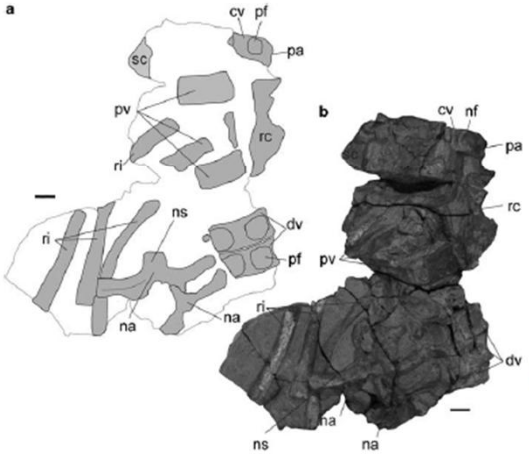


Fig. 3. *Aristonectes* cf. *parvidens*, MLP 89-III-3-2. Partial postcranial skeleton in dorsal view. **a.** Interpretative drawing, and **b.** photograph. Scale bar equals 40 mm.

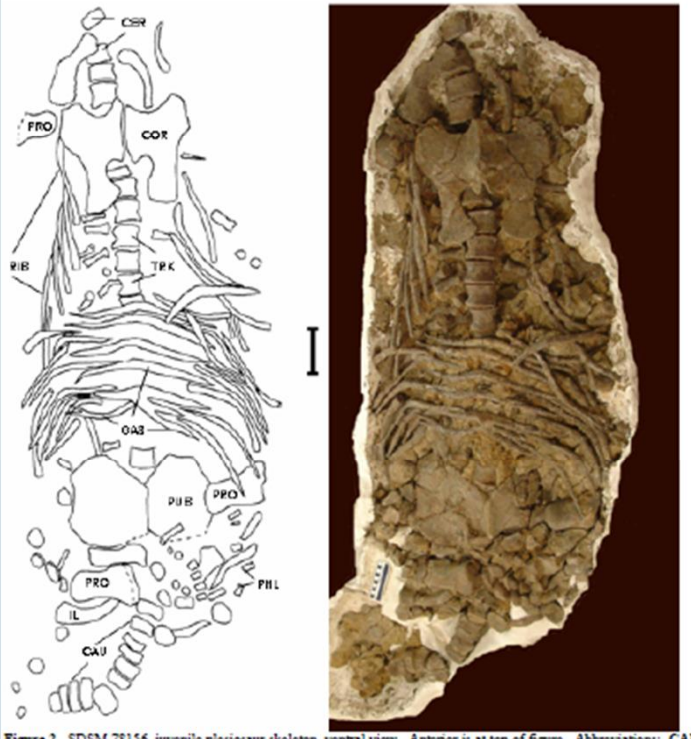
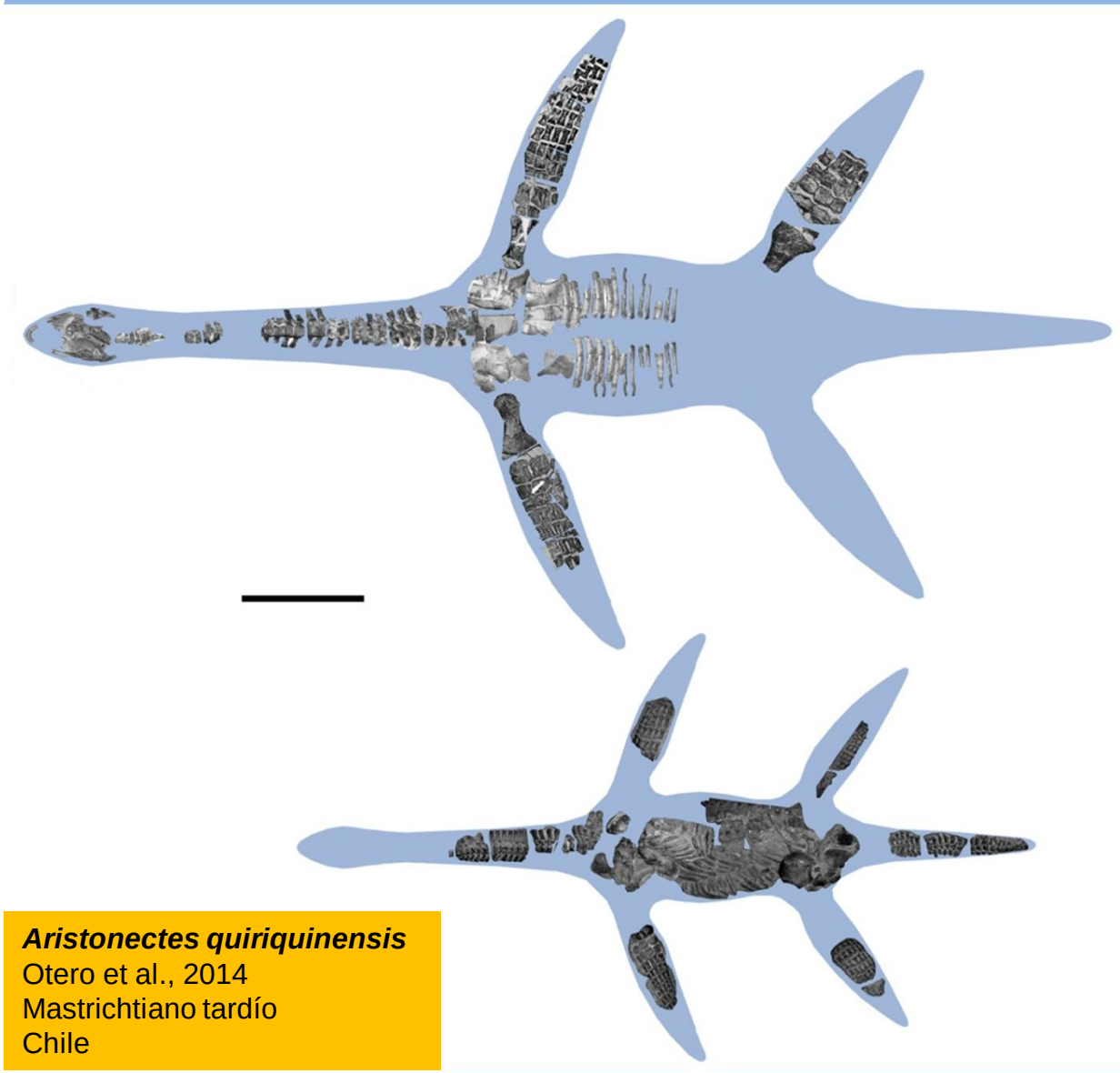


Figure 2. SDSM 78156, juvenile plesiosaur skeleton, ventral view. Anterior is at top of figure. Abbreviations: CAU-caudal vertebrae; CER-cervical vertebrae; COR-coracoid; GAS-gastralia; IL-ilium; PHL-phalanges; PRO-propodial; PUB-pubis; RIB-ribs; TRK-trunk vertebrae. Scales equal 10 cm.

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae

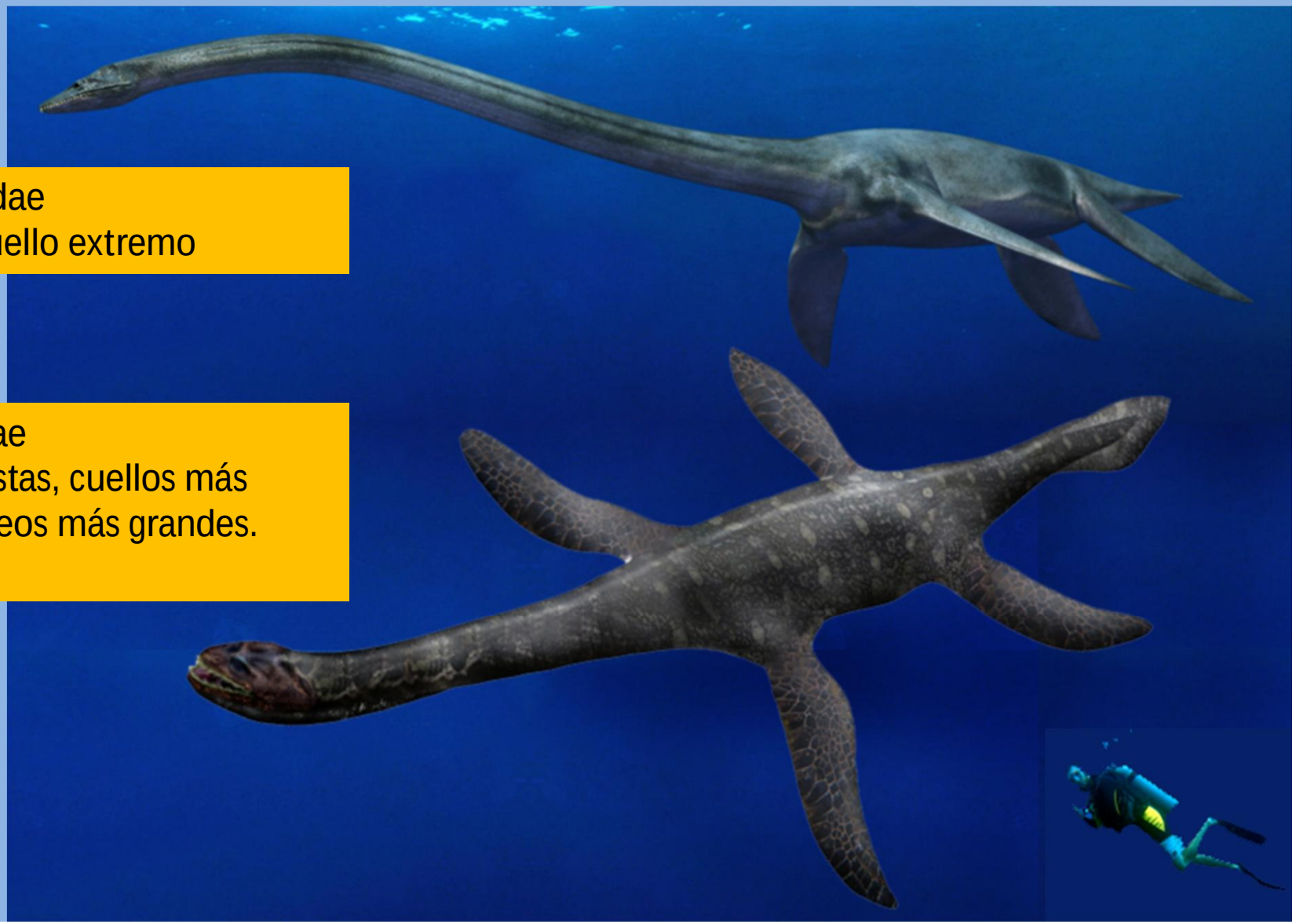


Aristonectes quiriquinensis
Otero et al., 2014
Mastrichtiano tardío
Chile

3) Diversidad en Plesiosauria

3.6. Cretácico Superior

Plesiosauroidea
Xenopsaria
Elasmosauridae



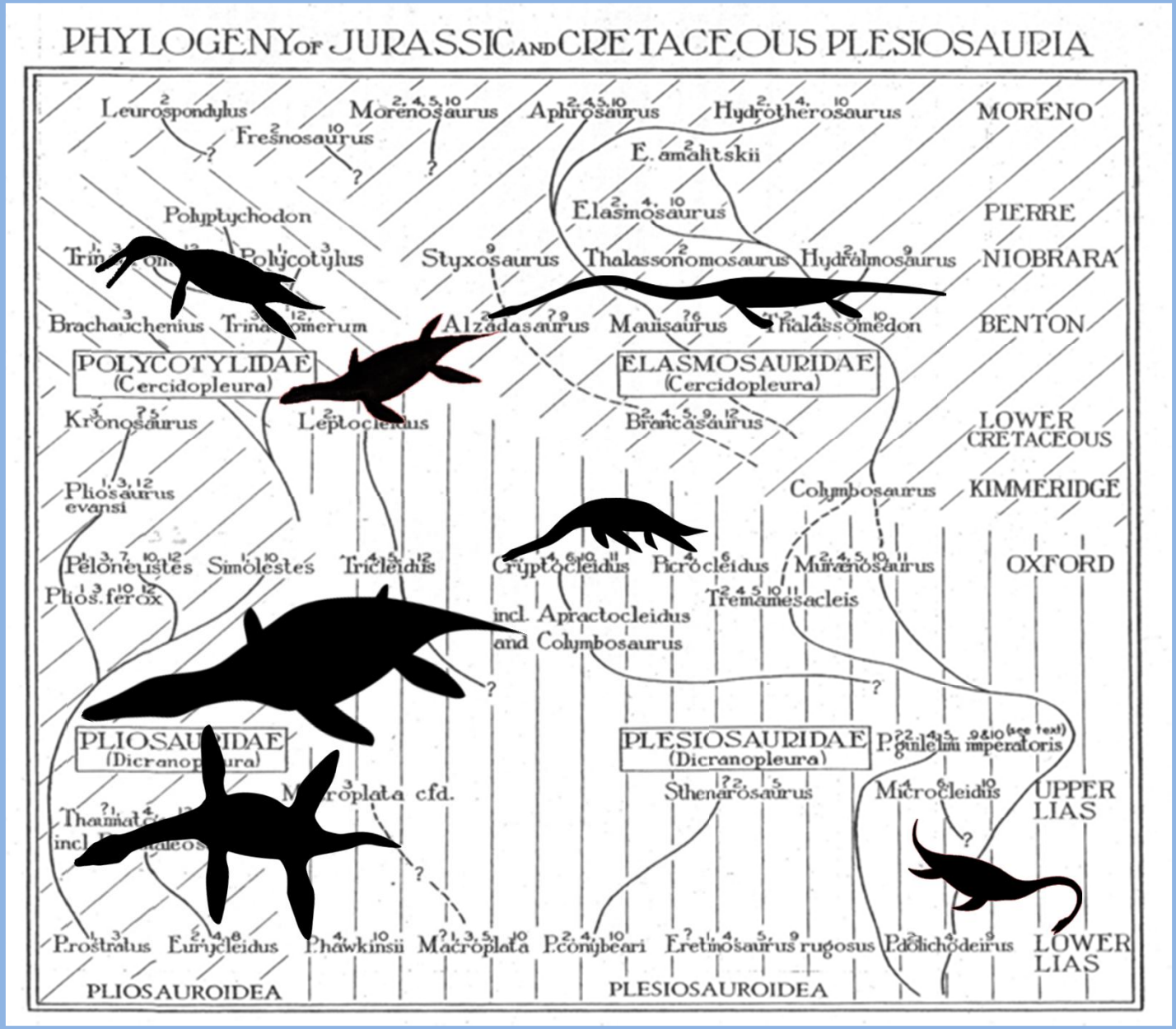
Elasmosauridae
Formas de cuello extremo

Aristonectinae
Formas robustas, cuellos más cortos y cráneos más grandes.

