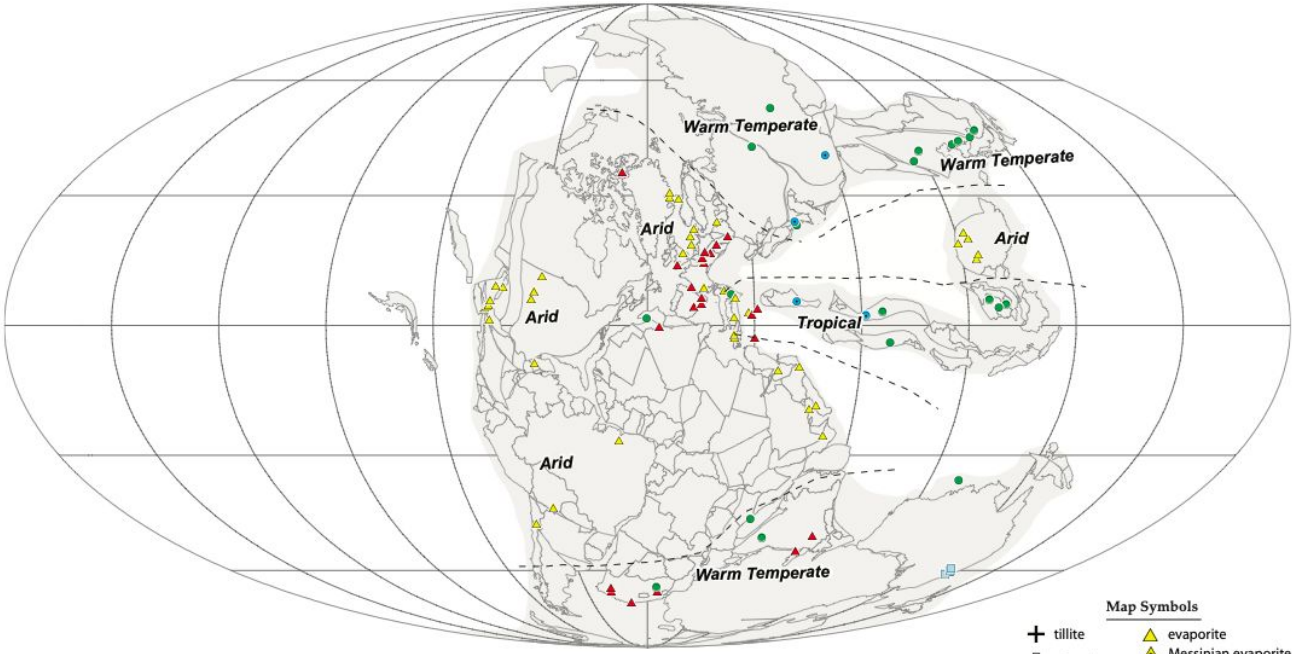
# Lecture 12: Triassic 3

*Coelophysis* and *Postosuchus* (source)

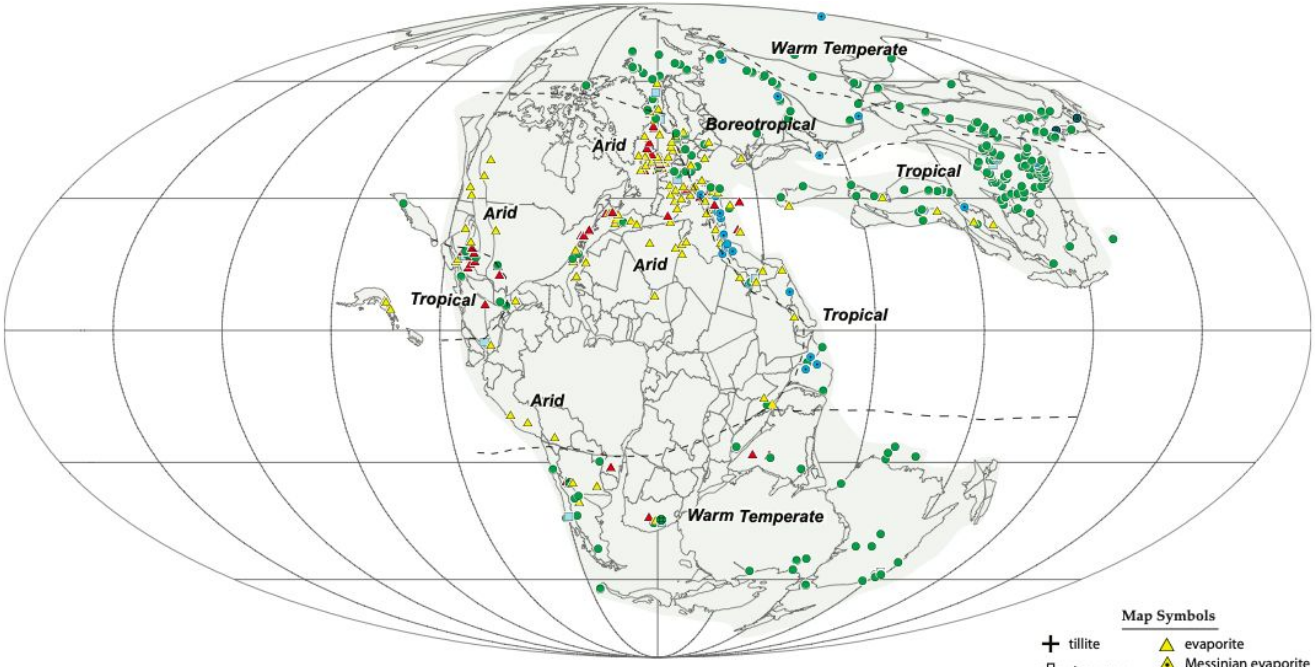
# Dinosaurs do not appear until the middle Triassic




Map 16 Early Triassic

Boucot, Arthur James, et al. "Phanerozoic paleoclimate: an atlas of lithologic indicators of climate." (2013).

# Dinosaurs do not appear until the middle Triassic

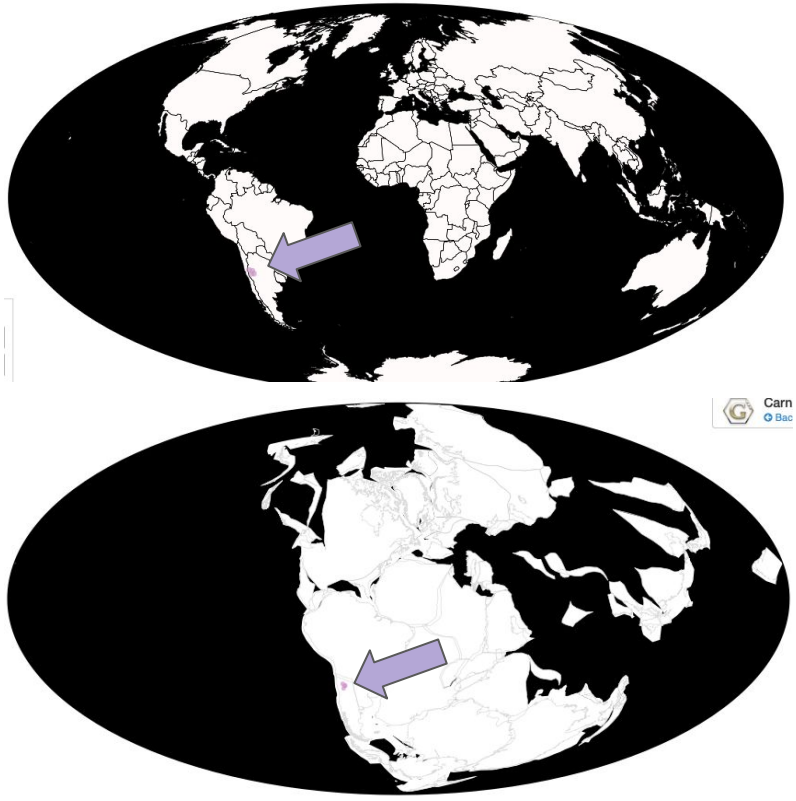



Map 18 Late Triassic (Carnian, Norian, Rhaetian)

Boucot, Arthur James, et al. "Phanerozoic paleoclimate: an atlas of lithologic indicators of climate." (2013).

