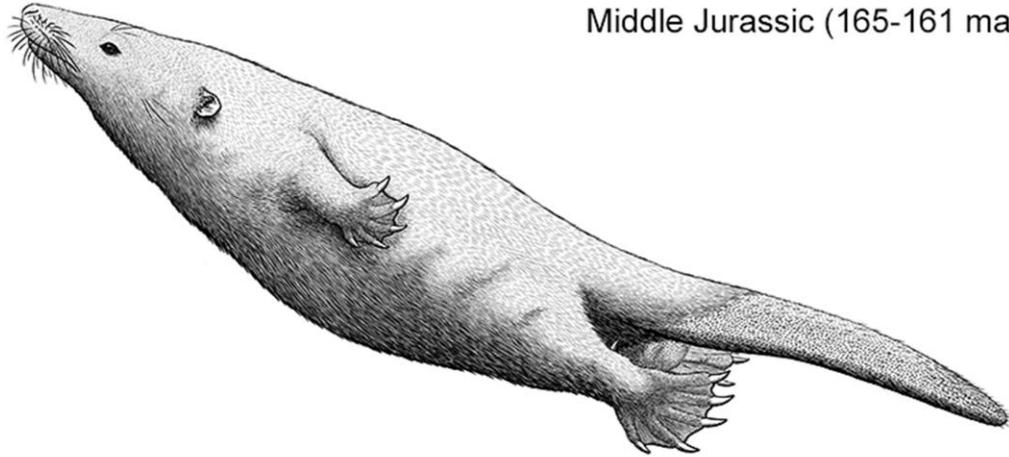
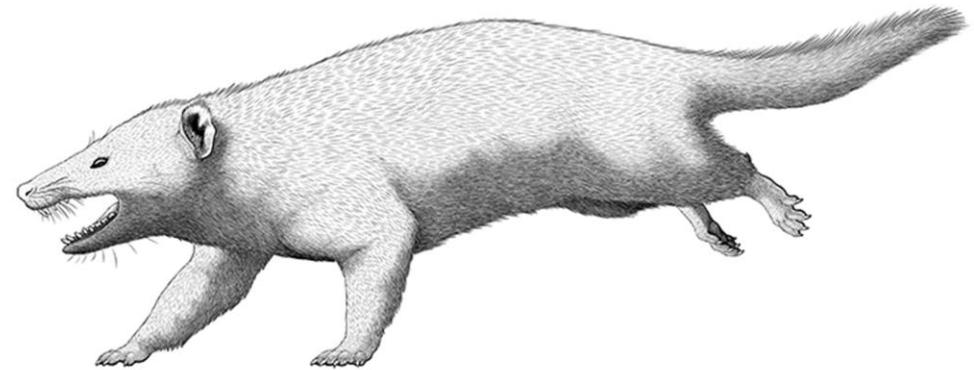


EWOLUCJA KONWERGENTNA KRĘGOWCÓW

Castorocauda lutrasimilis
Middle Jurassic (165-161 ma)



Repenomamus giganticus
Early Cretaceous (125-122 ma)



Mikrokręgowce i ich konwergencja



Dr Daniel Tyborowski

Katedra Geologii Historycznej, Regionalnej i Paleontologii

Wydział Geologii UW

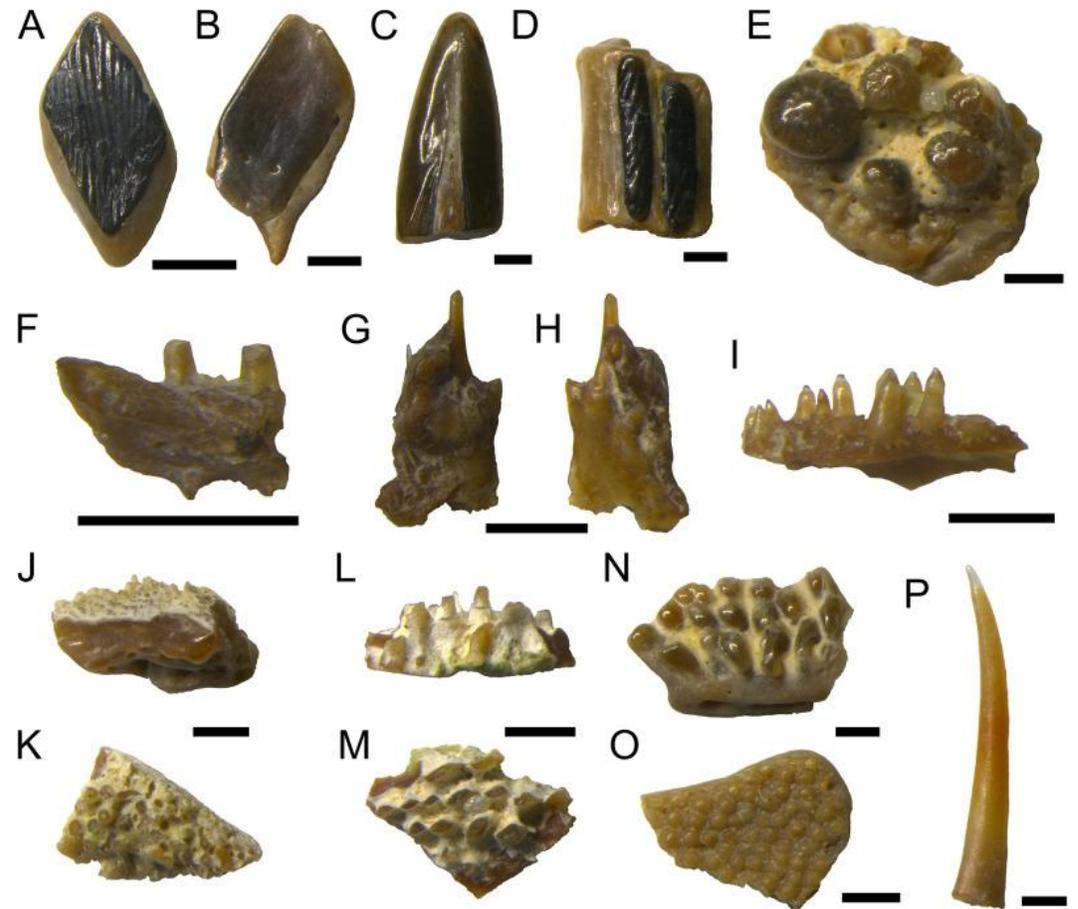
d.tyborowski@uw.edu.pl



UNIWERSYTET
WARSZAWSKI

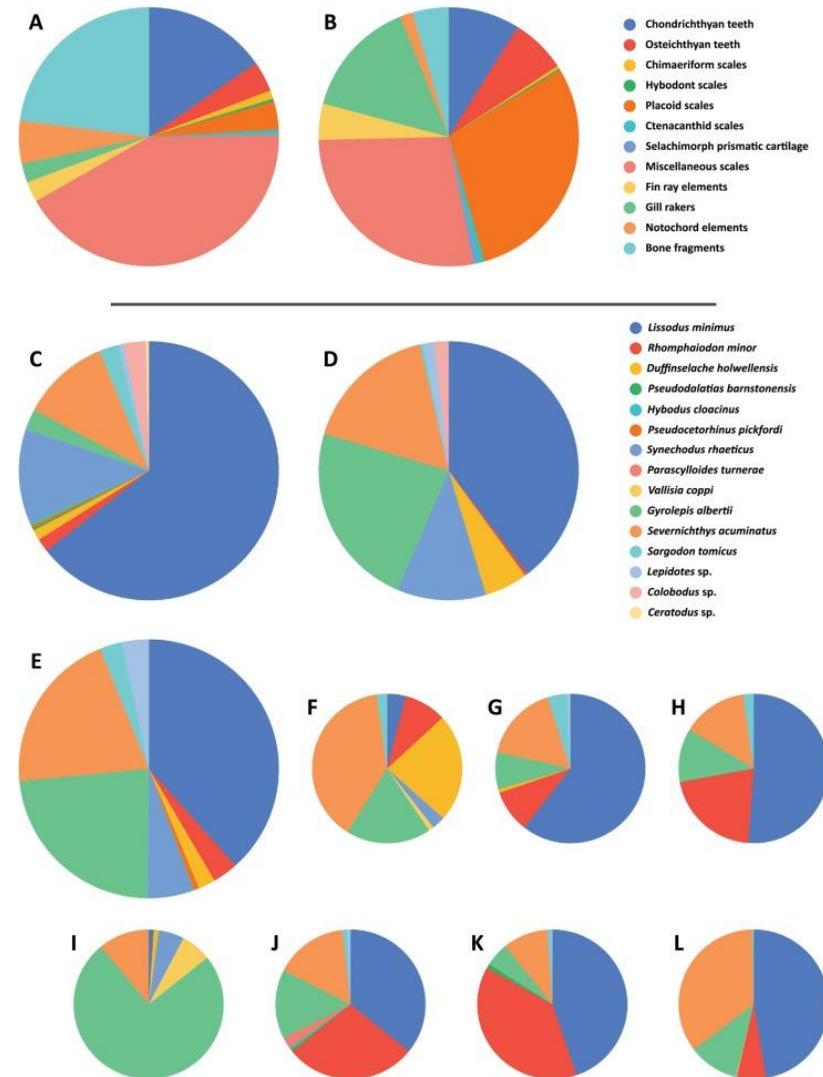
Mikrokręgowce = mikroskamieniałości kręgowców

- „Mikrokręgowce” to drobne (zwykle izolowane) **szczątki** kręgowców plasujące się w przedziale między 1mm a 1cm.
- Pochodzą one od zwierząt **różnej wielkości**, od drobnych przez średnie aż po duże formy.
- Dział paleontologii zajmujący się mikrokręgowcami to **mikropaleontologia kręgowców**.

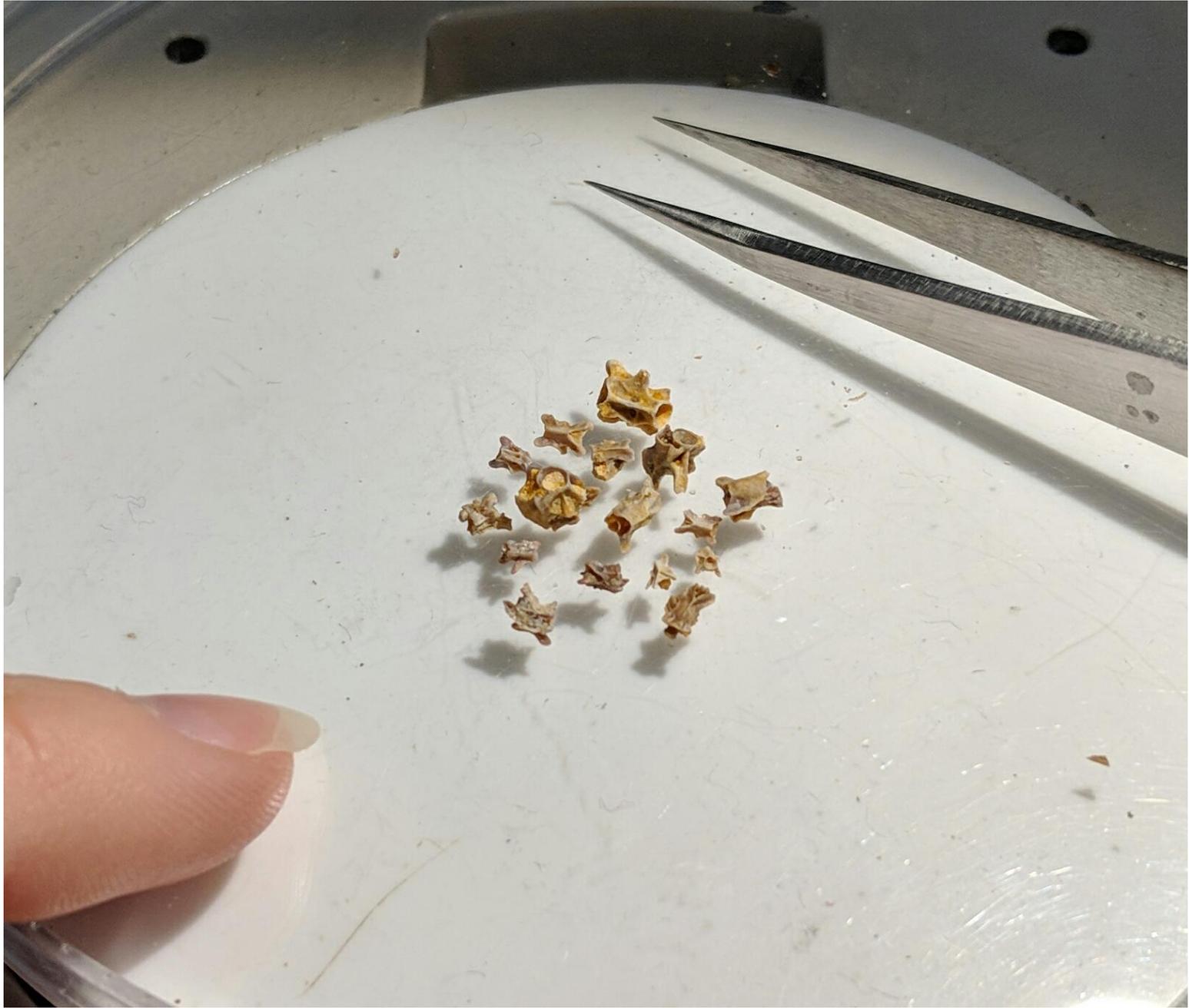


Mikrokręgowce - zastosowania

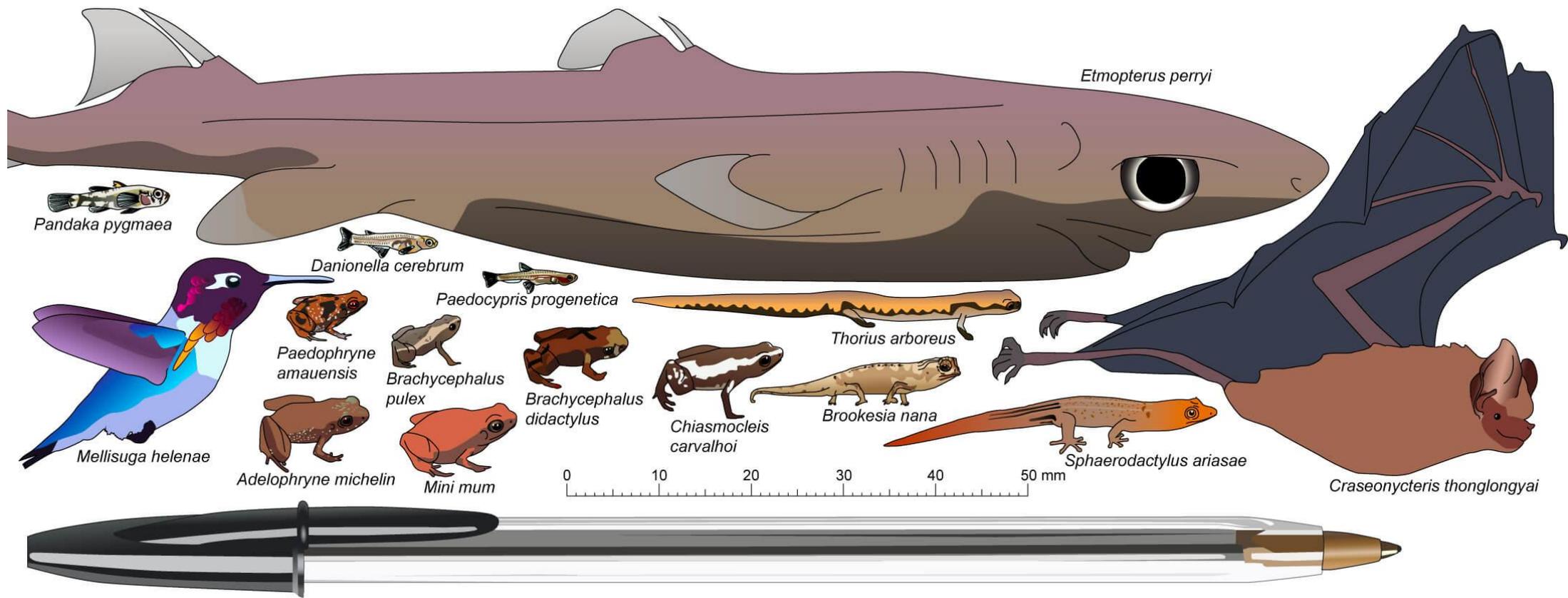
- Mikrokręgowce to doskonałe i bardzo czułe narzędzie do badań z zakresu:
 - Bioróżnorodności
 - Paleoekologii i rekonstrukcji paleośrodowiska
 - Zmian faunistycznych i biogeograficznych
 - Biostratygrafii



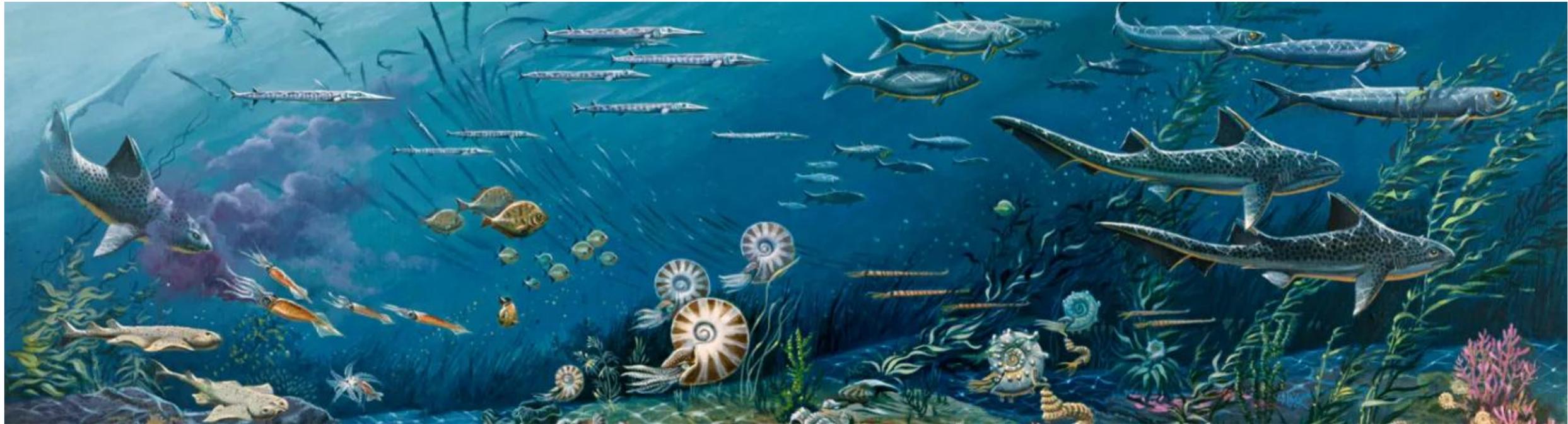
Weeks et al., 2025



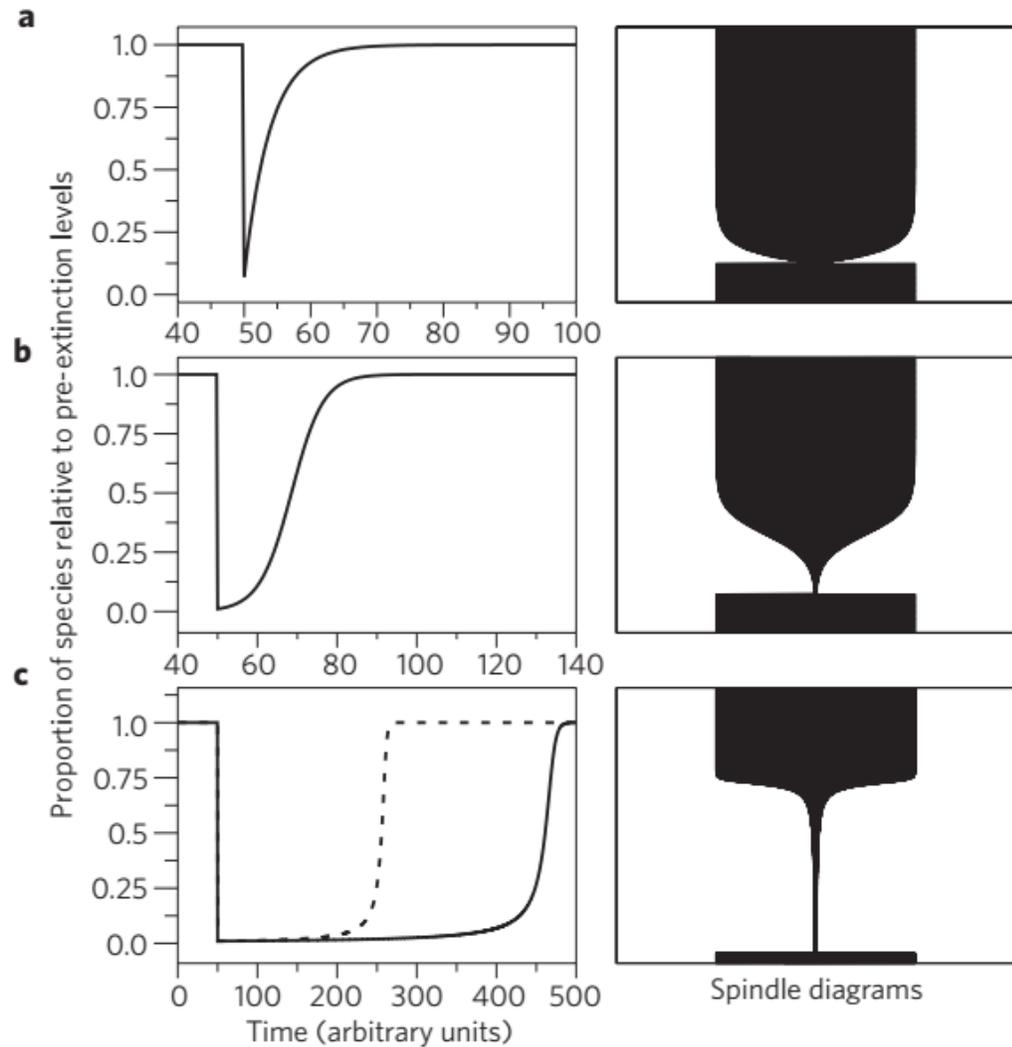
Współczesne „mikrokęgowce”



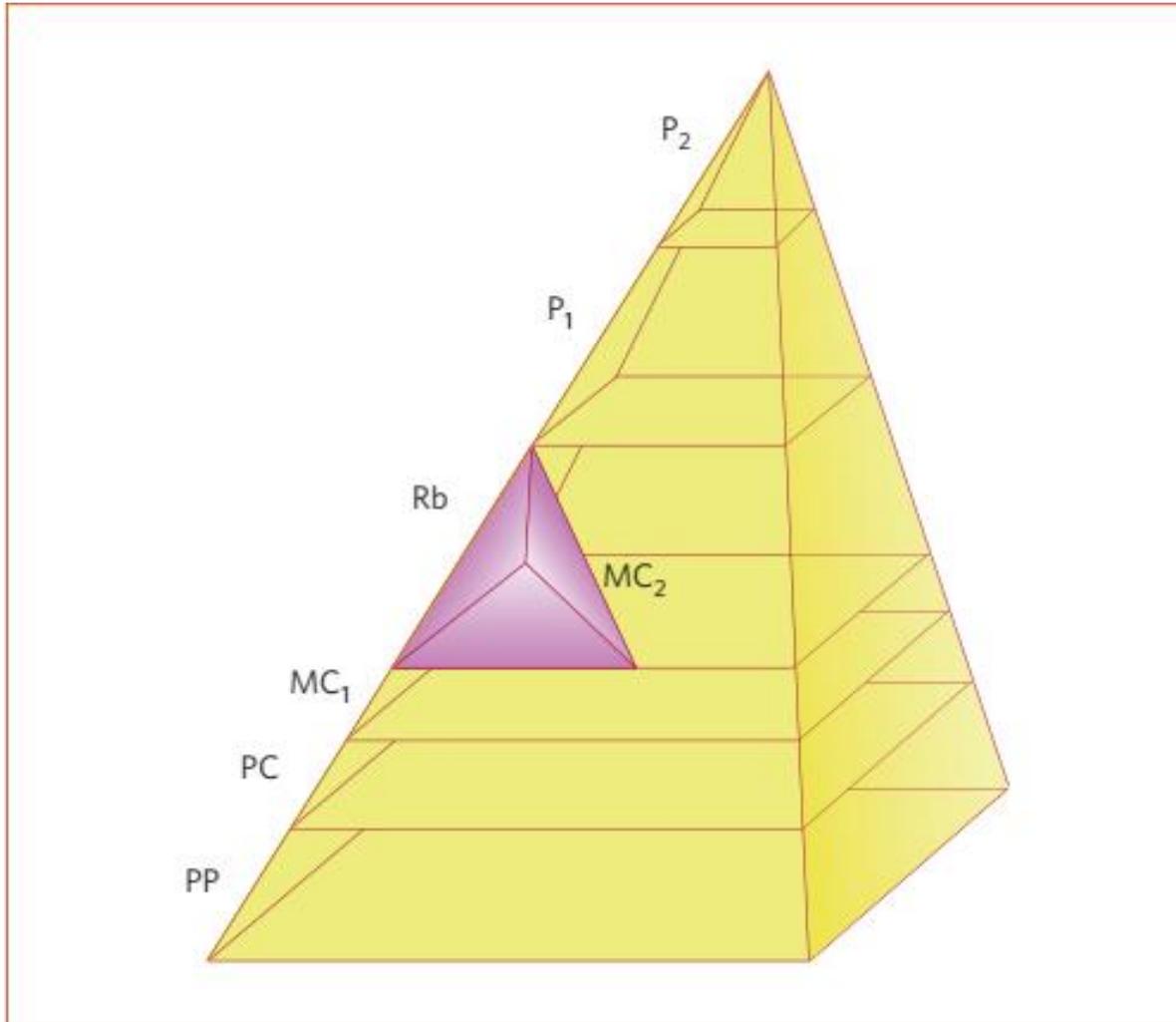
Granica perm/trias a początki miniaturyzacji kręgowców



Modele odbudowy bioróżnorodności

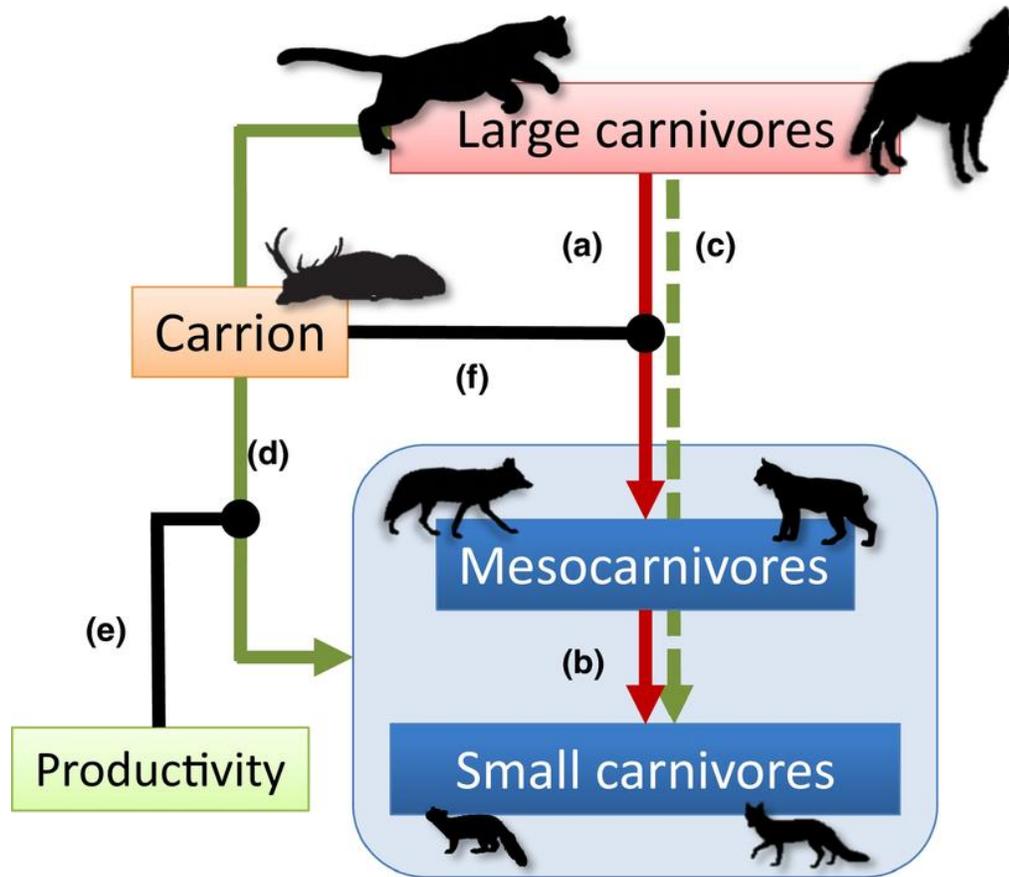


Piramida troficzna – podstawa (paleo)ekologii

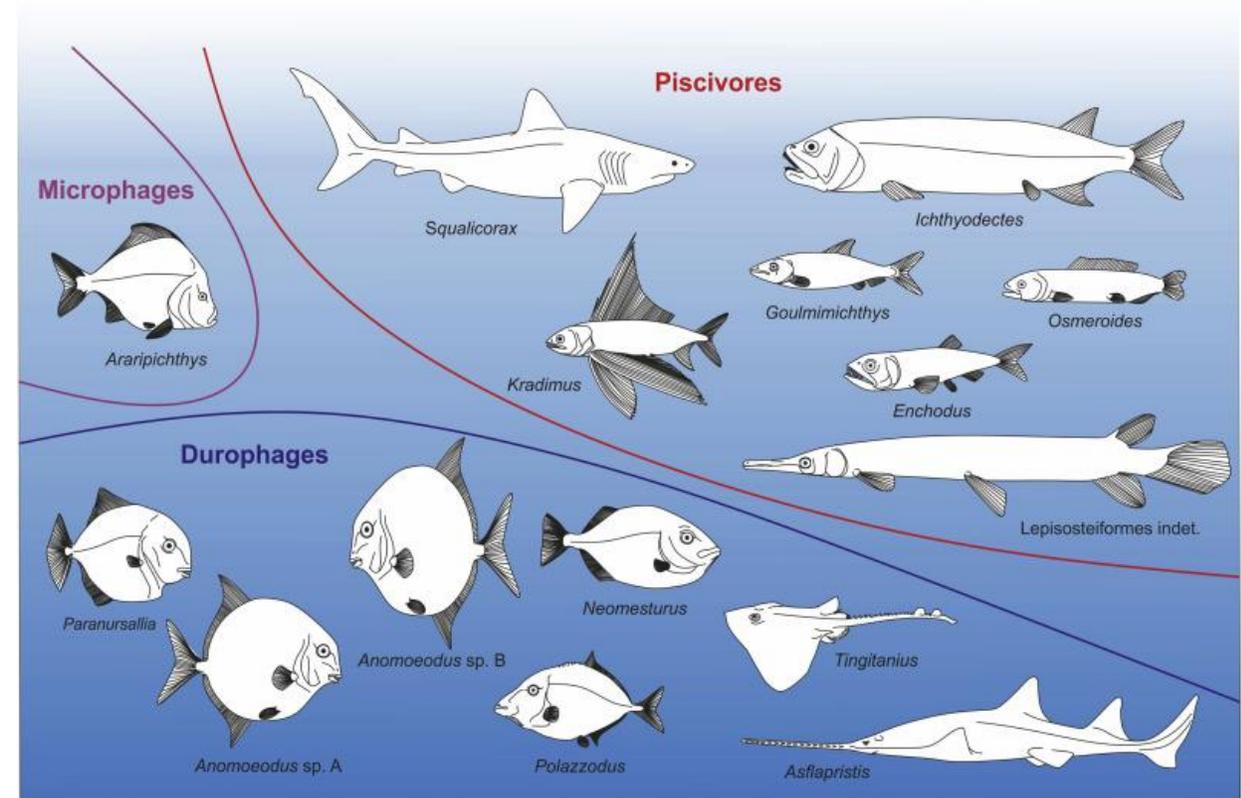


- PP – producenci (głównie mikroorganizmy morskie).
- PC – konsumenci I-ego rzędu (mikroorganizmy zwierzęce, np. otwornice)
- MC1 – mezo-konsumenci (np. infauna)
- MC2 – mezo-konsumenci (np. bentos lub drobny nekton).
- Rb – mezo-konsumenci rafotwórczy.
- P1 – drapieżne bezkręgowce (np. ślimaki, szkarłupnie, stawonogi) i mniejsze drapieżne kręgowce (ryby).
- P2 – wielkie drapieżne kręgowce (ryby, gady morskie).