Avances durante el Siglo XXI

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

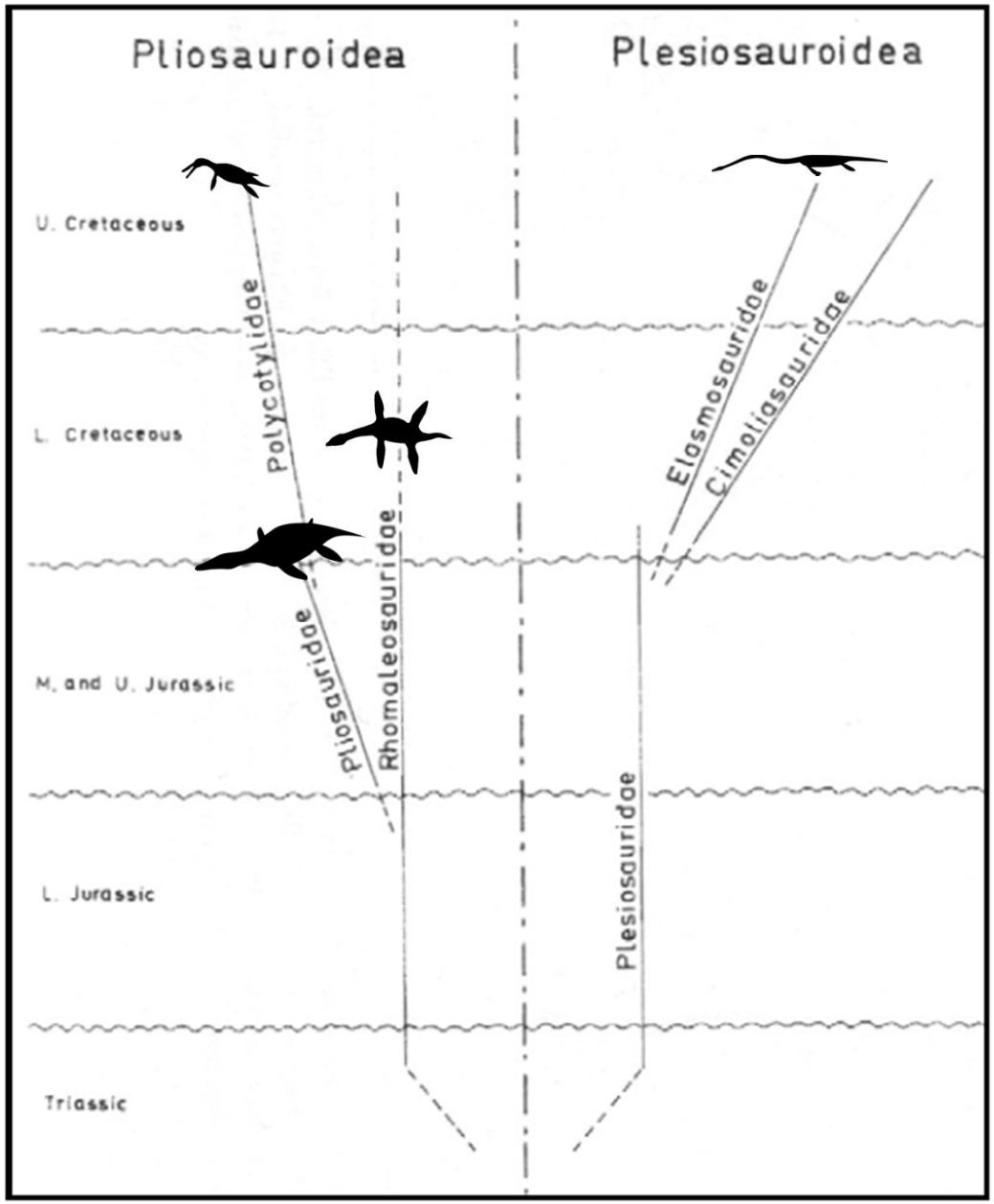


Welles, 1943

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

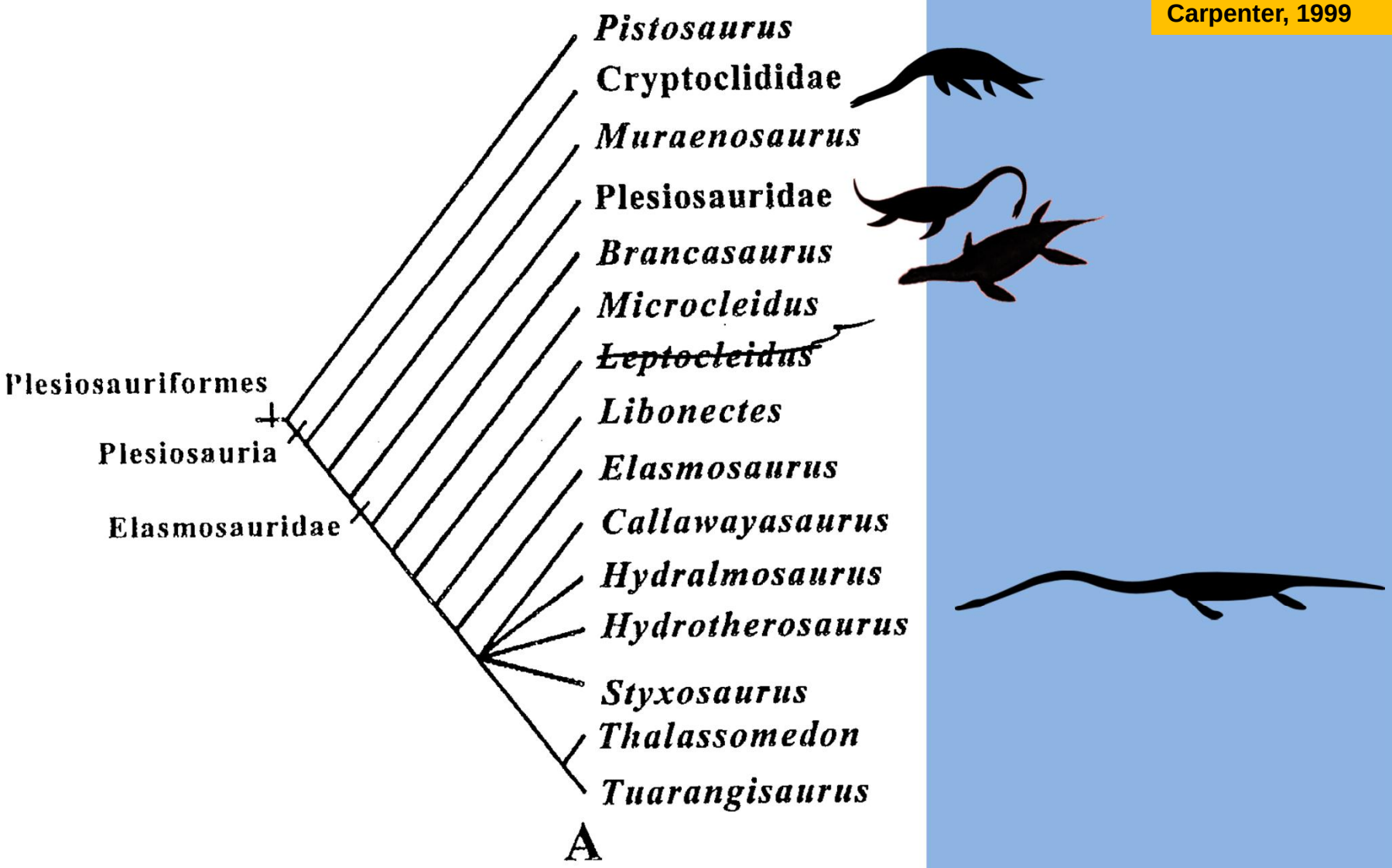
Persson, 1963



AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

Carpenter, 1999



AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

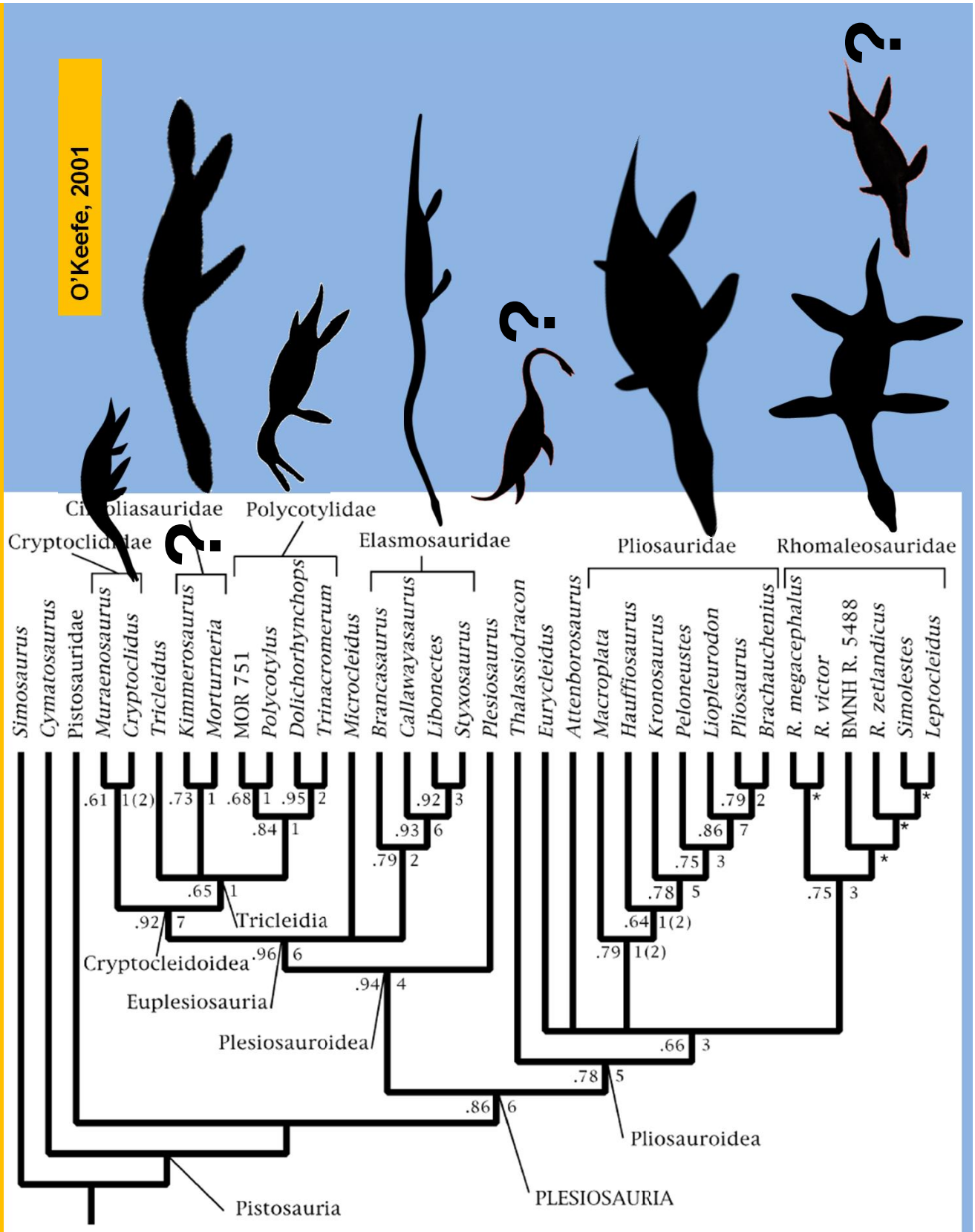


Fig. 20. Phylogenetic relationships of the Plesiosauria. Topology shown is the strict consensus of 12 MPTs, tree lengths 432. CI = 0.47, RCI = 0.34, RI = 0.72. Numbers just below and to the left of a given node are bootstrap support values; those to the right are decay indices. Indices in parantheses are the support for a given node after morphometric characters have been removed and analysis rerun. Dots represent nodes with less than 50% bootstrap support and a decay index of one. Named groups are diagnosed in the text.