# Fossil Deposit: The Ischigualasto Formation

- **Lagerstätte** in Northwest Argentina
- Between 231.7 and 225 Ma (defines the Carnian age of the late Triassic)
- Interpreted as a volcanically active floodplain with humid forests

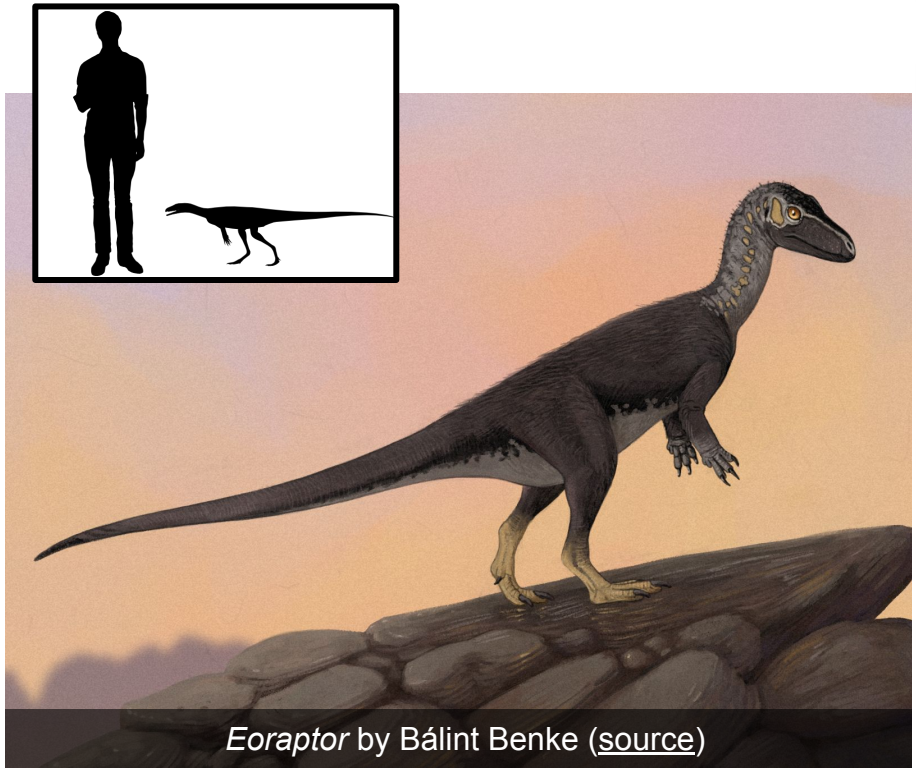


# Eoraptor

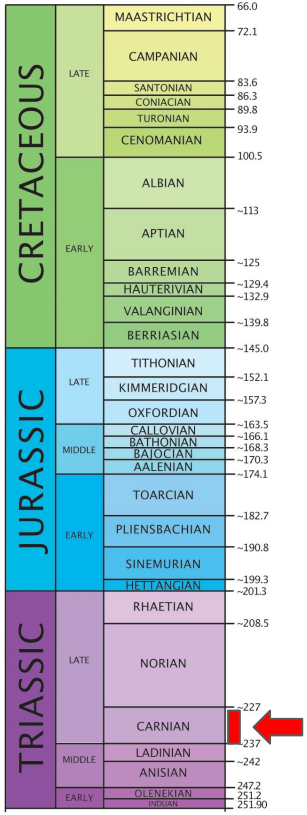
***Eoraptor***

Greek: “Eo” = dawn; “raptor” = theif

- ~231–228 Ma
- ~3.5 ft long

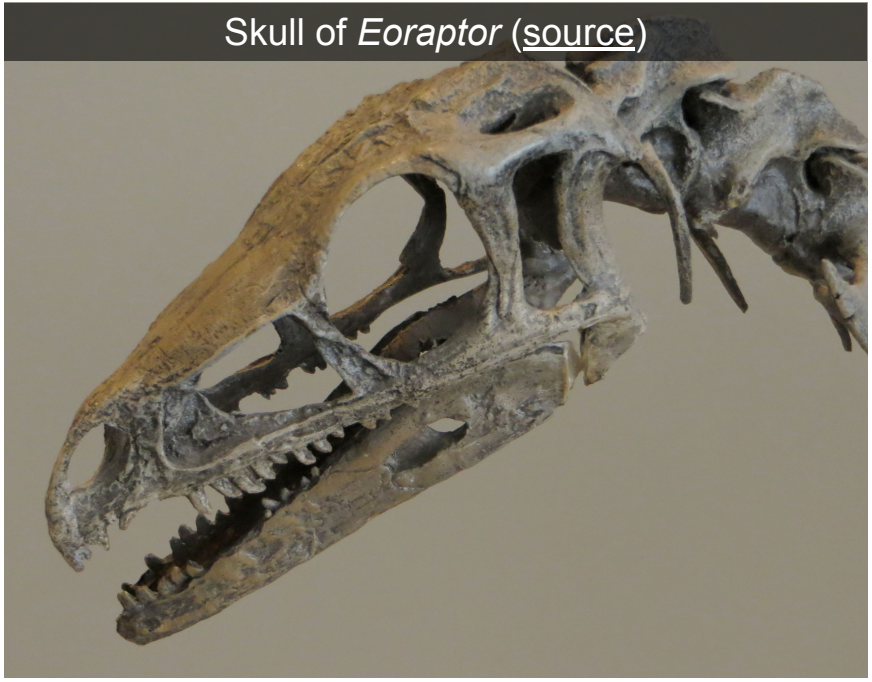


*Eoraptor* by Bálint Benke (source)



# Eoraptor

Skull of *Eoraptor* (source)

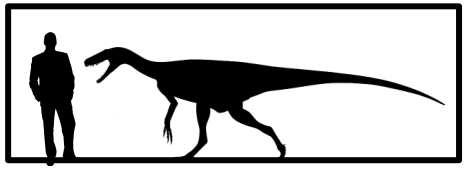


- Serrated teeth in upper jaw and leaf-shaped teeth in lower jaw
- Likely omnivore
- May be more closely related to sauropods (long-necked dinosaurs) than theropods (meat-eating dinosaurs)

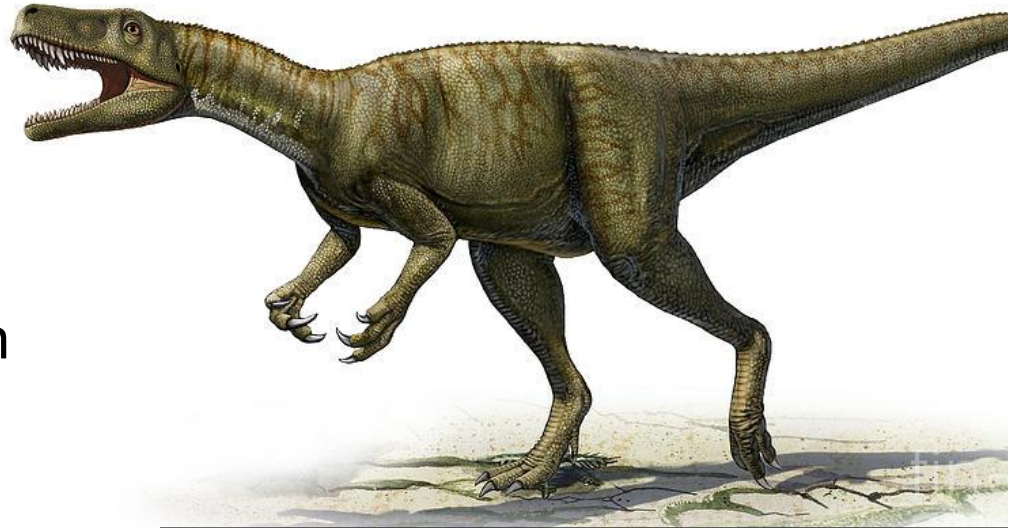
# Herrerasaurus

***Herrerasaurus***

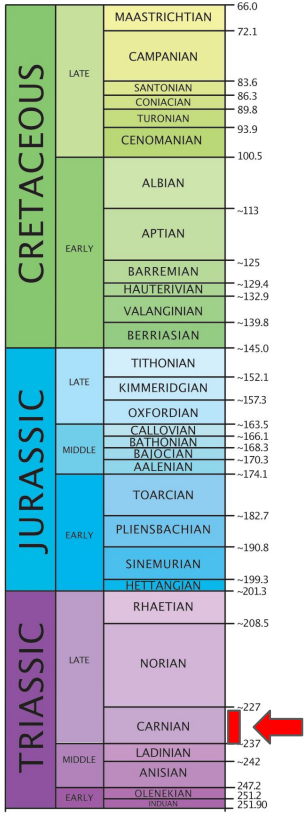
"Herrera" = the rancher who discovered it + Greek: "saurus" = lizard



- ~231–228 Ma
- Up to 20 ft long, though many specimens much smaller



*Herrerasaurus* by Sergey Krasovskiy (source)