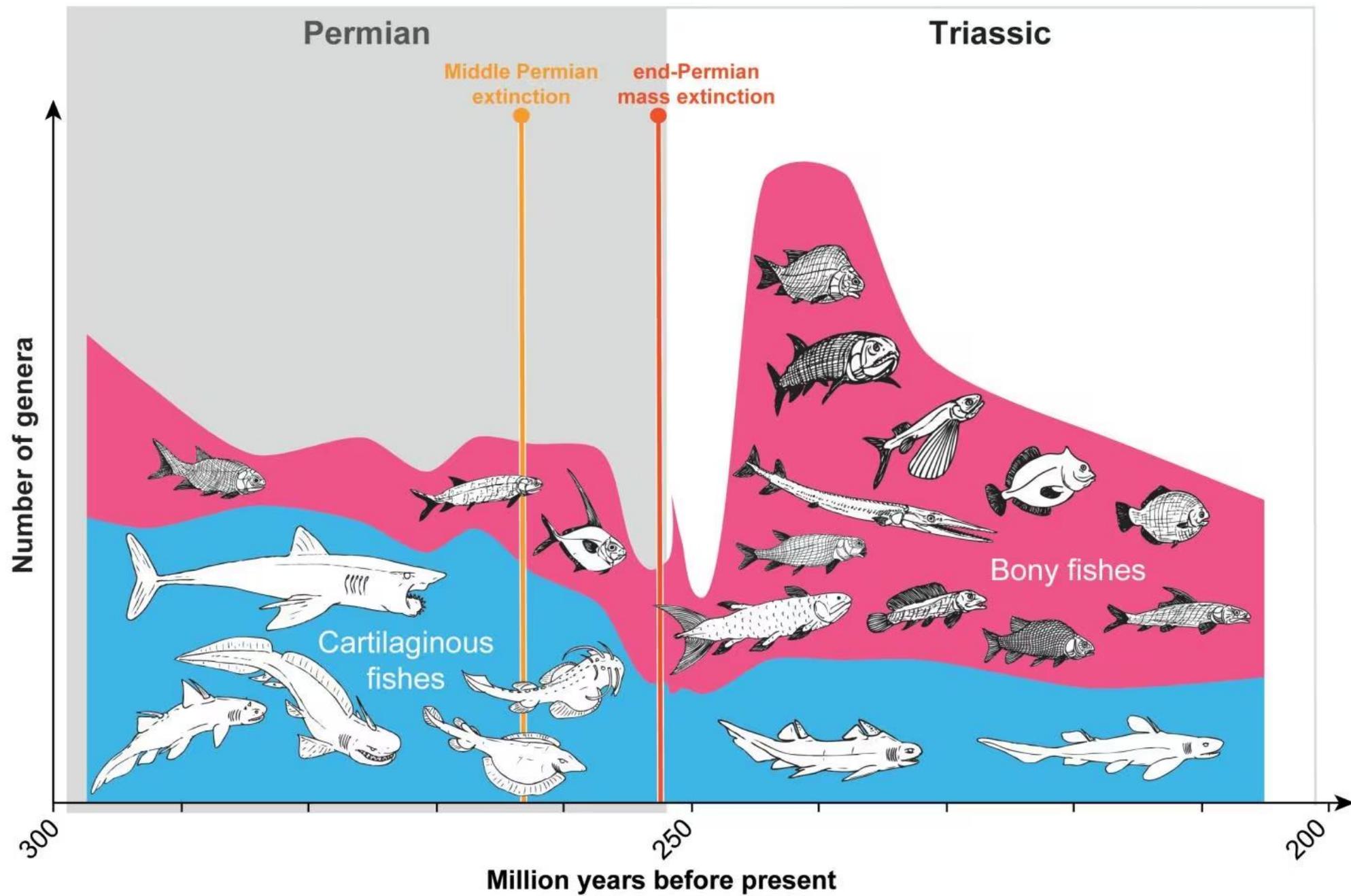
Mezo- i mikrodrapieżniki na lądach i w morzach

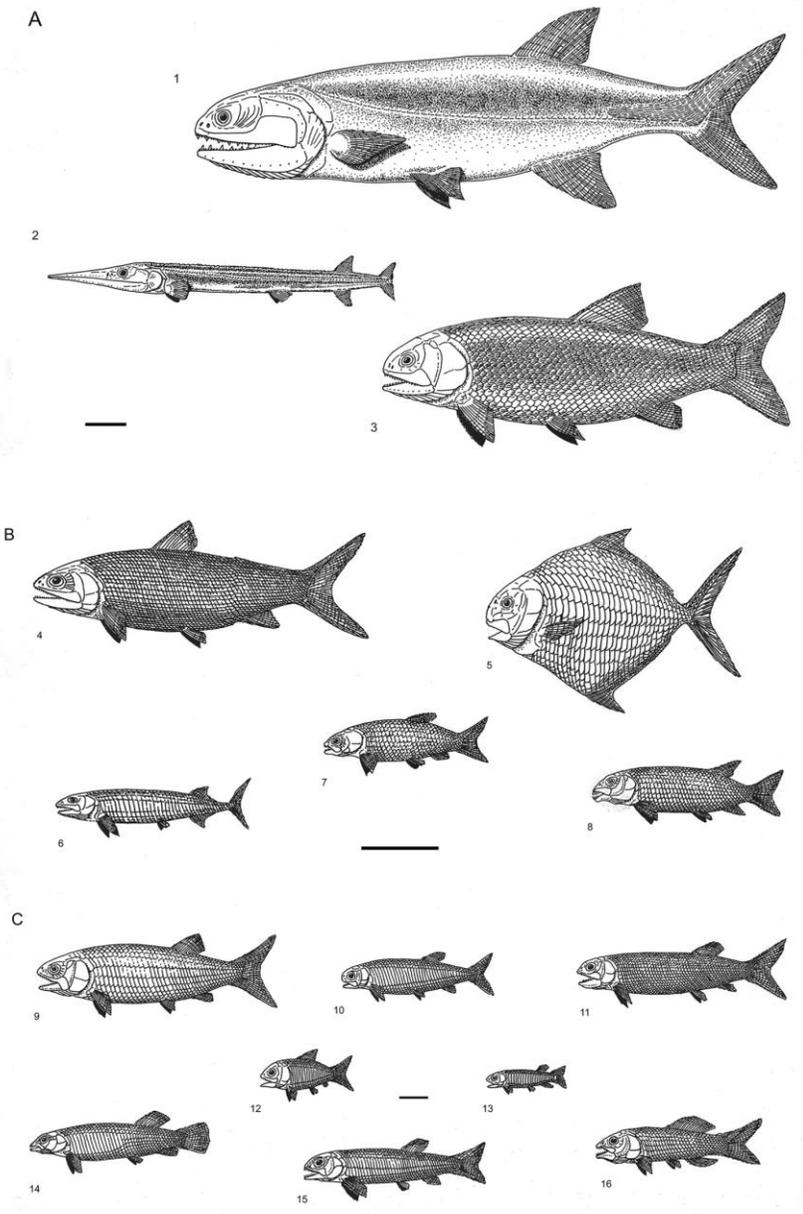


Prugh & Sivy, 2020

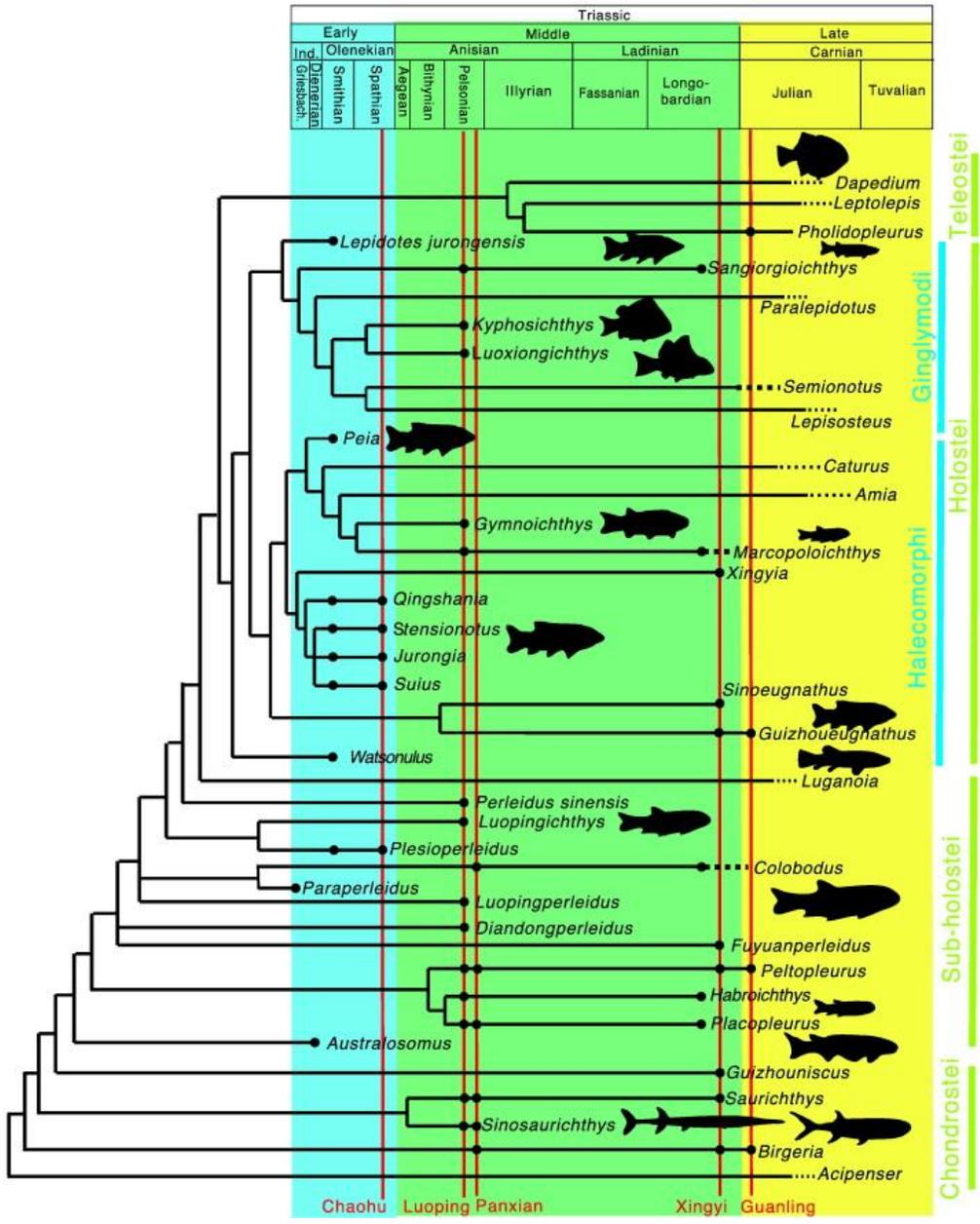


Cooper & Martill, 2020

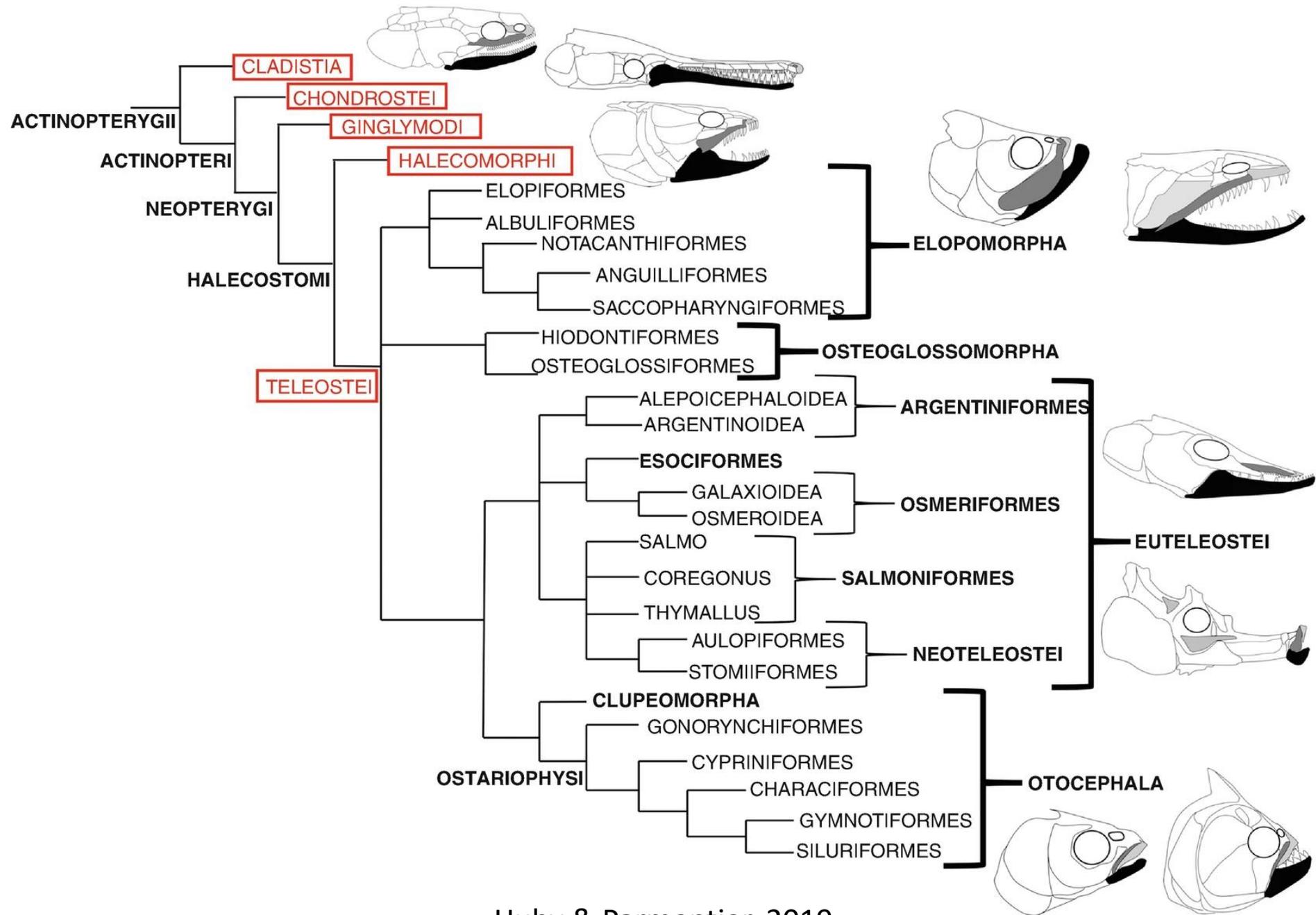




Bürgin, 2024

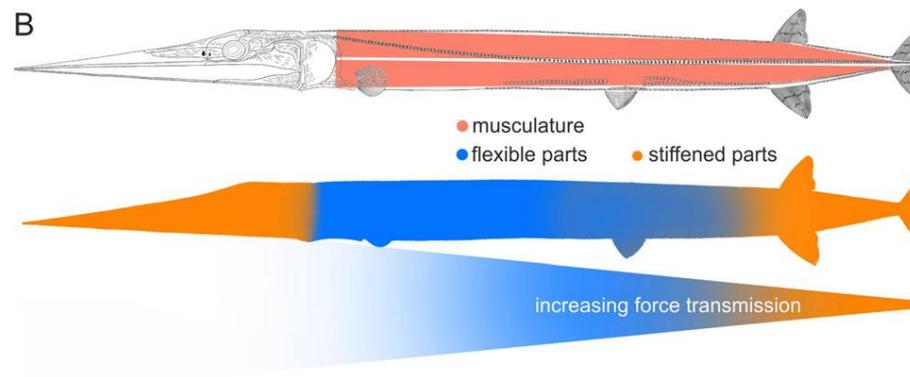
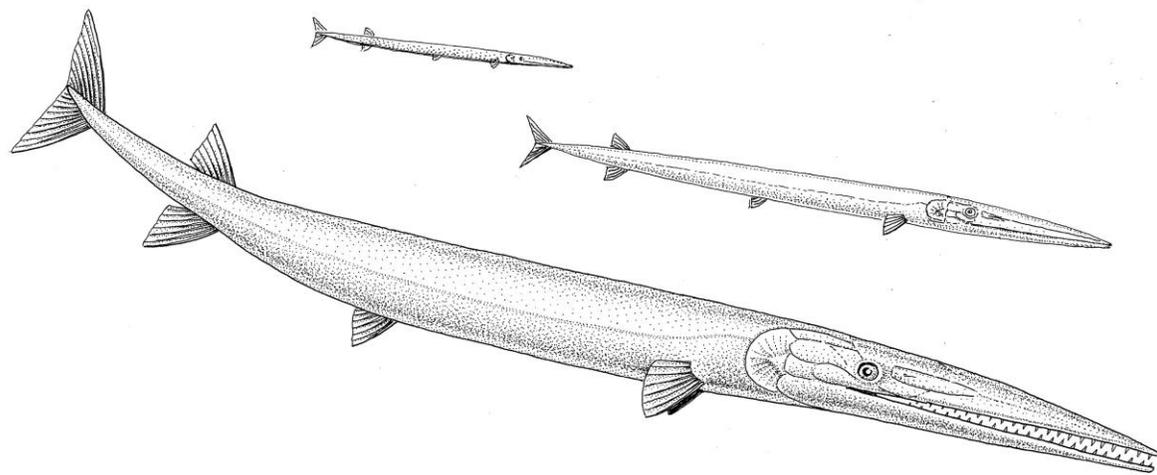


Benton et al., 2013



Huby & Parmentier, 2019

Saurichthys i ryby jaszczurokształtne



Kogan et al., 2015

Konwergencja ścigłych mezodrapieżników

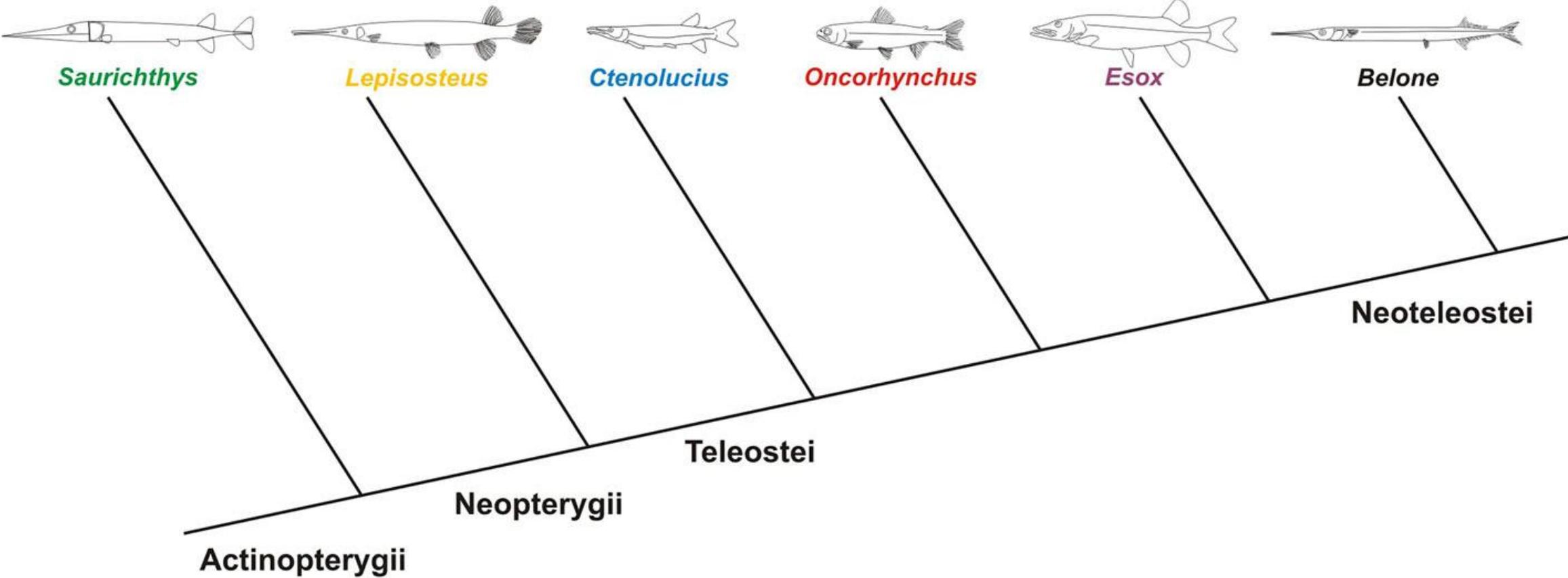
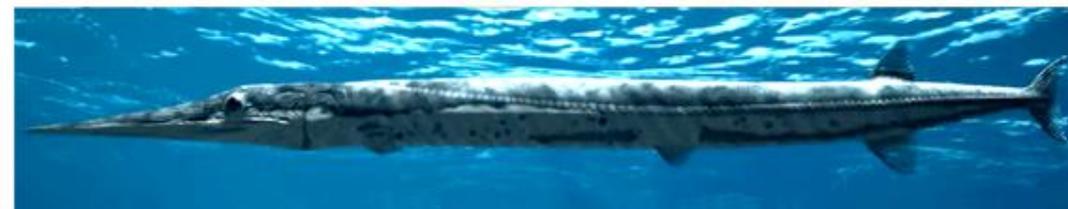
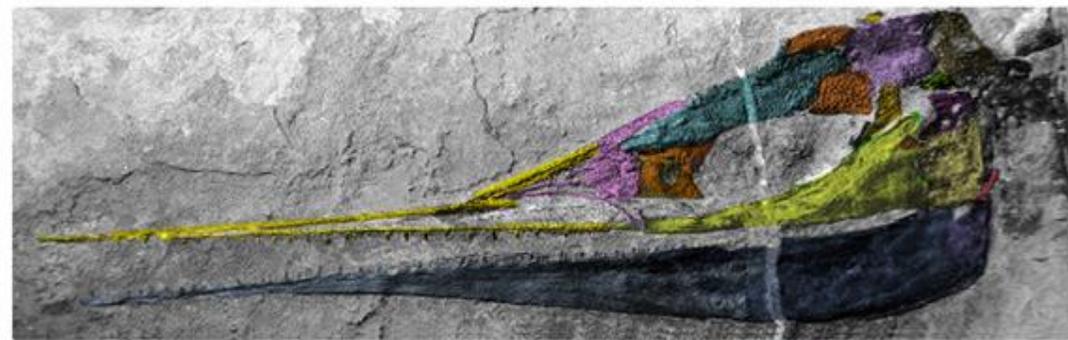
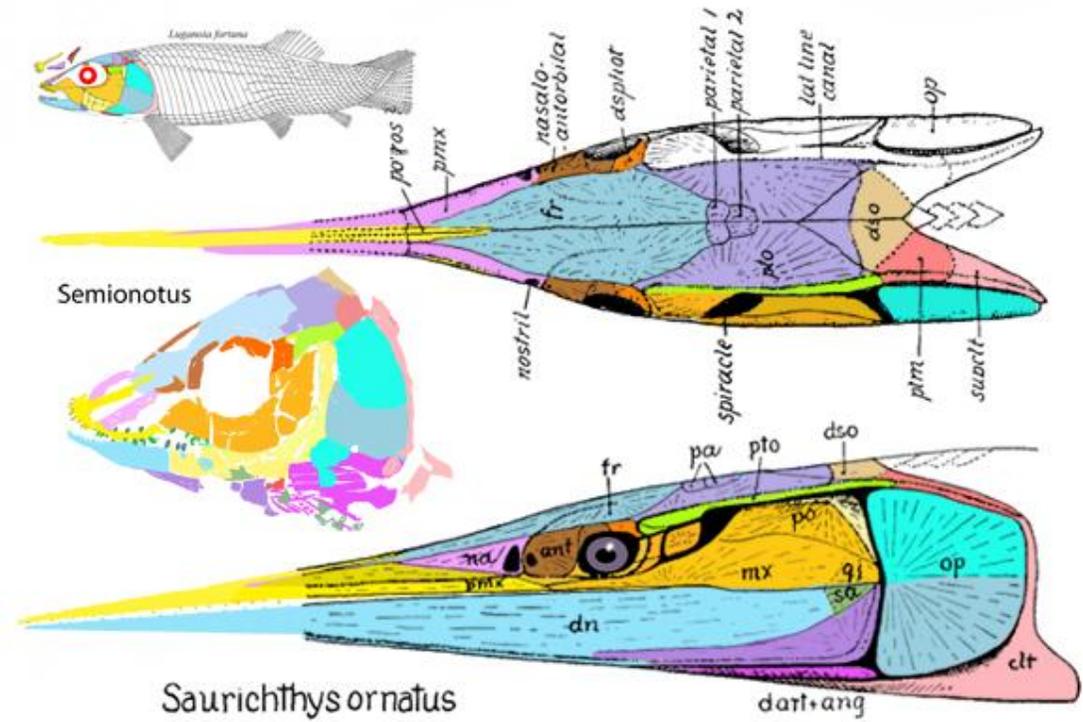
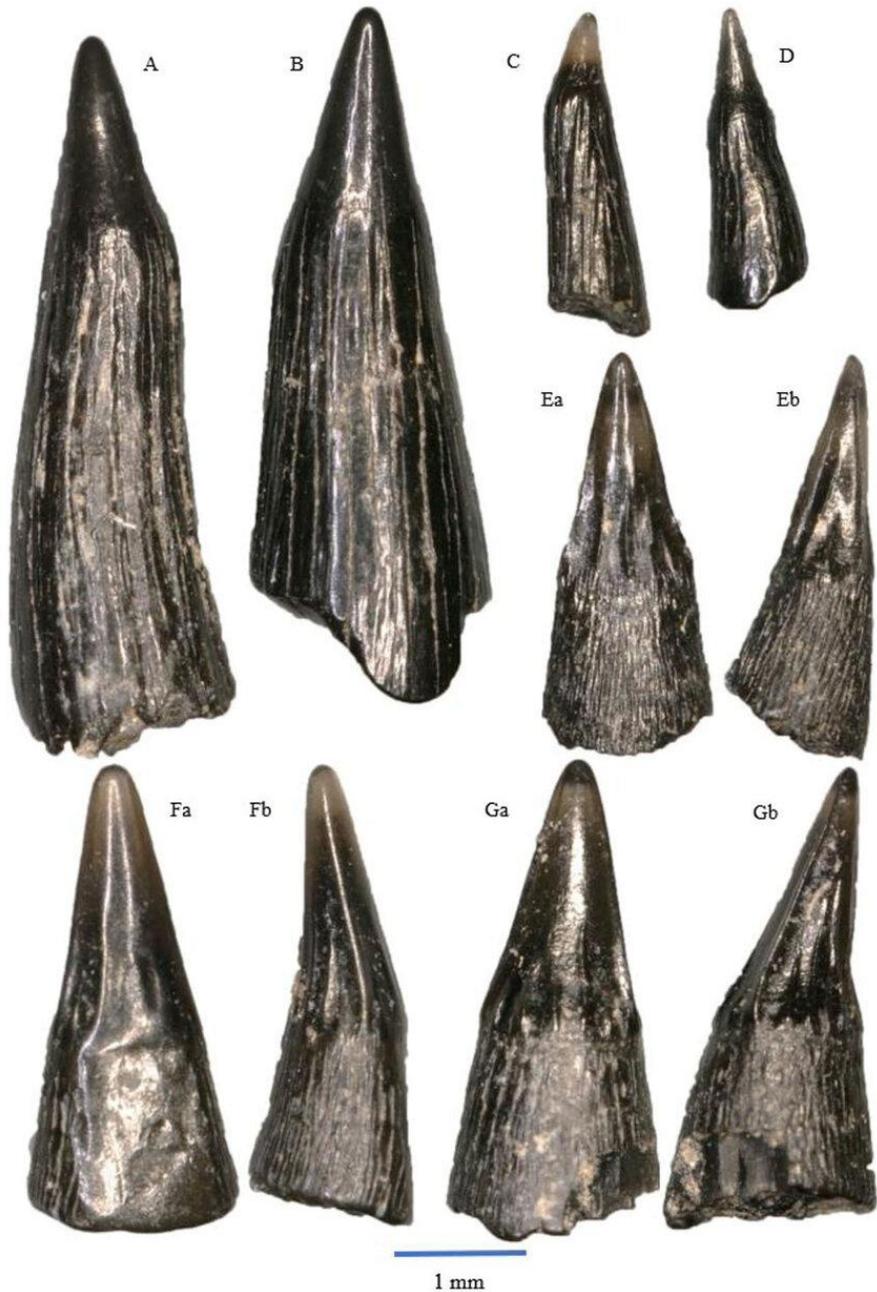
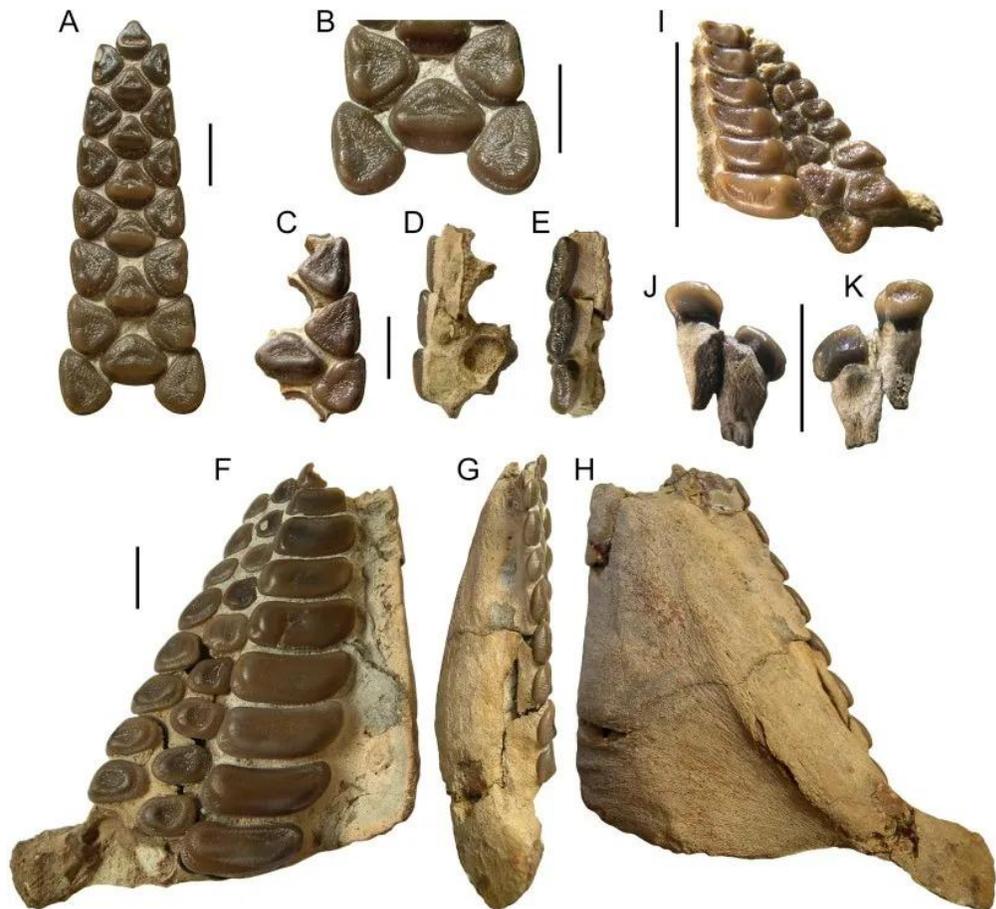


