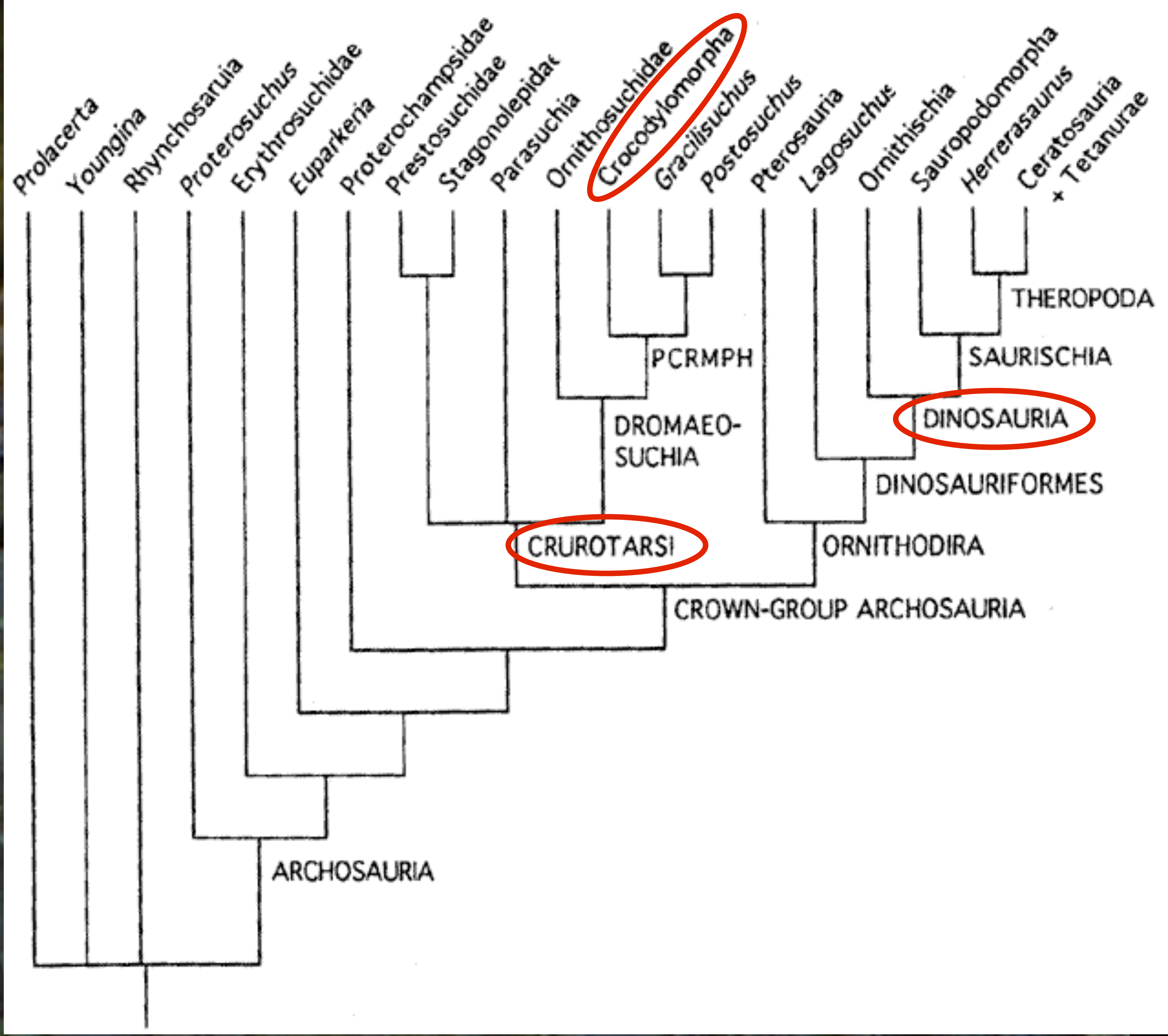
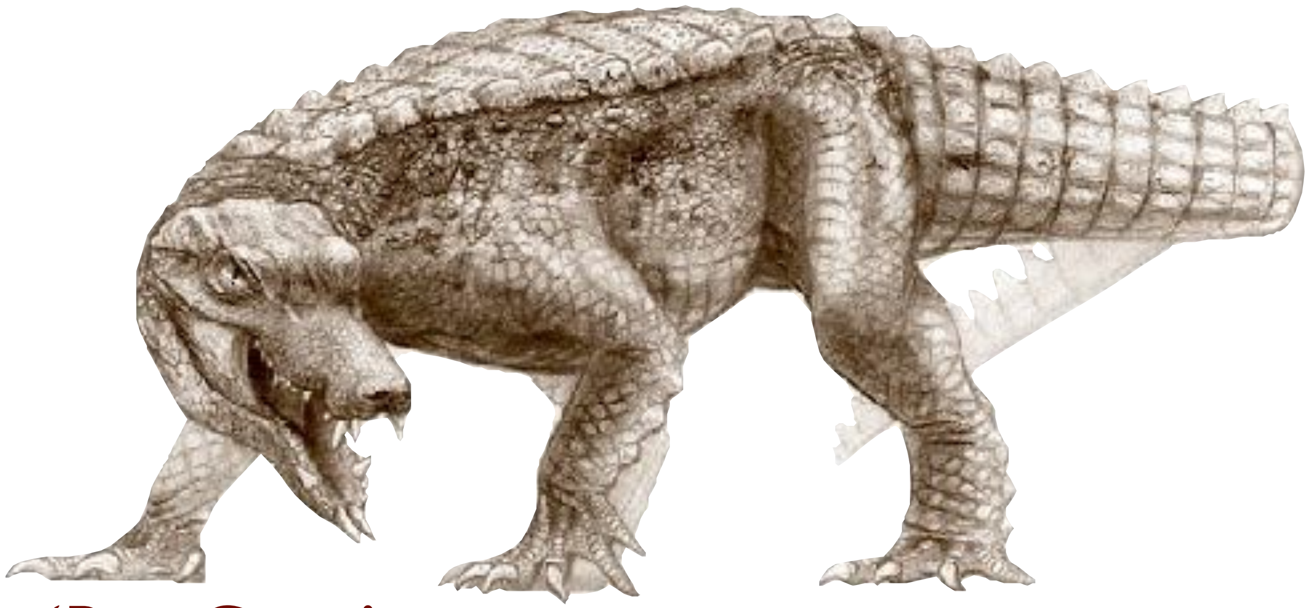
The Crocodylomorph explosion
Cretaceous

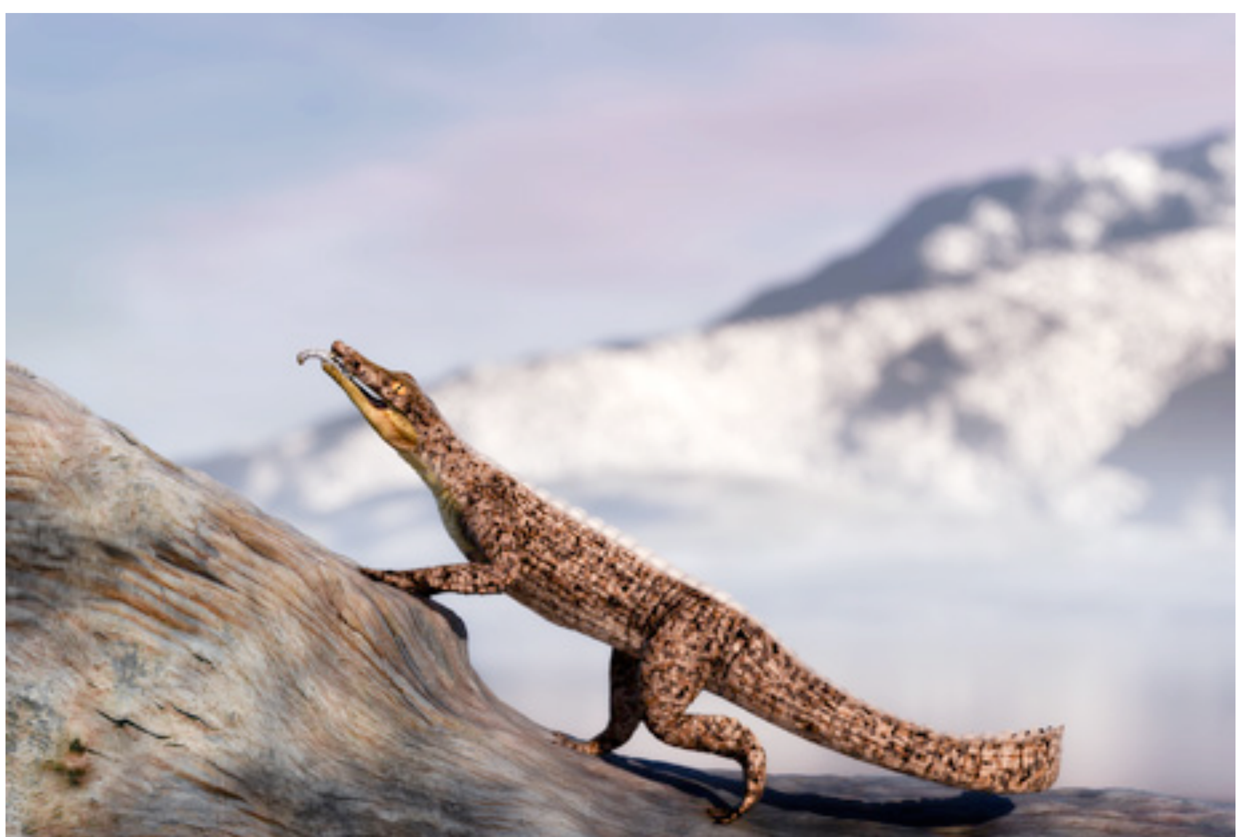


Prolacerta
Youngina
Rhynchosaruia
Proterosuchus
Erythrosuchidae
Euparkeria
Proterochampsidae
Prestosuchidae
Stagonolepidae
Parasuchia
Ornithosuchidae
Crocodylomorpha
Gracilisuchus
Postosuchus
Pterosauria
Lagosuchus
Ornithischia
Sauropodomorpha
Herrerasaurus
Ceratosauria
+ Tetanurae
THEROPODA
PCRMPH
SAURISCHIA
DINOSAURIA
DROMAEO-
SUCHIA
DINOSAURIFORMES
CRUROTARSI
ORNITHODIRA
CROWN-GROUP ARCHOSAURIA
ARCHOSAURIA

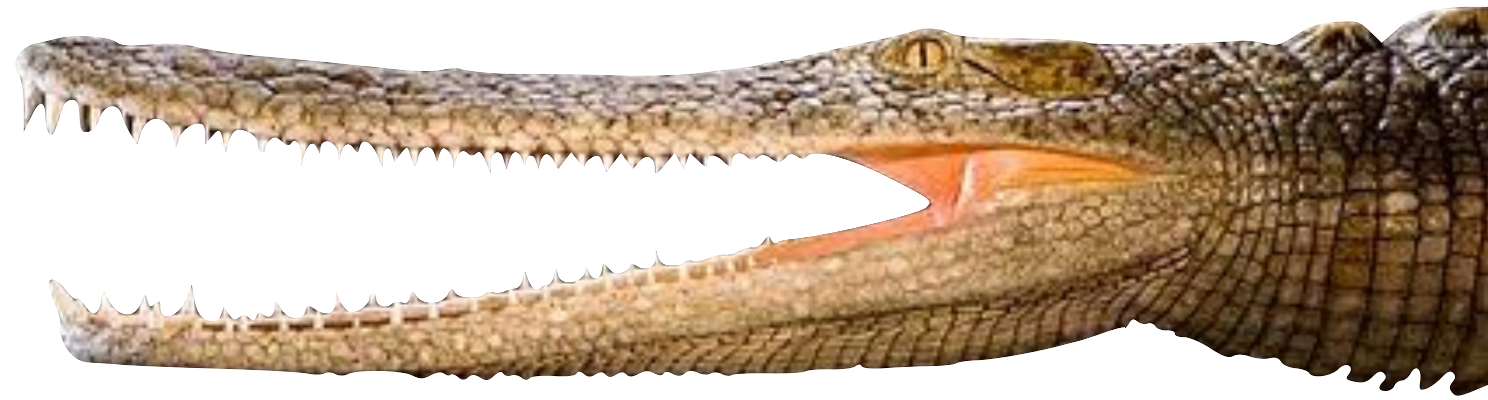
Terrestrial Crocodylomorphs



'Rat Croc'
Cretaceous
Araripesuchus
Skull was about the width of a credit card



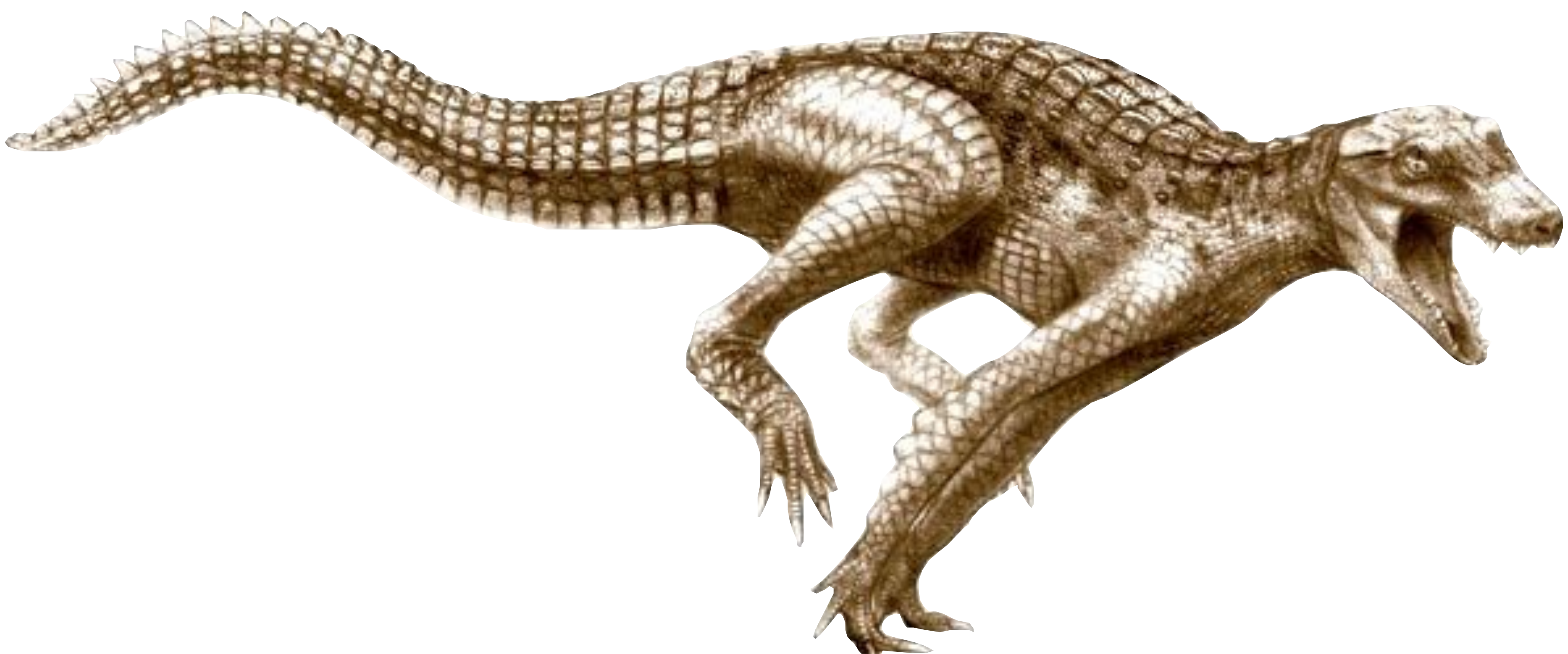
Terrestrial Crocodylomorphs



‘Pancake Croc’
mid-late Cretaceous
Laganosuchus
20 feet long
Jaw was not strong enough to wrestle prey
Was a sit-and-wait underwater predator