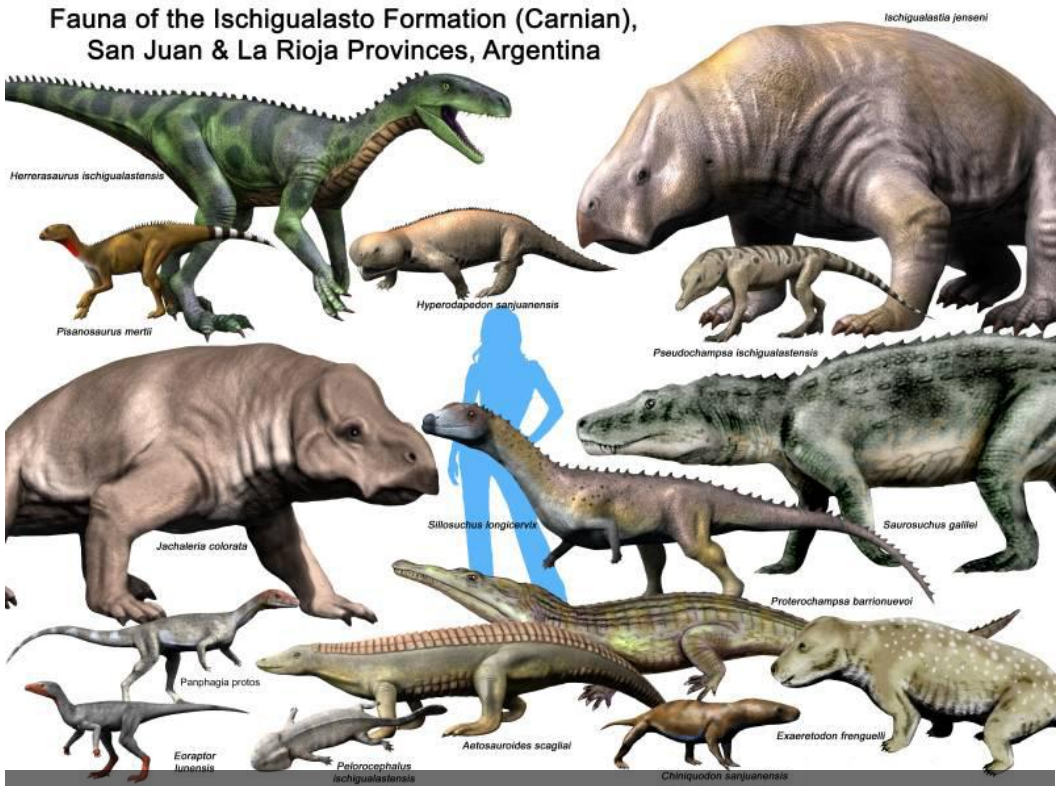
# Herrerasaurus

Skeleton of *Herrerasaurus* (source)

- Serrated teeth in top and bottom jaw
- Flexible joint in the lower jaw (**kinetic** jaw) could slide back and forth for a grasping bite
- Unusual mix of traits seen in later dinosaurs makes it hard to place

# Other animals of the Ischigualasto Formation

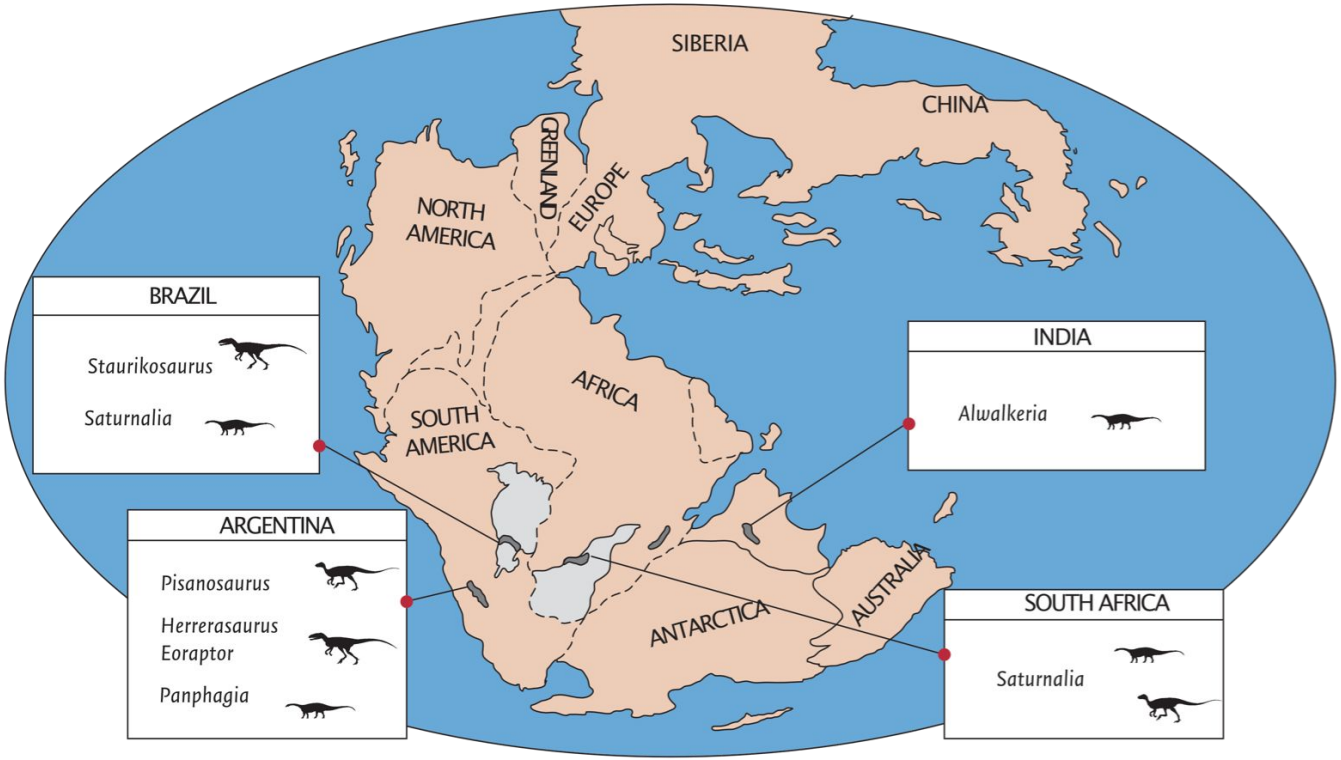
- Only ~6% of fossils are dinosaurs
- The rest are crurotarsi, synapsids, and other tetrapods

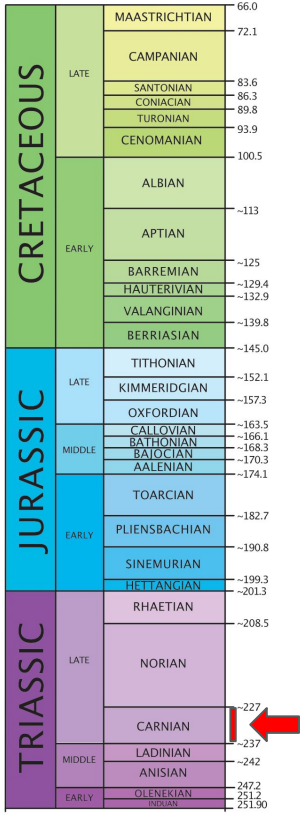


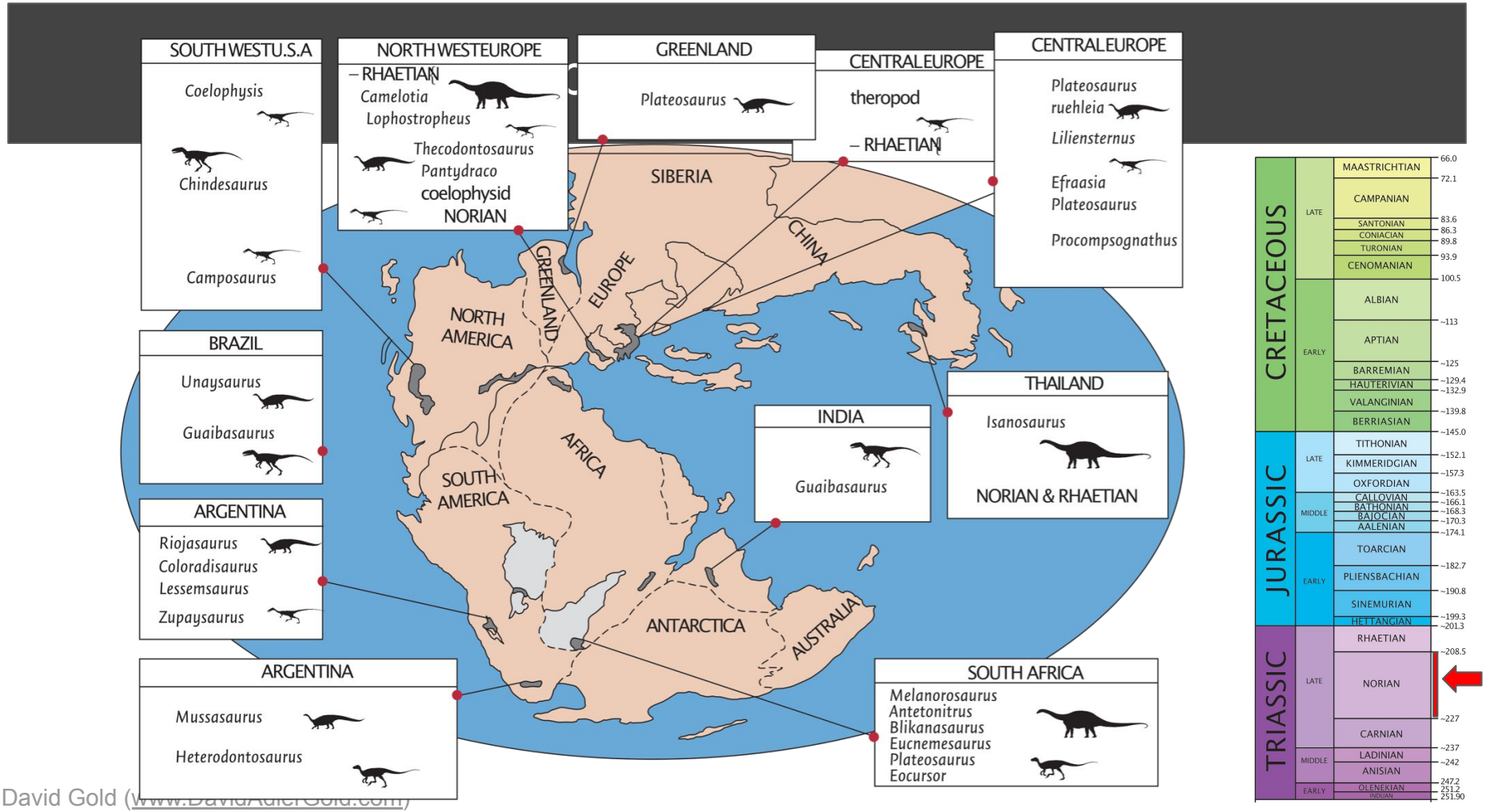
Fauna of the Ischigualasto Formation by Nobu Tamura (source)