Fig. 2. Overview of the fish taxa investigated in this study. Phylogenetic relationships are summarized in the cladogram. The outgroup *Saurichthys* is the Kogan et al., 2015

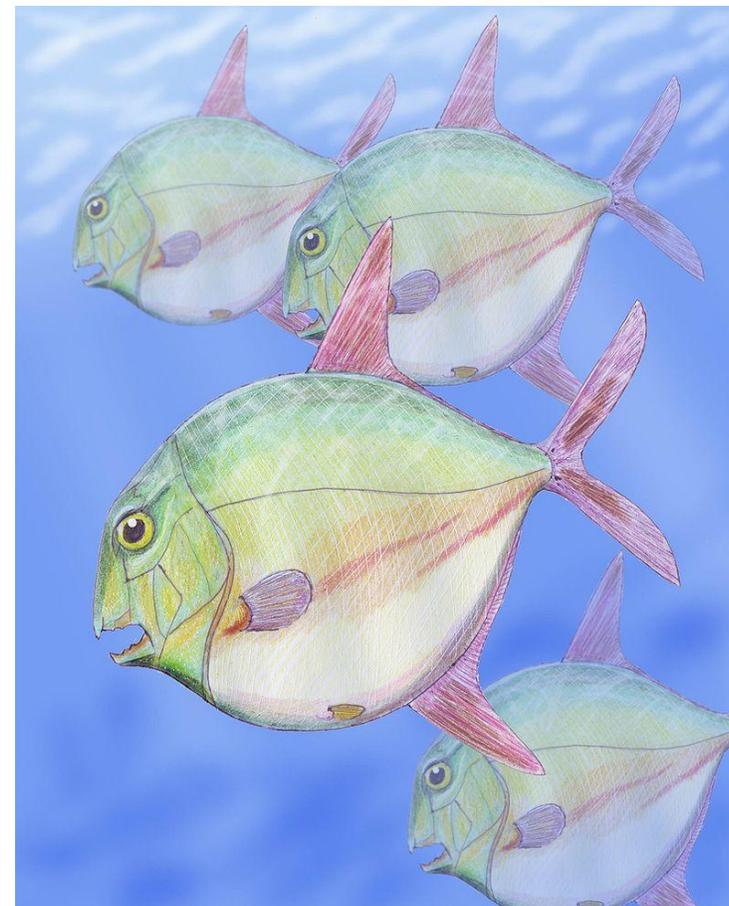


Lange et al., 2023

Pyknodonty – ryby o stalowych szczękach!



Vullo et al., 2018

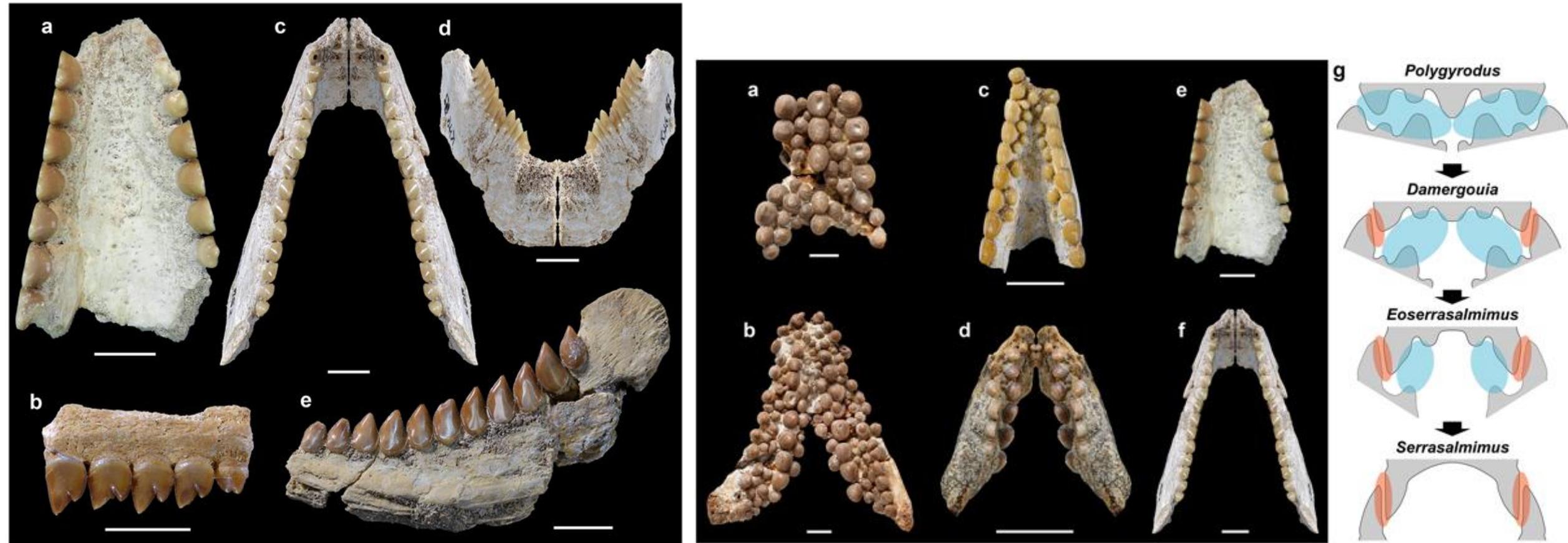


Rekonstrukcja: Dmitry Bogdanov

Pyknodonty i papugoryby

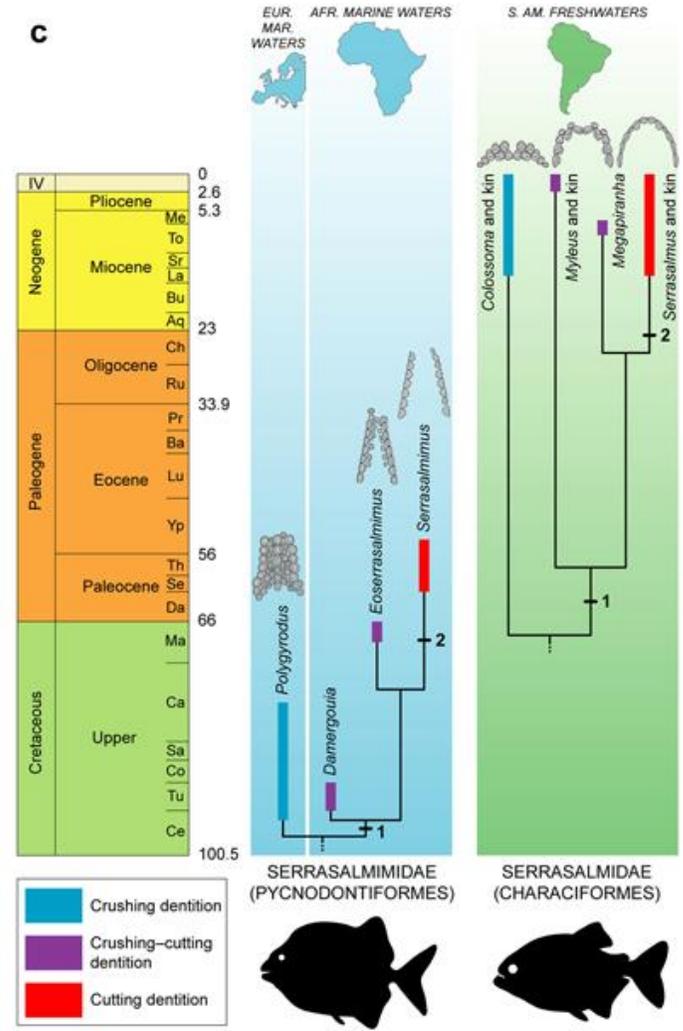
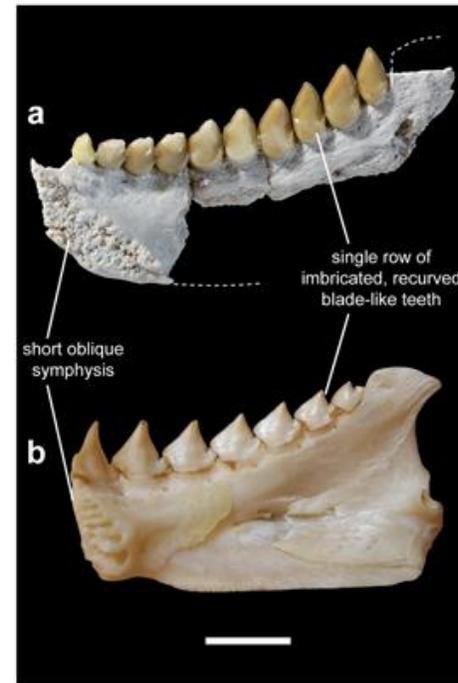
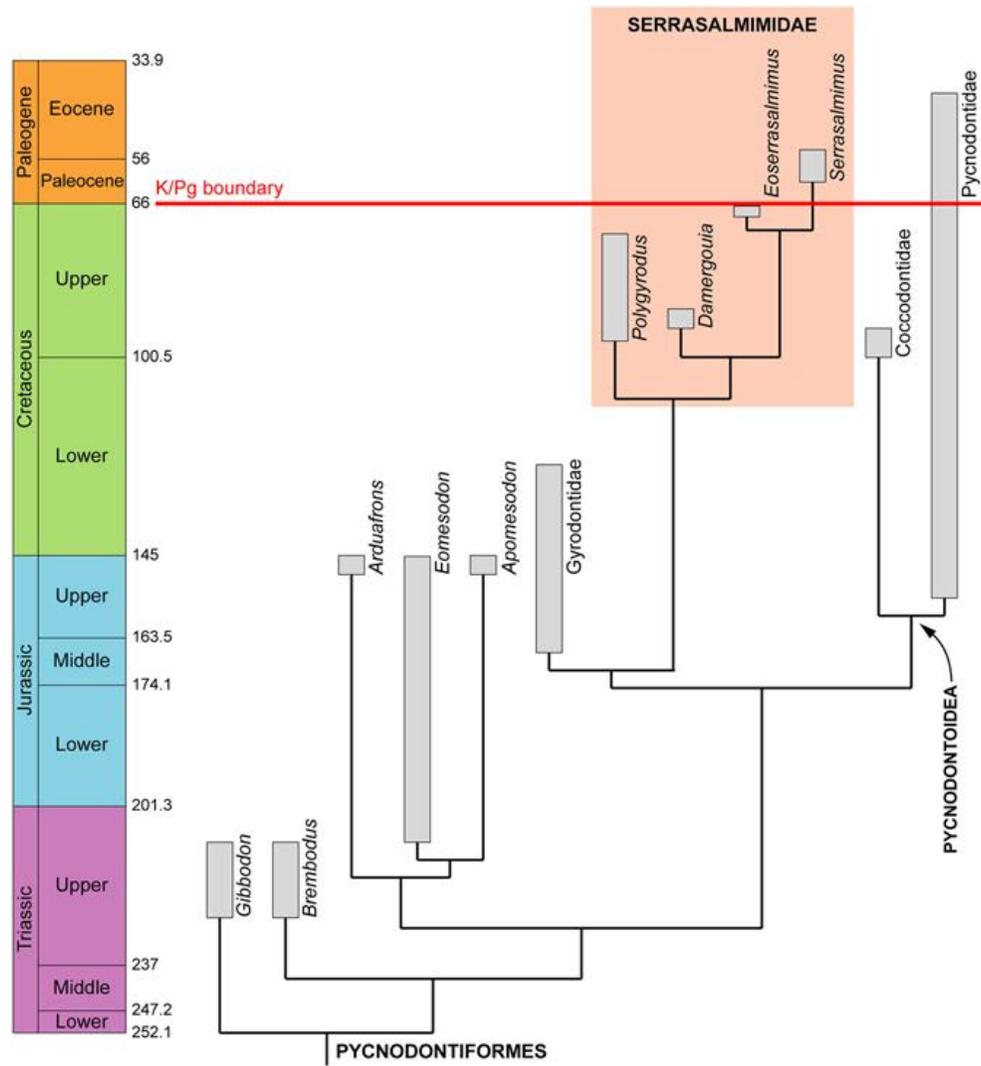


Transformacja z uzębienia kruszącego w tnące

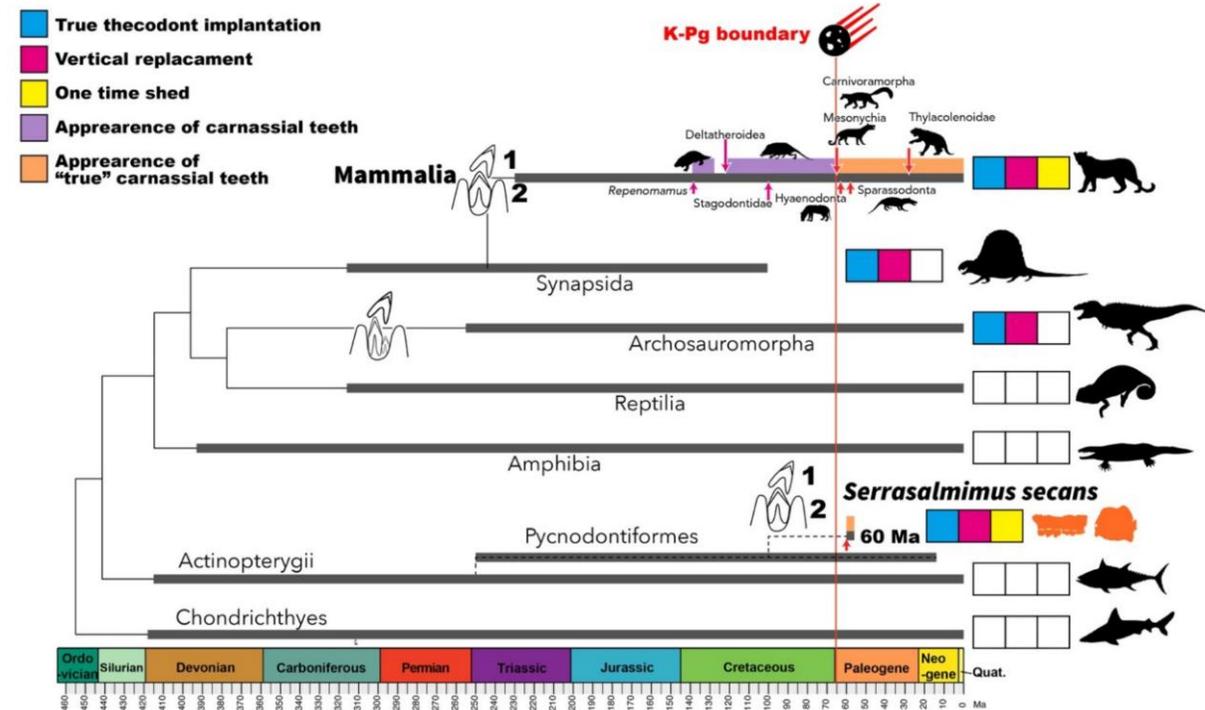
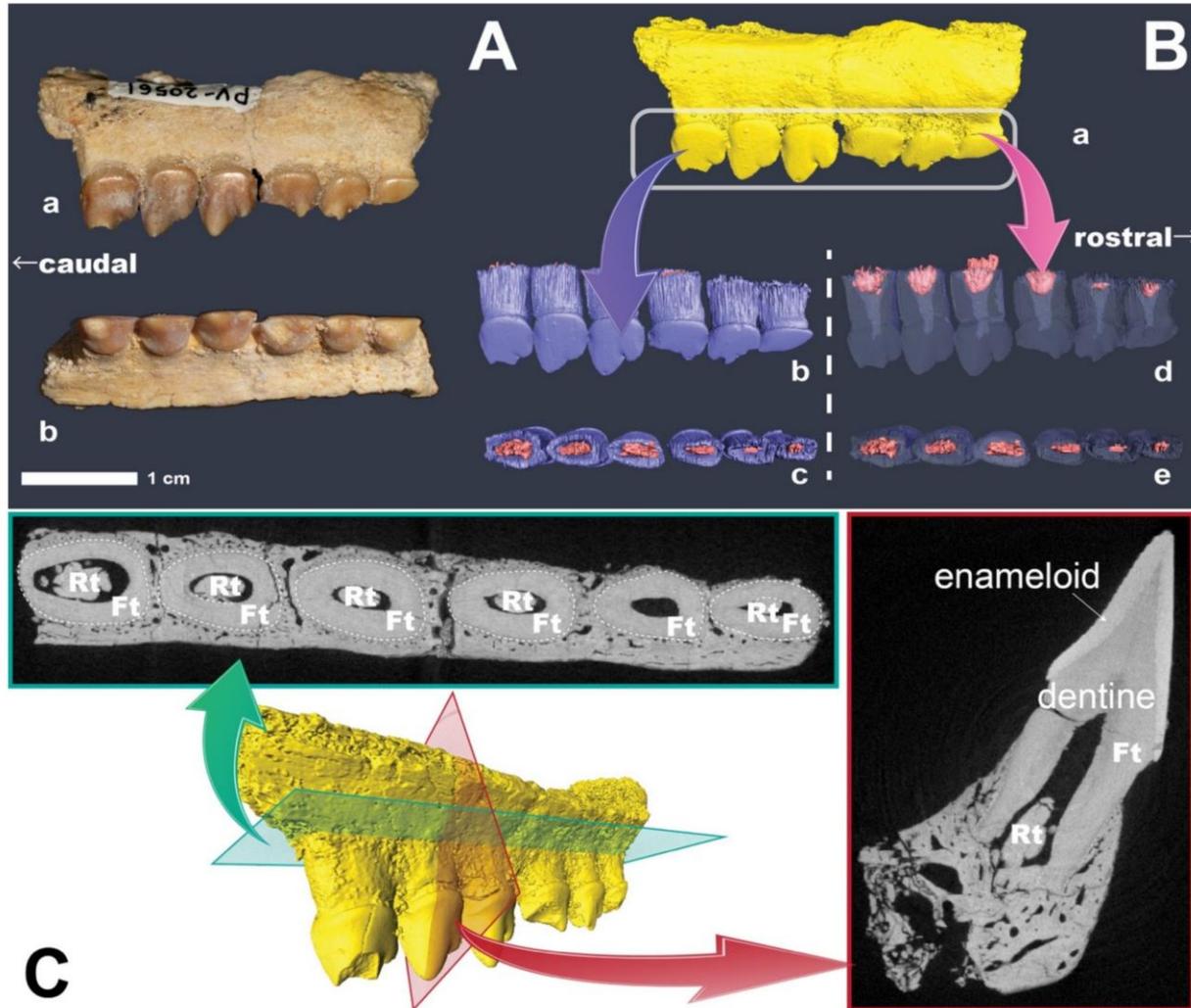


Serrasalmimus

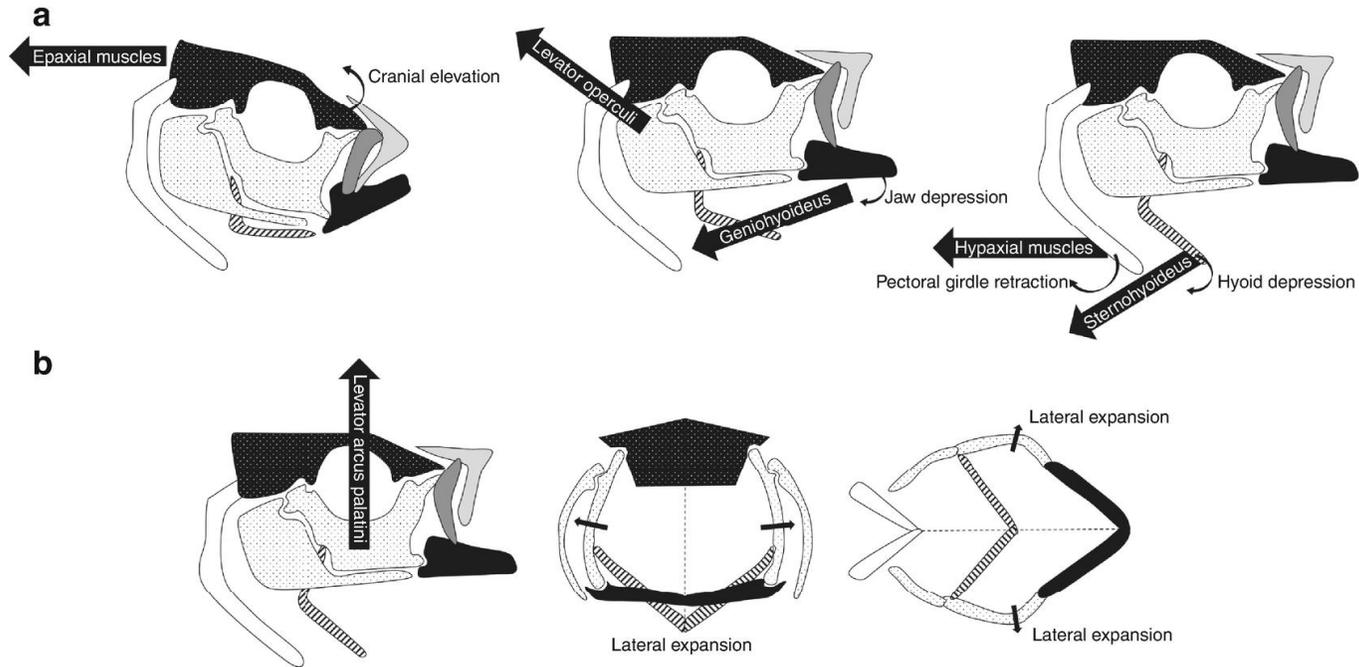
Konwergencja funkcjonalna z piraniami!



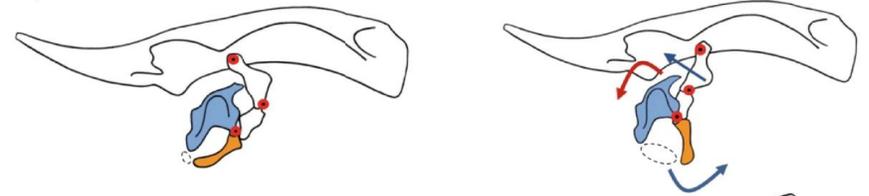
Konwergencja rozwojowa ze ssakami!



