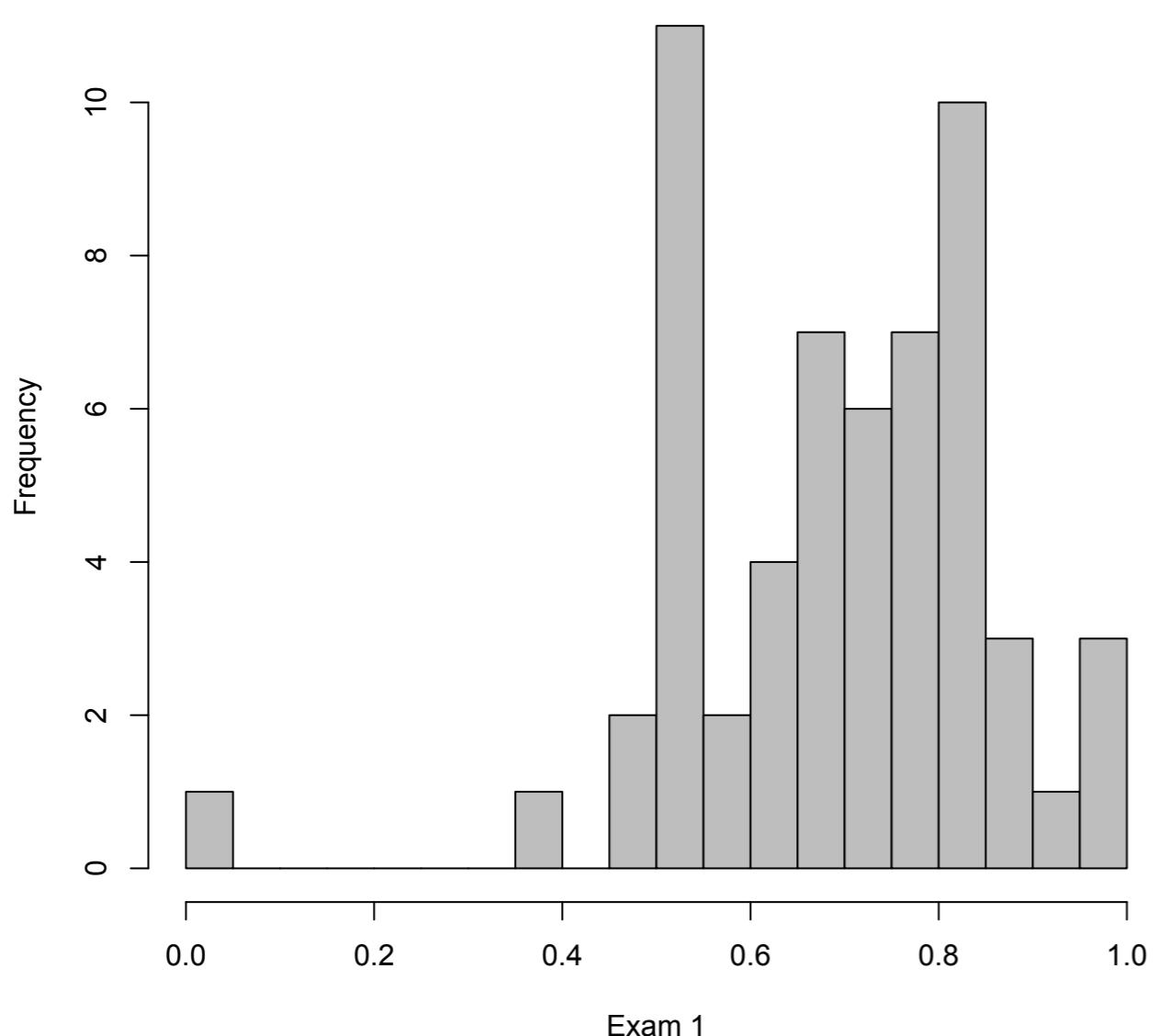
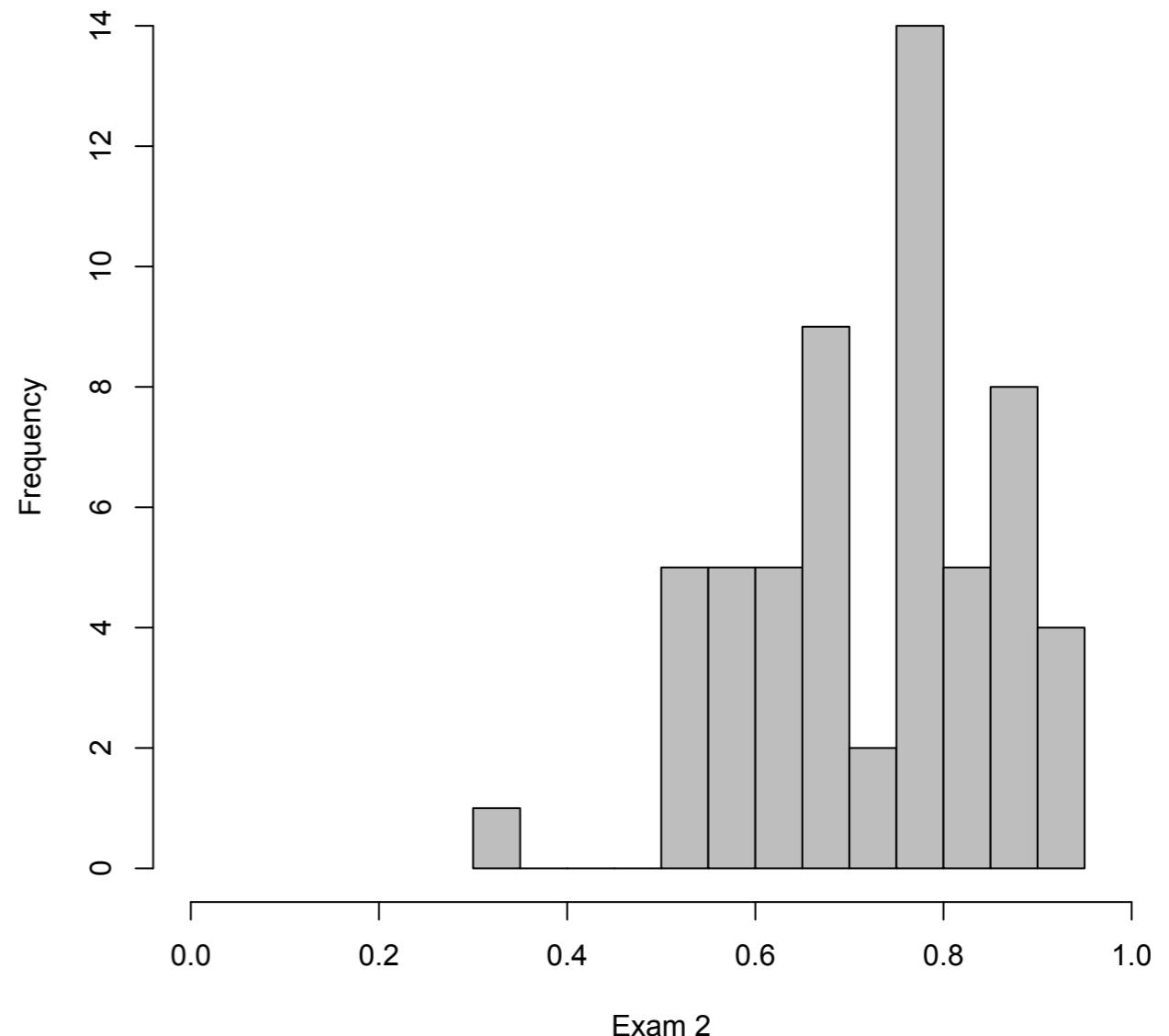




Histogram of e1

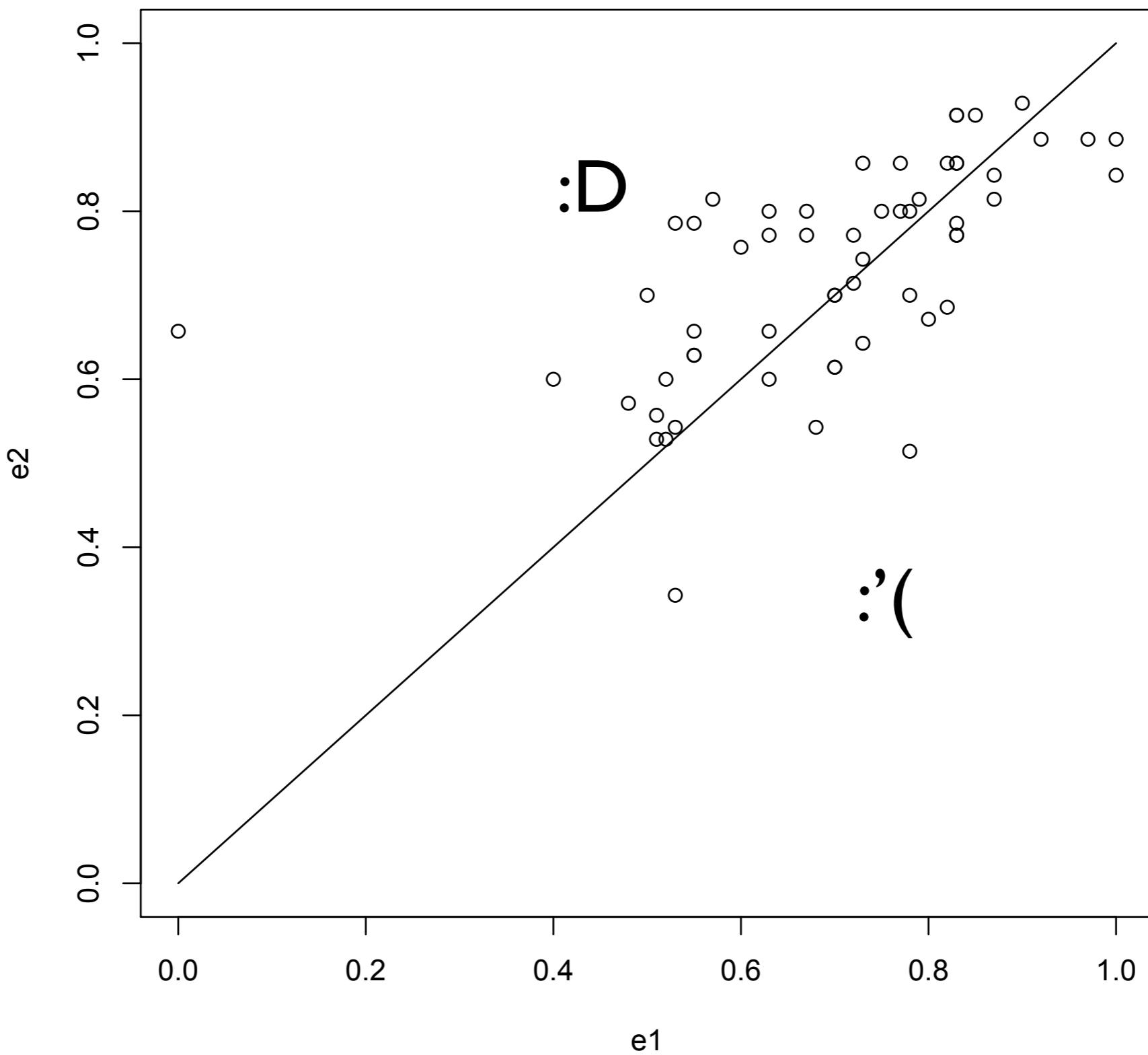


Histogram of e2

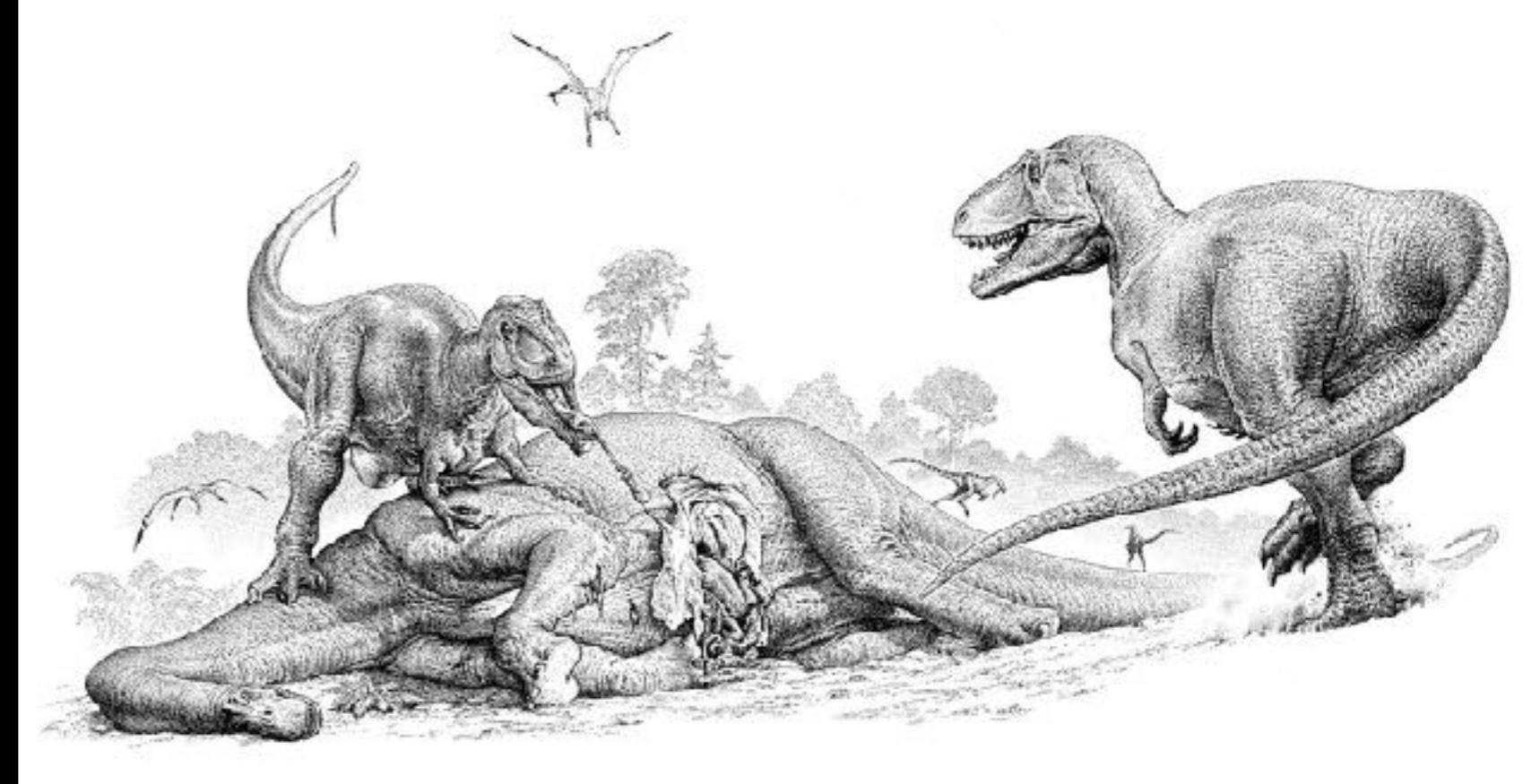


Mean: 69%

Mean: 73%



Enter Saurischia!



Saurischians:

Two major clades:

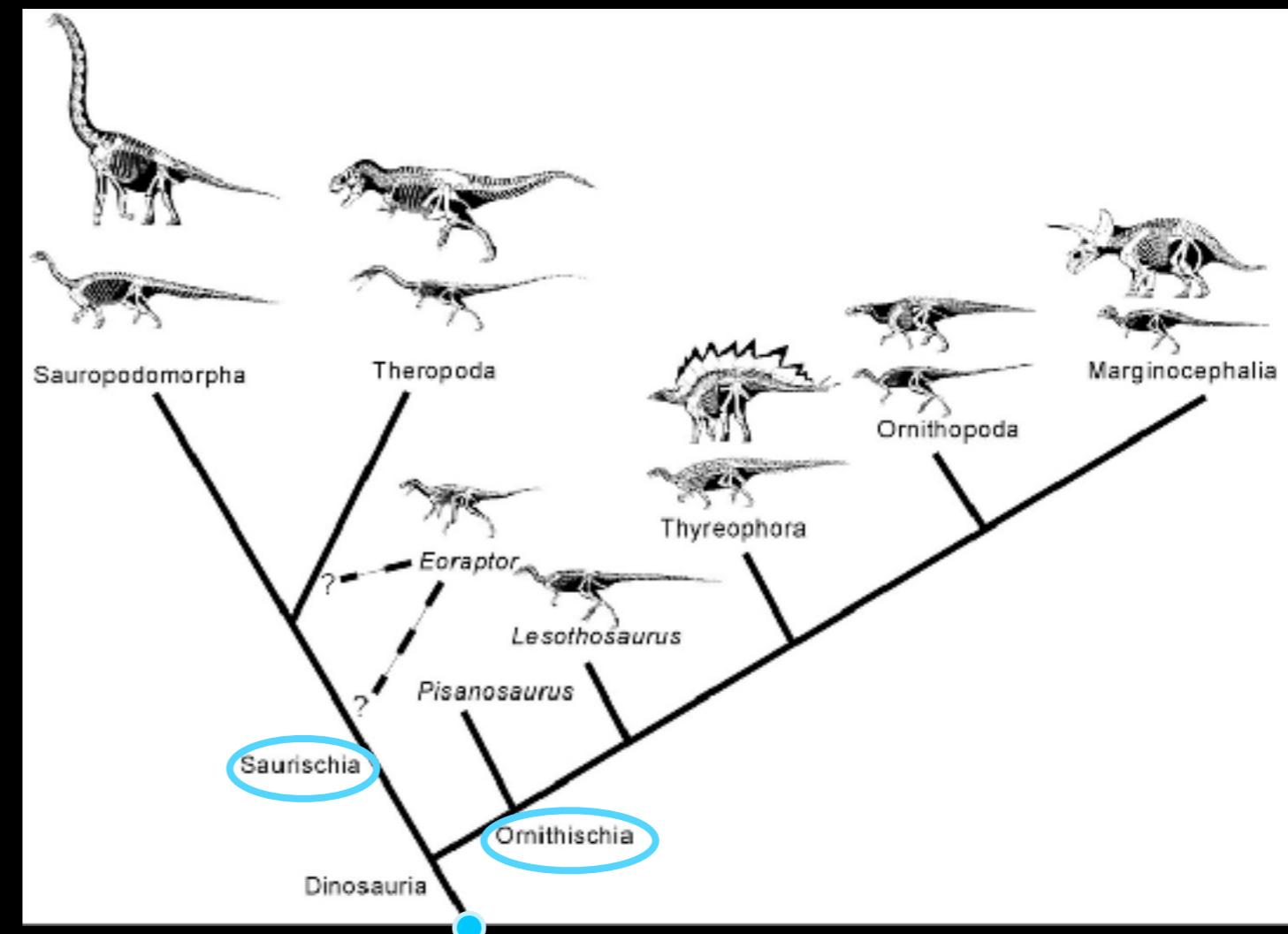
-**Sauropodomorpha**

The Big

-**Theropoda**

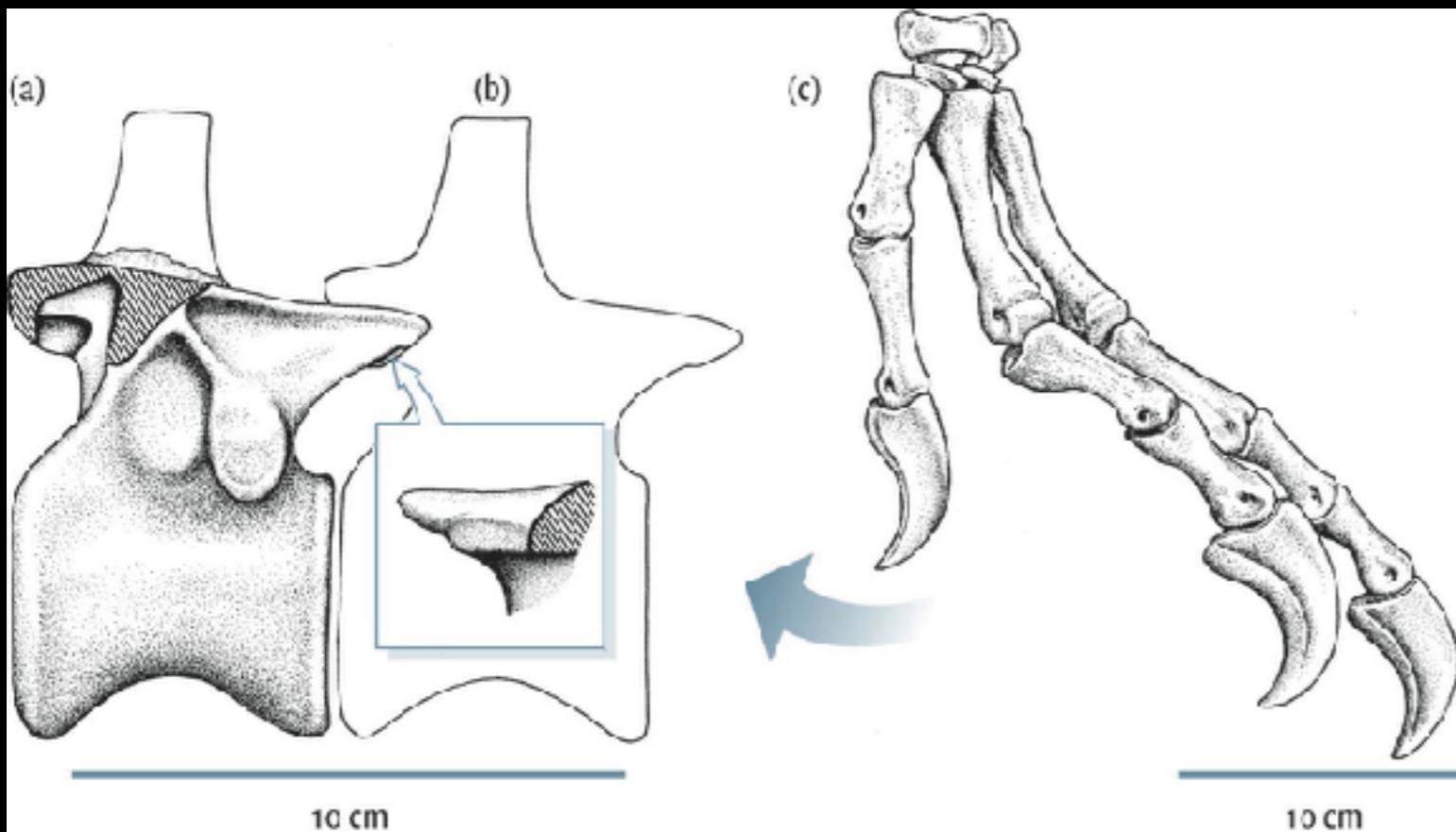
The Bad

The Ugly



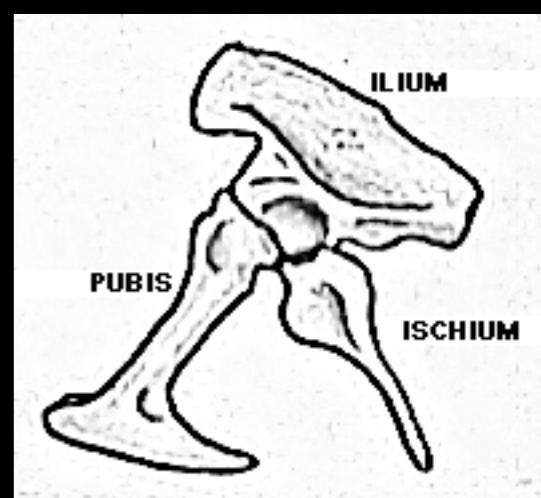
What characterizes Saurischian Dinosaurs?