Rogers, R. R.; Swisher, III; Sereno, P.C.; Monetta, A.M.; Forster, C.A.; Martinez, R.N. (1993). "The Ischigualasto tetrapod assemblage (Late Triassic, Argentina) and 40Ar/39Ar dating of dinosaur origins". Science. 260 (5109): 794–797.

# The expansion of dinosaurs



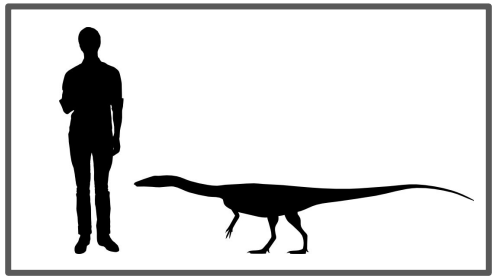



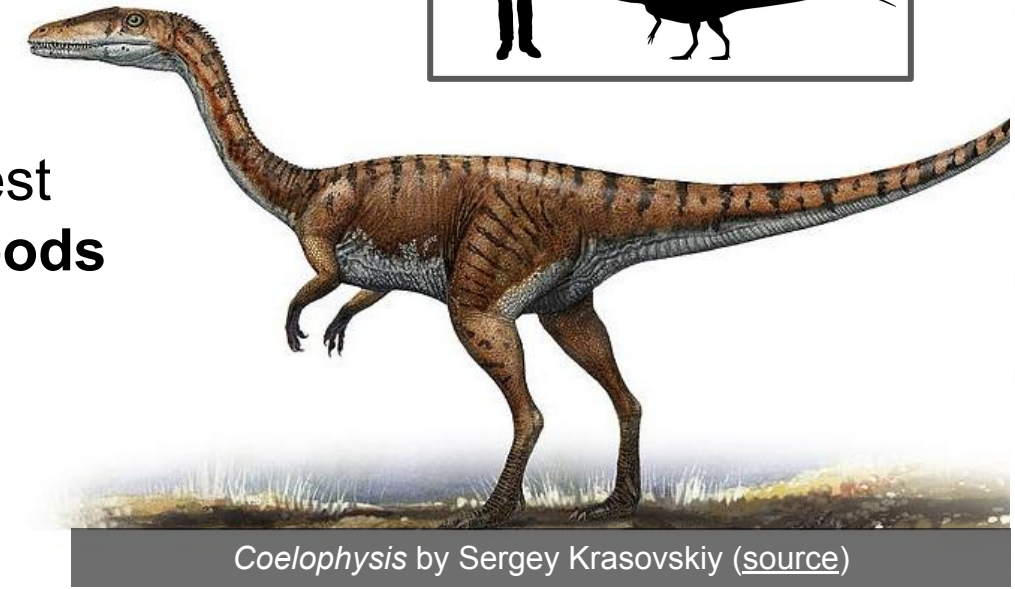


# *Coelophysis*

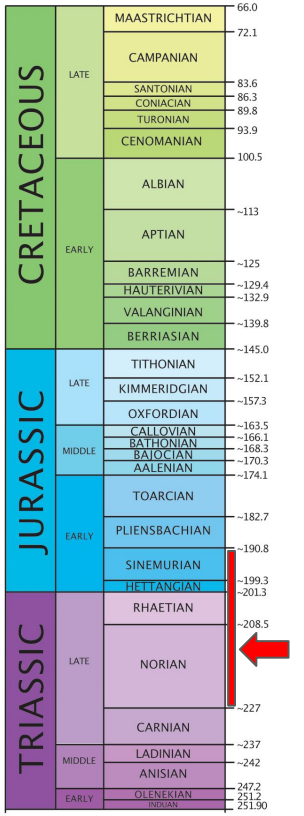
***Coelophysis***
Greek: “coelo” = hollow; “physis” = process/form

- ~221-196 My
- One of the earliest definitive **theropods**





*Coelophysis* by Sergey Krasovskiy (source)



# Three great clades of dinosaurs

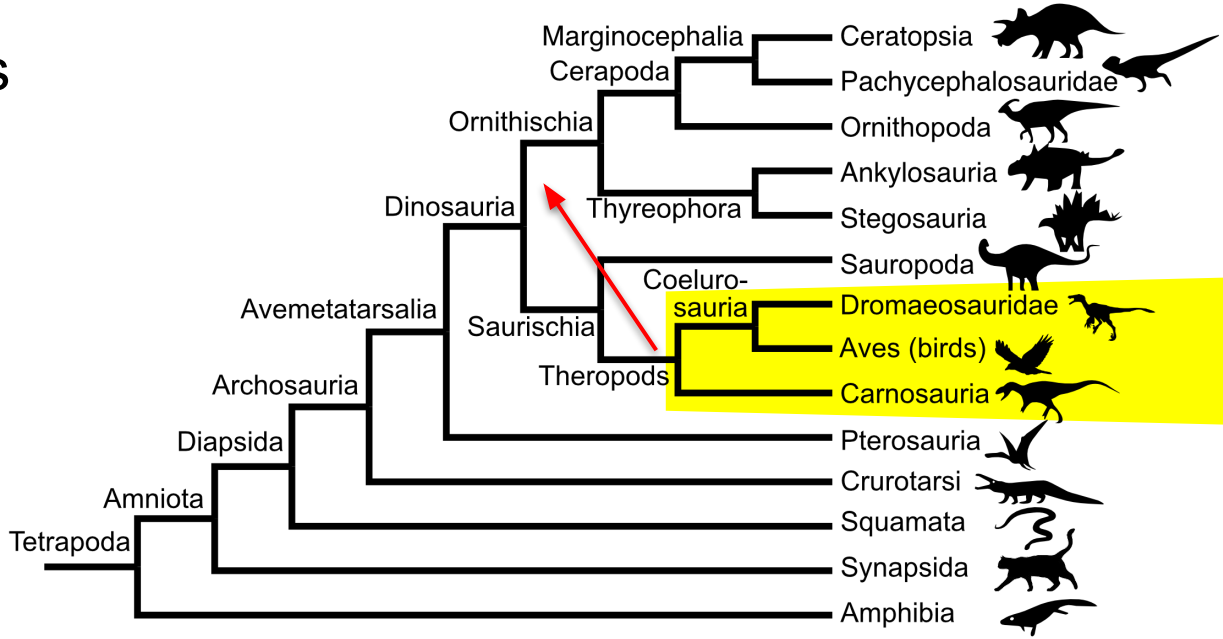
**theropods**
(clade **Theropoda**)
Greek: “theros” = wild beast; “pod” = foot

- Some of the most morphologically diverse
- Nearly all are meat eaters

Theropod diversity by Andrey Atuchin and Santi Mezzei (source)