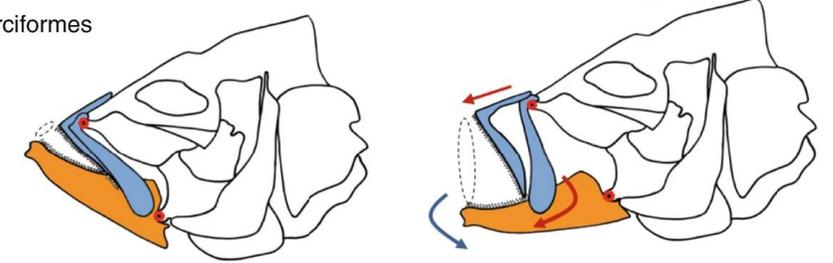
Ewolucyjne modyfikacje trzewioczaszki



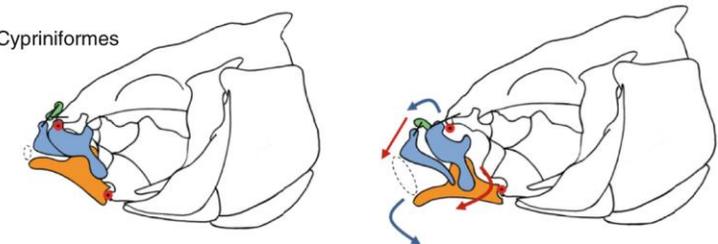
(1) Acipenseriformes



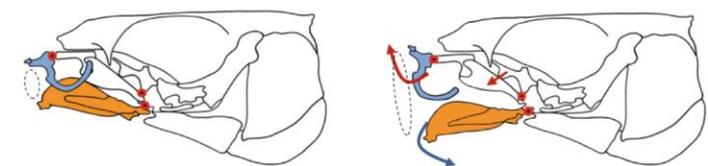
(2) Perciformes



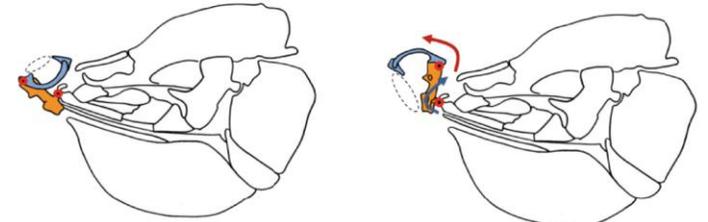
(3) Cypriniformes

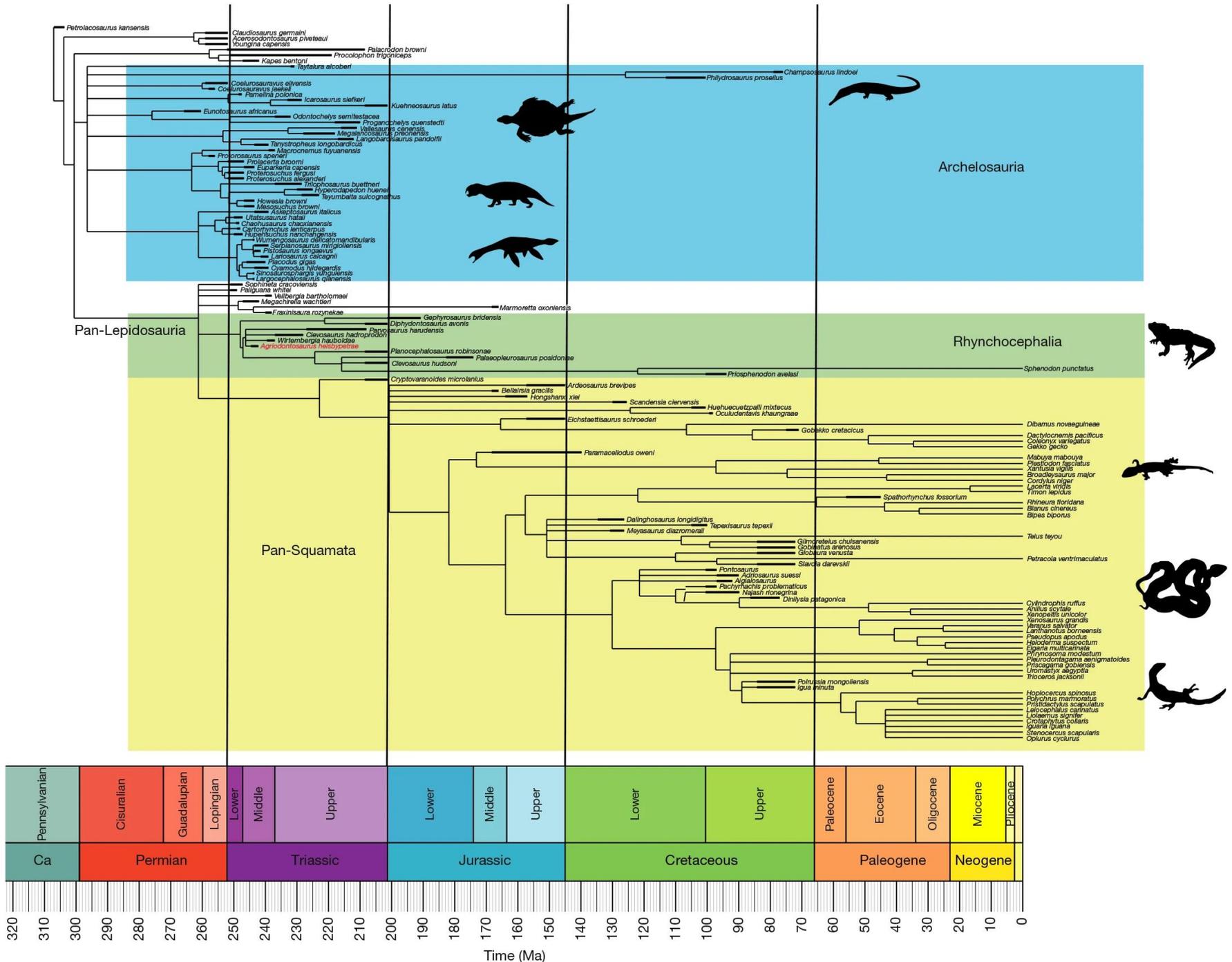


(4) Characiformes (*Bivibranchia* sp.)

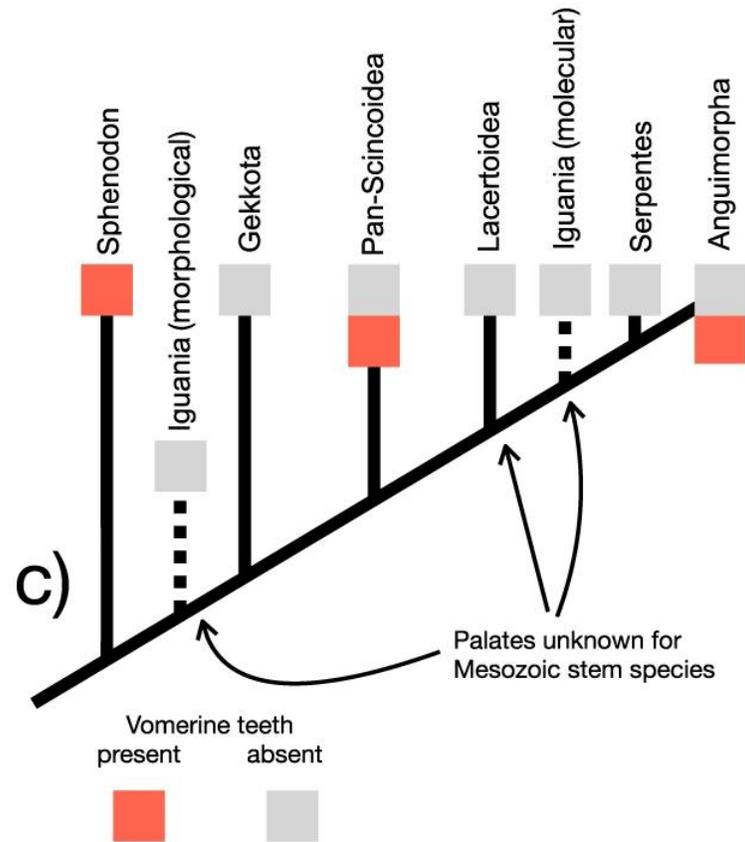
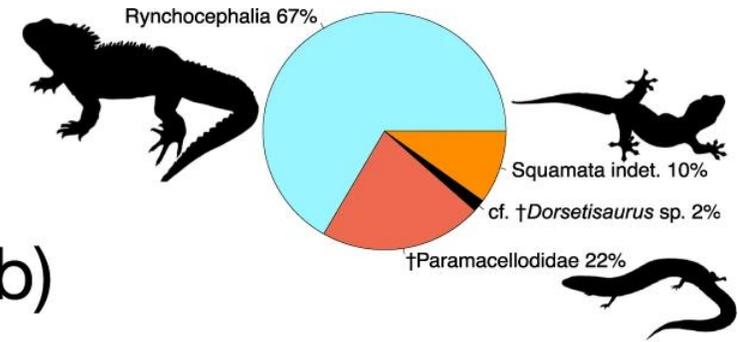
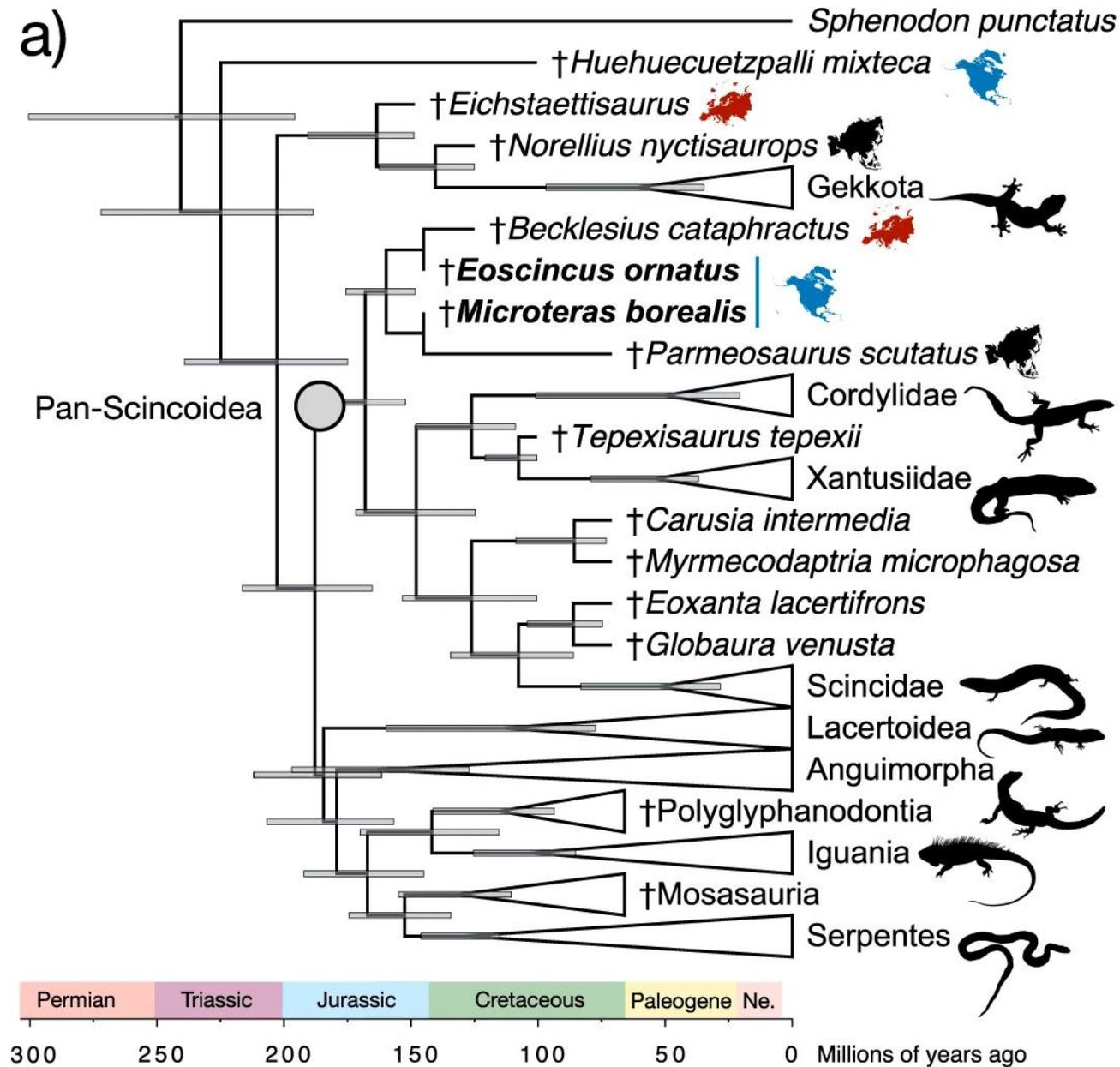


(5) Gonorynchiformes (*Phraetolemus* sp.)



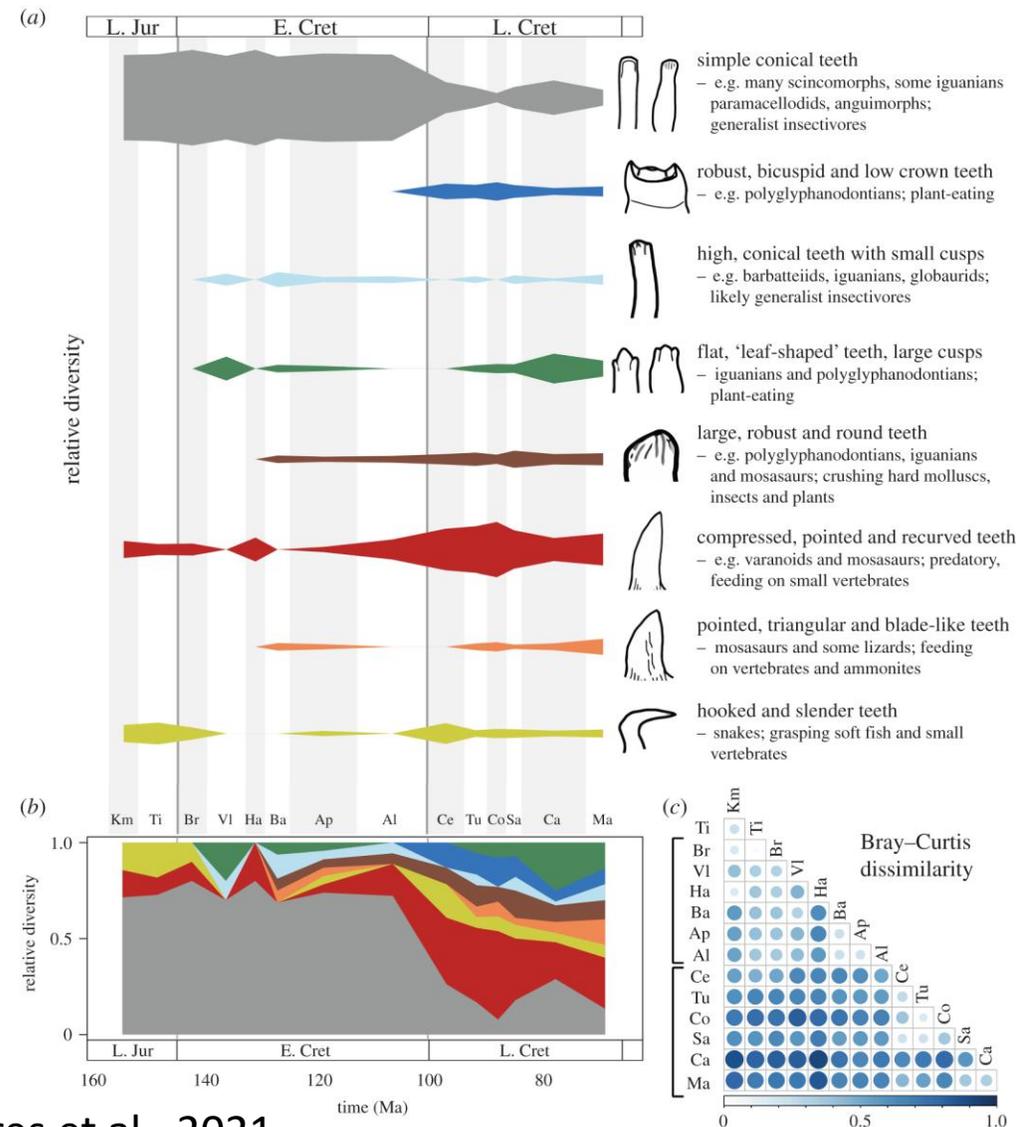


Marke et al., 2025



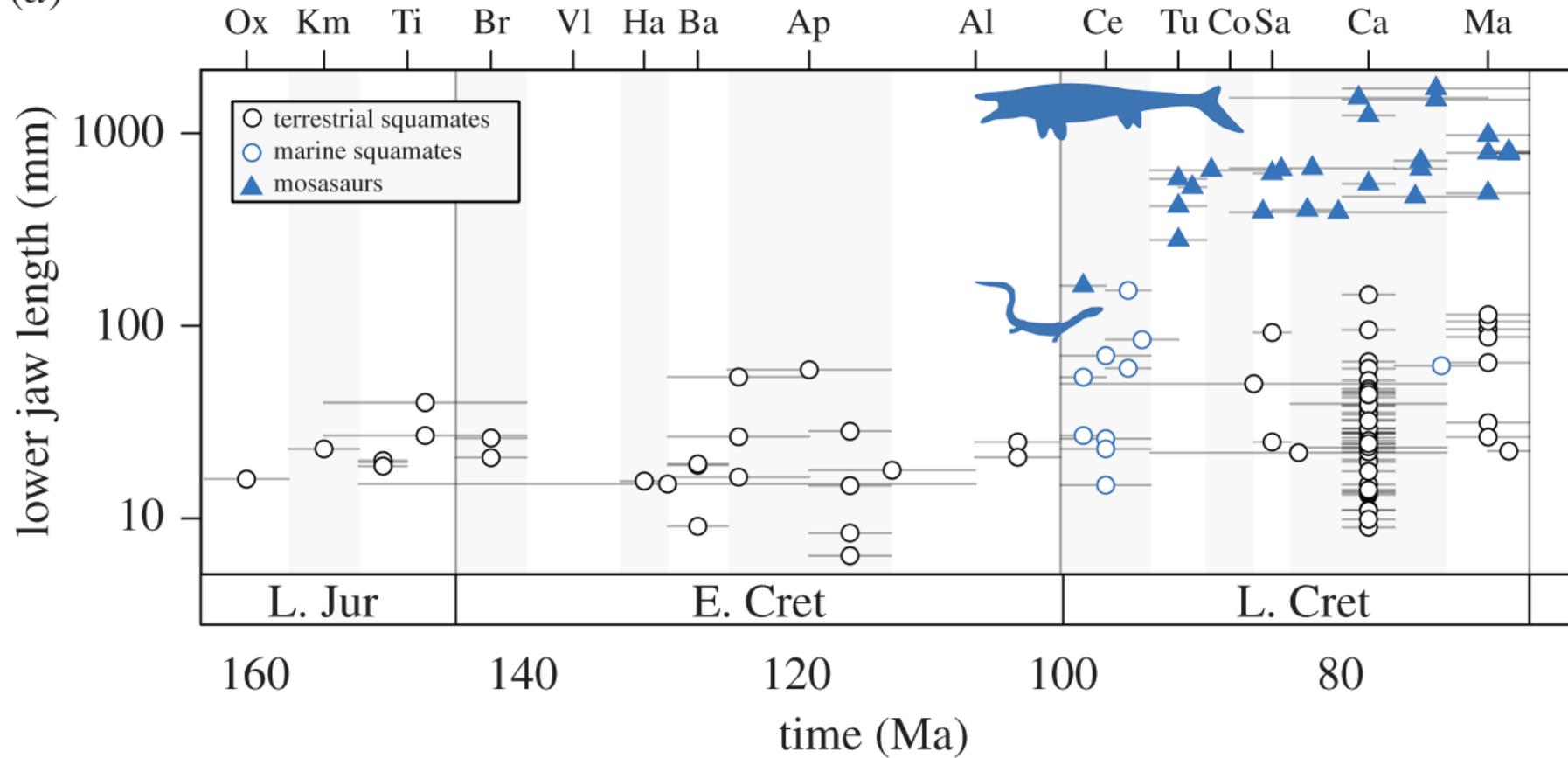
Ekomorfologiczna dywersyfikacja jaszczurek

- Jaszczurki stały się ważnym komponentem faun małych kręgowców dopiero w **późnej kredzie**.
- Nowe morfotypy zębów (nowe gildie) pojawiają się na stałe w **późnej kredzie** → stabilizacja mikrobiocenoz?
- Przełom kredy wczesnej i późnej to czas dynamicznej miniaturyzacji ale i początek gigantyzmu.
- Element **Kredowej Rewolucji Lądowej**.

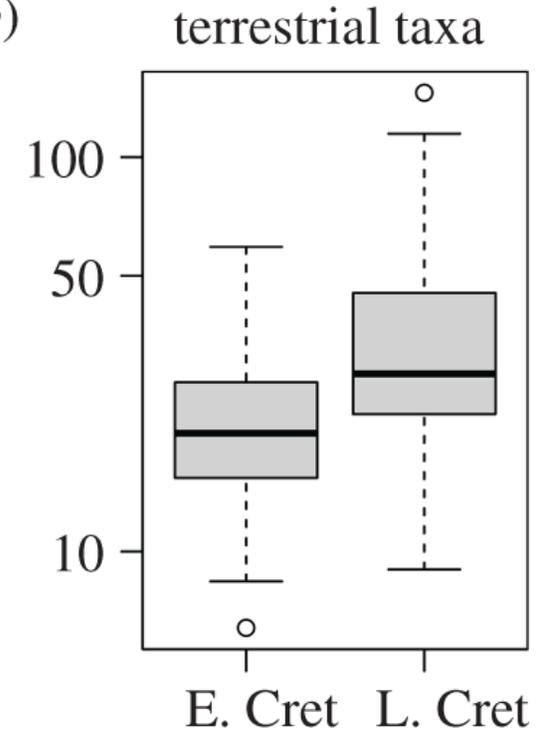


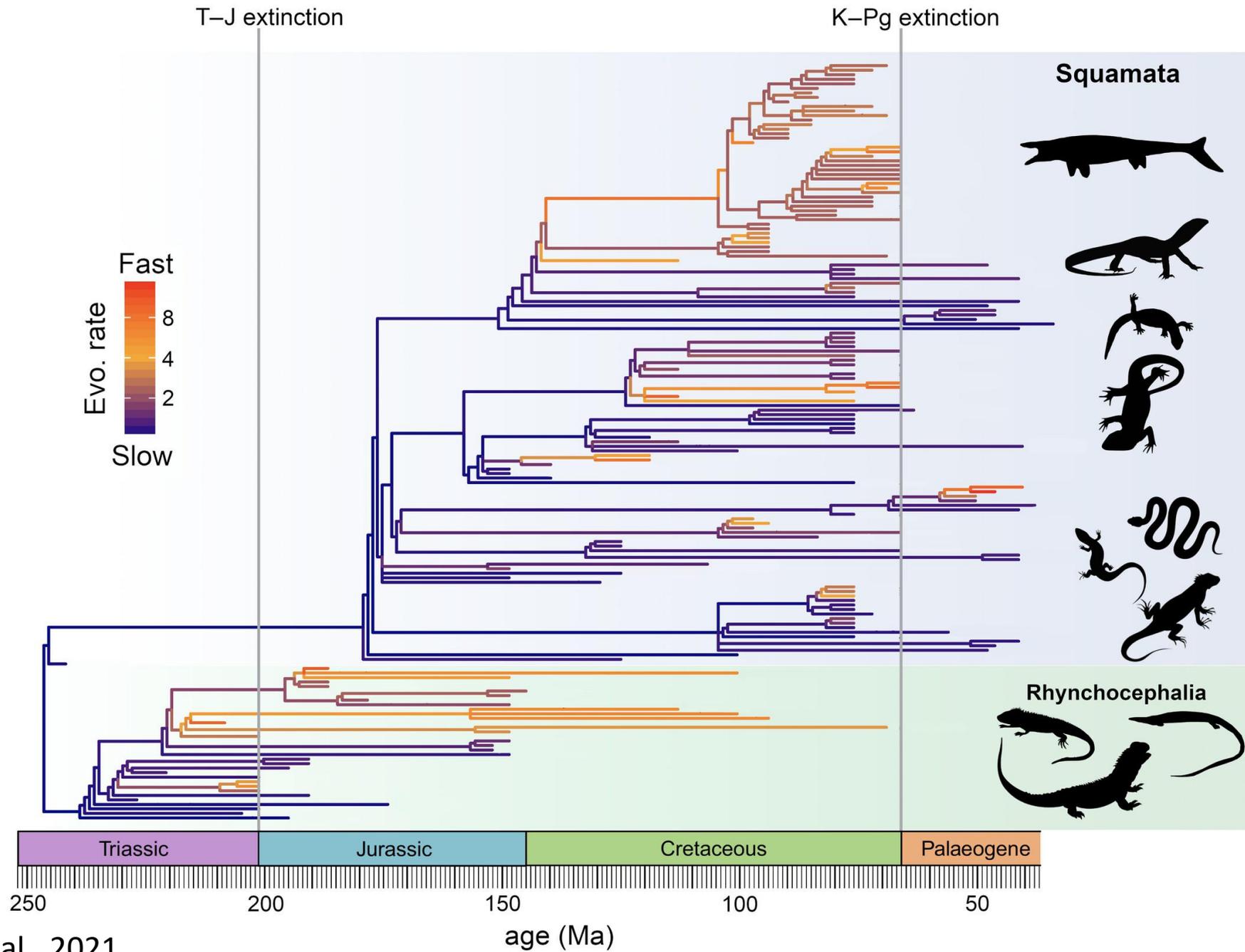
Dynamika ewolucji rozmiarów ciała

(a)

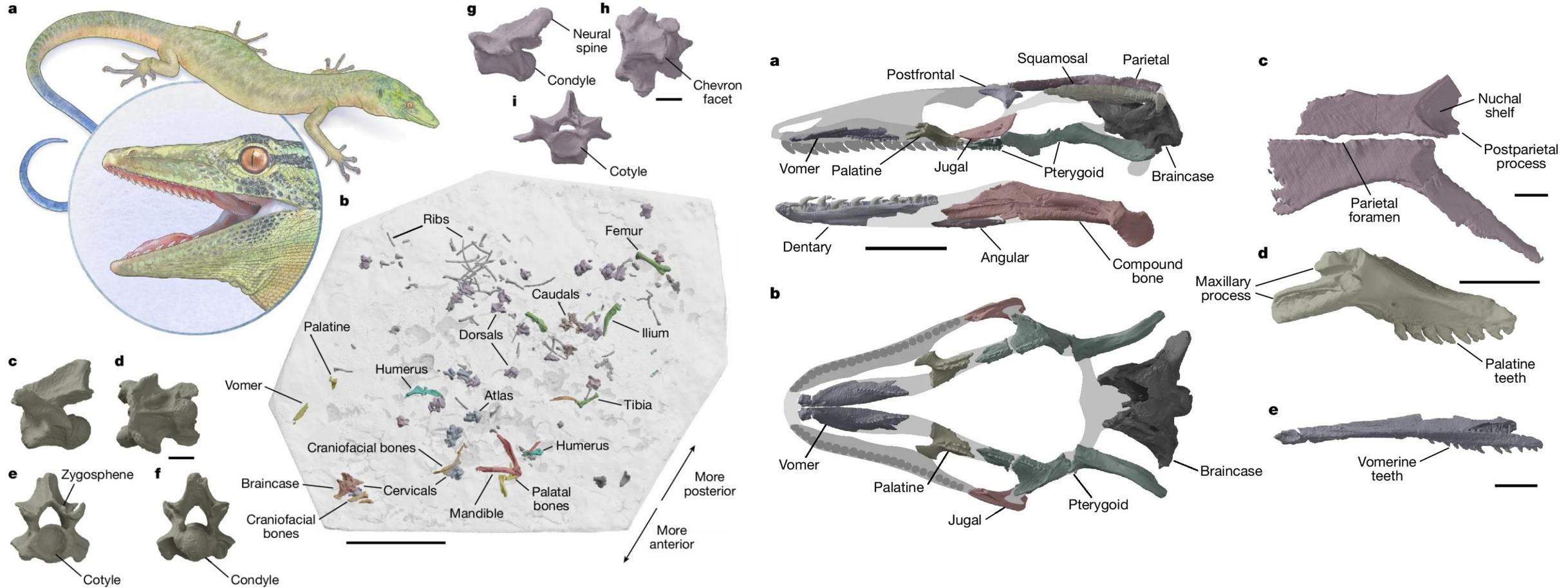


(b)