1. Subnarial foramen
2. Extra articulation on dorsal vertebrae
3. Twisted thumb



Tyrannosaurus

Ancestral characteristics:
-'Lizard Hip' three-pronged pelvis structure

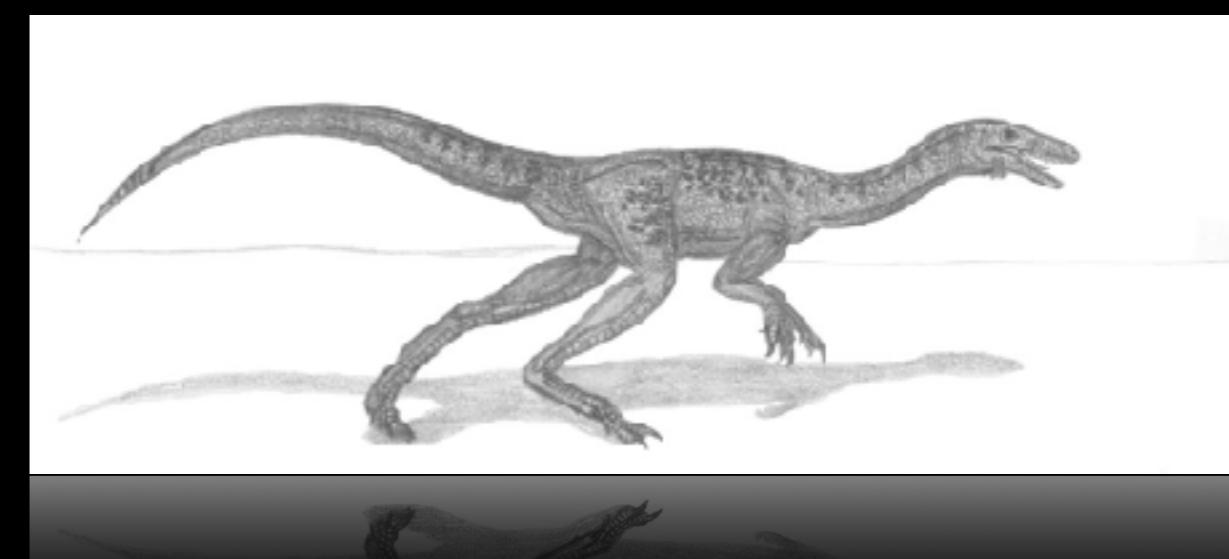
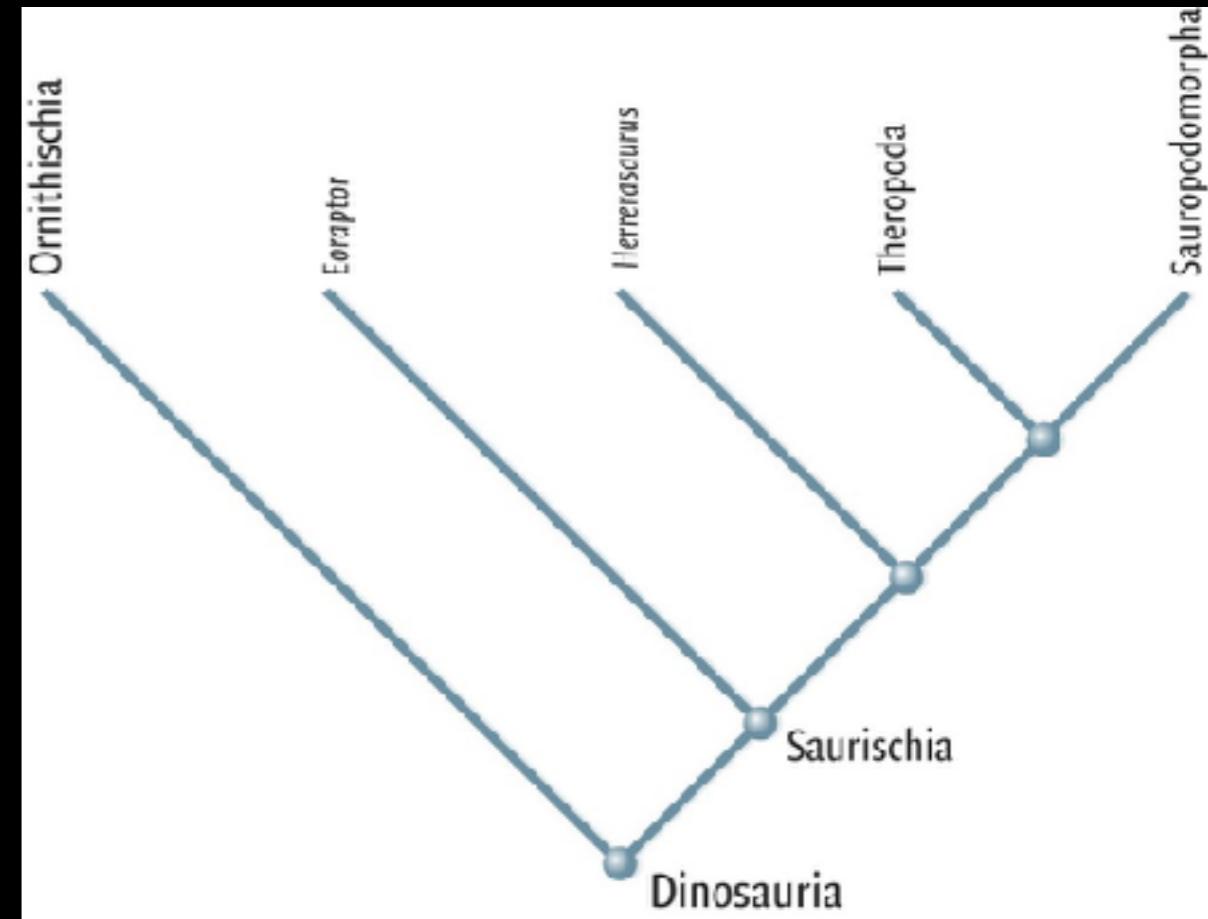


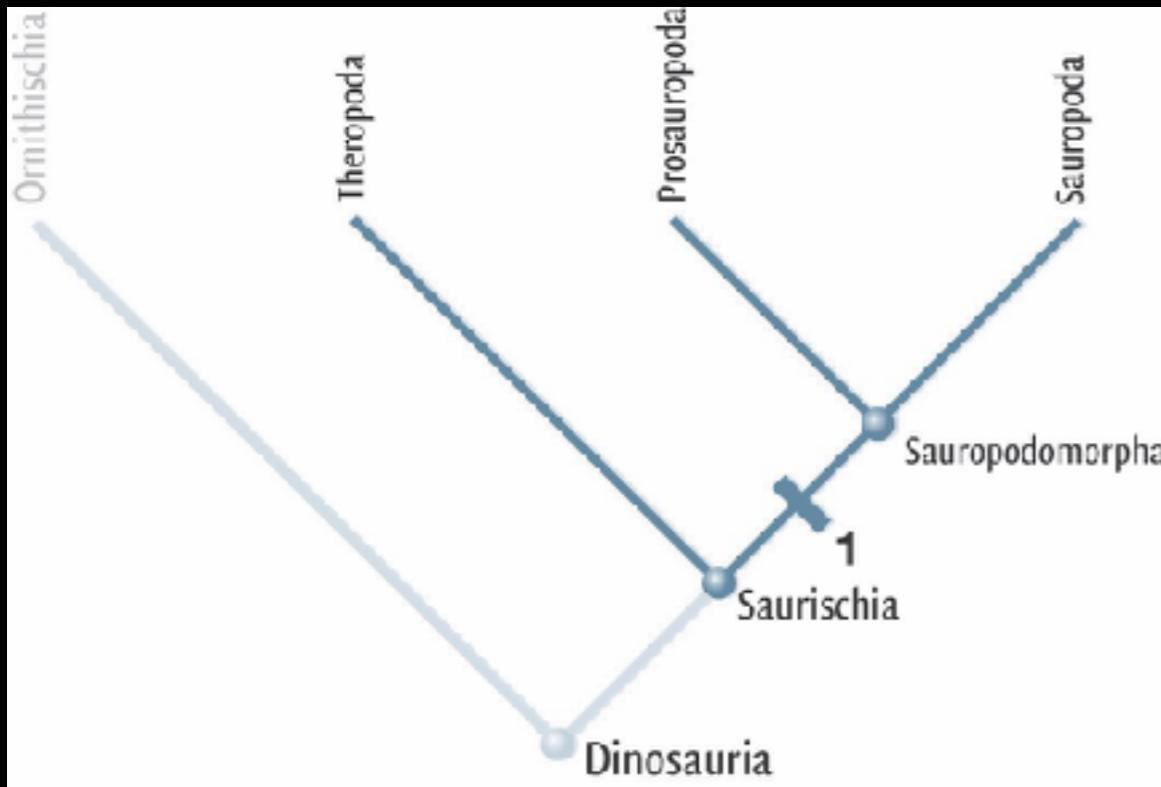


Basal, non-sauropoda Saurischians



Possibly a very early sauropodomorpha: *Saturnalia*



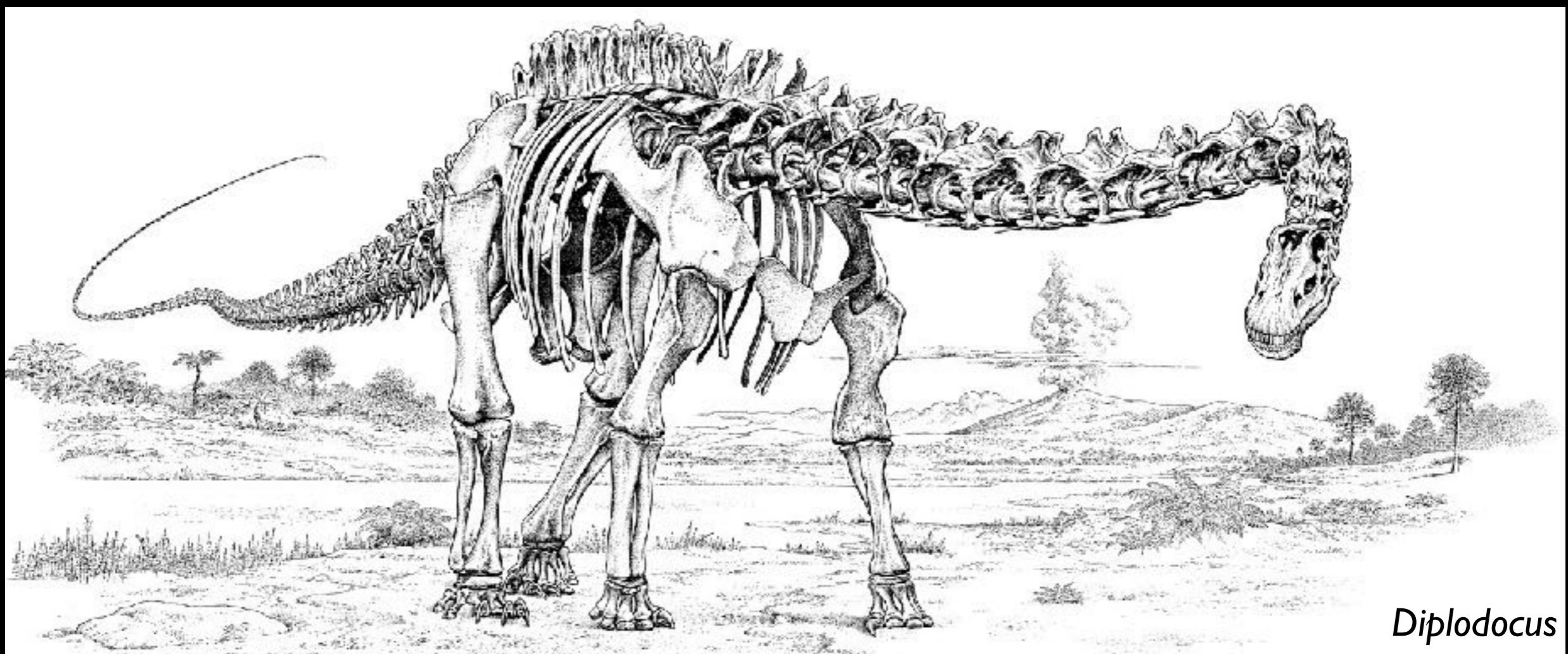


Sauropodomorpha

1. Prosauropoda
2. Sauropoda



Massospondylus



Diplodocus

Sauropodomorpha

Shared, derived characteristics

Relatively small skull

Long neck (10 vertebrae or more!)

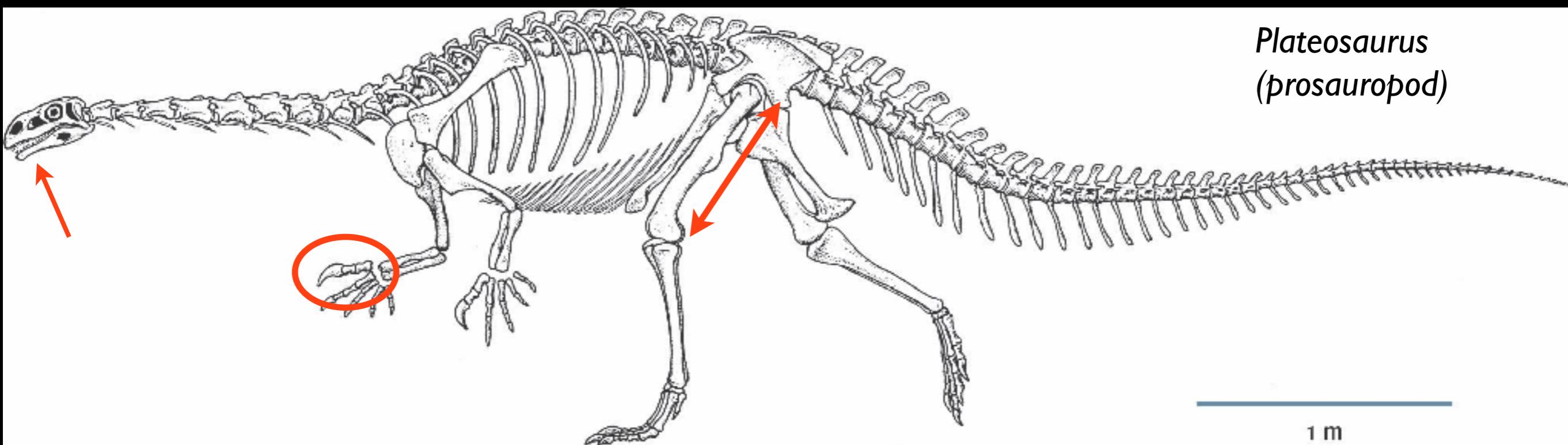
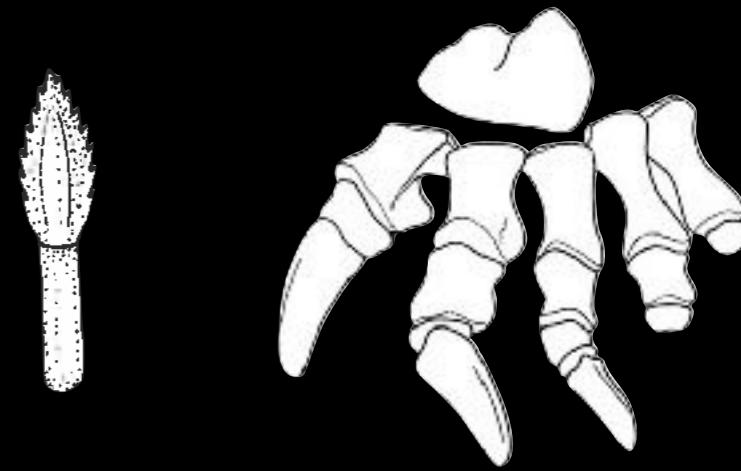
Deflected front end of lower jaw

Elongate, peg-like teeth

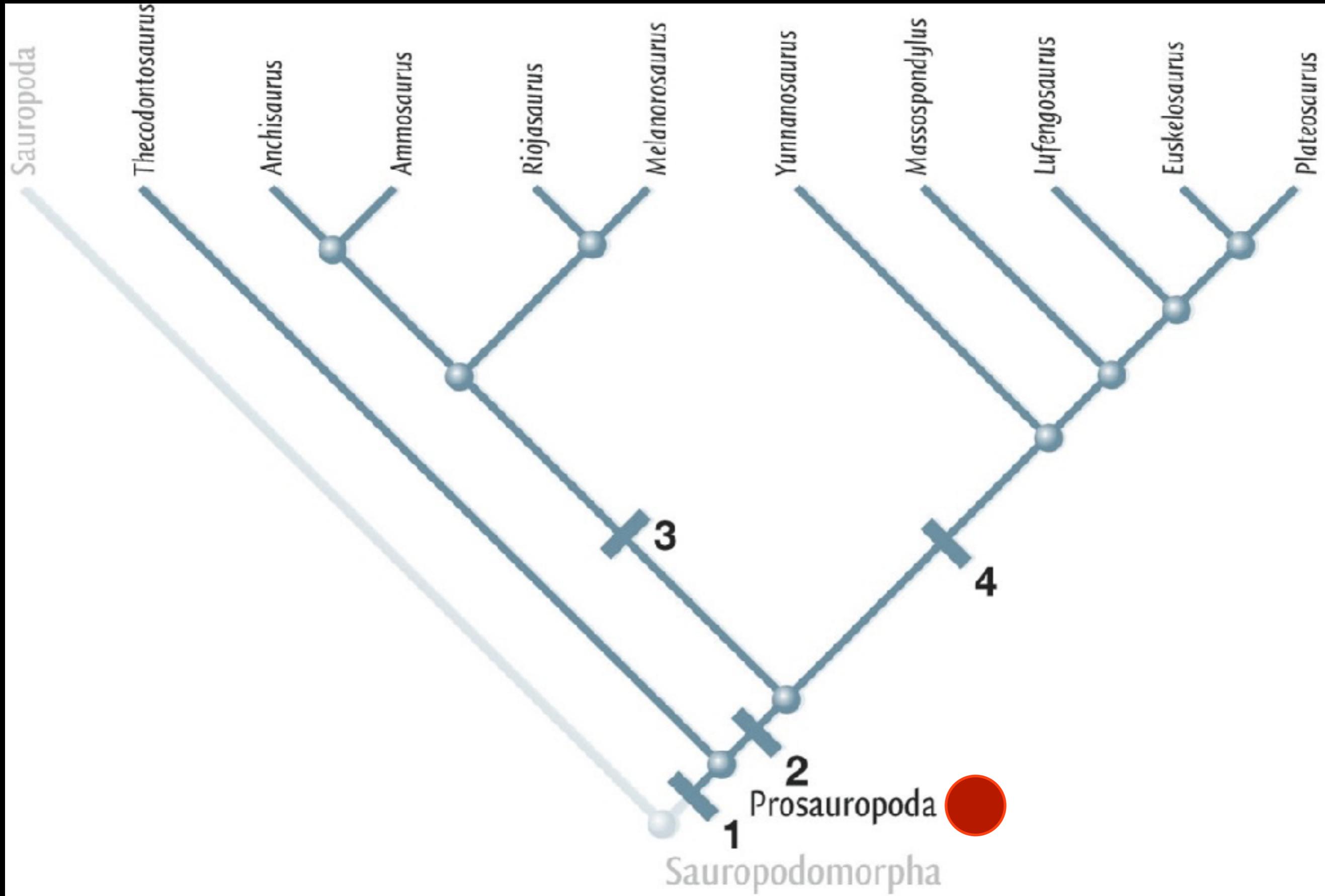
Added dorsal vertebrae in front of and behind the sacrum