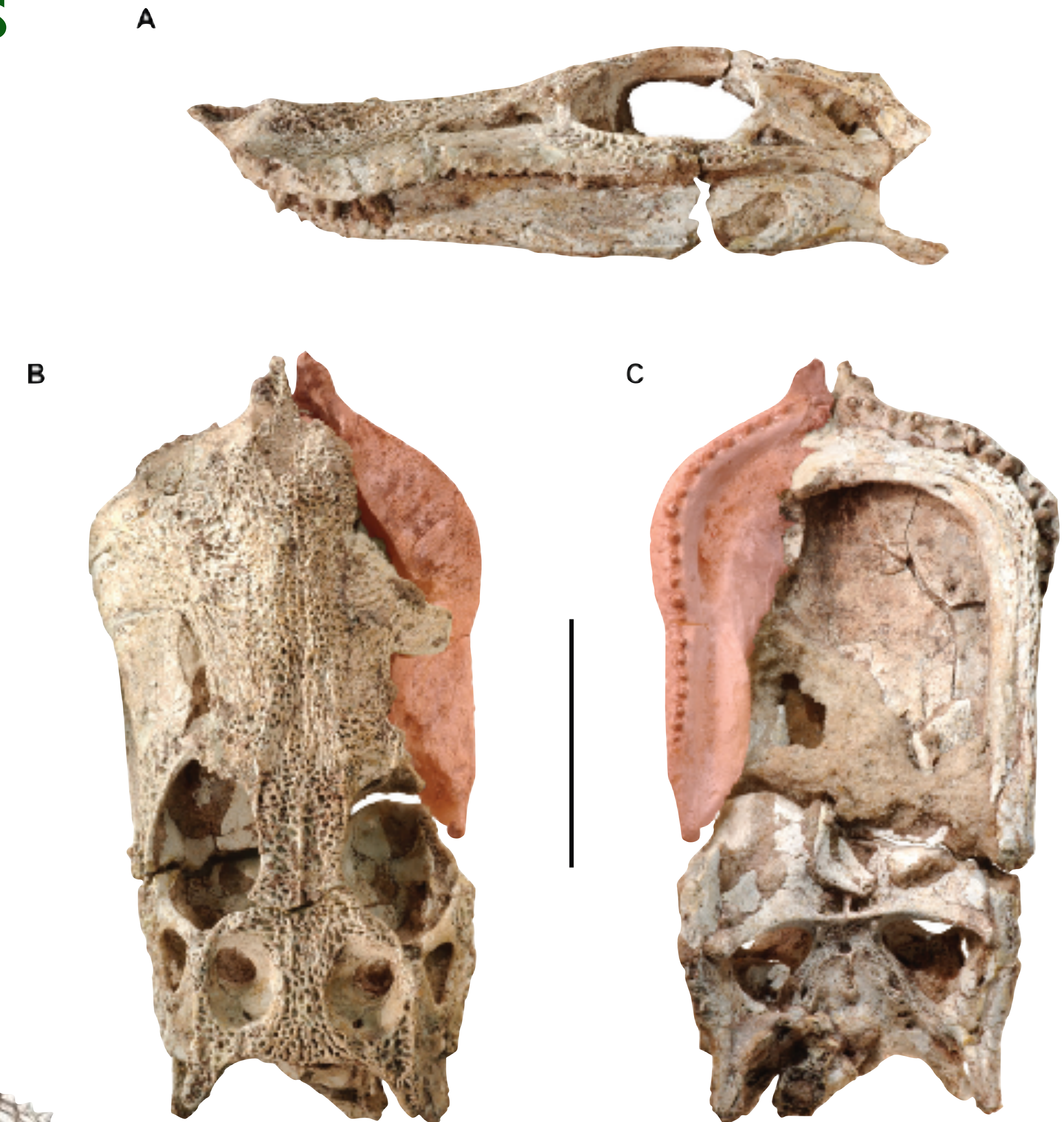
Terrestrial Crocodylomorphs

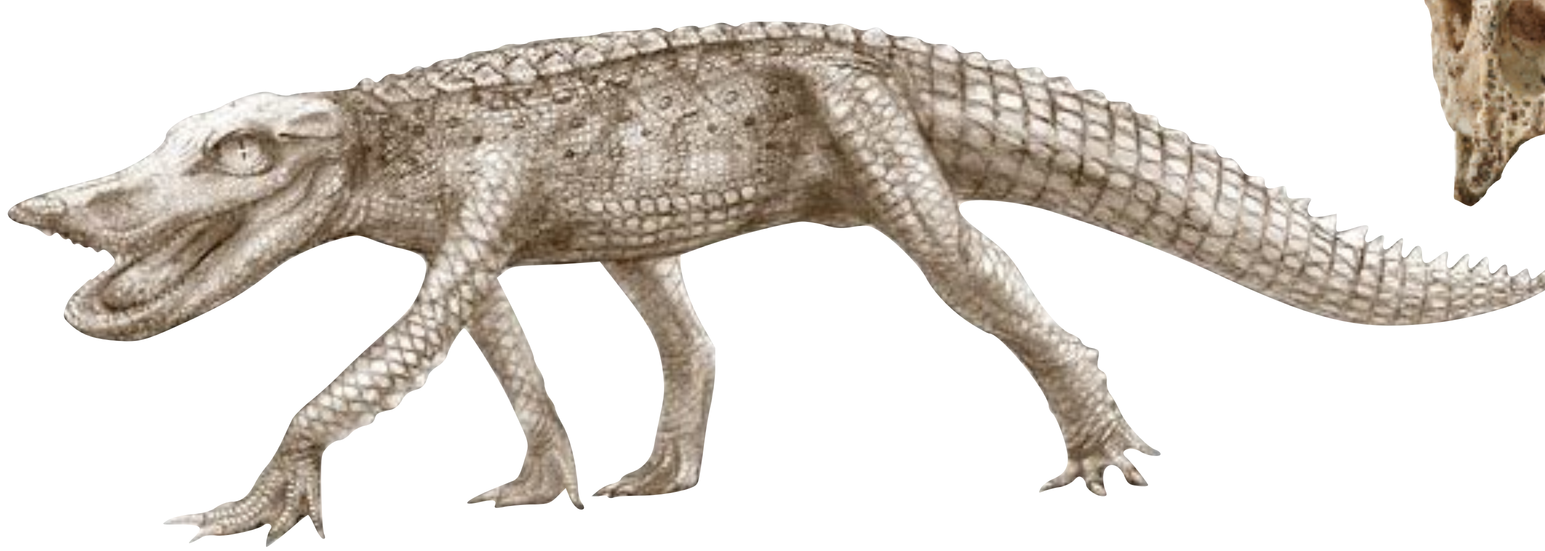
‘Dog Croc’
Araripesuchus
mid-late Cretaceous
Large fore-brain
3 ft long
Plant and grub eater



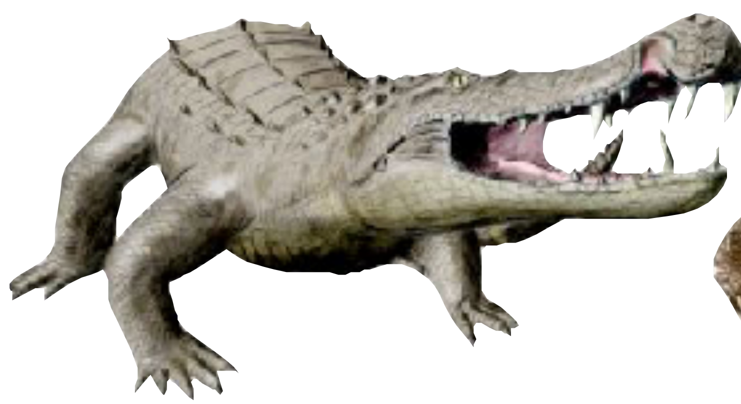
Terrestrial Crocodylomorphs

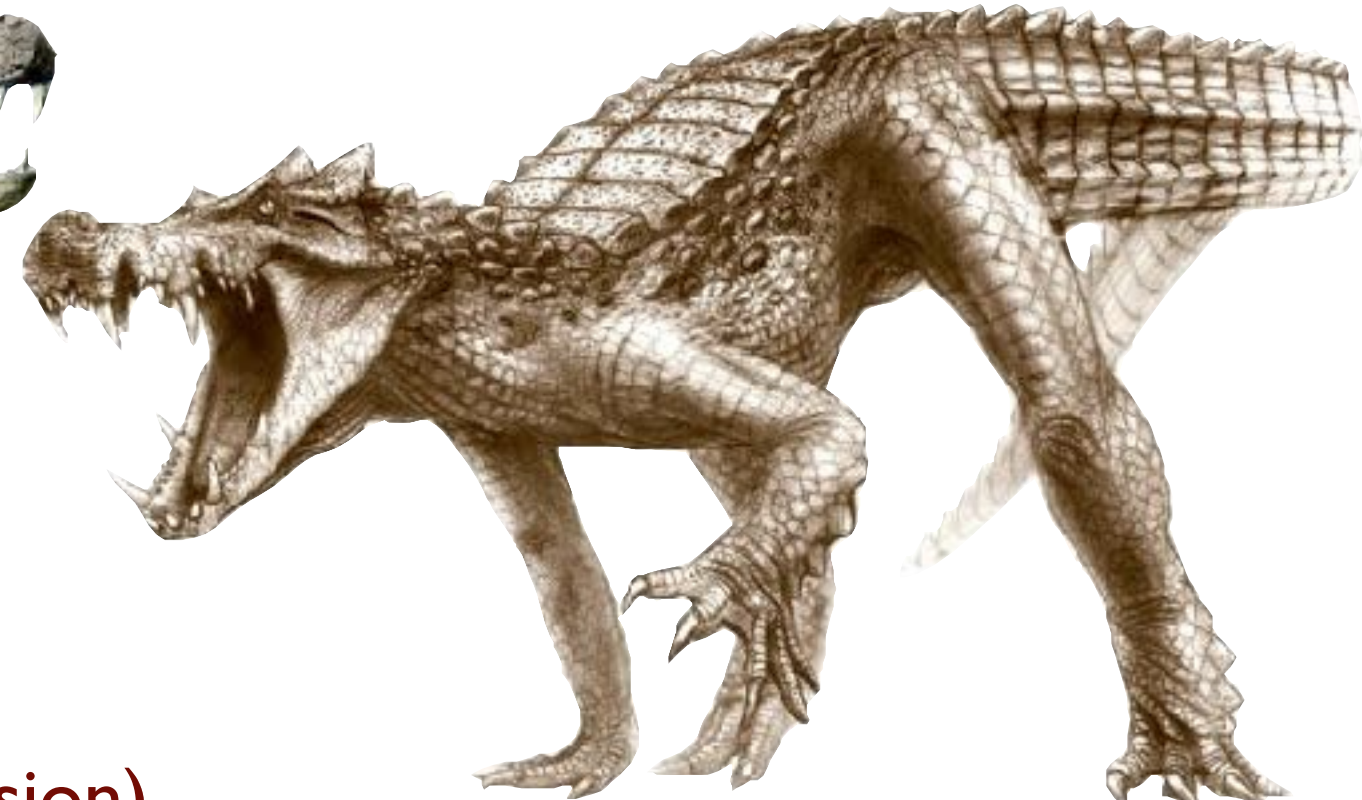
'Duck Croc'
Anatosuchus
mid-late Cretaceous
2.5 ft long
Built to move on land
Brain surrounded by air pockets…
Specialized nose ~ heightened sensory perception





Terrestrial Crocodylomorphs

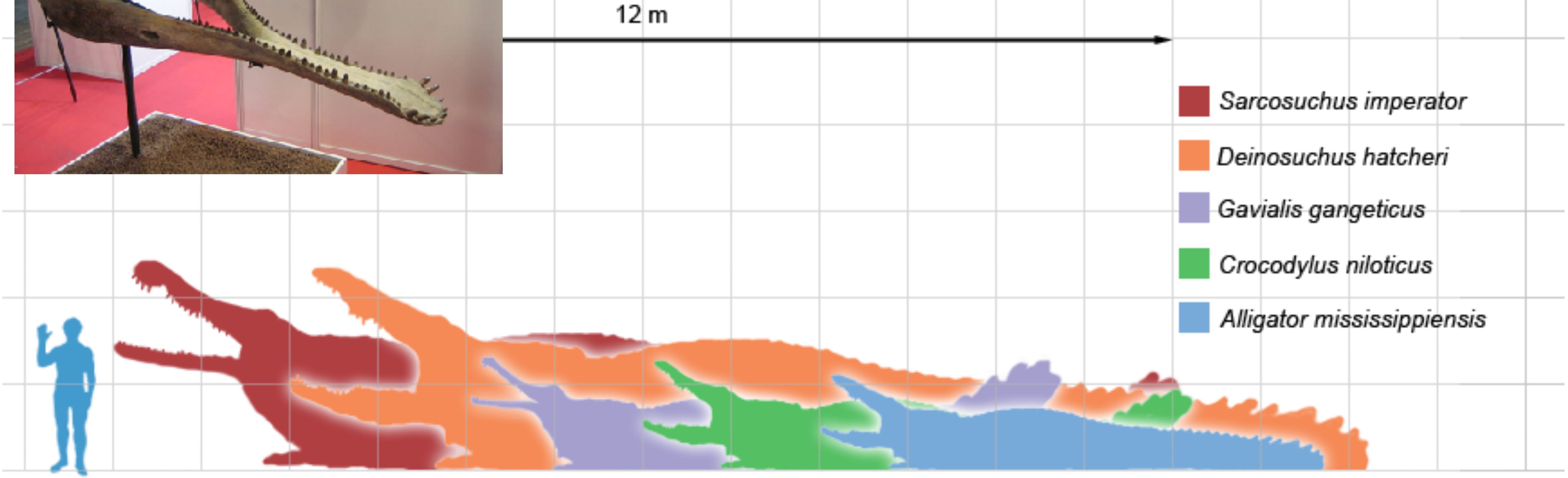




'Boar Croc'
Kaprosuchus
Late Cretaceous
20 ft long
Terrestrial
3 sets of caniniform, notched, teeth
unique among Crocodiliforms
Orbits angled forward (stereoscopic vision)
DINOSAUR EATER

Freshwater Crocodylomorphs

'Super Croc'
Sarcosuchus
Early-Mid Cretaceous
40 ft long; 6 ft long skull
Thinner snout than Deinosuchus
Prey: large fish, turtles, small Dinosaurs



Freshwater Crocodylomorphs

Food

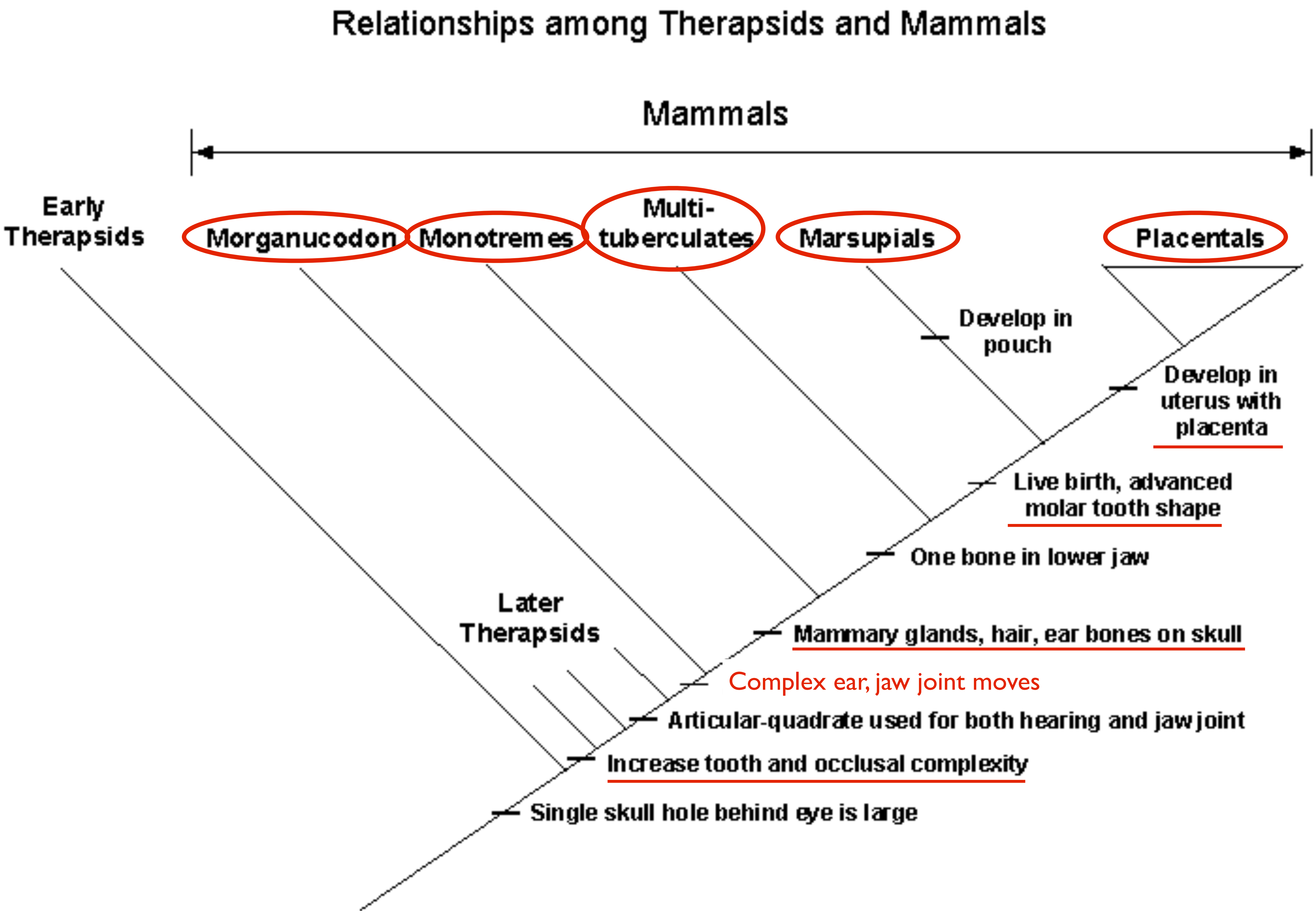
‘Dreadful Croc’
Deinosuchus
Early-Mid Cretaceous
35-40 ft long
Robust skull, teeth: built for crushing/tearing
Prey: large Dinosaurs (hadrosaurids: tooth marks on tail vertebrae)


Uma pista tentadora sobre um mundo perdido.