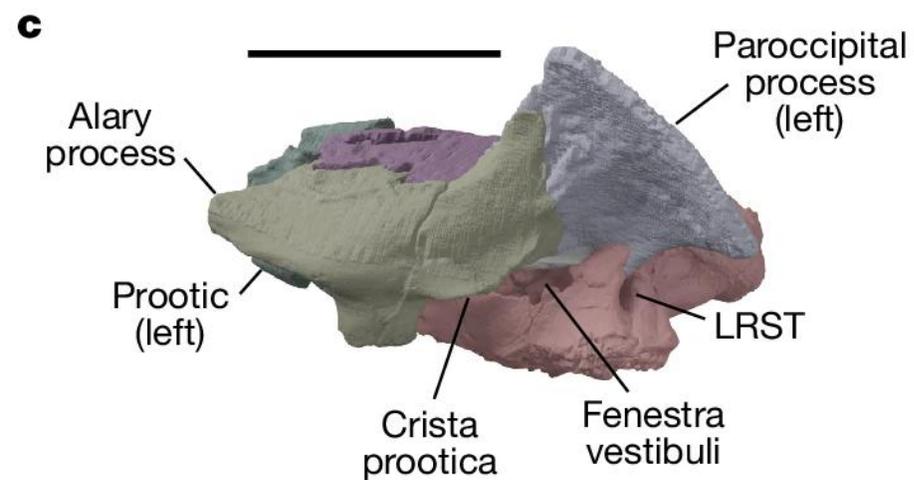
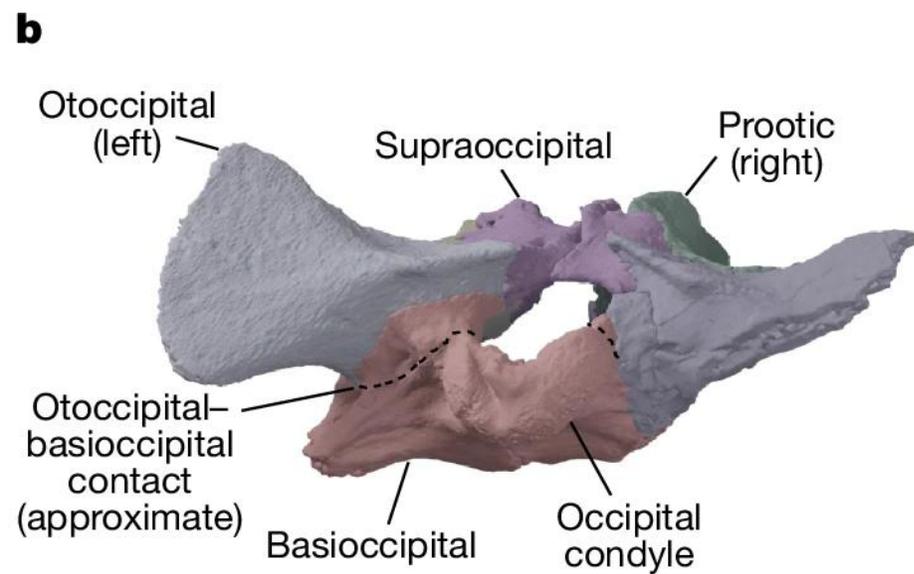
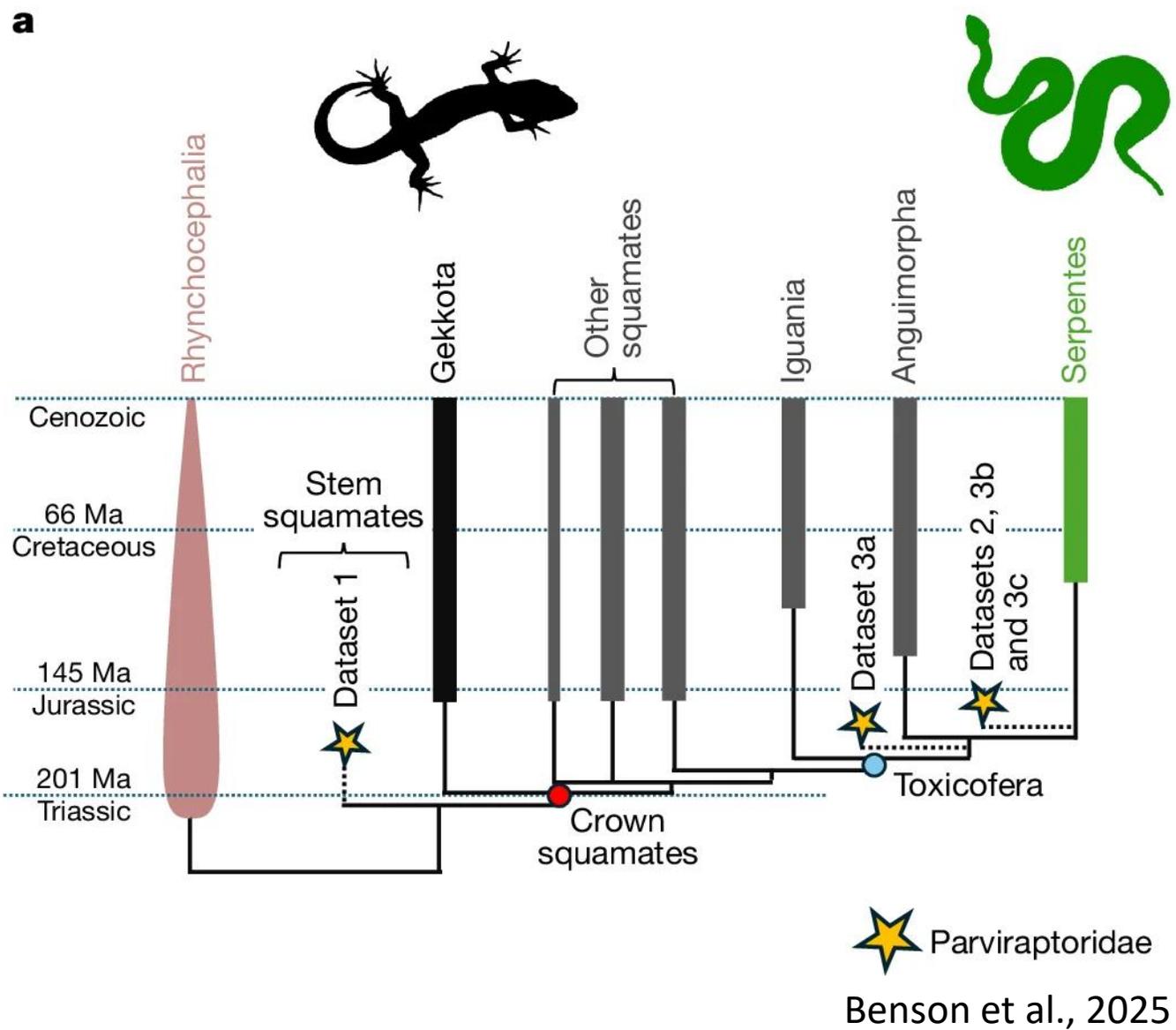


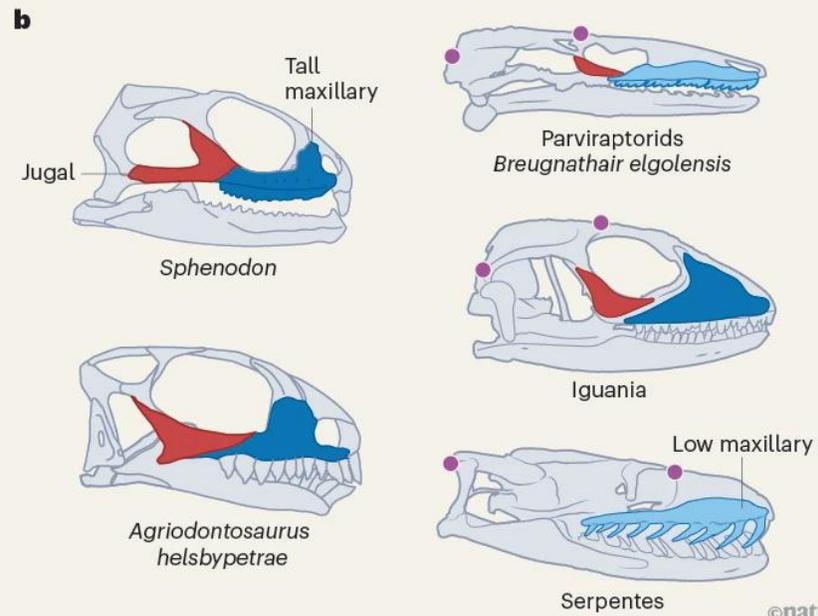
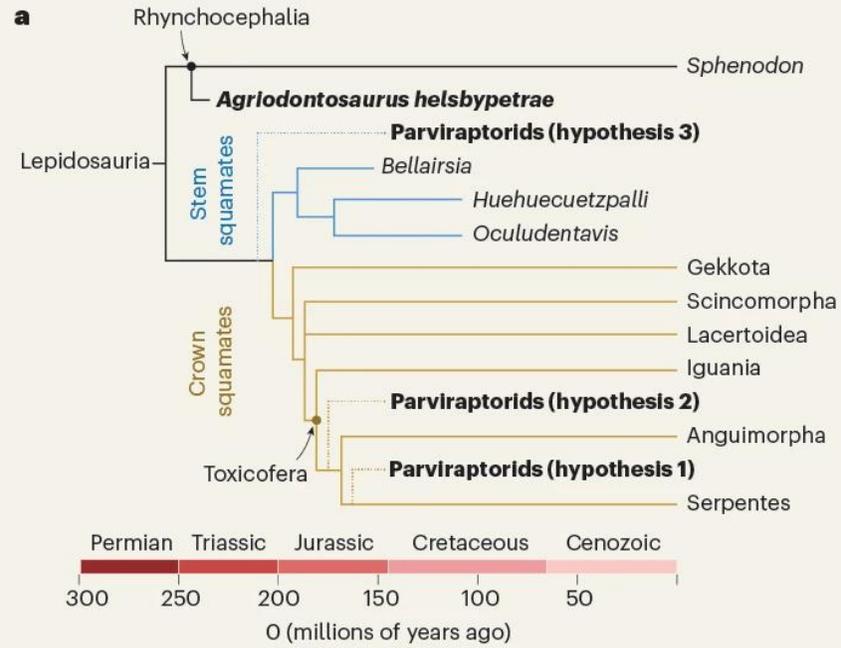


Parwiraptory – kłopotliwe ale kluczowe

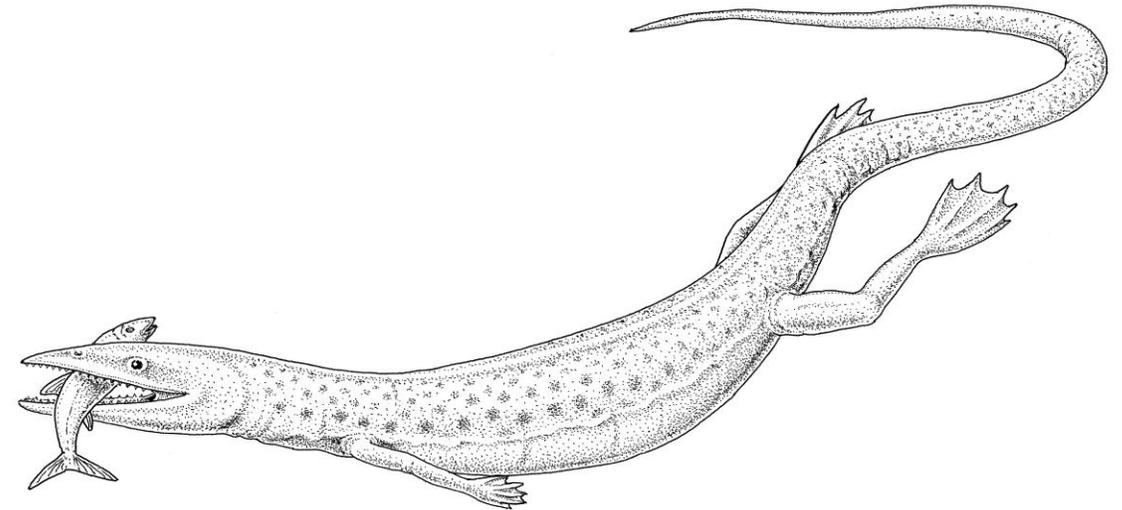
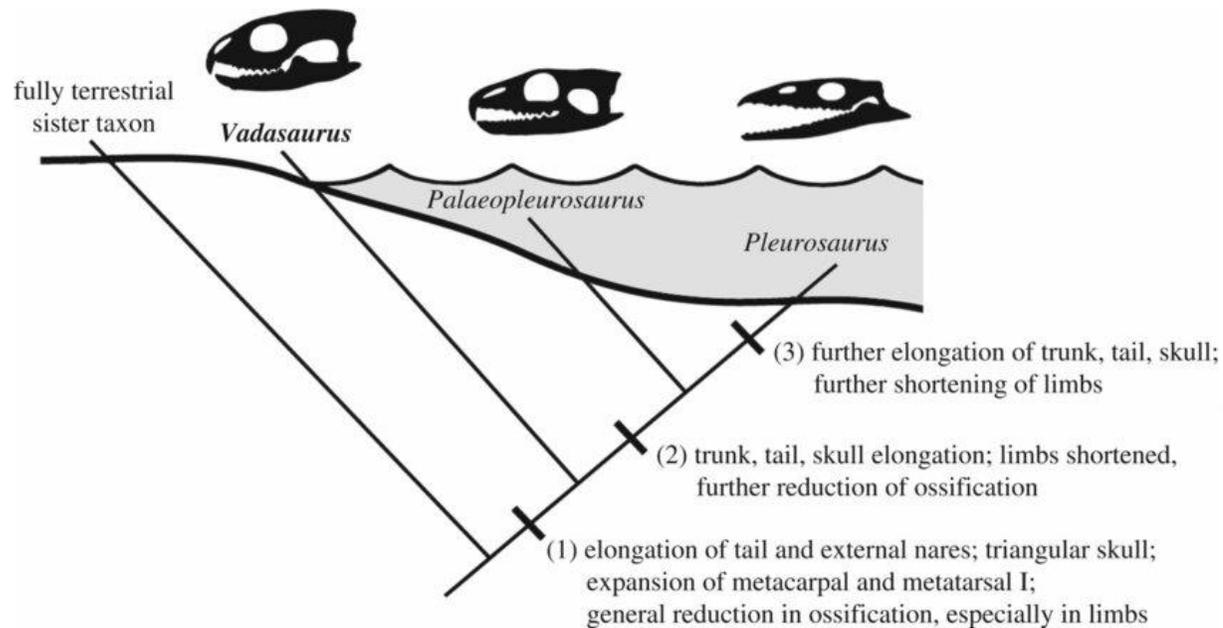


Benson et al., 2025





Pleurozaury – pierwsze wodne lepidozaurowe



Bever & Norell, 2017

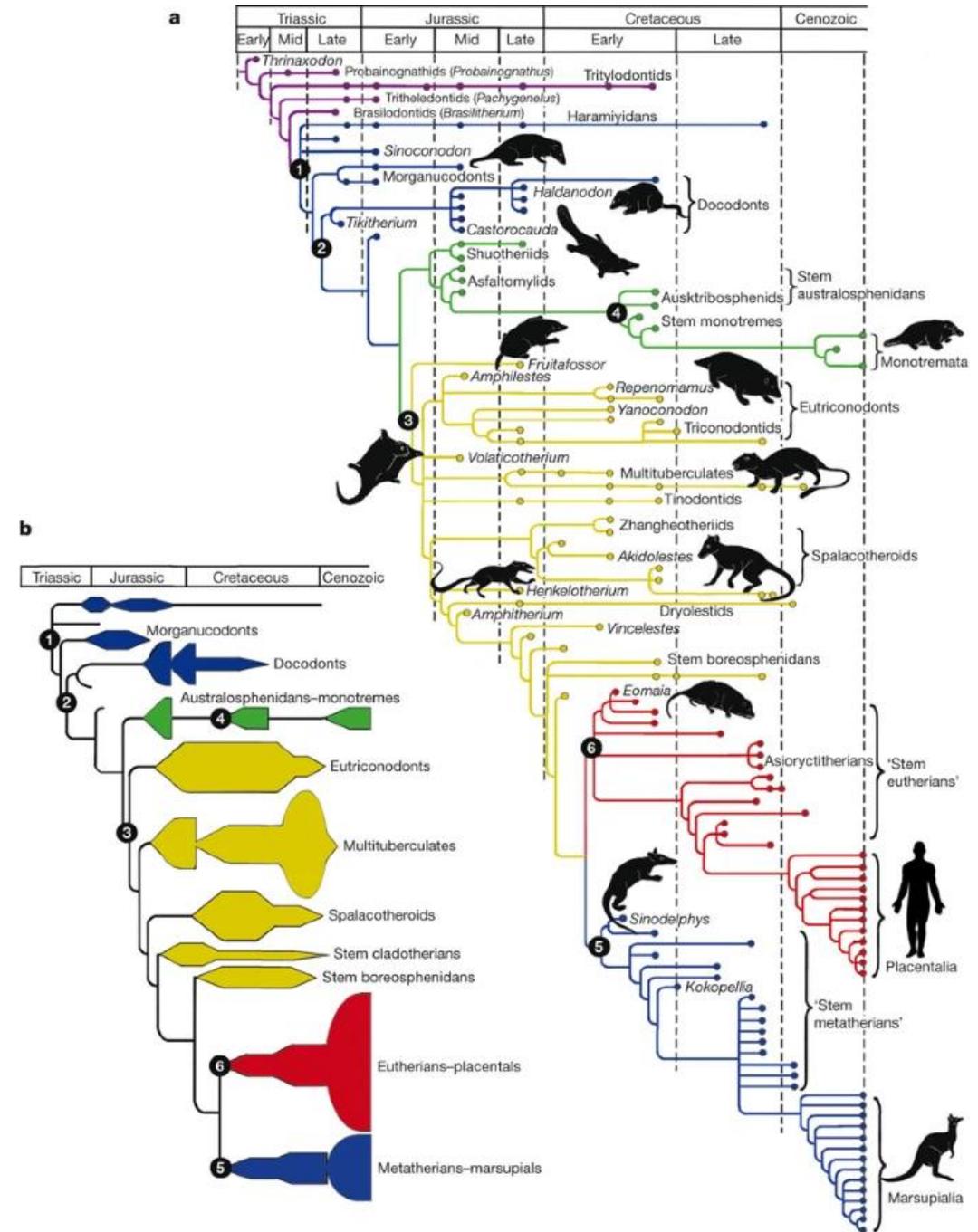


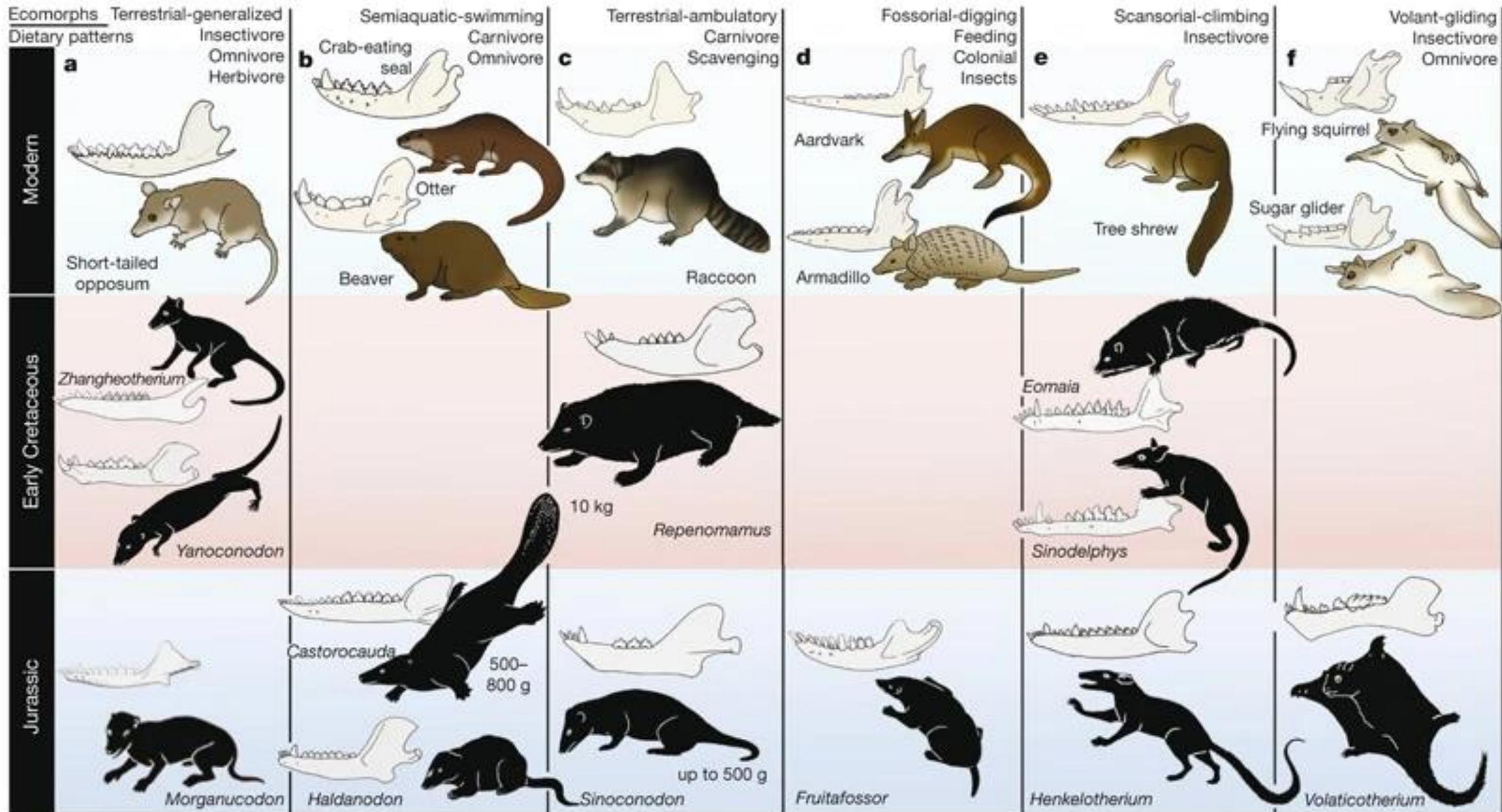
- W mezozoiku ssaki (Mammalia) i ssakopodobne (Mammaliaformes) przeszły kilka faz ewolucyjnego rozwoju:

- 1. Radiacja pierwotnych ssakopodobnych i australosfenidów → etap jurajski.

- 2. Radiacja eutrykonodontów, multituberkulatów i trybosfenidów (boreosfenidów) → etap kredowy.

- Na gruncie paleontologicznym najważniejszymi cechami są budowa ucha środkowego i ewolucja trybosfenicznych trzonowców.



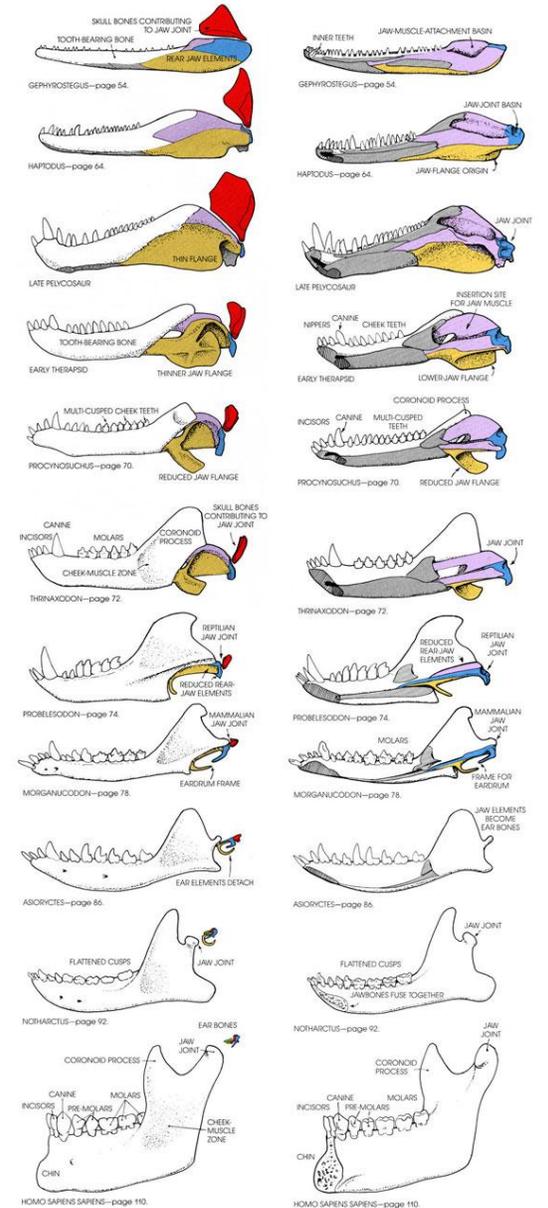
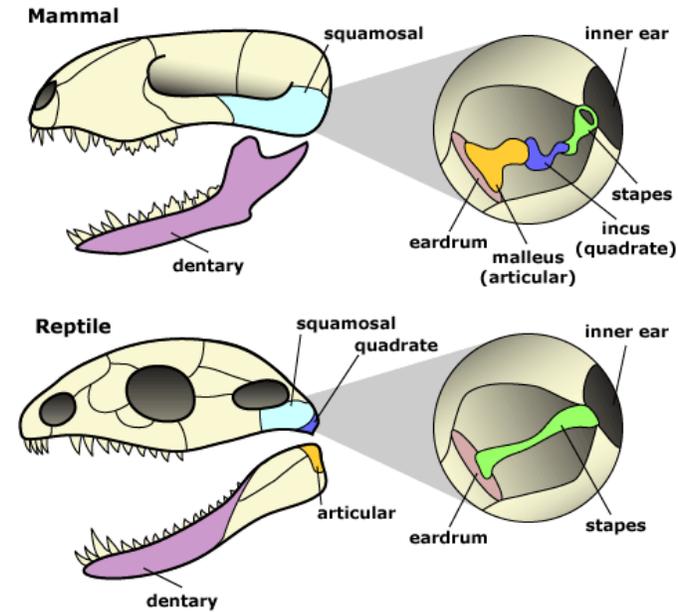


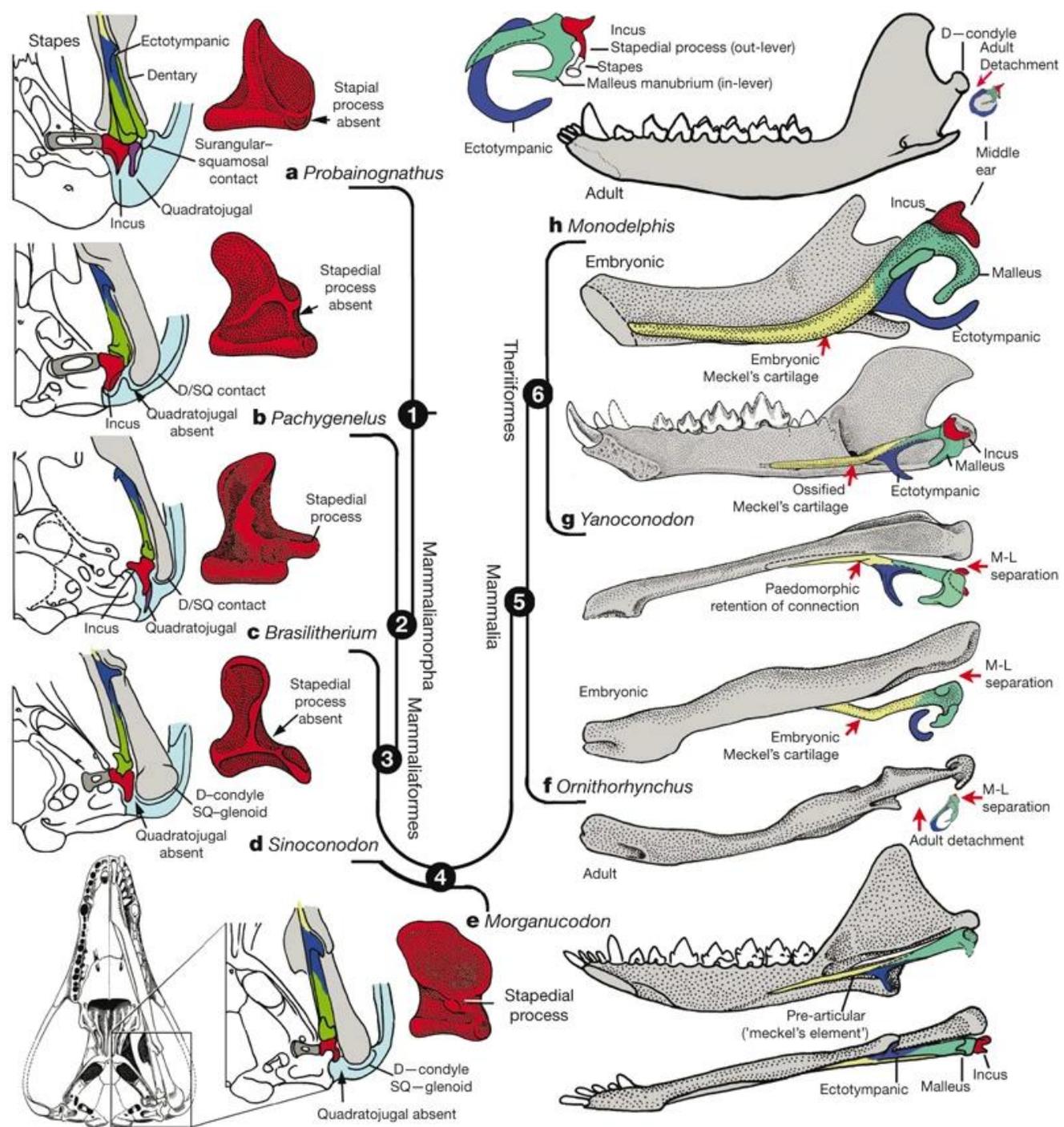
"Stereotypes"