Enormous thumb

Elongate femur (upper leg bone)

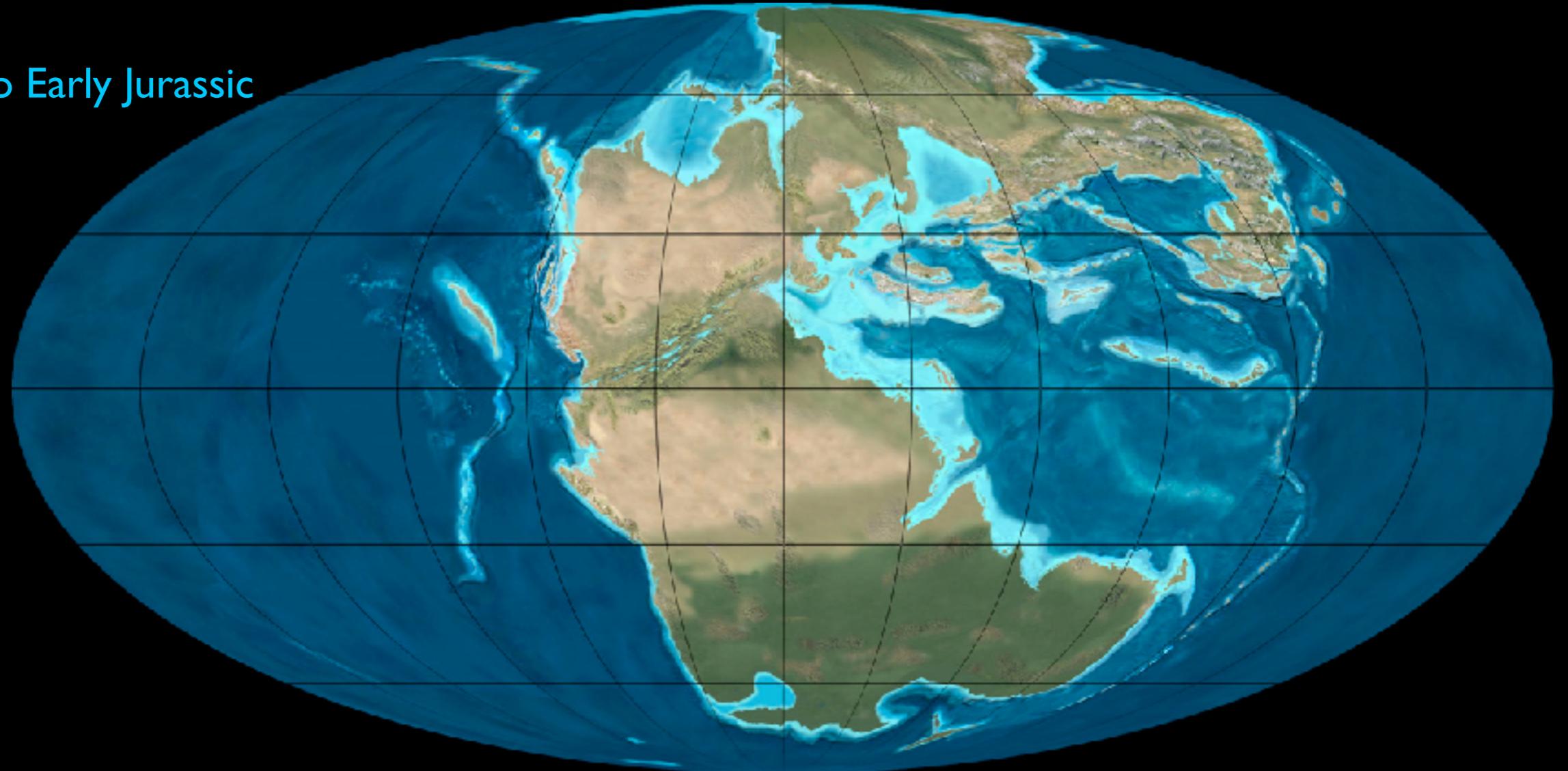


Prosauropoda



ProsauroPods

Late Triassic to Early Jurassic



Squares = prosauropod fossil localities

Dinosaur families that diversified early were able to spread around the globe
(Pangea effect)

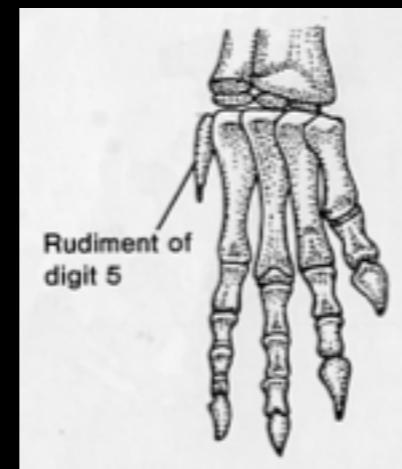
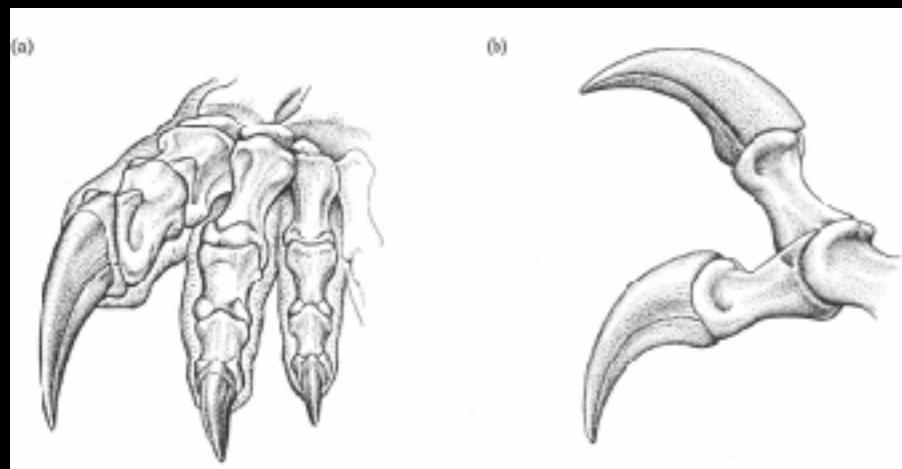
Prosauropoda

Shared, derived characteristics

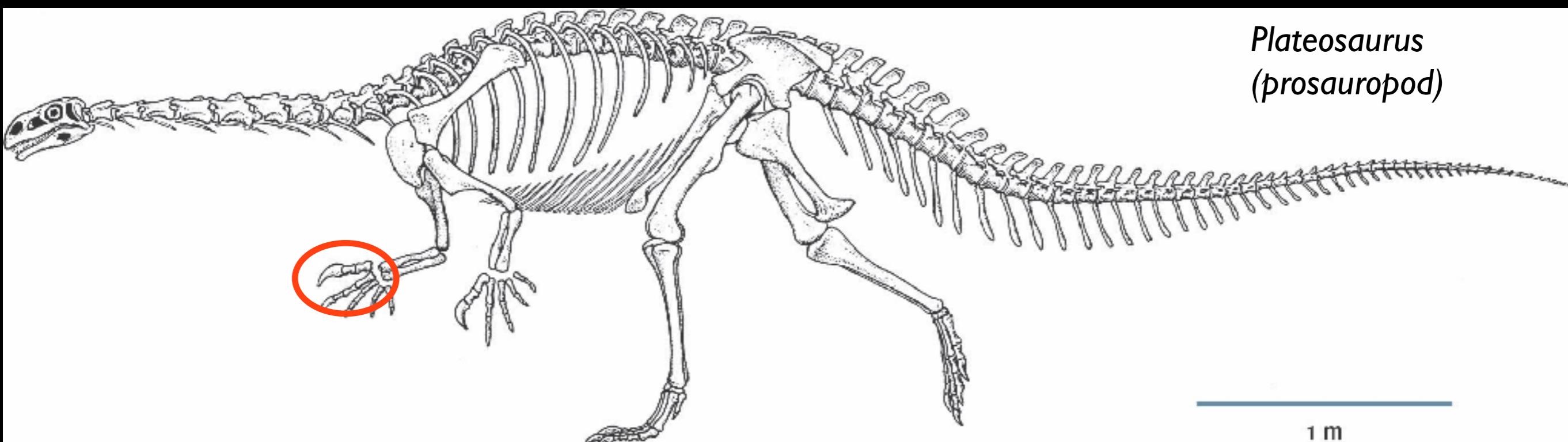
Whopping big claw on thumb

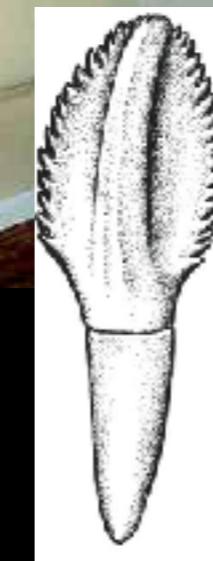
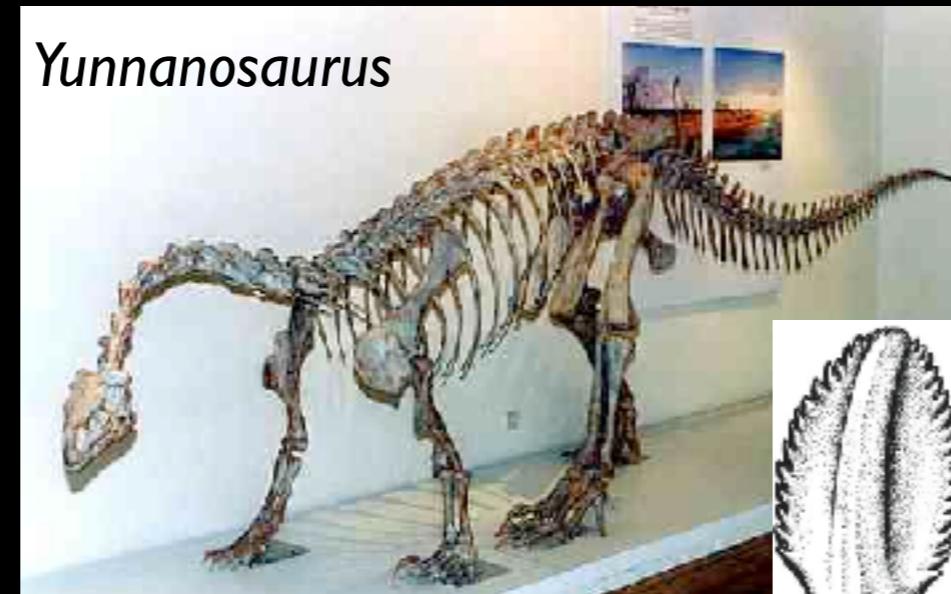
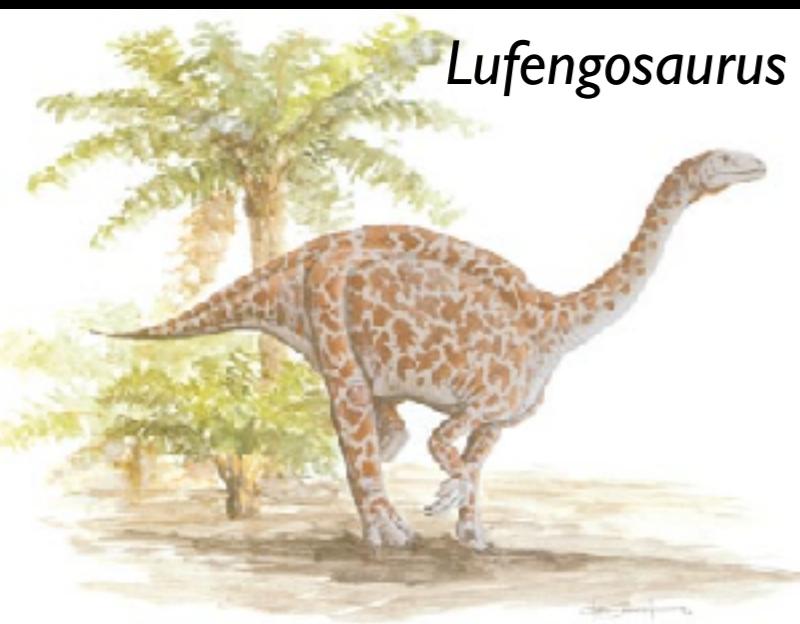
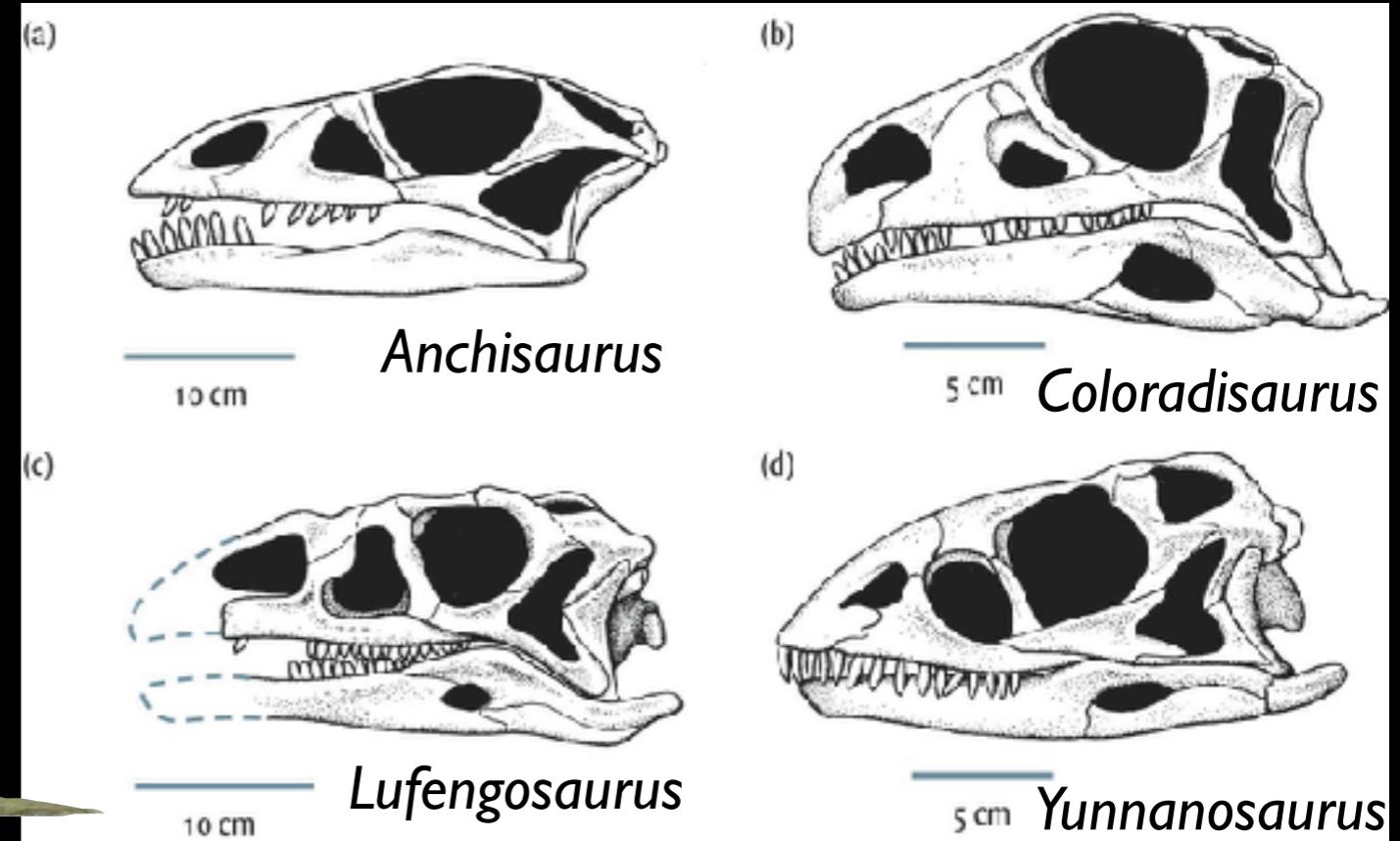
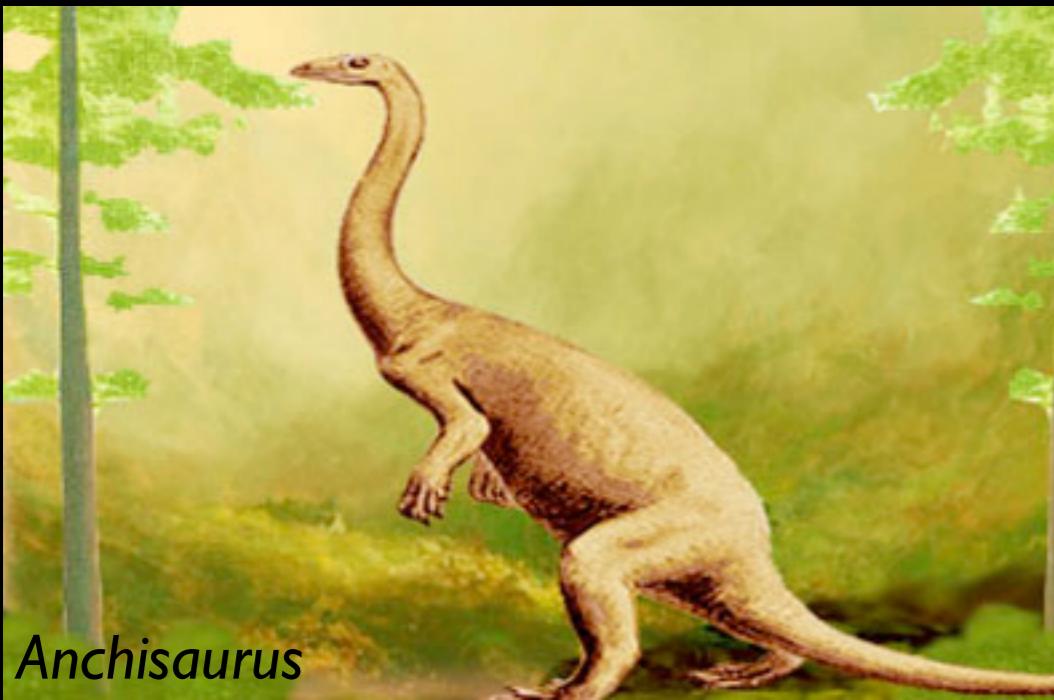
Reduced pinky toe

Front limbs shorter than hind limbs



Plateosaurus





Skull:

Not meant for chewing
Jaw joint below tooth row
Leaf-shaped teeth (few grinding marks)

NOT CHEWERS

Predominantly herbivorous, but some basal forms may have been omnivorous

Gastroliths, in situ



Gastroliths a-plenty

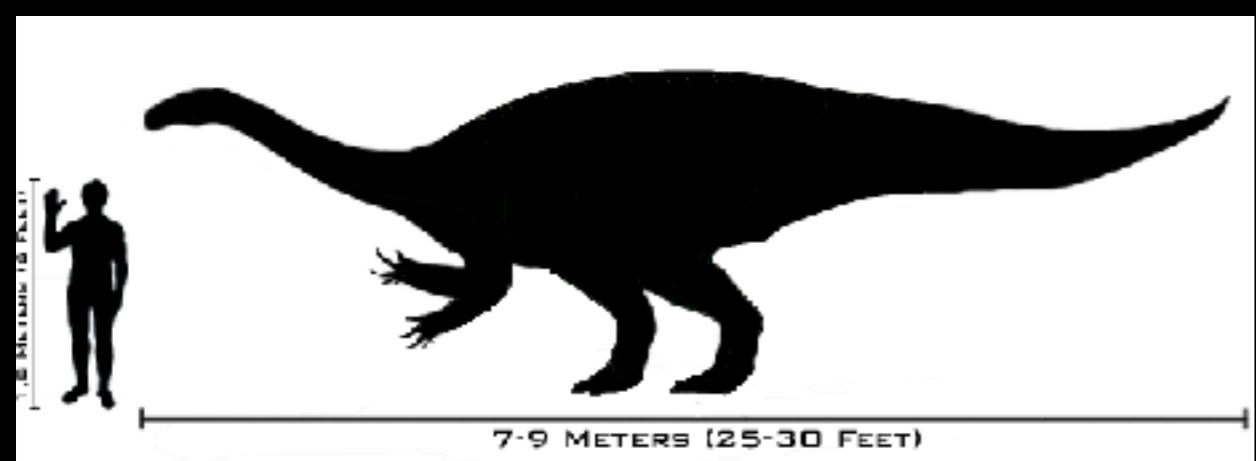
Likely utilized stomach fermentation

Stomach-contents finds and morphology suggest gymnosperms were likely important

The increase in diversity of prosauropods parallels gymnosperm diversity!