The Origin of Mammals

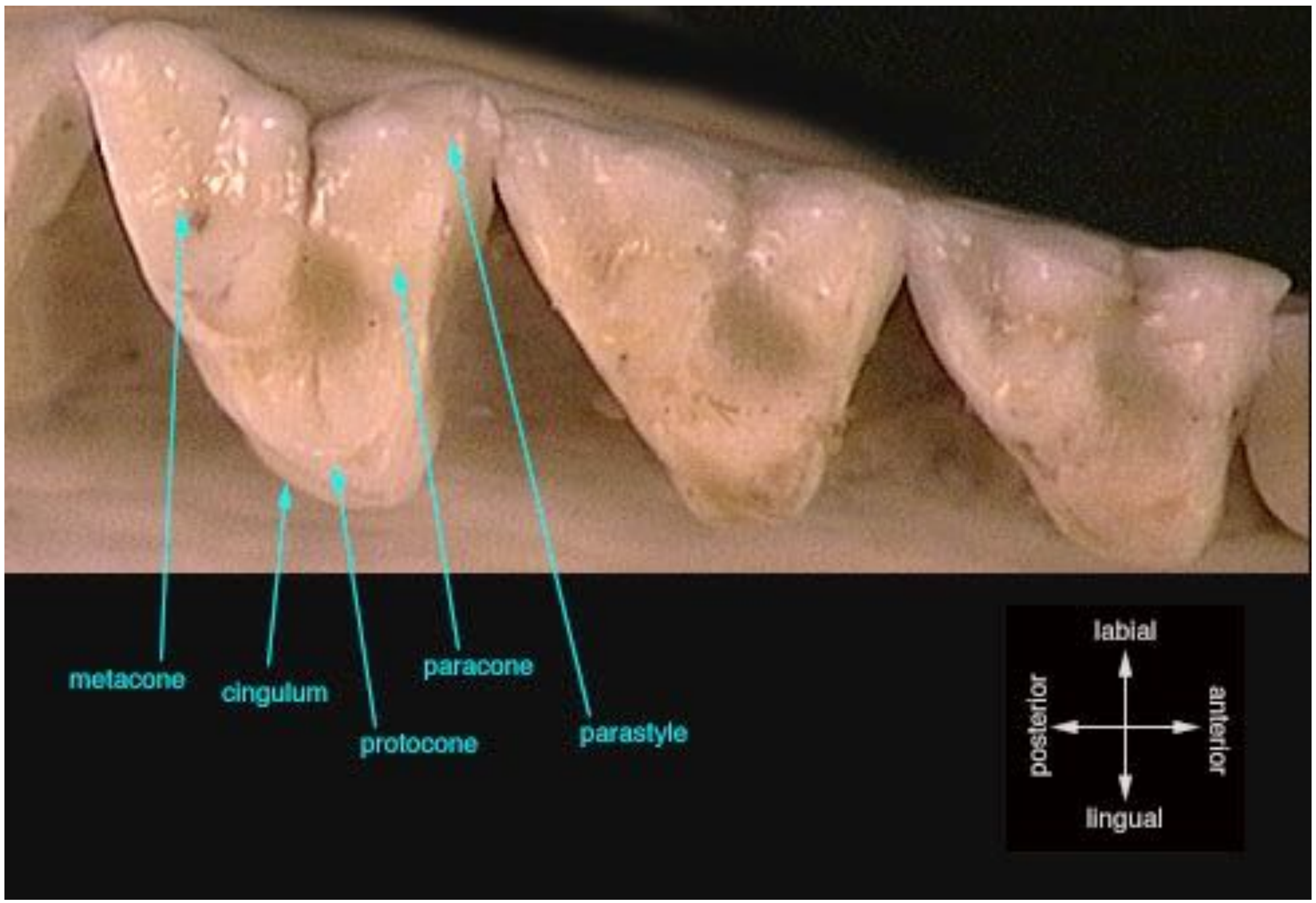
Of teeth and ears

The Origin of Mammals

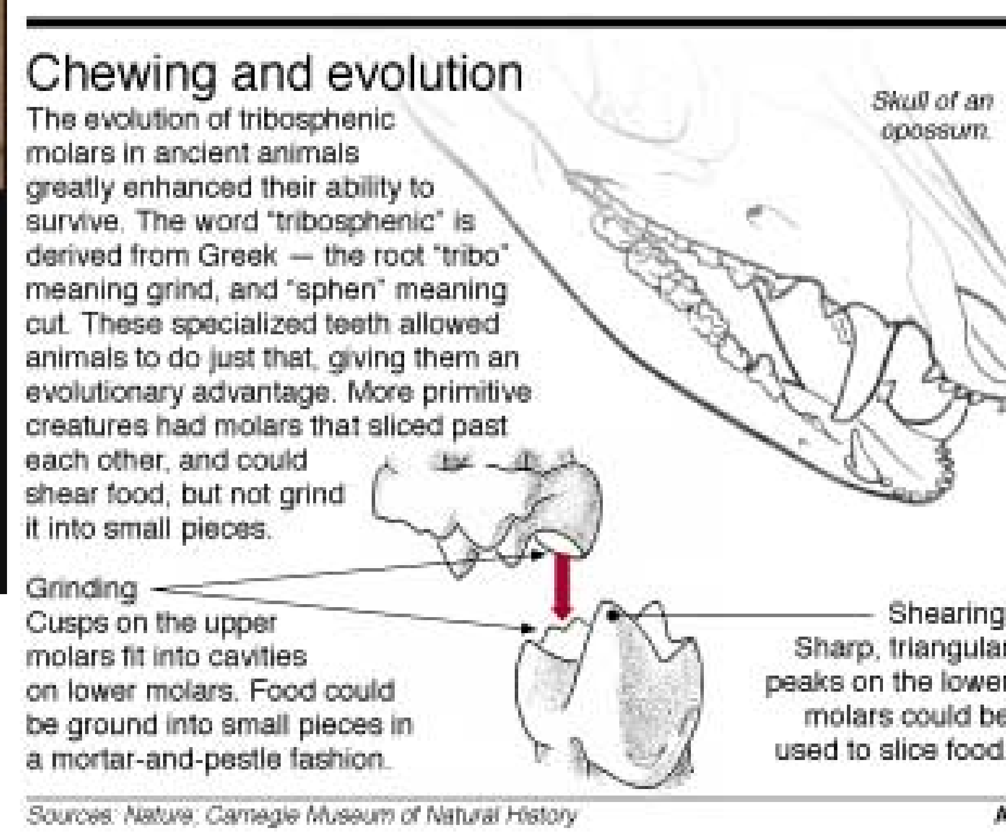


Mammal Teeth

Mammal teeth have complex shapes
Different types of teeth in jaws
Complex occlusion

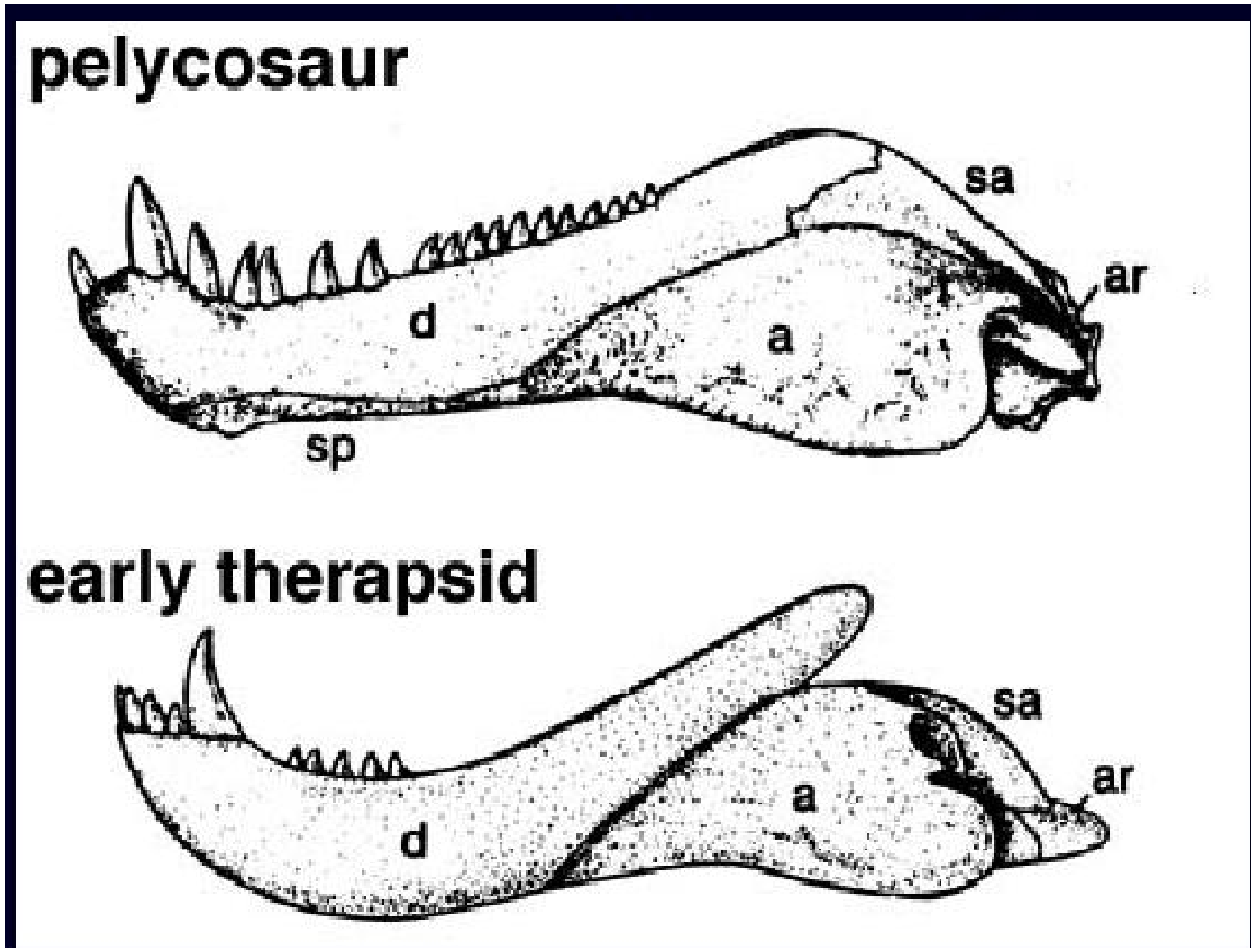


The tribosphenic molar: "grind-cut"

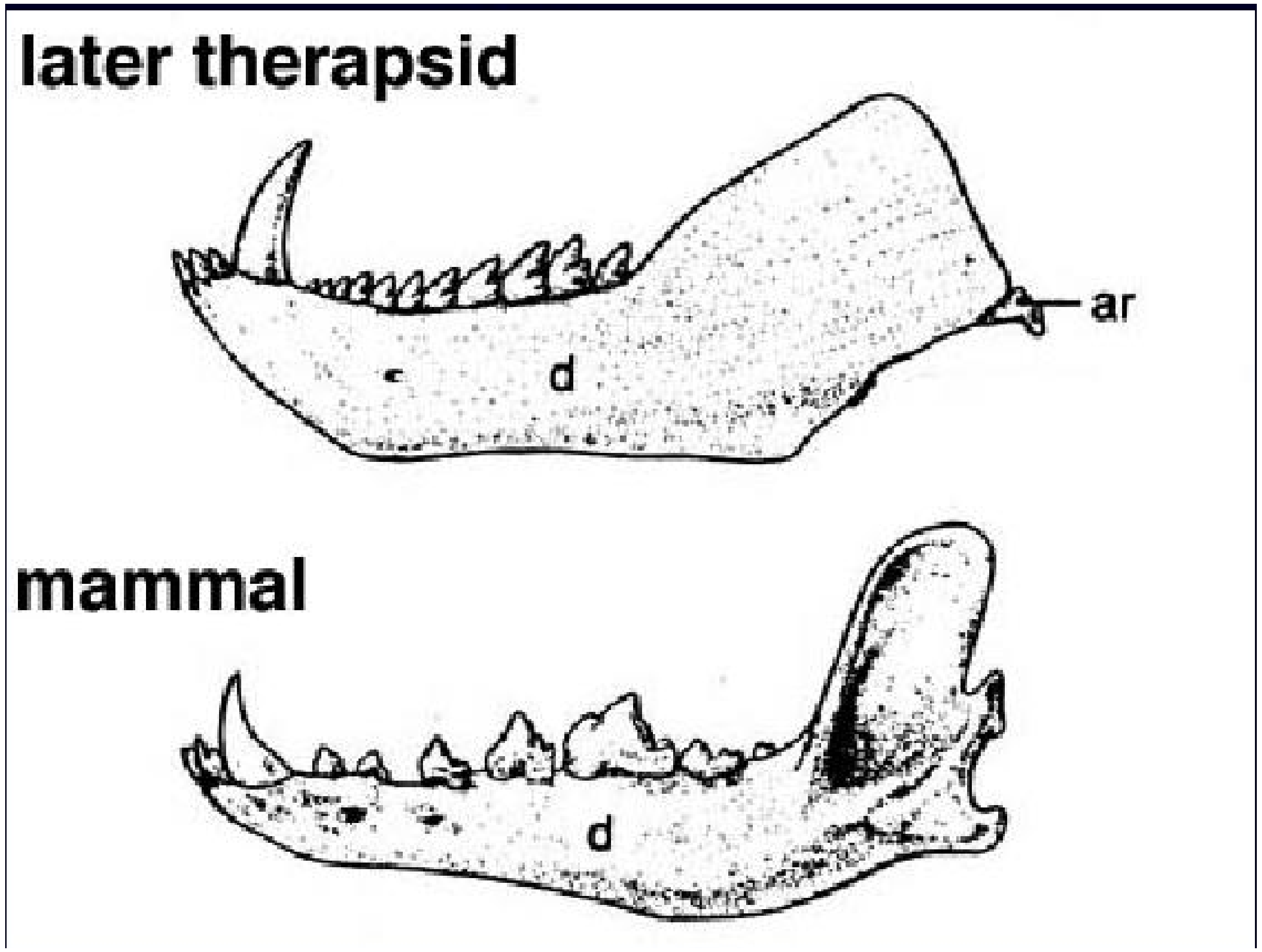


Mammal Jaws

Early synapsids have lower jaws made up of several dermal bones...