Newly discovered ecomorphological diversification in Mesozoic mammals

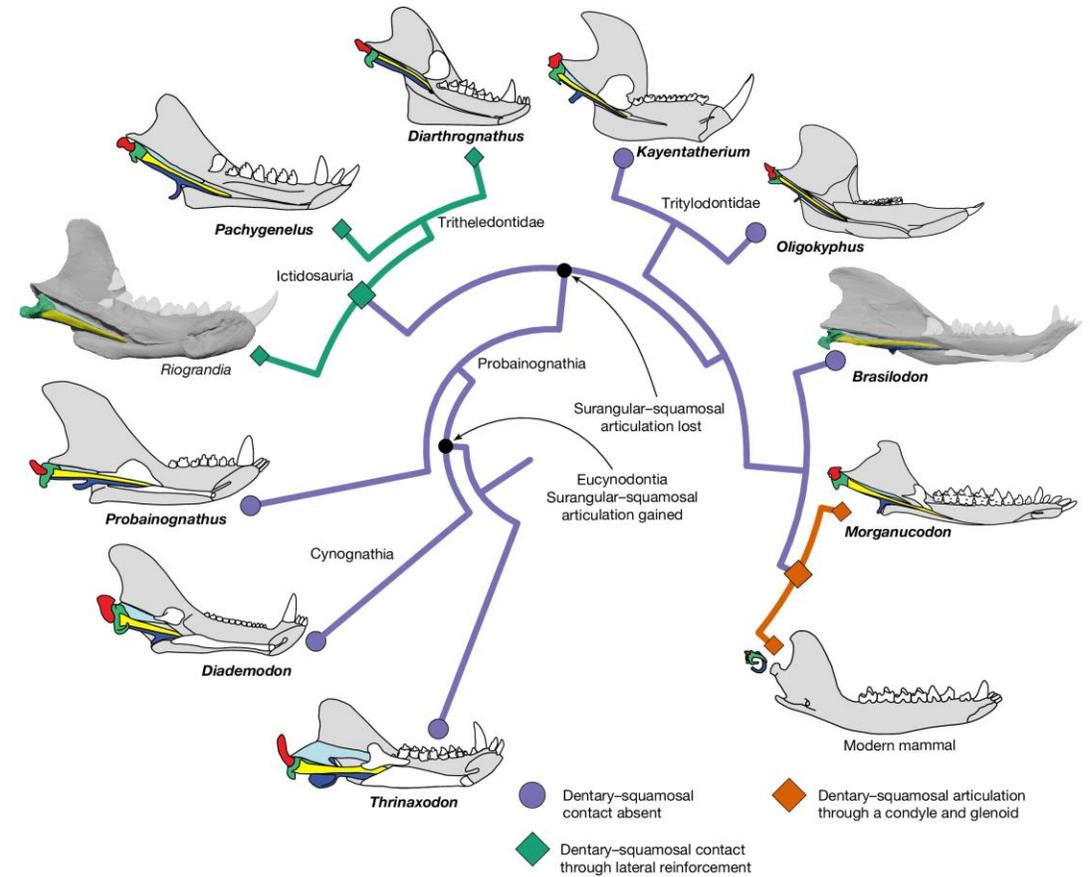
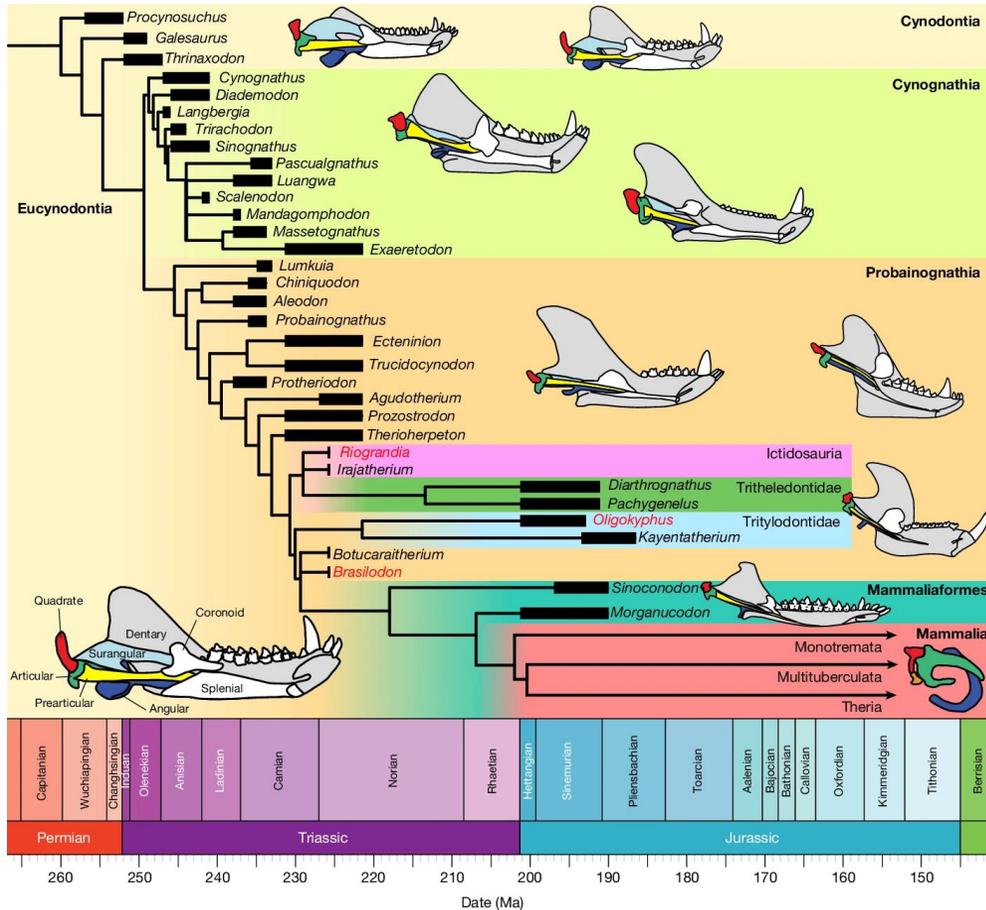
Teoria Reicherta-Gauppa

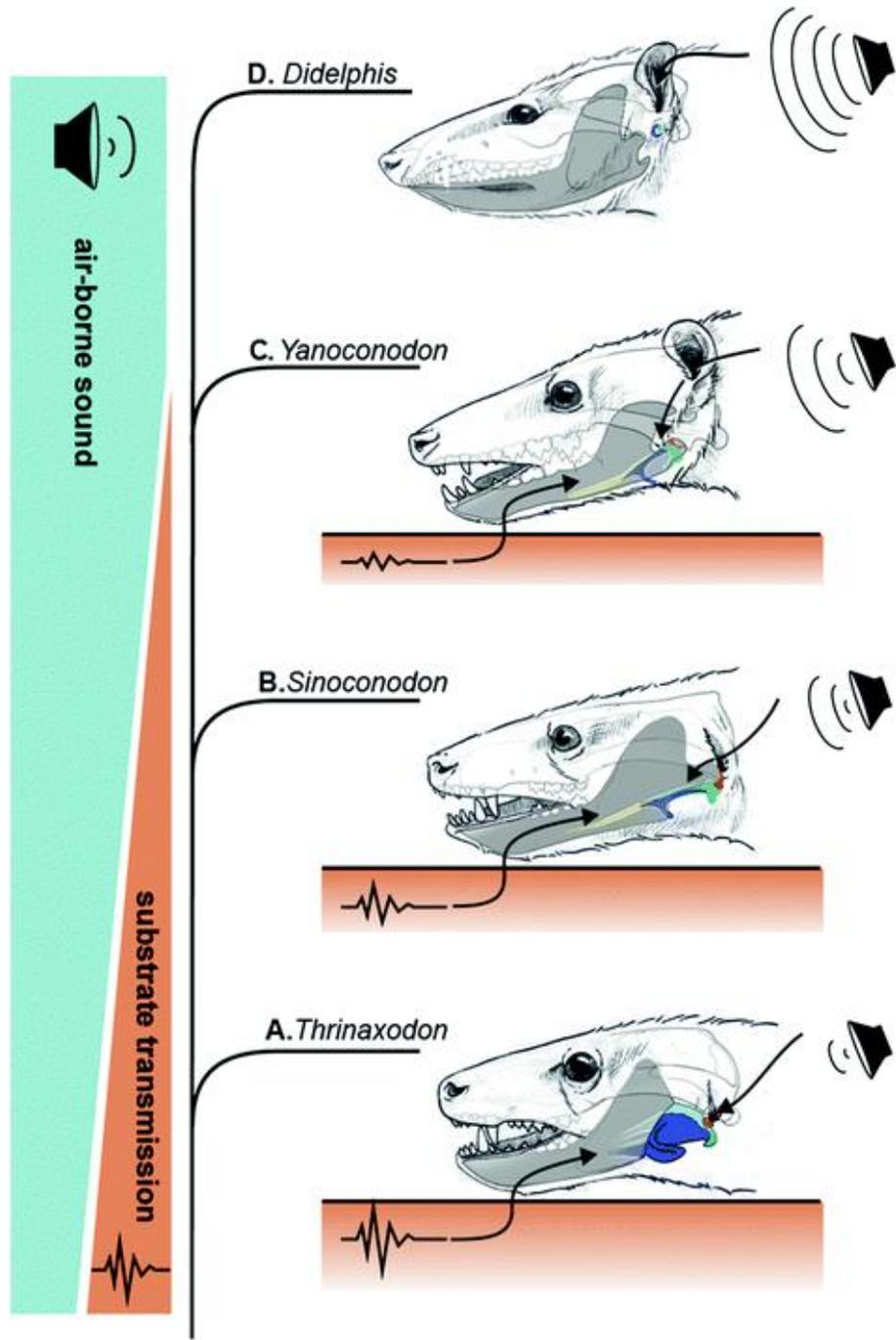
- Szereg transformacji ewolucyjnych wywołanych redukcją kości żąbrowych i rozbudową regionu dziobiastego kości żębowej:
- Kość kwadratowa → kowadełko
- Kość kąтова → młoteczek
- Blaszka kości kątovej → kość bębenkowa
- Strzemiączko odziedziczone po wczesnych Tetrapoda