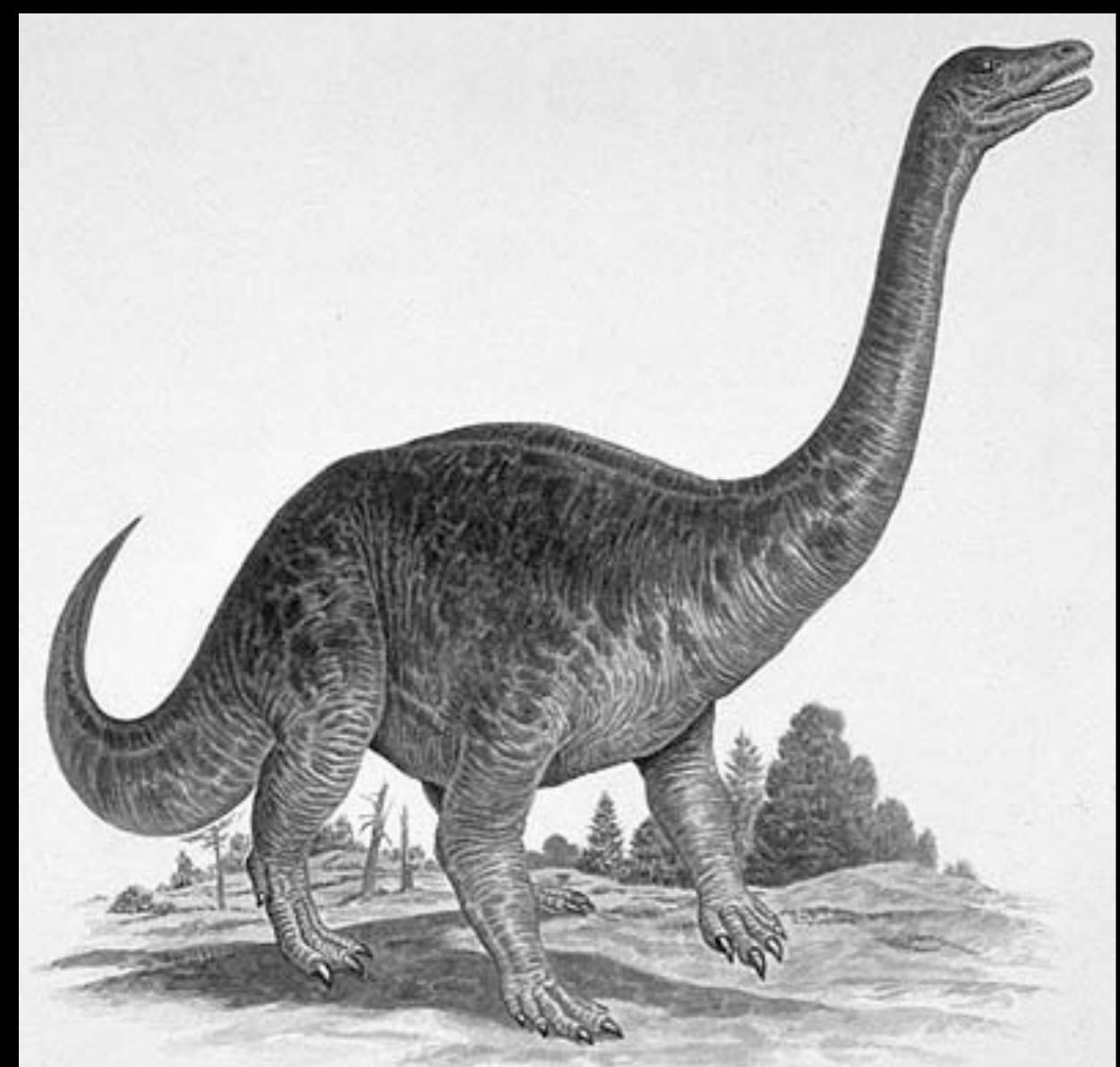


Derived Prosauropoda



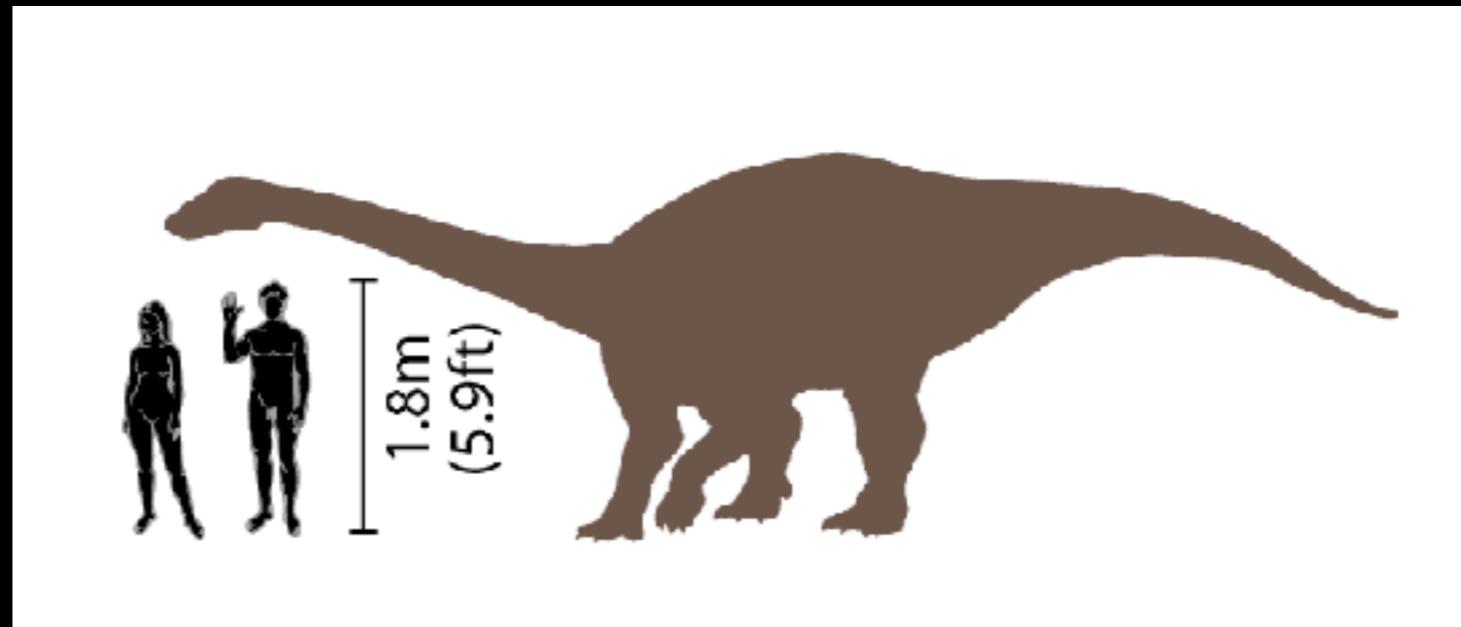
Plateosaurus

Quadrupedal / Facultative bipedal



Riojasaurus

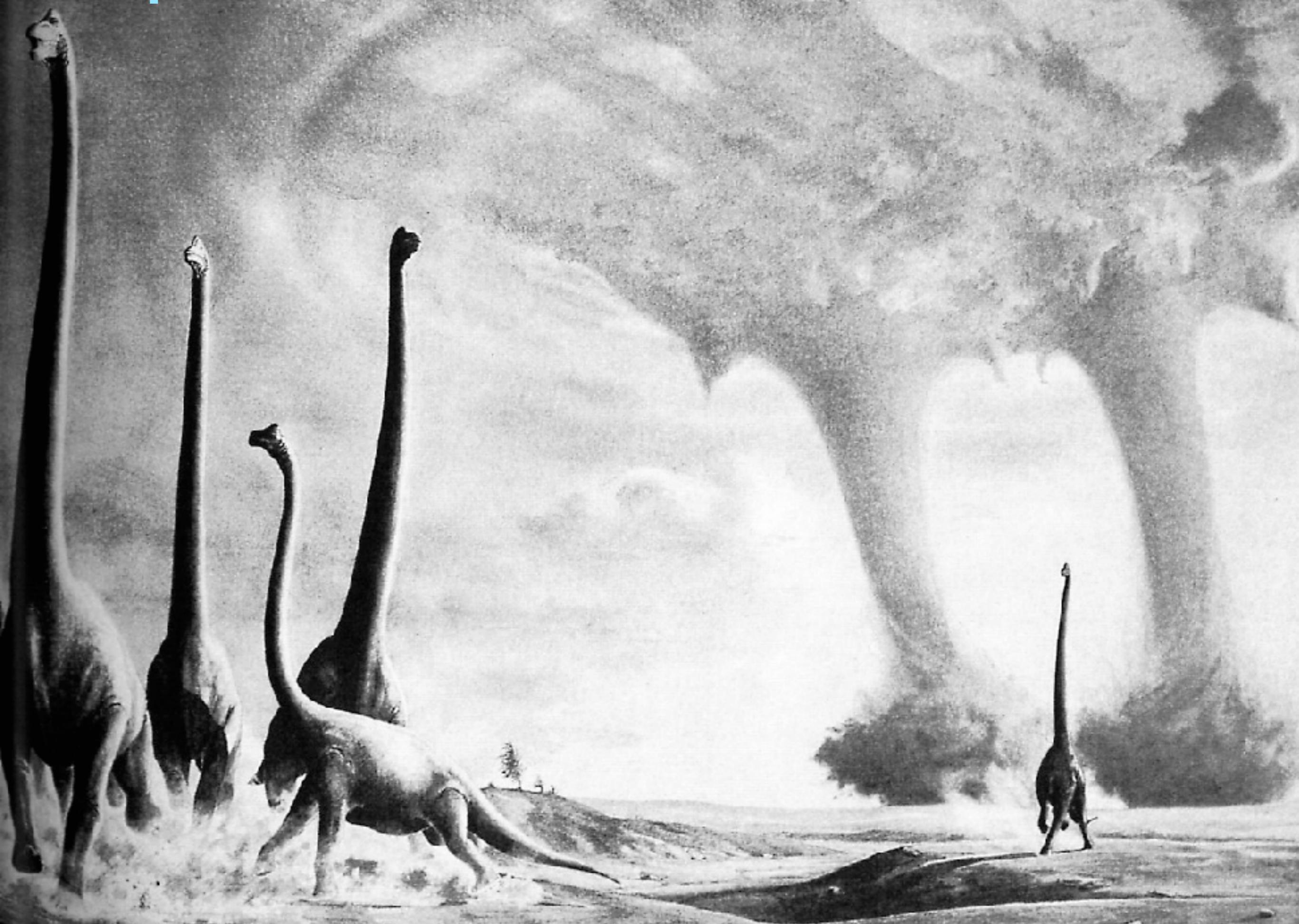
Fully quadrupedal

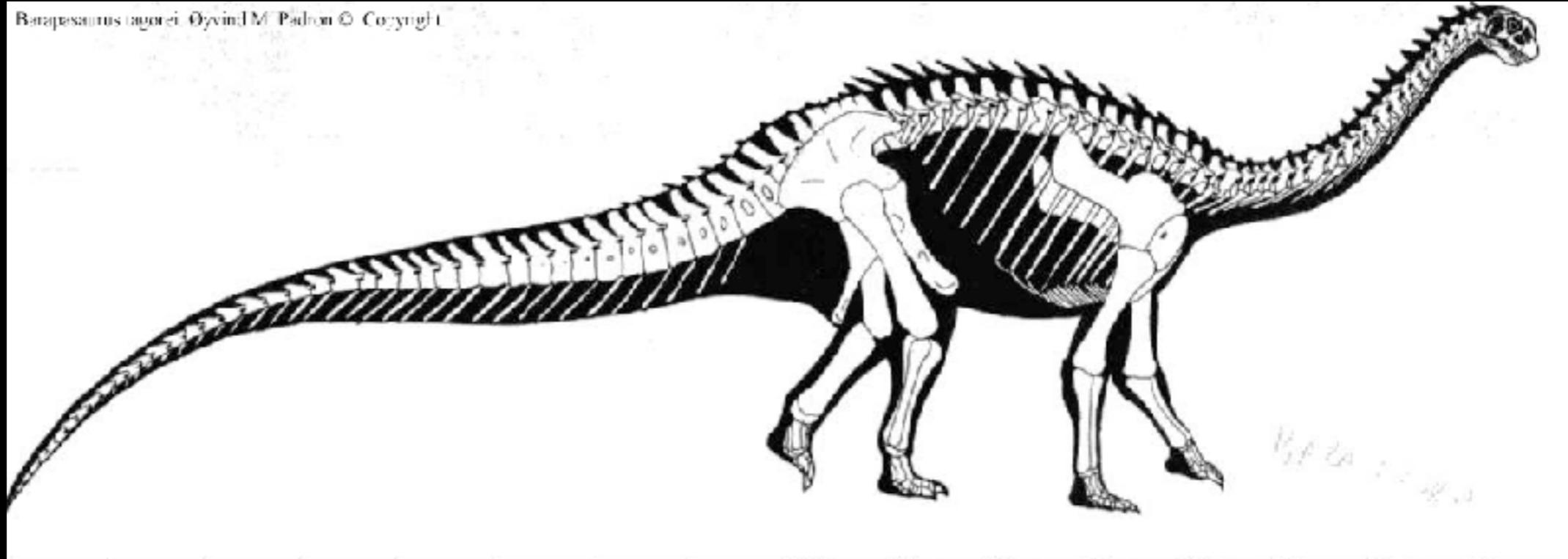




Mussaurus
(late Triassic)
Adults probably 10 ft long

Sauropoda

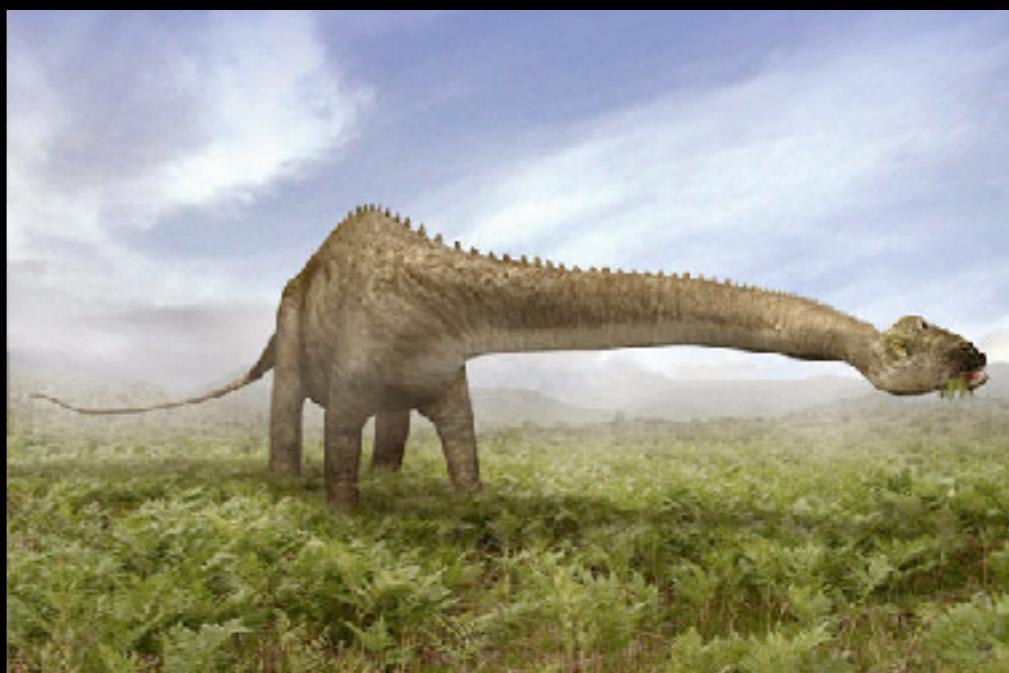


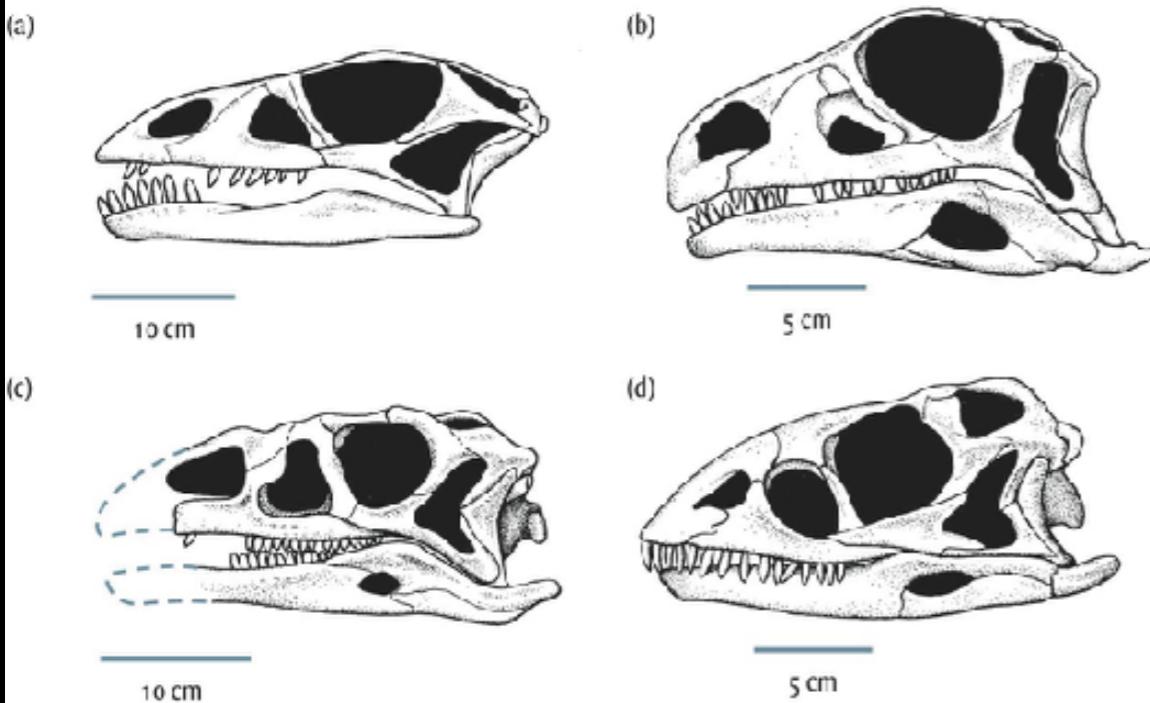


Cetiosaurus- first sauropod discovered
Had spongy bone (similar to whales), hence it's name
Thought to be strictly aquatic & related to crocodiles
Later, finds of the leg bone suggested an upright stance,
rather than a crocodilian sprawling posture



