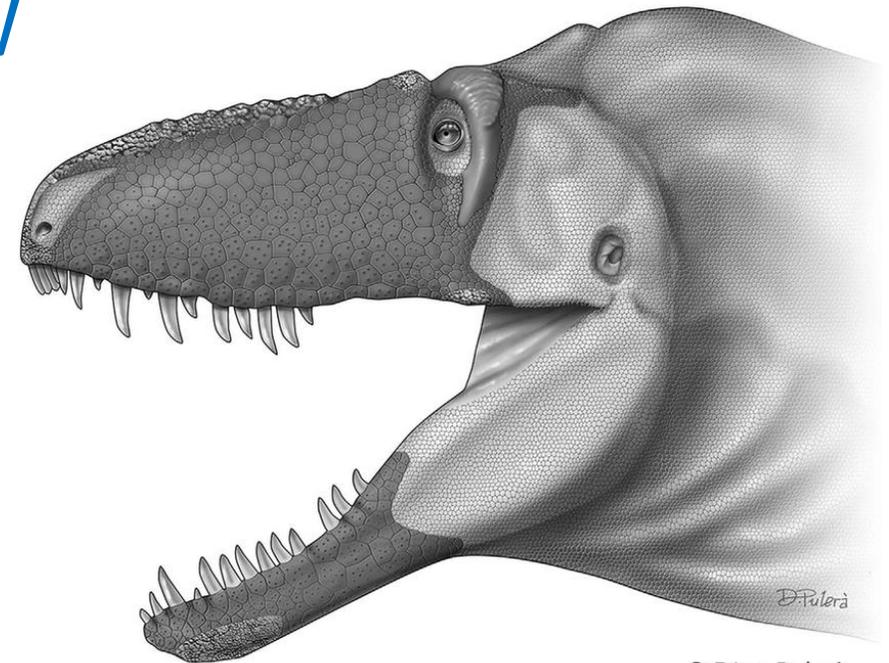
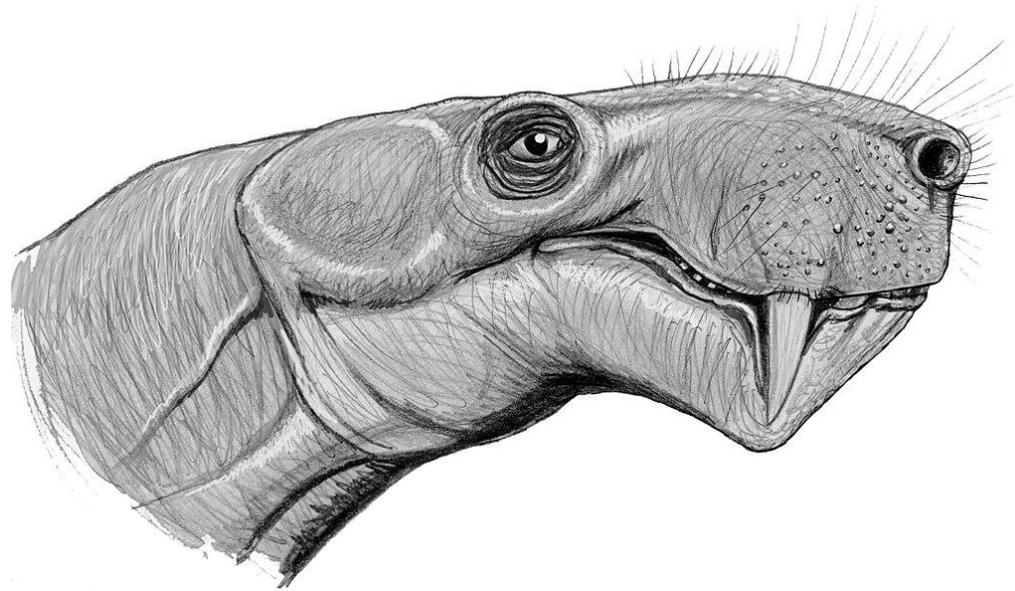


EWOLUCJA KONWERGENTNA KRĘGOWCÓW



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Megadrapieżniki w czasie i przestrzeni



Dr Daniel Tyborowski

Katedra Geologii Historycznej, Regionalnej i Paleontologii

Wydział Geologii UW

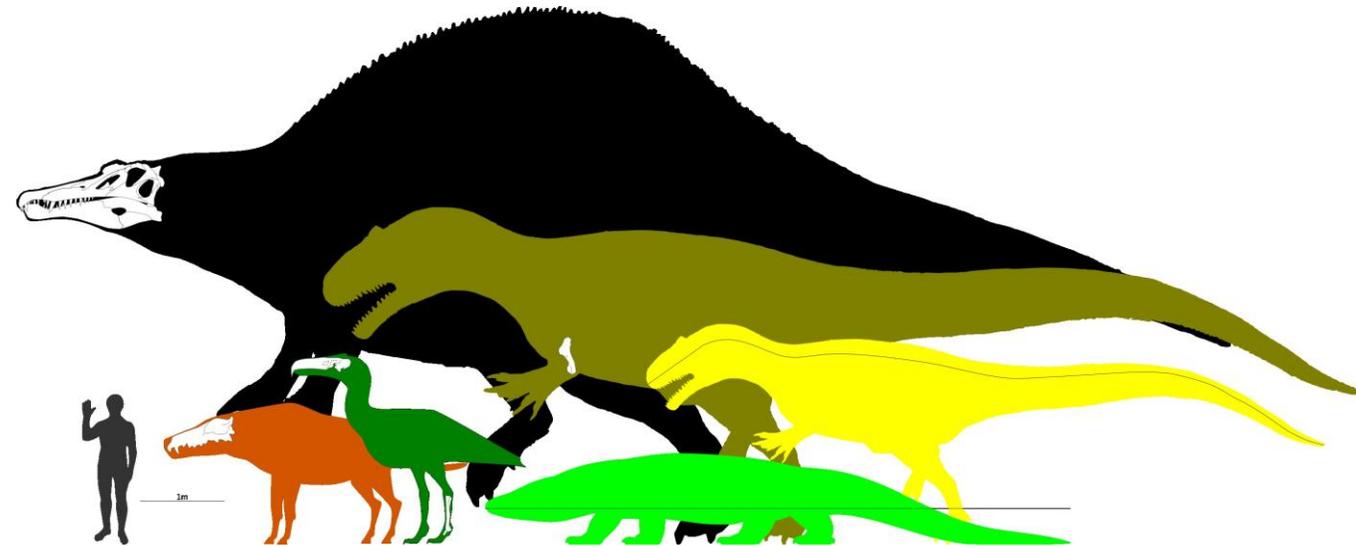
d.tyborowski@uw.edu.pl



UNIWERSYTET
WARSZAWSKI

Megadrapieżniki (drapieżniki szczytowe)

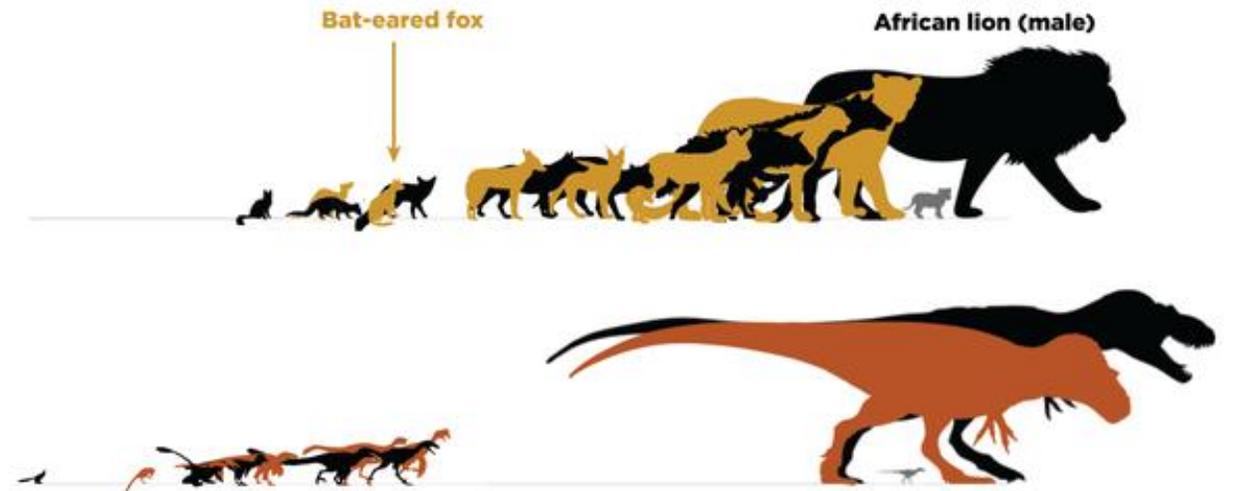
- Zajmują **szczyt piramidy troficznej**.
- Duże rozmiary i masywna budowa (choć **brak dokładnego kryterium masy**).
- **Zaawansowane adaptacje** do polowania na rozmaite typy zdobyczy.
- **Złożone strategie łowieckie** (polowanie w grupach, atakowanie z zasadki).
- Ogromne znaczenie ekologiczne – **duży wpływ na niższe poziomy troficzne i równowagę ekosystemową**.
- Pojawianie się megadrapieżników w danym momencie historii geologicznej jest świadectwem **stabilnych warunków środowiskowych i ogromnej bazy pokarmowej**.



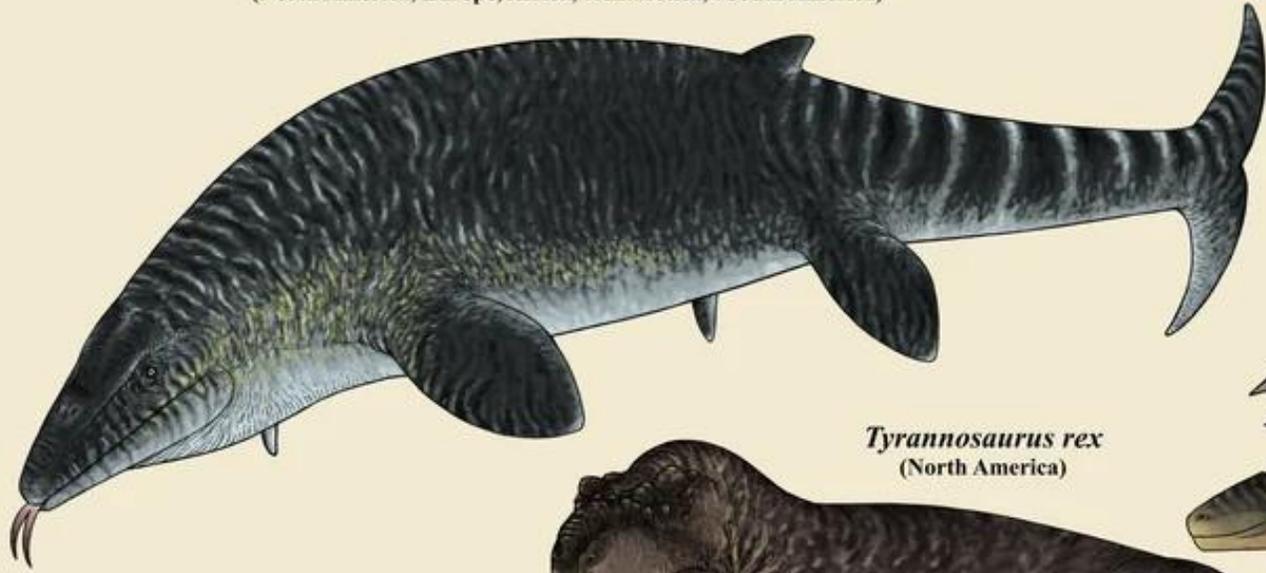


Ewolucja i radiacje megadrapieżników

- Pierwsze lądowe formy megadrapieżne pojawiły się w permie → **synapsydy** (pelikozaury i terapsydy).
- W mezozoiku następuje **radiacja megadrapieżnych zauropsydów** → **na lądach archozaury** (dinozaury, pterozaury i formy pokrewne); **w morzach lepidozauromorfy** (ichtiozaury, plezjozaury, mozazaury) i **niektóre archozaury** (krokodylomorfy).
- W kenozoiku **radiacja megadrapieżnych synapsydów** → **ssaki**.
- Ostatnie 250 milionów lat to czas wielu szeregów rozwojowych megadrapieżników, które następowały jedne po drugich.



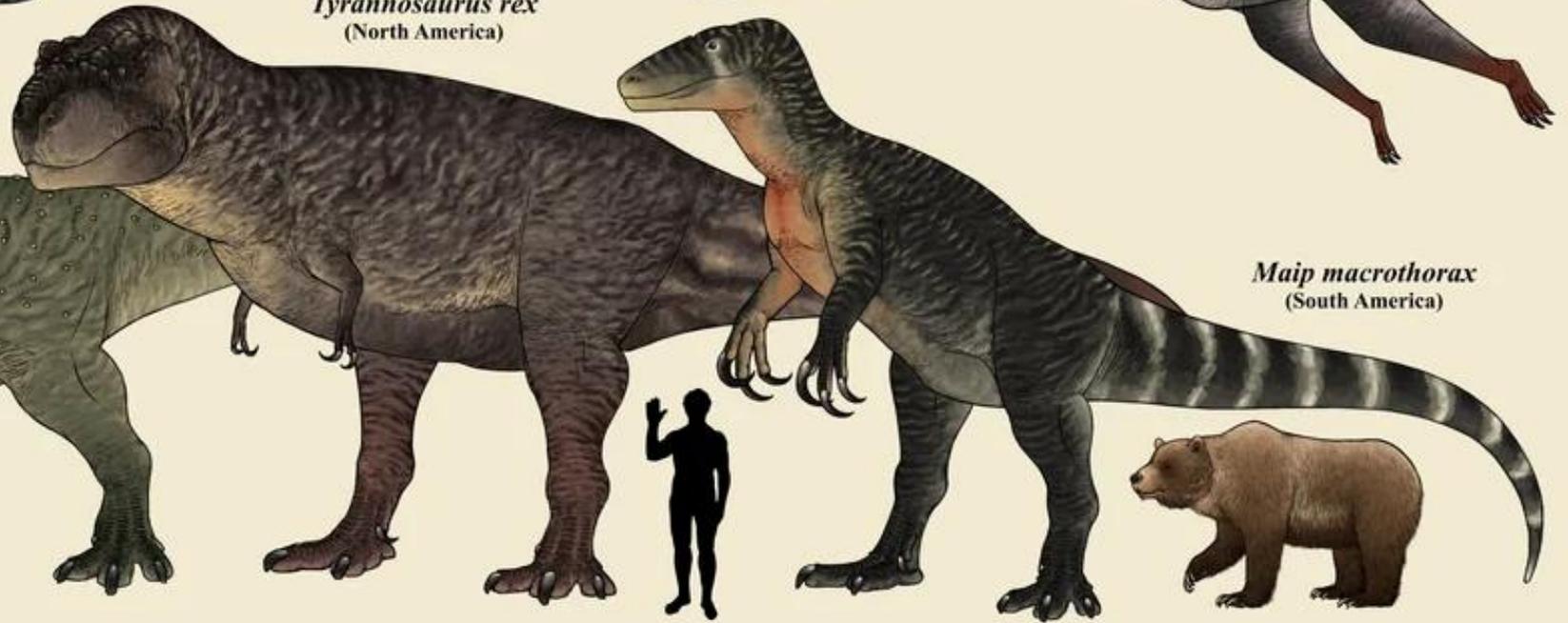
Mosasaurus hoffmannii
(North America, Europe, Africa, ?Antarctica, ?South America)



Hatzegopteryx thambema
(Europe)



Tyrannosaurus rex
(North America)



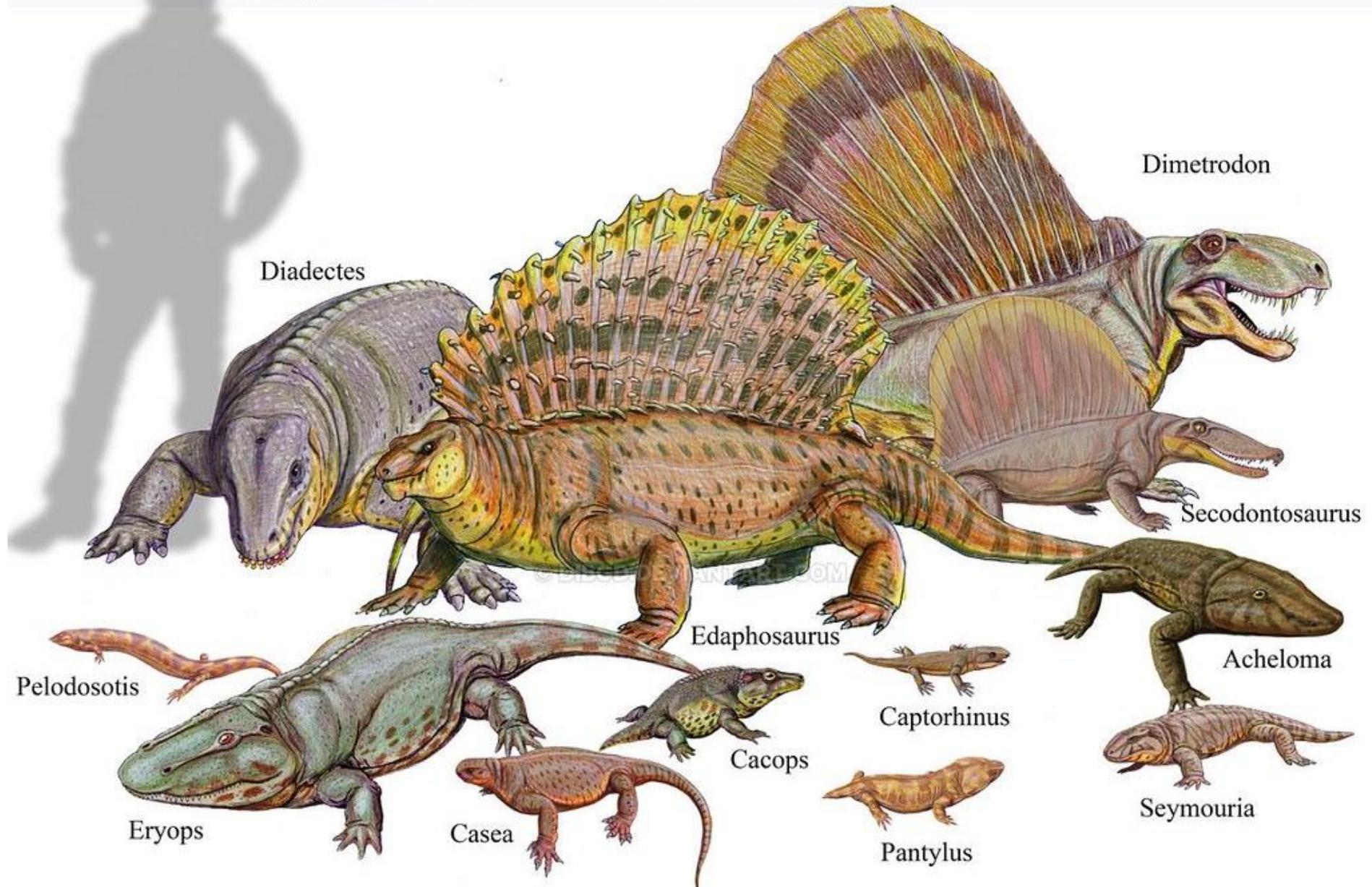
Maip macrothorax
(South America)



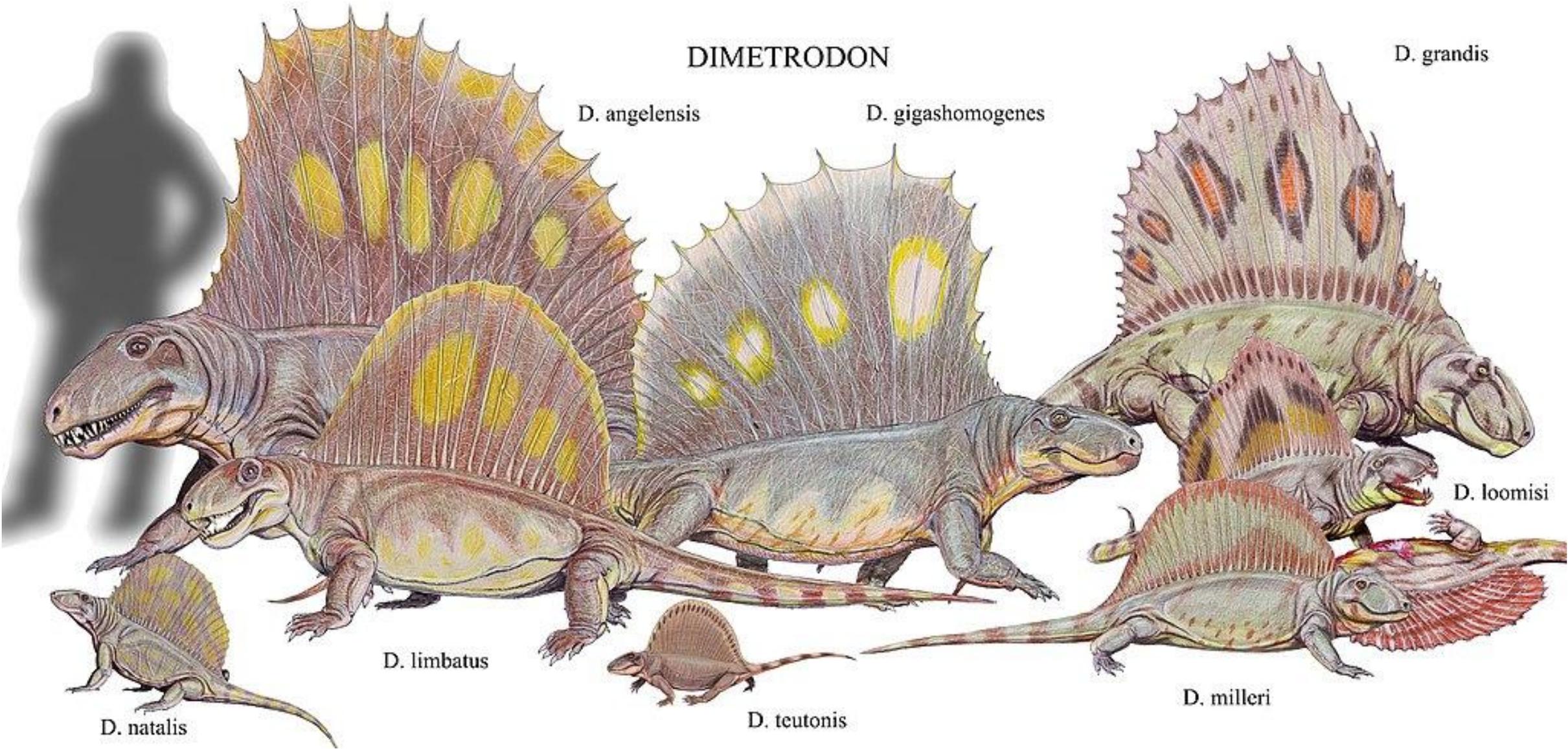
"Turkana Grits"
giant abelisaurid
(Africa)