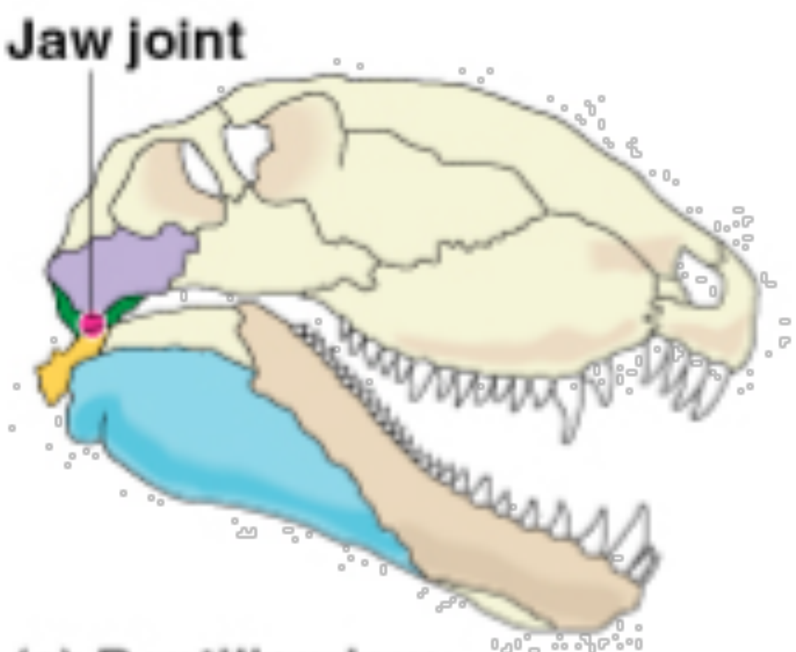
In later Therapsids, the tooth-bearing bone (dentary) takes over and all other bones are lost



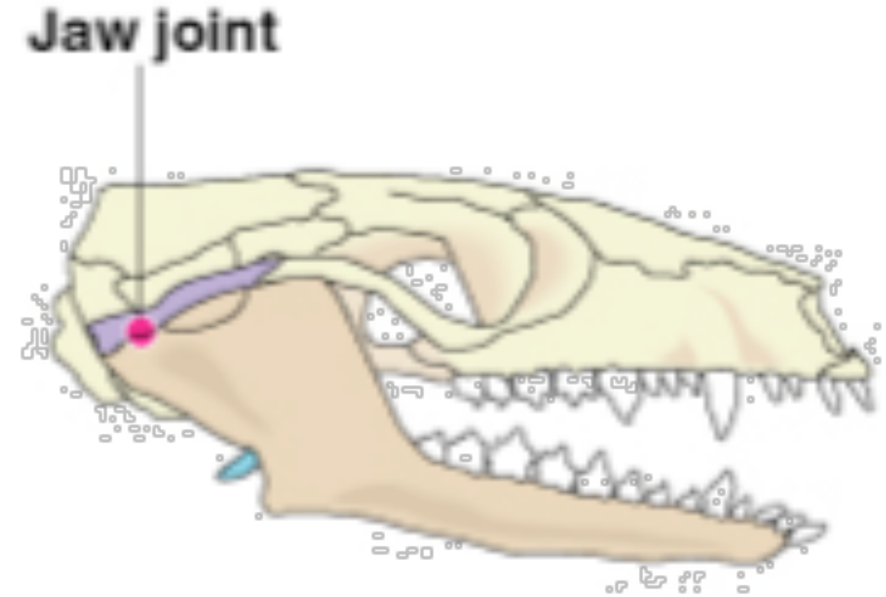
Mammal Jaws + Breathing

- Secondary Palate

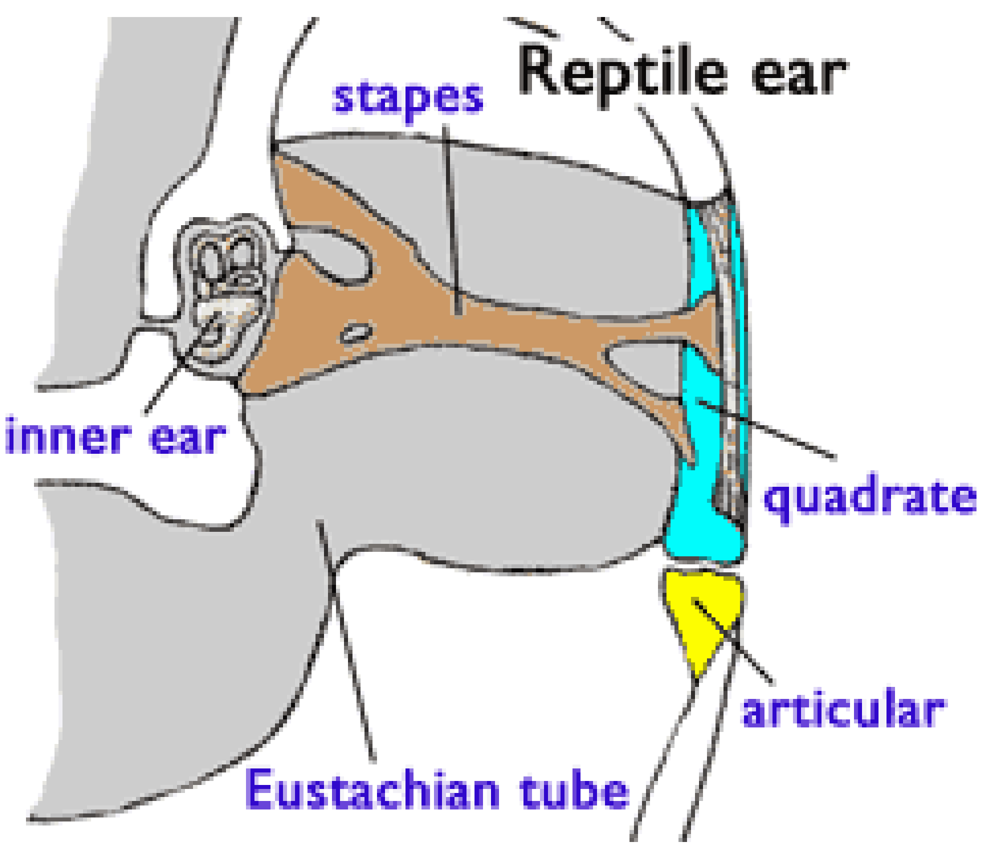
Mammal Ears

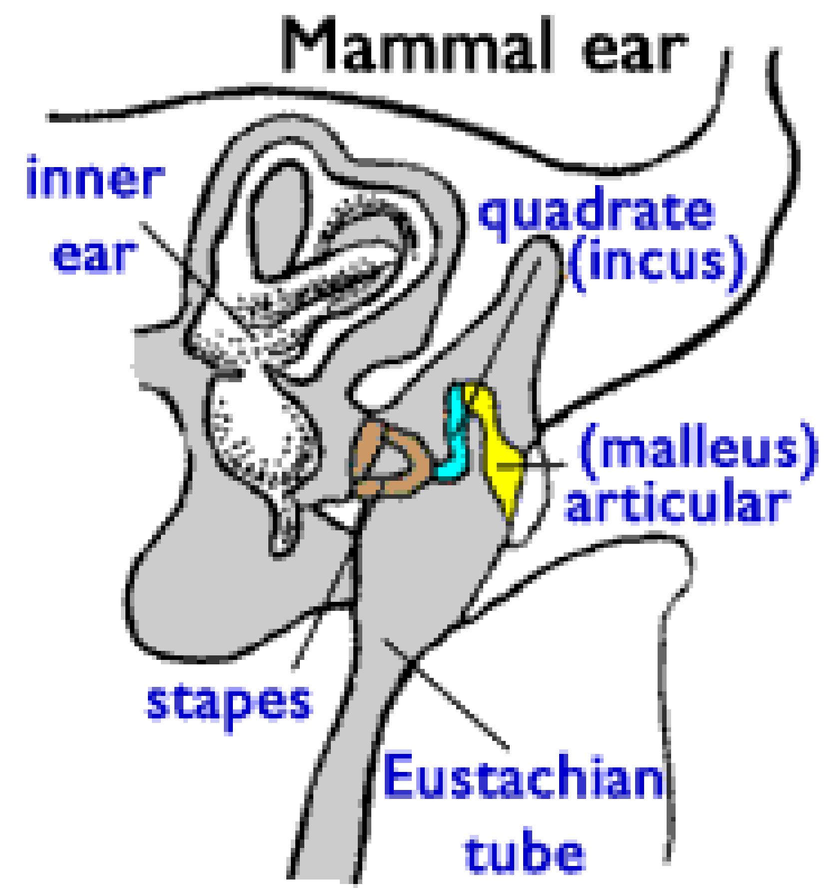


(a) Reptilian jaw



(b) Mammalian jaw





Mammal Ears

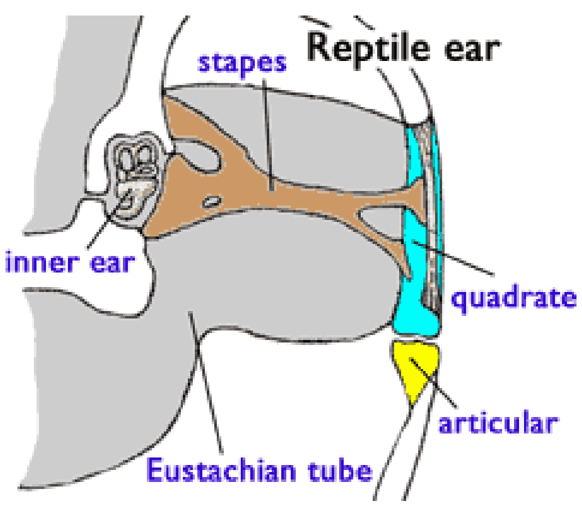
Probainognathus: beginning of the switch

Reptile/Bird Quadrate-Articular

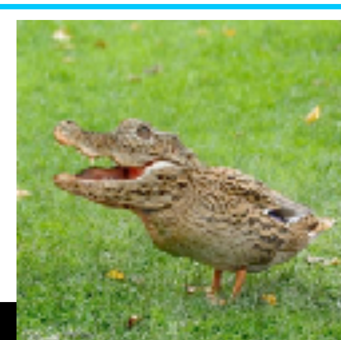
↓

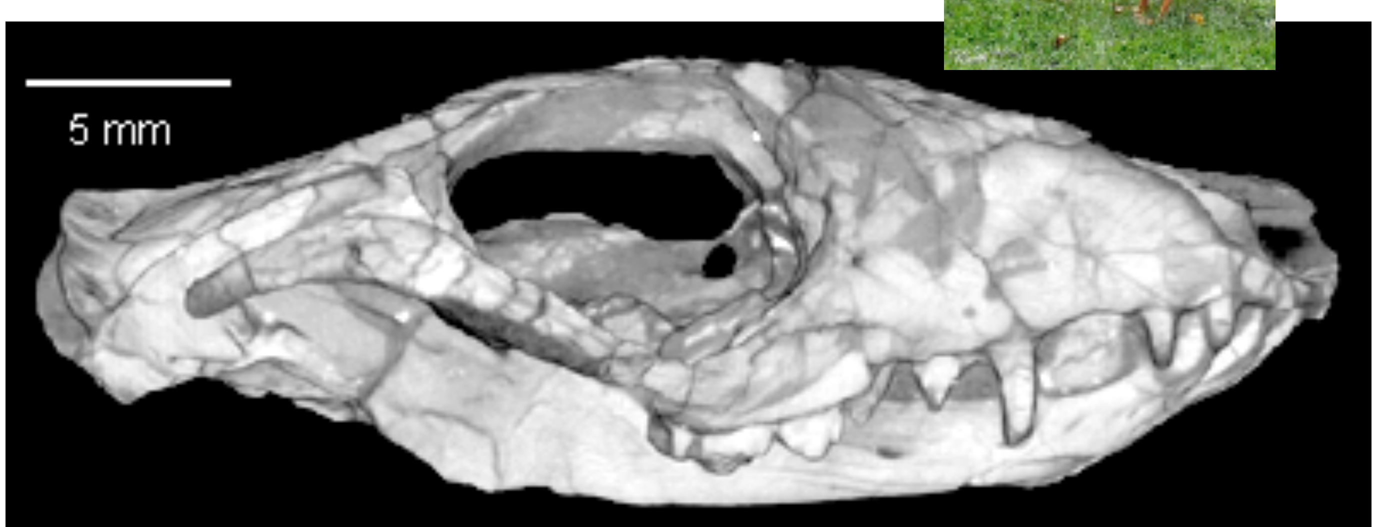
Mammal Squamosal-Dentary

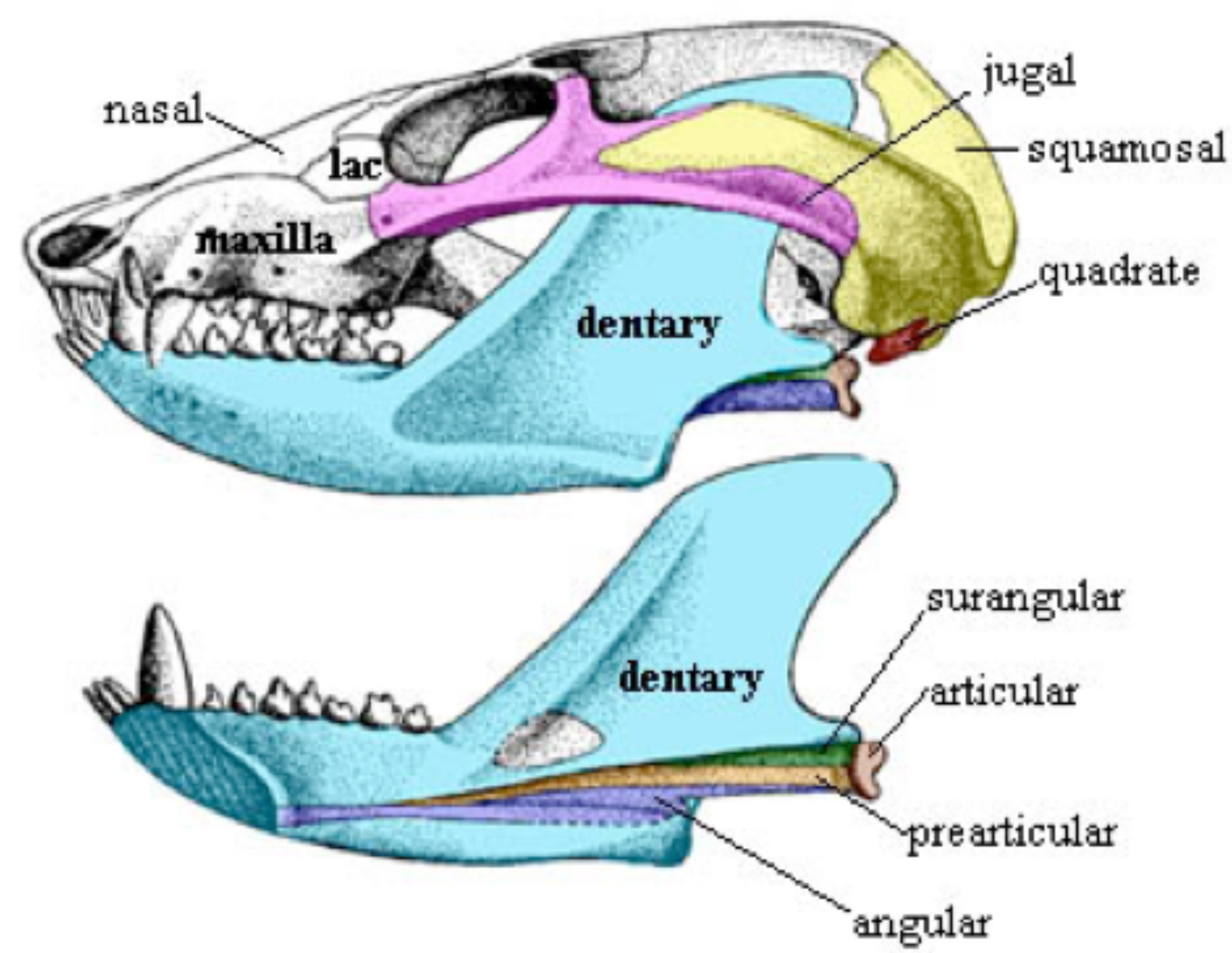
- Expansion of dentary bone
- Reduction of articular and quadrate bones
- First mammals have Dentary-Squamosal articulation
- Initially ear bones were still connected to lower jaw: did not move to the inner ear region until later
- Modern mammalian ear bones attached to SKULL rather than JAW