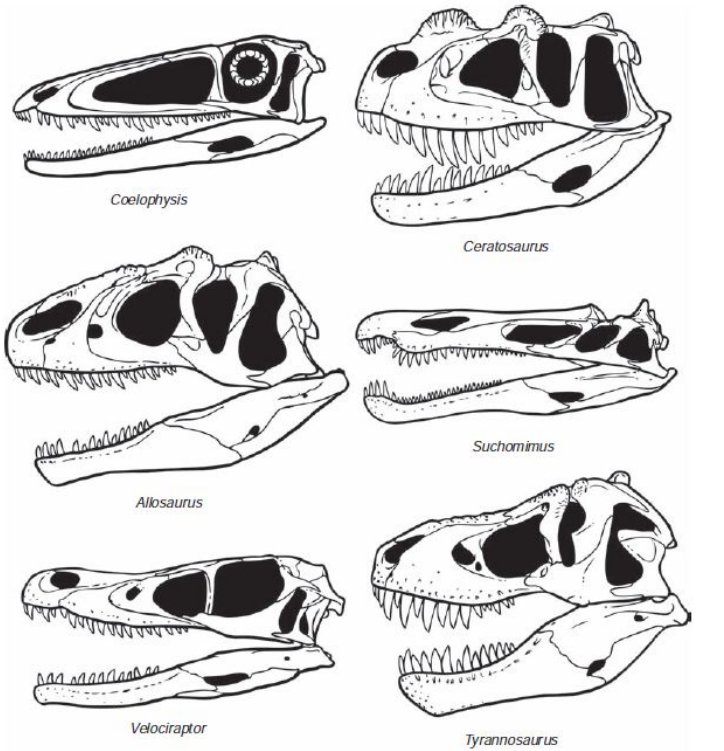
# Where theropods fit in the tree of life

- Most scientists consider theropods saurischian dinosaurs
- An alternative hypothesis is that they are more closely related to ornithischians



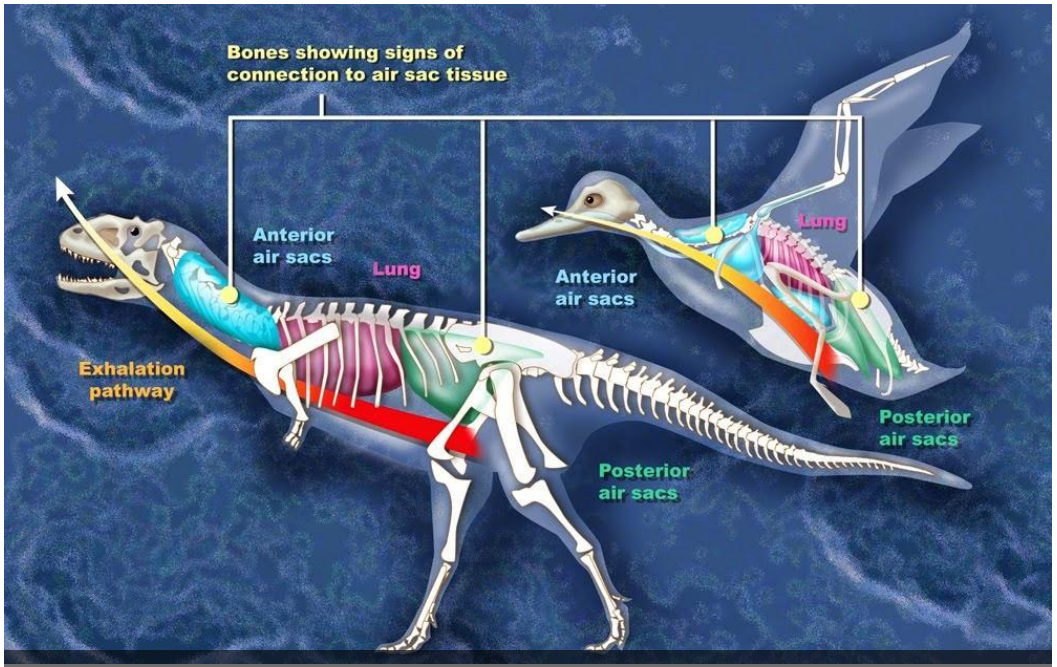
# Common Theropod traits

- Flattened, serrated teeth
- Ancestrally carnivores, although different clades evolve to specialize on other diets



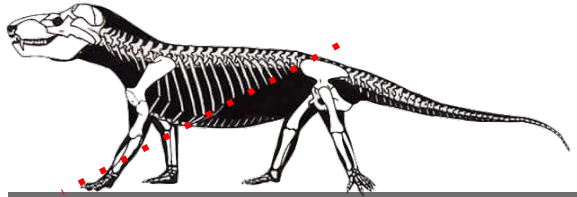

Theropod skulls, from Scott Sampson's Dinosaur Odyssey (source)

# Common Theropod traits




The pulmonary air-sac systems of dinosaurs and birds exhibit striking similarities, including predicted regions air of sac integration into the skeleton. The air sacs act like bellows to move air through the rigid lungs. Credit: Zina Deretsky, National Science Foundation (source)

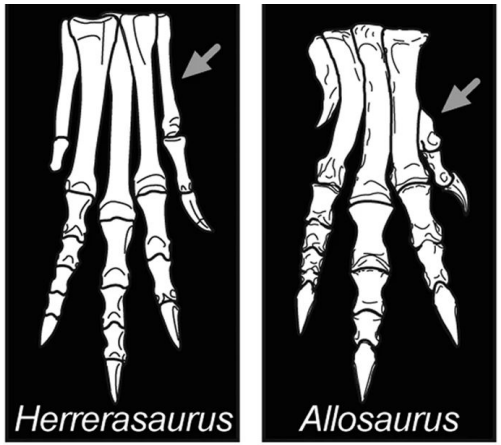
- Hollow bones allowed for advanced respiration, suggesting a high metabolism
- Distinct method of increasing airflow from mammals

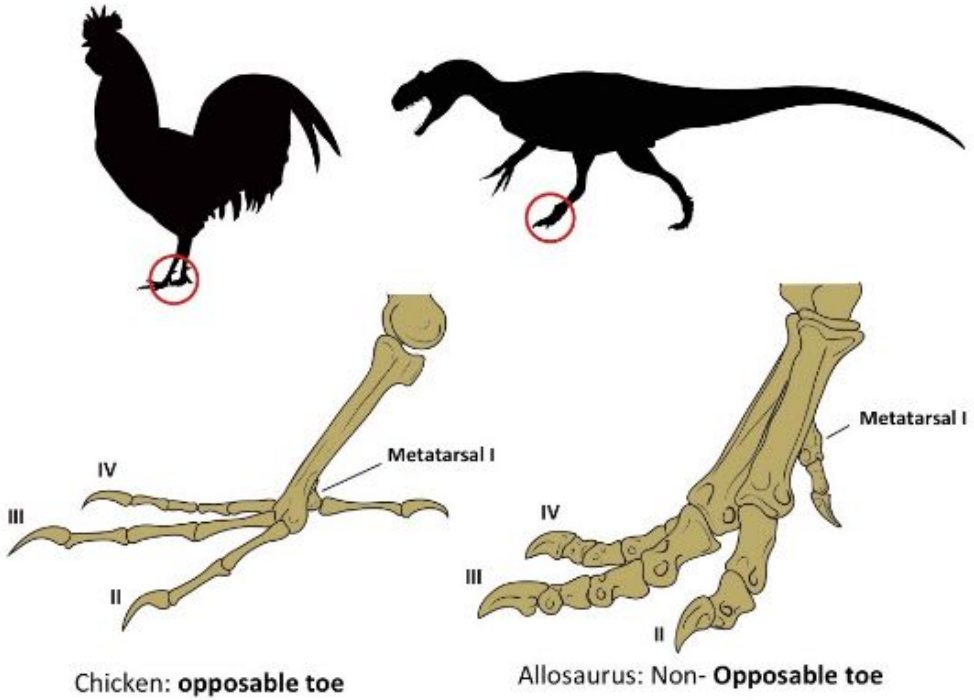


*Cynognathus* skeleton (source)