Early Permian terrestrial fauna of North America



DIMETRODON



D. angelensis

D. gigashomogenes

D. grandis

D. limbatus

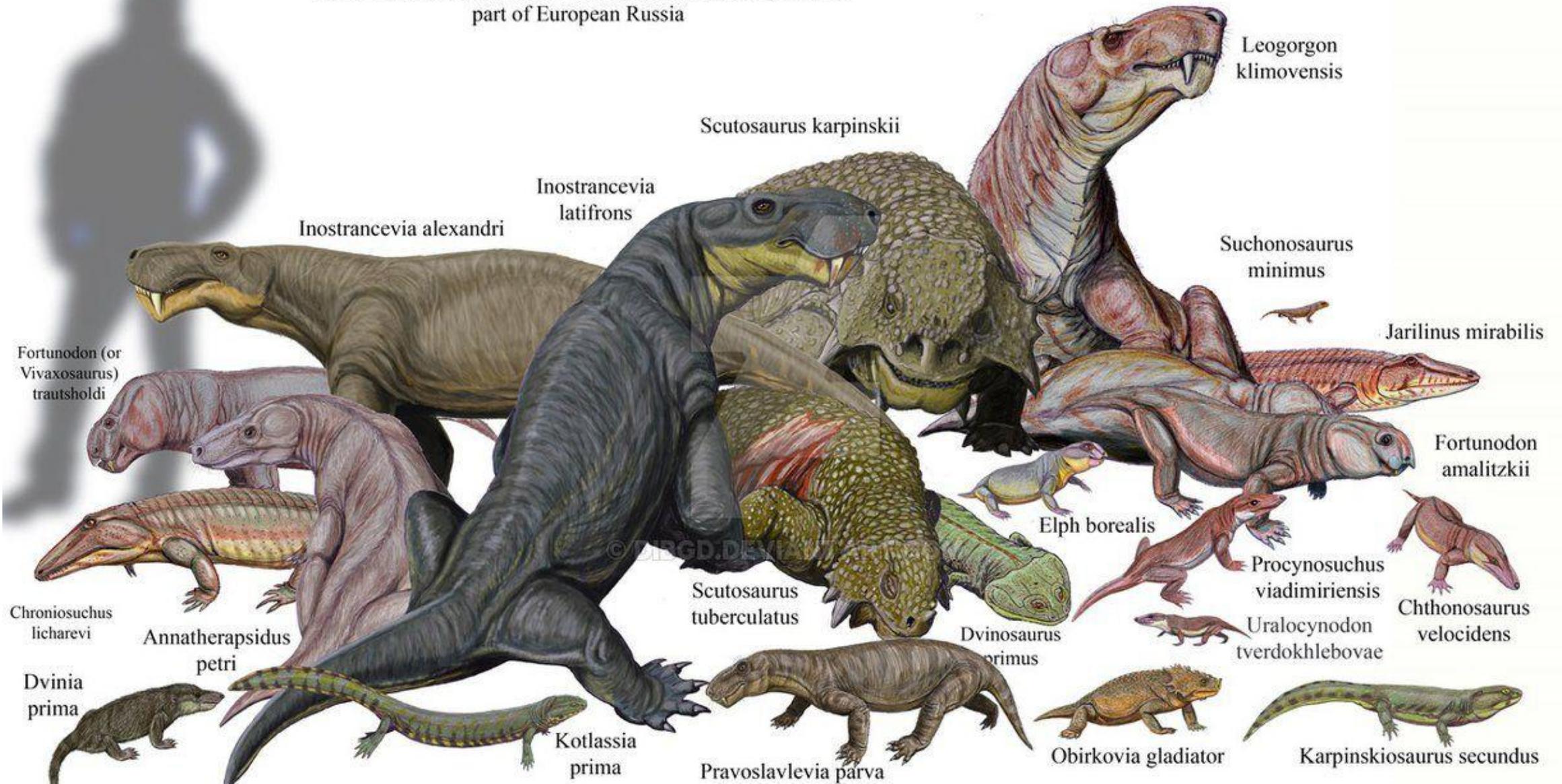
D. natalis

D. teutonius

D. milleri

D. loomisi

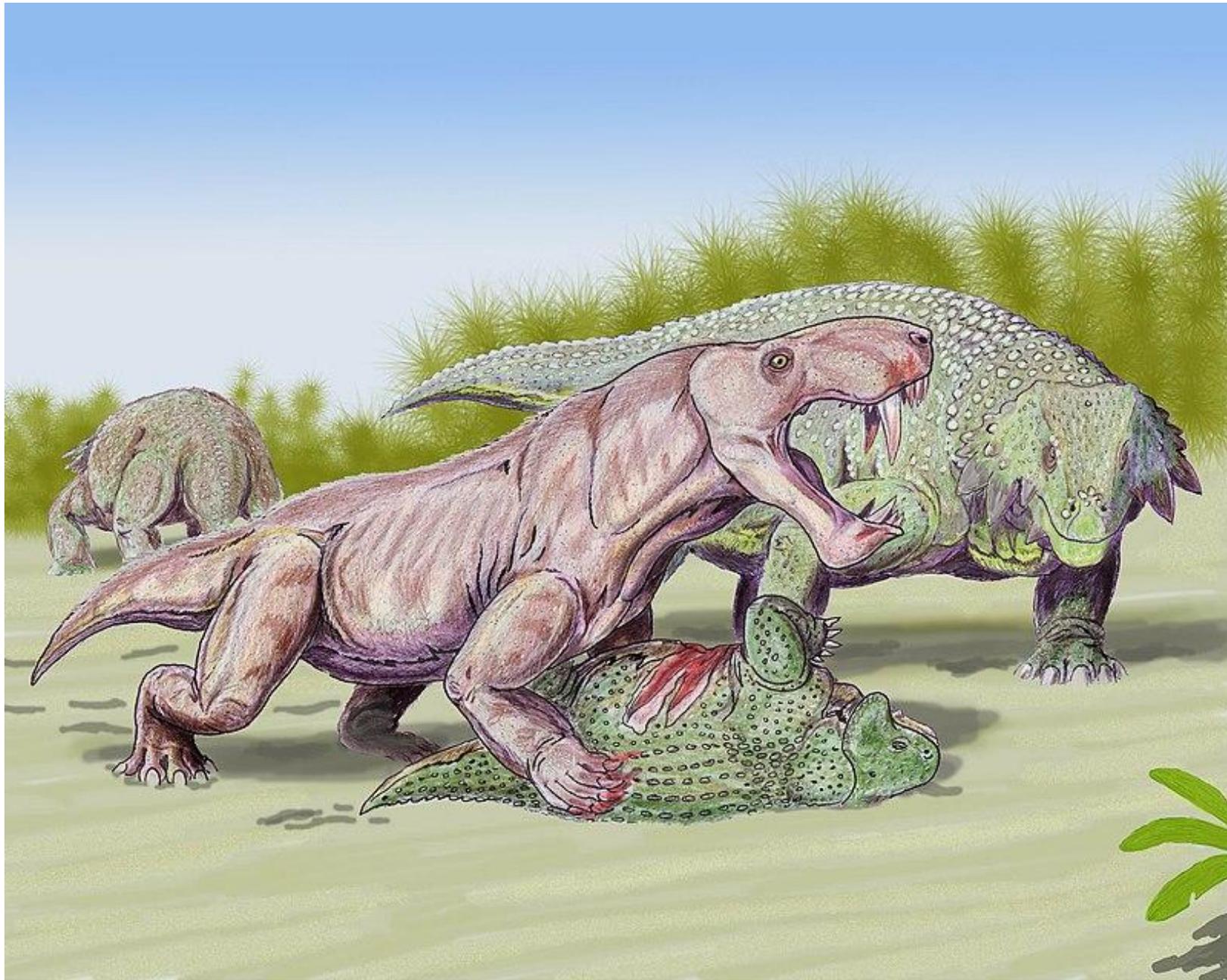
Sokolki Faunal Assemblage - Late Late Permian of Northern part of European Russia





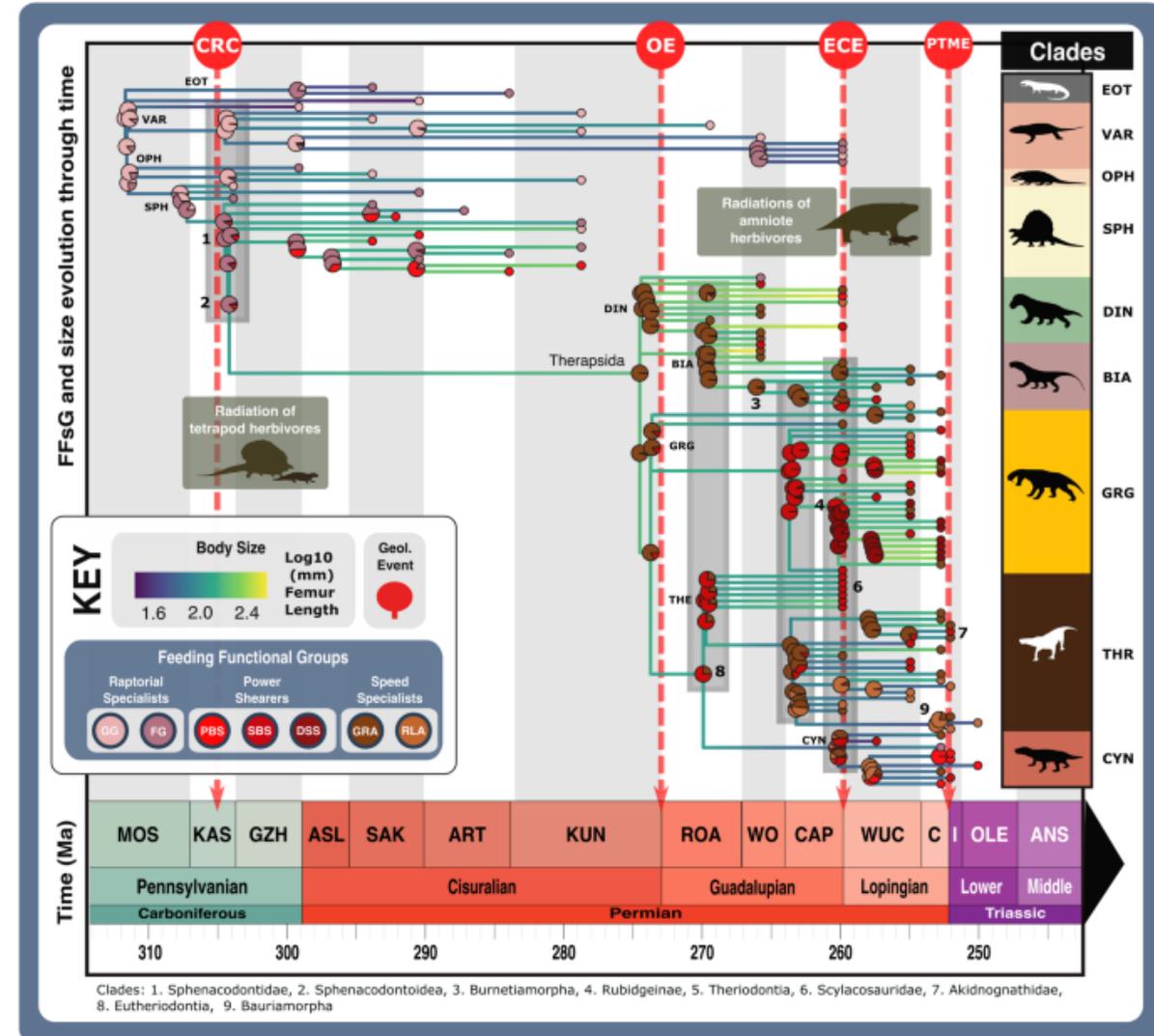
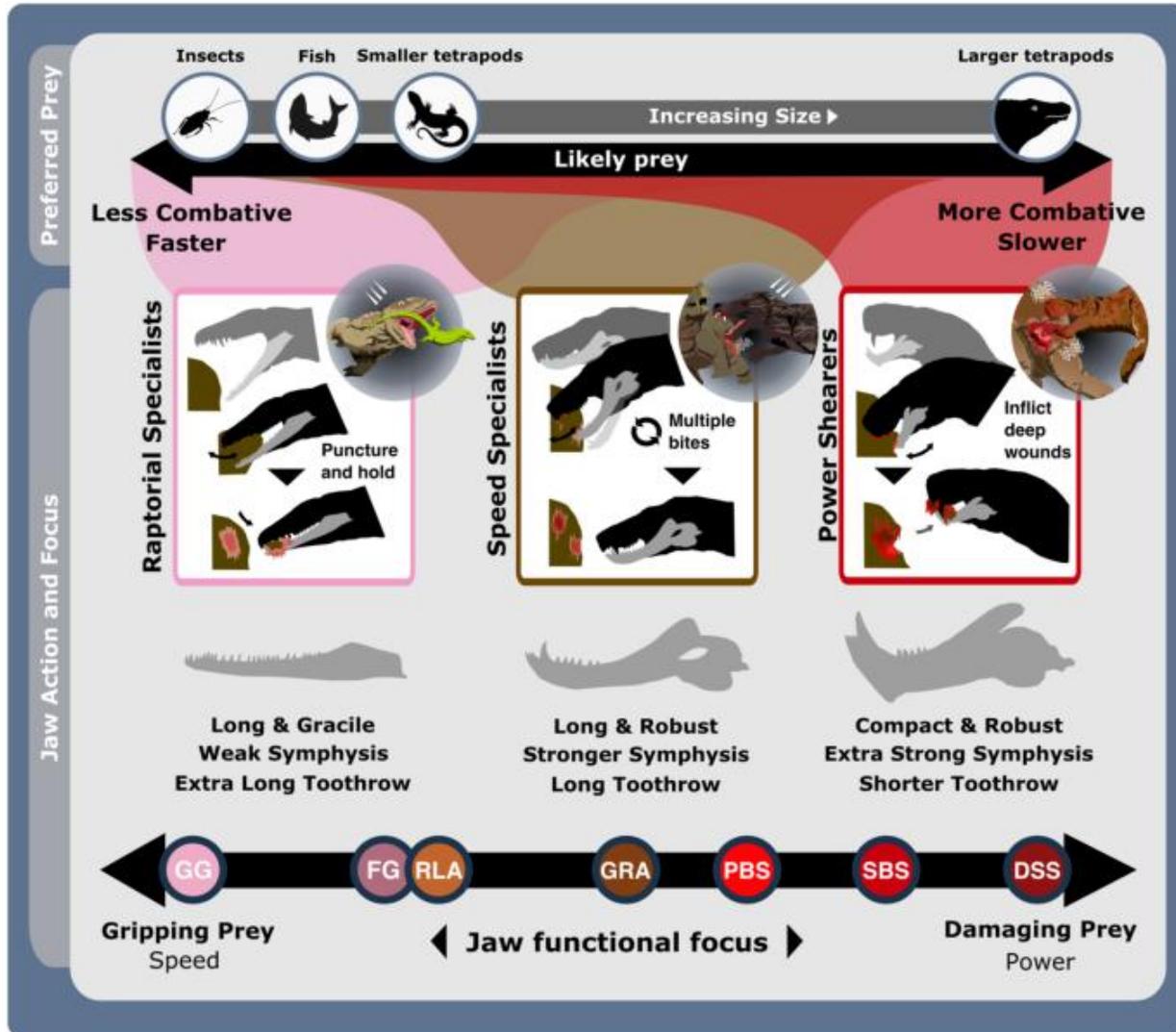


Rekonstrukcja Mario Lanzas



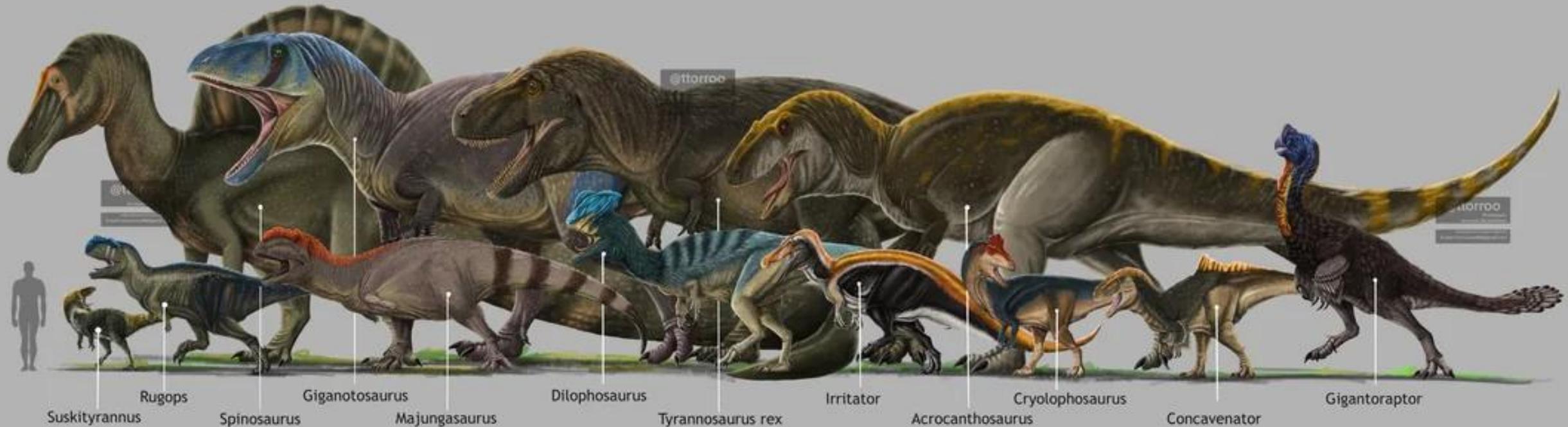
Rekonstrukcja Dmitry Bogdanov

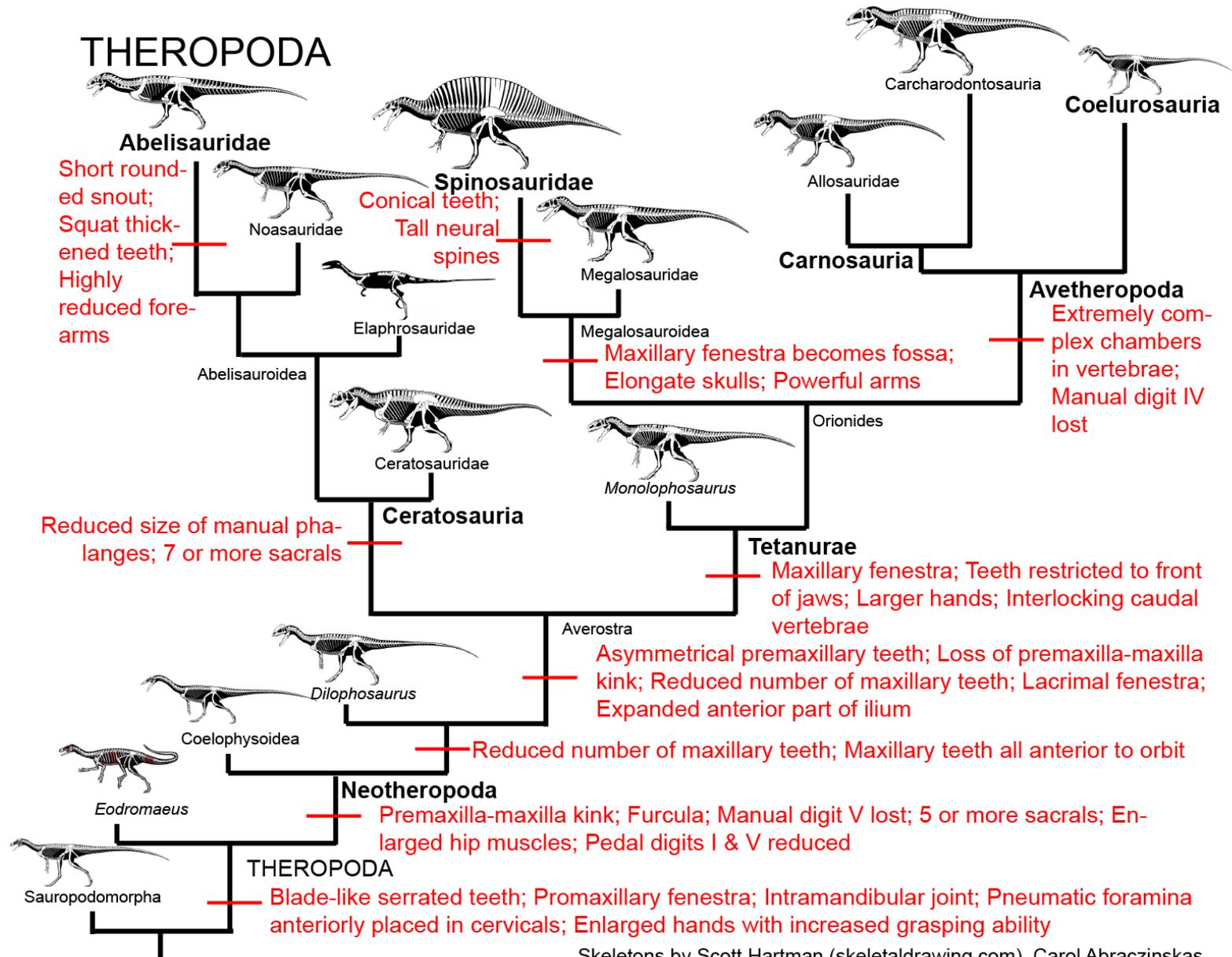
Początki megadrapieżnictwa



Megateropody – mezozoiczne „*machiny wojenne*”