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

Gasparini et al., 2003

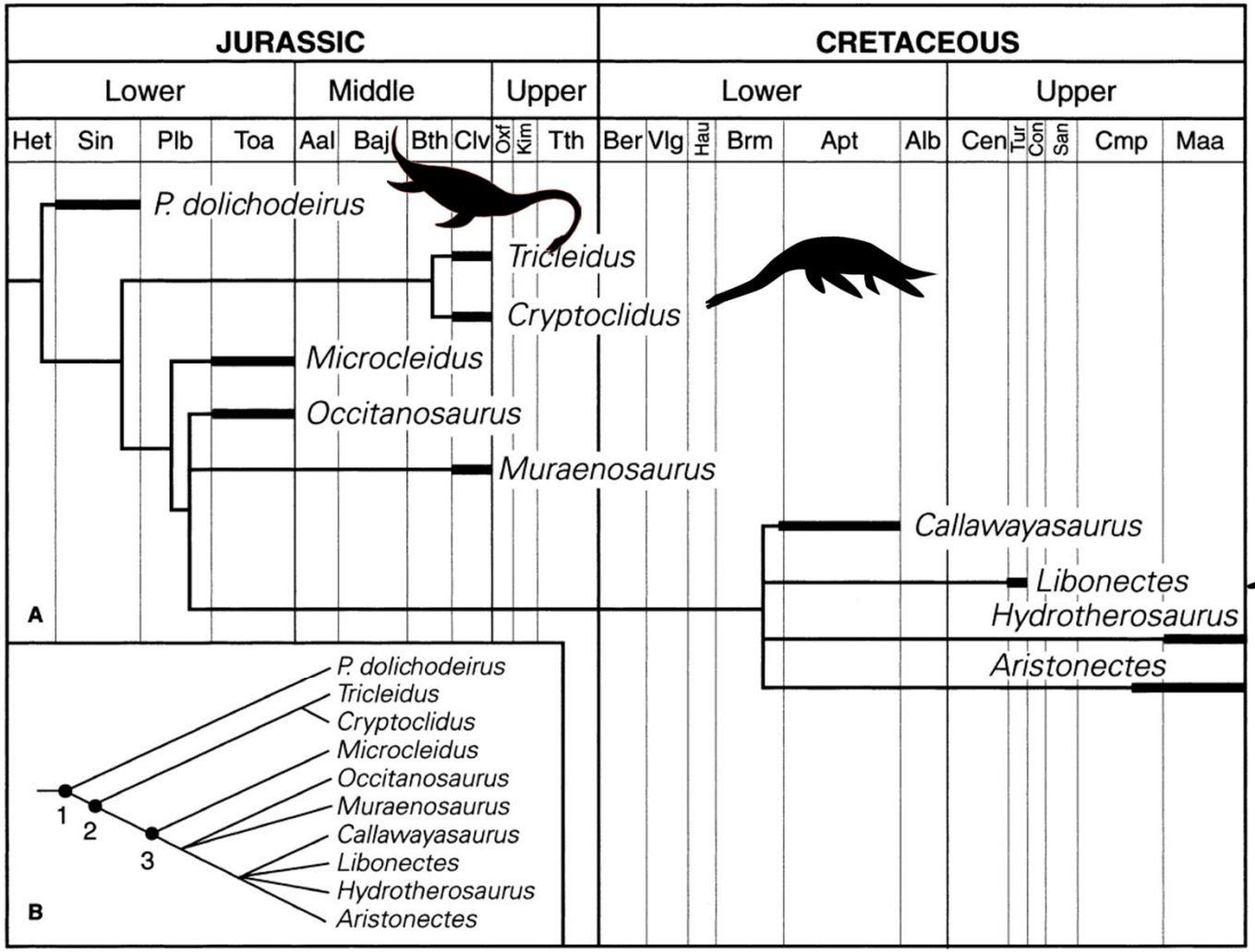
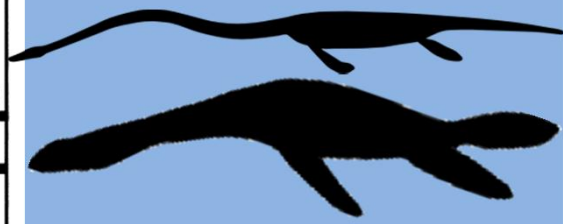
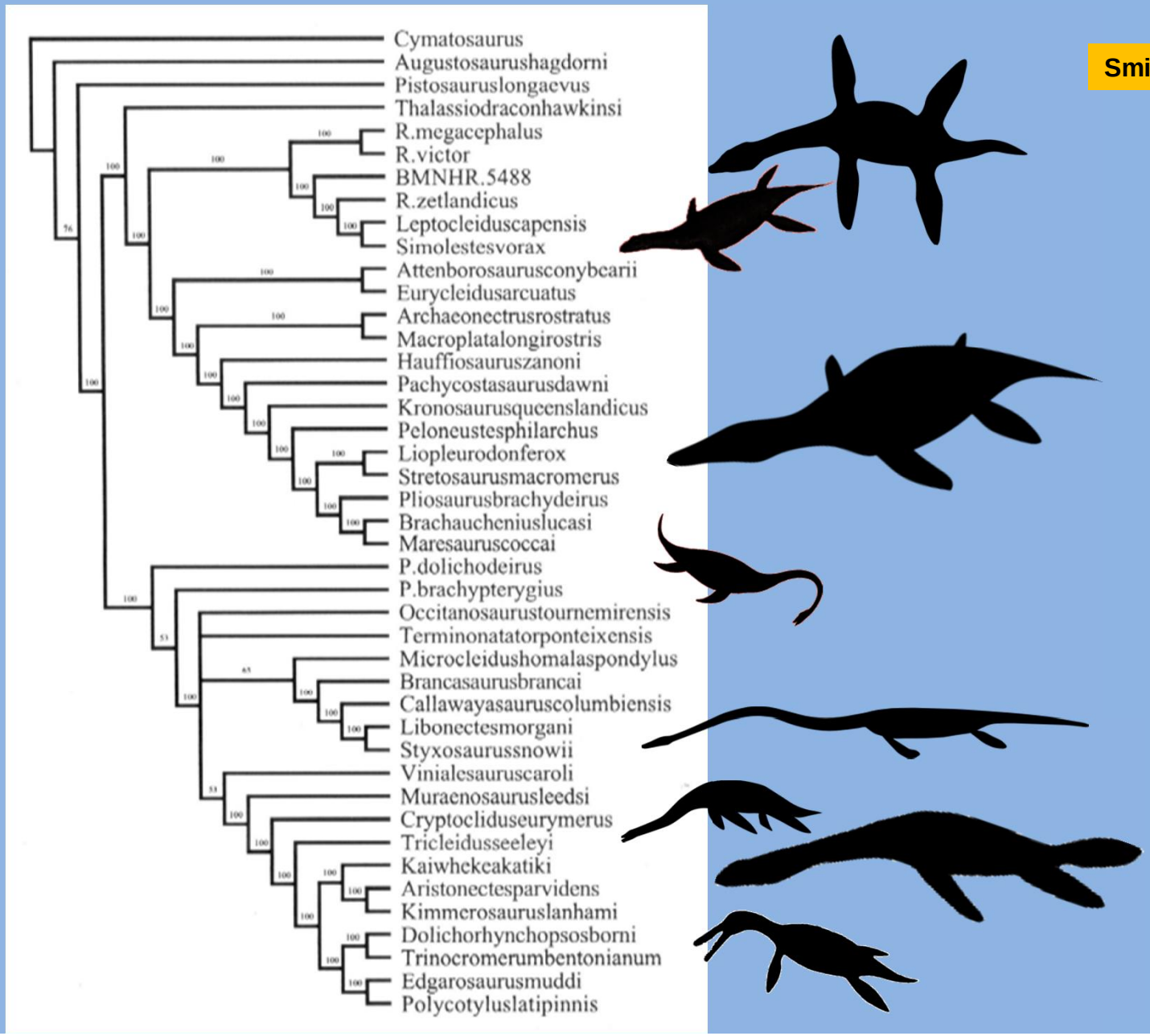


FIGURE 4. Phylogenetic relationships of *Aristonectes* among a selection of Plesiosauroidea (node 1). *Aristonectes* is shown to be rooted within the Elasmosauridae (node 3). **A**, relationships represented with stratigraphical ranges; **B**, strict consensus tree.



AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos



Smith, 2003

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

Druckenmiller and Russell, 2008

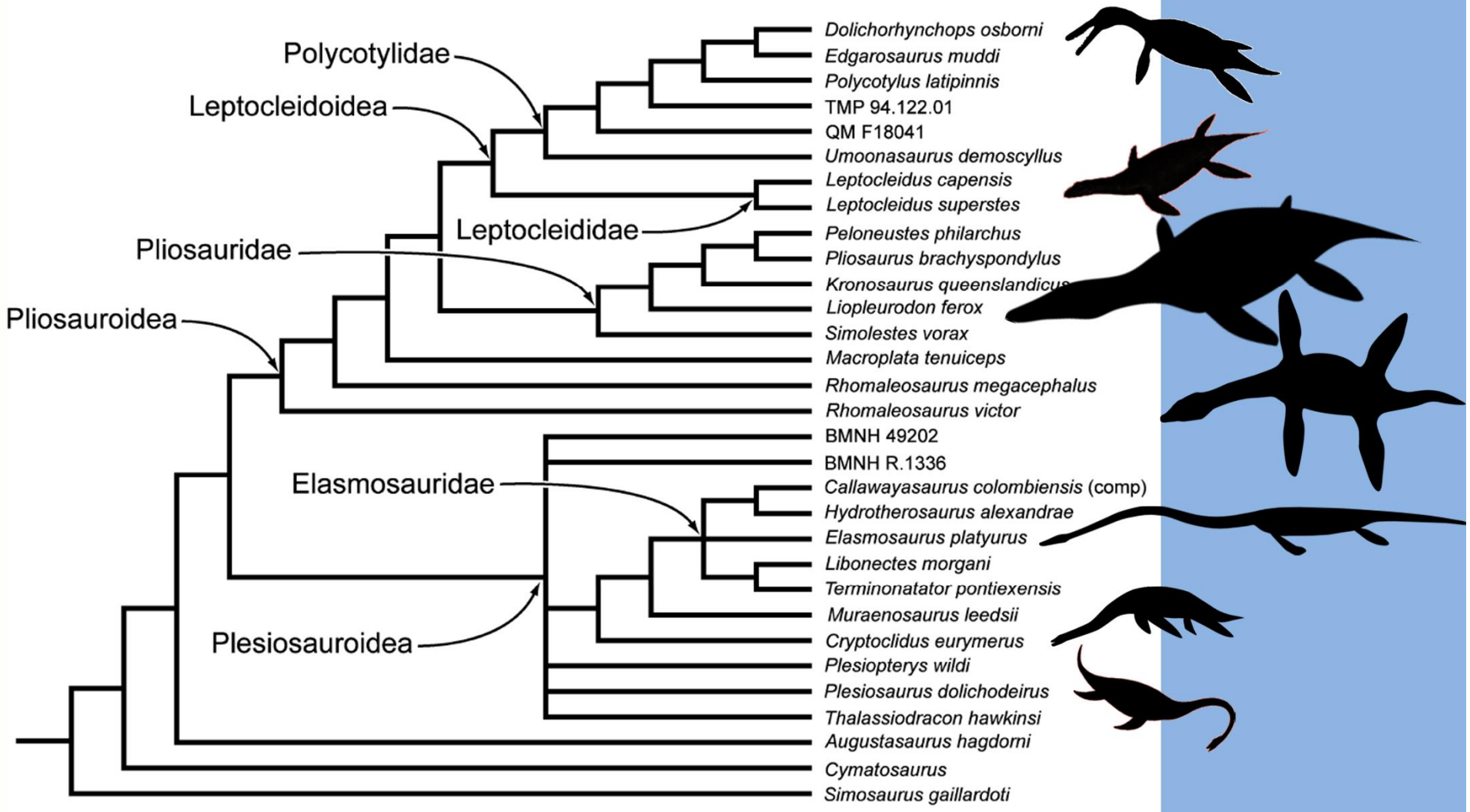


FIGURE 22. Hypothesis of relationship for Plesiosauria with clades named in this study. Clade names are defined and diagnosed in the text.

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

O'Keefe & Street, 2009

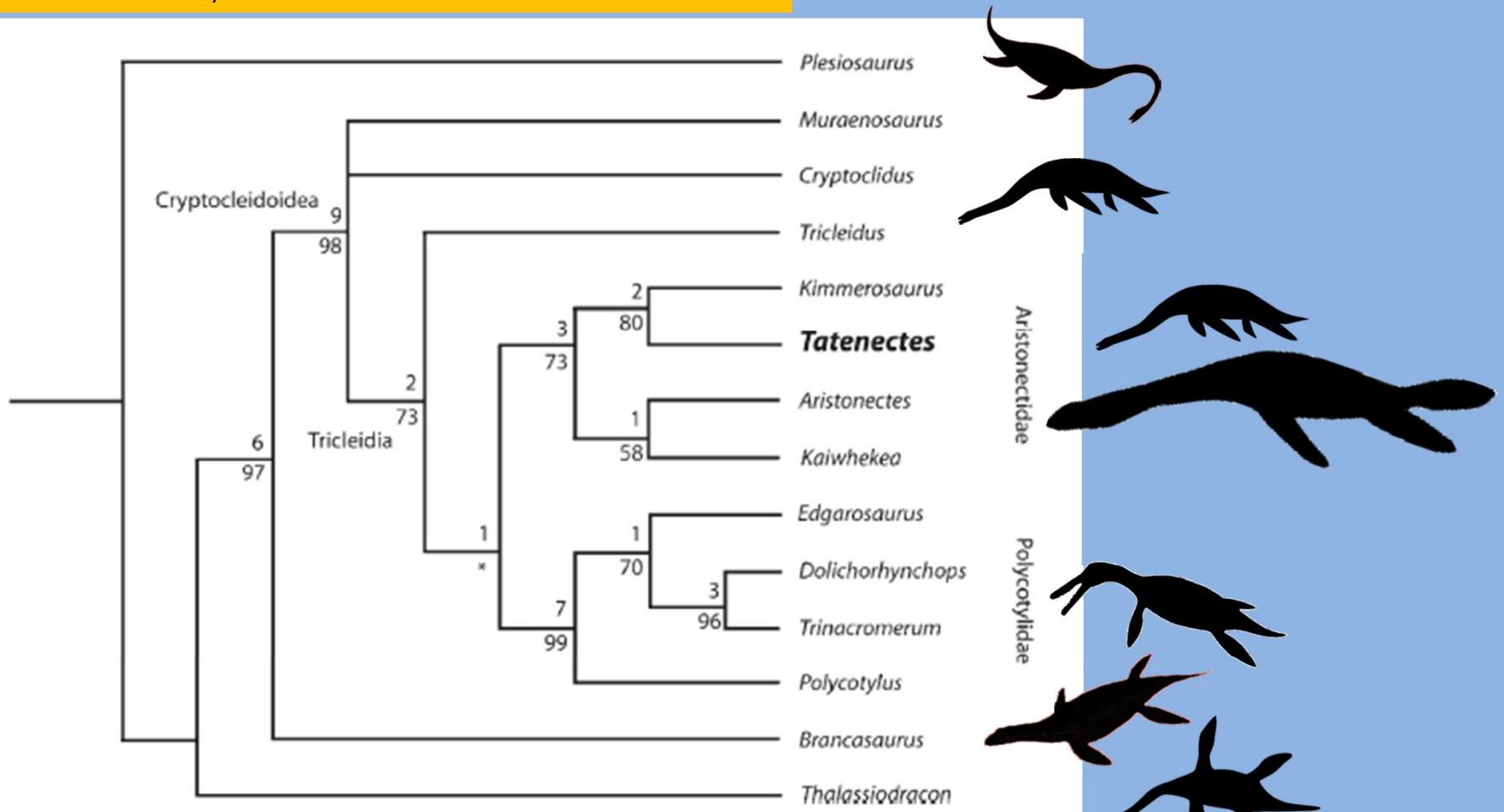


FIGURE 8. Hypothesis of relationships among the members of the Cryptocleidoidea. Integers at each node are decay indices (above branch); bootstrap values are below each branch. An asterisk represents values below 50%.