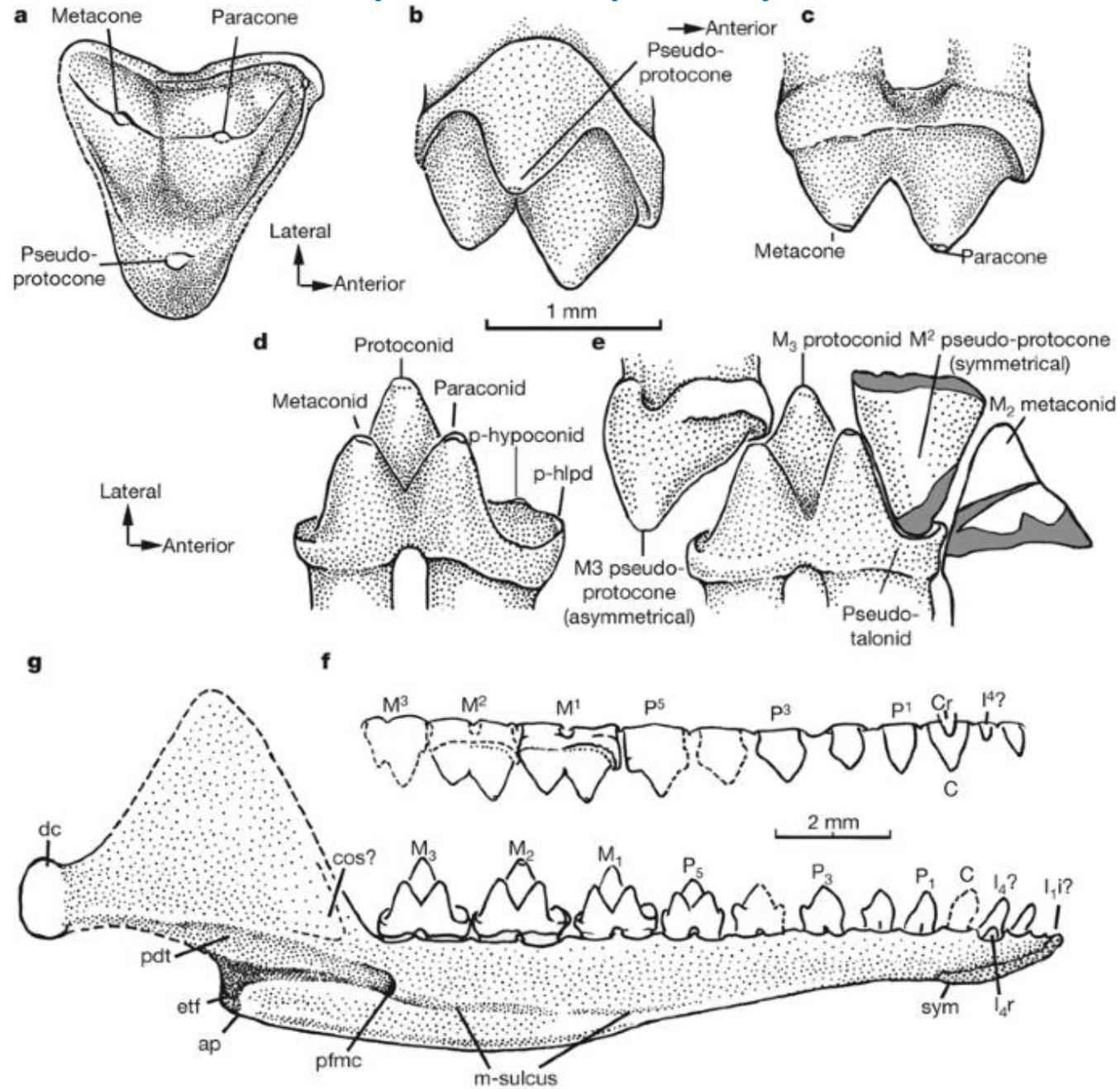


Homoplazja stawu szczękowego

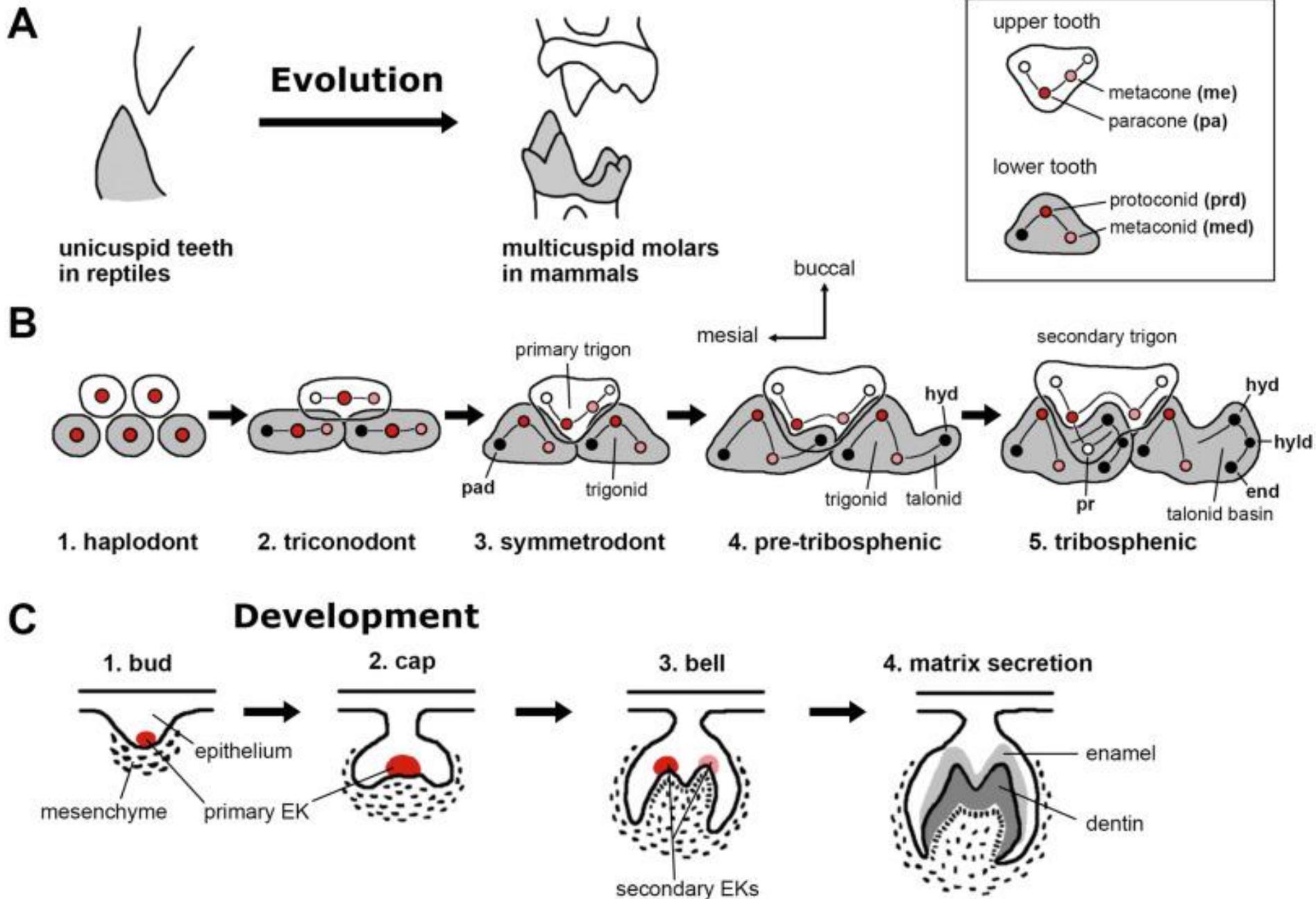


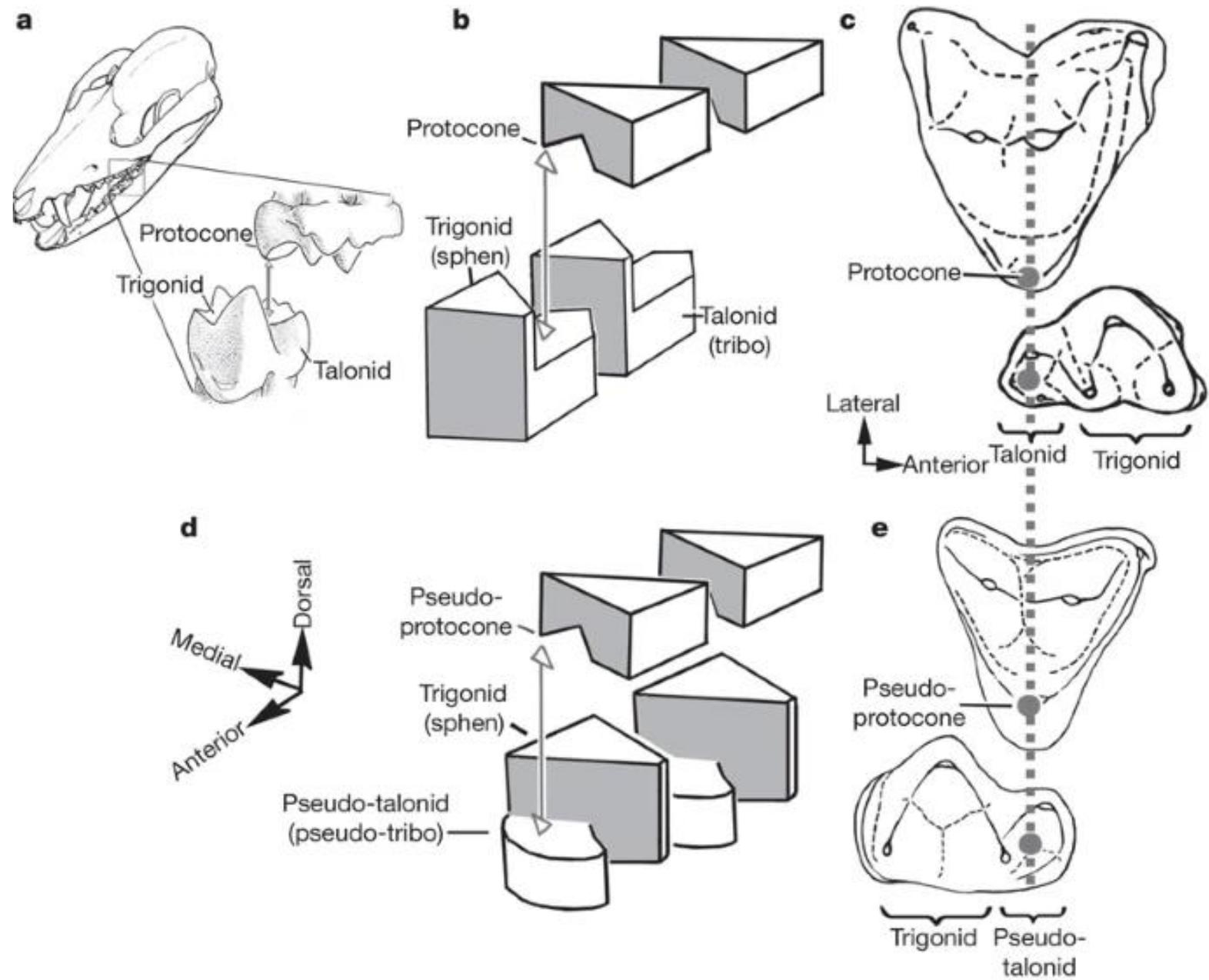


Trzonowce trybosfeniczne i pseudotrybosfeniczne

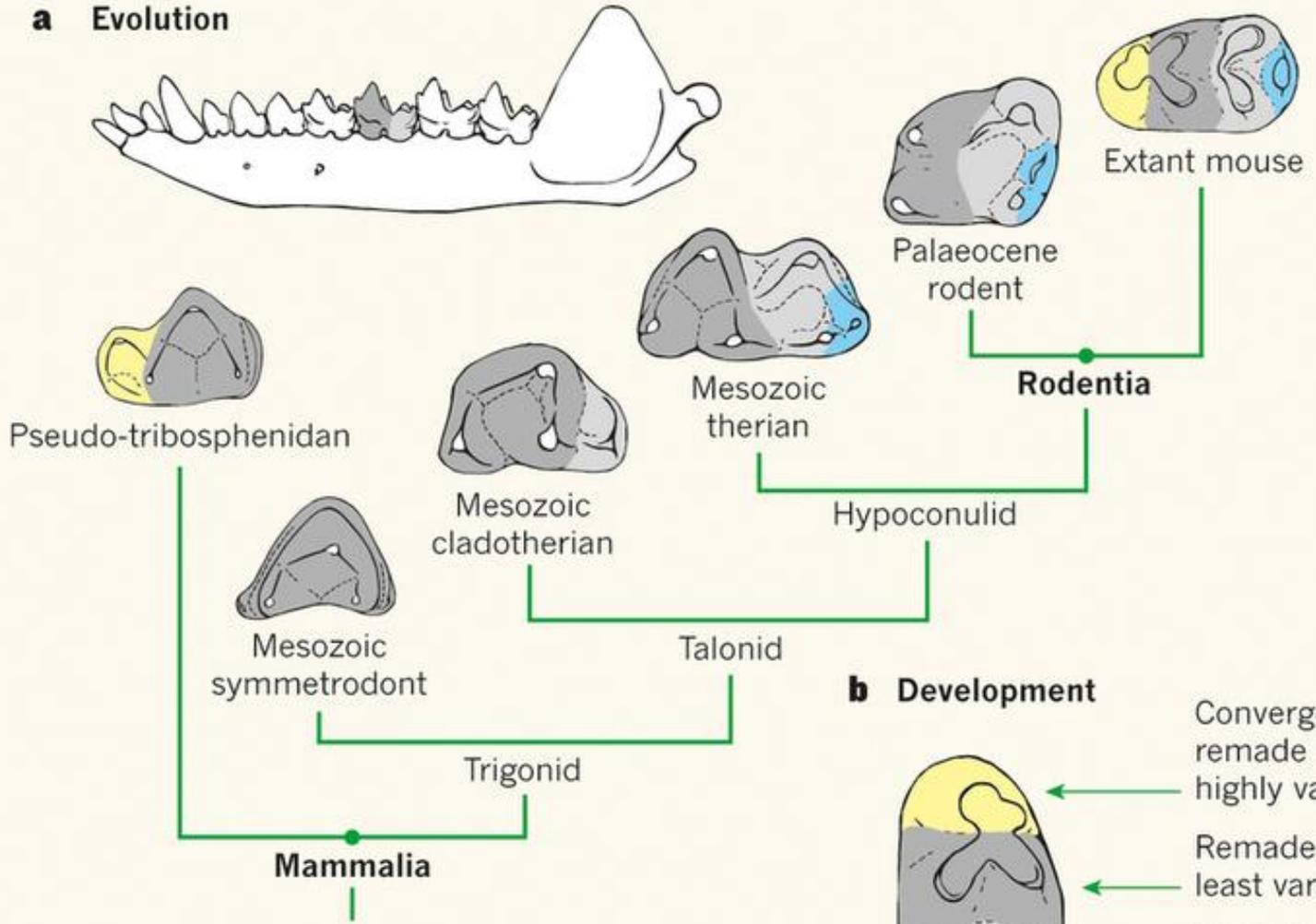


Model Copea-Osborna

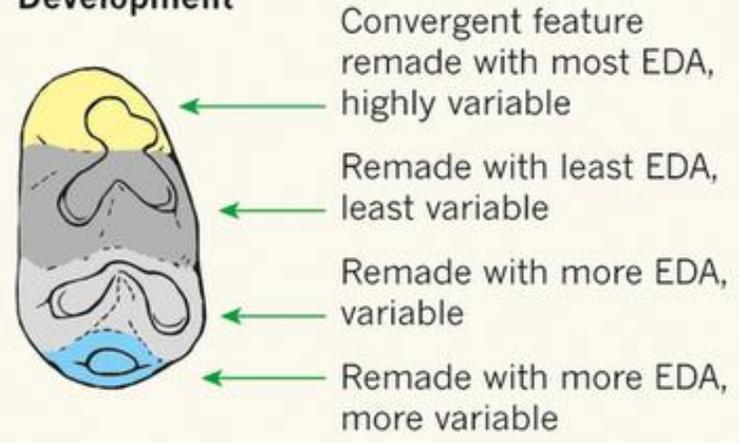


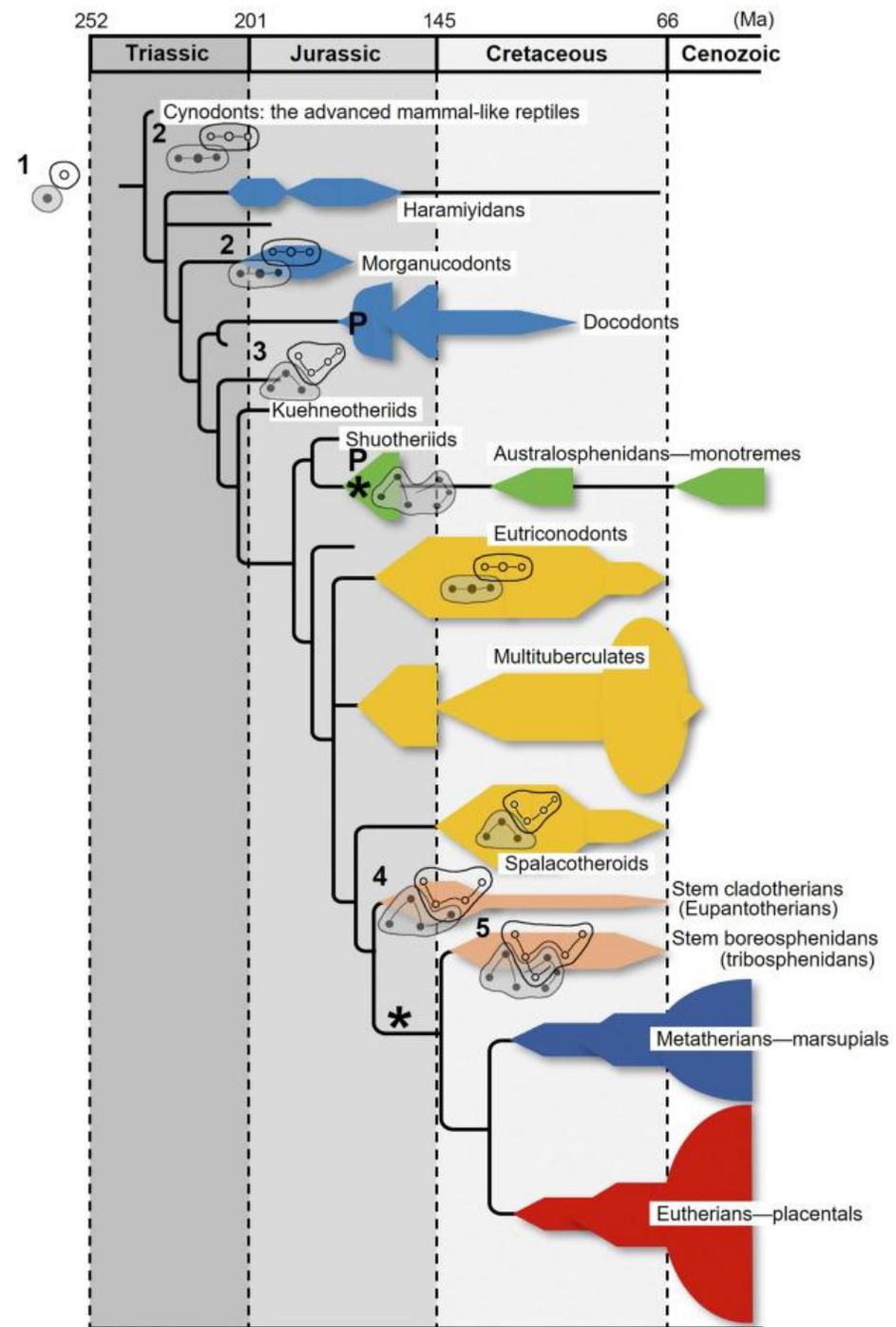


a Evolution

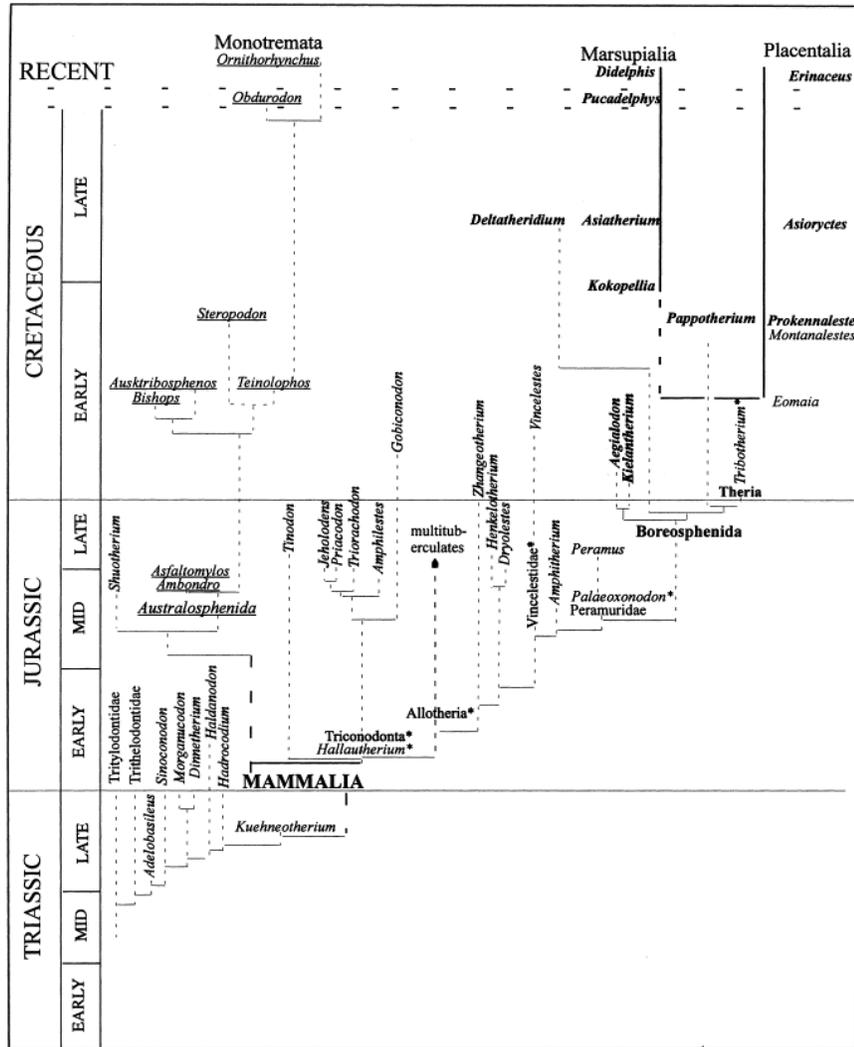


b Development

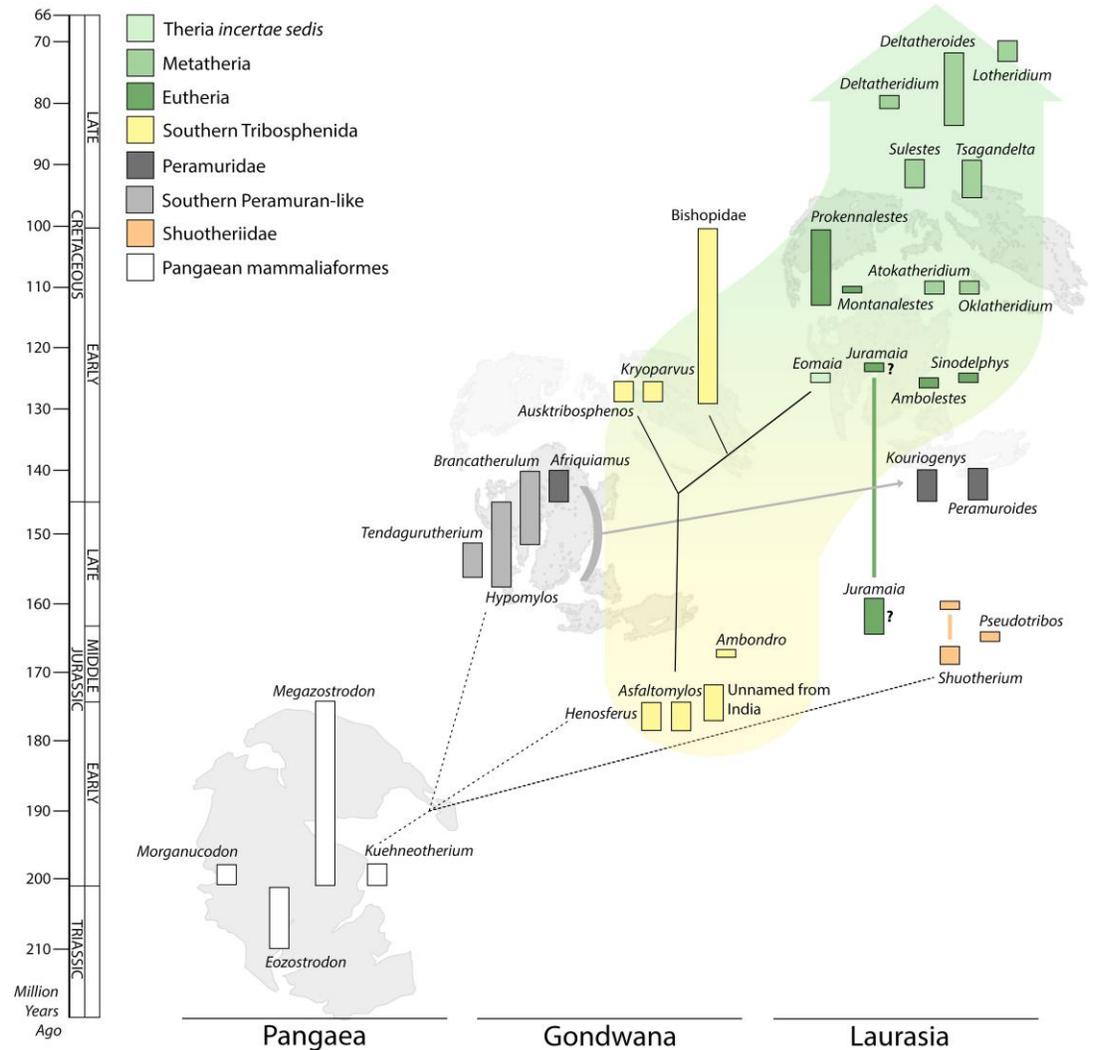




Biogeografia australosfenidów i boreosfenidów



Woodburne et al., 2003

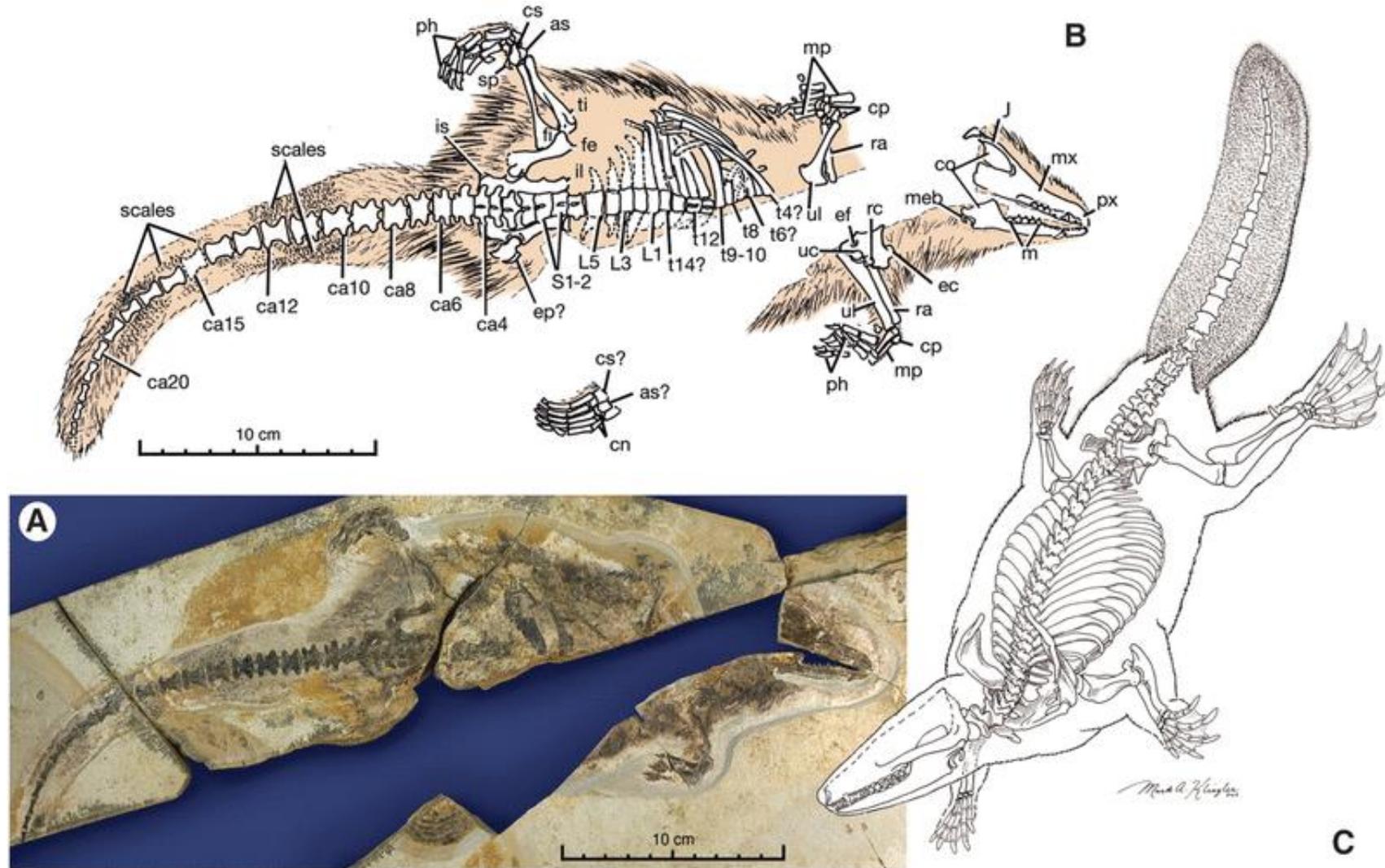


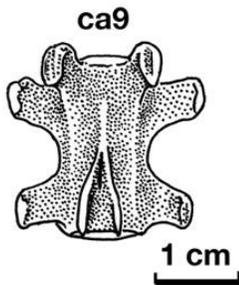
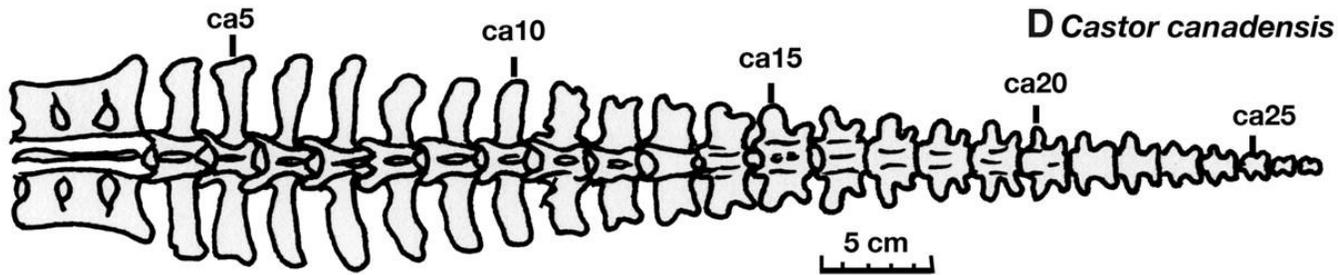
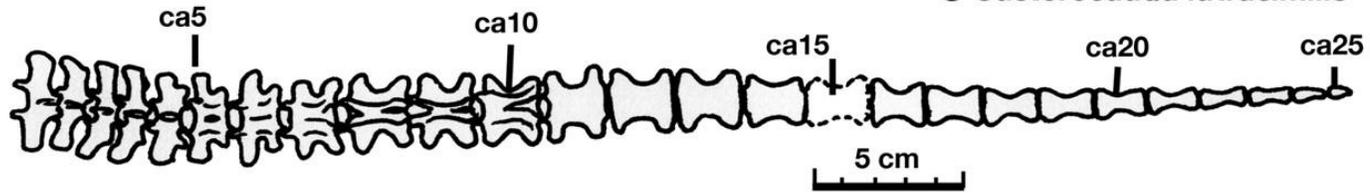
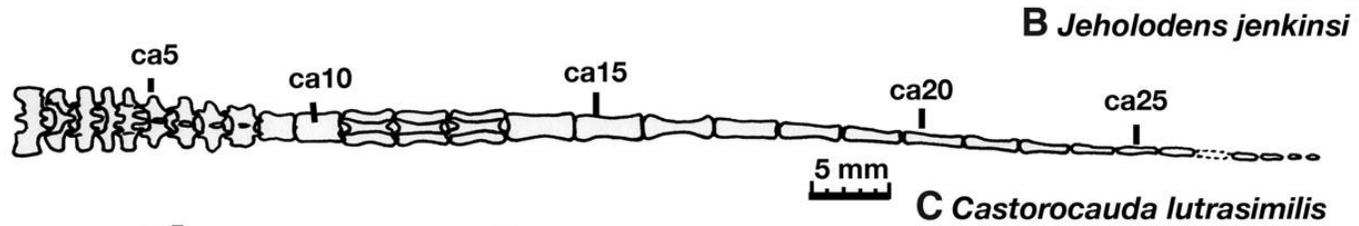
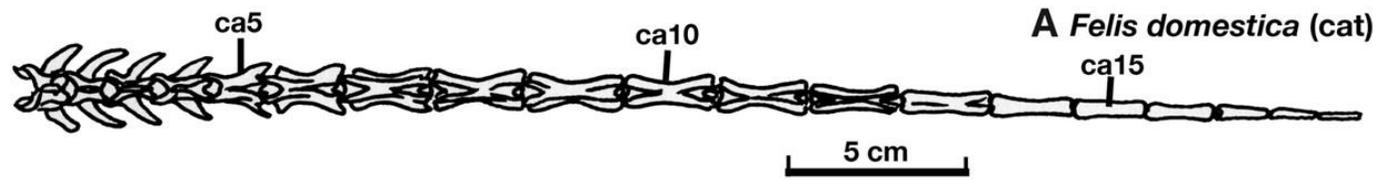
Flannery et al., 2022

Morganucodon

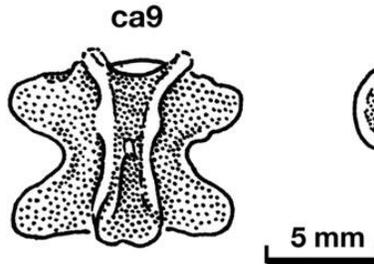


Castorocauda lutrasimilis

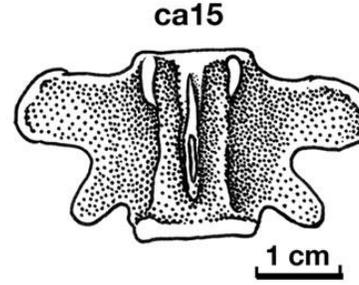
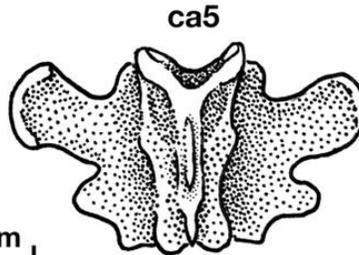




E *Lutra*



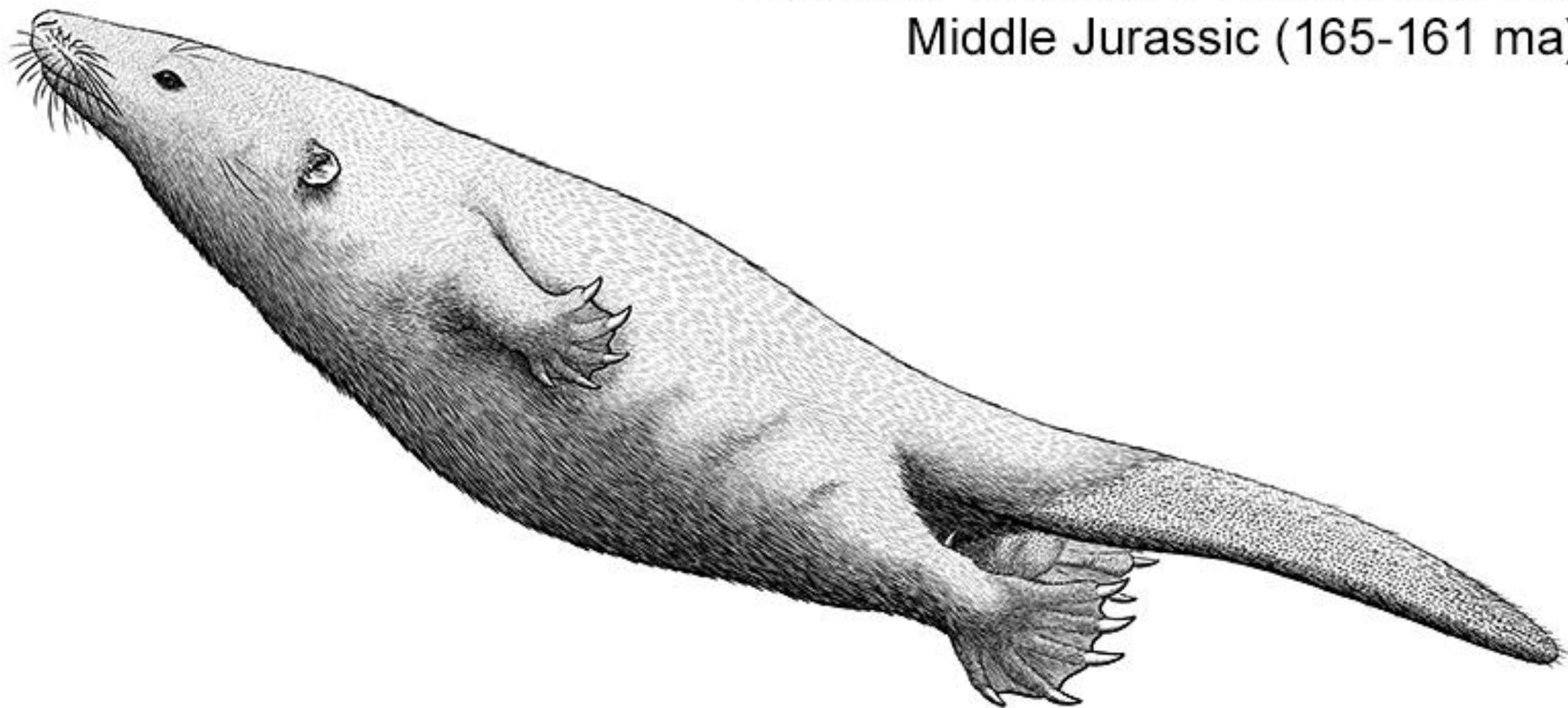
F *Castorocauda*



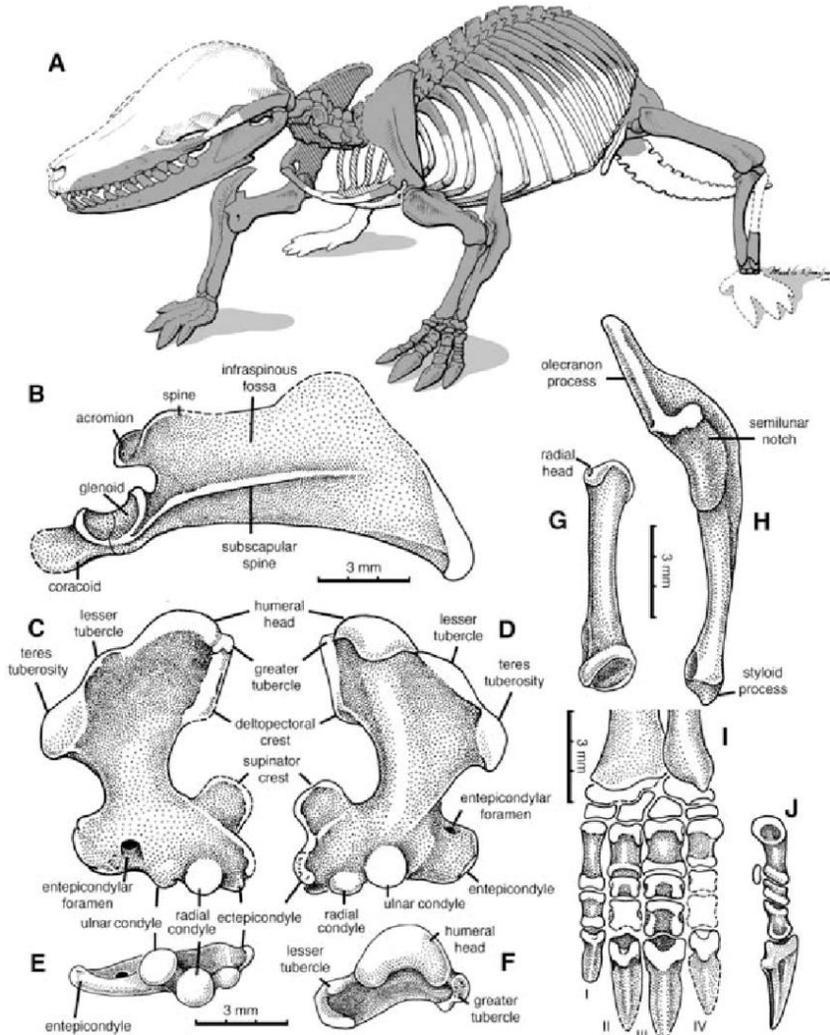
G *Castor*

Castorocauda lutrasimilis

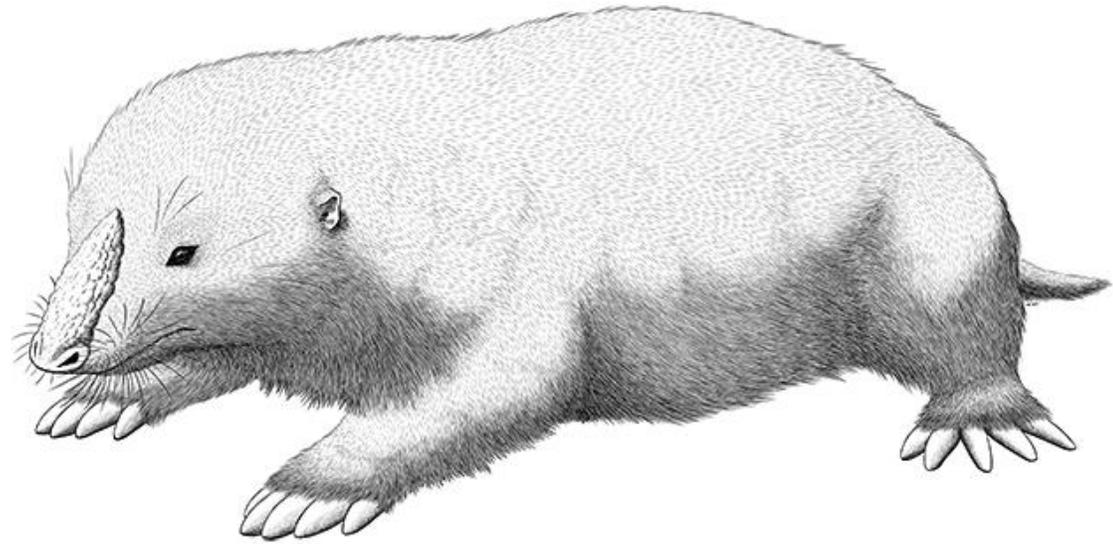
Middle Jurassic (165-161 ma)



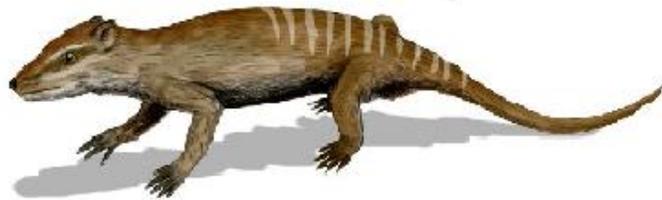
Fruitafossor i *Docofossor*



Docofossor brachydactylus
Middle Jurassic (161-155 ma)