Theropod dinosaurs

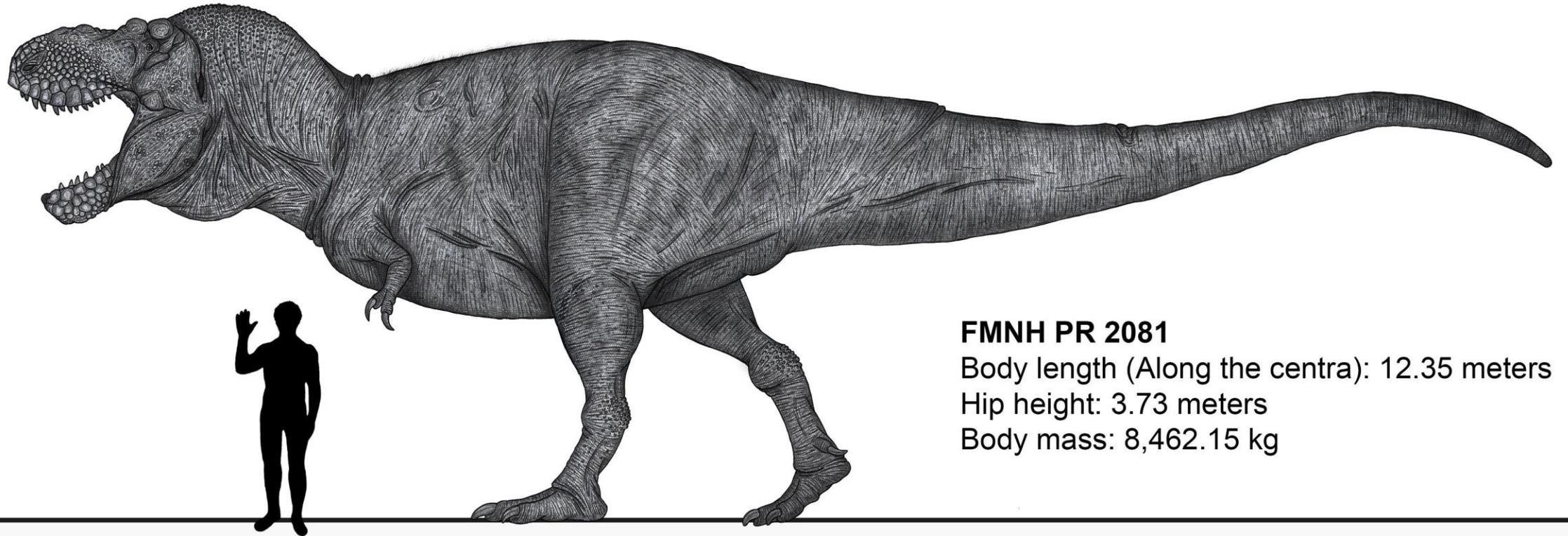




Skeletons by Scott Hartman (skeletaldrawing.com), Carol Abraczinskas

Tyrannosaurus rex

Osborn, 1905



FMNH PR 2081

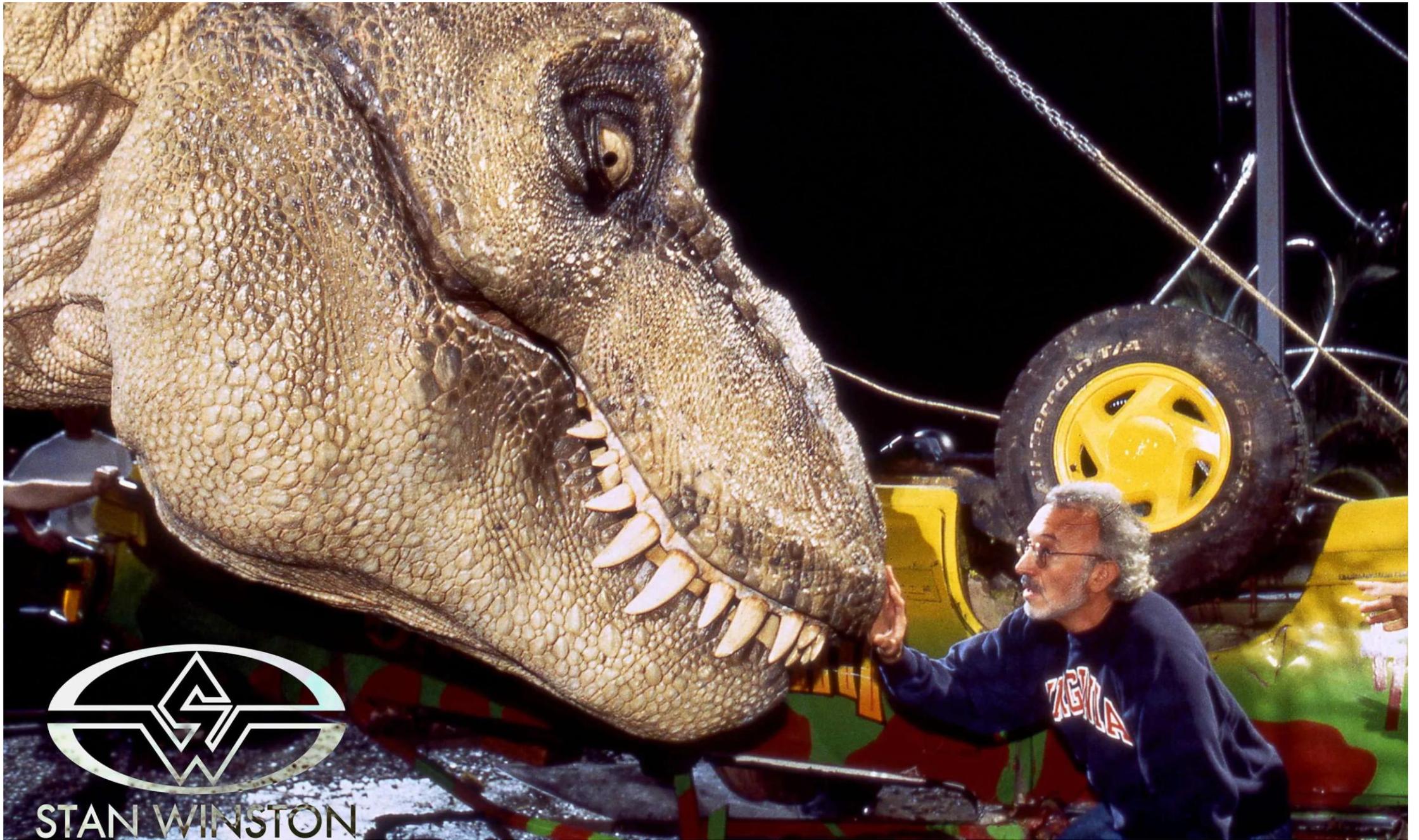
Body length (Along the centra): 12.35 meters

Hip height: 3.73 meters

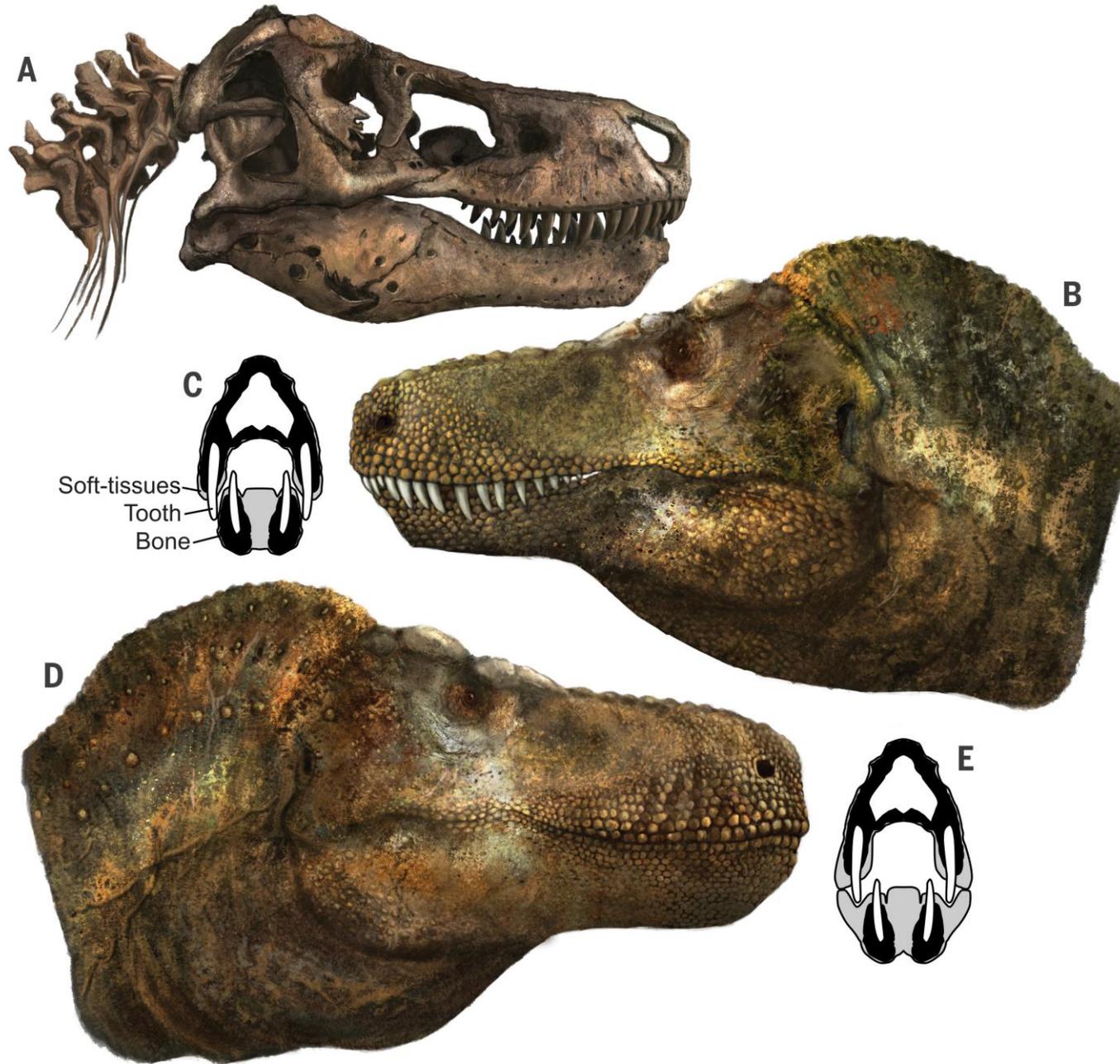
Body mass: 8,462.15 kg

12.35 meters

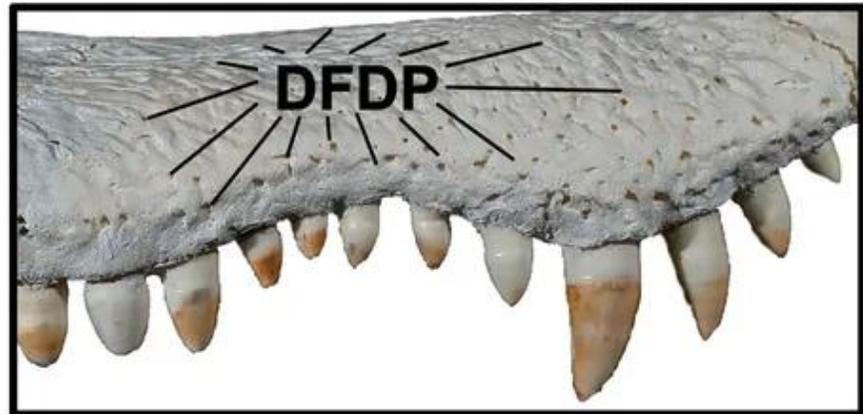
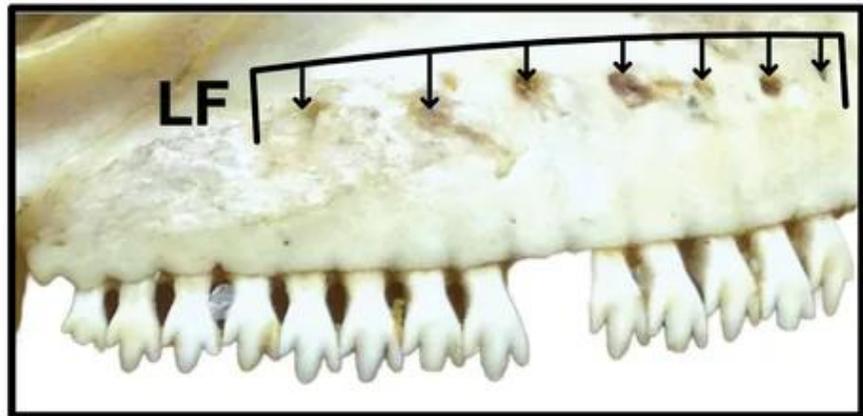
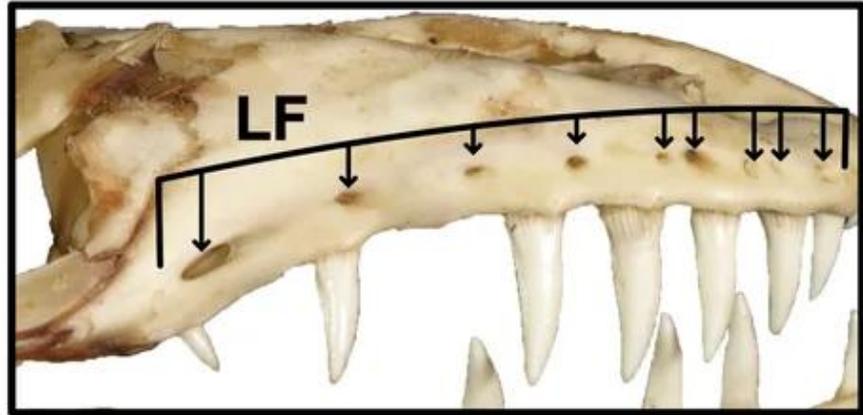
RHYS MEYERKORT

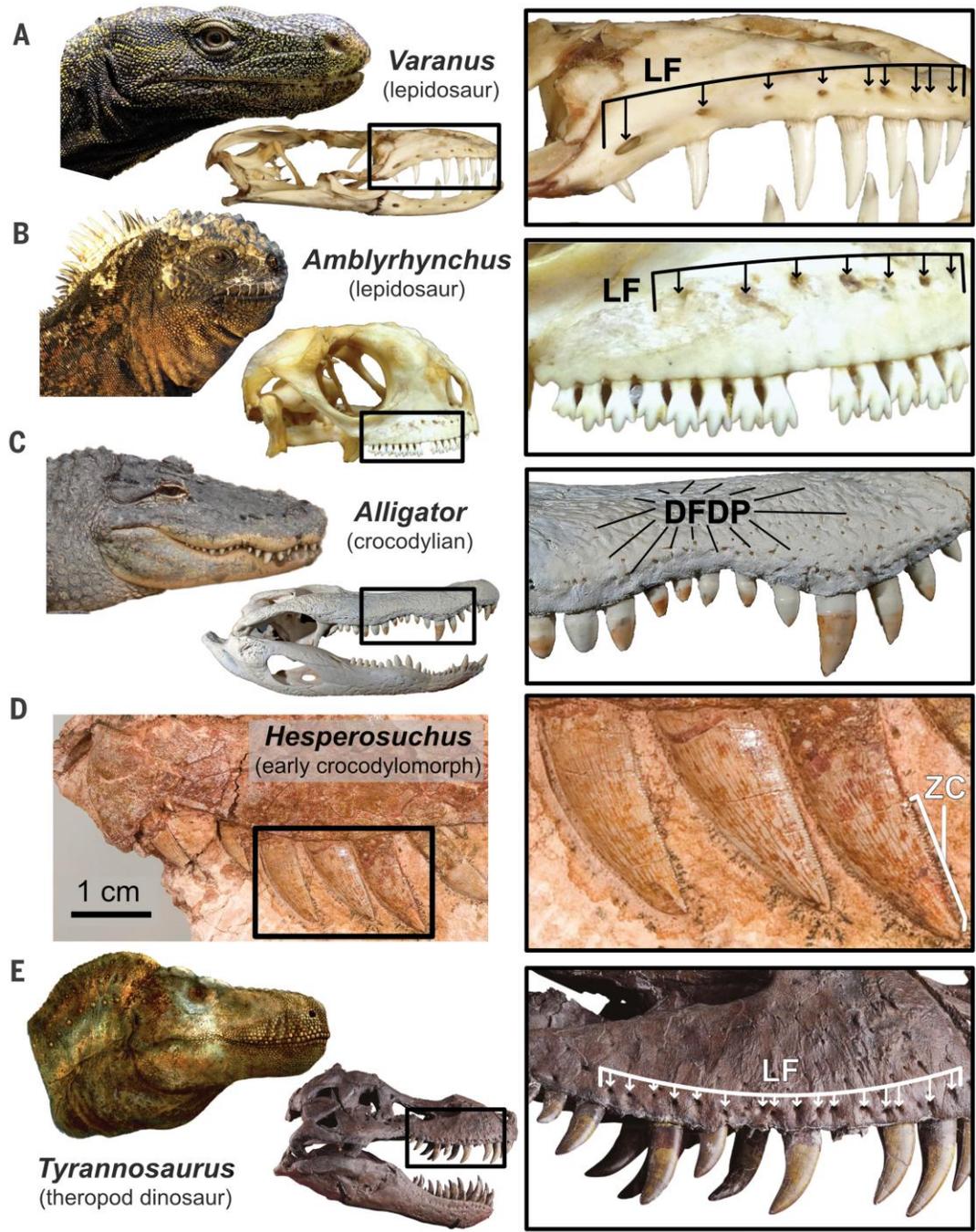


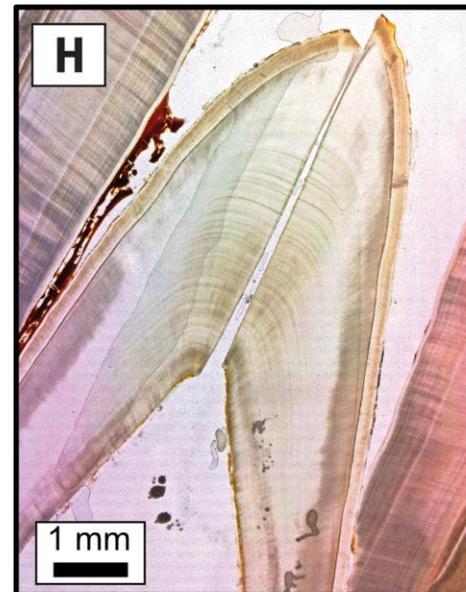
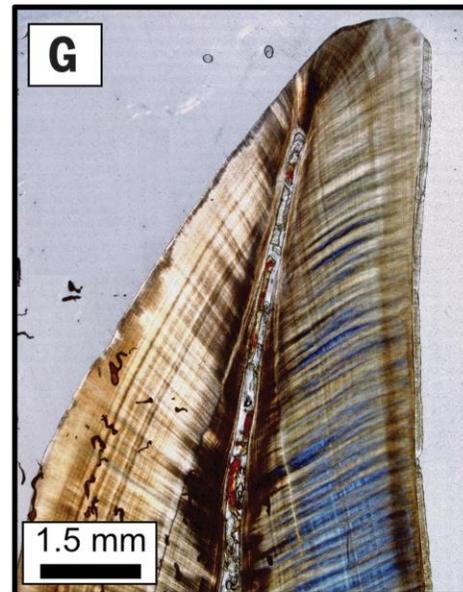
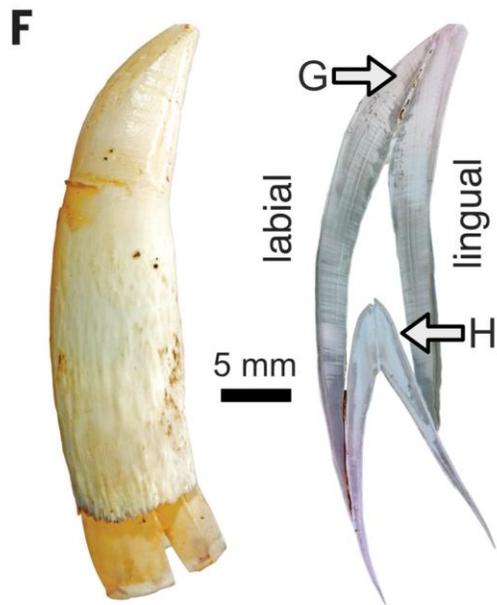
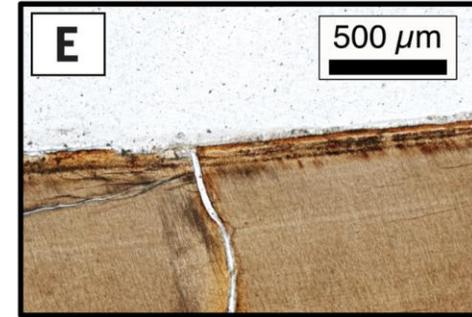
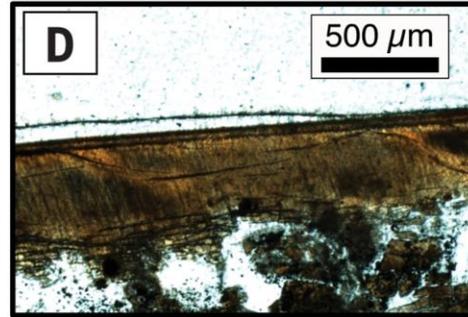
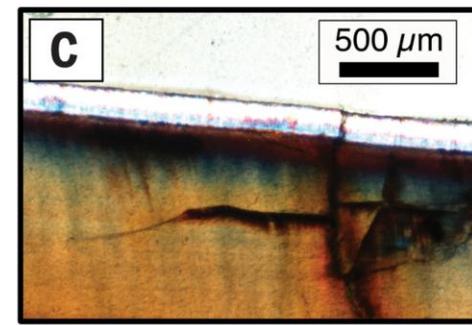
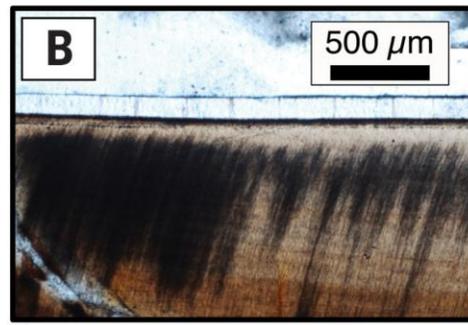
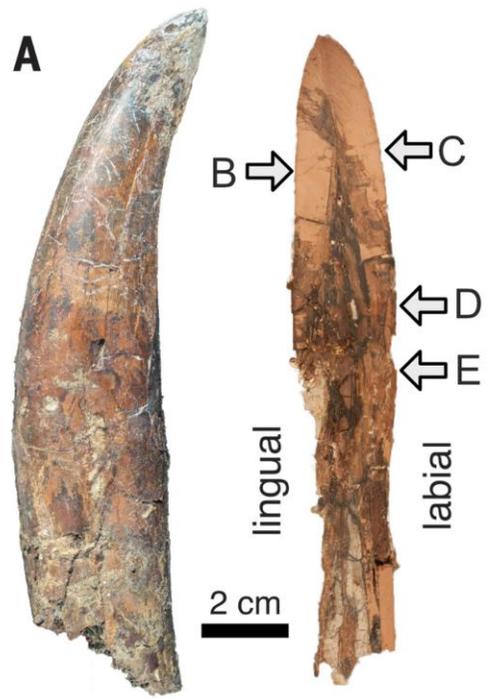
STAN WINSTON