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

Ketchum & Benson, 2010

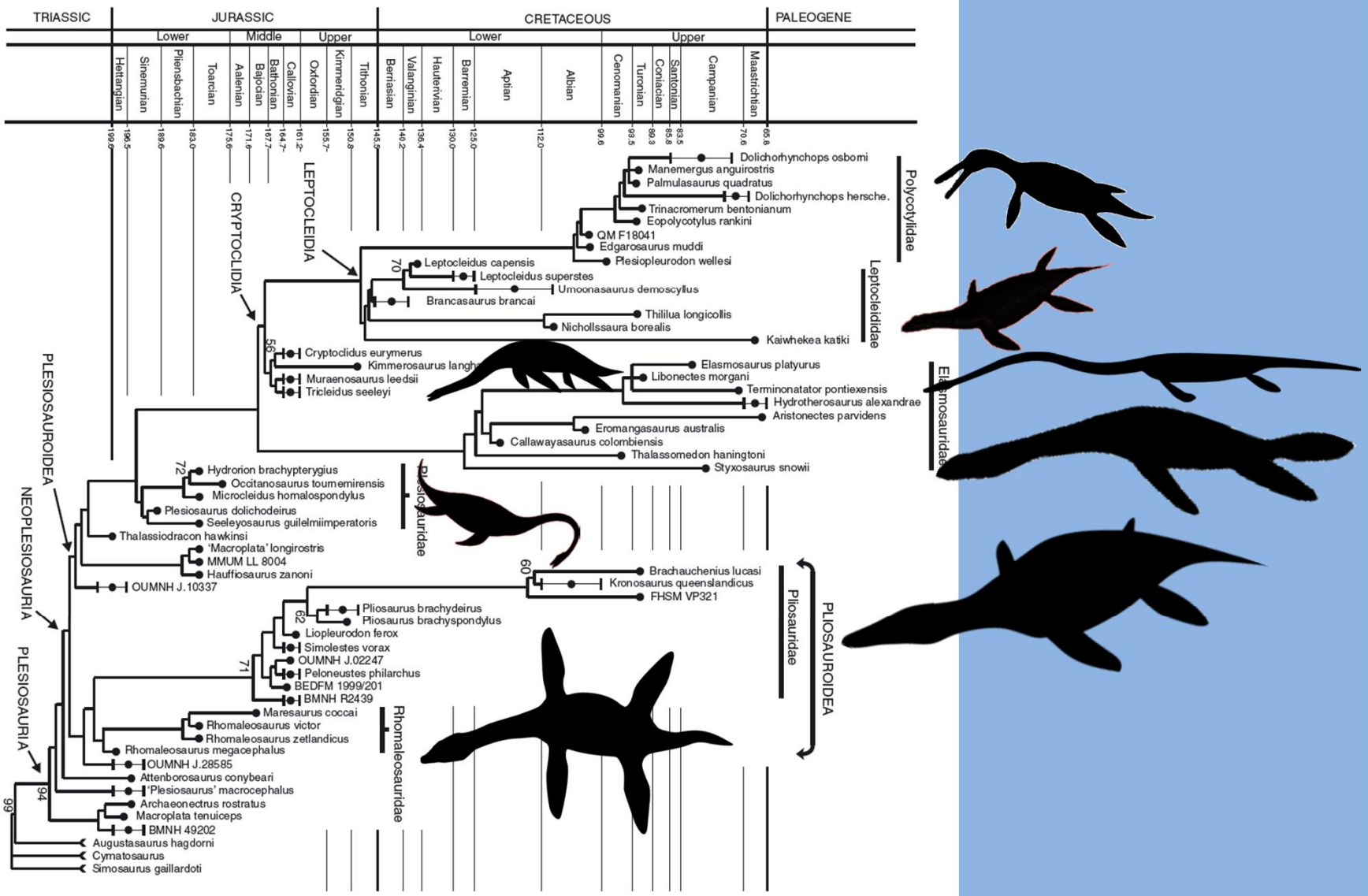
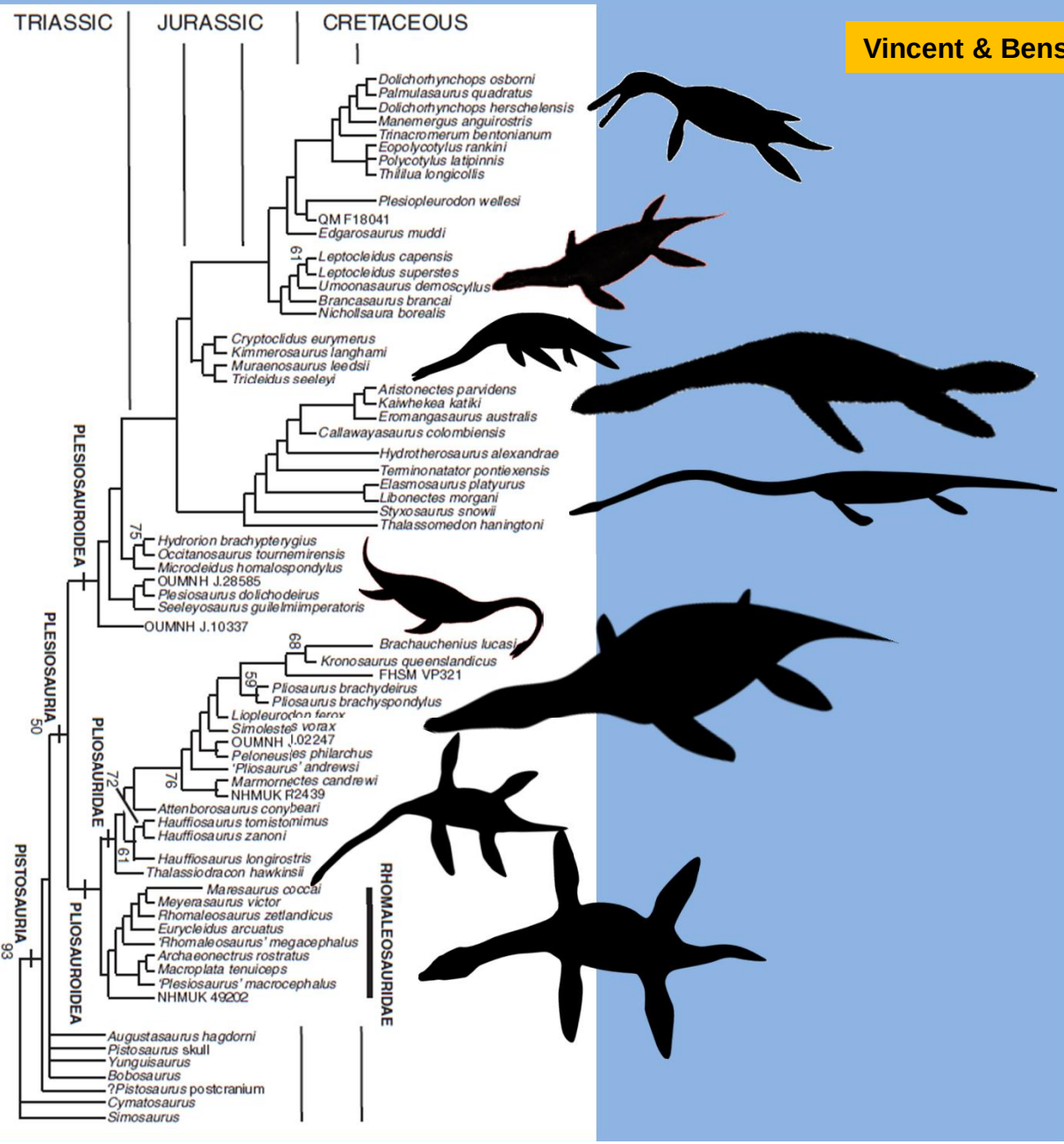


Fig. 6. Time-calibrated strict reduced consensus cladogram of nine most parsimonious trees remaining after deletion of 'wildcard' taxa (*Eurycleidus arcuatus*, '*Pliosaurus*' *andrewsi*, *Polycotylus latipinnis*). Numbers adjacent to nodes indicate bootstrap support values (only reported where > 50%). For institutional abbreviations see section 1.2.

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

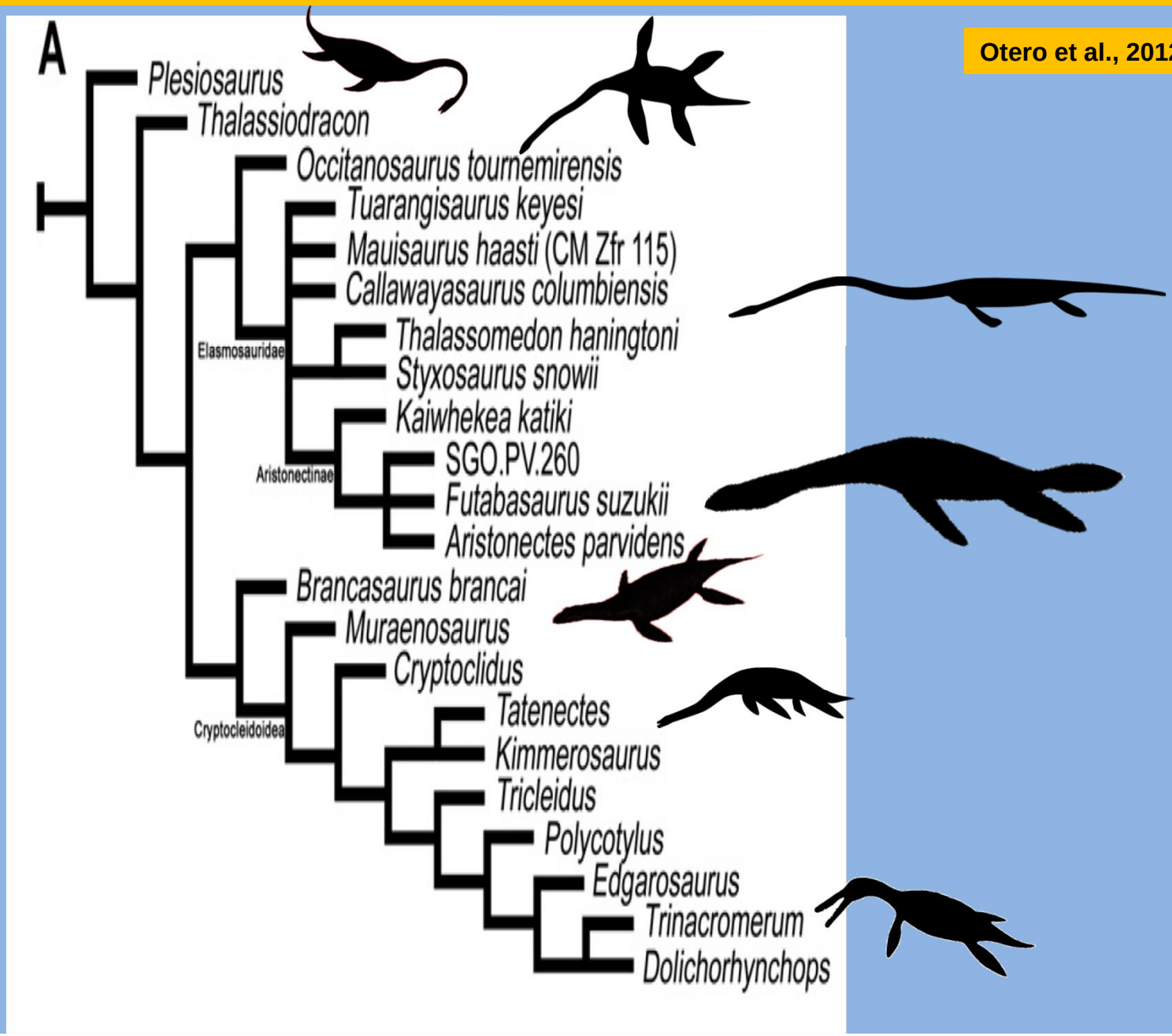
Vincent & Benson, 2011



TEXT-FIG. 16. Strict consensus tree of 12 most parsimonious cladograms (length = 18 832 steps) arising from analysis of a modified version of the data matrix of Ketchum and Benson (2010, see Supporting Information). Operational taxonomic units are approximately placed within epoch-level time horizons. Values adjacent to (below) nodes indicate bootstrap support.