# Theropod traits

- Bipedal stance
- Three toes on the ground and a fourth off



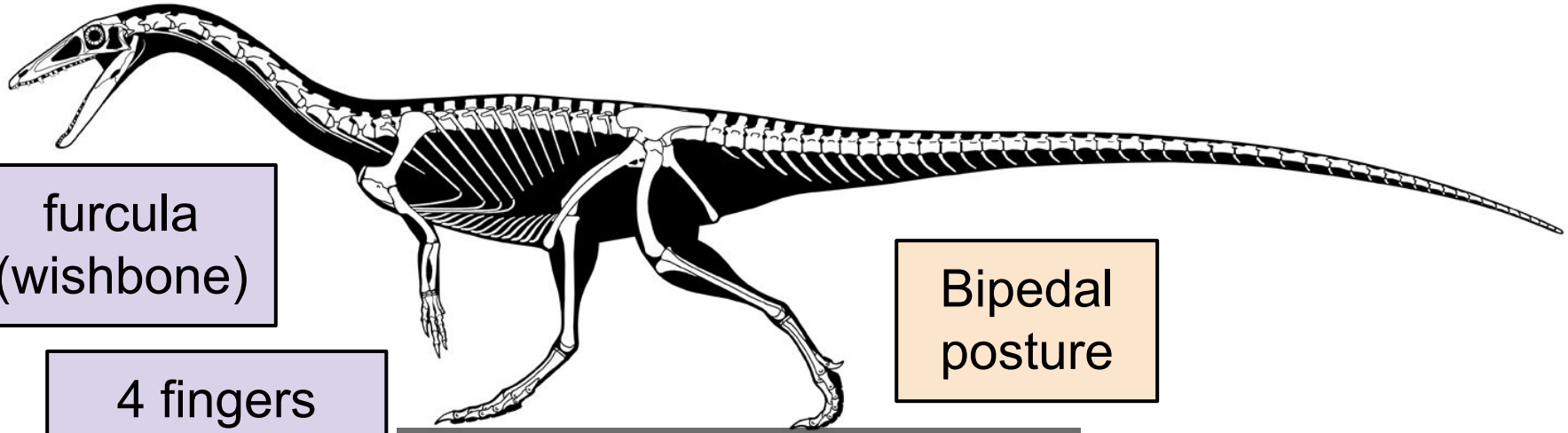




Botelho, João Francisco, et al. "Skeletal plasticity in response to embryonic muscular activity underlies the development and evolution of the perching digit of birds." Scientific reports 5.1 (2015): 1-11.

# Common traits in theropod dinosaurs

furcula (wishbone)

4 fingers (1 vestigial)



Bipedal posture

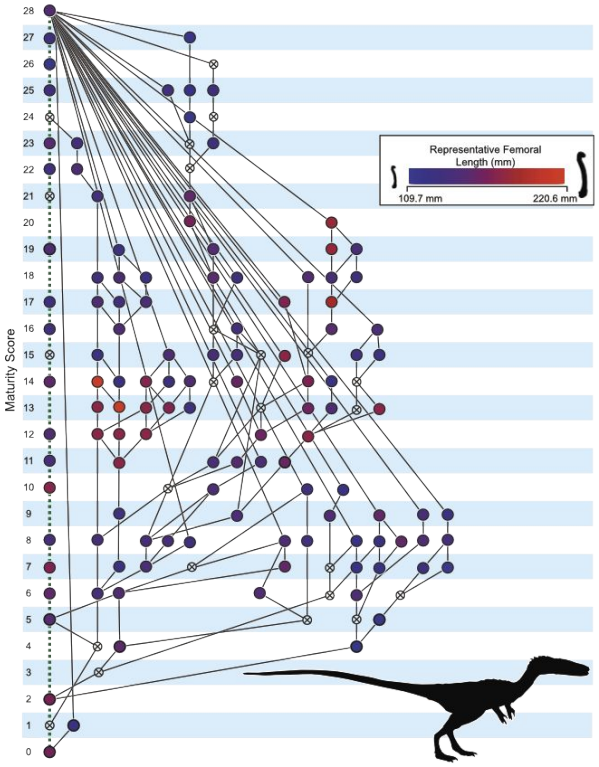
*Coelophysis* skeleton by Scott Hartman (source)

# *Coelophysis* bone beds reveal details of biology

- The Ghost Ranch bonebed in New Mexico preserved >1,000 specimens
- Supports pack behavior hypothesis (*Coelophysis* is rare in the larger Chinle Formation)

*Coelophysis* fossils from Ghost Ranch (source)

# *Coelophysis* bone beds reveal details of biology



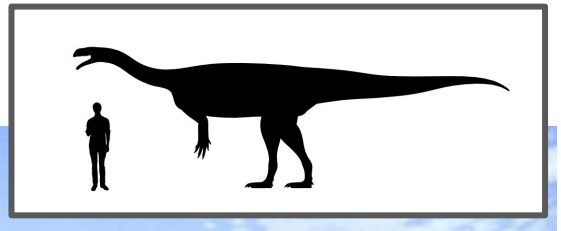

- Rapid rate of growth (larger than a similar sized reptile)
- High variation in final adult size (variable rate of growth)

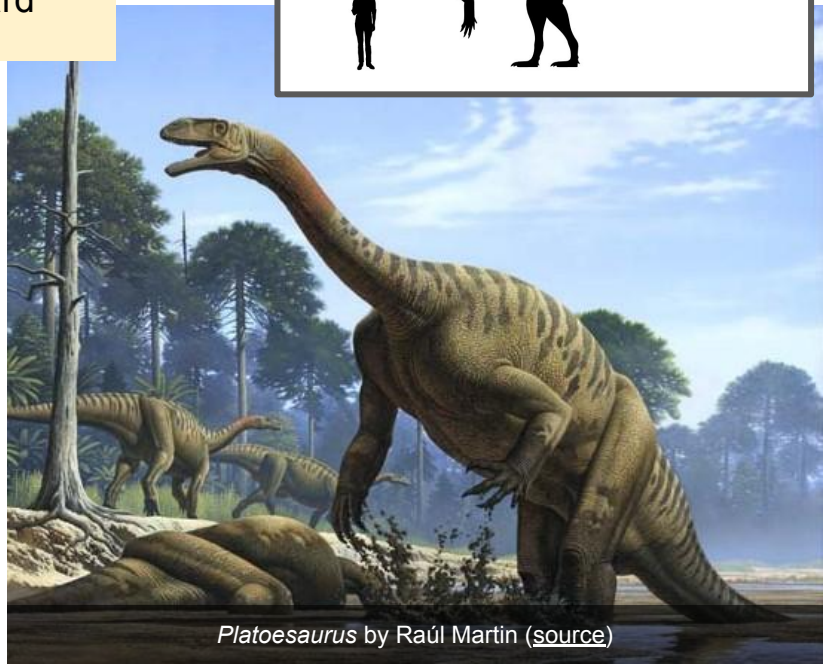
Griffin, Christopher T., and Sterling J. Nesbitt. "Anomalously high variation in postnatal development is ancestral for dinosaurs but lost in birds." *Proceedings of the National Academy of Sciences* 113.51 (2016): 14757-14762.

# *Plateosaurus*

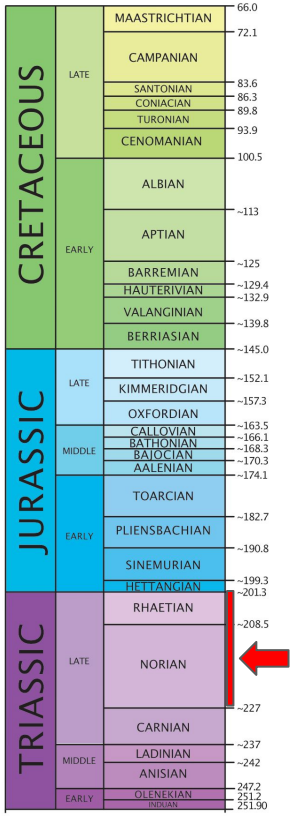
***Plateosaurus***
Greek: “plateo” = broad; “saurus” = lizard

- ~214-204 Ma
- A bipedal herbivore
- One of the earliest definitive **Sauropodomorphs**





*Platoesaurus* by Raúl Martin (source)



# Three great clades of dinosaurs

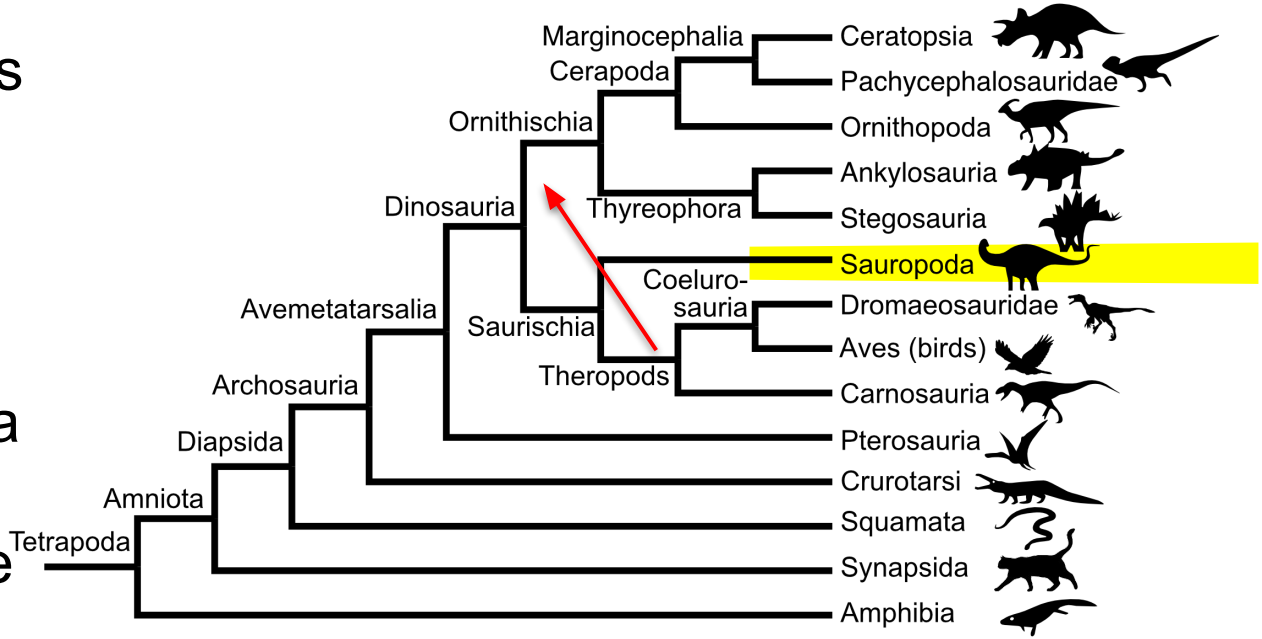
**sauropods** and **prosauropods**
**(clade Sauropodomorpha)**
Greek: “sauro” = lizard; “pod” = foot