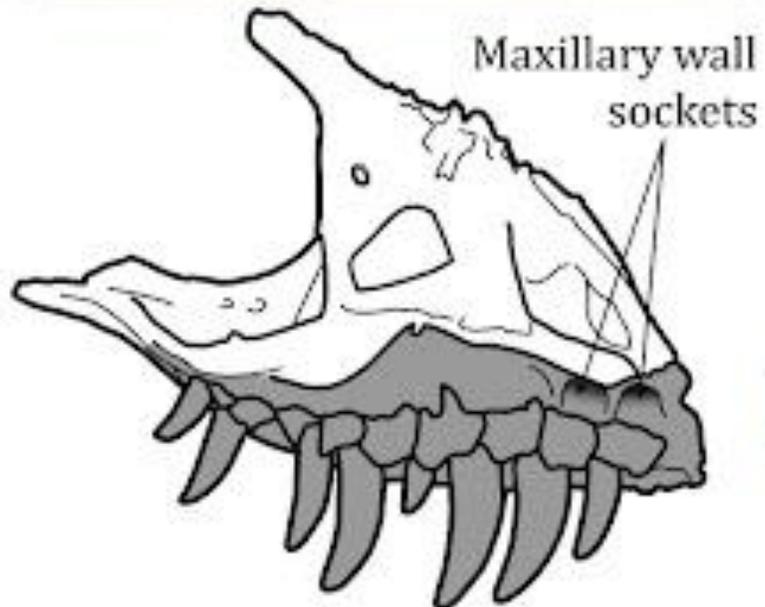
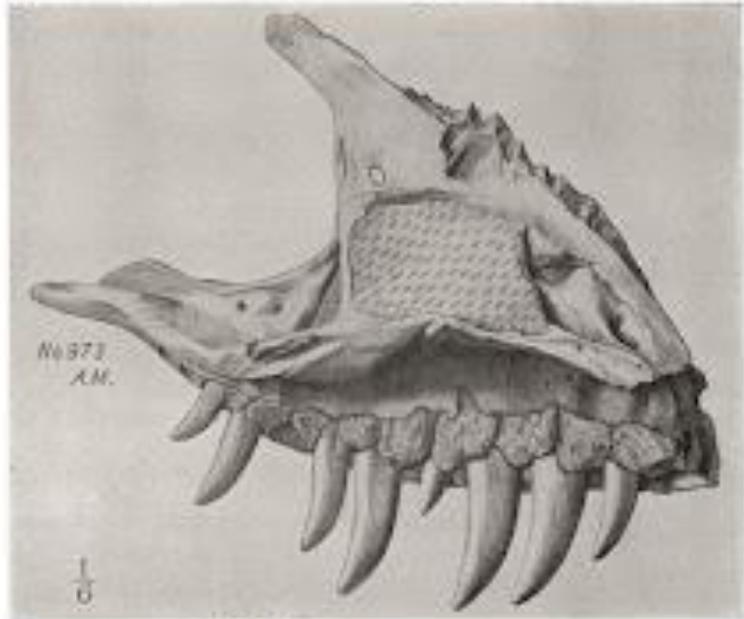




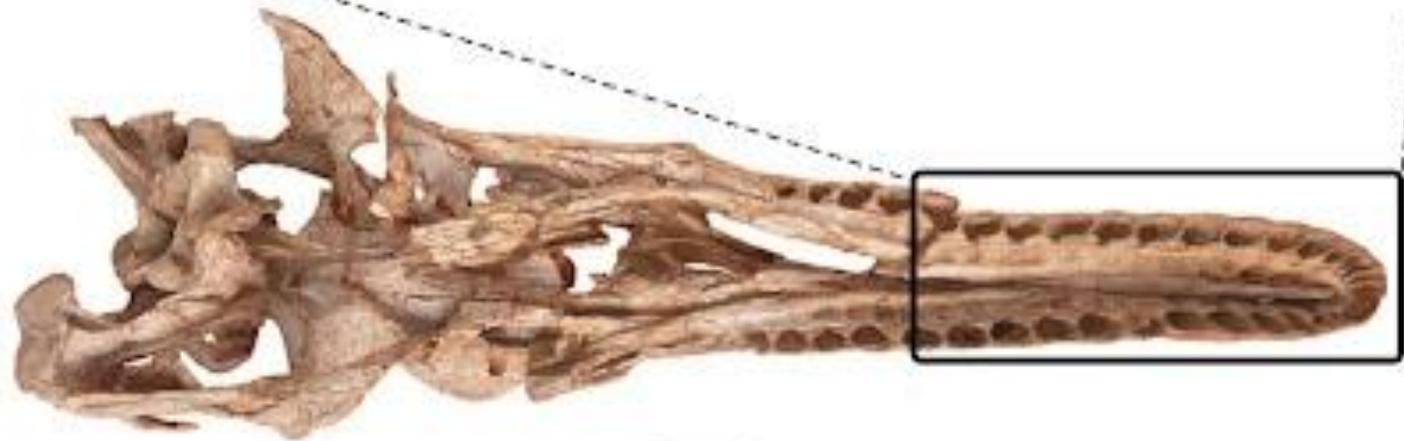




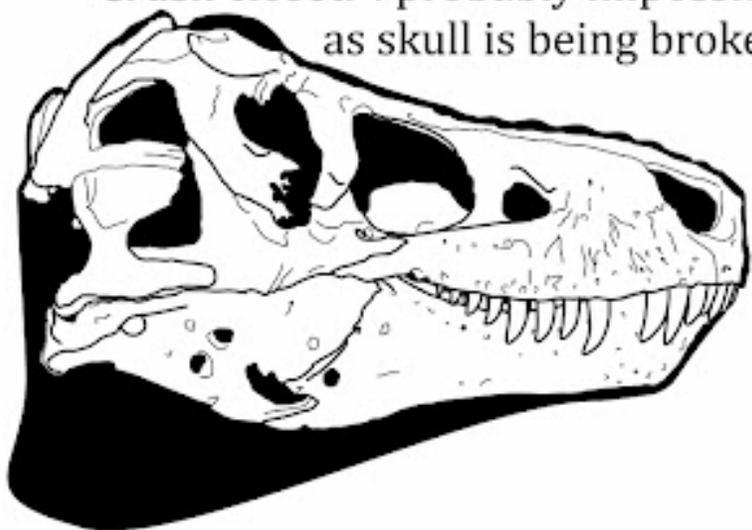
Tyrannosaurus rex
(after Osborn 1912)



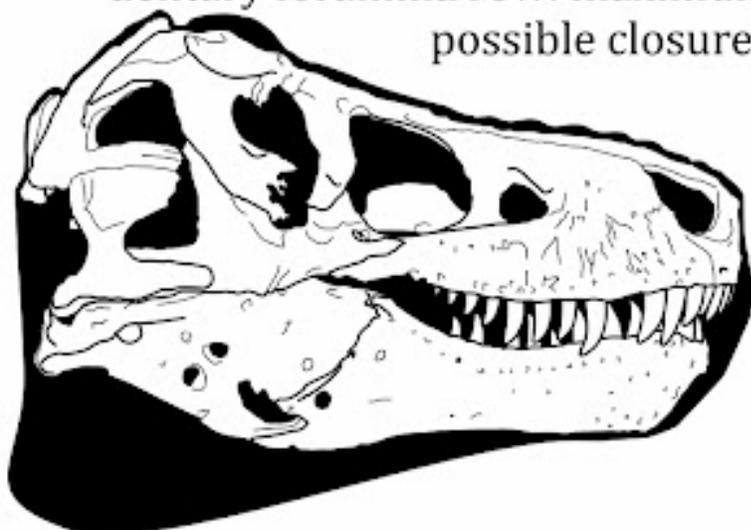
Qianzhousaurus sinensis (from Lü et al. 2014)



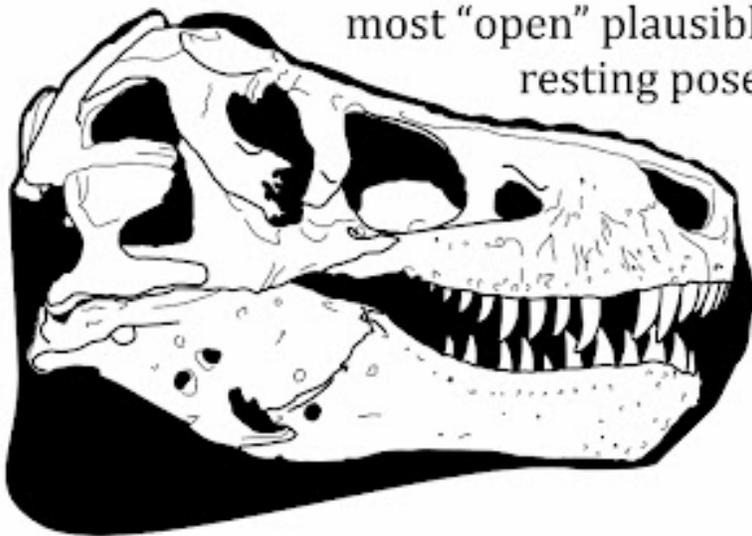
“Crush closed”: probably impossible
as skull is being broken!



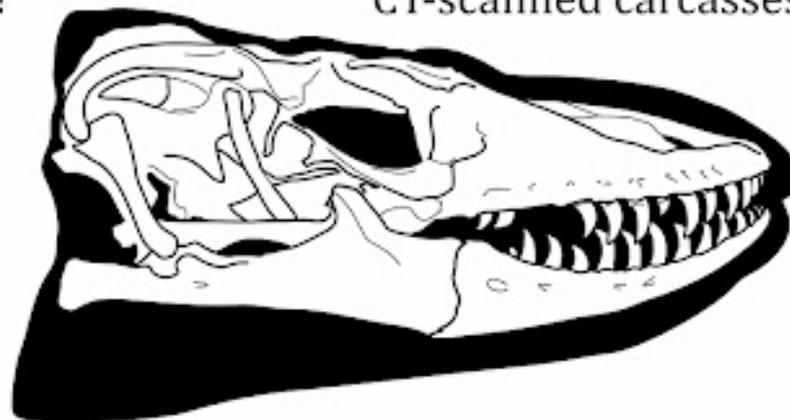
Maxillary teeth not overlapping
dentary foramina row: maximum
possible closure?

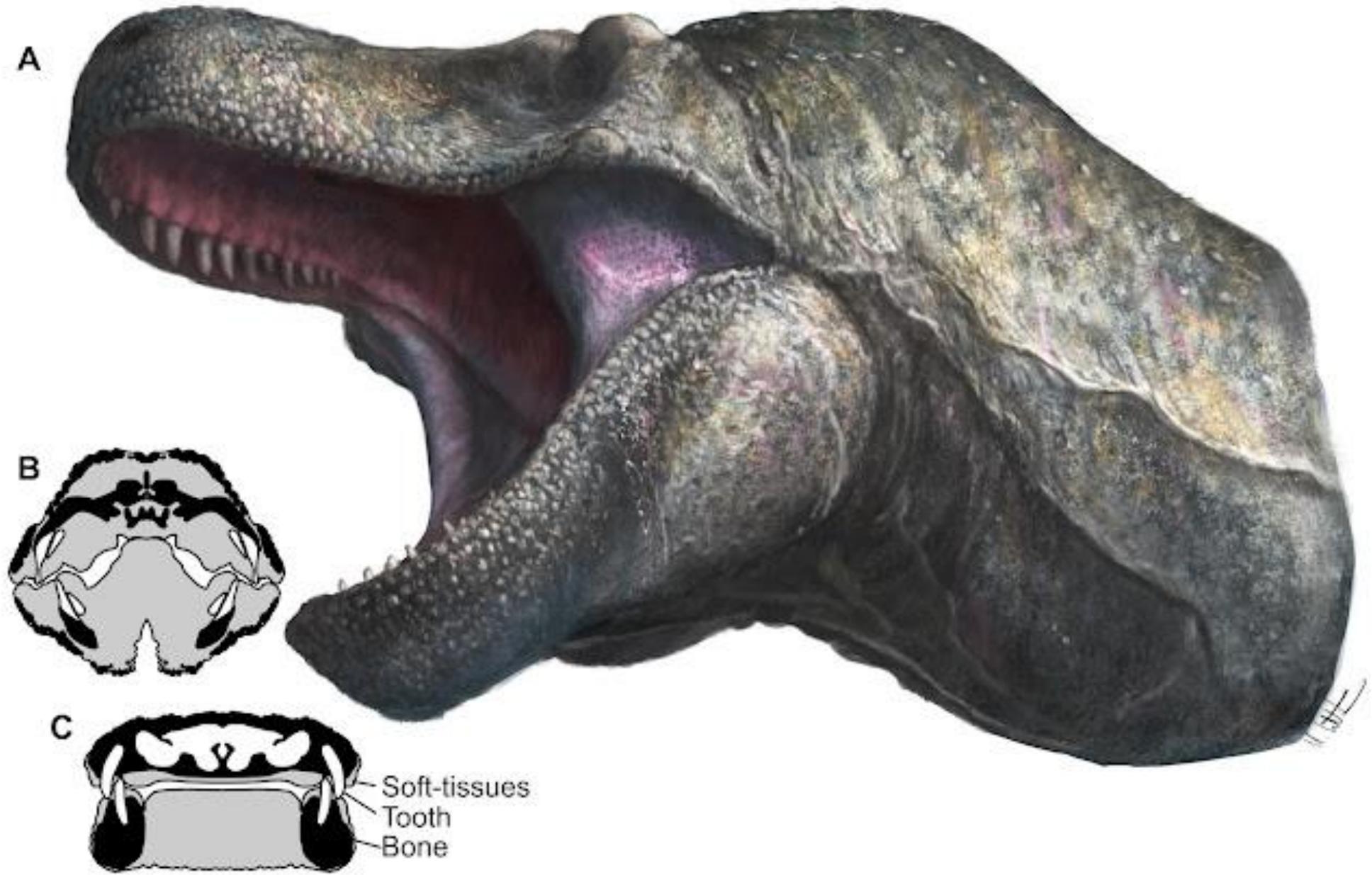


Loose, lepidosaur-like closure:
most “open” plausible
resting pose?

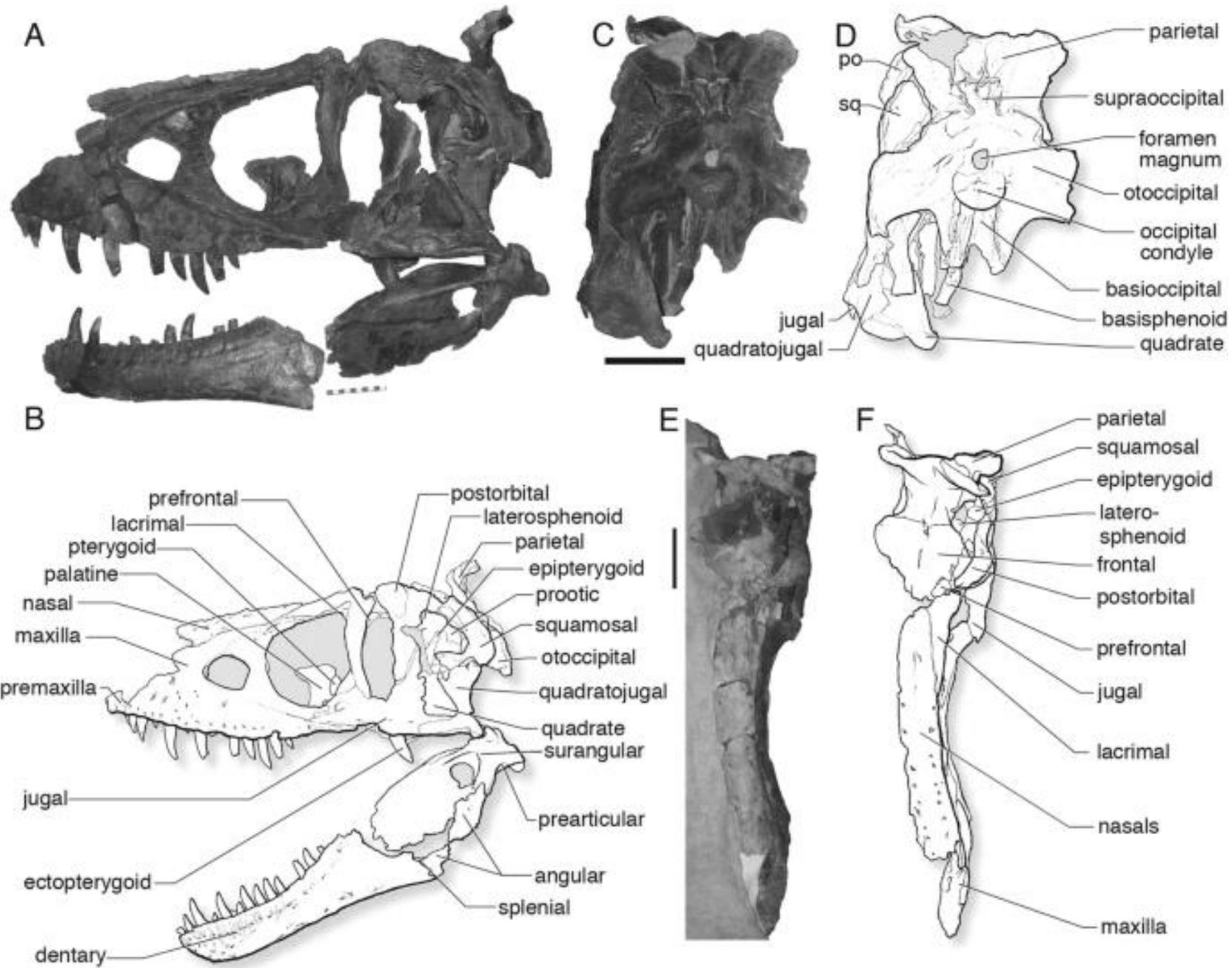


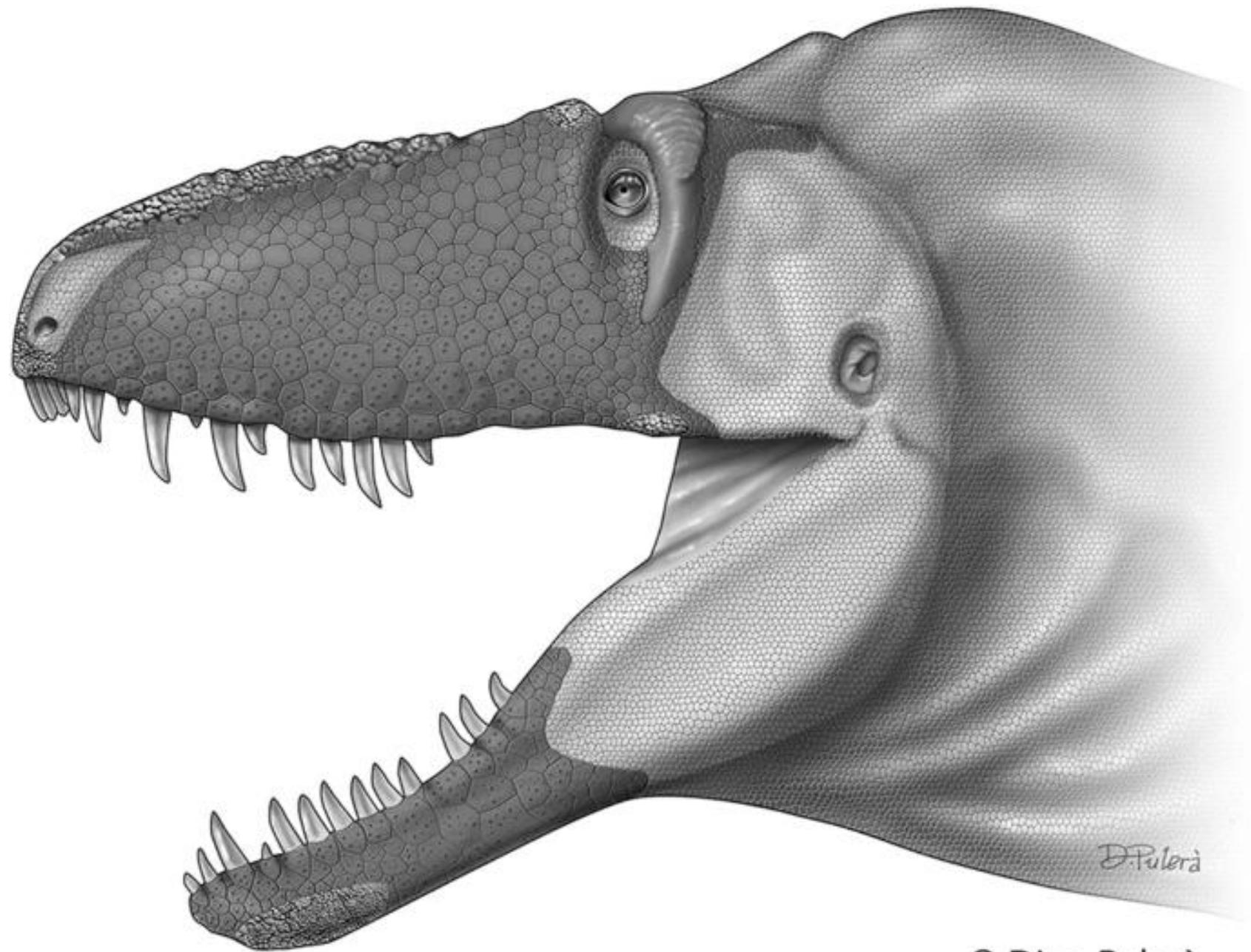
Fully closed jaws of *Varanus komodoensis*, based on
CT-scanned carcasses





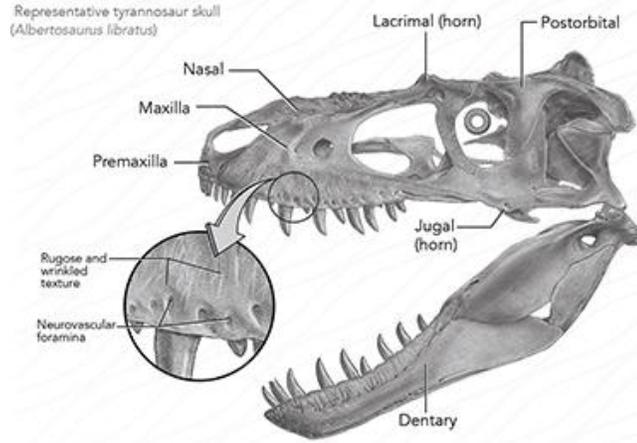
Na podstawie Cullen et al., 2023.