Edward Drinker Cope





ProsauroPods

Sauropod Skulls

Shortened head

Rounded snout

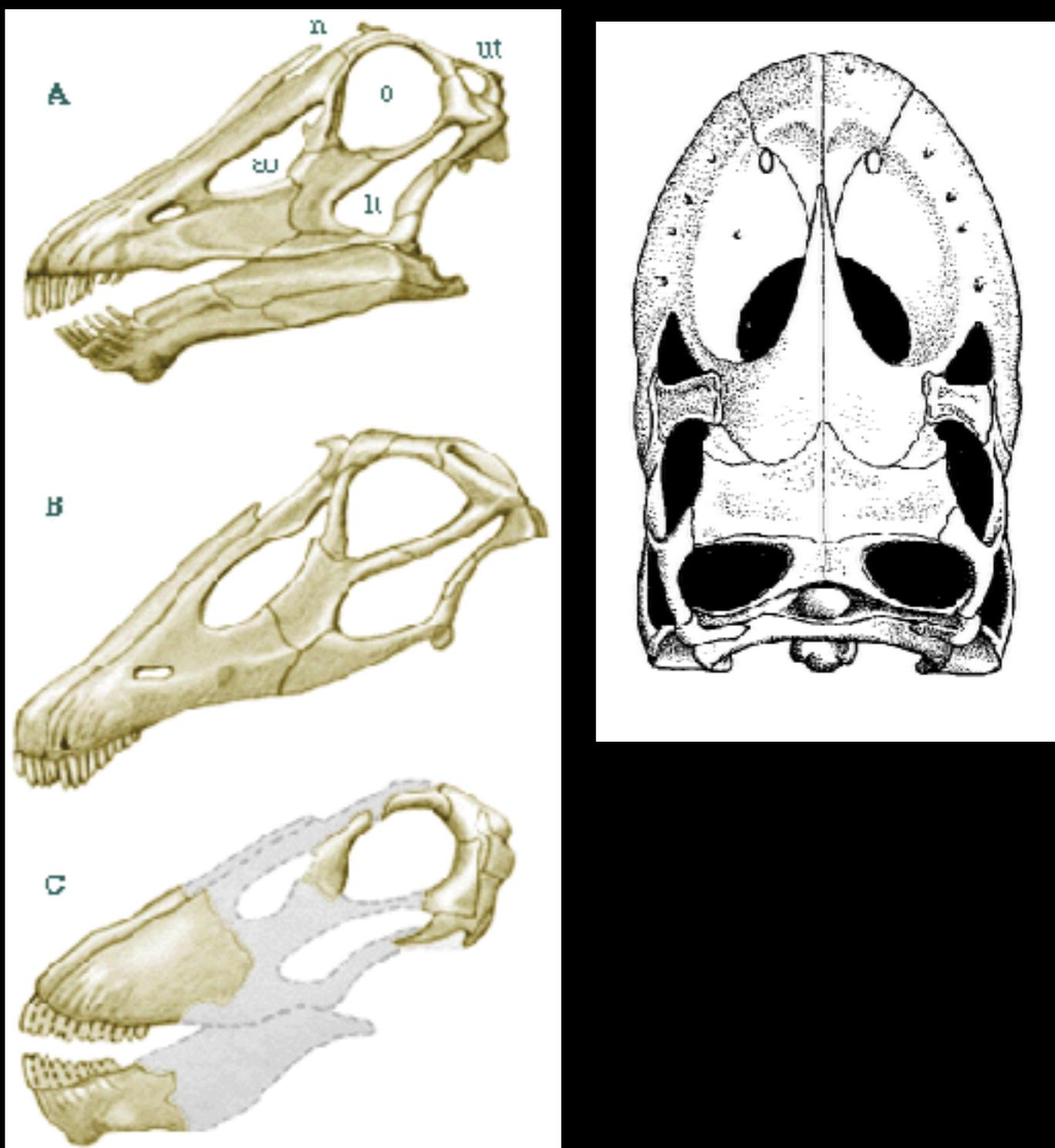
Lower temporal fenestra below orbit

No inset cheek teeth

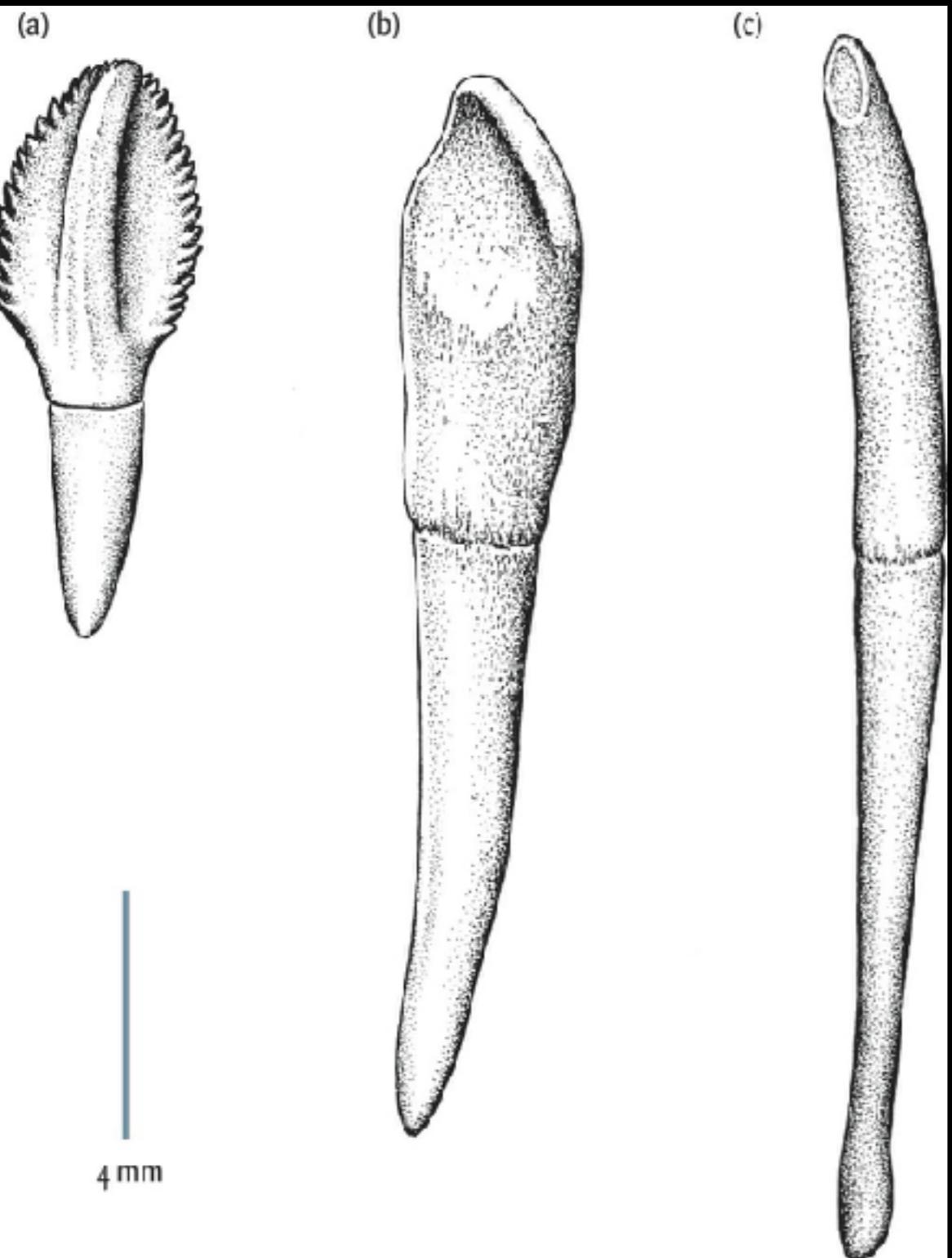
-not chewers

Delicate- not built to withstand large forces

Evolutionary trend: nares gradually move to the top of the skulls



Sauropods

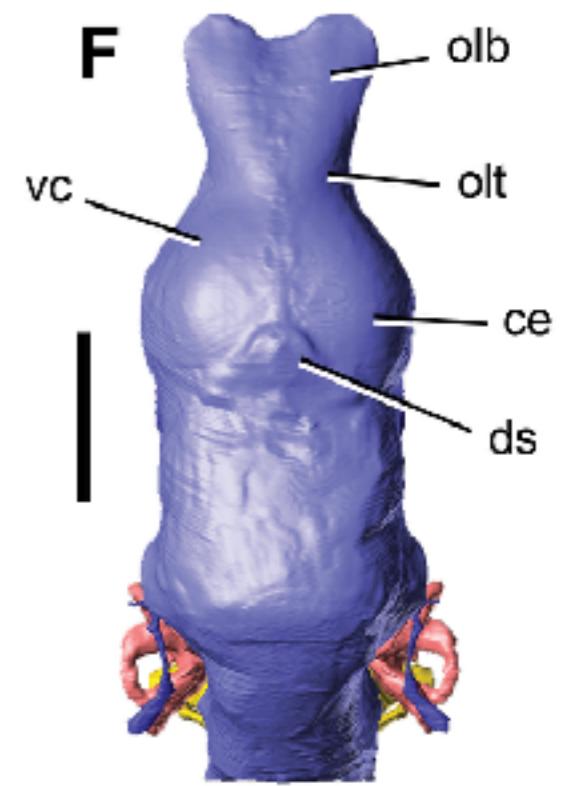
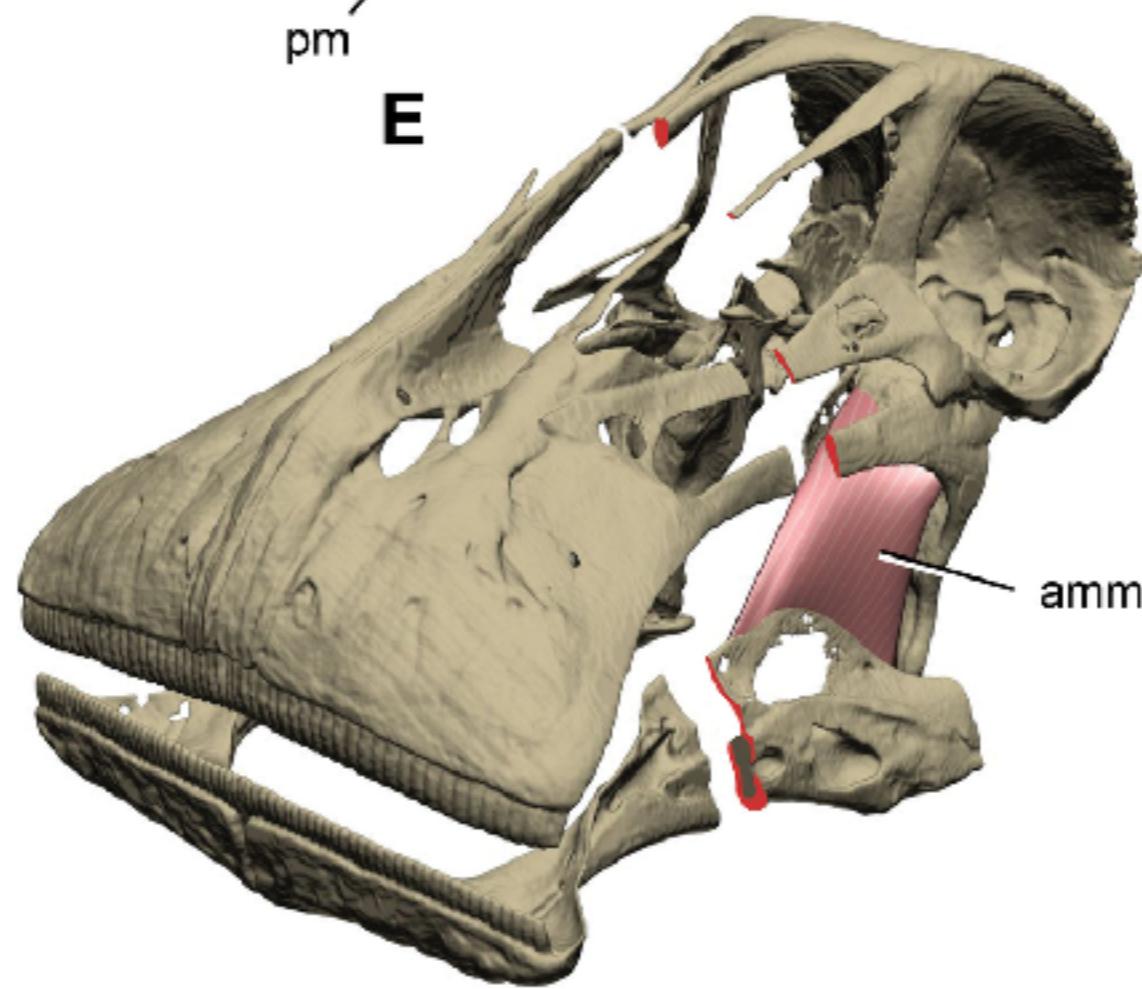
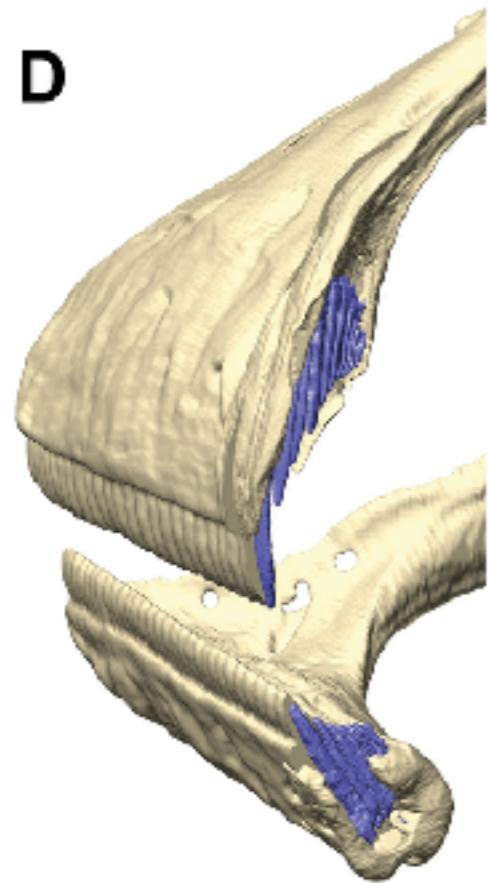
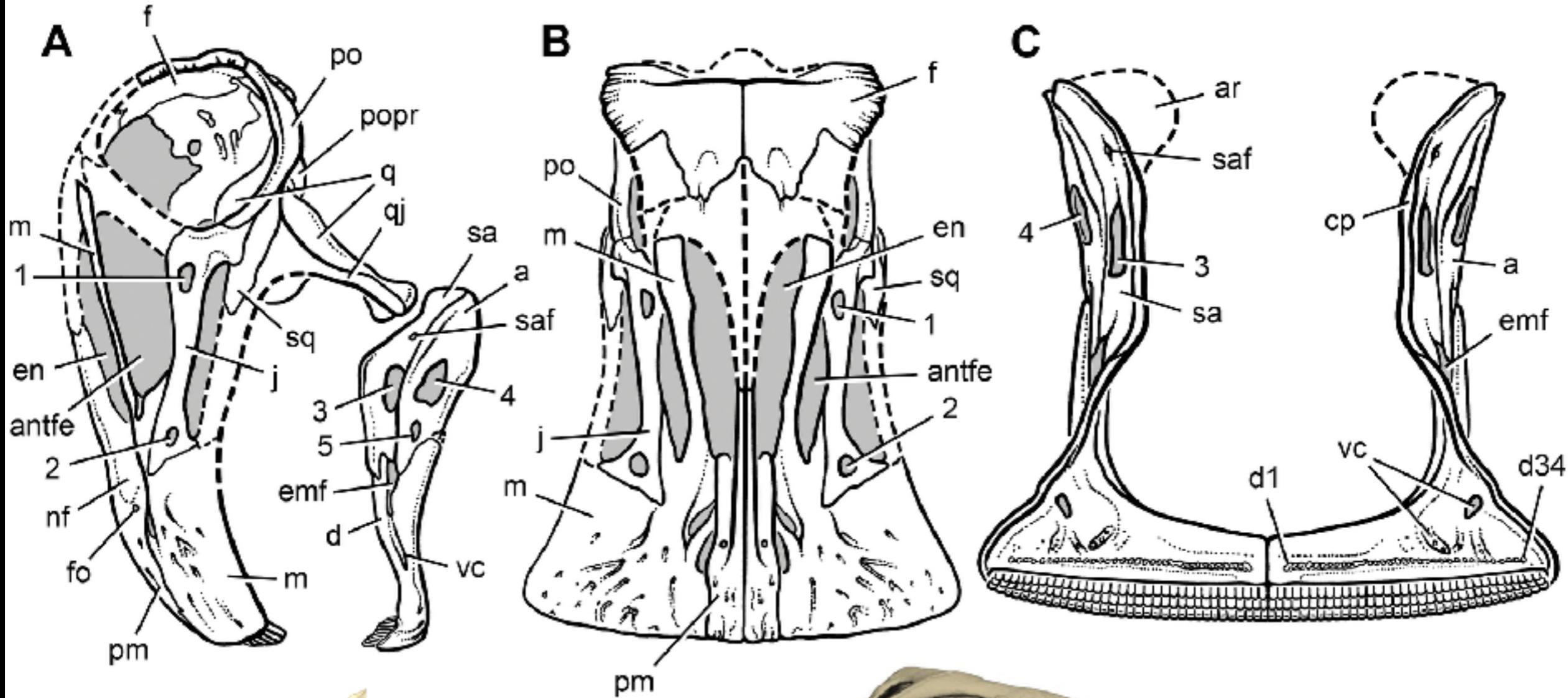


Triangulate, spatulate, or pencil-like teeth
In some clades, teeth are limited



Nigersaurus





Sauropoda-Neosauropoda

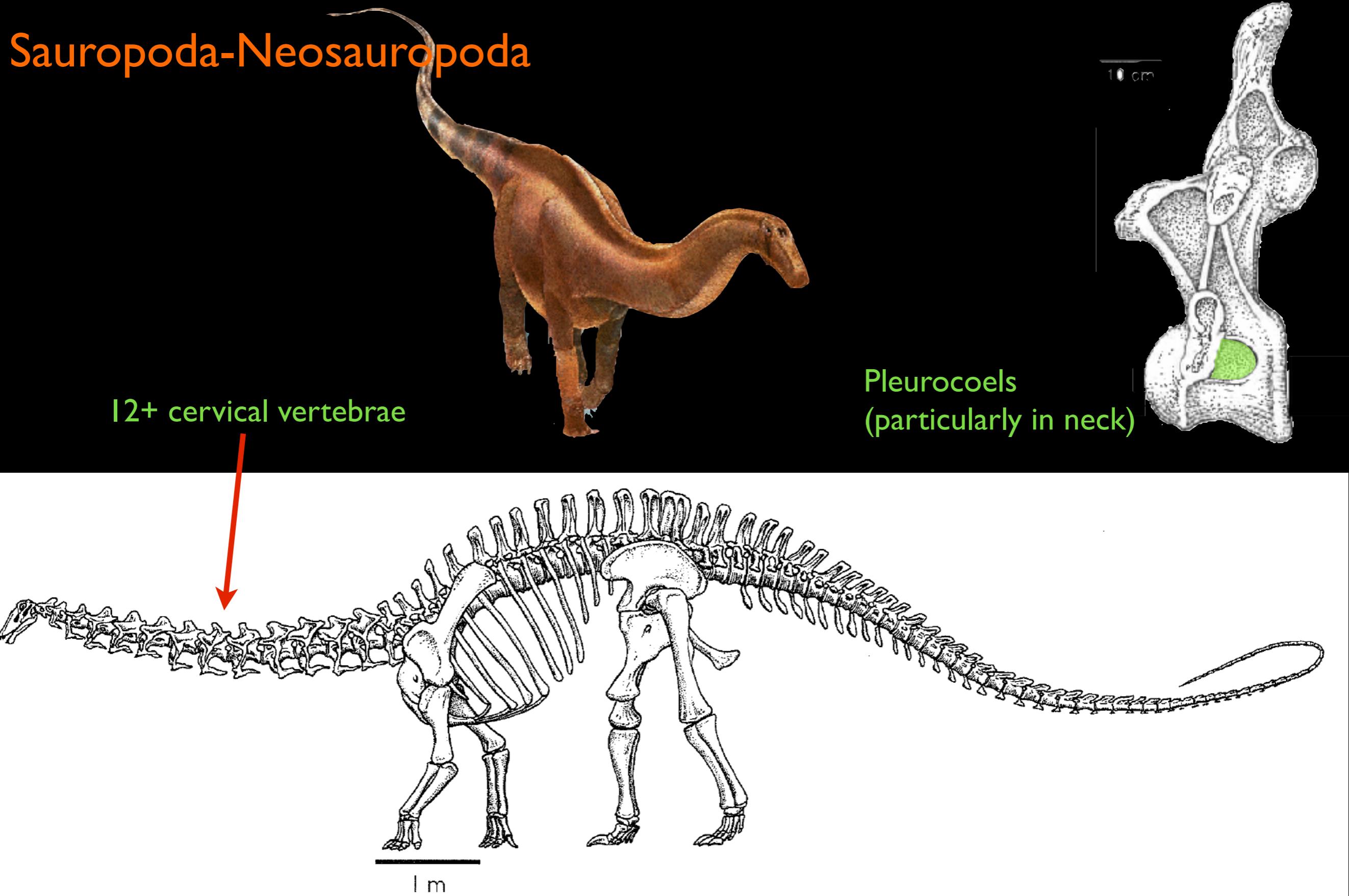
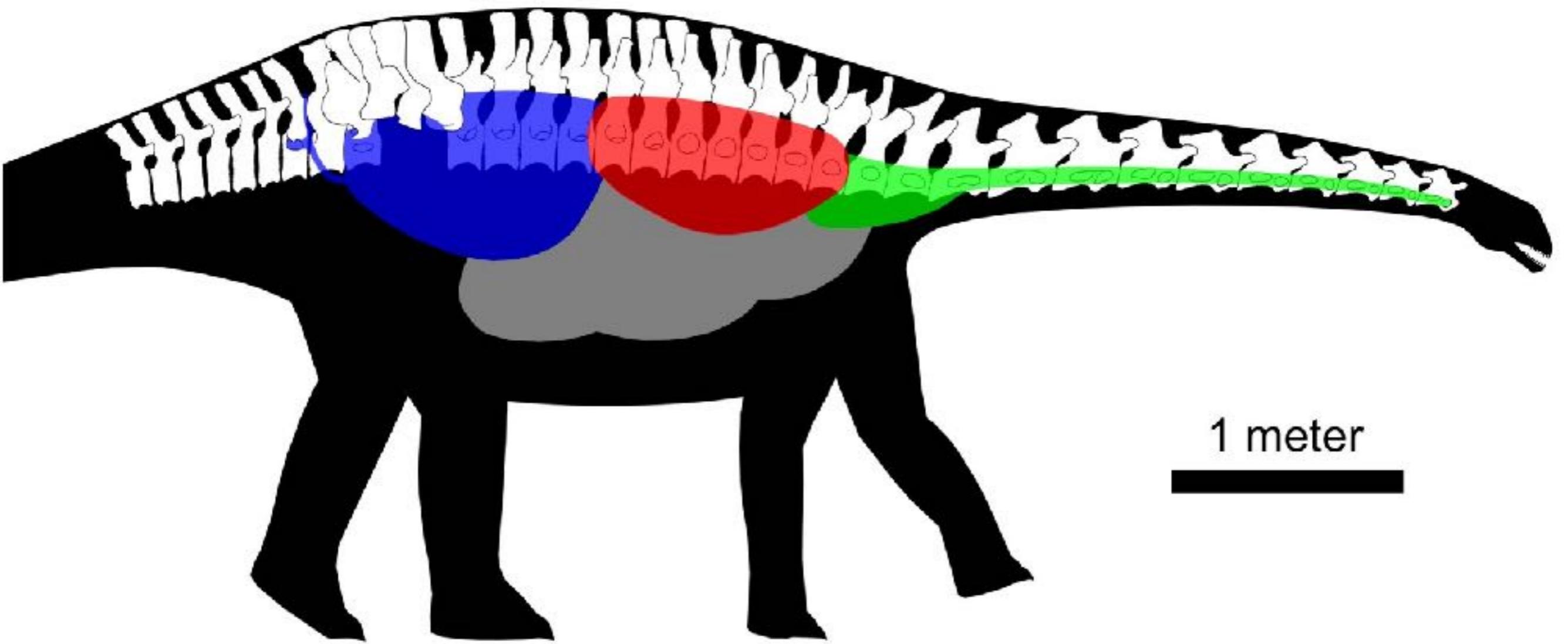


Figure 11.5. Left lateral view of the skull and skeleton of *Apatosaurus*.