Evolution →



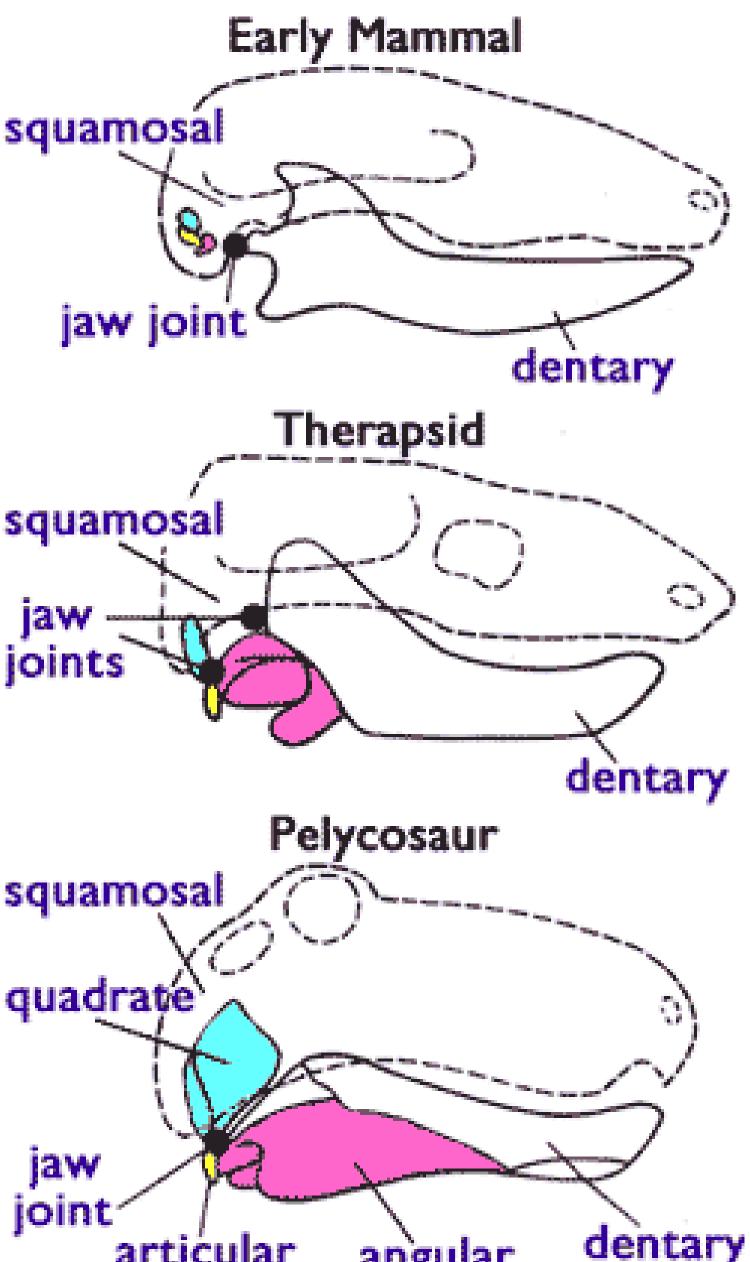


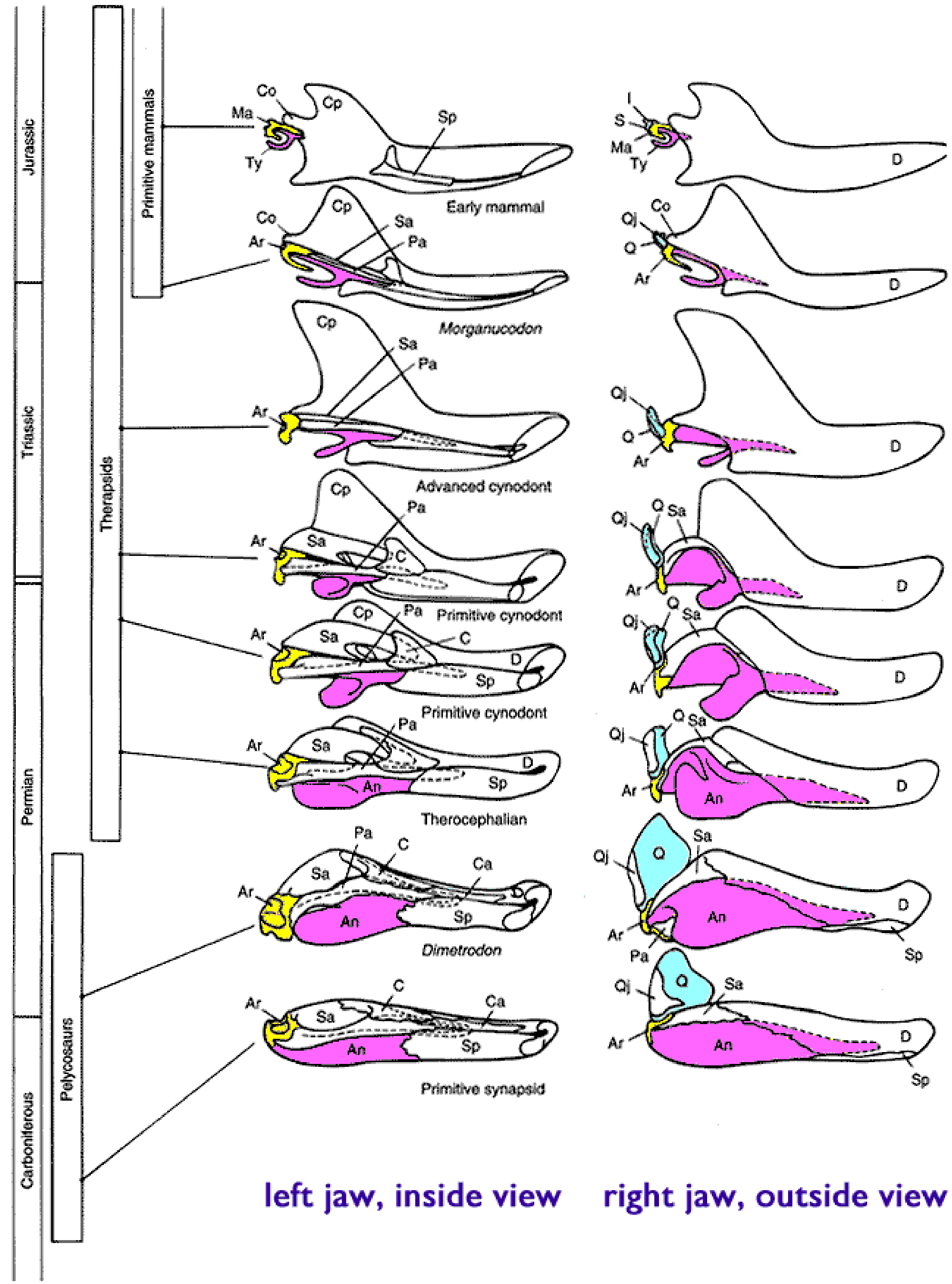


Probainognathus: skull and mandible in left lateral view. Modified from Carroll (1988)

Mammal Ears

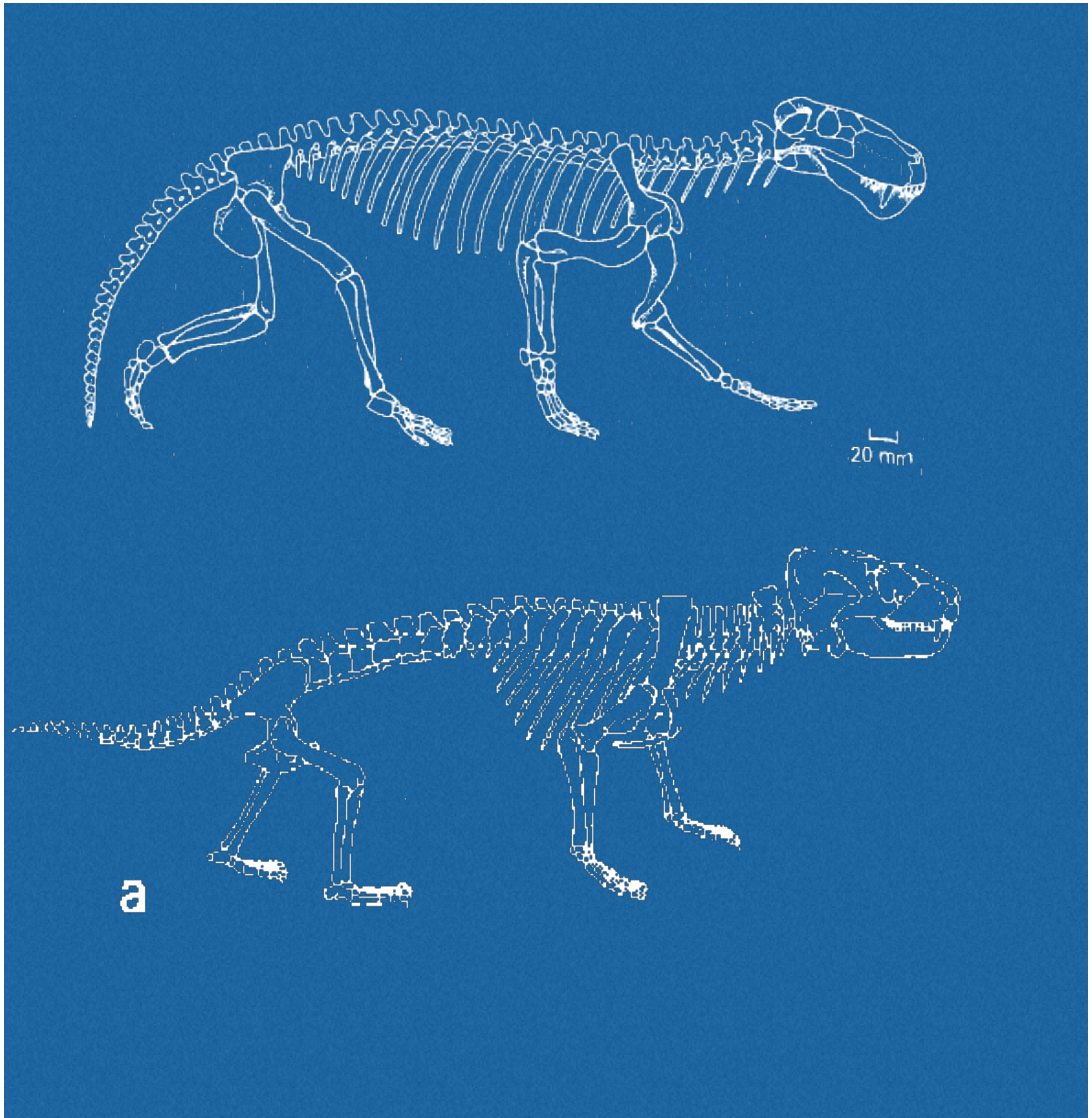
Intermediates? You want 'em, we got 'em

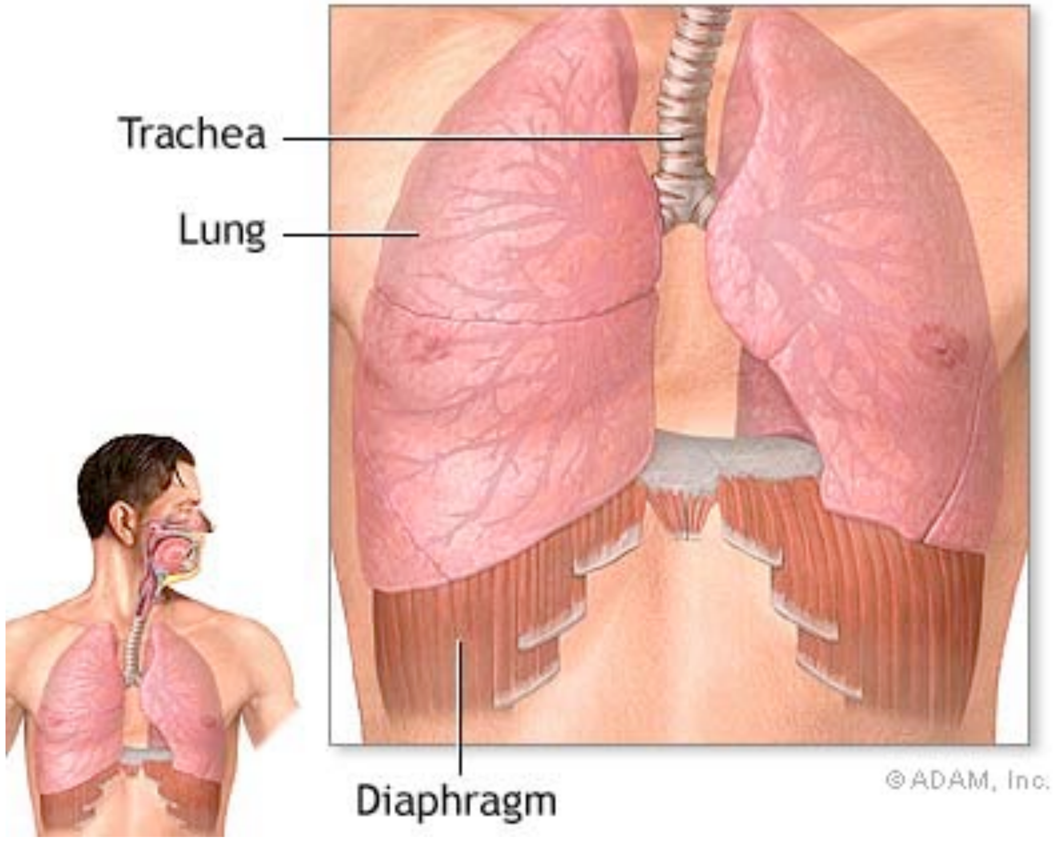


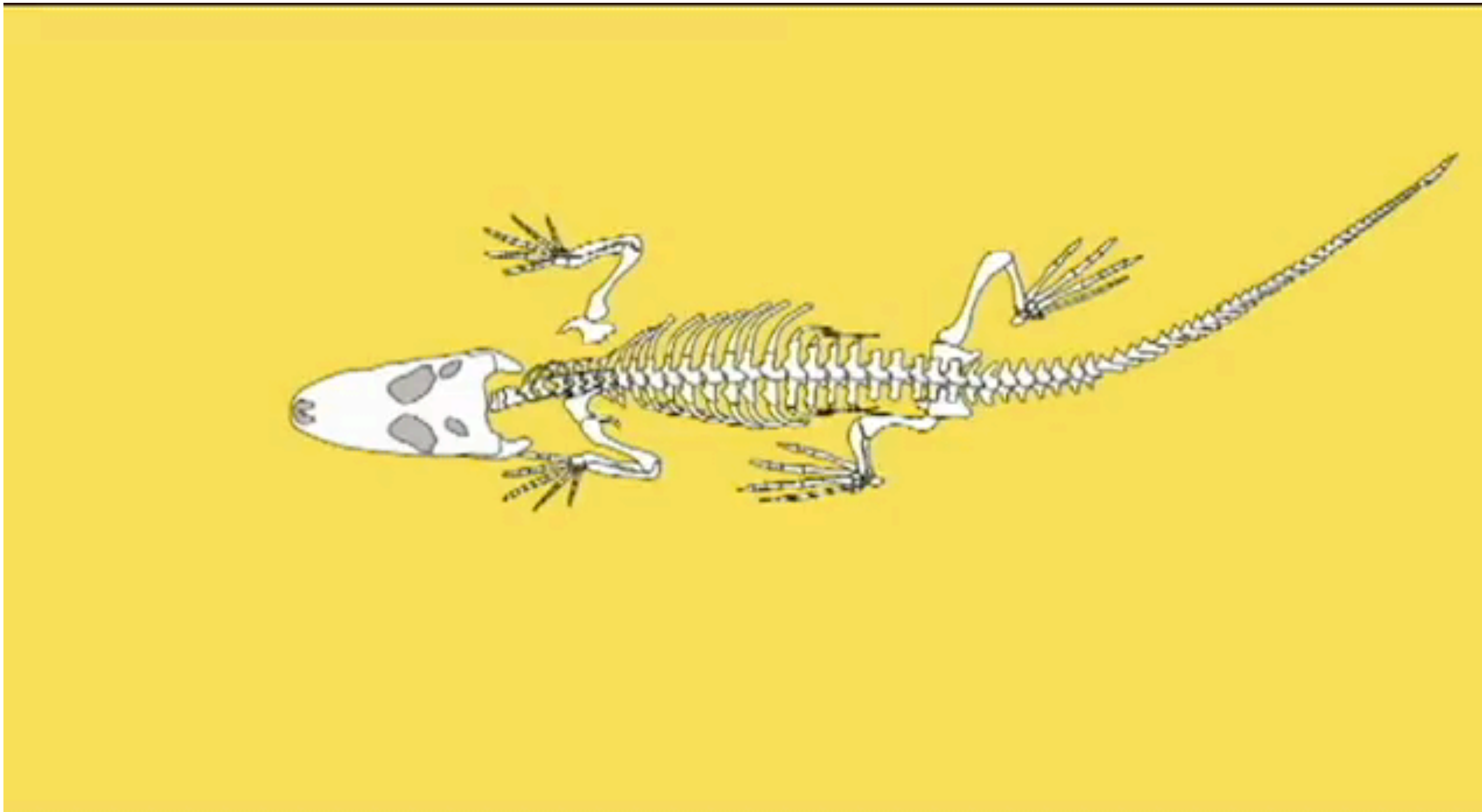


Mammalian locomotion and breathing

- Shift breathing contractions from rib muscles to DIAPHRAM
- This transition can be tracked by counting ribs