Carr et al., 2017

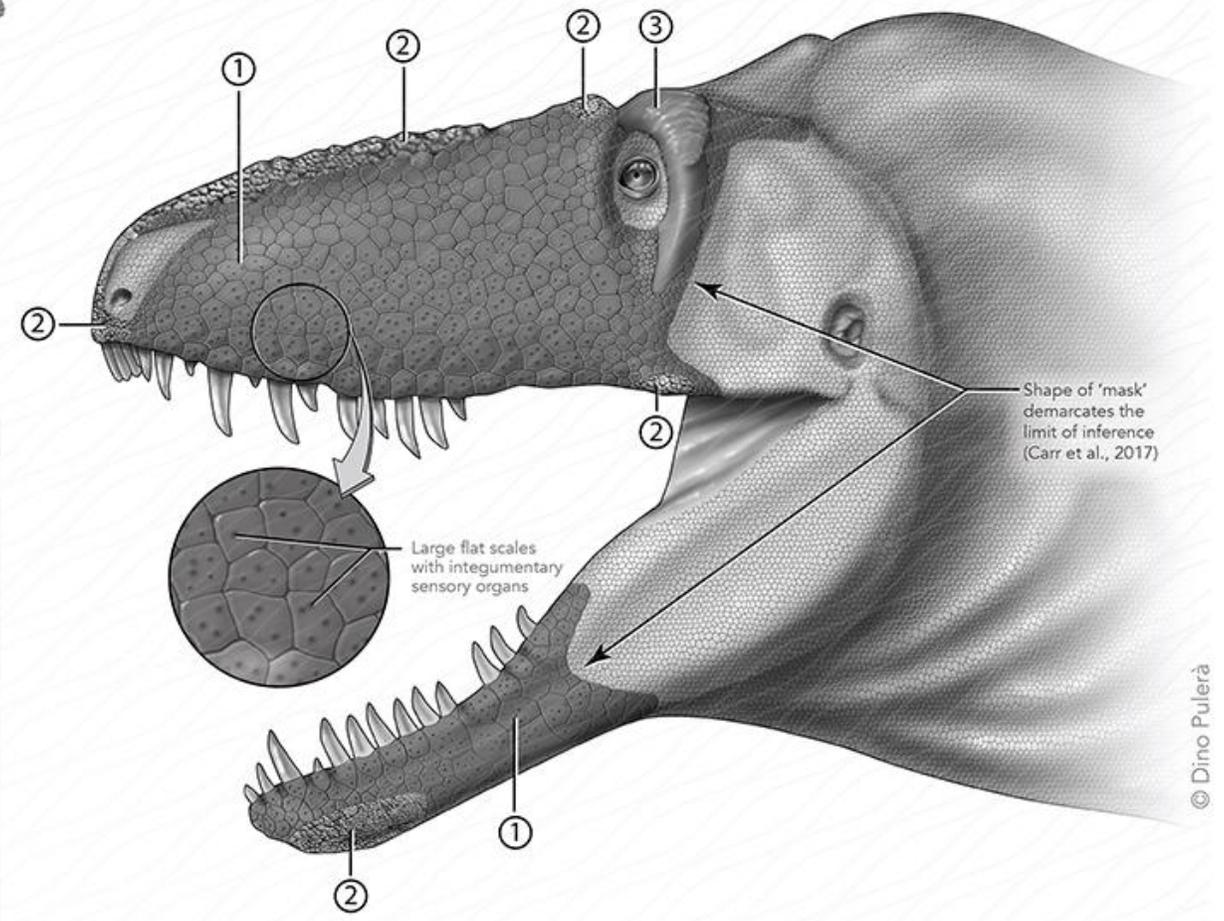
© Dino Pulerà



The osteological texture of tyrannosaur facial bones compares best with the rough and wrinkled texture that is consistent with overlying scales as is seen in living crocodylians. Crocodylian and tyrannosaur snouts and jaws are penetrated by numerous neurovascular foramina allowing hundreds of branches of nerve endings to innervate the skin. Some tufts of these nerve endings are capped under a tiny dome (integumentary sensory organs) which increases the sensitivity of the skin in modern crocodylians and probably tyrannosaurs too.

Distribution of facial integument	
Facial bones	Integument
Maxilla and dentary with numerous neurovascular foramina	➔ ① Large flat scales Scales closely associated with bone leave a rugose and sculptured surface texture. Therefore the presence of bumpy and coarse bone textures is a strong correlate for a lip-less 'mask' of large flat scales.
Premaxilla, nasal, lacrimal (horn), jugal (horn) and dentary (chin)	➔ ② Armor-like skin Extremely coarse bone, e.g. nasal bone, supported armor-like skin on the snout and on the sides of the lower jaws. The armor-like skin would have protected tyrannosaurs from abrasions, perhaps sustained when hunting and feeding
Postorbital	➔ ③ Keratin sheath Coarse and rim-like edges with smooth central region, indicate a cornified sheath-like covering of keratin

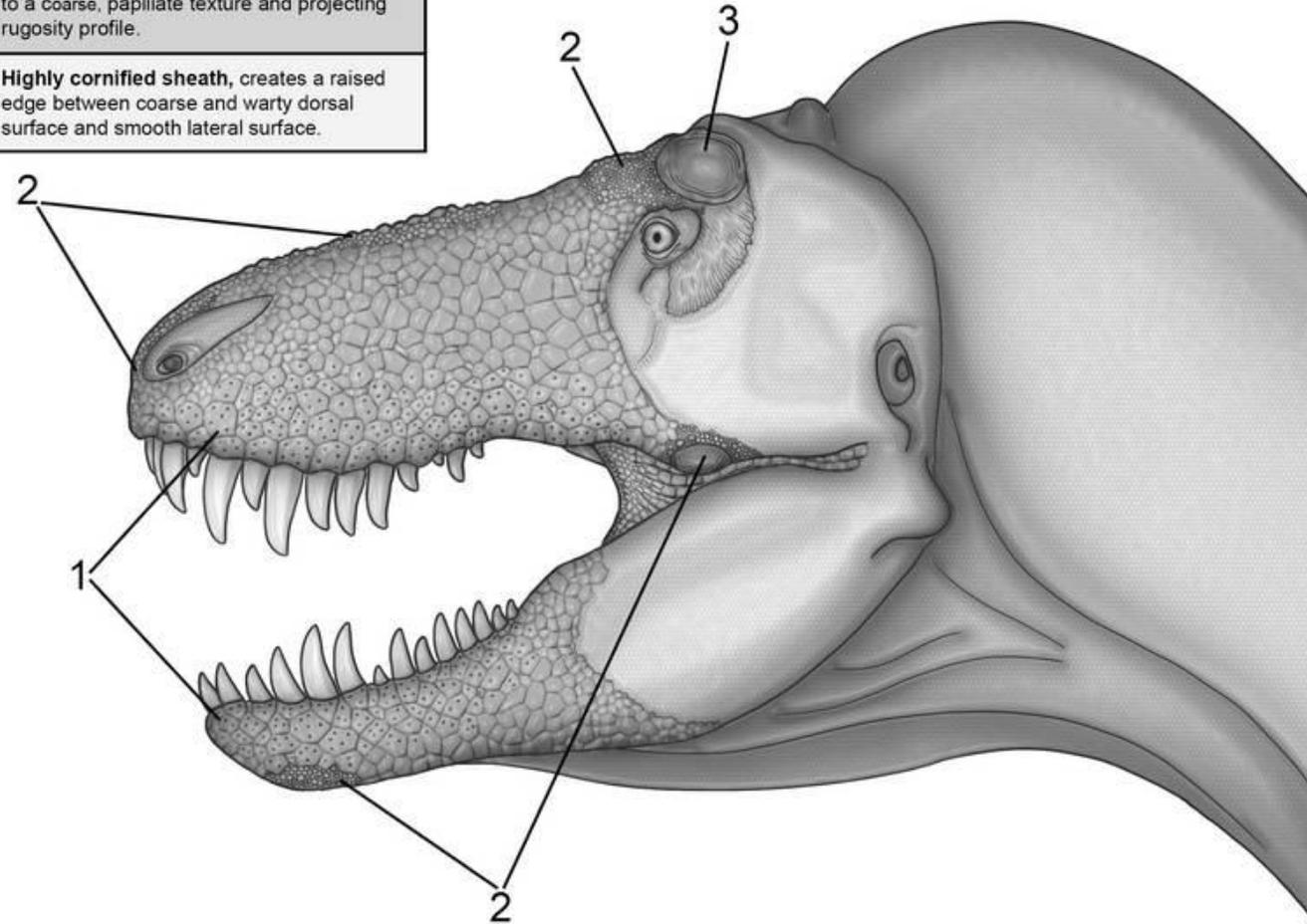
Life reconstruction of the integument of *Daspletosaurus horneri*, based on the distribution of texture on the facial bones



Source: Carr, T. D., D. J. Varricchio, J. C. Sedimayr, E. M. Roberts & J. R. Moore. 2017. A new tyrannosaur with evidence for anagenesis and crocodile-like facial sensory system. *Scientific Reports* 7, Article number: 44942. doi:10.1038/srep44942

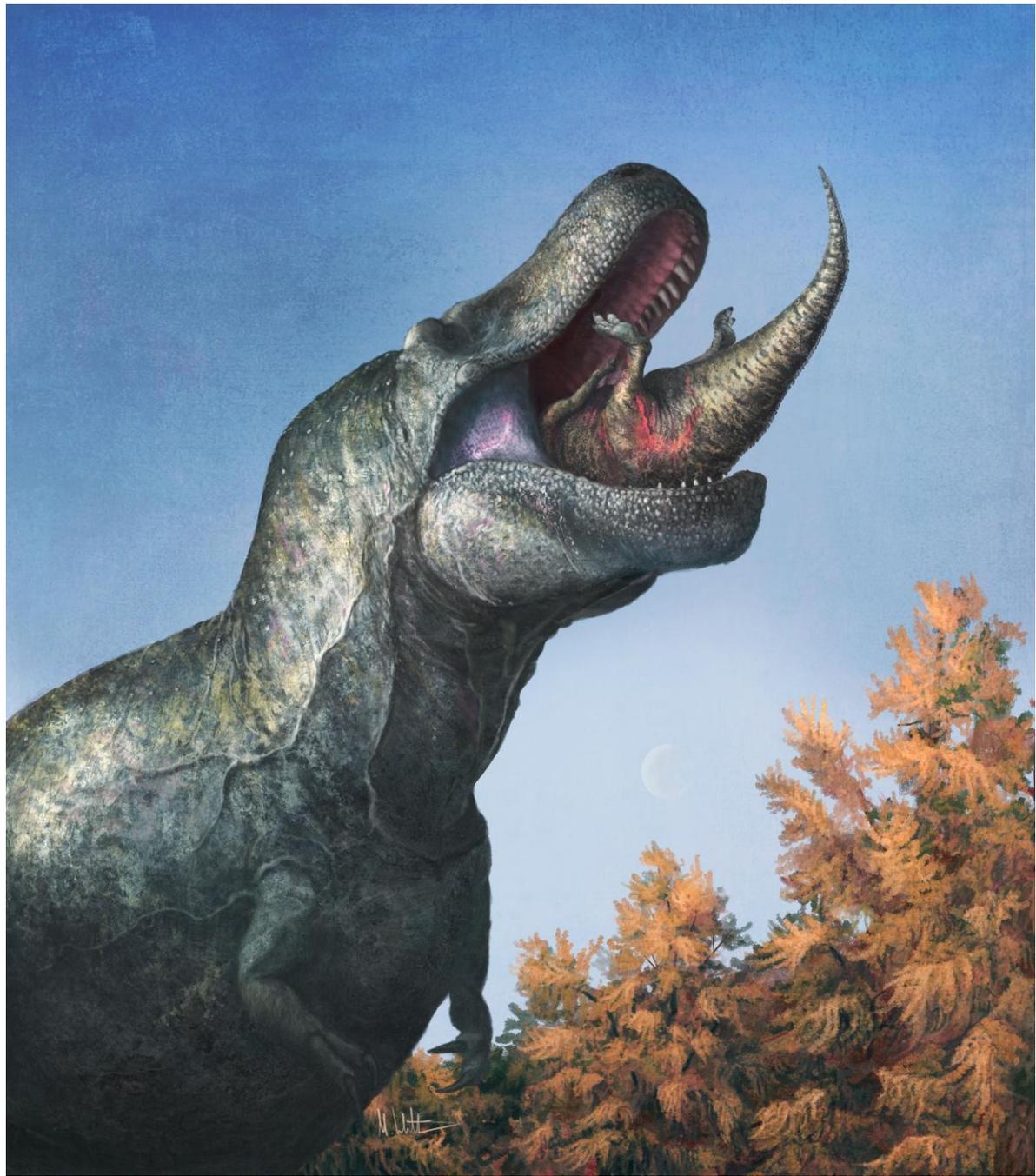
© Dino Pulerà

Facial bones	Integument
Maxilla, dentary	Keratinised sheath that cracks with growth, creating the illusion of "flat scales." This integument heavily sculpts the underlying bone texture, leaving a shallow, hummocky rugosity profile.
Premaxilla, nasal, lacrimal (horn), jugal (horn), dentary (chin)	Cornified armour-like dermis. Correlates to a coarse, papillate texture and projecting rugosity profile.
Postorbital boss	Highly cornified sheath, creates a raised edge between coarse and warty dorsal surface and smooth lateral surface.



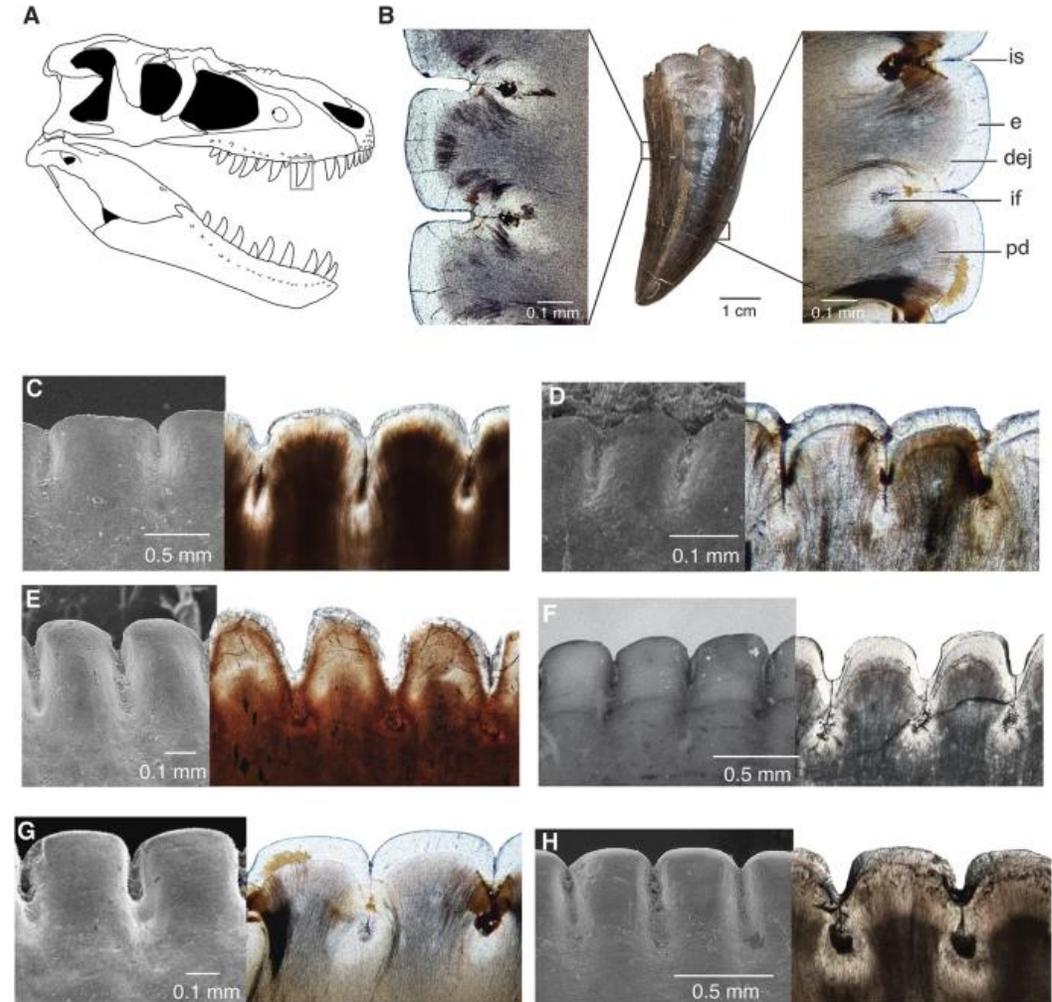
Life restoration of *Tyrannosaurus rex* with facial integument inferred from the distribution of surface textures on the facial bones according to Carr et al. (2017).