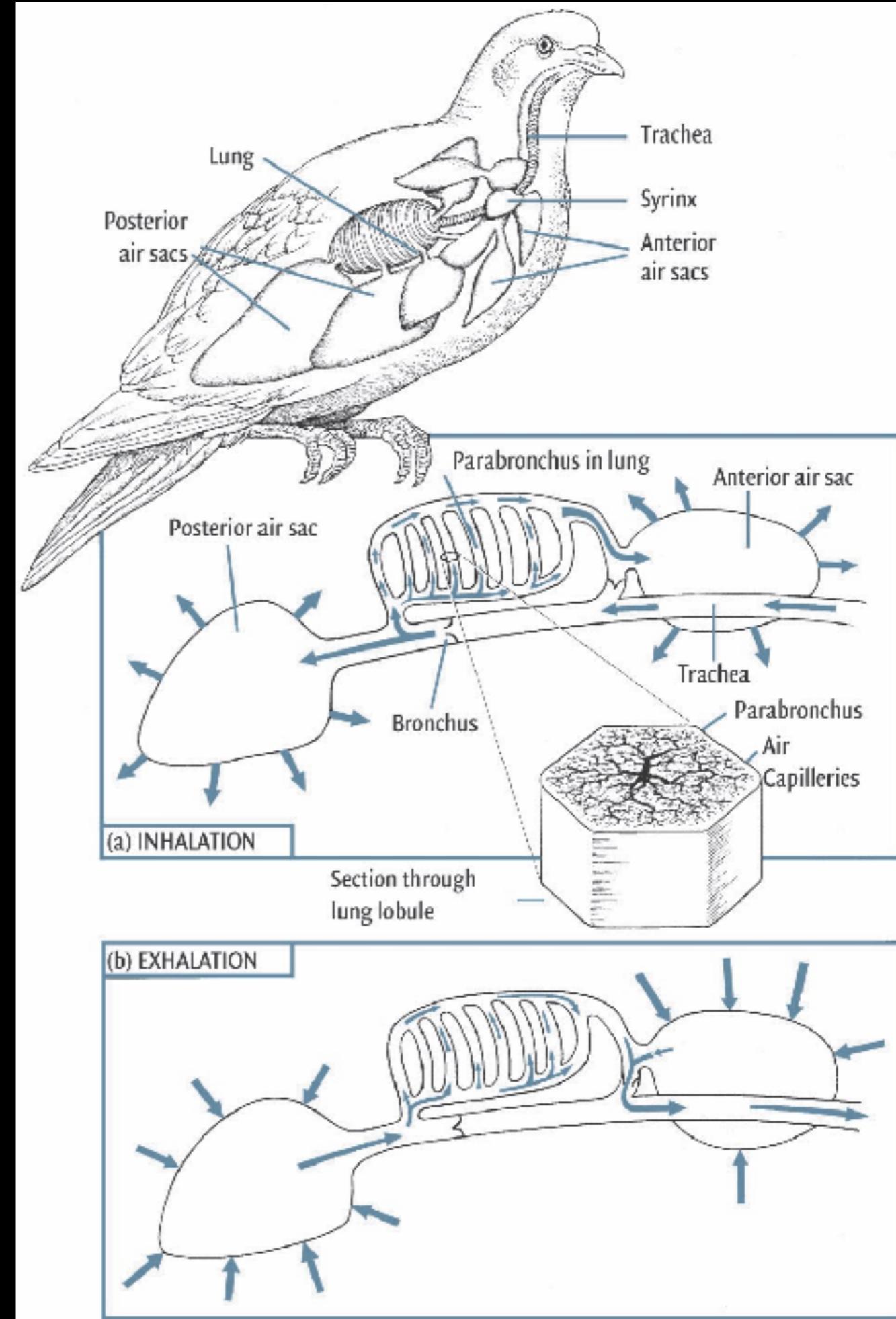


Uni-Directional Breathing

Air flows in one direction
Pumped by auxiliary air sacs
More O₂ can be extracted
Auxiliary airsacs partly housed in cavities within bones (sinuses) ~ pneumatic foramen
Sauropods have these cavities in their backbones... dual purpose

Uni-Directional Breathing

compared to bi-directional breathing
(Mammals, lizards, snakes, crocodiles)



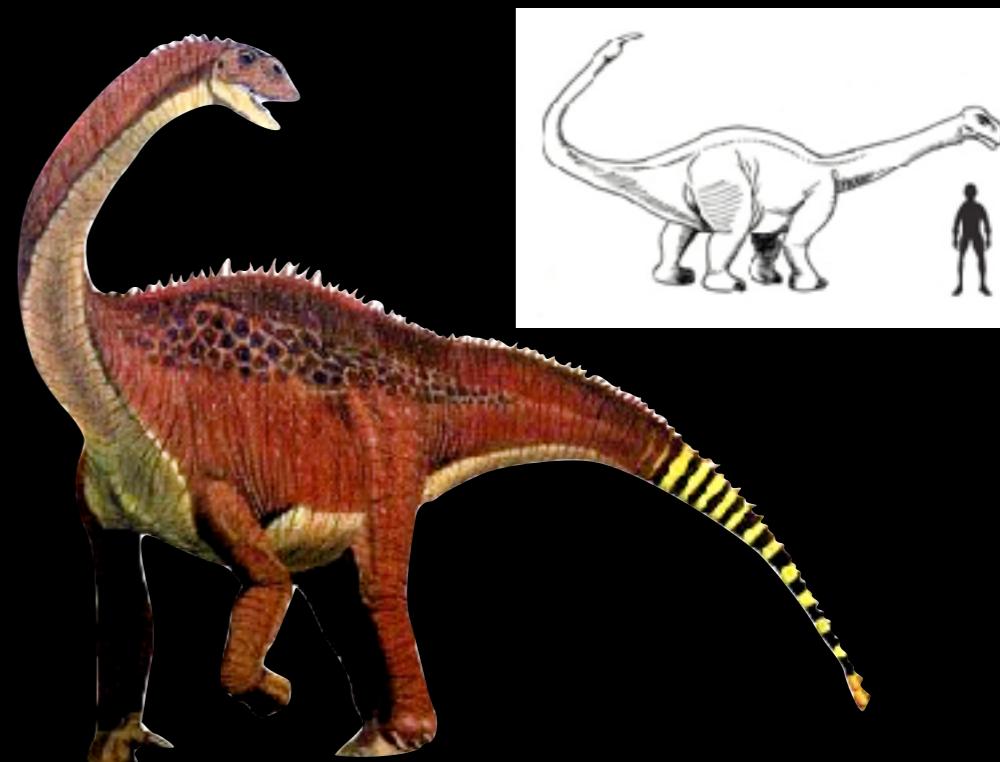
<https://www.youtube.com/watch?v=rfh-64s5va4>

Basal Sauropods



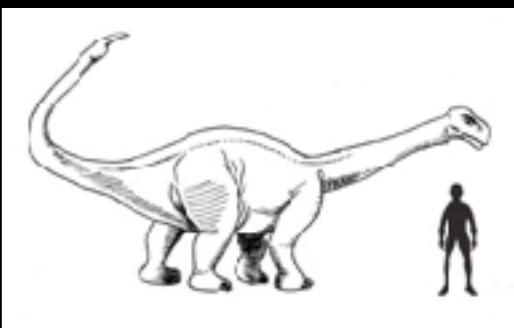
Vulcanodon
Early Jurassic

6.5 m (20 ft) long



Shunosaurus
Middle Jurassic

10 m (32 ft) long
Club Tail



Omeisaurus
Late Jurassic

Dinorail 2007



15.2 m (50 ft) long
4 m (12 ft) high



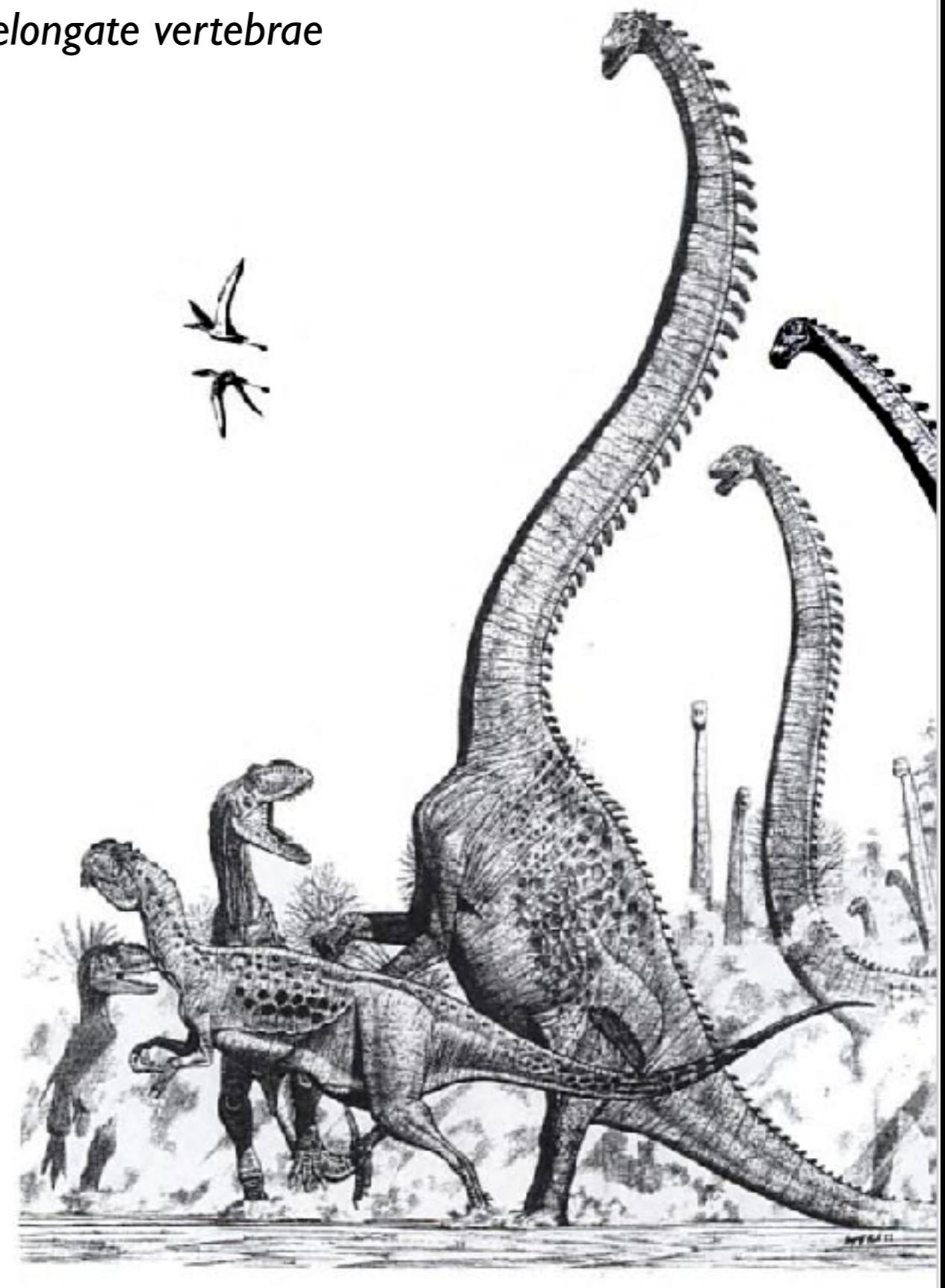
Omeisaurus in Hong Kong; 17 cervical vertebrae