AVANCES DURANTE EL SIGLO XXI

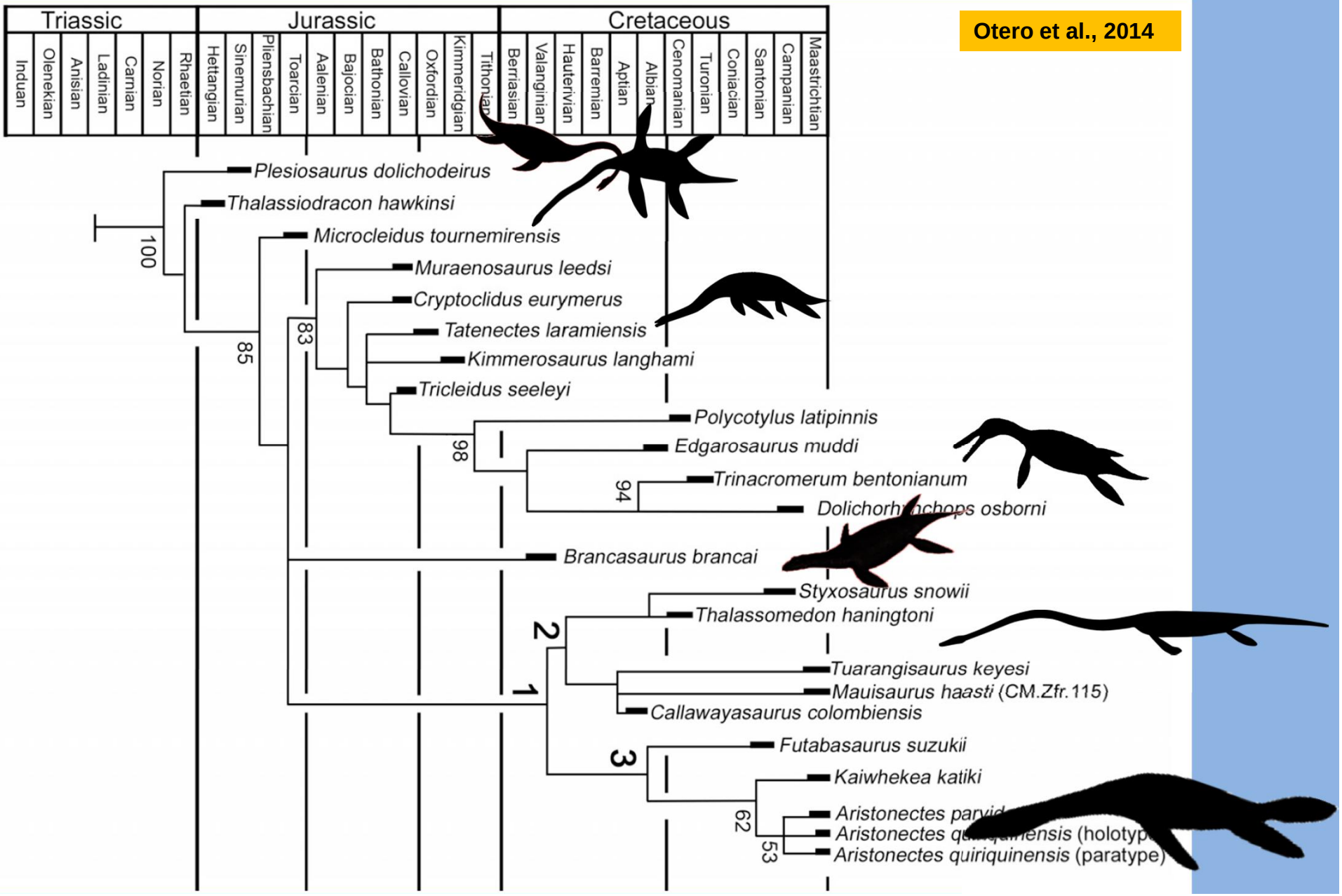
Análisis filogenéticos



Otero et al., 2012

AVANCES DURANTE EL SIGLO XXI

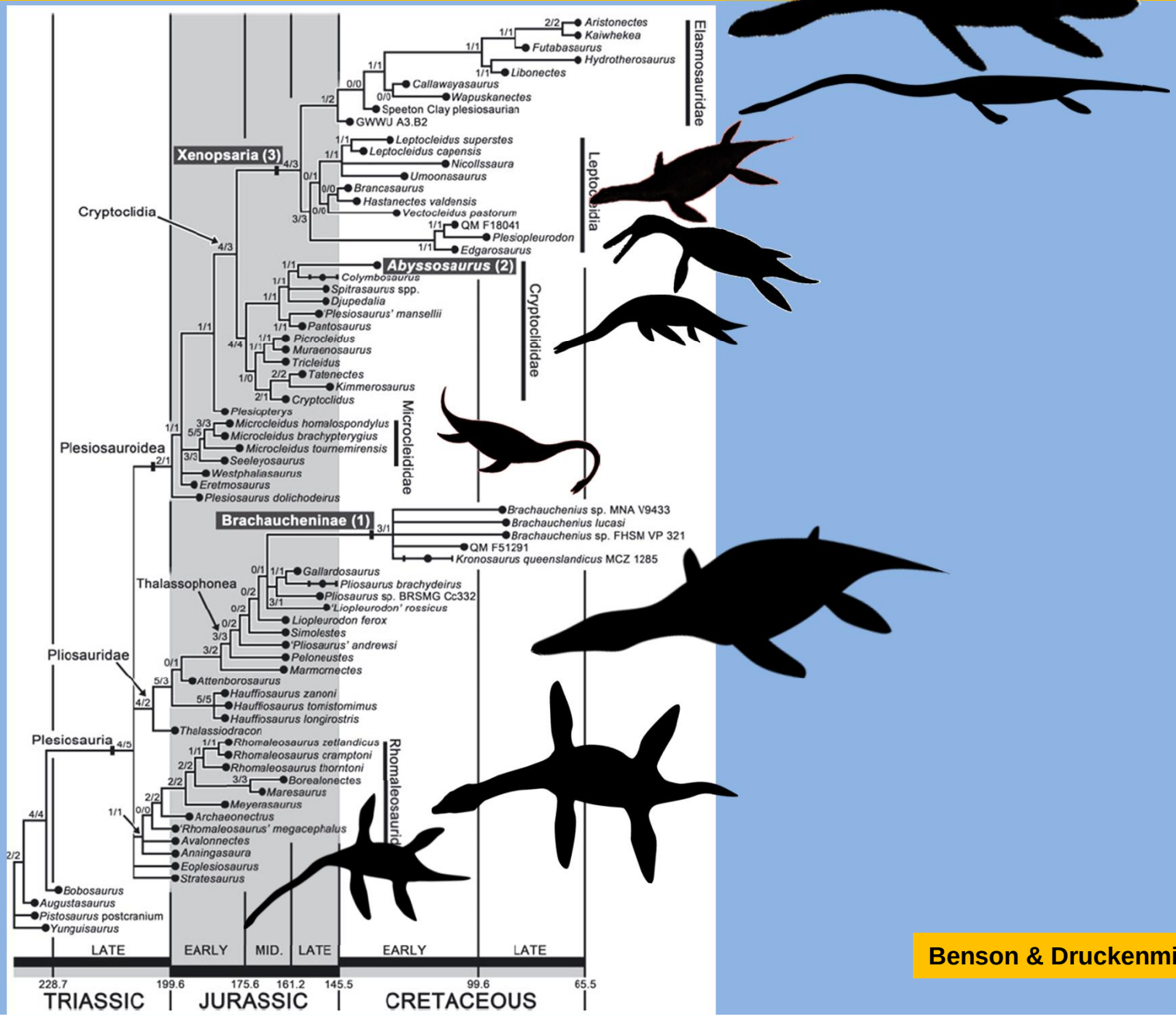
Análisis filogenéticos



Otero et al., 2014

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

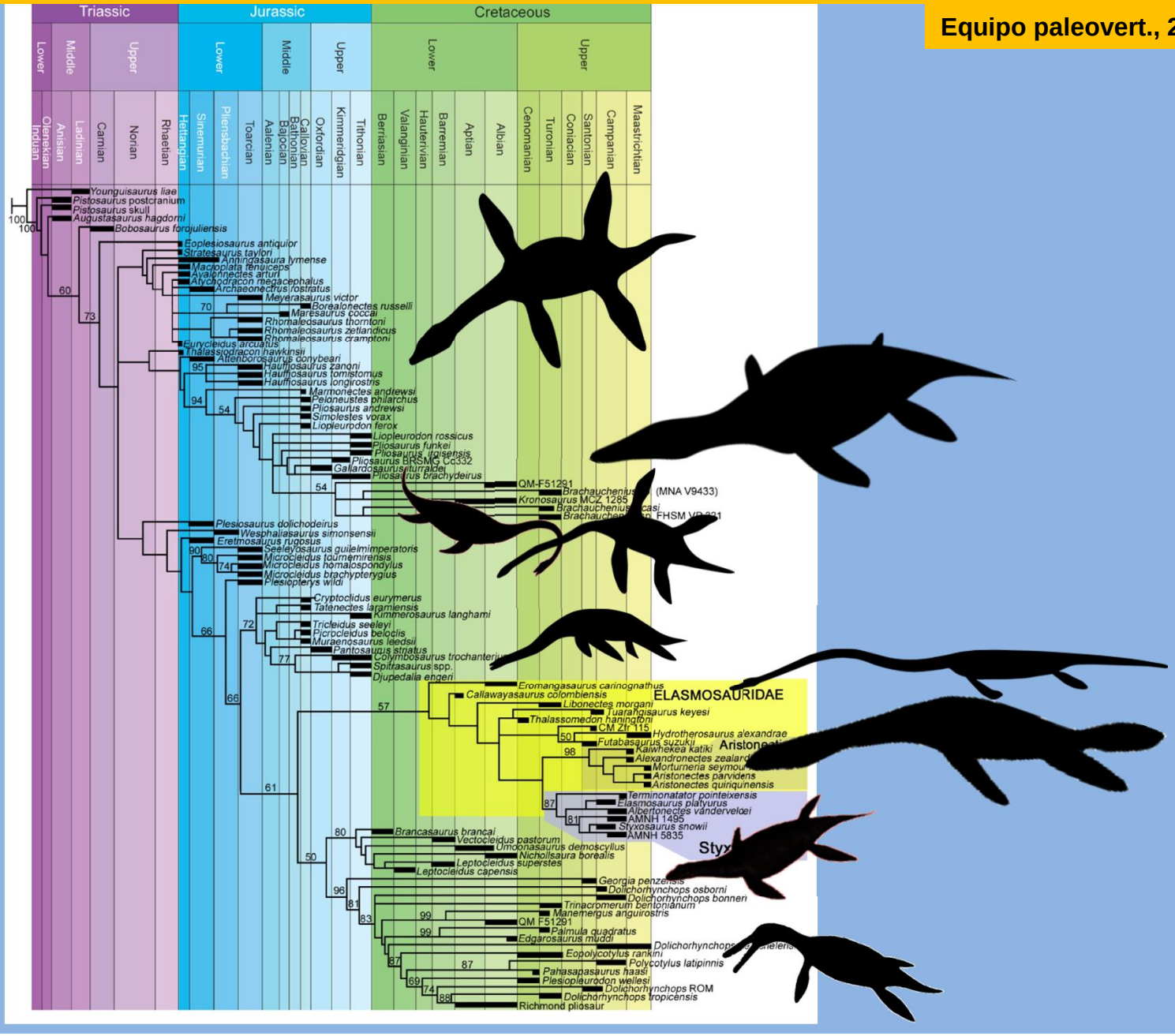


Benson & Druckenmiller, 2014

AVANCES DURANTE EL SIGLO XXI

Análisis filogenéticos

Equipo paleovert., 2016



AVANCES DURANTE EL SIGLO XXI
Análisis filogenéticos

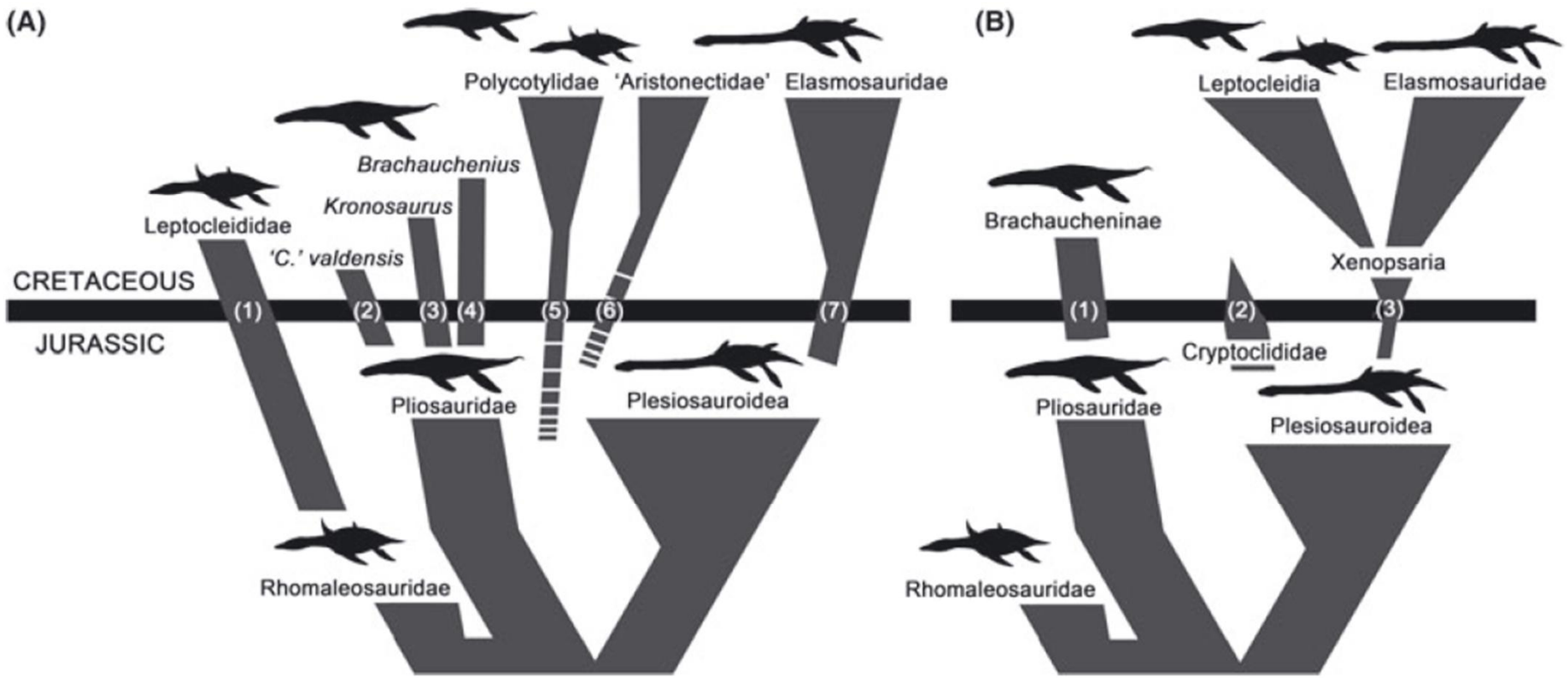


Fig. 1. Hypotheses of plesiosaurian lineages crossing the Jurassic–Cretaceous boundary. (A) Schematic depiction of previous hypotheses showing the maximum number of lineages hypothesised as crossing the boundary (seven lineages); (B) simplified depiction of the tree recovered from our dataset in which only three lineages crossed the boundary (see Figs 2 and 3).

AVANCES DURANTE EL SIGLO XXI

Cambios de paradigmas: Diversidad hacia fines del Cretácico

En el hemisferio norte el registro de plesiosaurios declina hacia el Santoniano.

Al contrario, durante el Campaniano-Maastrichtiano, los plesiosaurios son muy abundantes en todo el hemisferio sur, llegando incluso al límite K/Pg.

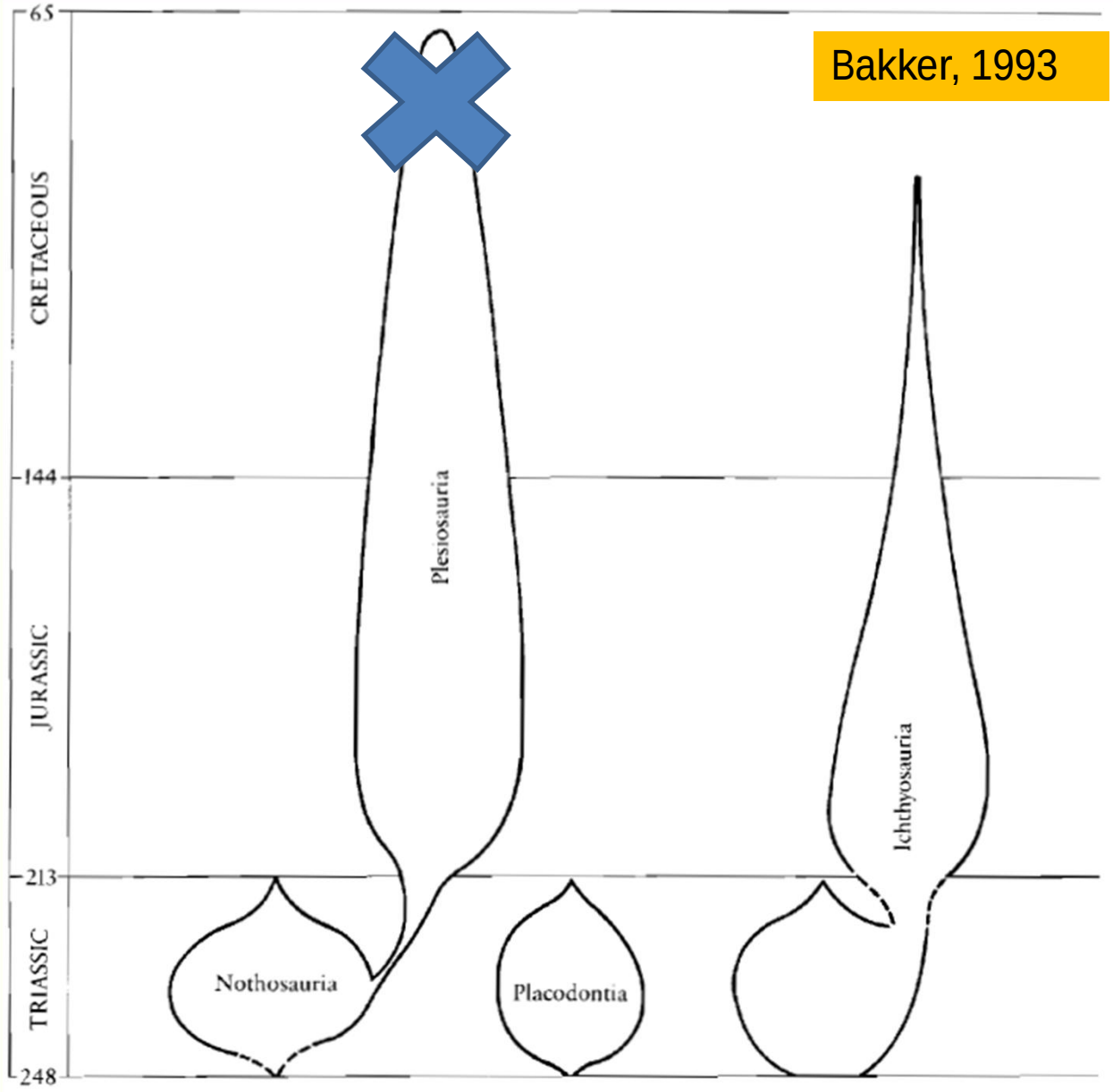


Figure 12-1. STRATIGRAPHIC RANGES OF MESOZOIC AQUATIC REPTILES.