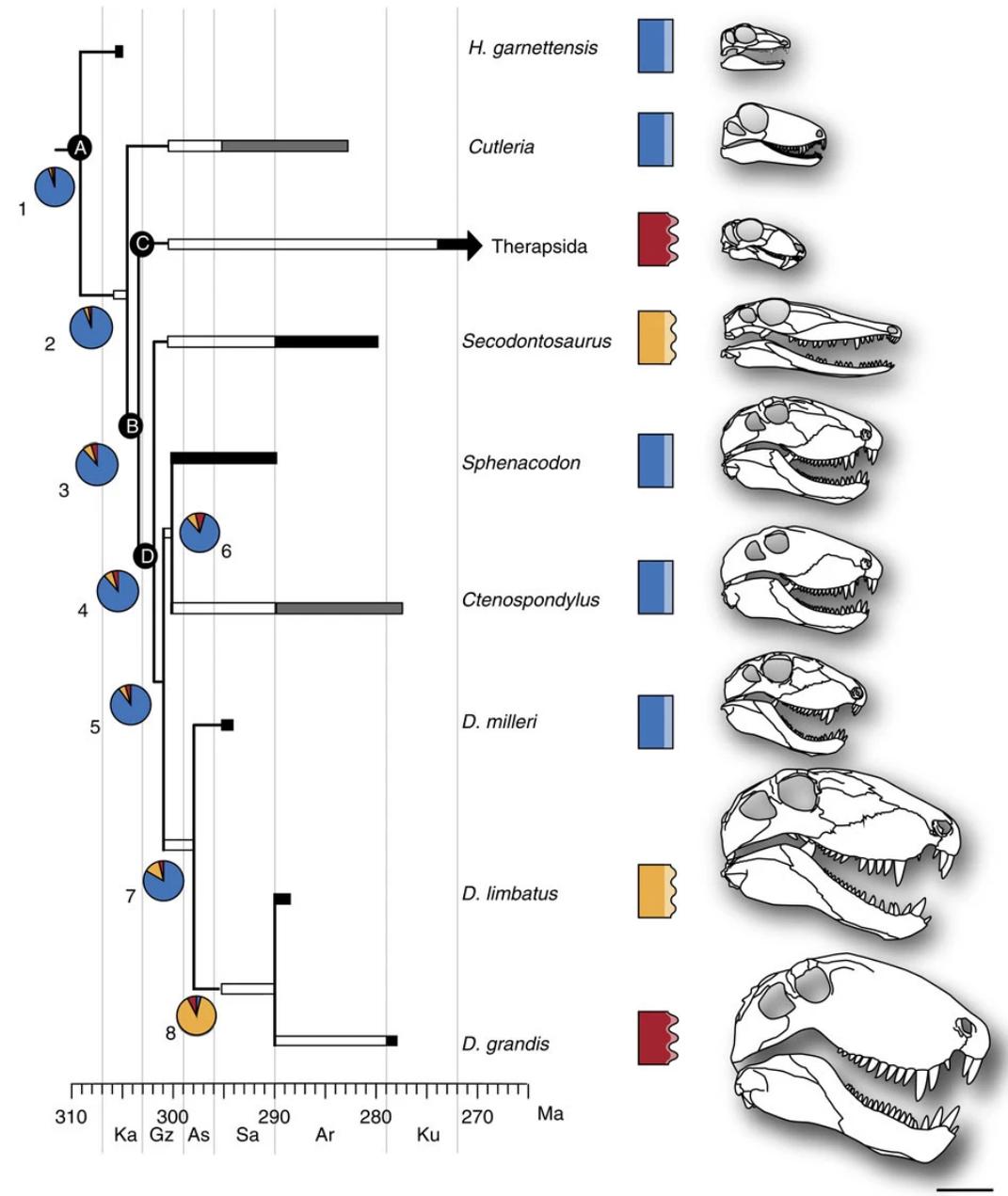
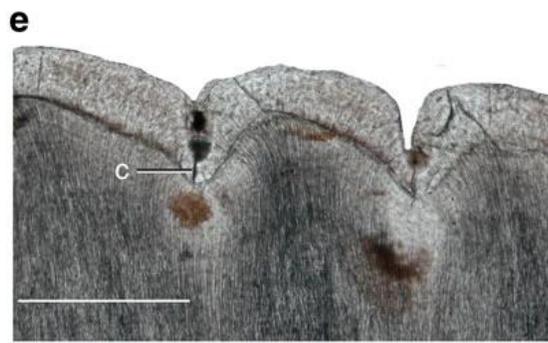
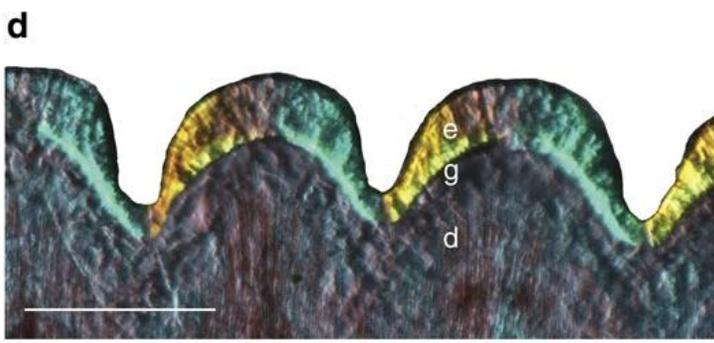
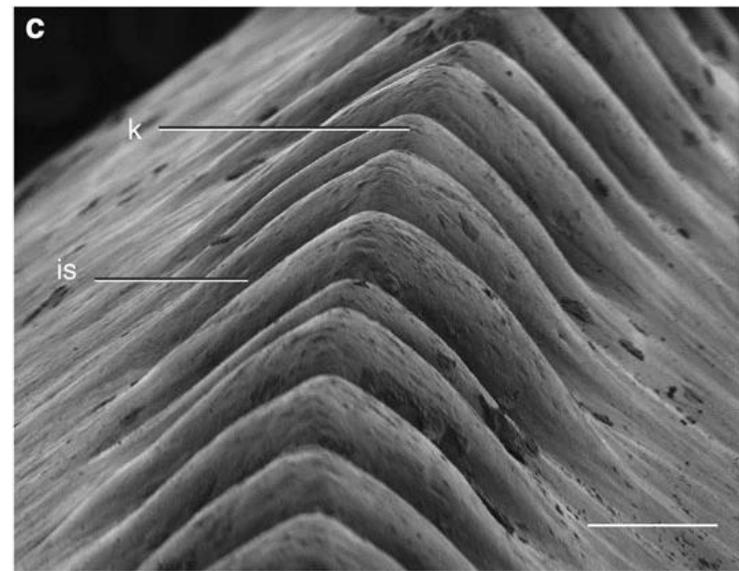
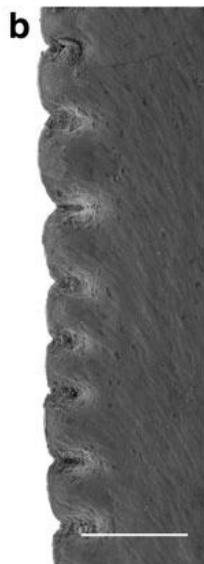


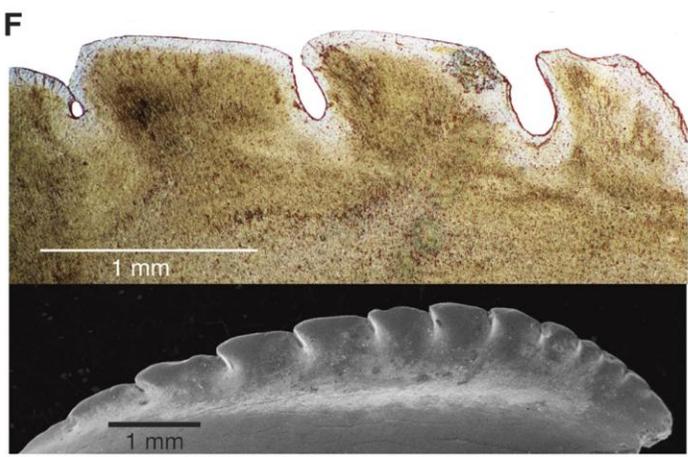
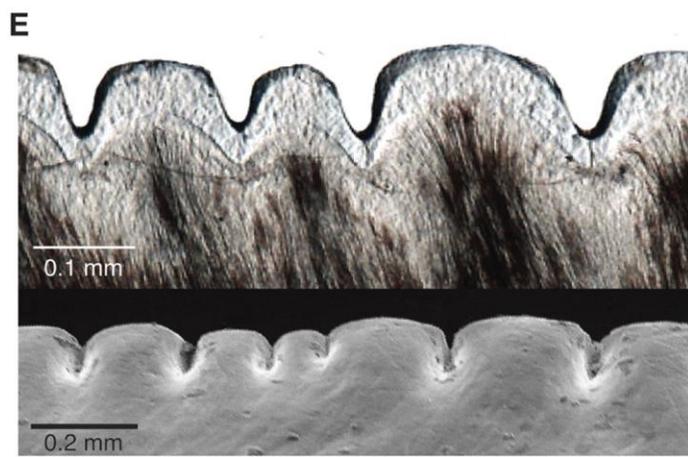
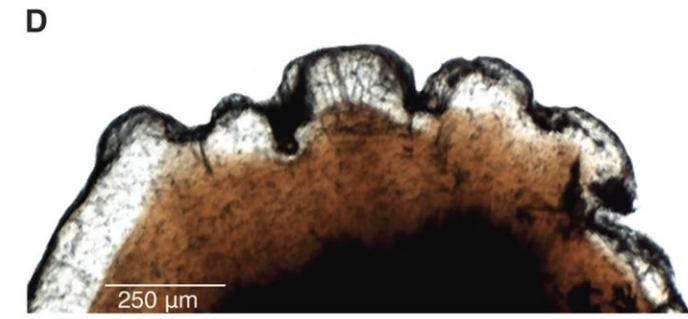
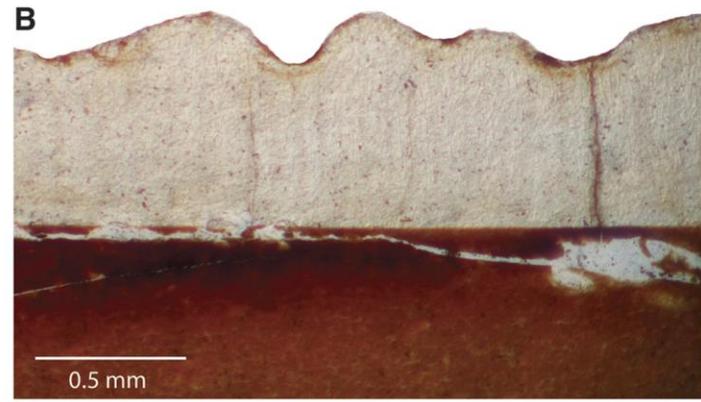


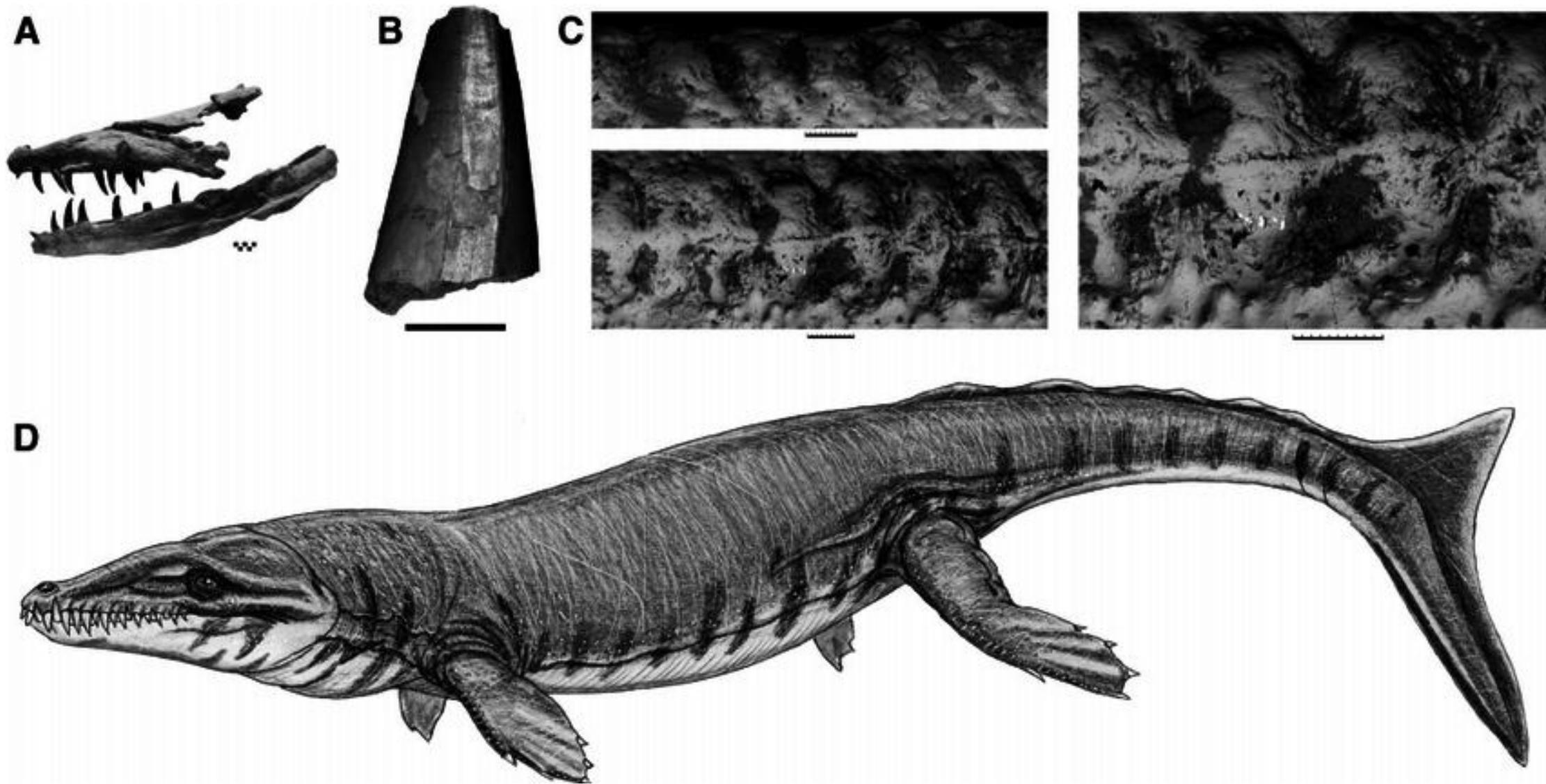
Zyfodontyzm – kluczowa adaptacja dla megadrapieżników

- Zęby spłaszczone dwubocznie o ząbkowanych krawędziach.
- Funkcjonalne przystosowanie do rozrywania powłok ciała dużych ofiar.
- Pojawienie się fałdów międzyzębinowych nadało dodatkową odporność biomechaniczną → zdolność do miążdżenia kości (osteofagia).



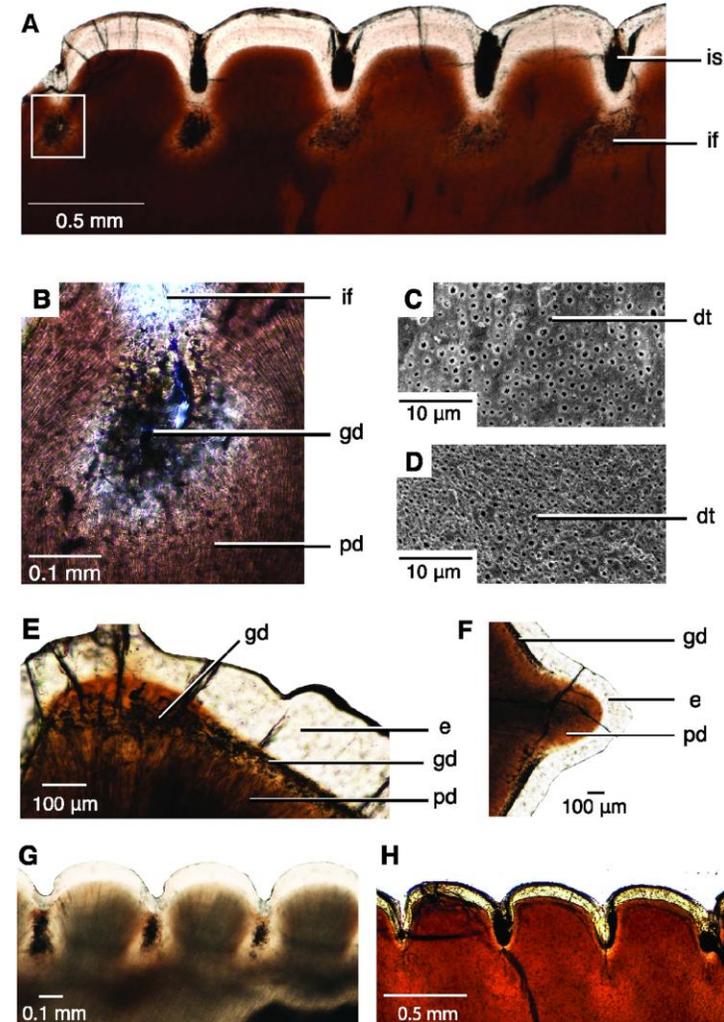
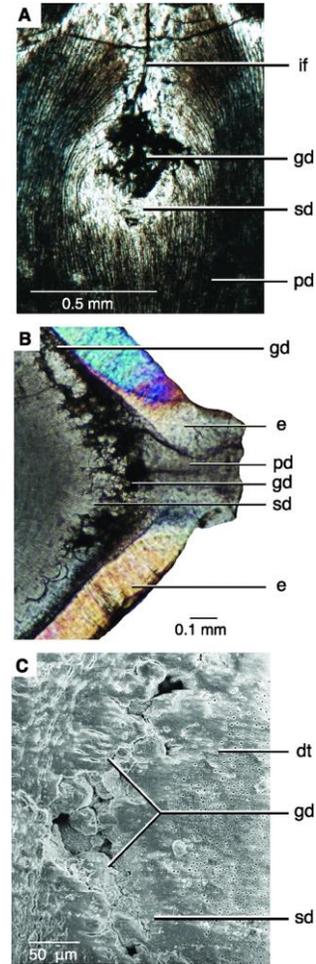
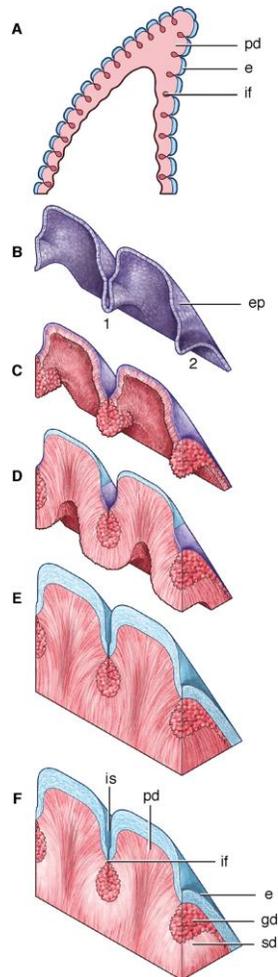


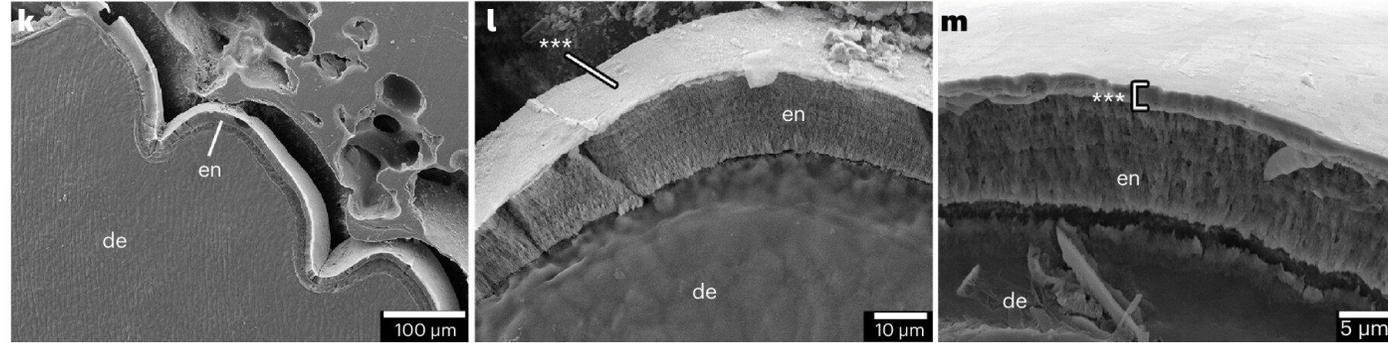
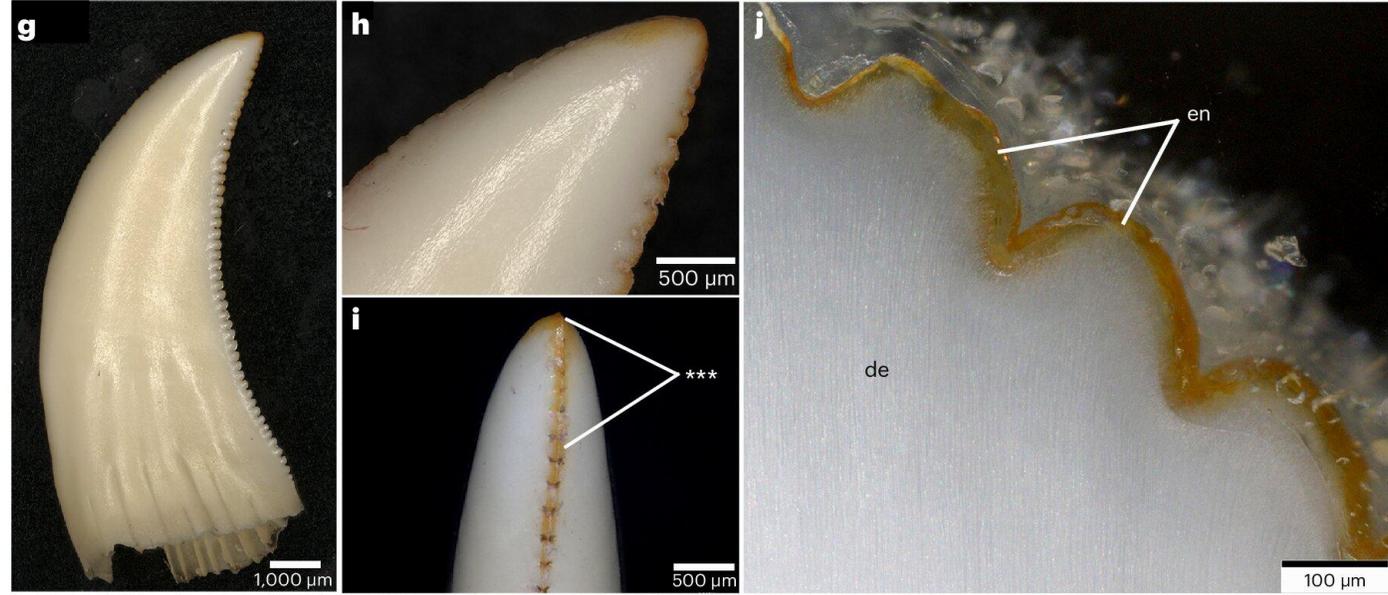
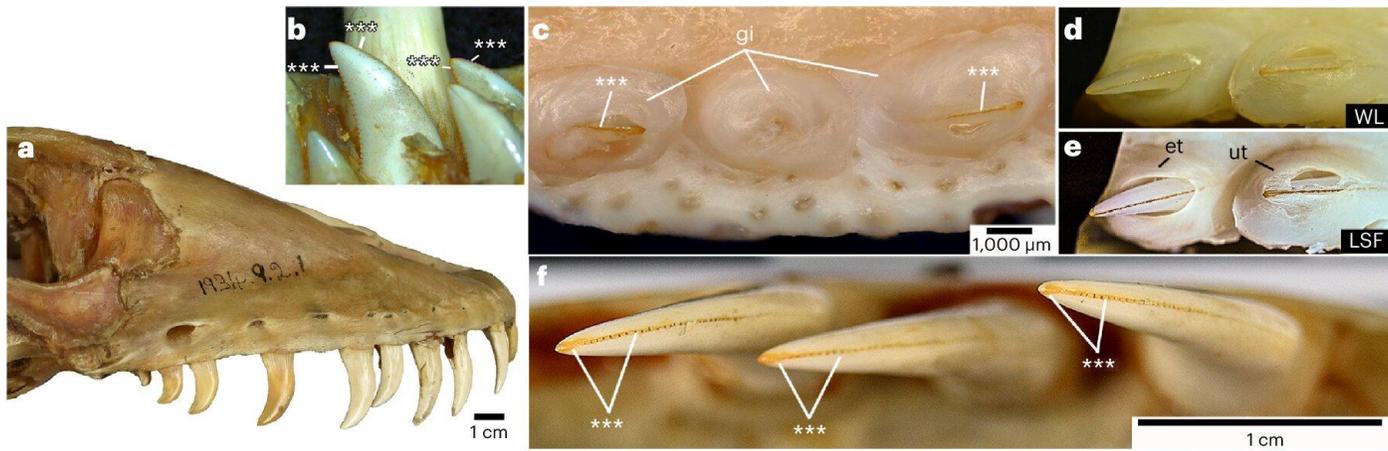