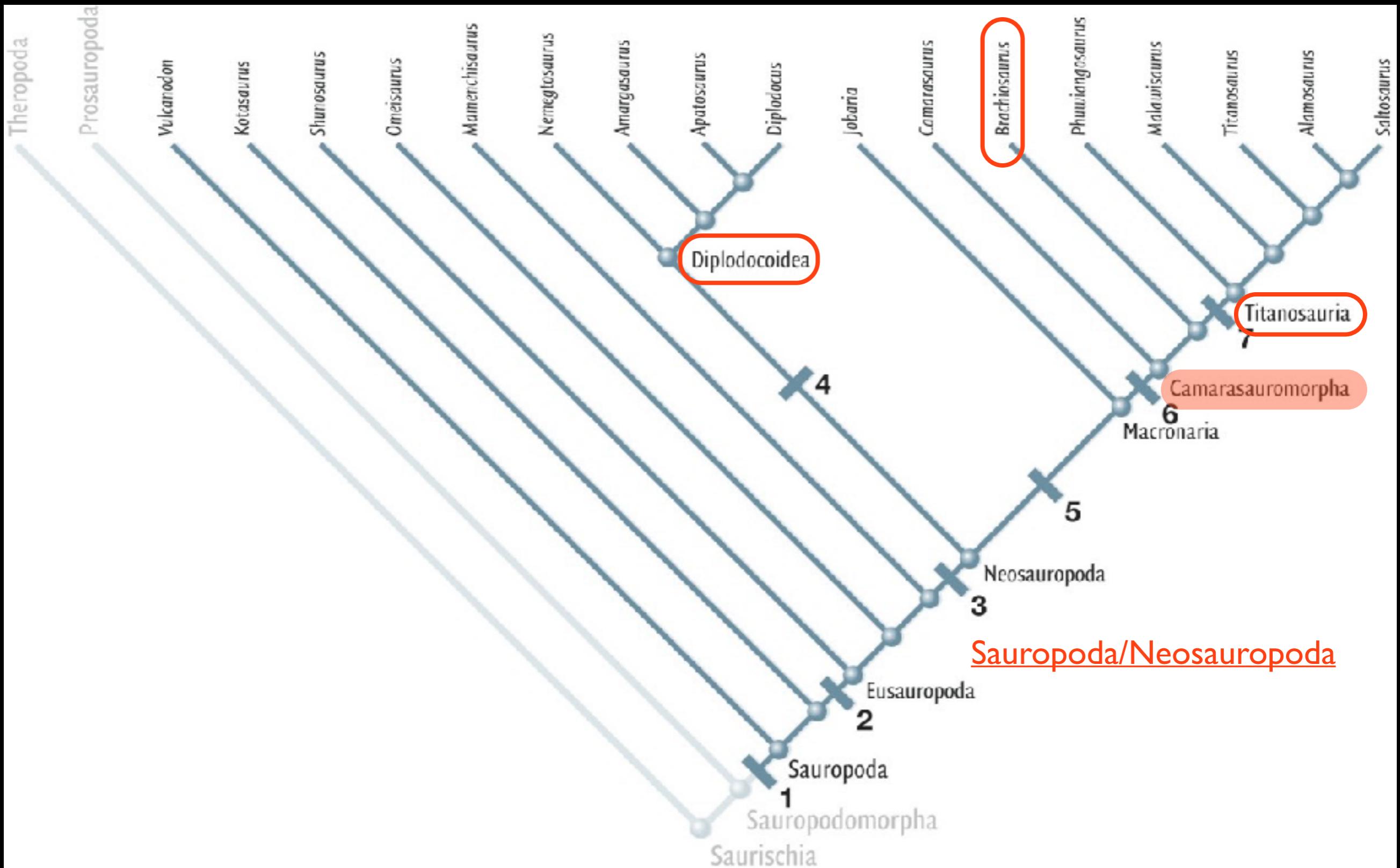
Omeisaurus
Late Jurassic

Mamenchisaurus
Late Jurassic

I9 elongate vertebrae



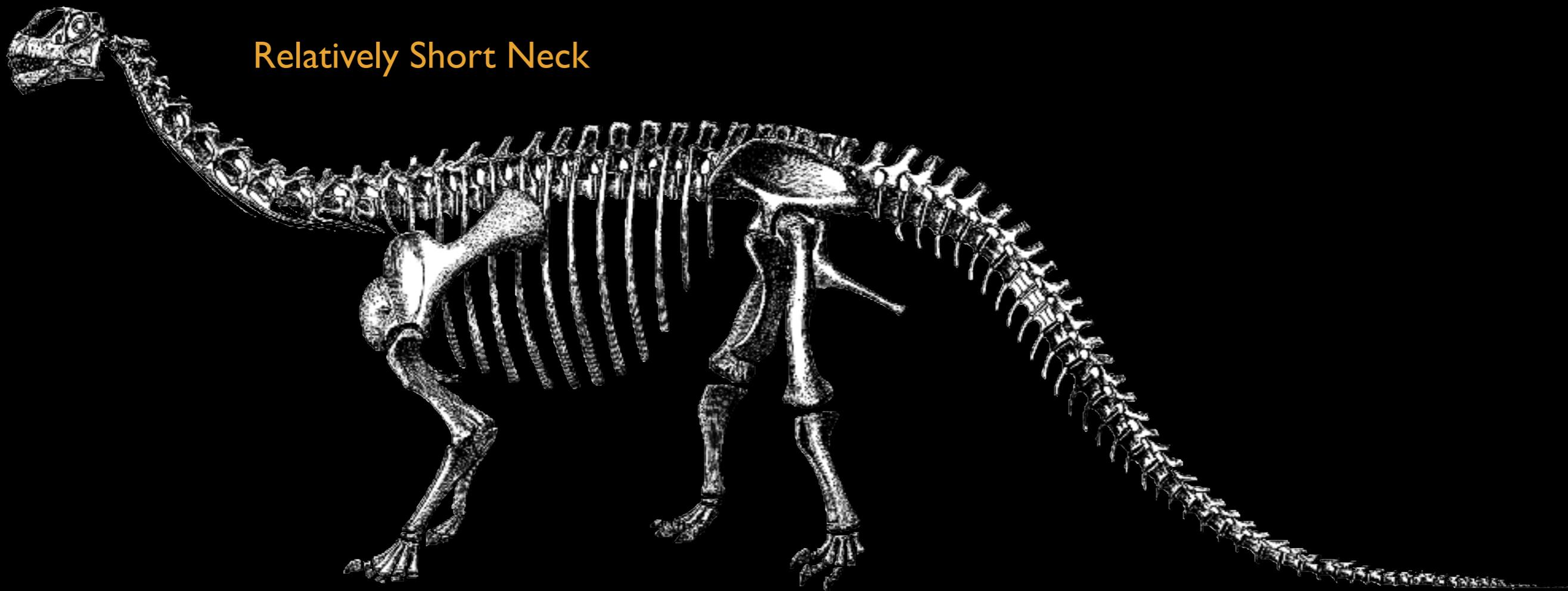
Camarasauromorpha



Camarasauromorpha

Large Nares

Relatively Short Neck

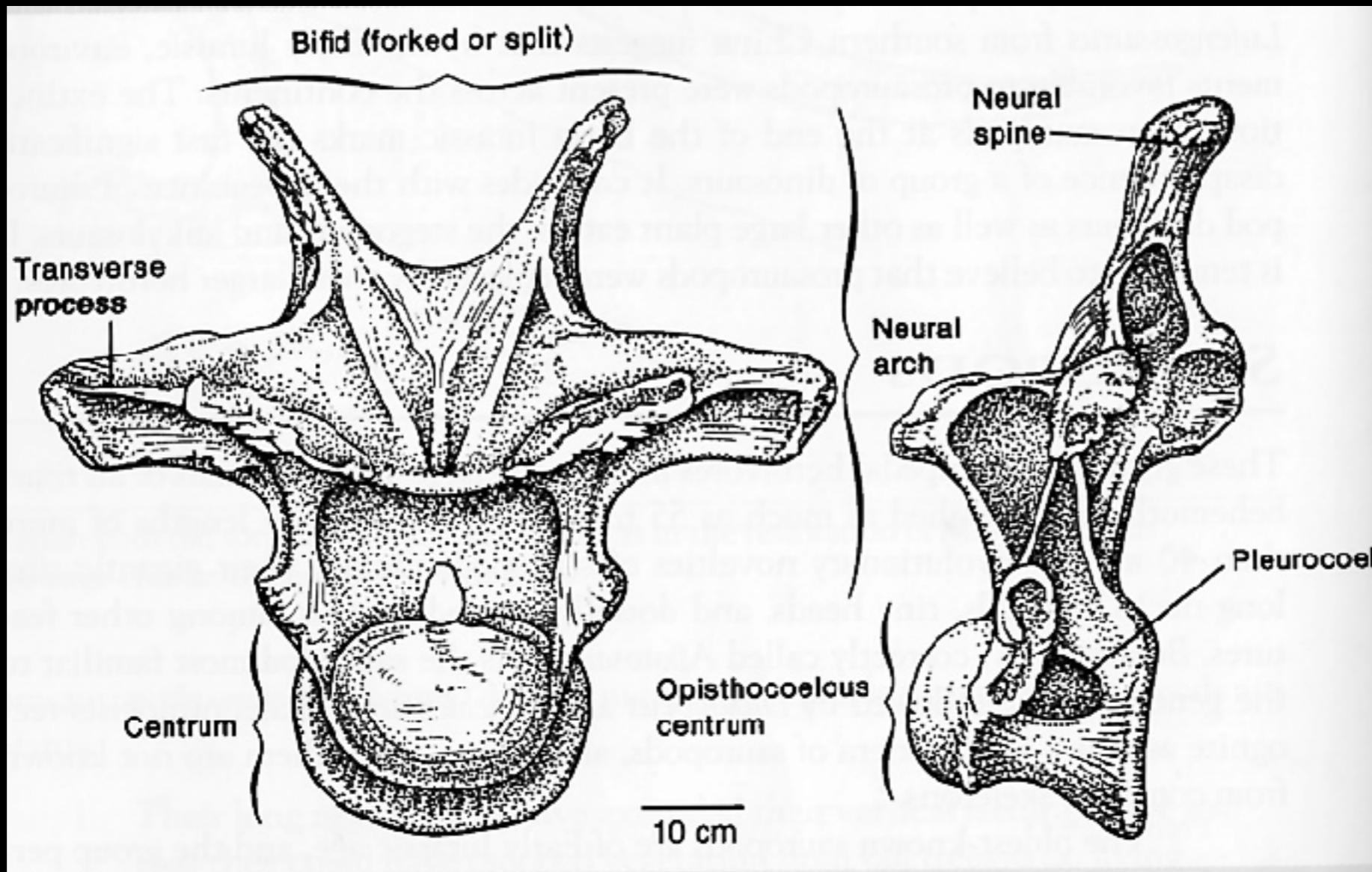


Relatively long forelimbs

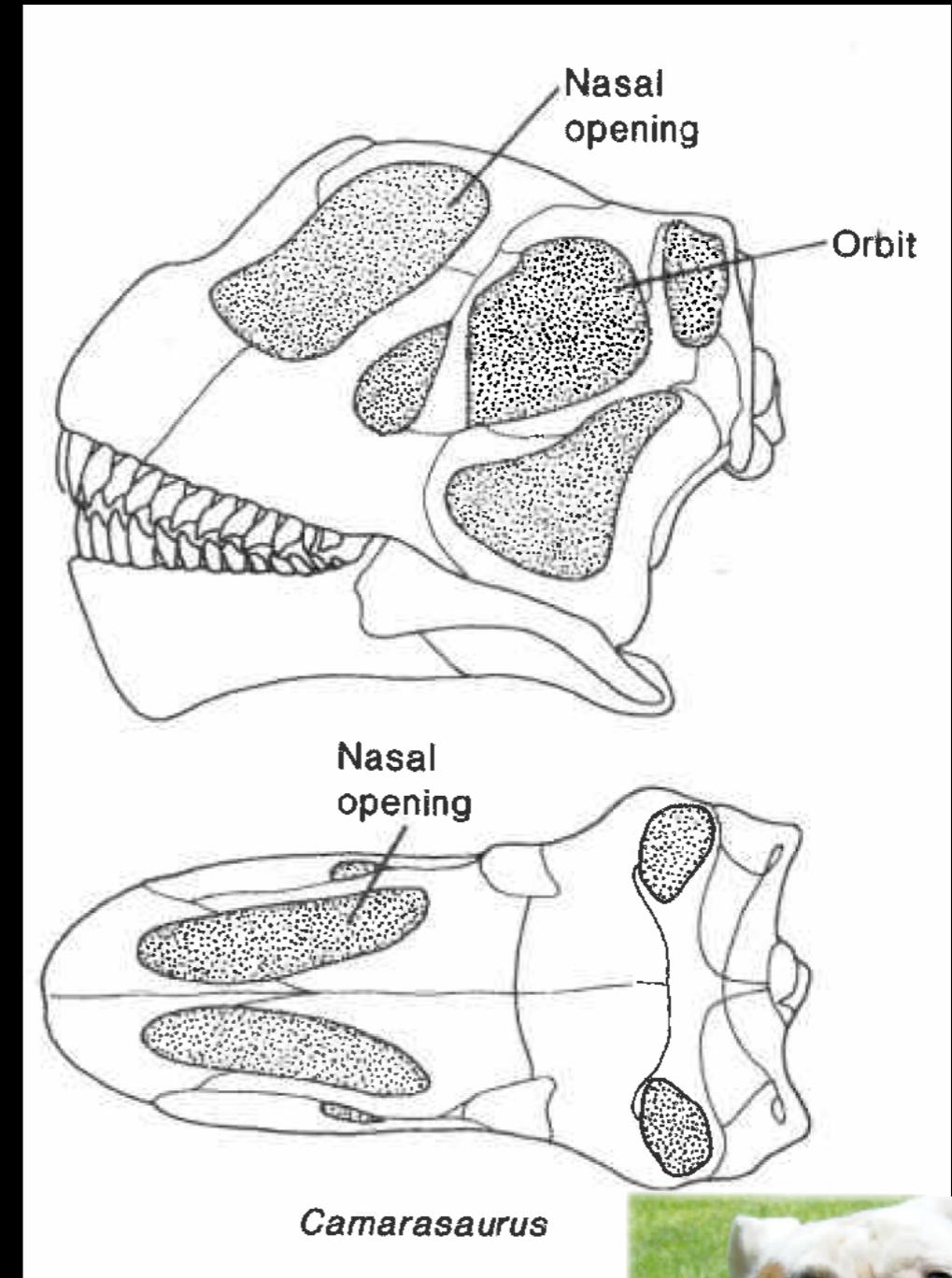
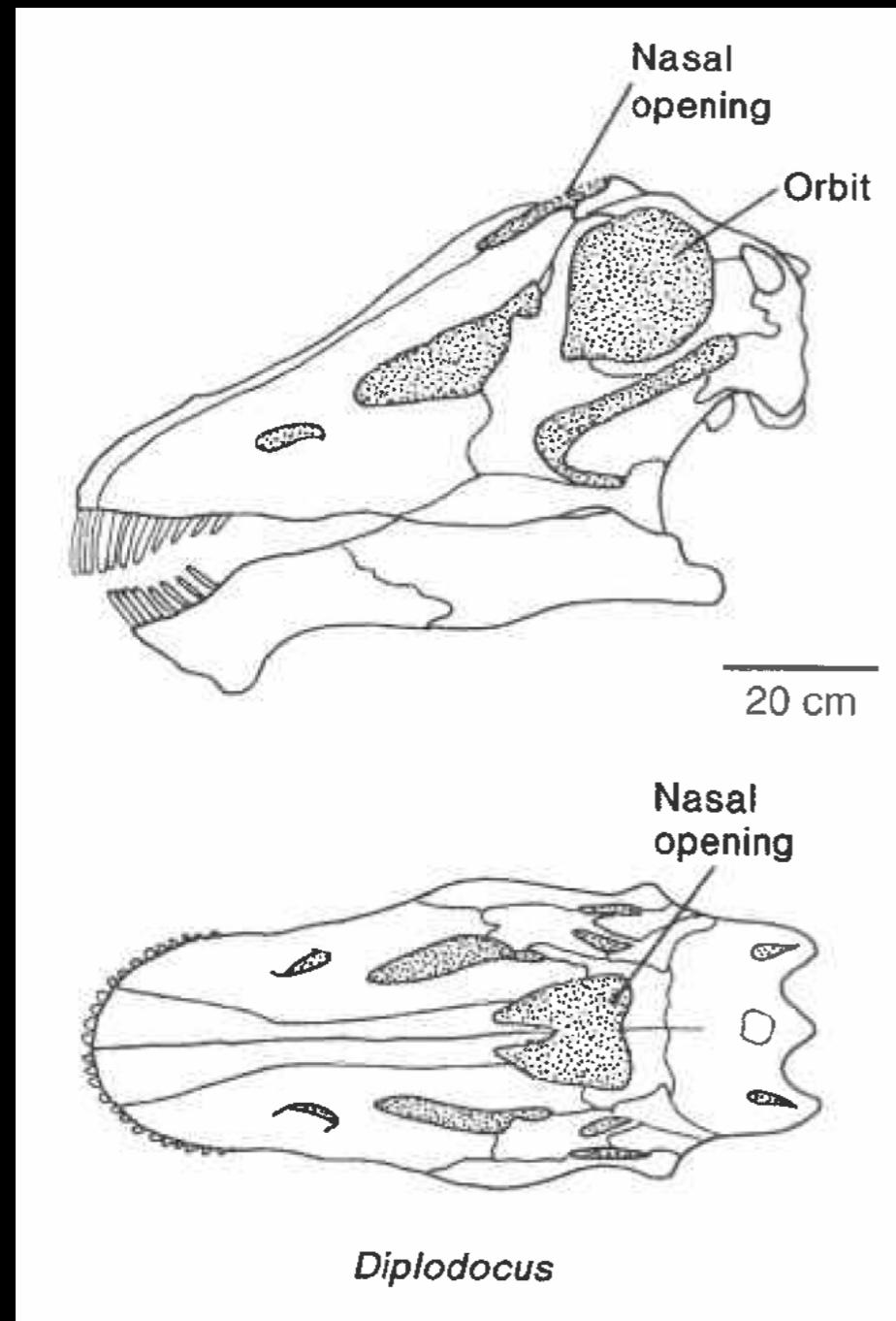
Camarasauromorpha

U-shaped neck vertebrae

To house strong, thick neck ligaments!



Camarasauromorpha



Shorter snout
Enlarged external nares

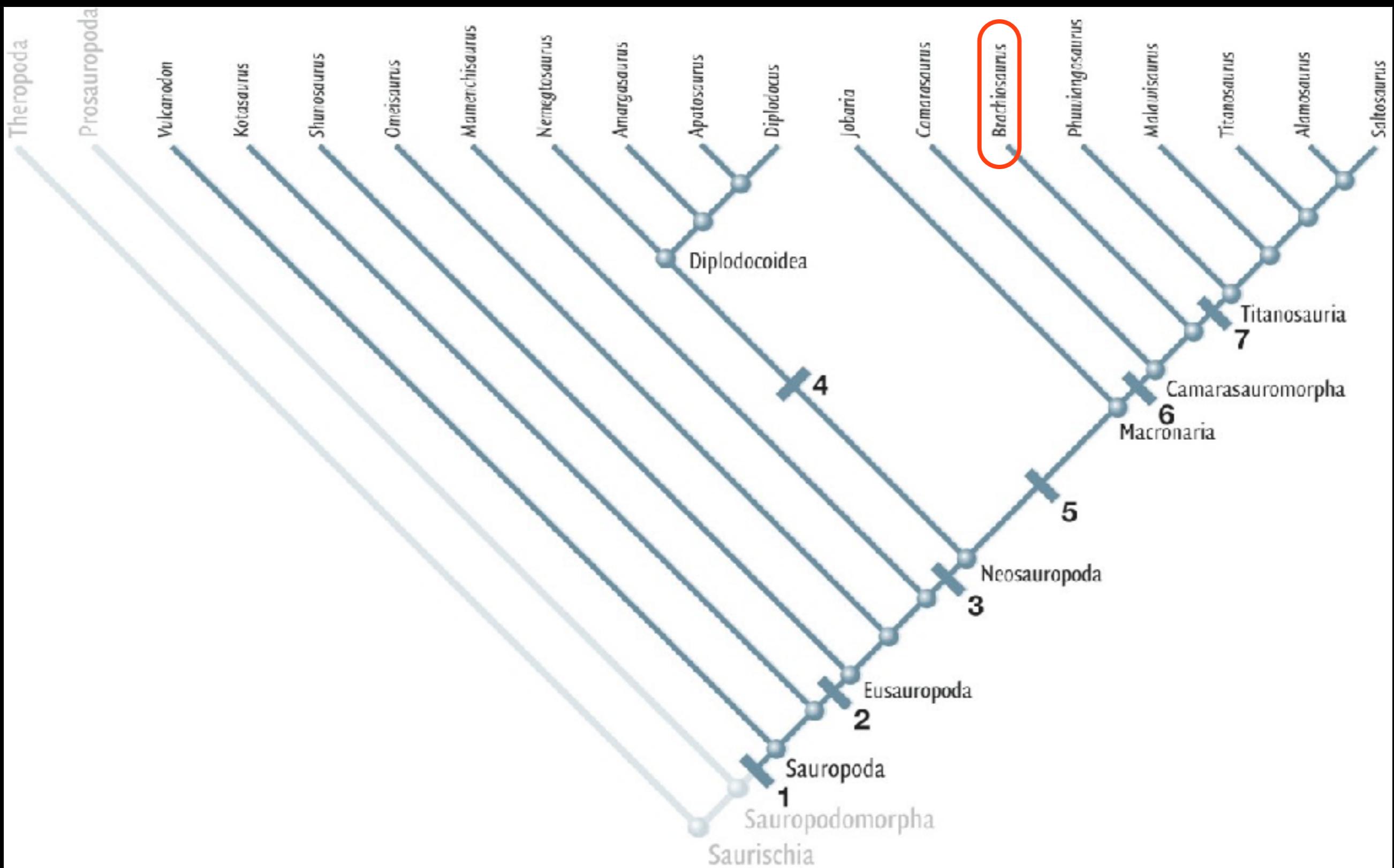


Camarasauromorpha



Camarasaurus

18 m (60 ft) long



Brachiosaurids

13 elongate vertebrae
Distinct snout
Vaulted skull
Very long forelimbs
Neck held vertically



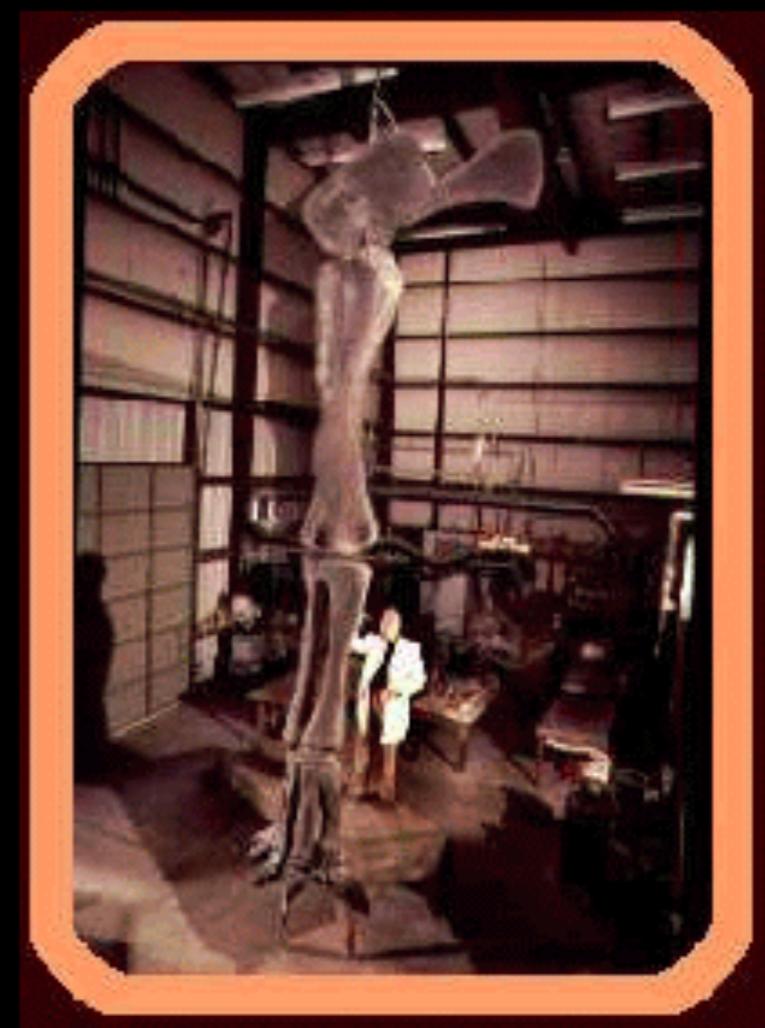
16 m (52 feet) tall

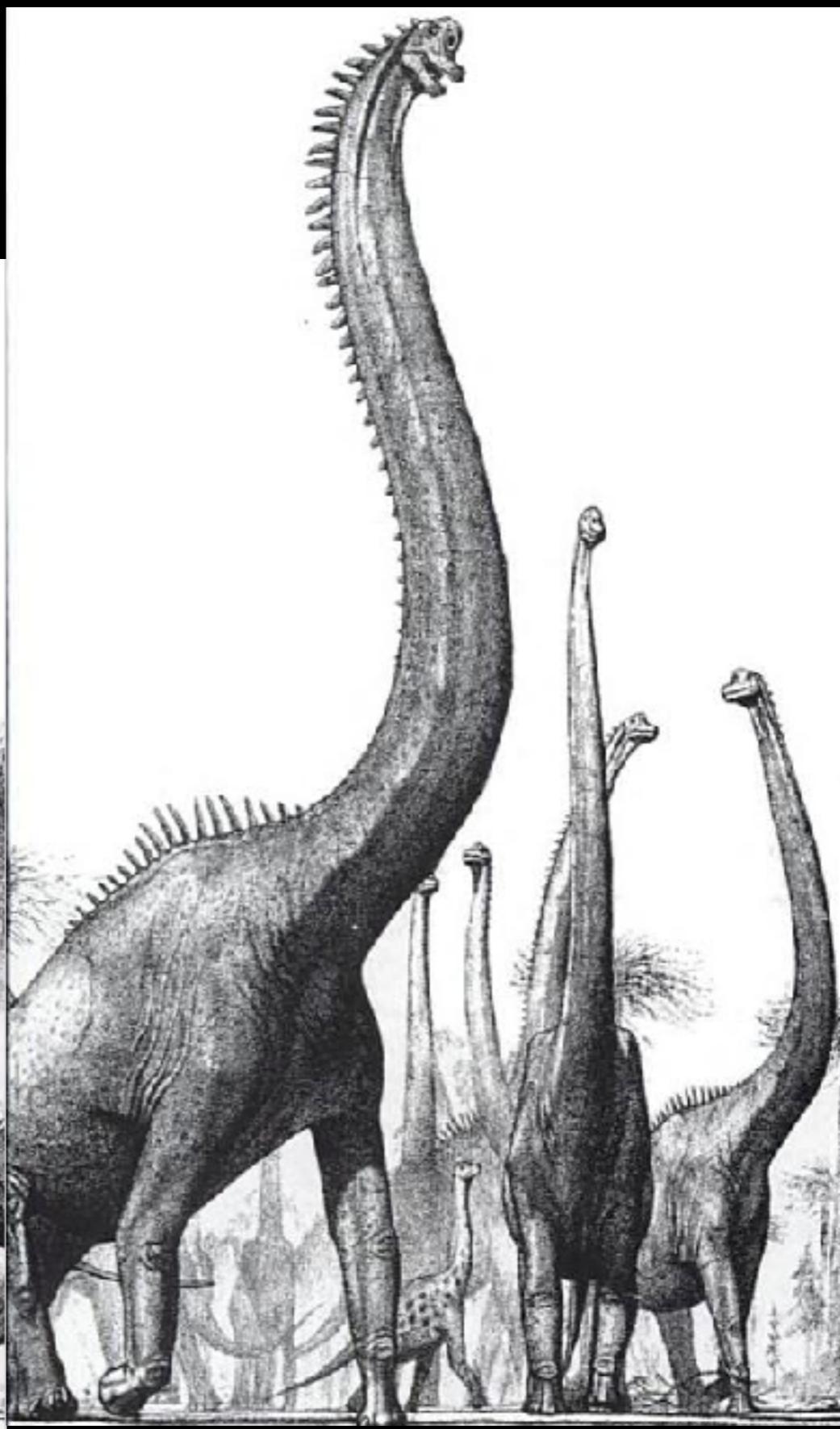
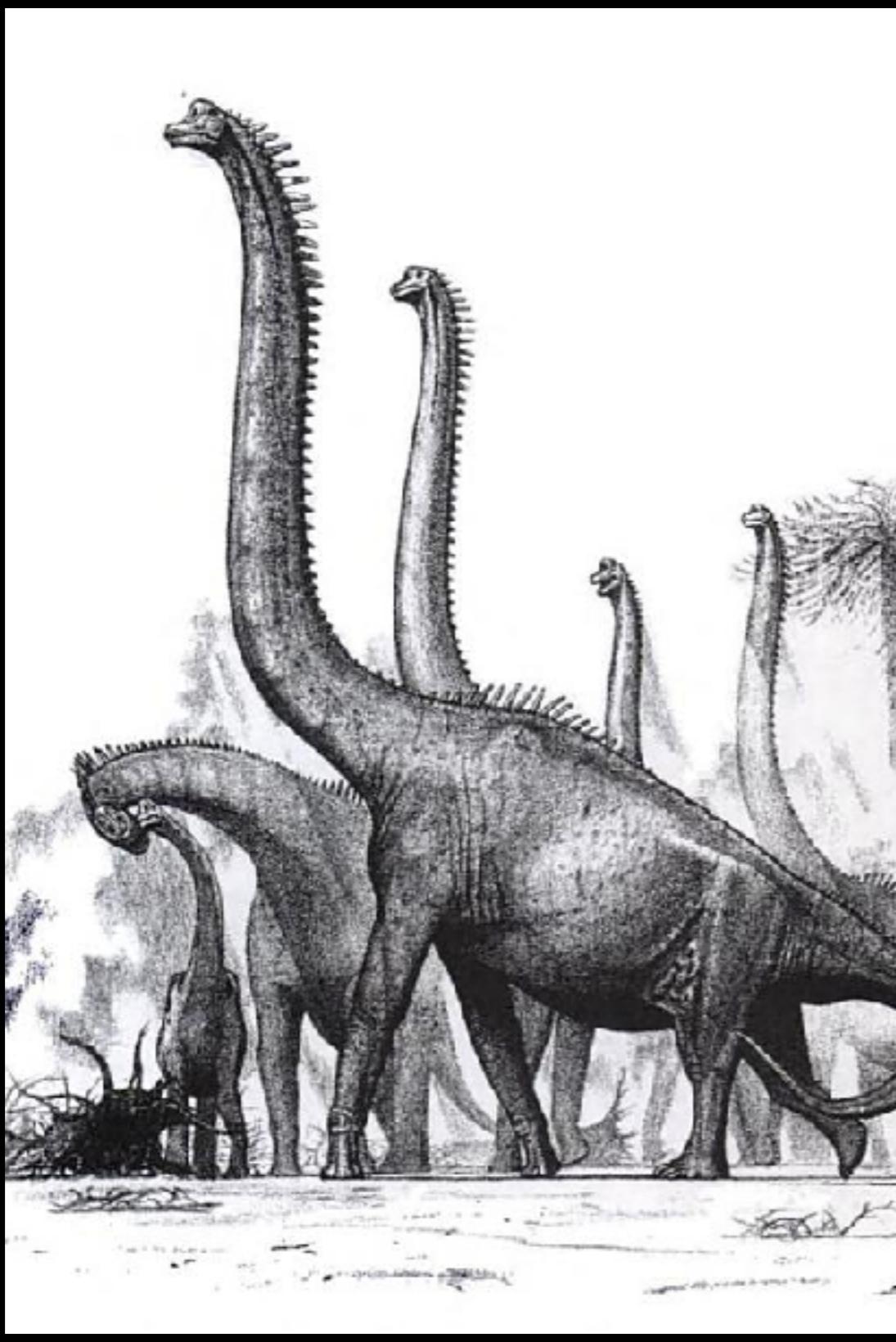