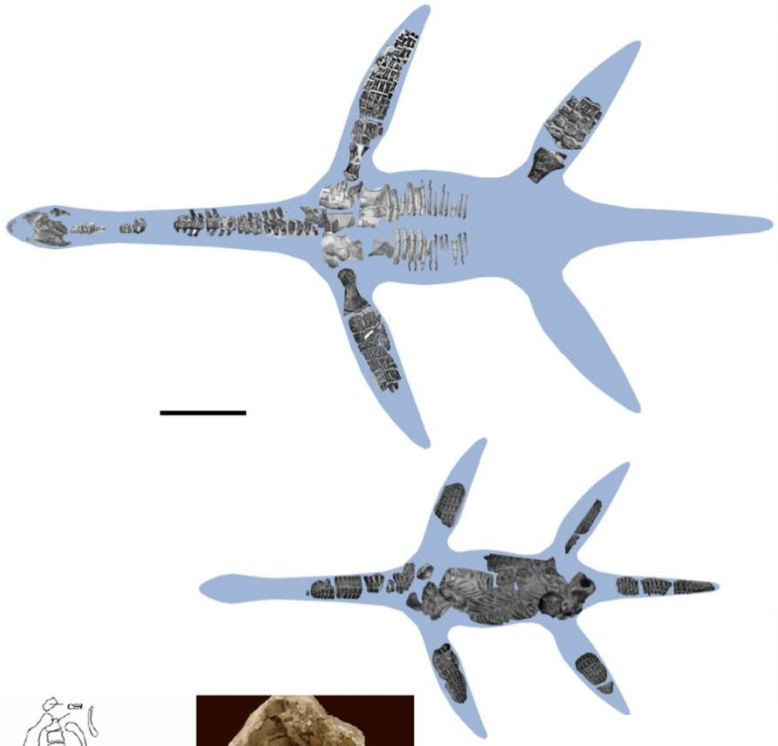
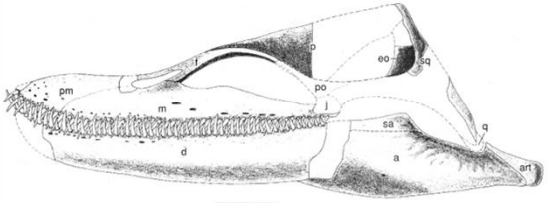
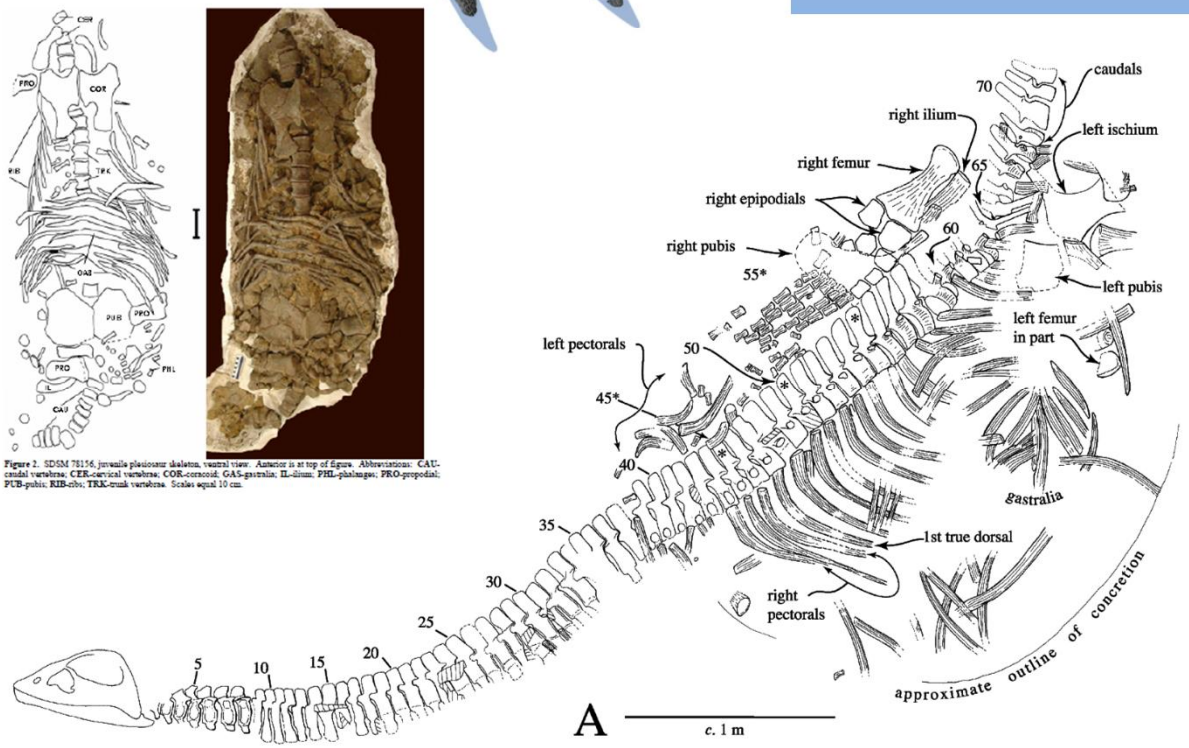
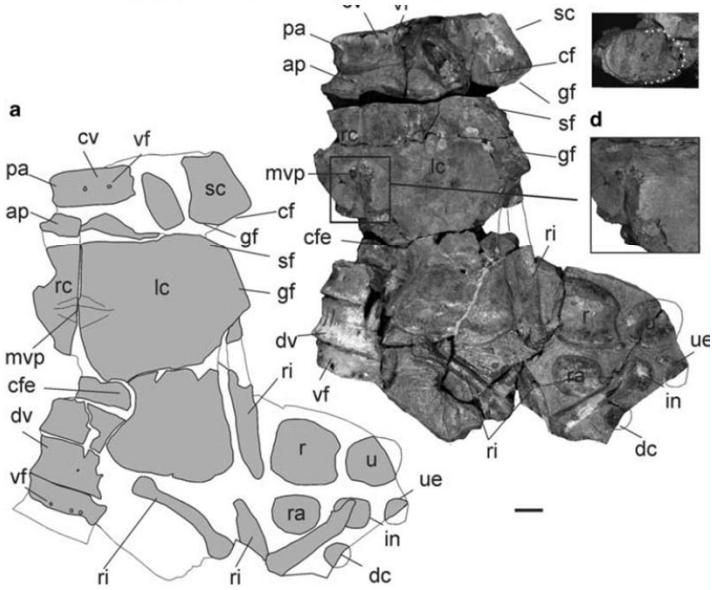


Figure 2. SDSM 78156, juvenile plesiosaur skeleton, ventral view. Anterior is at top of figure. Abbreviations: CAU-caudal vertebrae; CER-cervical vertebrae; COR-coracoid; GAS-gastralia; IL-ilium; PHL-phalanges; PRO-propodial; PUB-pubis; RIB-ribs; TRK-trunk vertebrae. Scales equal 10 cm.







AVANCES DURANTE EL SIGLO XXI

Cambios de paradigmas: ¿Huevos o crías vivas?

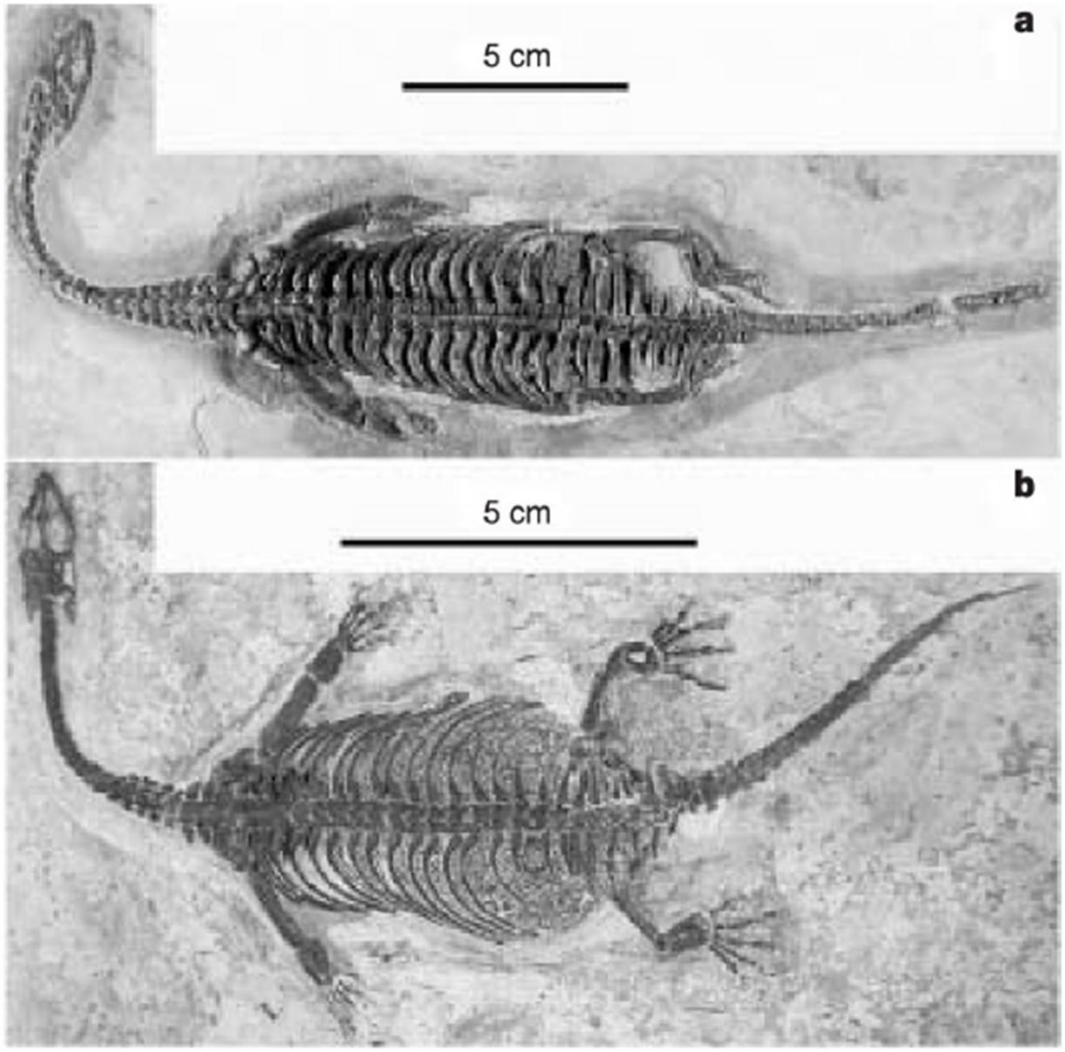


Figure 1 Two gravid specimens of *Keichousaurus hui* in dorsal view. **a**, NMNS-cyn2002-01; **b**, NMNS-VL191.

Cheng et al., 2004

4) Avances durante el Siglo XXI

4.2. Cambios de paradigmas: ¿Huevos o crías vivas?

AVANCES DURANTE EL SIGLO XXI

Cambios de paradigmas: ¿Permanentemente en el mar o también en tierra?

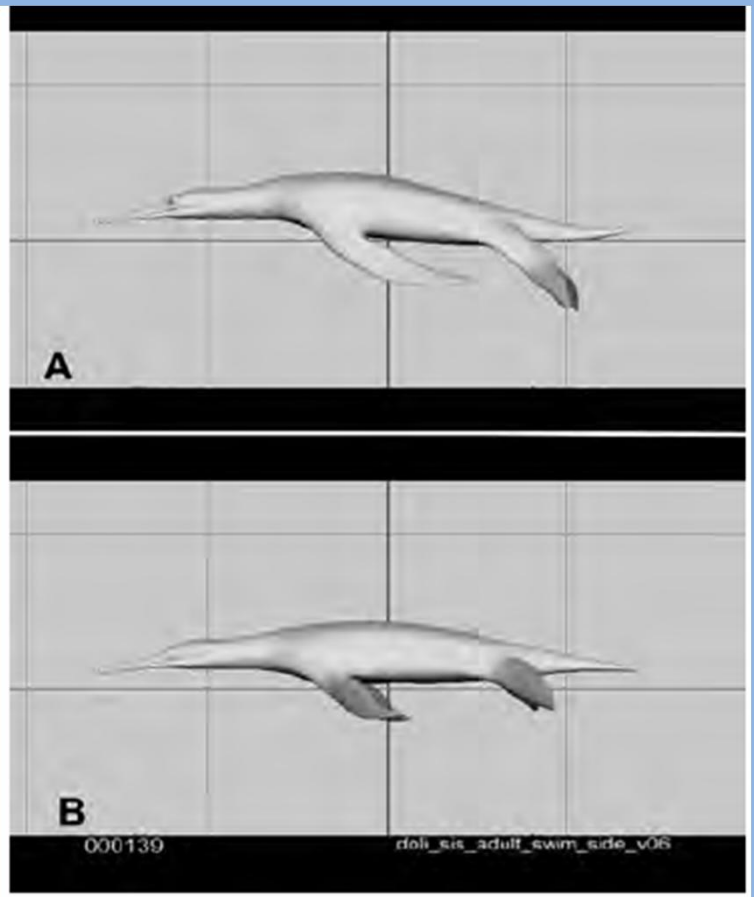


Figure 15. Stills from two examples of plesiosaur swimming created by D.A.M.N.™ A, sea-lion model, which was dismissed due to join mechanics (see Figure 5F); B, semi-synchronous model. Computer graphic models allowed testing of various hypotheses of flipper motion. Courtesy of D.A.M.N.™