Brandalise de Andrade et al., 2010

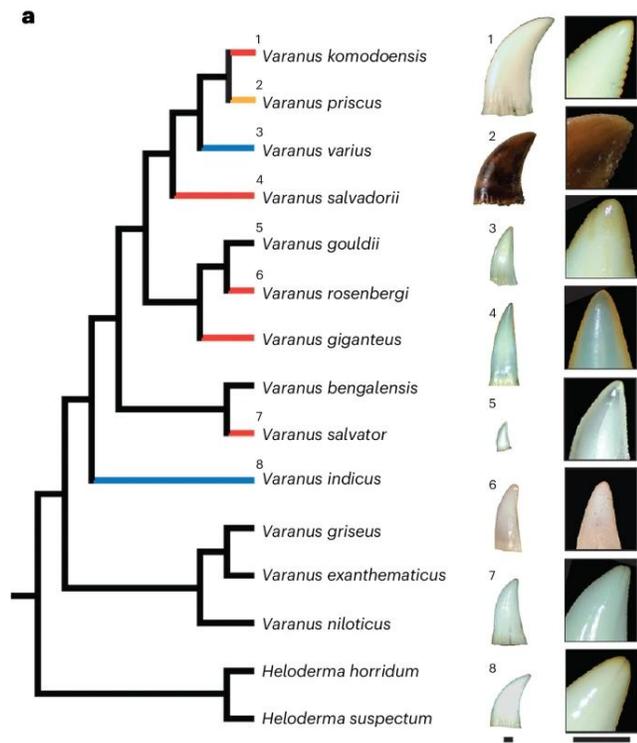
Biomineralizacja fałdów międzyzębinowych



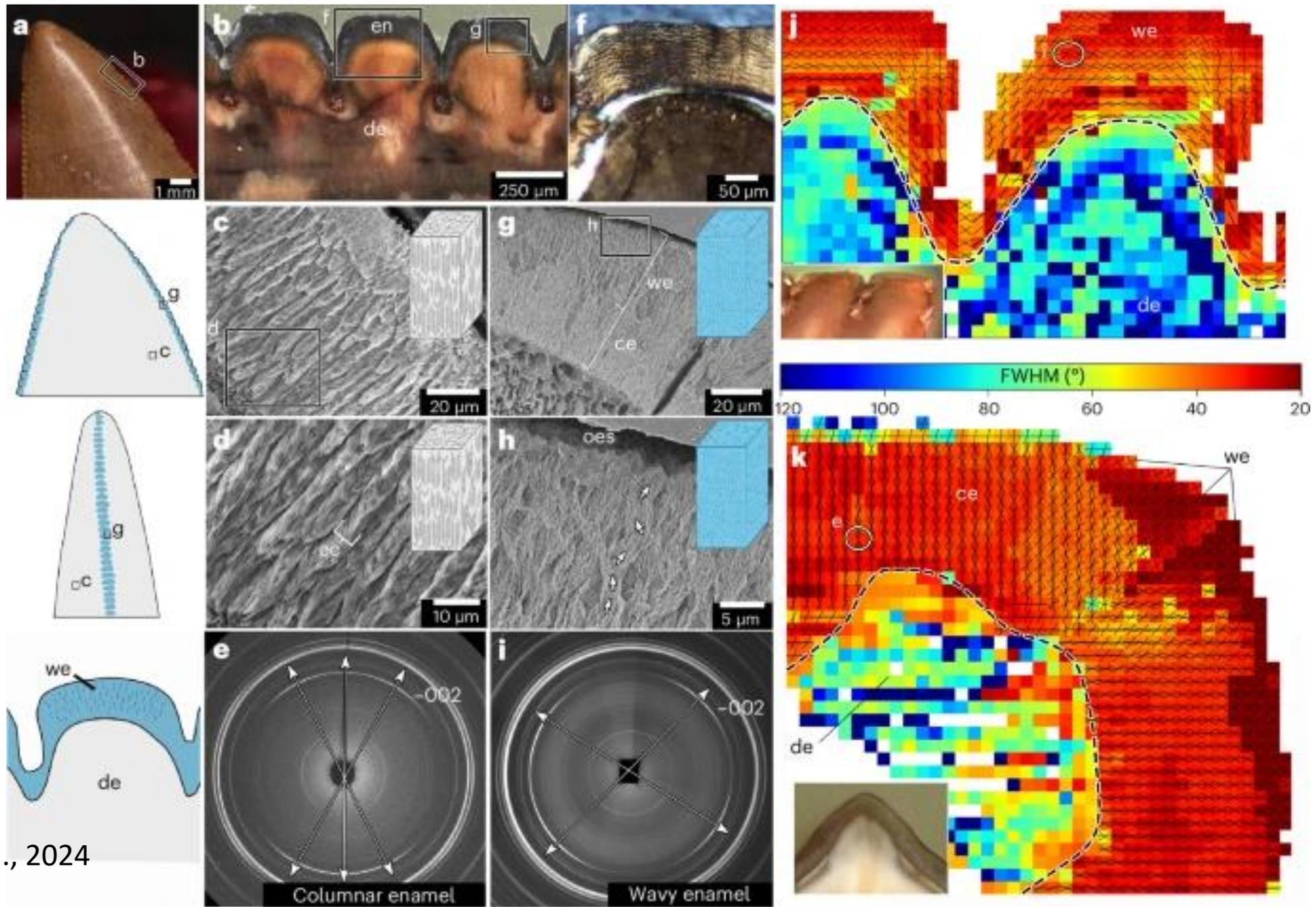


Pokrycie żelazem zwiększa odporność mechaniczną

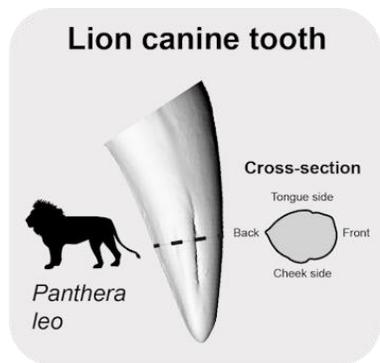




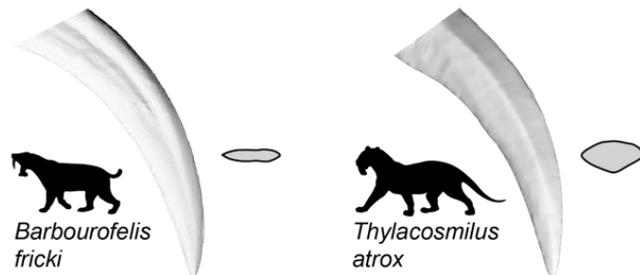
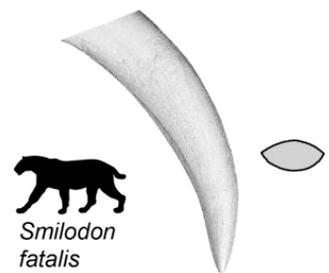
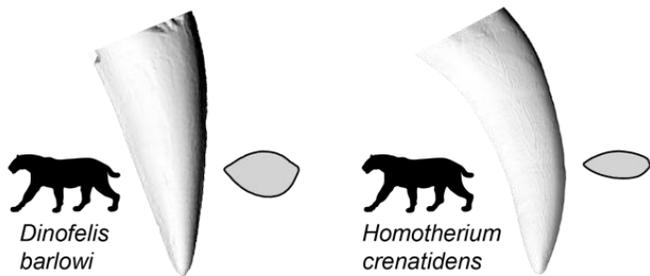
LeBlanc et al., 2024



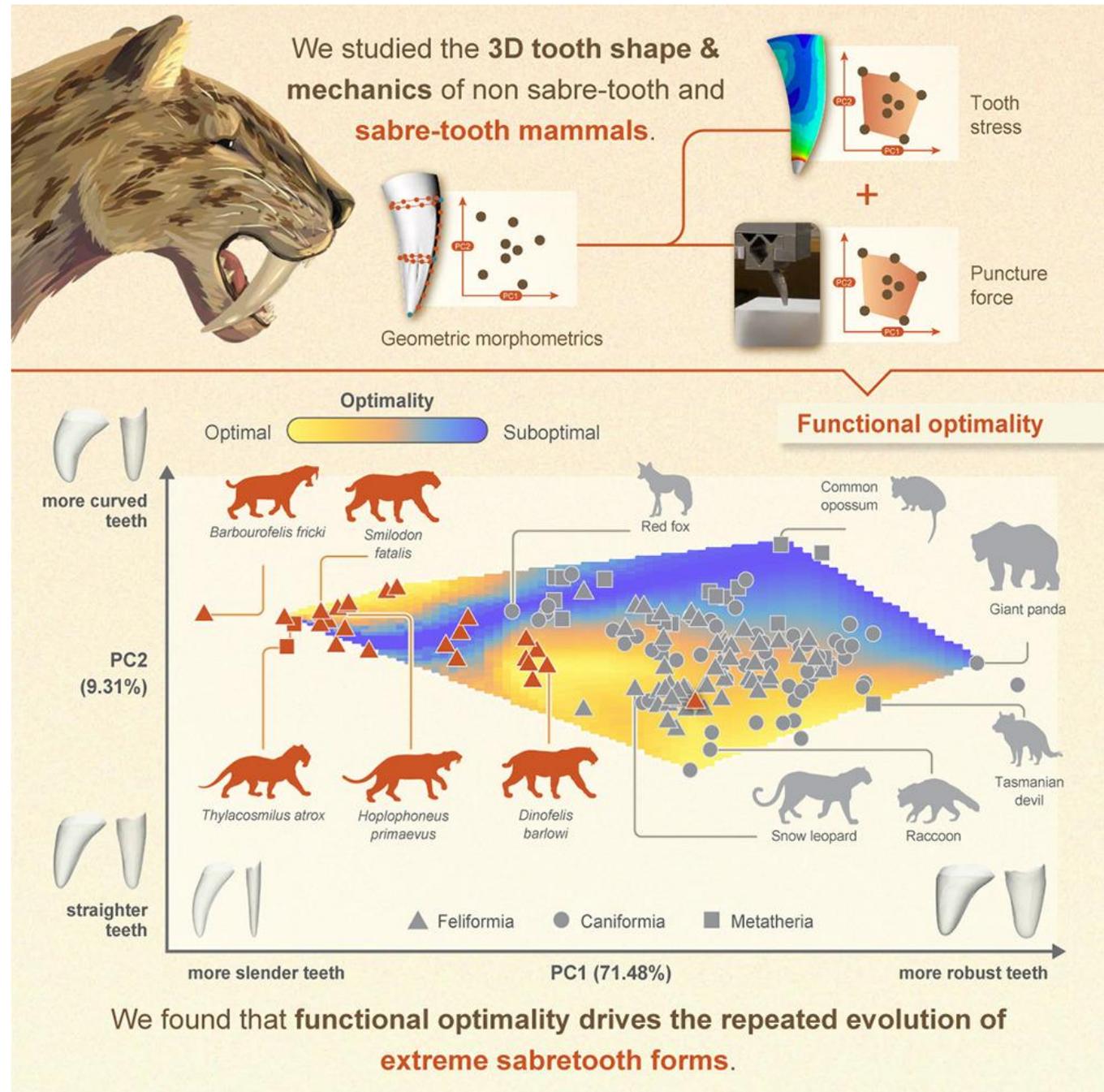


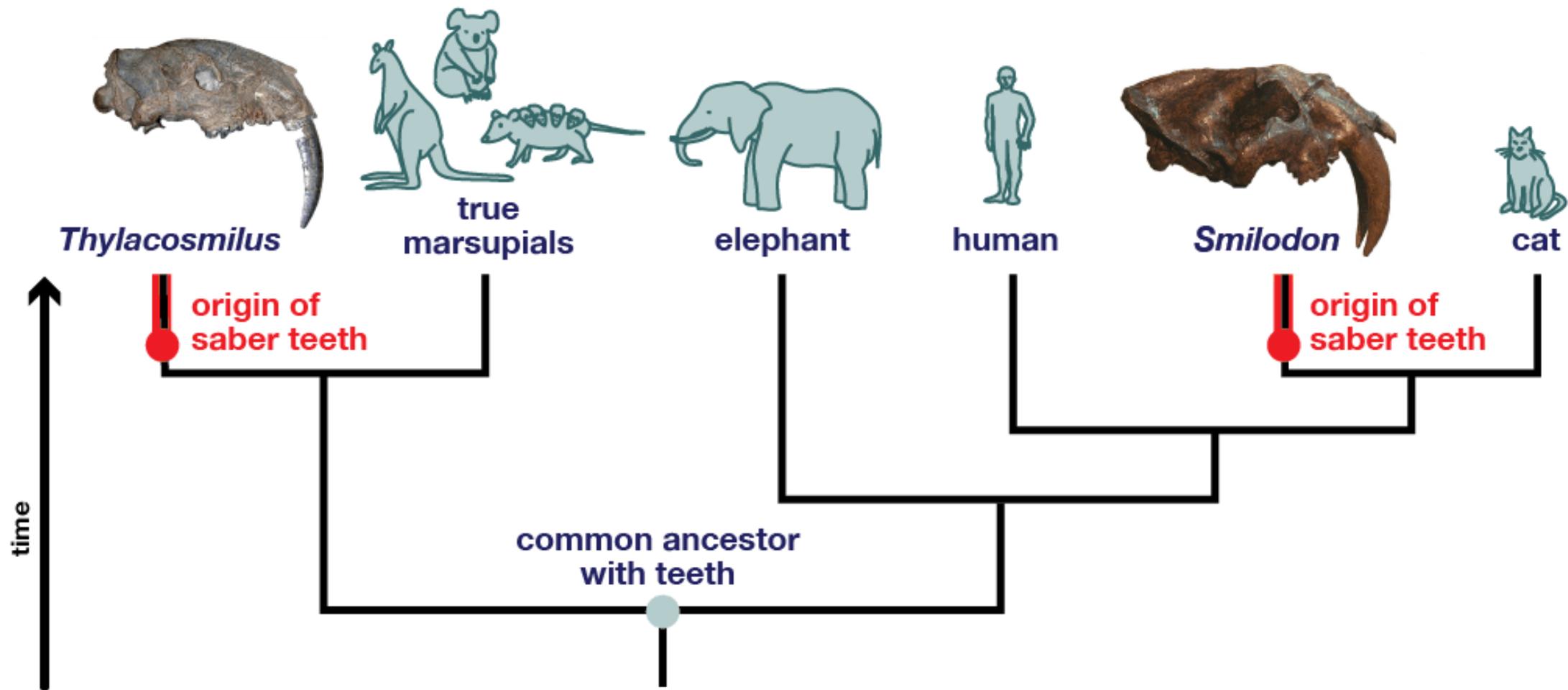


Canine teeth of sabre-toothed predators

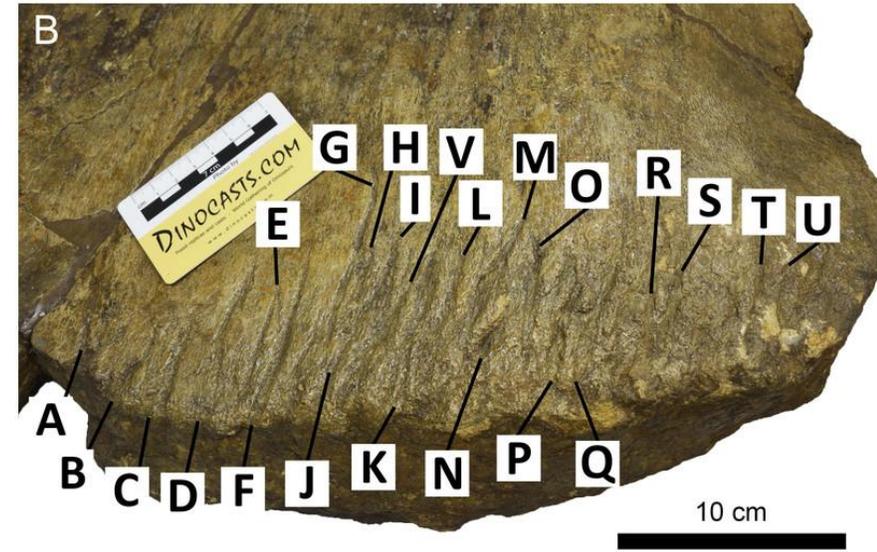
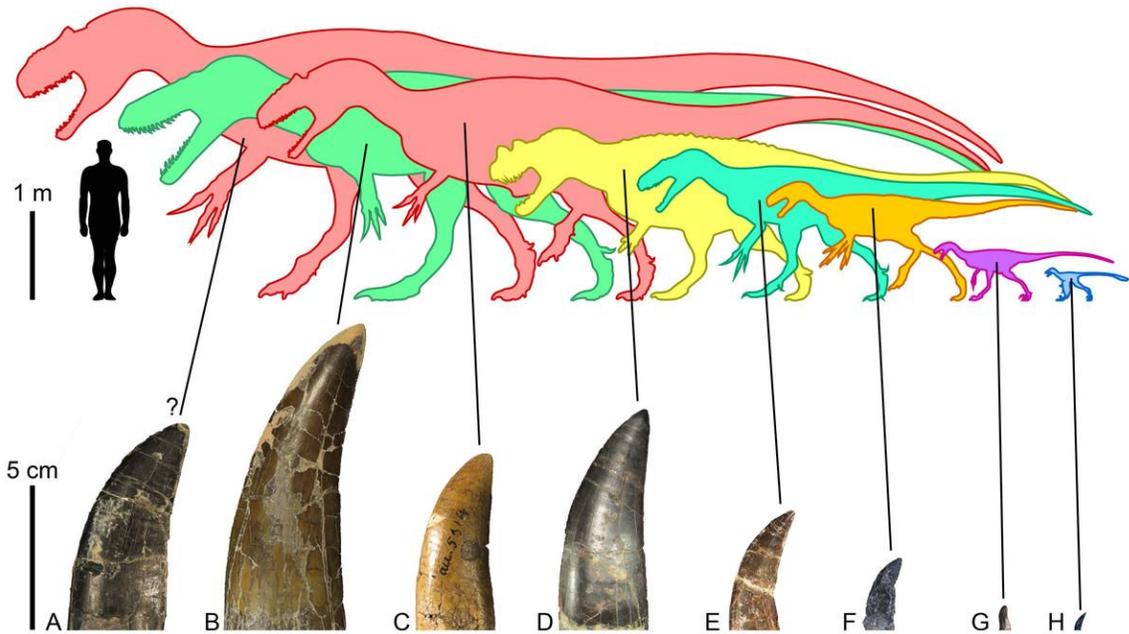