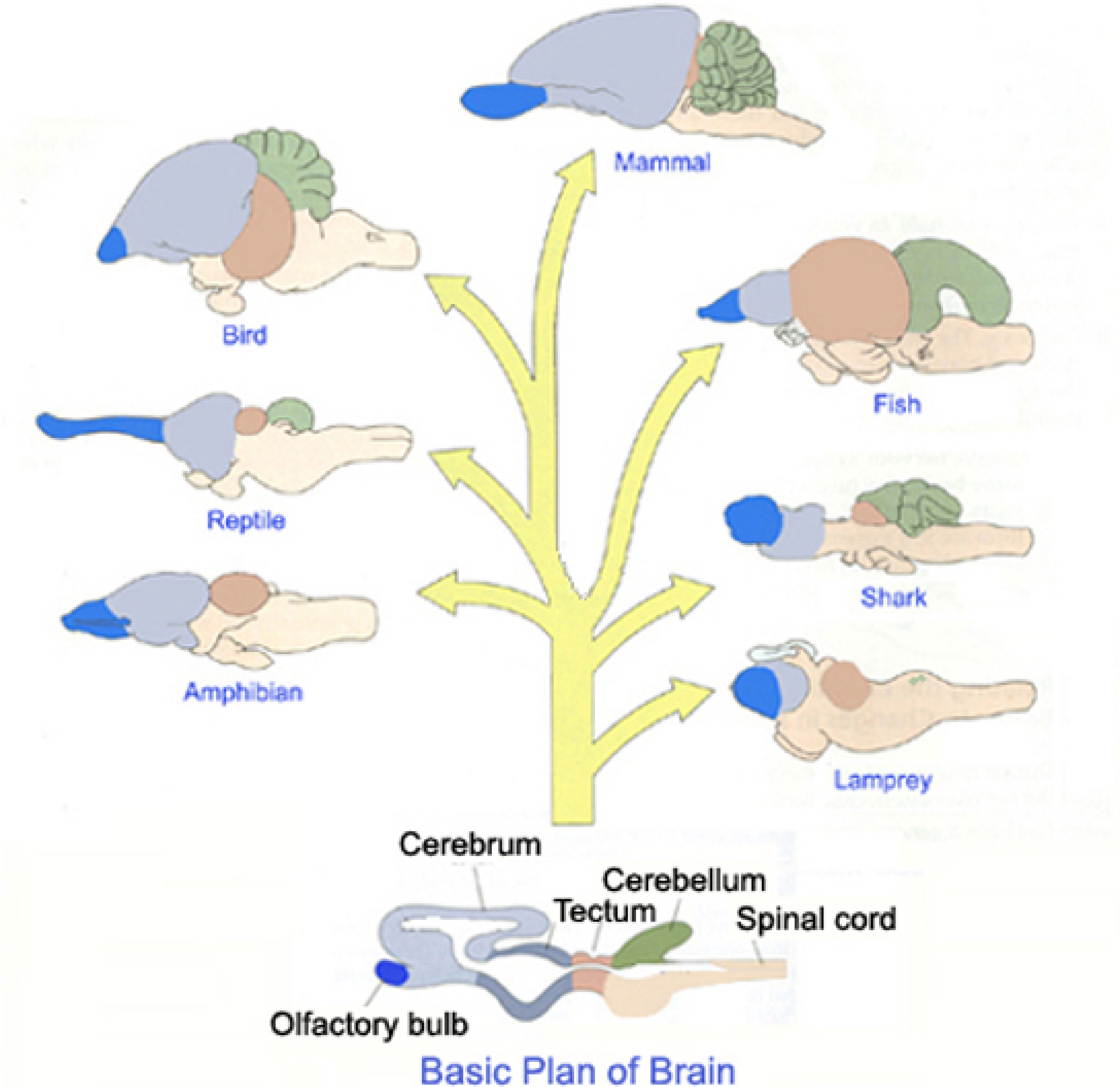
The Mechanics of Respiration

Isolated View of Diaphragm in Motion

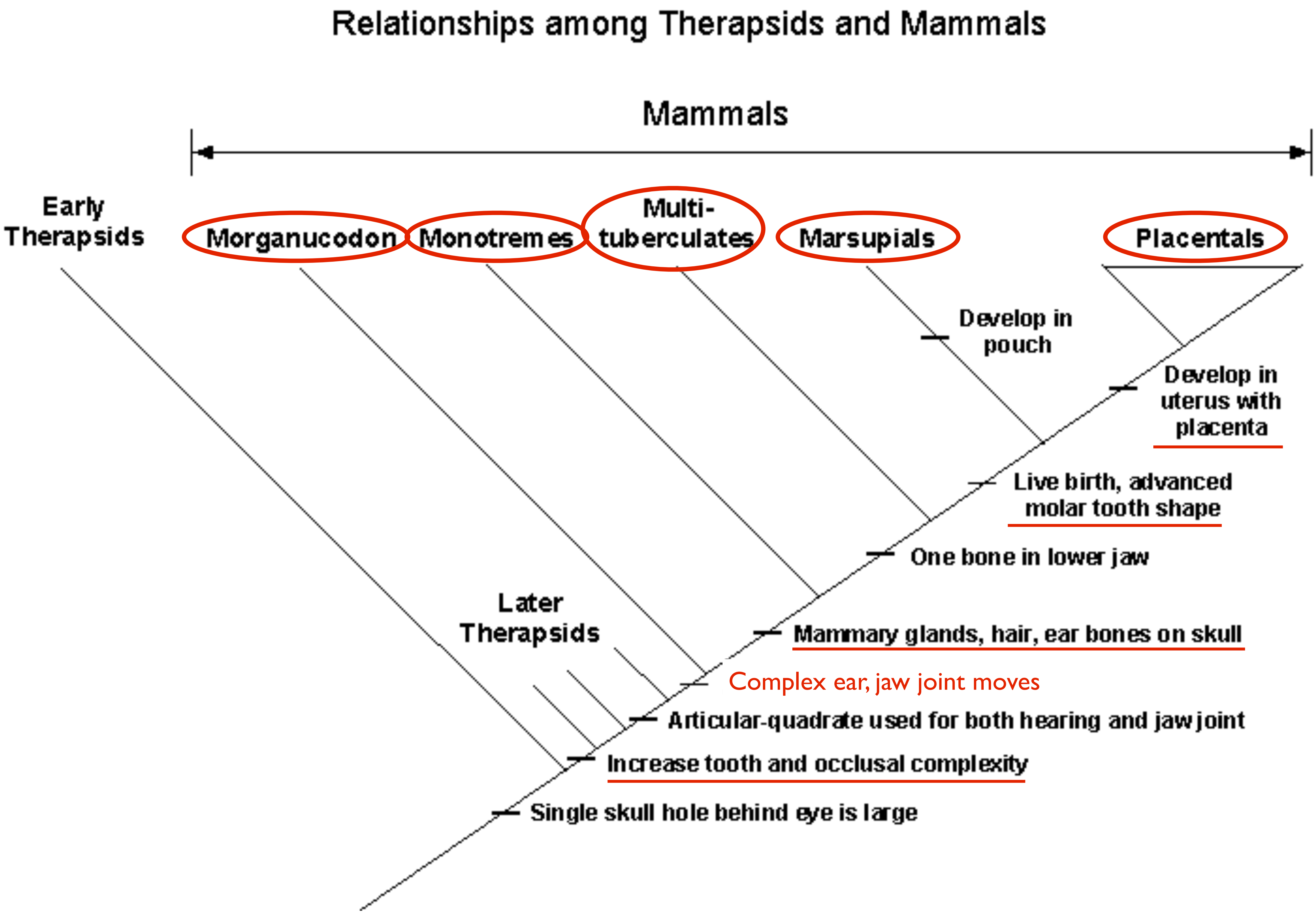
Video Demo

www.3D-Yoga.com

Mammalian Brains



The Origin of Mammals



The earliest Mammal: *Morganucodon*

- Late Triassic
- Small insectivore
- Climber, Jumper
- True mammal ear but still attached to jaw… not the skull
- Upright hindlimb
- More than one bone in lower jaw and sprawling forelimbs

The Monotremes

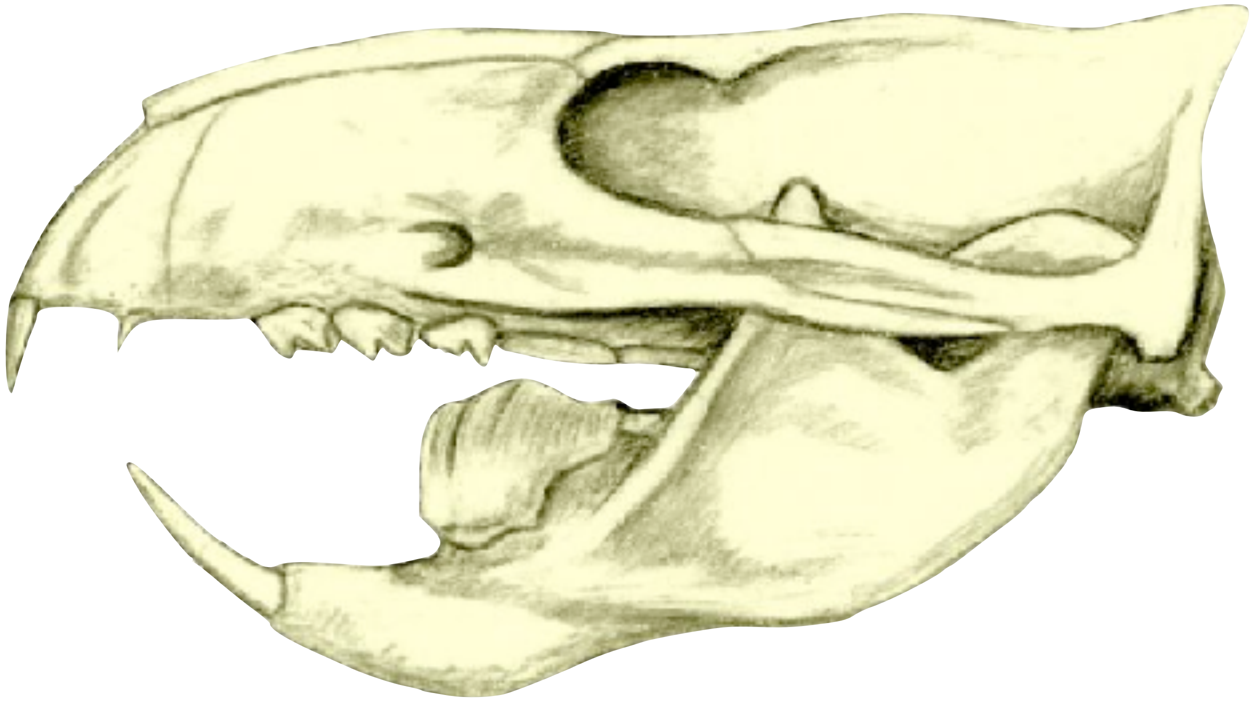
- Cretaceous to Recent
- Lay eggs!
- No breasts; milk oozes from skin
- Hair
- Ear bones shift from lower jaw to skull during development
- Electroreception
- Modern forms:
  - Insectivores
  - One species is semi-aquatic
  - Only poisonous mammal

Echidna

Platypus

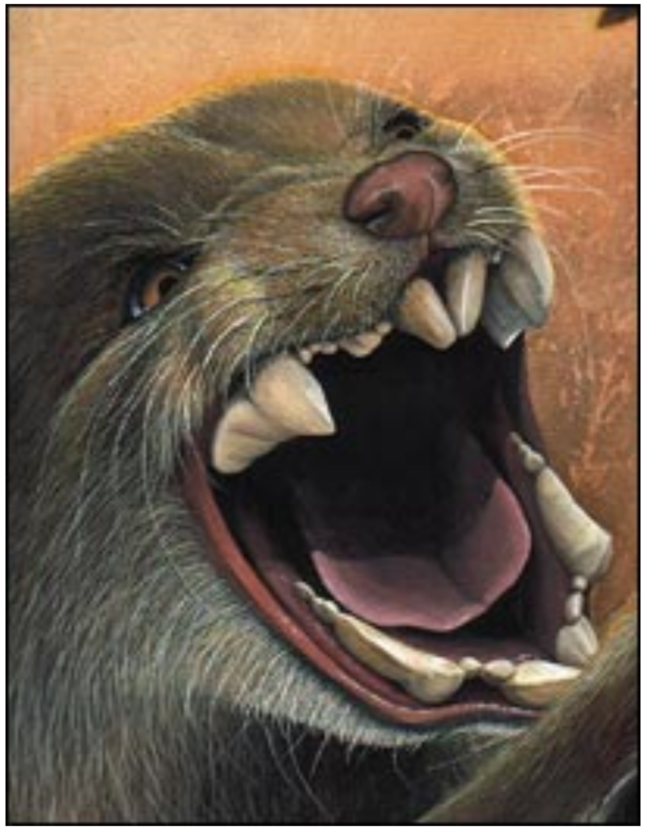
The Multituberculates

- Jurassic to Eocene
- (100 Ma lineage)
- Important small herbivores in Cretaceous and Cenozoic
- Single bone in lower jaw
- Many types of teeth
  - incisors
  - premolars
  - molars
- Evidence of hair in the fossil record
- Some may have given birth to live young



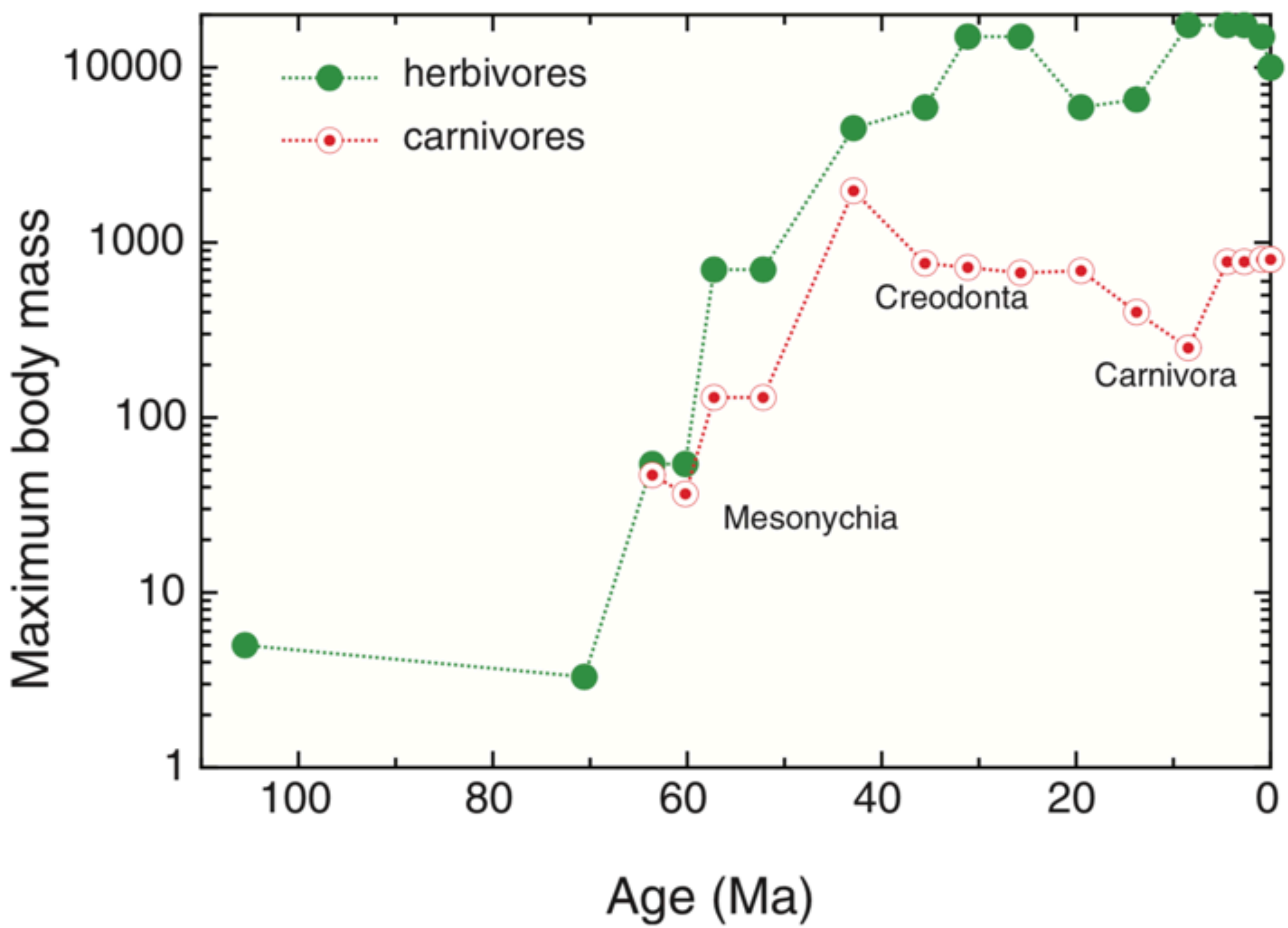
The Marsuplials

•Cretaceous to Recent
•Live young (embryos) crawl to pouch, attach to nipple and continue development
•Share complex molar tooth shape with placentals
•Cretaceous forms mostly opossum-like in terms of ecology
•Modern forms diverse- peak diversity in Australia and South America