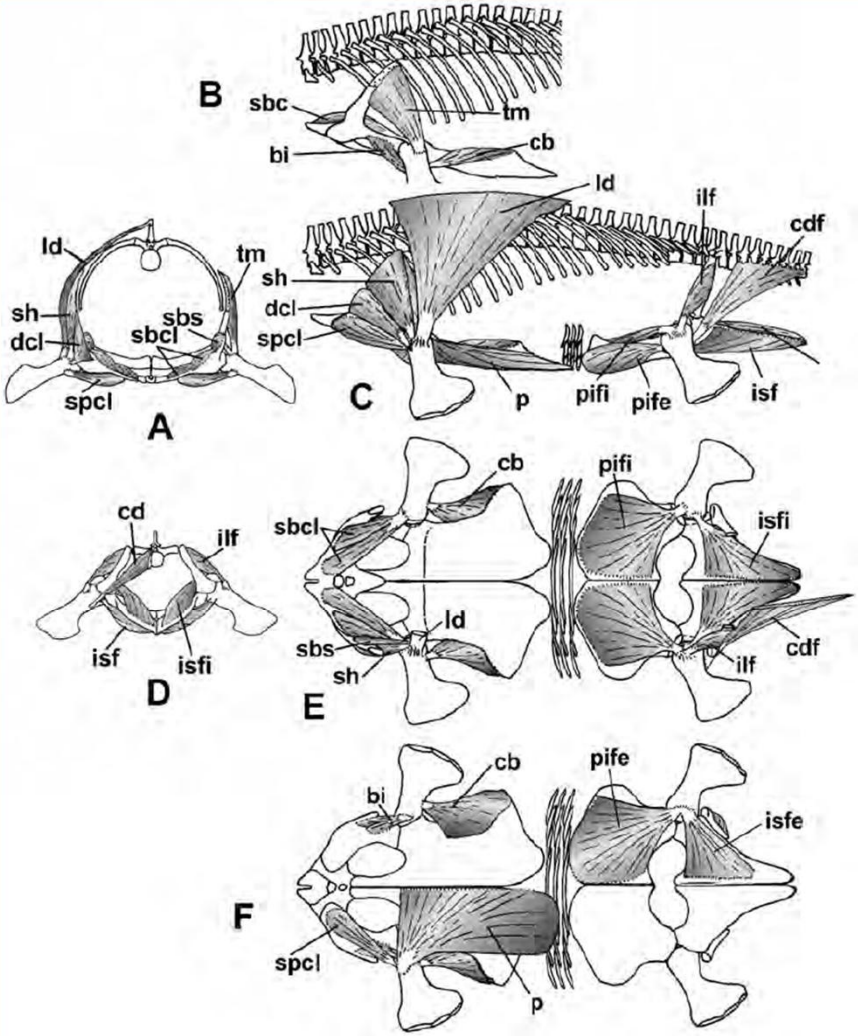
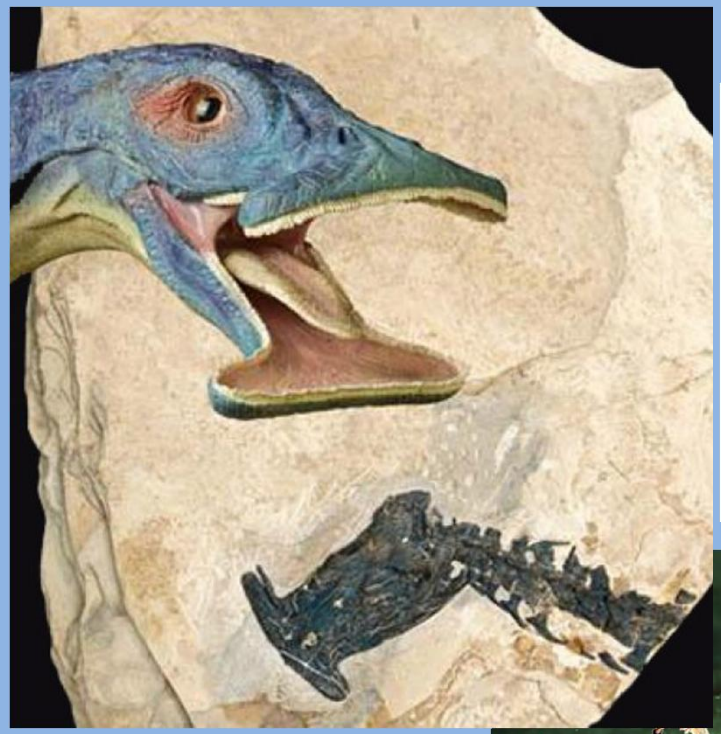
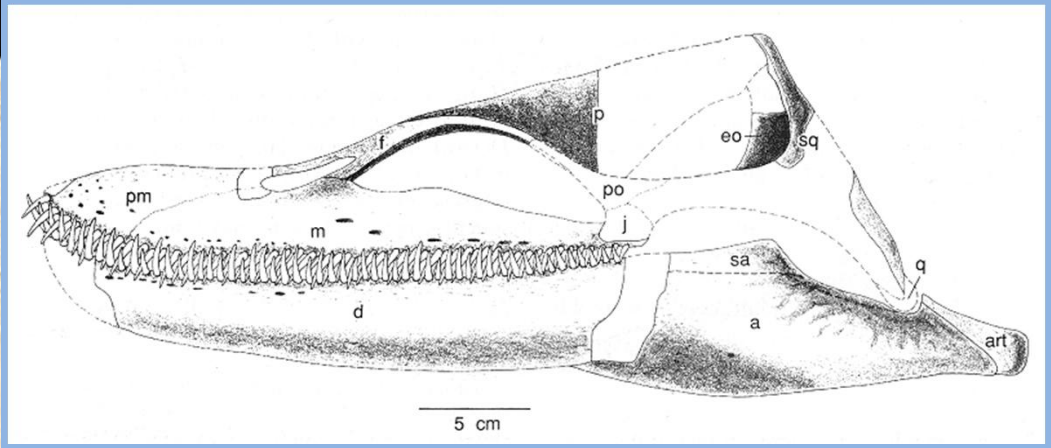


Figure 17. Reconstructed limb-girdle musculature for *Dolichorhynchops*. A, anterior view of pectoral; B, left lateral deep muscles; C, left lateral superficial muscles; D, posterior view of pelvic; E, dorsal (visceral) view; F, ventral view. Abbreviations: bi - biceps; cb - coracobrachialis; cdf - caudofemoralis; dcl - deltoideus clavicularis; ds - deltoideus scapularis; ilf - iliofemoralis; isf - ischiofemoralis; ld - latissimus dorsi; p - pectoralis; pife - puboischiofemoralis externus; pifi - puboischiofemoralis internus; sbcl - subclavicularis; sbs - subscapularis; sh - scapulohumeralis; spcl - supraclavicularis; tm - terres major.

AVANCES DURANTE EL SIGLO XXI

Cambios de paradigmas: ¿exclusivamente piscívoros?





AVANCES DURANTE EL SIGLO XXI

Cambios de paradigmas: Adquisición del cuello largo como propiedad emergente (va y viene; ocurre en varios linajes)

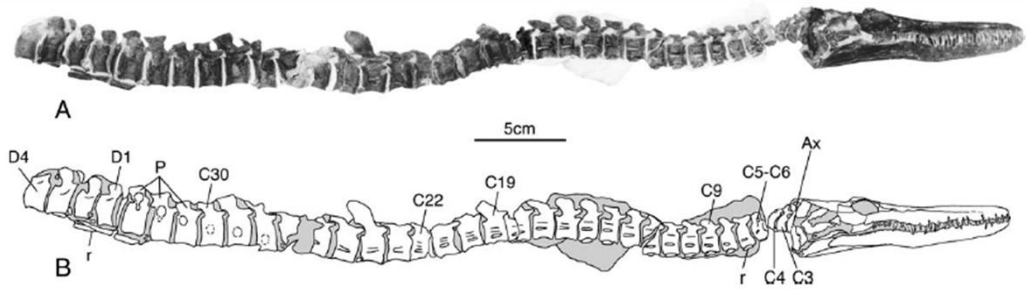
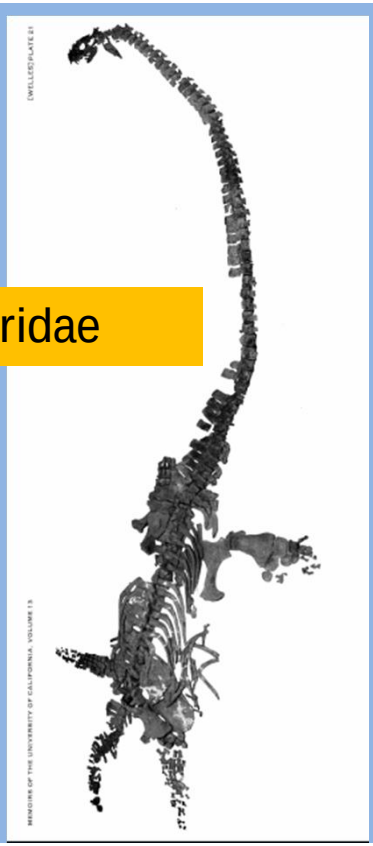


Fig. 2. *Thililua longicollis* gen. et sp. nov., holotype MNHGr.PA.11710, Goulmima region, Turonian, Morocco. **A**, Skull, mandible and associated vertebrae in articulation in right lateral view; **B**, interpretation. Abbreviations: **Ax**, axis; **C**, cervical; **D**, dorsal; **P**, pectoral vertebra; **r**, rib.

Polycotylidae

Elasmosauridae



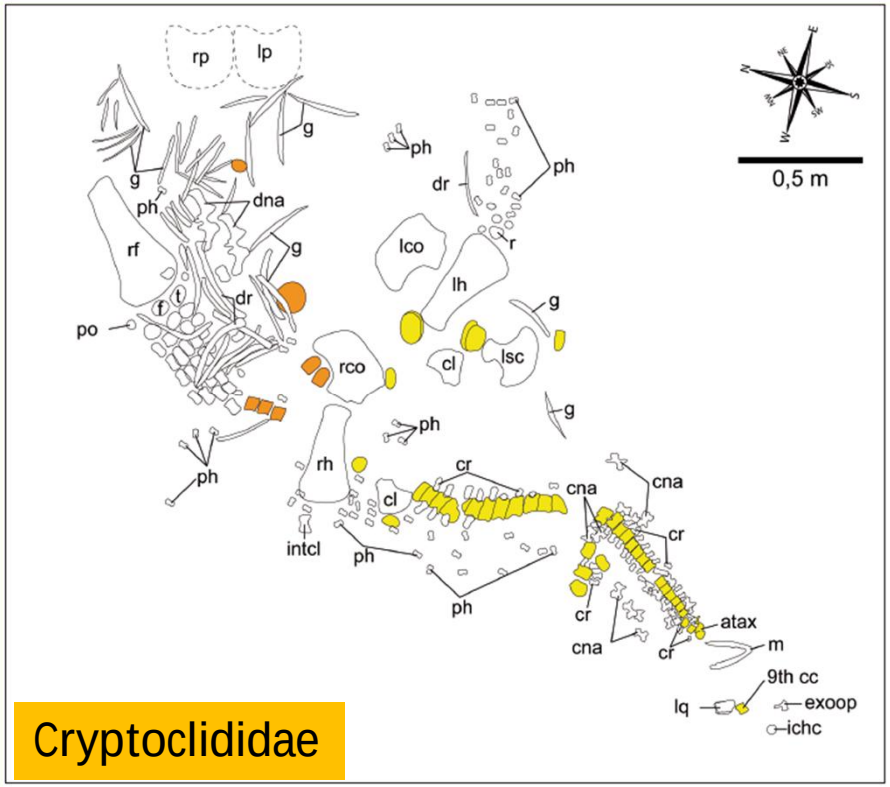


Figure 2. Quarry map of Djupedalia engeri *gen. et sp. nov. (PMO 216.839). The neck is largely separated into two major articulated series of vertebrae. Cervical vertebral centra are coloured yellow, and dorsal vertebral centra are coloured orange. Approximate outline of pubes shown as dashed lines. atax=atlas-axis, cl=clavicle, cna=cervical neural arch, cr=cervical rib, dna=dorsal neural arch, dr=dorsal rib, exoop.=exoccipital-opisthotic, f=fibula, g=gastralia, intcl=interclavicle, ichc= ichthyosaur vertebral centrum, lco=left coracoid, lh=left humerus, lp=left pubis, lq=left quadrate, lsc=left scapula, m=mandible, ph=phalanx, po=postaxial ossicle, r=radius, rco=right coracoid, rf=right femur, rp=right pubis, t=tibia, 9th cc=9th cervical centrum.*

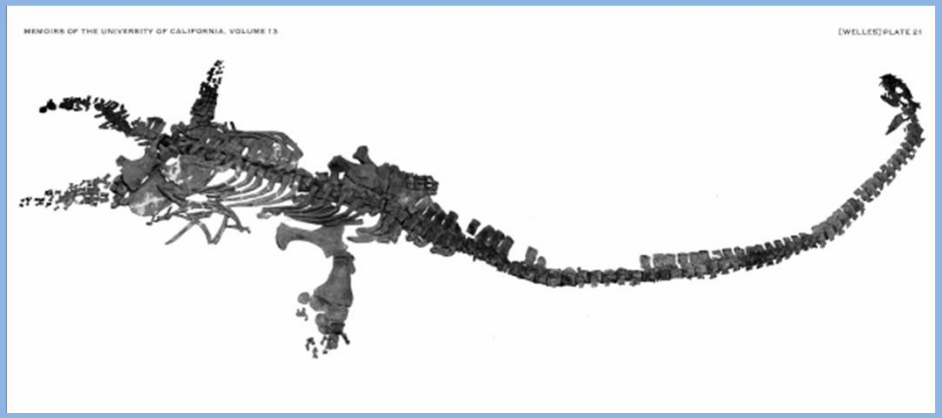
Cryptoclididae

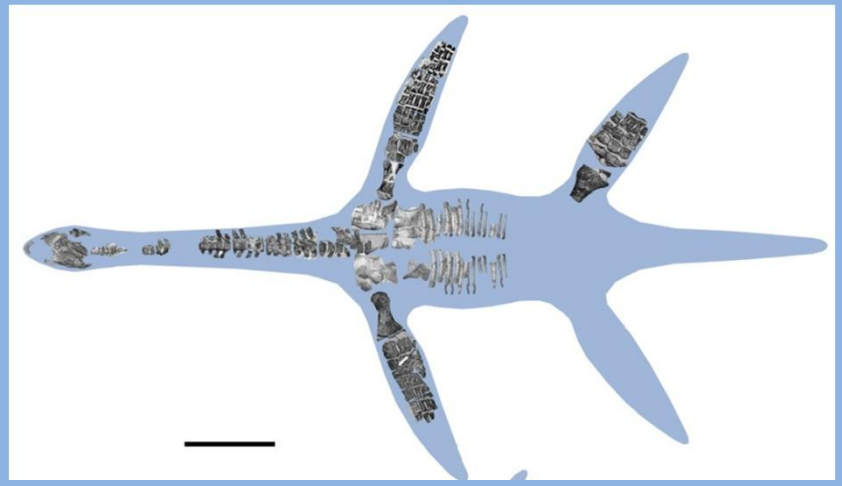
AVANCES DURANTE EL SIGLO XXI

Cambios de paradigmas: Adquisición del cuello largo como propiedad emergente (va y viene; ocurre en varios linajes)