- The largest dinosaurs
- Notable for their long necks, which contained 10+ vertebrae

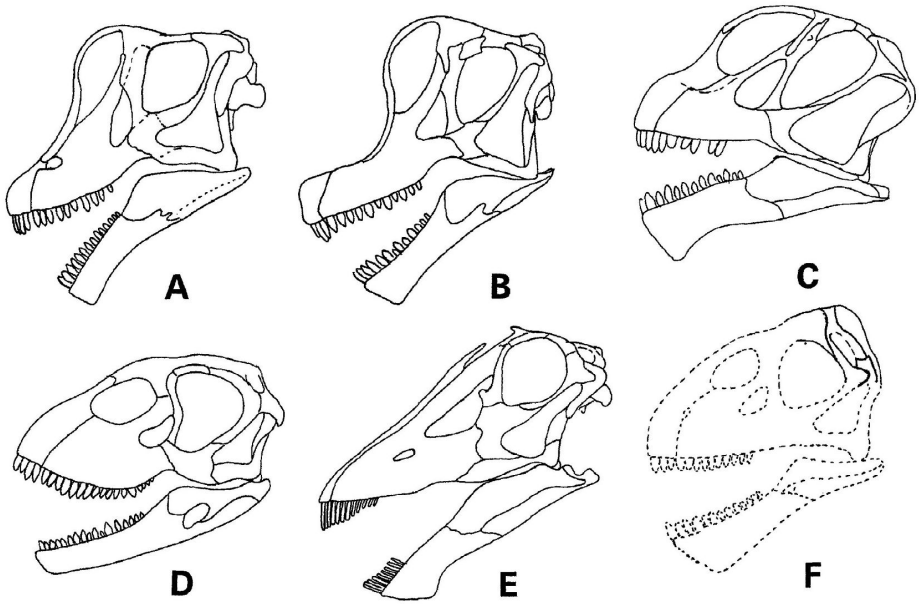
Sauropod diversity by Andrey Atuchin and Santi Mezzei (source)

# Where sauropods fit in the tree of life

- Most scientists consider sauropods saurischian dinosaurs
- If theropods and ornithischians are a clade, sauropods would be in a clade by themselves



# Sauropod traits

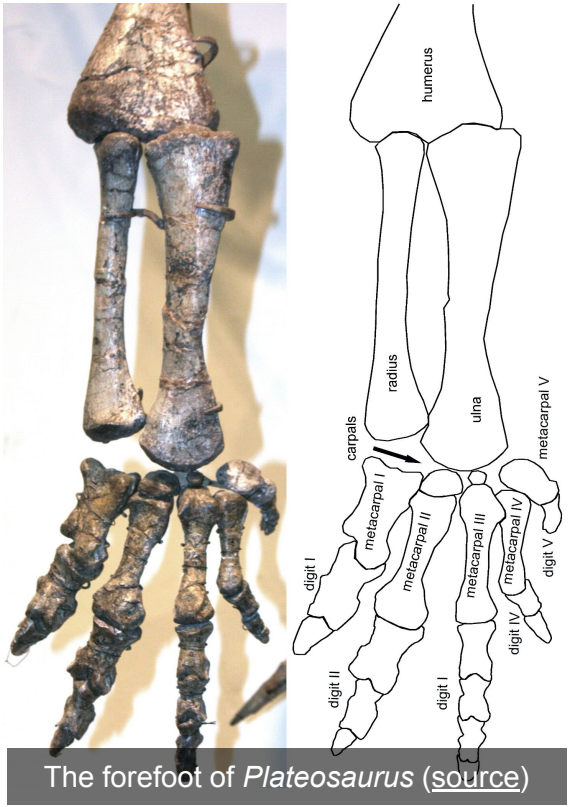



Examples of sauropod skull diversity (source)

- Weak teeth, used stomach stones (gastroliths) to grind up food
- Large nostrils that sometimes sat high on the skull

# Sauropod traits

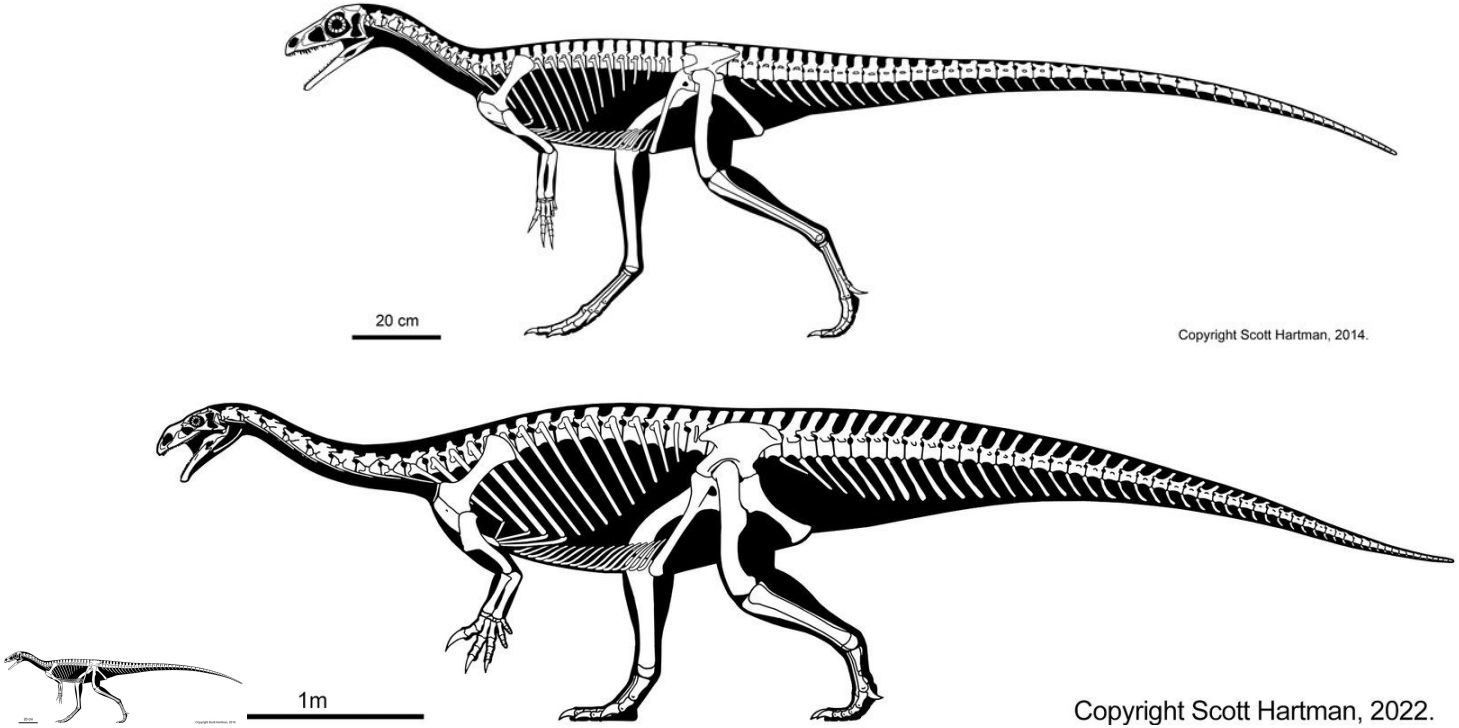
- Initially bipedal but most species were quadrupedal
- Large claw on the first digit retained in most species



The forefoot of *Plateosaurus* (source)


The forefoot of *Apatosaurus* (source)

# The skeleton of *Plateosaurus*




**Traits to consider:**

- Skull fenestrae
- Pelvis
- Humerus vs tibia/fibula
- Neural spines

# The skeleton of *Plateosaurus*

10 caudal vertebrae

Leaf shaped teeth

Bipedal posture

five digit hands

Plateosaurus by Scott Hartman (source)