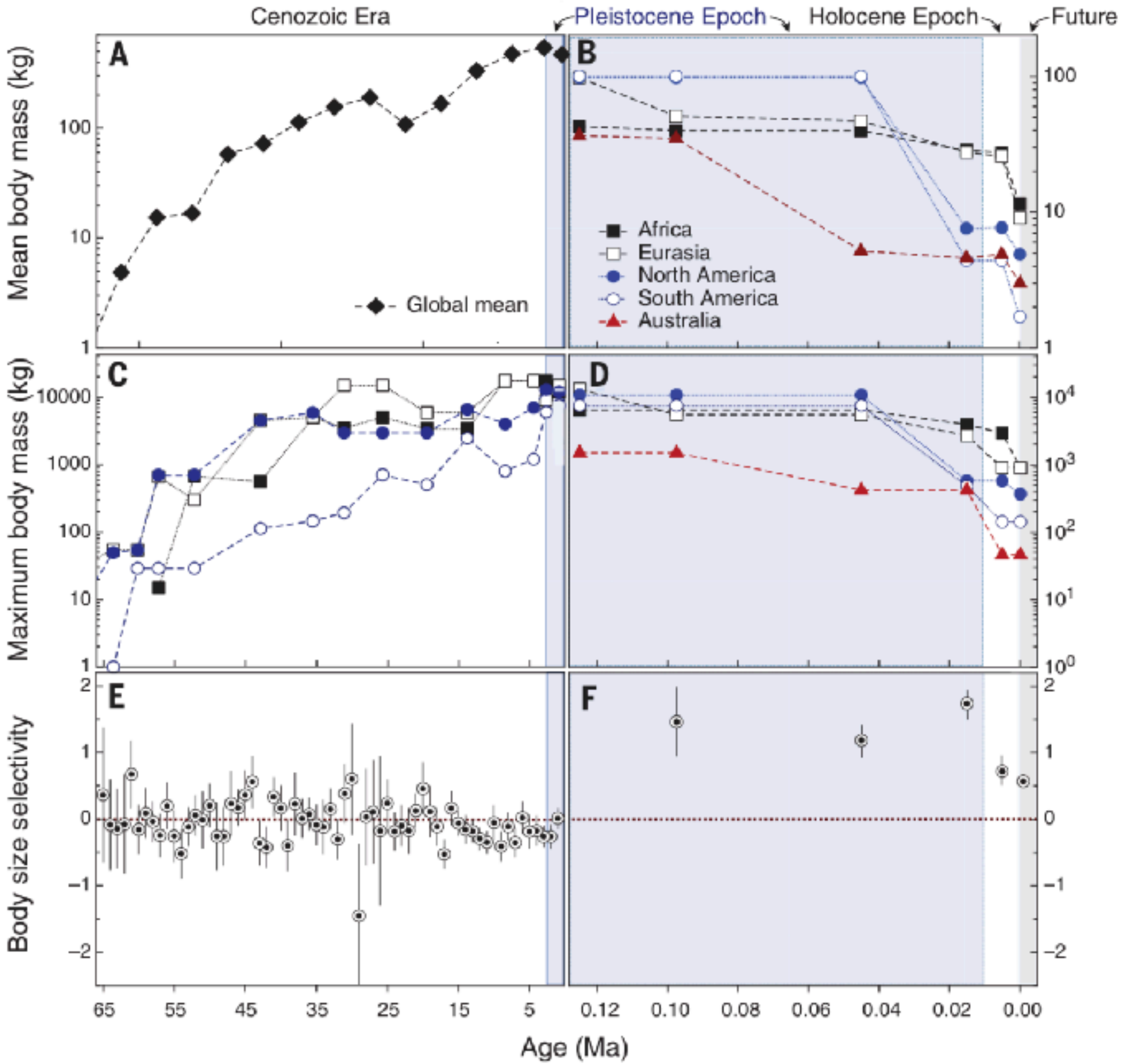


The Placentals

- Cretaceous to Recent
- Give birth to fully developed young
- Fetus nourished by the Placenta
- Cretaceous forms were mostly shrew-like in terms of ecology
- Modern forms are the dominant group in most ecosystems



herbivores
carnivores
Creodonta
Carnivora
Mesonychia
Maximum body mass
1
10
100
1000
10000
Age (Ma)
100
80
60
40
20
0



Cenozoic Era
Pleistocene Epoch
Holocene Epoch
Future
A
B
C
D
E
F
Mean body mass (kg)
Maximum body mass (kg)
Body size selectivity
Global mean
Africa
Eurasia
North America
South America
Australia
Age (Ma)

Biology: Ecology and Evolutionary Biology at UC Merced

Biological Sciences Major

- Molecular and Cell Biology
- Human Biology
- Ecology and Evolutionary Biology
- Developmental Biology
- Microbiology and Immunology

Earth Systems Sciences @ UC Merced

Earth Systems Science

Earth systems science (ESS) is a major that prepares students to understand and solve critical challenges facing our environment, such as climate change, water and soil pollution, conservation of biological diversity and management of natural resources. It integrates the study of fundamental physical, chemical and biological processes that shape our environment with practical applications to real-world problems. The major is taught by a highly interdisciplinary group of faculty members. Check out their lab websites to learn more about their research and the courses they teach.

LES
Life & Environmental Sciences

Photo Credit: jdyeakel

Jean-Philippe Gibert, McDonnell Fellow "I study how phenotypic variation affects the structure and dynamics of complex food webs and how this effect is mediated by environmental factors such as temperature. To do so, I integrate information across systems and taxa and often combine mathematical, computational and empirical tools." **Jean Philippe will be joining Duke University in the Fall, 2018 as an Assistant Professor!**

Uttam Bhat "I study problems in ecology using tools from physics. In particular, currently I'm studying how different foraging behaviors affect the depletion pattern in the environment, and in turn how the depletion affects the forager's lifetime. For this, I use tools from random walks, first-passage processes and asymptotic analysis."

Ritwika VPS "I joined UC Merced as a physics grad student in Fall 2015. I have long been interested in the scope of using physics to solve problems in ecology and evolutionary biology, hence my interest in the Yeakel lab. Currently, I work on an eclectic collection of problems which includes looking at vocalisation in human infants as an acoustic foraging process, studying the dynamics of a population of foragers given a choice of strategies, and looking at the collective motion of phototactic bacteria."

Taran Rallings "I am interested in how we set conservation baselines. I want to use modelling, food web theory, and paleocology to compare modern and historical communities with an eye to conservation and restoration. This includes questions of how to best restore food webs to early baselines - the usefulness of ecological surrogates and de-extinction, stabilizing reintroduction orders, etc. This information may help us make better decisions about existing projects like Pleistocene Park and help structure future rewilding attempts."

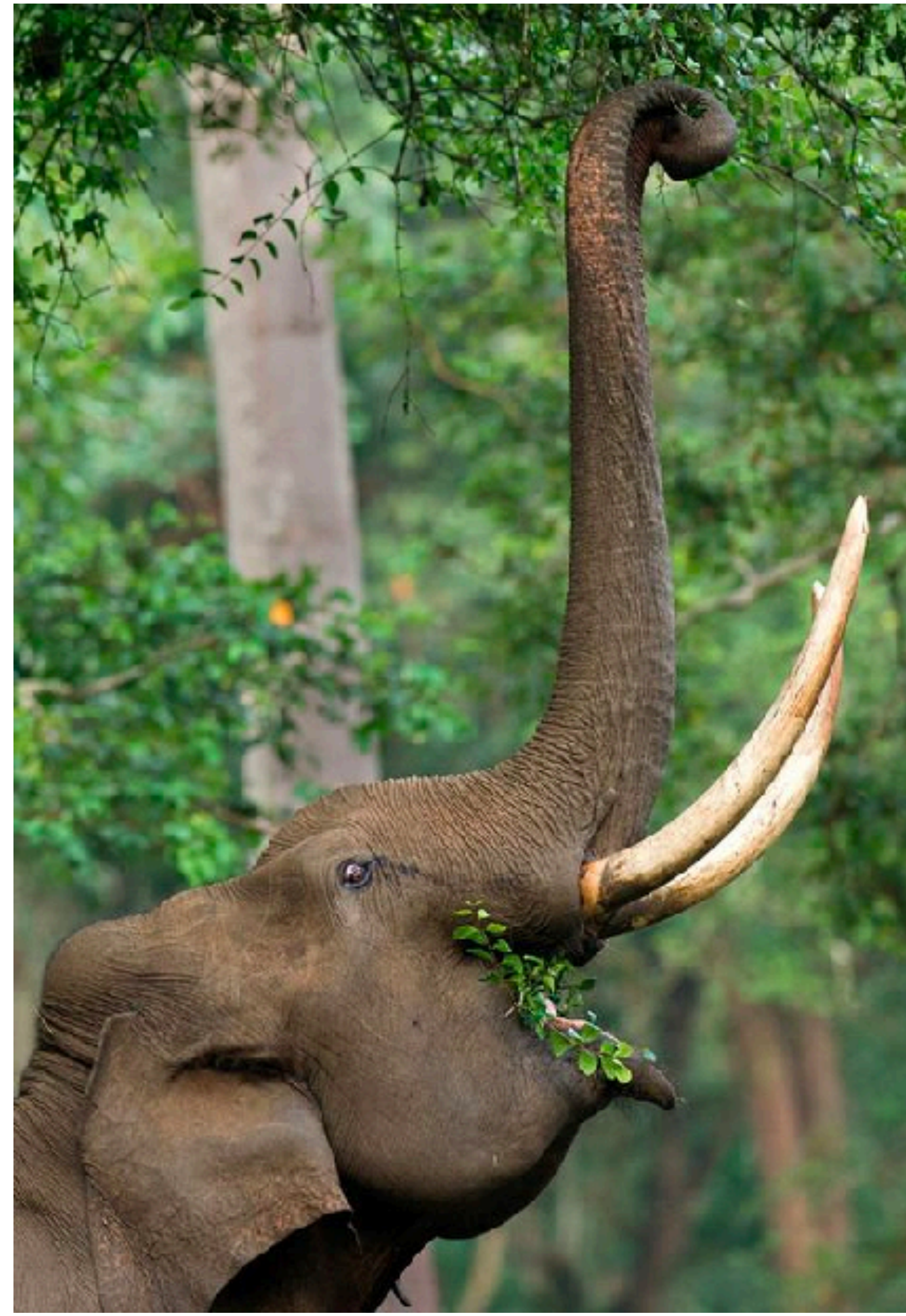
Irina Birskis Barros "I will join UC Merced as a PhD student in Fall 2018. I am interested in how species assemble into communities, especially how diversity shapes and is shaped by species interactions. I aim to use empirical data, mathematical modeling and network theory to investigate how ecological networks assemble and what factors might influence their stability and structure over evolutionary time."

Predicting the maximum size that a mammal can attain based on

How much energy it takes to:

1) Reproduce
2) Maintain tissue
3) Build tissue

…while foraging for resources that are harder to find when there are a lot of consumers on the landscape



What is a <u>minimal model</u> to incorporate

-Growth

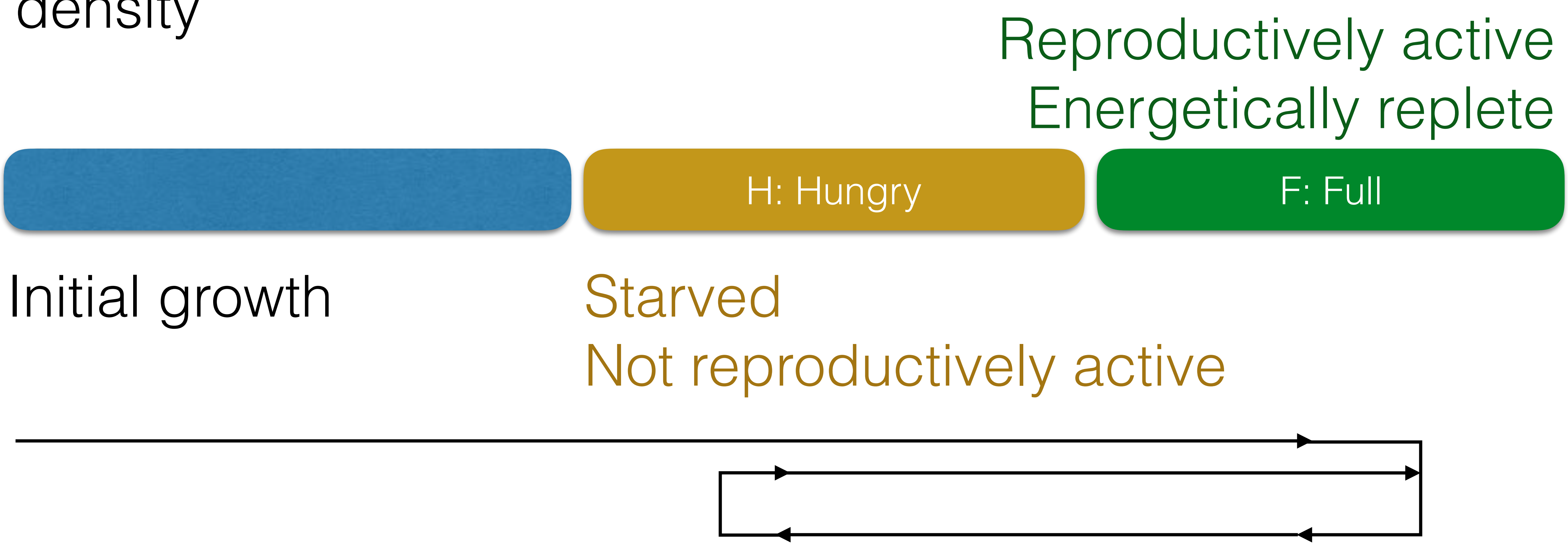
-Starvation

-Recovery

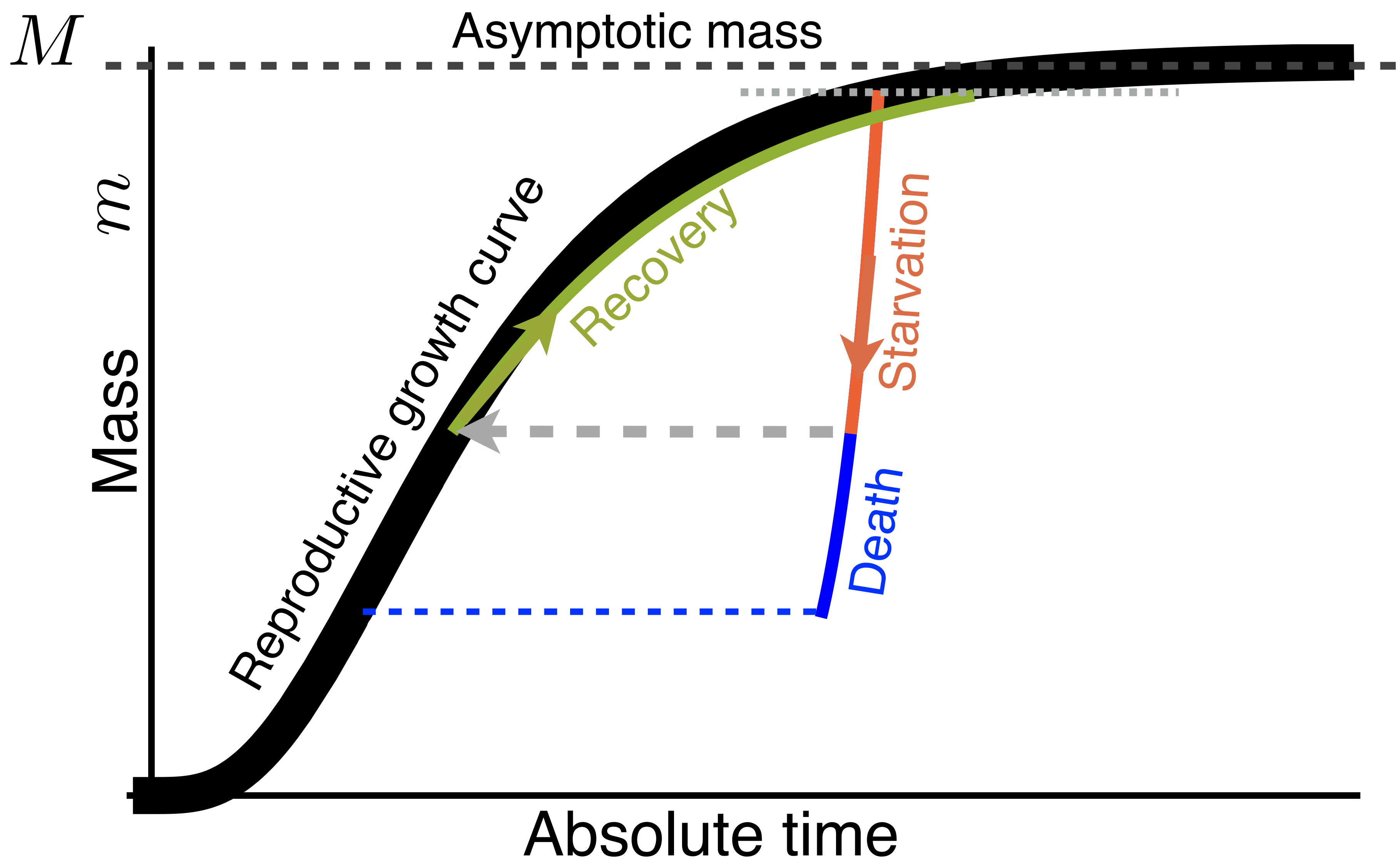
Deriving an *explicit* version:

Full & **H**ungry consumer class (C=F+H)

**The transition from H→F, F→H is driven by resource density

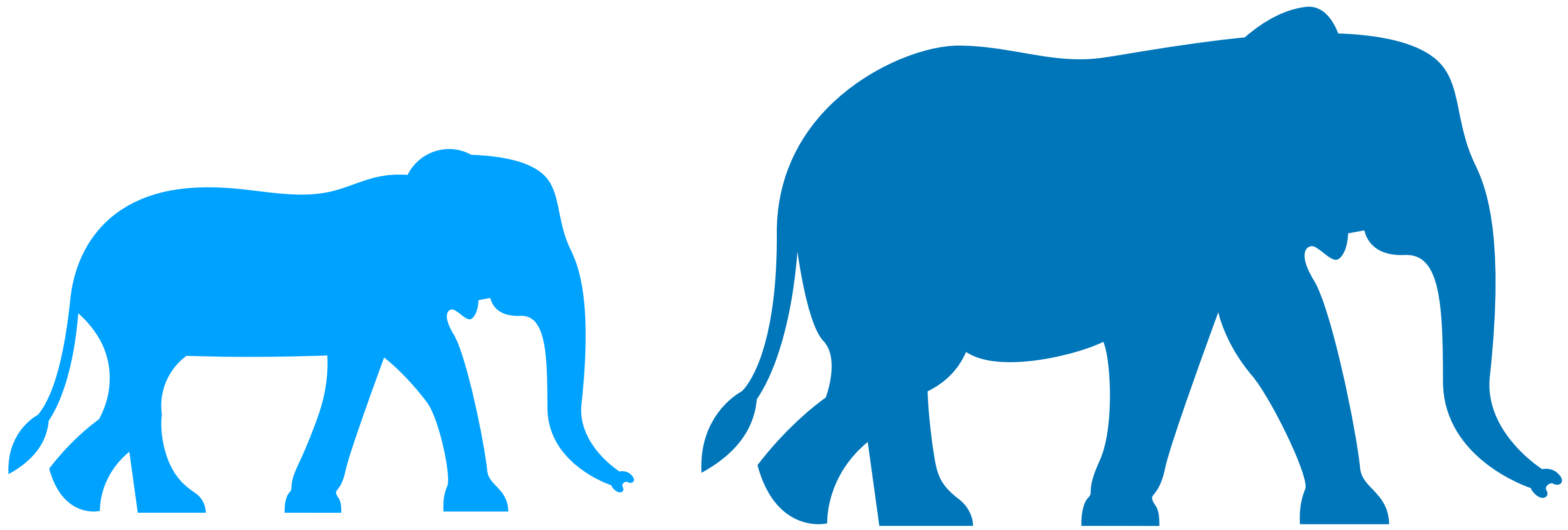


Model for ontogenetic growth supplies nearly all of the rates



Metabolic rate = Growth + Maintenance

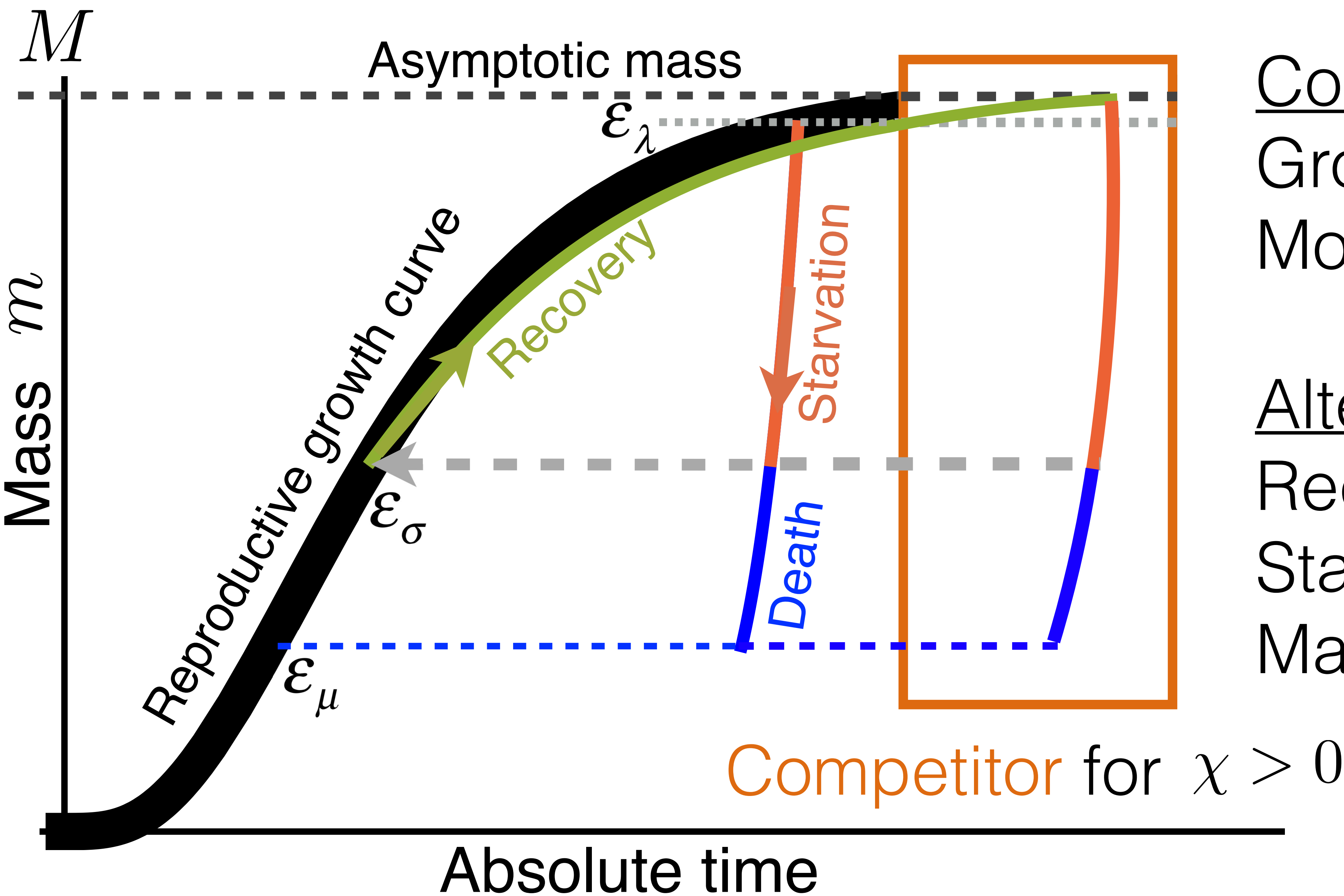
Who has the competitive edge? The fatter individual or the leaner individual?



Resource competition theory:

Whoever can live on fewer resources wins

Characterizing the rates of a competing species

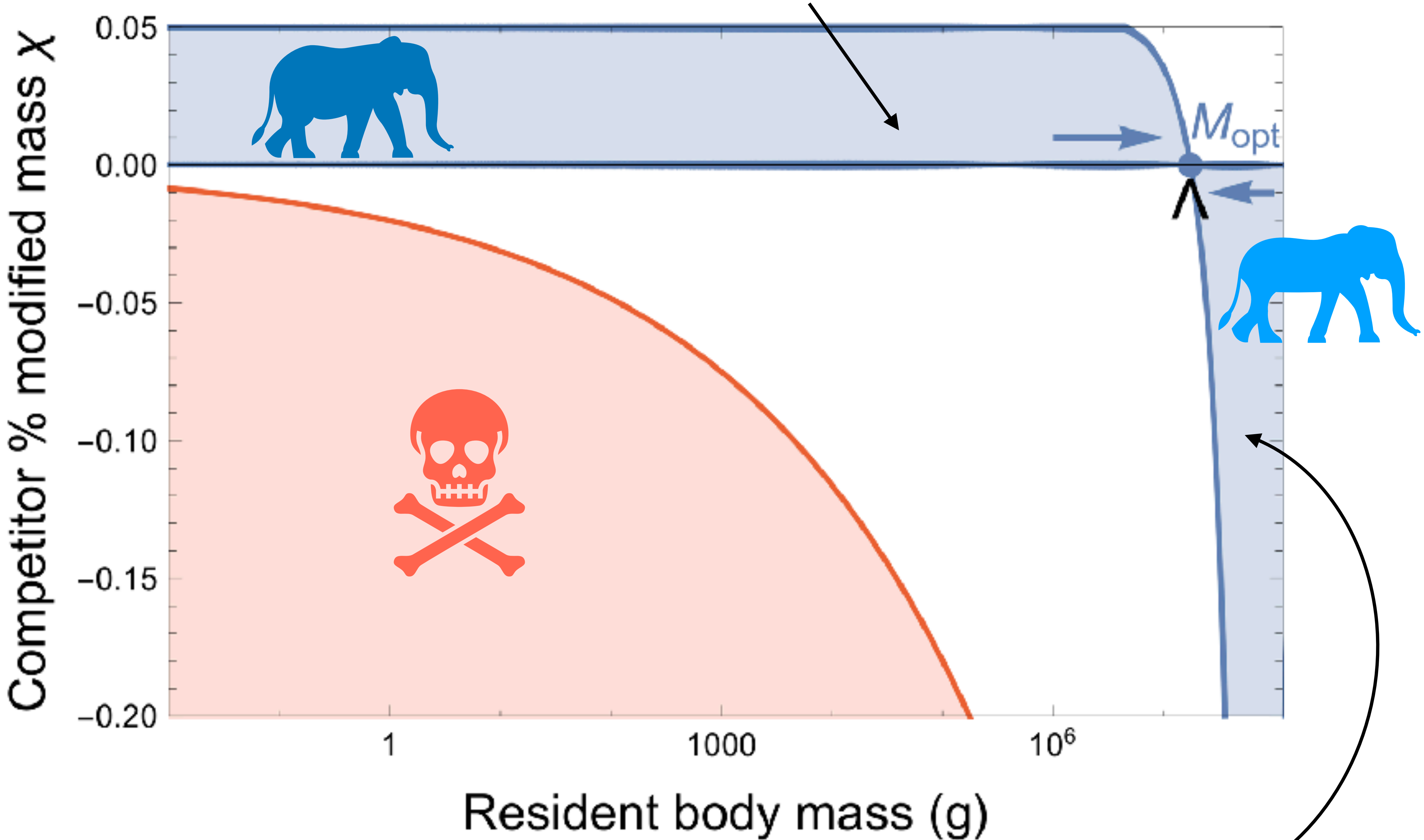


Conserved
Growth rate
Mortality rate

Altered
Recovery rate
Starvation rate
Maintenance rates

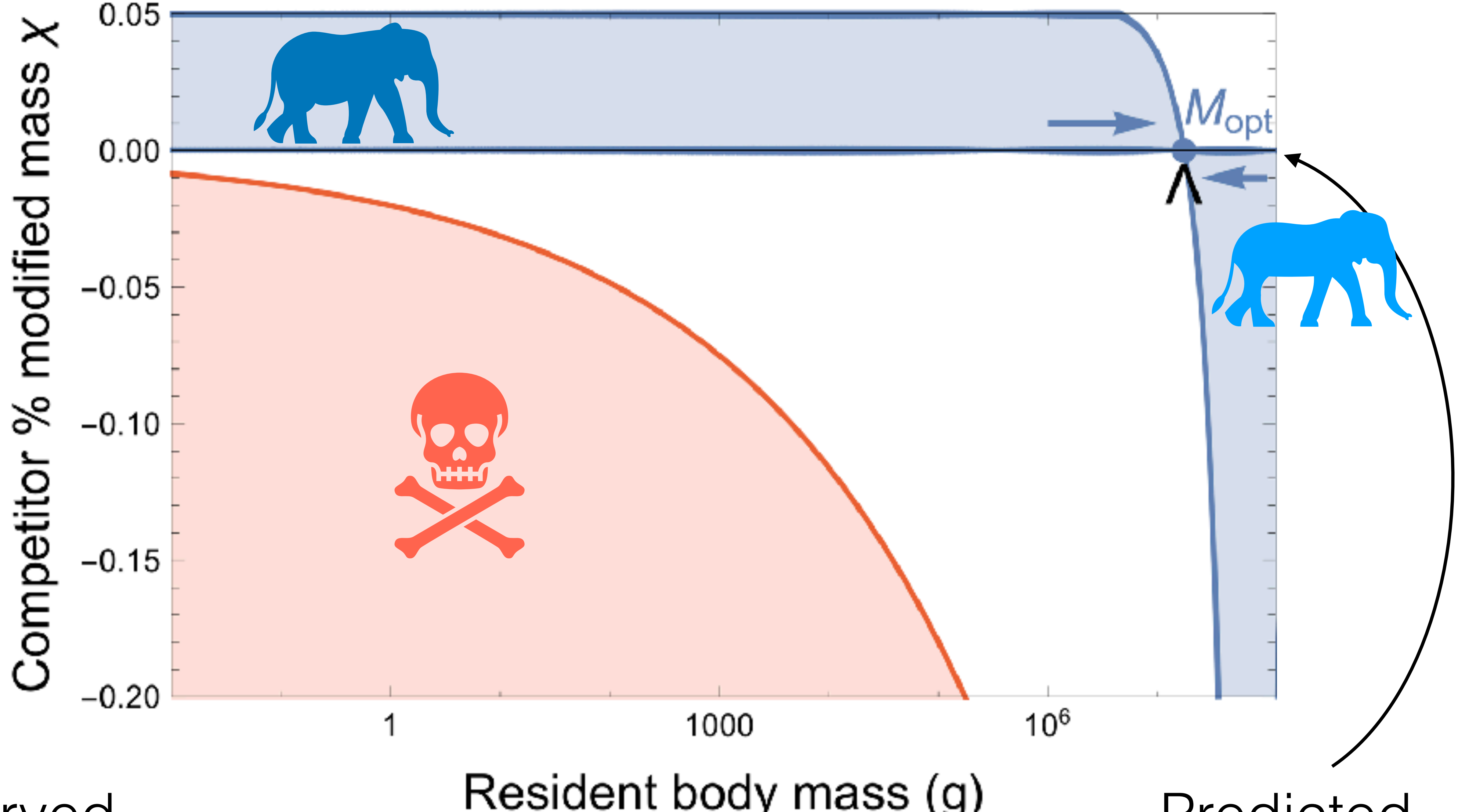
Selection via: who can push resource densities lower?
[R* theory]

Competitor with increased reserves outcompete (lower R*)



Invaders with decreased reserves outcompete (lower R*)

Evolutionary attractor?



Observed

$$M_{Indricotherium} = 1.5 \times 10^7$$
$$M_{Deinotherium} = 1.74 \times 10^7$$

Predicted

$$M_{\rm opt} = 1.748 \times 10^7$$