Pollock et al., 2025

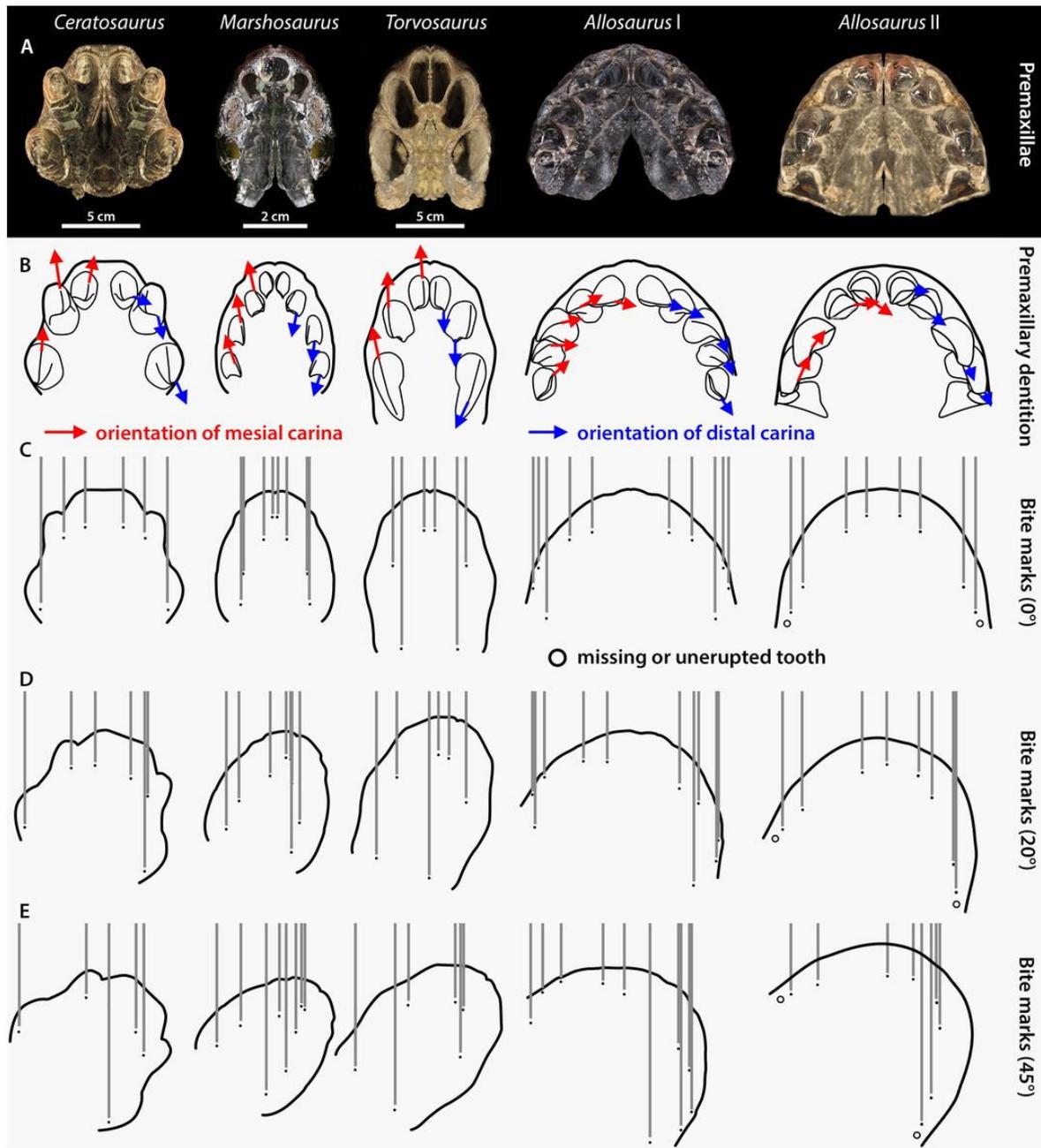




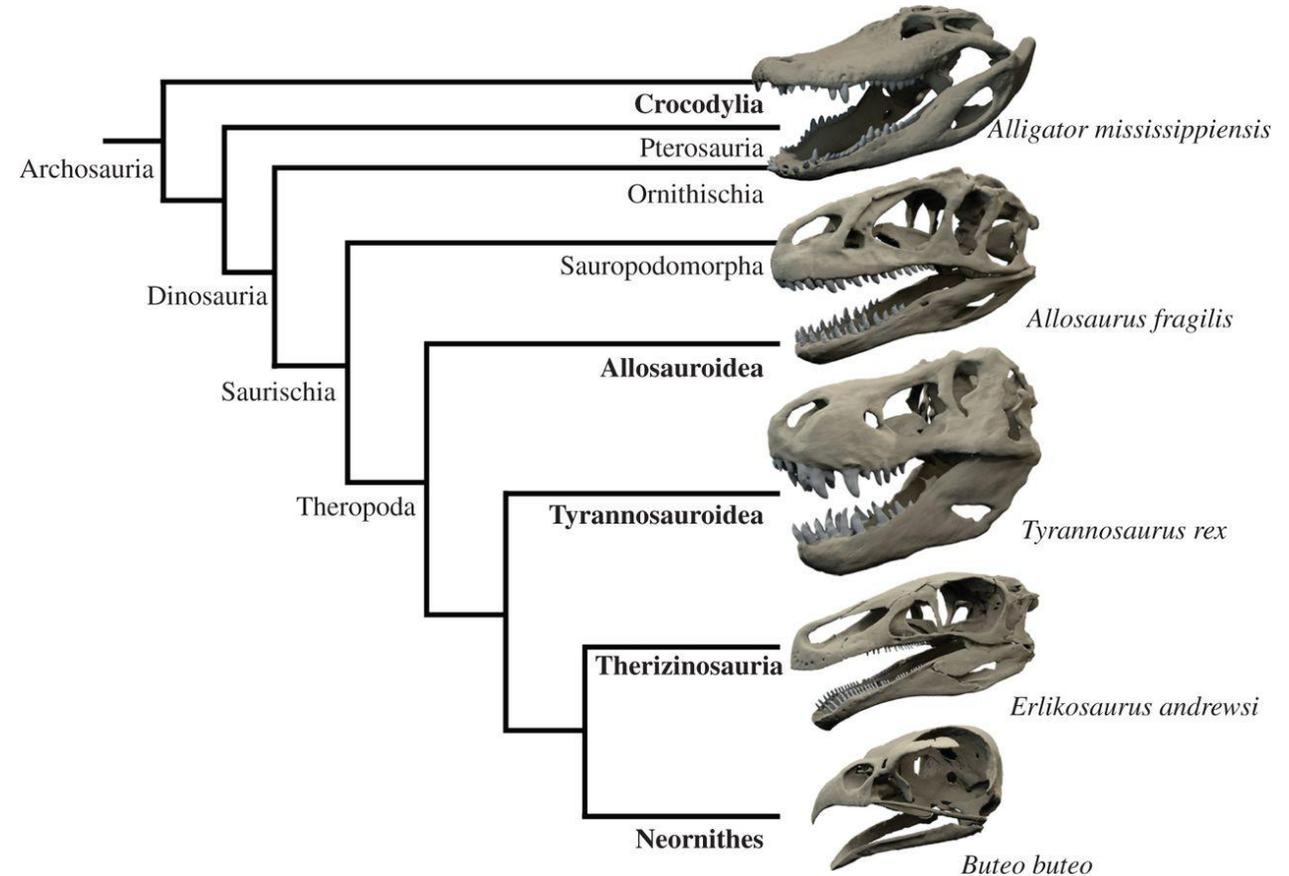
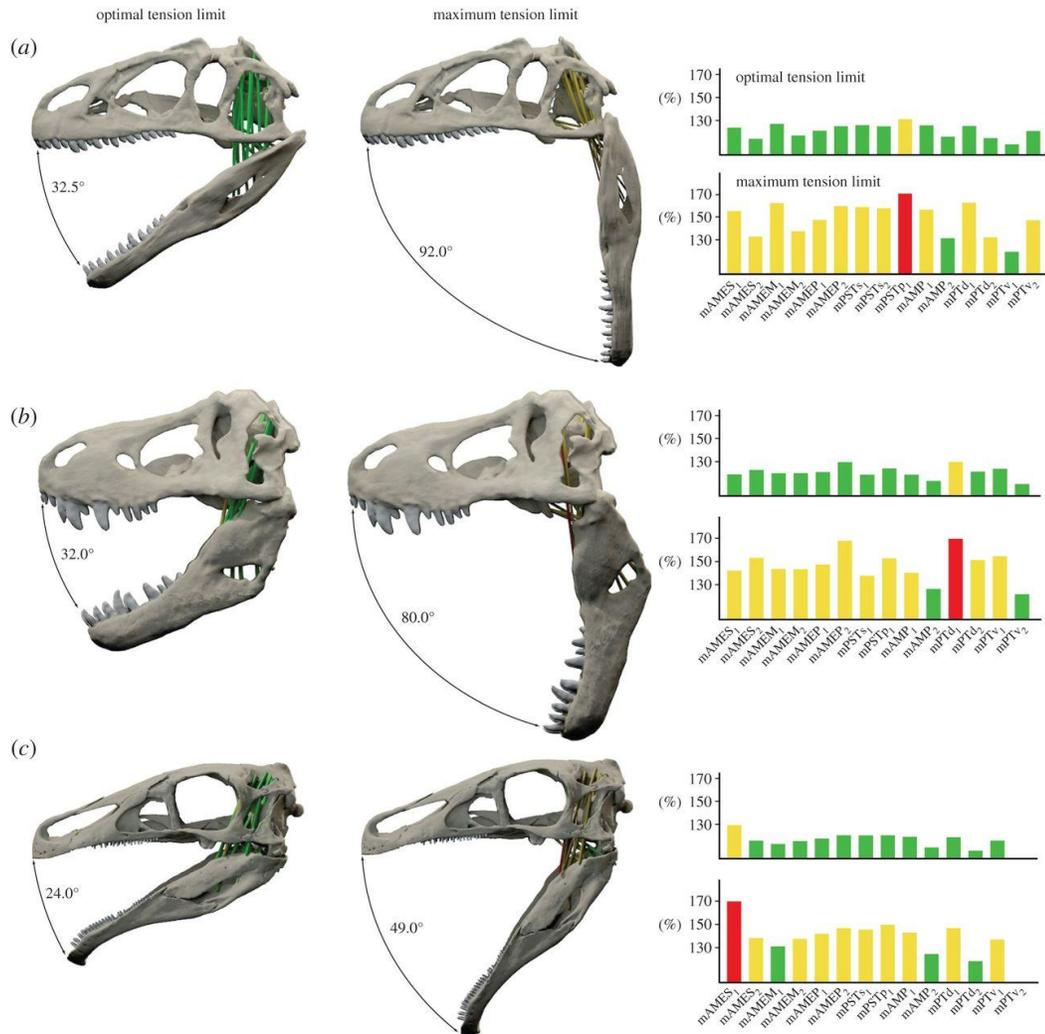
Osteofagia – wymogi funkcjonalne

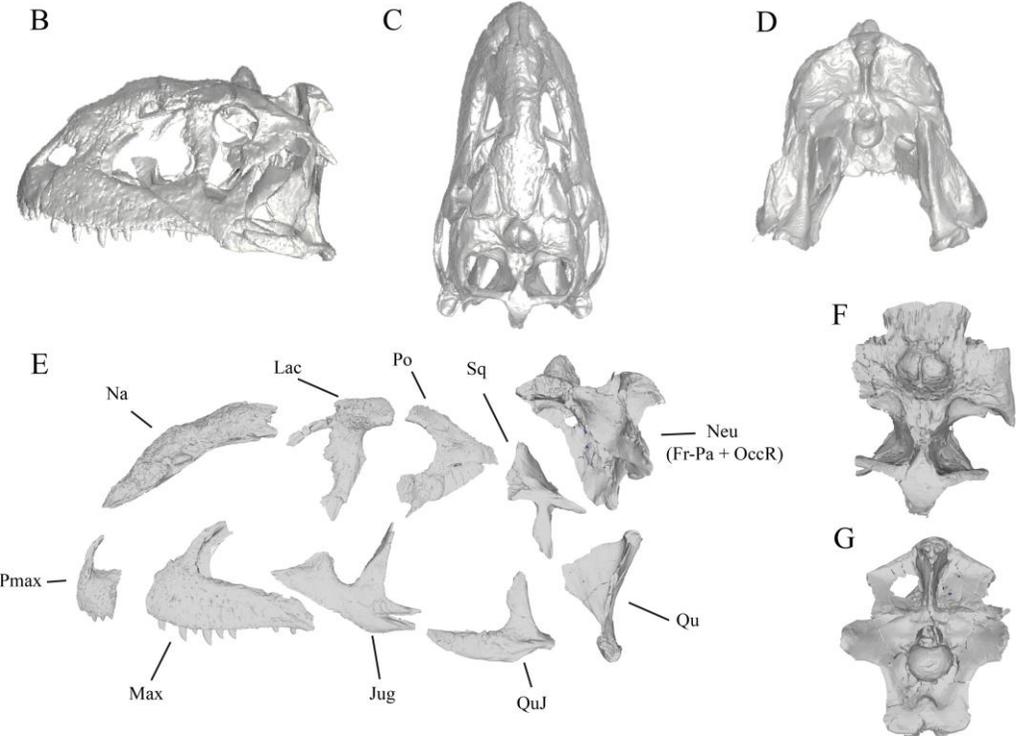
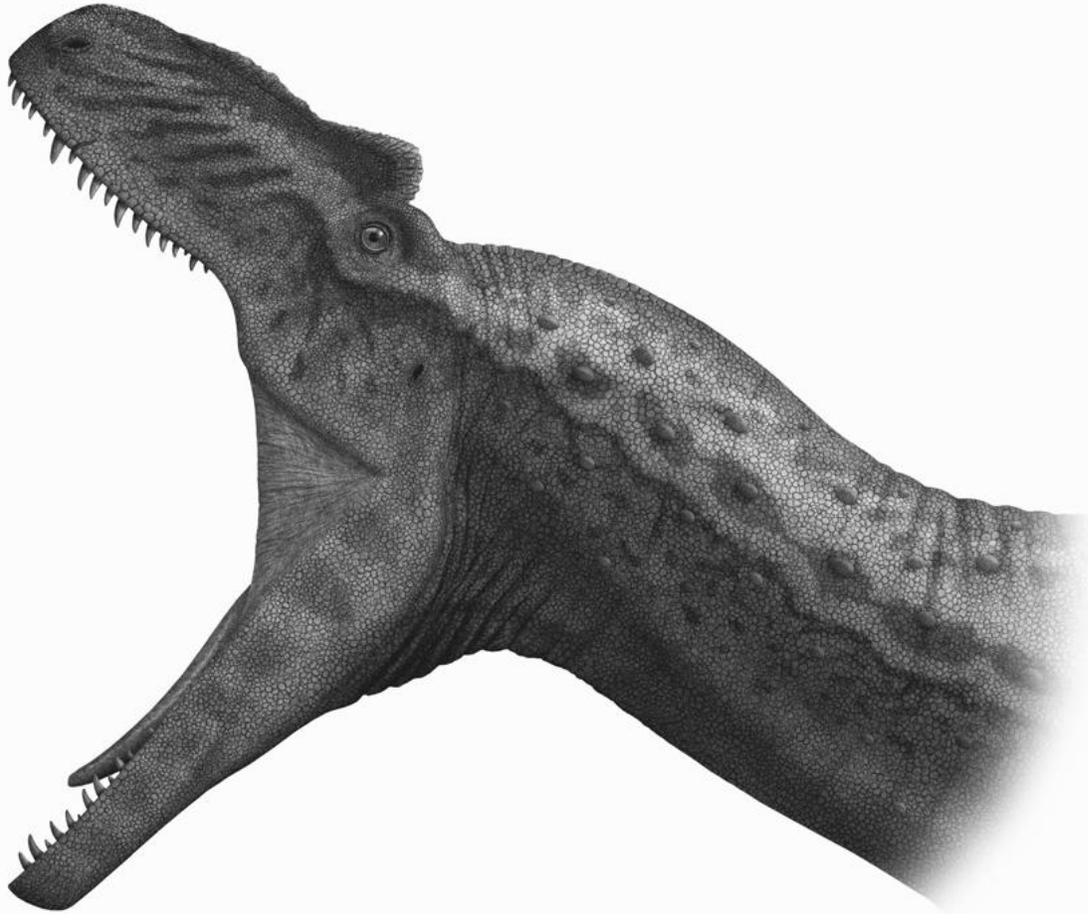


Lei et al., 2023



Najlepsze szeroko otwarte szerokie pyski

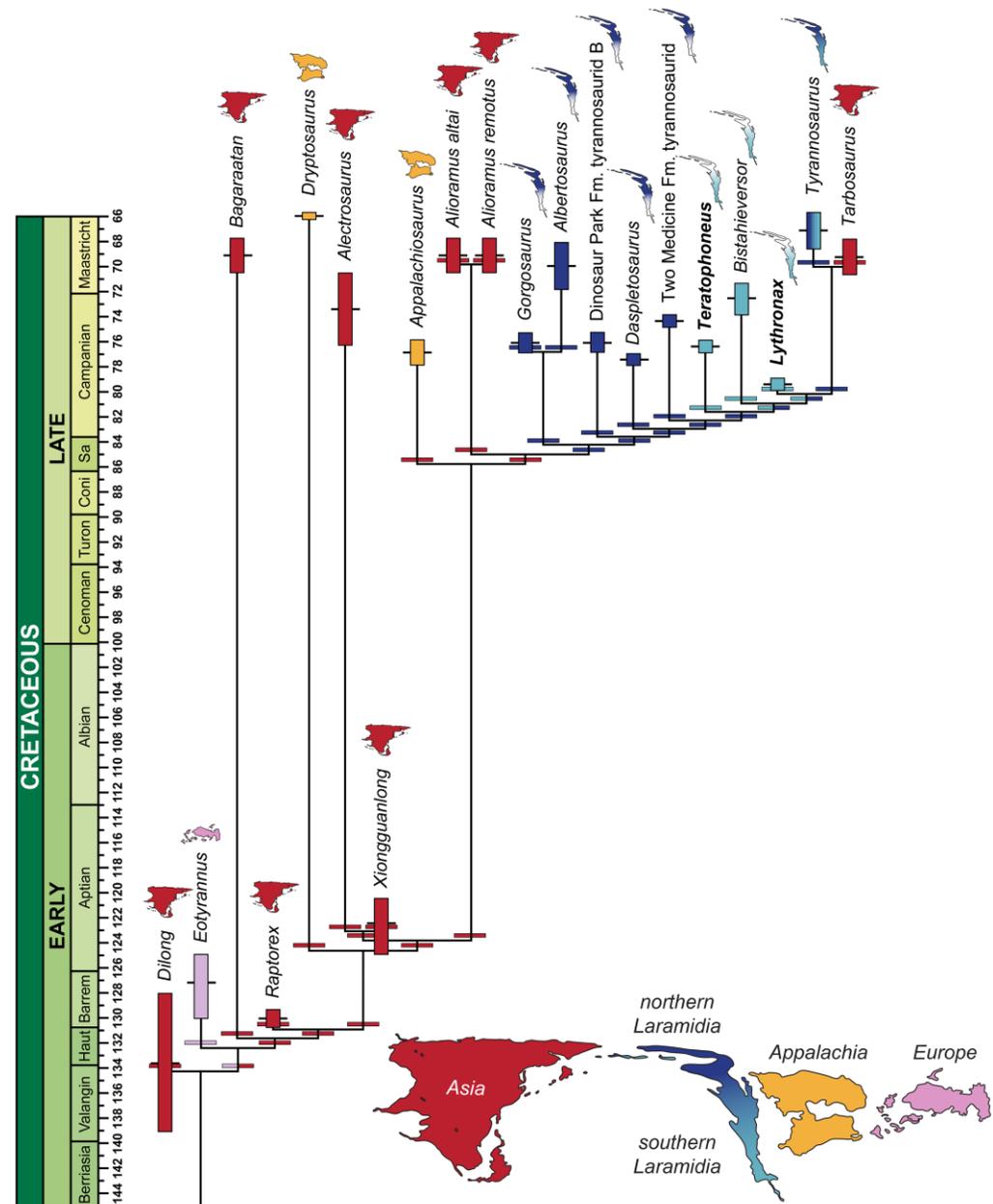
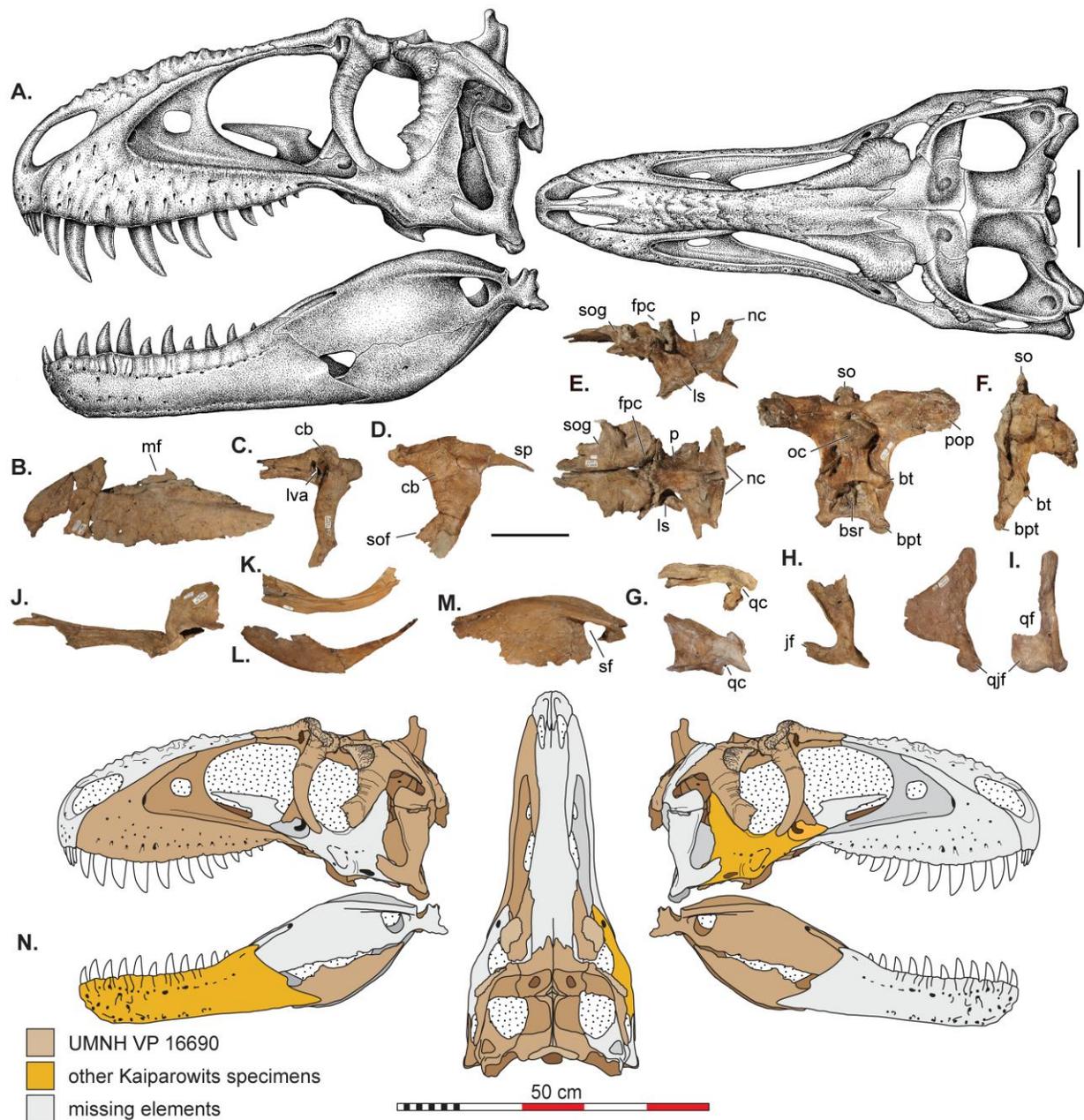




Pereyra et al., 2025



...rior, 65 millones de años.
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Loewen et al., 2013

Radiacje megadrapieżników efektem transgresji morskich?

- Radiacja tyranozaurów w trakcie wielkiej transgresji kredowej.
- W tym samym czasie radiacja olbrzymich mozazaurów w morzach.
- W okresie jurajskim największe drapieżniki również pojawiały się w czasie najwyższego poziomu mórz.
- Transgresjom morskim towarzyszy rozwój rozległych obszarów aluwialnych i równin nadbrzeżnych – habitat dla wielkich kręgowców.