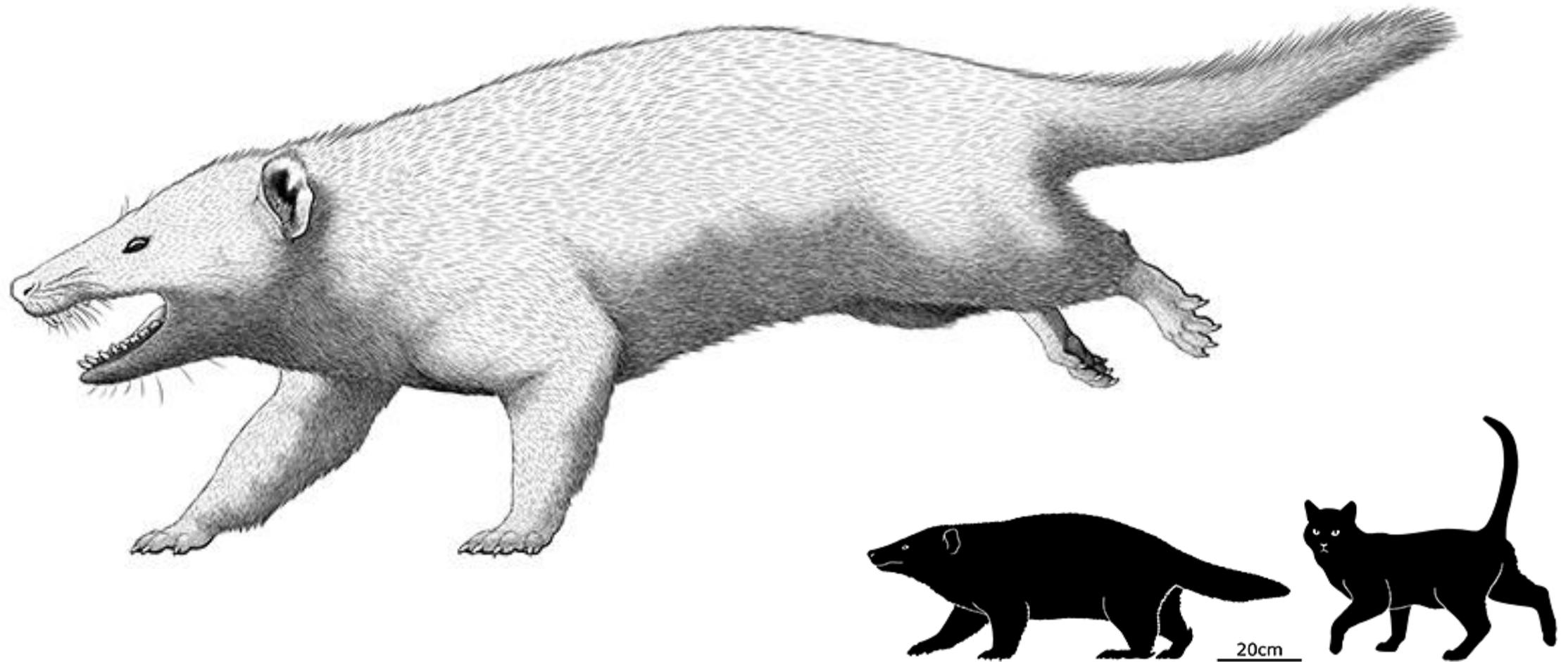


Eutrykonodonty

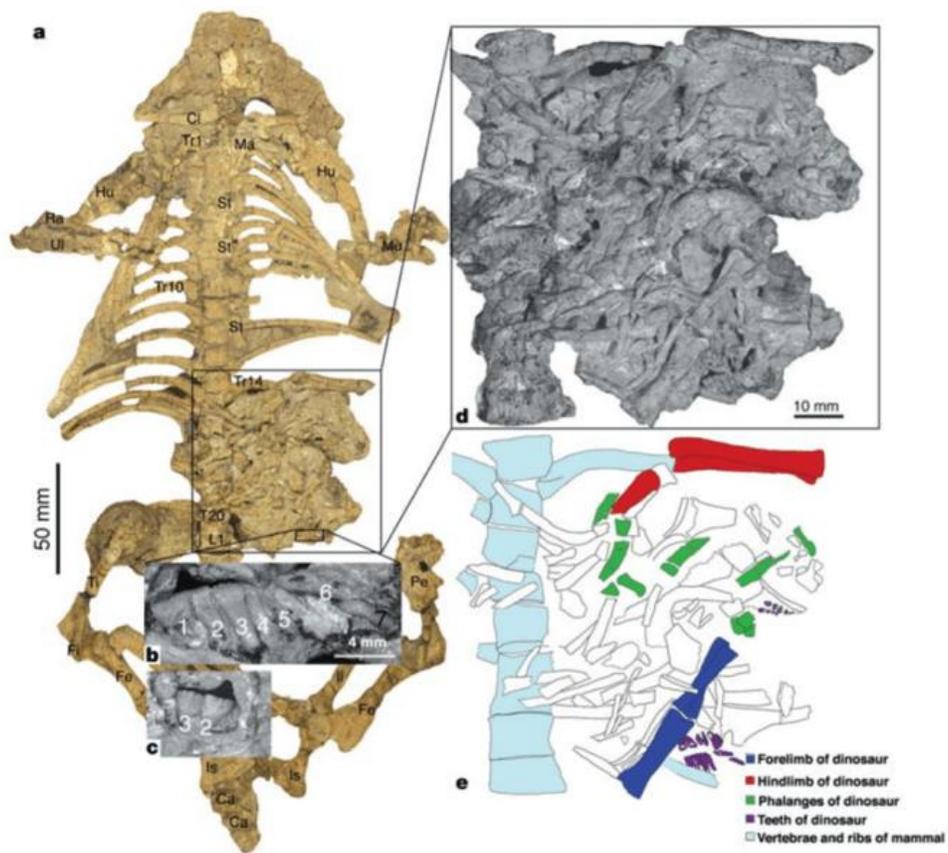


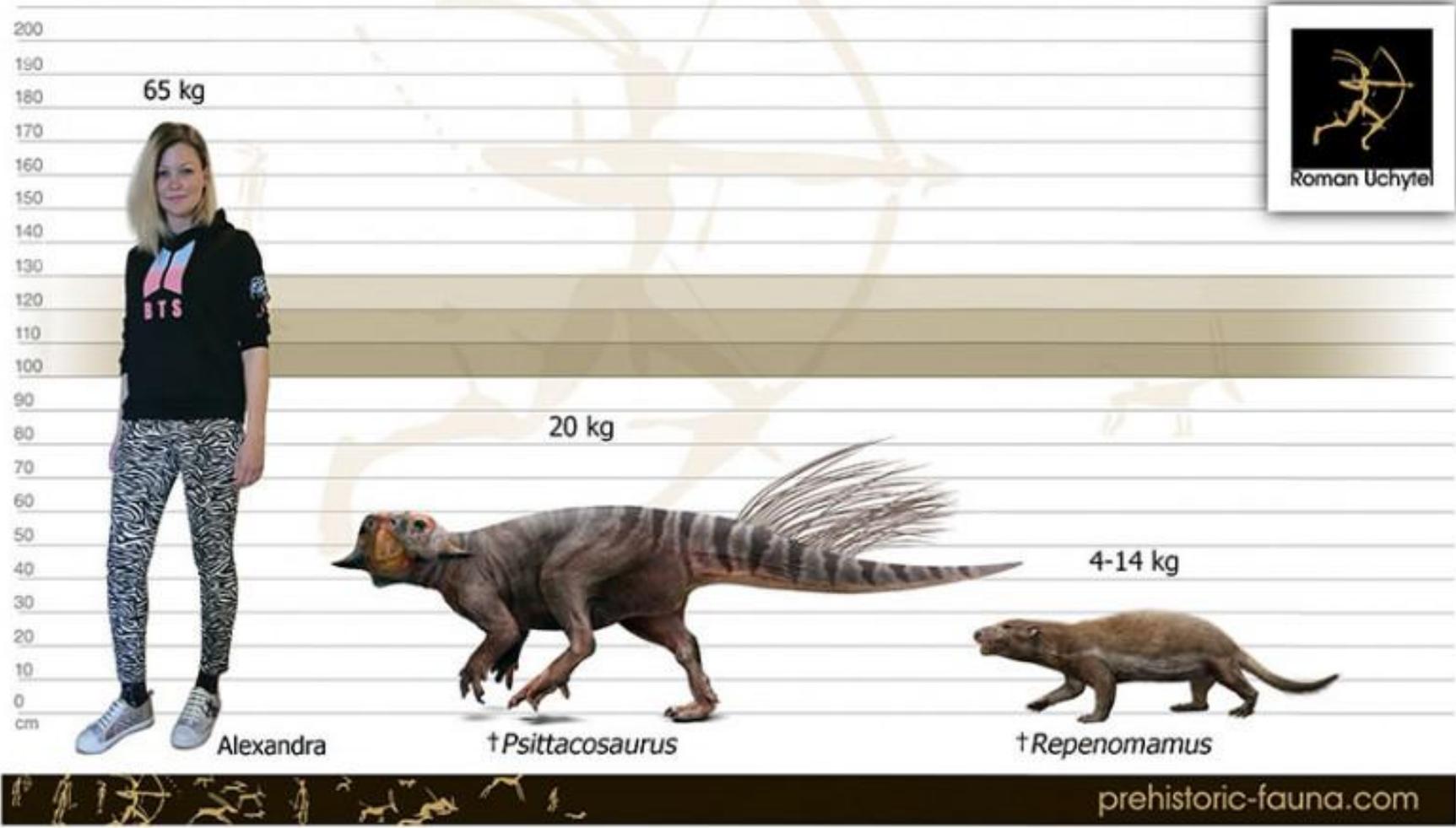
Repenomamus giganticus

Early Cretaceous (125-122 ma)



Ssak polujący na dinozaury!



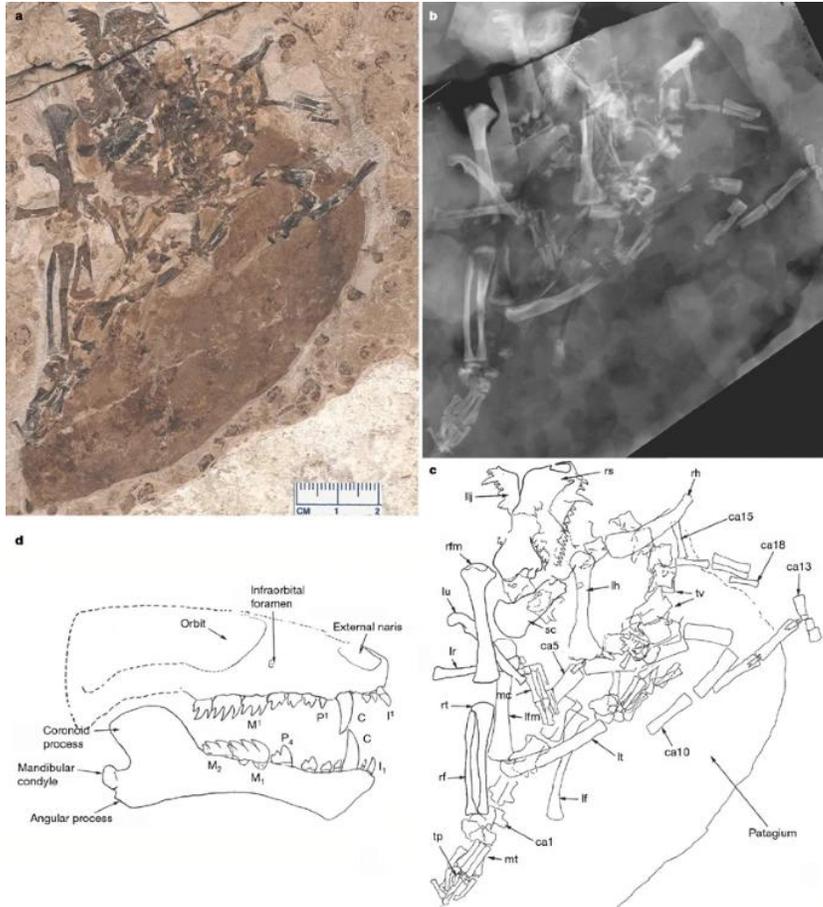


Gobiconodon ostromi



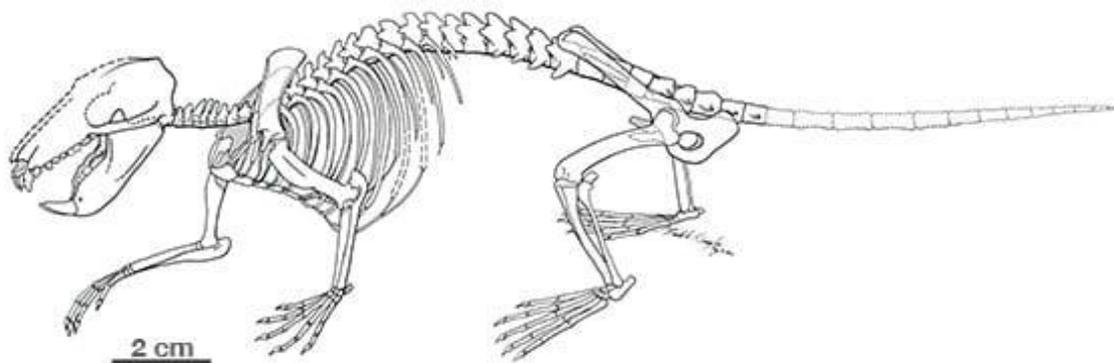
[https://en.wikipedia.org/wiki/Gobiconodon#/media/File:Gobiconodon_ostromi_skeleton_cast_3_\(cropped\).jpg](https://en.wikipedia.org/wiki/Gobiconodon#/media/File:Gobiconodon_ostromi_skeleton_cast_3_(cropped).jpg)

Volaticotherium

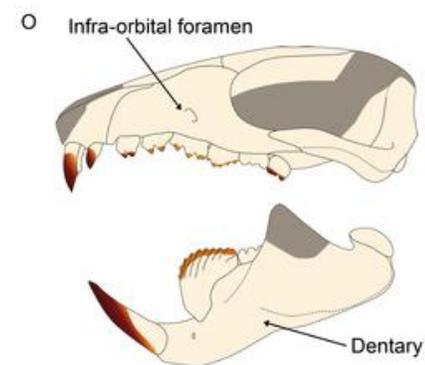
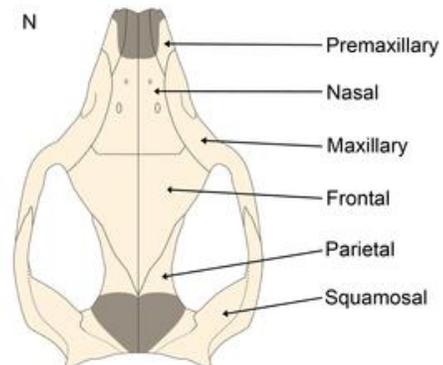
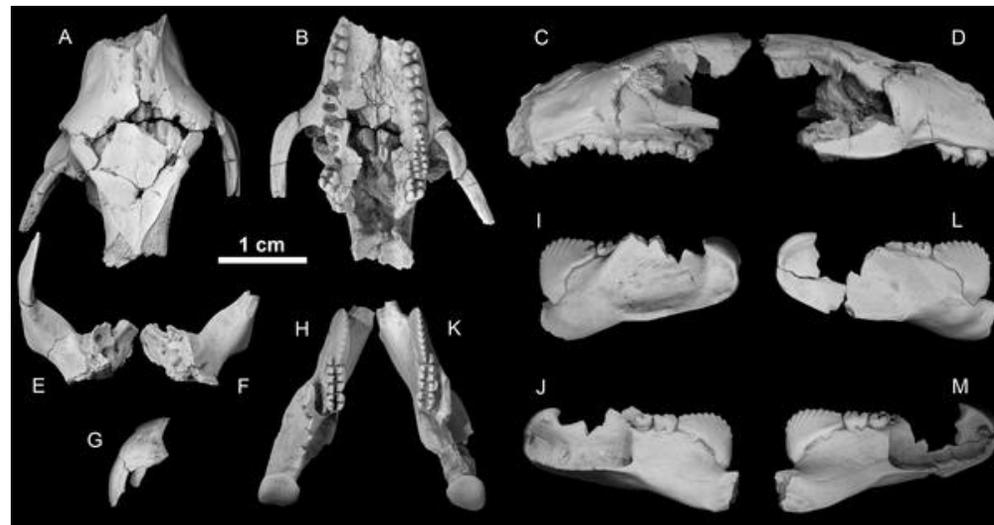


<https://www.deviantart.com/dontknowwhattodraw94/art/Volaticotherium-antiquus-445151485>

Wieloguzkowce (Multituberkulaty)



Life Reconstruction (above) by April Isch of University of Chicago.
Reconstruction of skeleton (below) by Mark Klingler of Carnegie Museum.



Zofia Kielan-Jaworowska

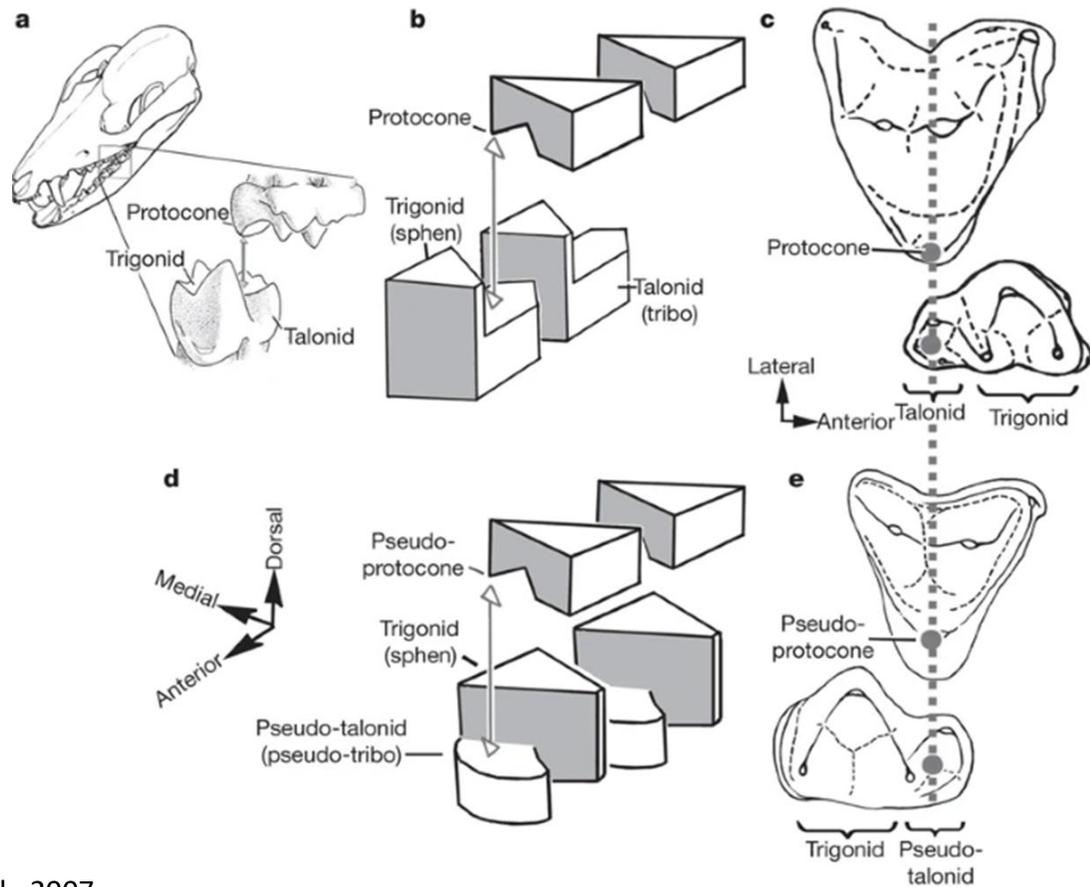




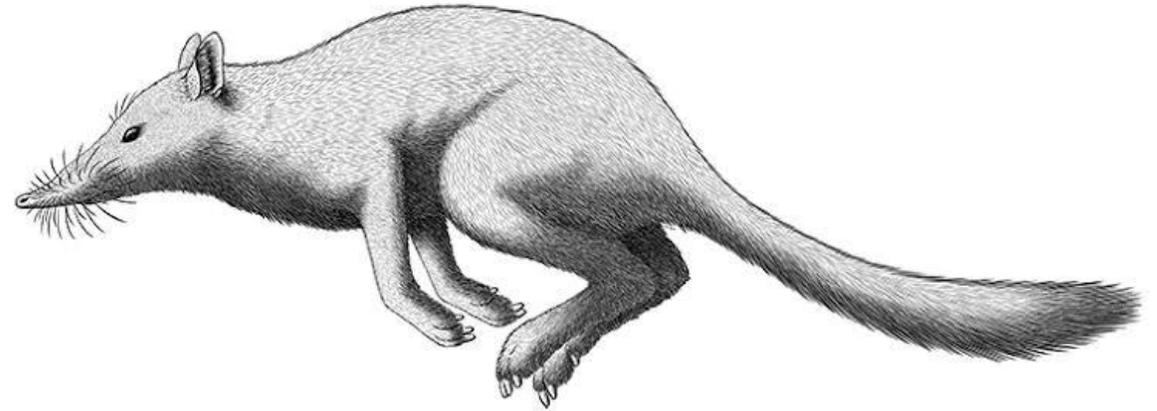
Zofiabaatar

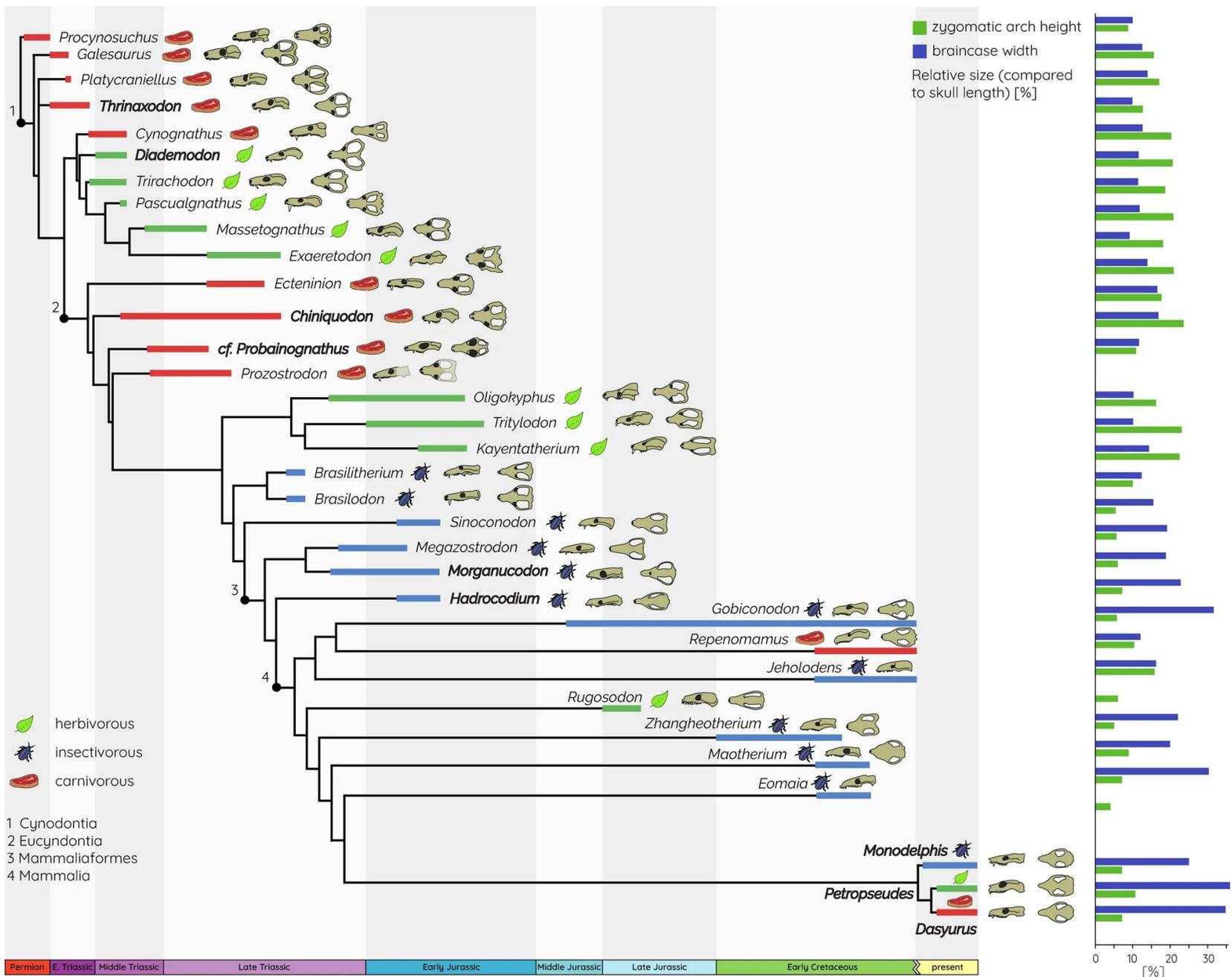
JULIO LACERDA

Trybosfenidy (Boreosfenidy)

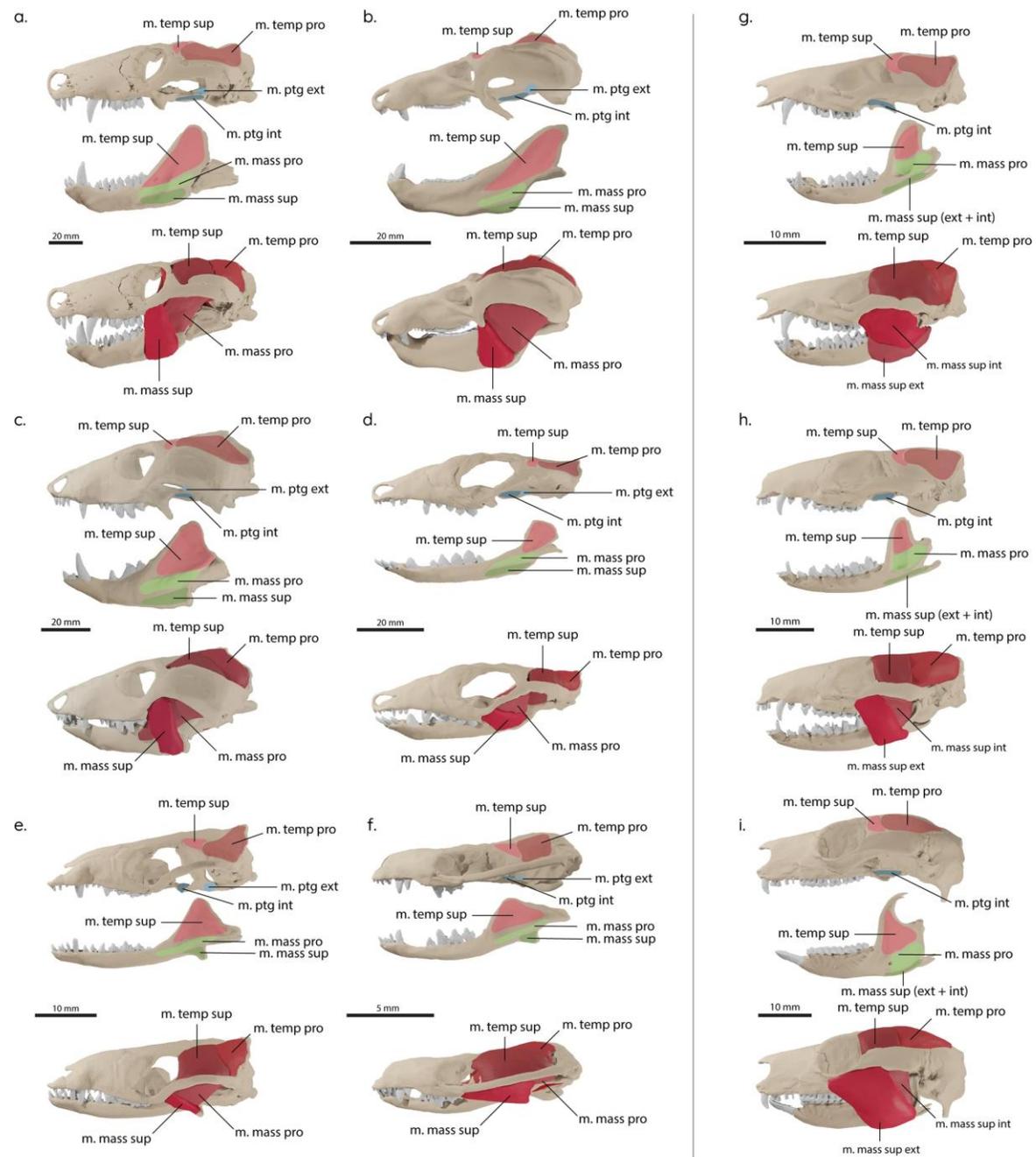


Zalambdalestes lechei
Late Cretaceous (85-70 ma)



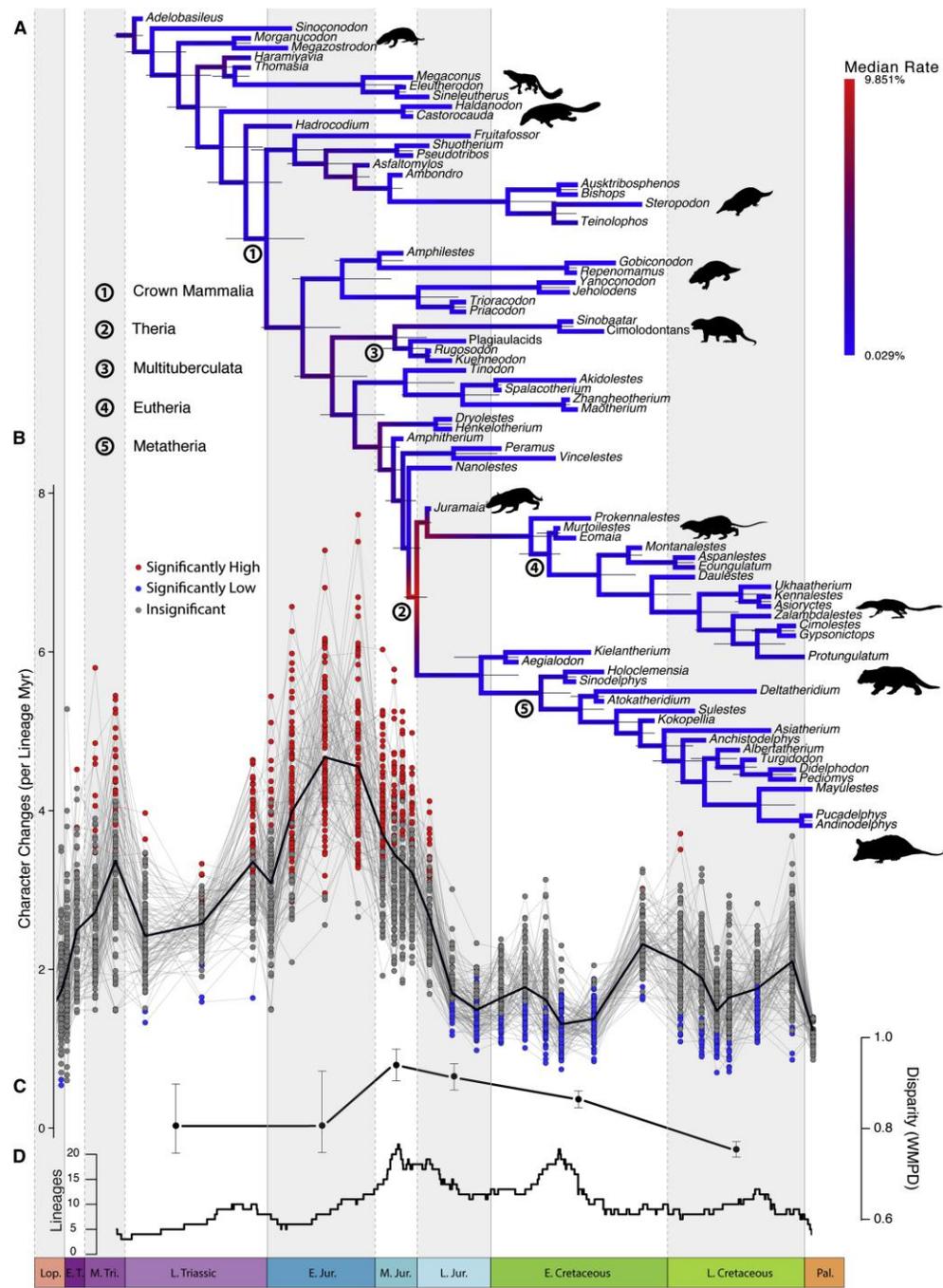


Lautenschlager et al., 2023



fossil cynodonts and mammaliaforms

extant marsupials



Close et al., 2015