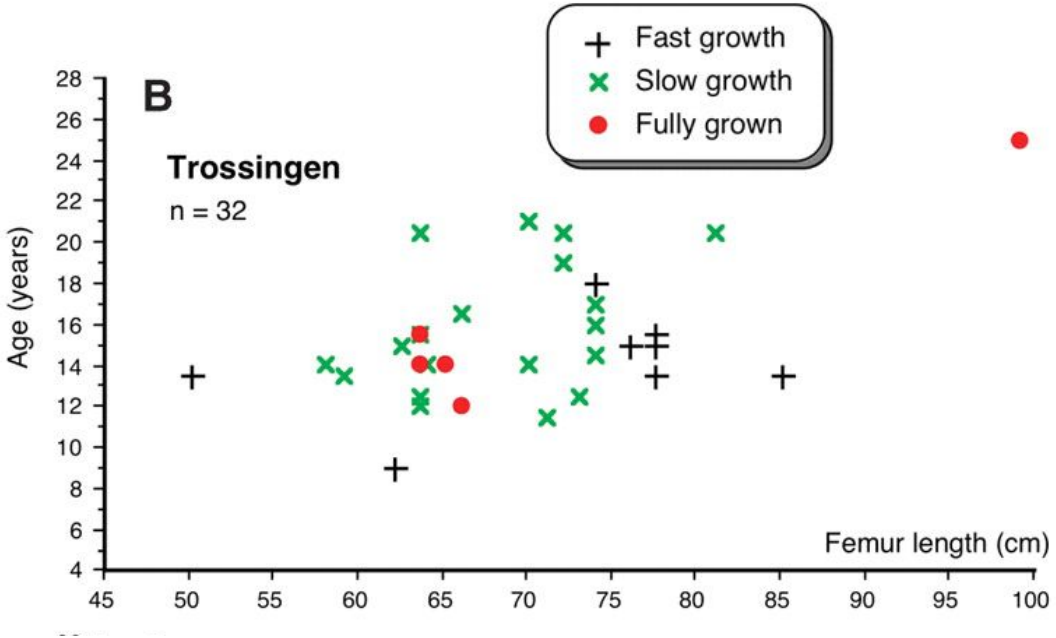
# *Plateosaurus* showed similar growth patterns to *Coelophysis*

A nearly complete skeleton from Trossingen (source)

- Three bone beds in Germany preserve dozens of Plateosaurus specimens
- All are monospecific for *Plateosaurus*
- Skeletons are often articulated but the heads are missing
- A mud trap is the best current hypothesis

# *Plateosaurus* showed similar growth patterns to *Coelophysis*

- Rapid variable growth
- Adults range from ~16-33 feet
- Not seen in later theropods or sauropods; could be an ancestral trait




Sander, M.; Klein, N. (2005). "Developmental plasticity in the life history of a prosauropod dinosaur". *Science*. **310** (5755): 1800–1802.

# Competition vs opportunity


Cover art for the scientific journal describing *Lisowicia* (source)

*Cynognathus* feeding on *Placerias* by Mark Hallett (source)

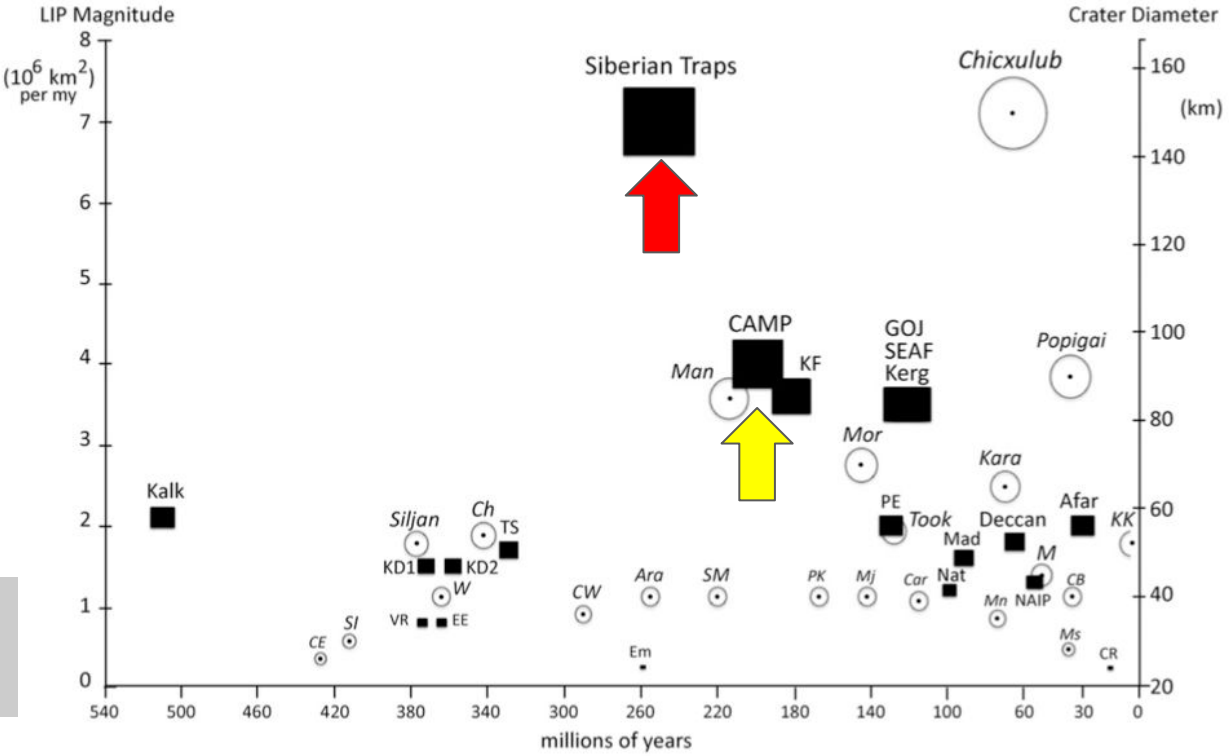
*Effigia* by Raúl Martin (source)

# Competition vs opportunity

- Variable growth rates may have been advantageous in tough environments
- Diapsids remove nitrogen waste with uric acid, which requires less water than synapsid urea

Bird nesting site. White markings represent uric acid (source)

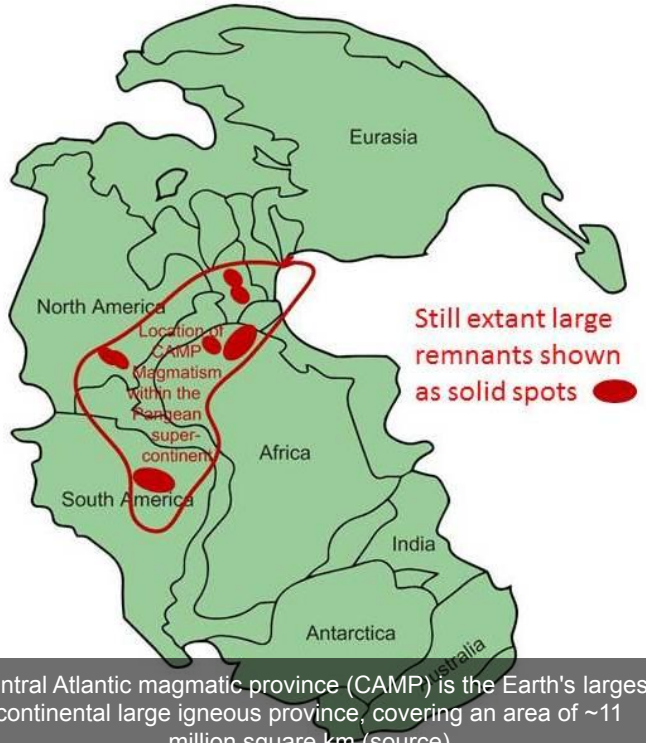
# The Triassic Jurassic extinction event




Scotese, Christopher R., et al. "Phanerozoic paleotemperatures: The earth's changing climate during the last 540 million years." *Earth-Science Reviews* 215 (2021): 103503.

# The Triassic/Jurassic Extinction

- Likely caused by volcanism again
- Extinctions were not uniform; no major loss of plants, for example
- Following this event, dinosaurs become the dominant terrestrial vertebrates for ~135 Ma




Central Atlantic magmatic province (CAMP) is the Earth's largest continental large igneous province, covering an area of ~11 million square km (source)

Blackburn, Terrence J. (2013). "Zircon U-Pb Geochronology Links the End-Triassic Extinction with the Central Atlantic Magmatic Province". *Science* **340**: 941–945.

# Conclusion

- Dinosaurs became increasingly common through the Triassic
- They may have had adaptive advantages over other lineages–at minimum they could hold their own

*Plateosaurus, Silesaurus,* and *Herrerasaurus* by Mohamad Haghani (source)

# Next class

*Barosaurus* and *Allosaurus* by FredtheDinosaurman (source)