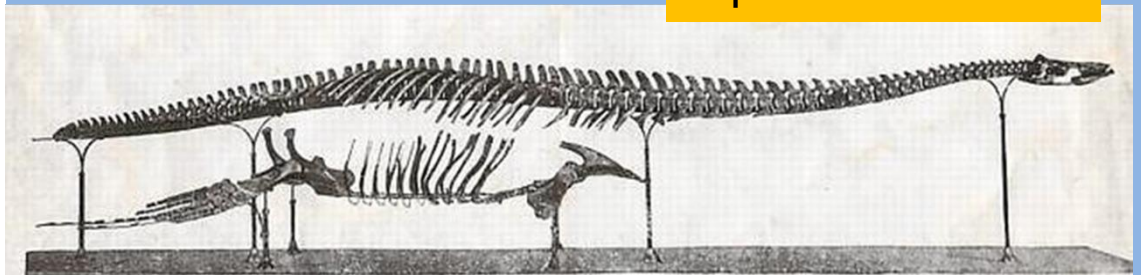
Pliosauridae

Elasmosauridae





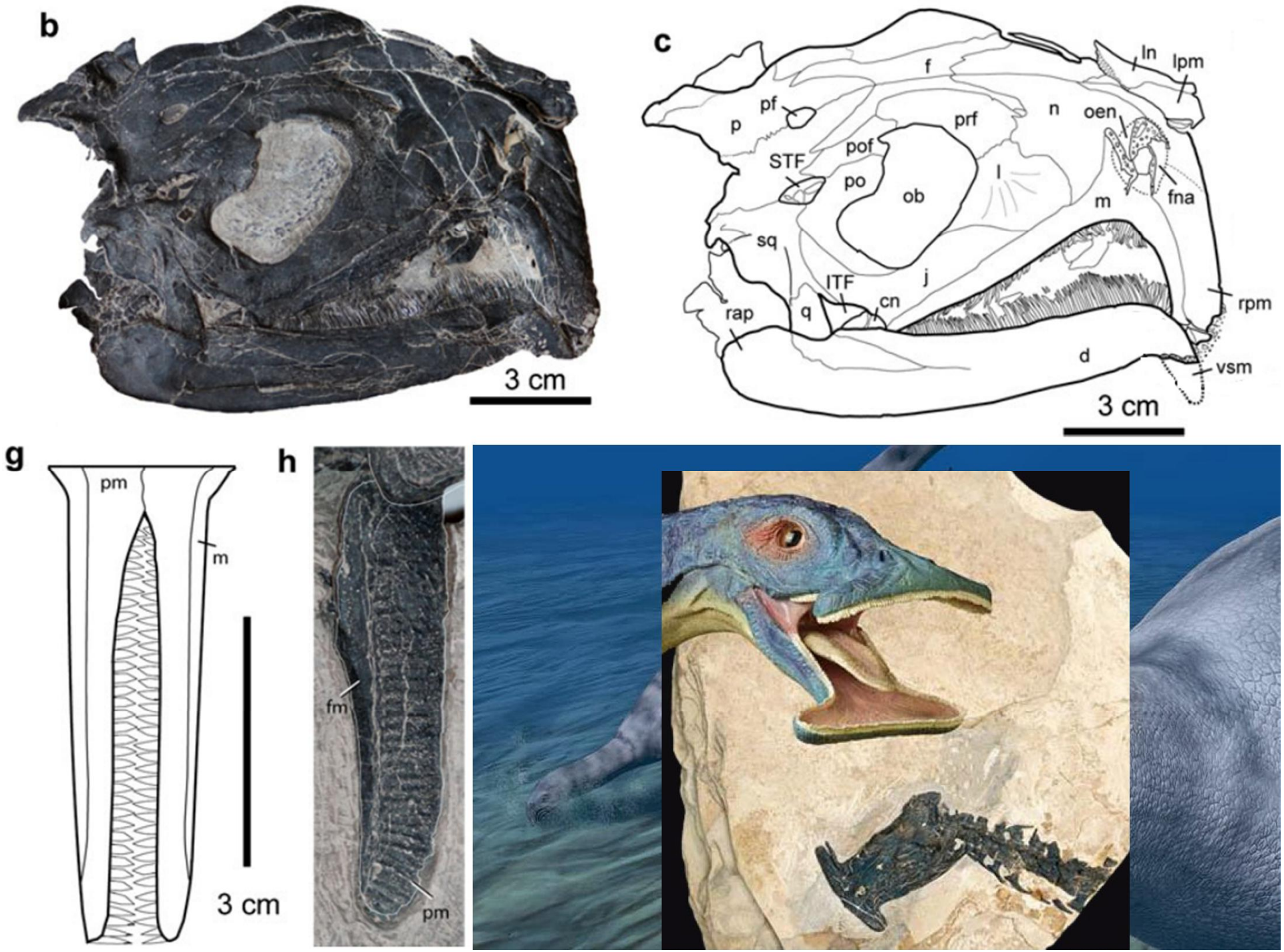
Leptocleididae



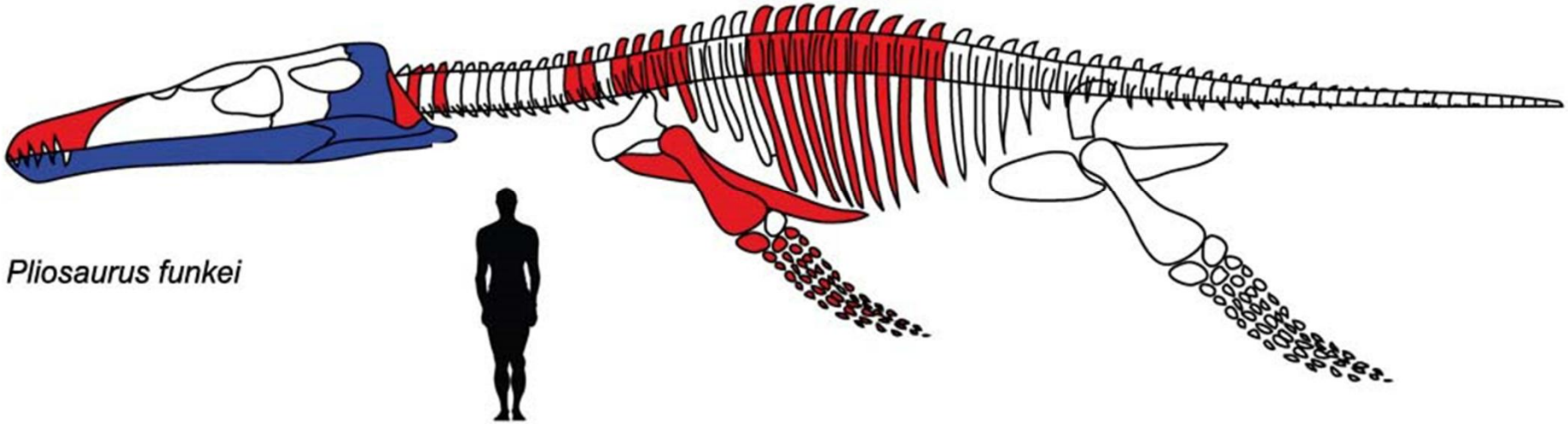
Plasticidad en Sauropterygia

(ejemplos de formas extremas)

Atopodentatus unicus Cheng et al., 2014
Triásico medio (Anisiano)
China

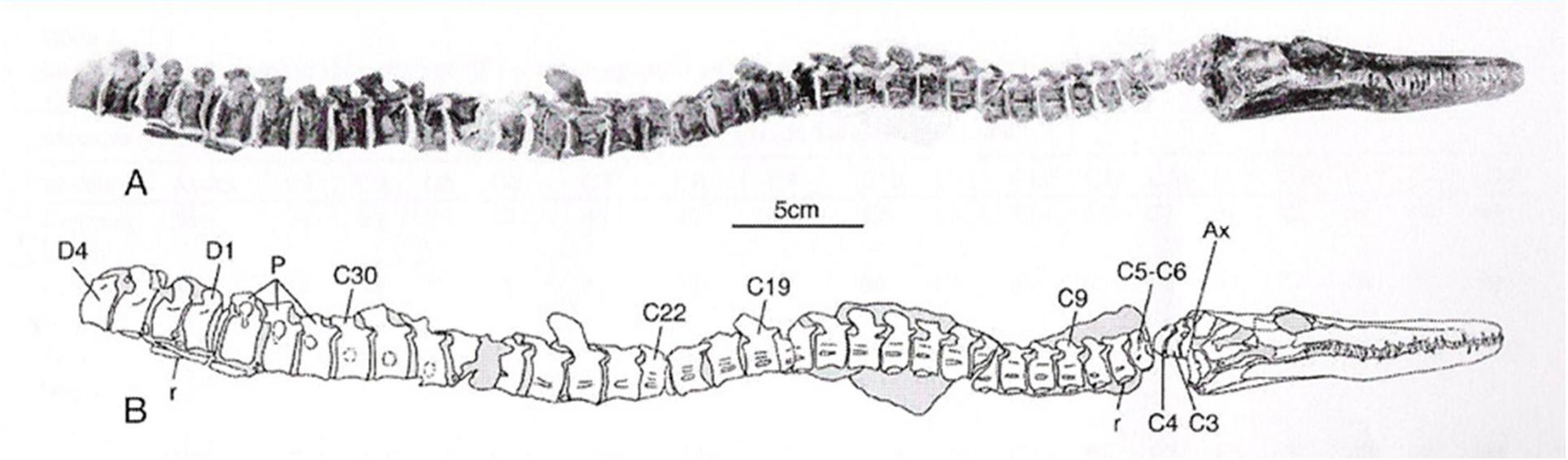

b
3 cm
c
f
ln
lpm
pf
p
prf
n
oen
pof
STF
po
ob
l
m
fna
sq
j
ITF
cn
rap
q
rpm
d
vsm
3 cm
g
pm
m
3 cm
h
fm
pm

Pliosaurus funkei Knutsen et al., 2012
Titoniano
Noruega

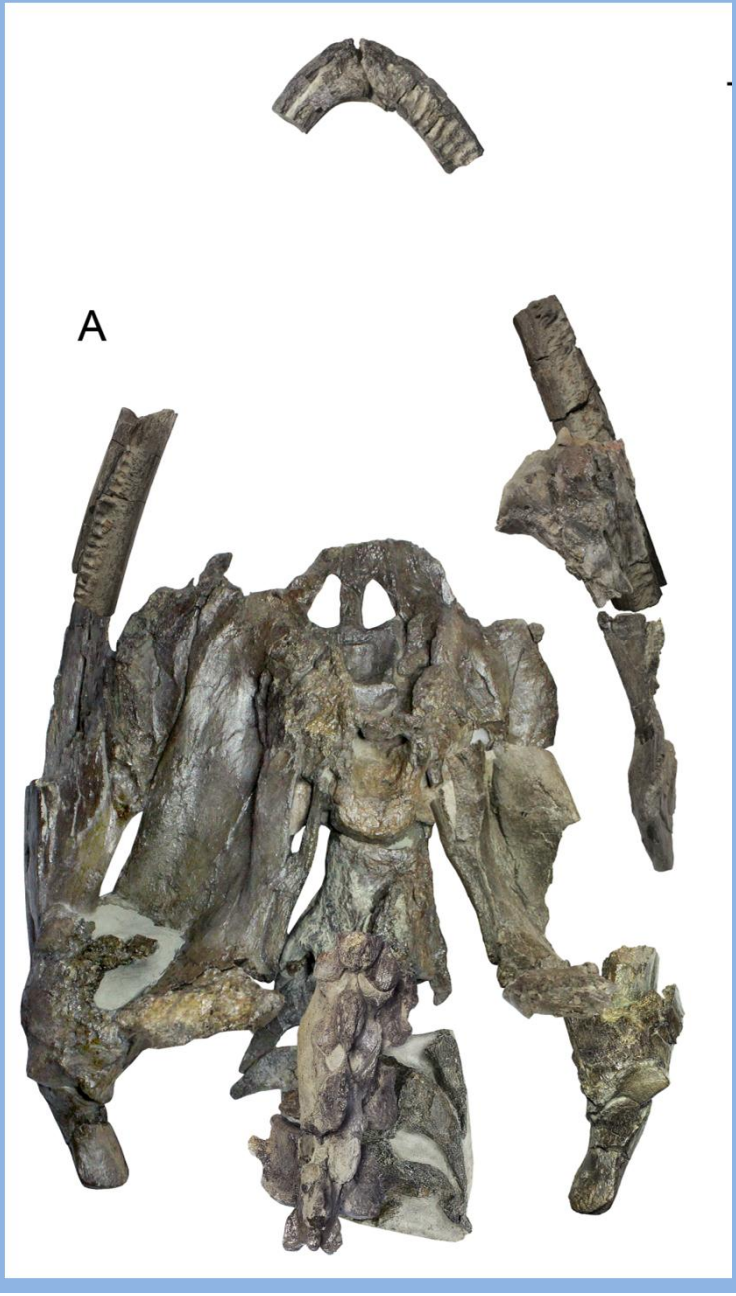


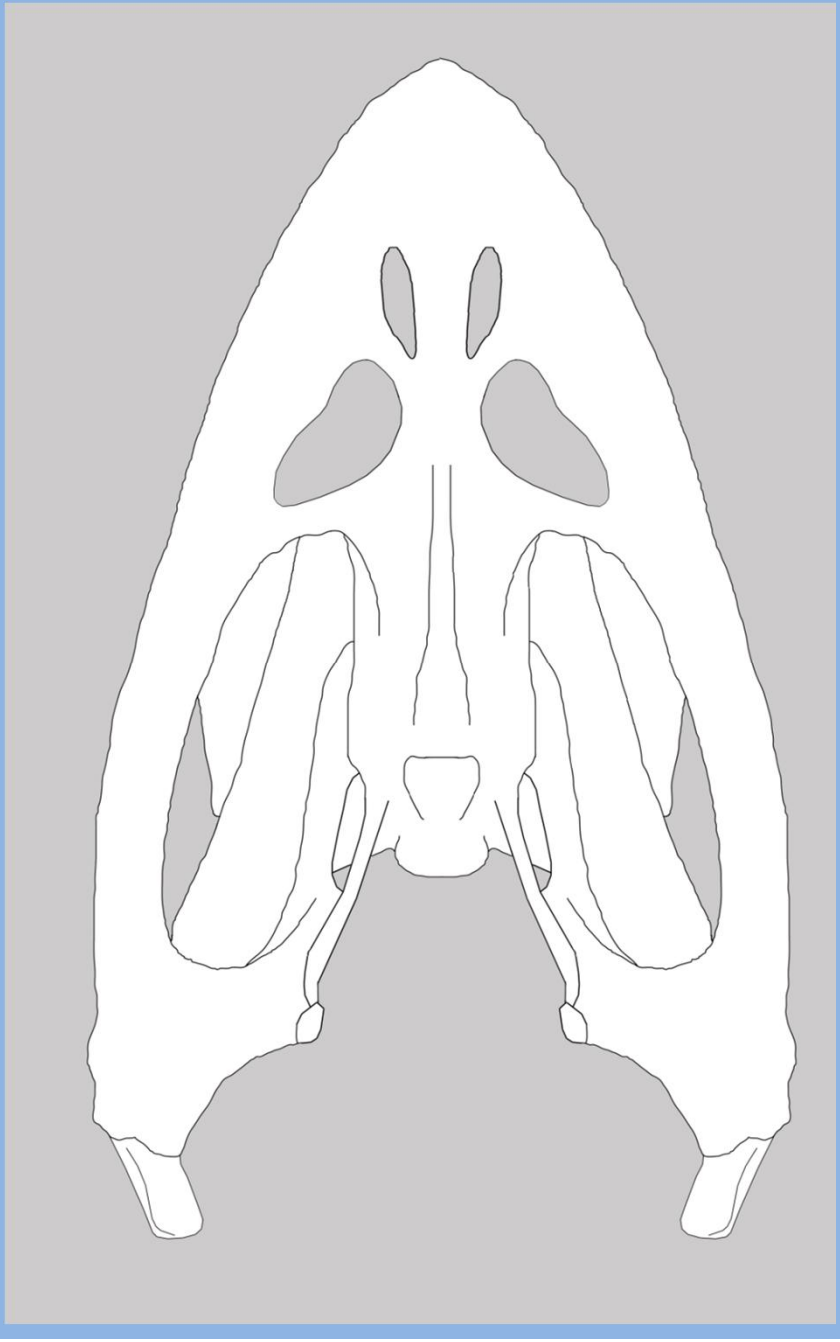
Elasmosaurus platyurus Cope, 1868
Campaniano
Estados Unidos

Thililua longicollis Berdet et al., 2002
Turoniano
Marruecos



Aristonectes quiriquinensis Otero et al., 2014
Maastrichtiano tardío
Chile






MUCHAS GRACIAS POR SU ATENCIÓN