Brachiosaurus

Brachiosaurids

Brachiosaurus





Brachiosaurids

Sauroposeidon

Late Jurassic

Neck: 37-40 ft long

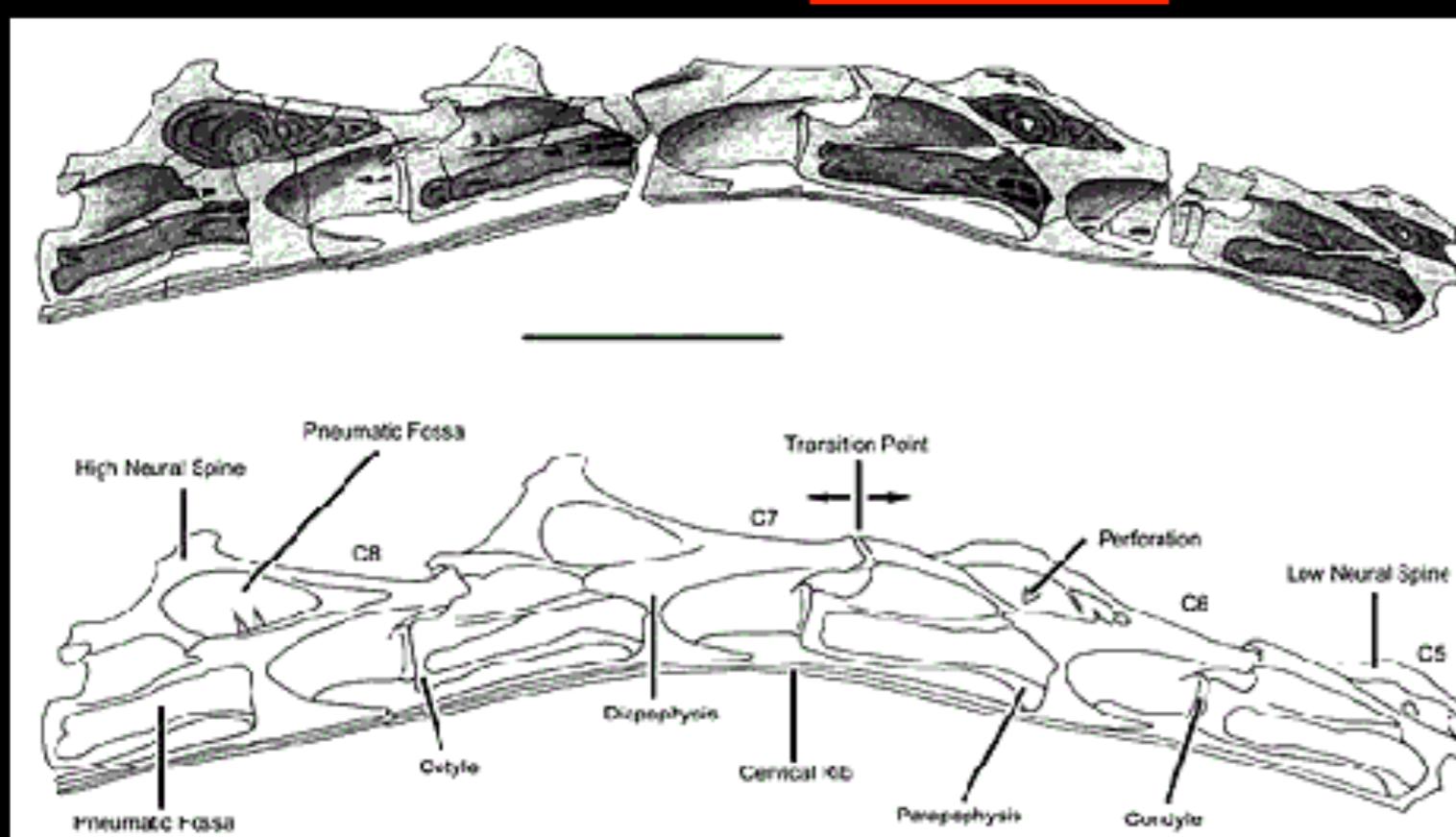
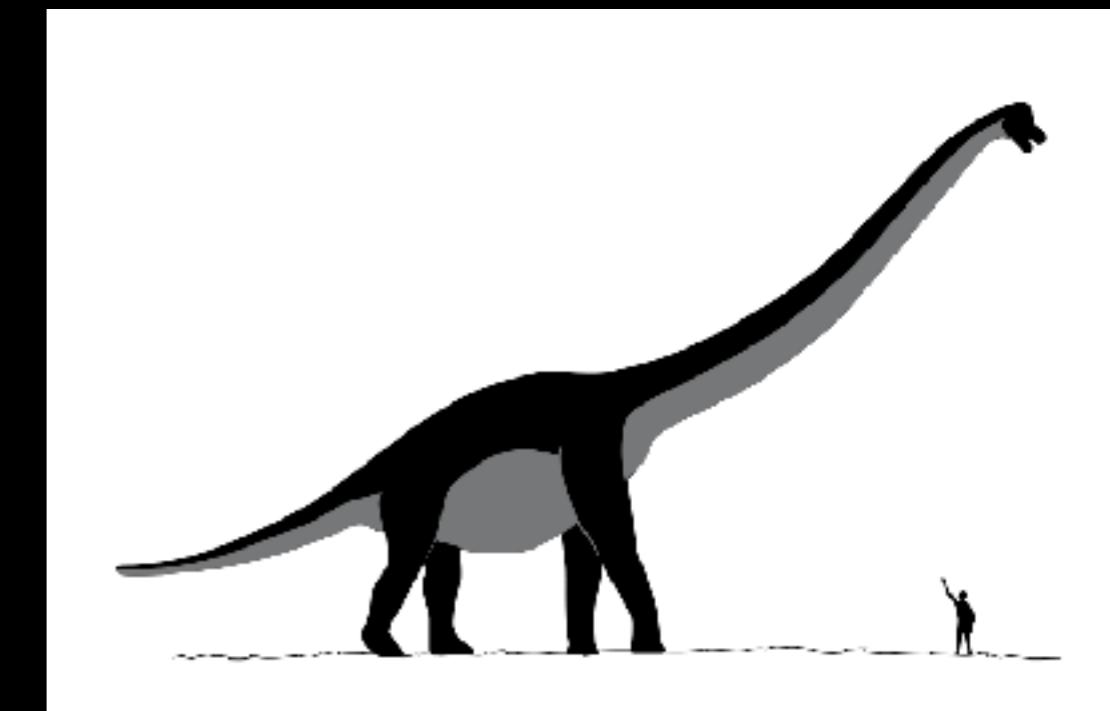
Vertebrae EXTREMELY ELONGATED

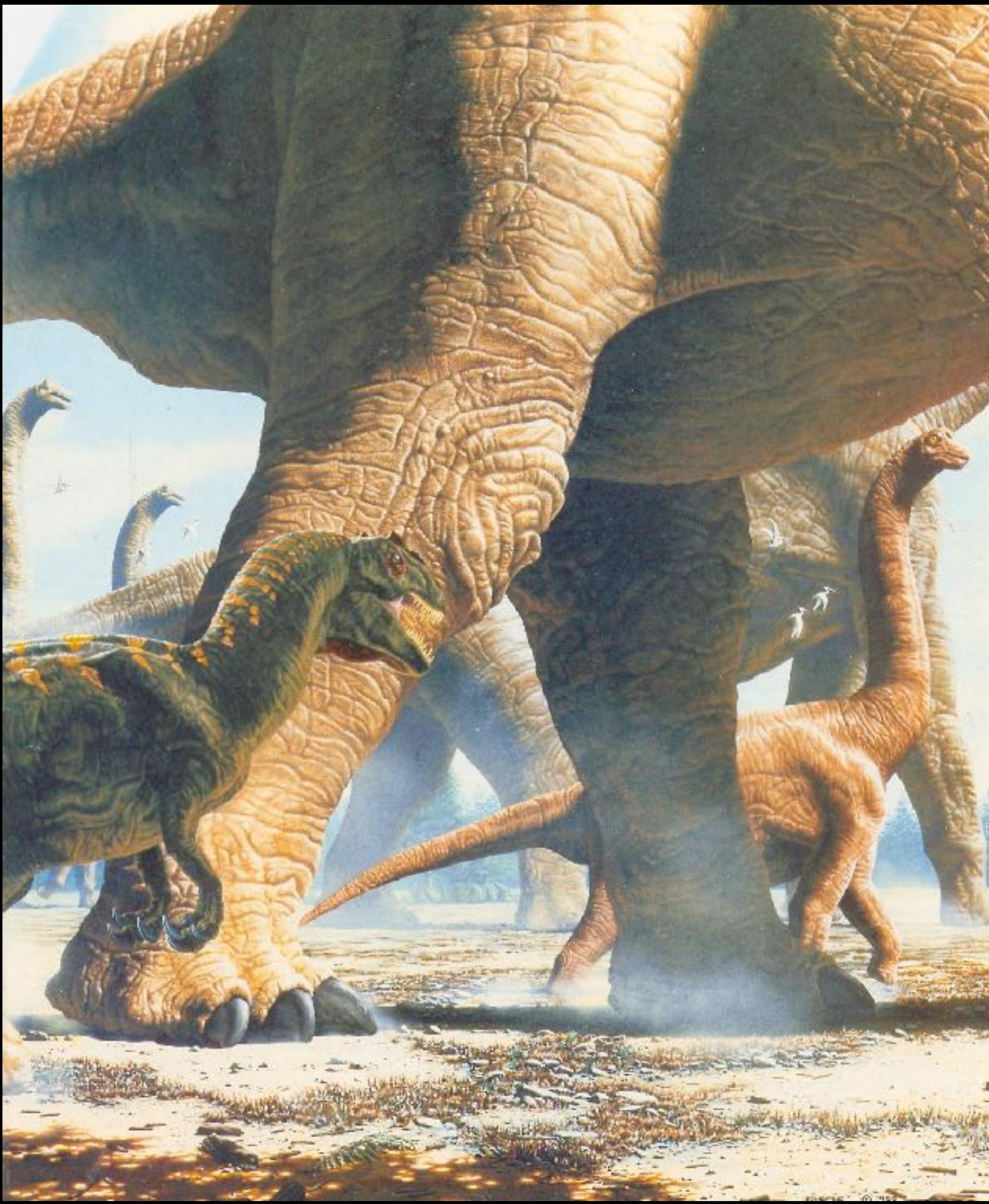
Honeycombed with tiny air cells

Bones very thin

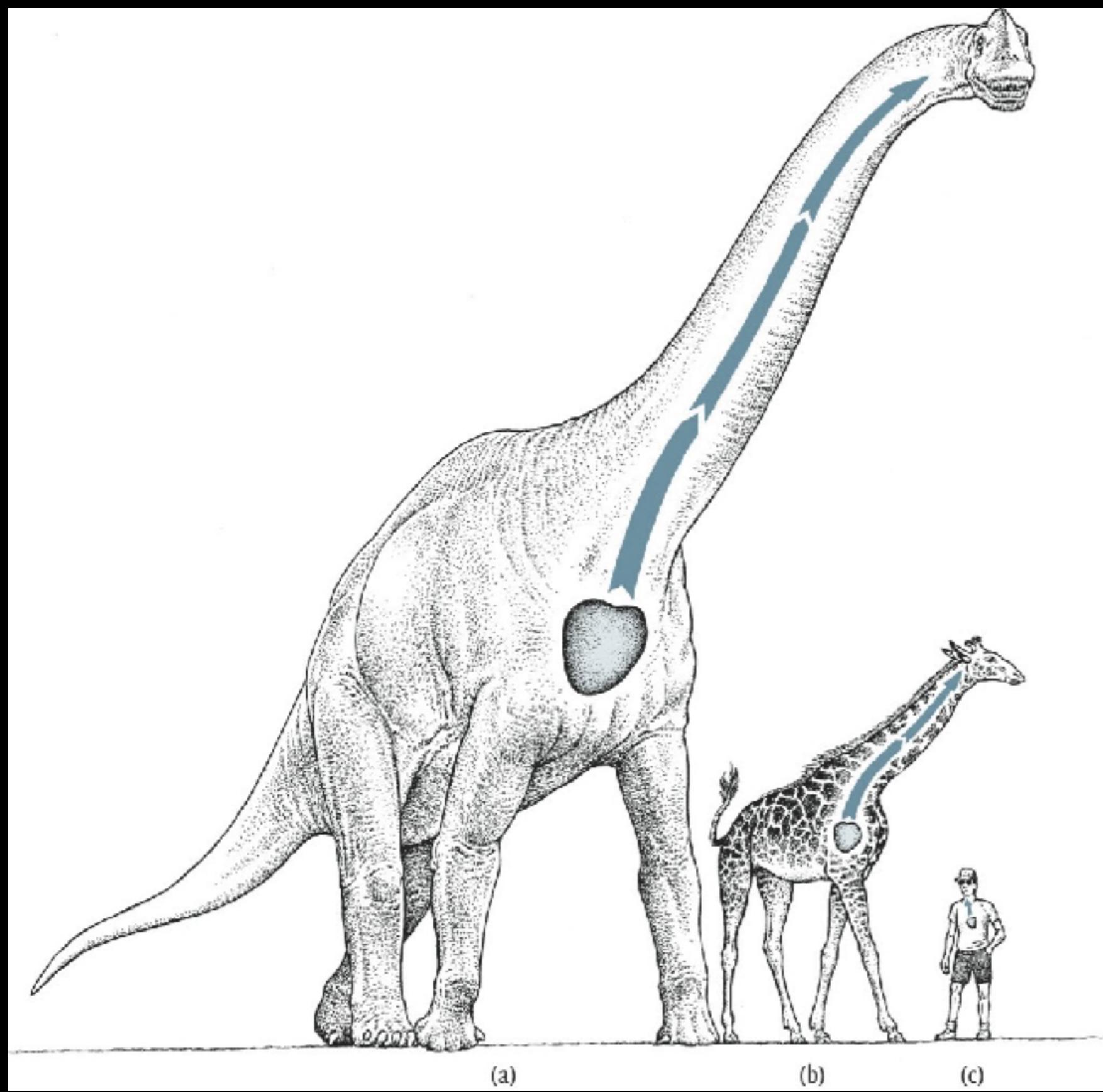
Longest sauropod neck vertebrae on record

Likely able to raise it's head 6 stories high

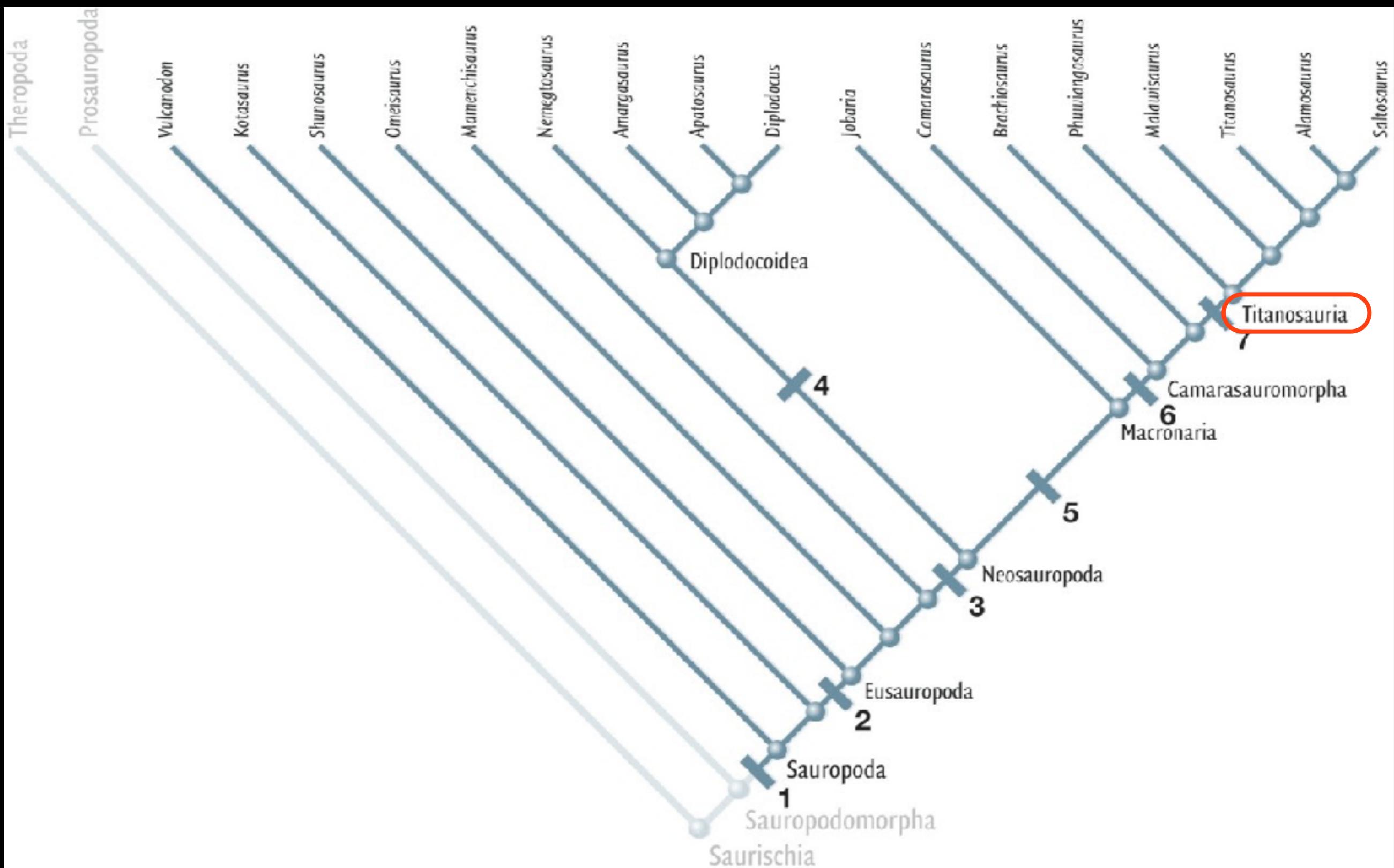




Brachiosaurids: an interesting physical problem...



Titanosaurids



Titanosaurids: primarily in the Cretaceous

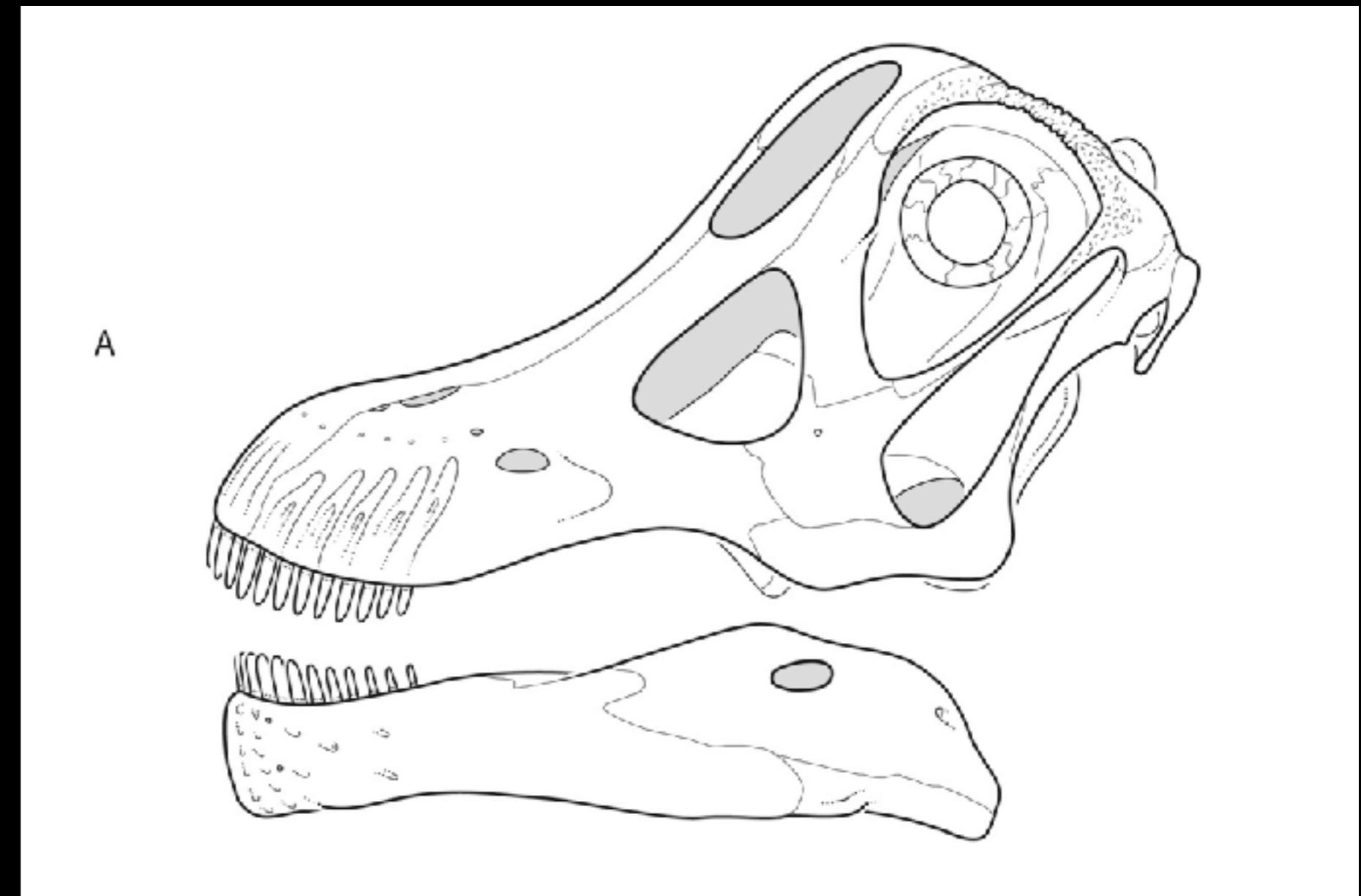
Alamosaurus

Very small heads

Osteoderms!

~9-10 m (30 ft) long



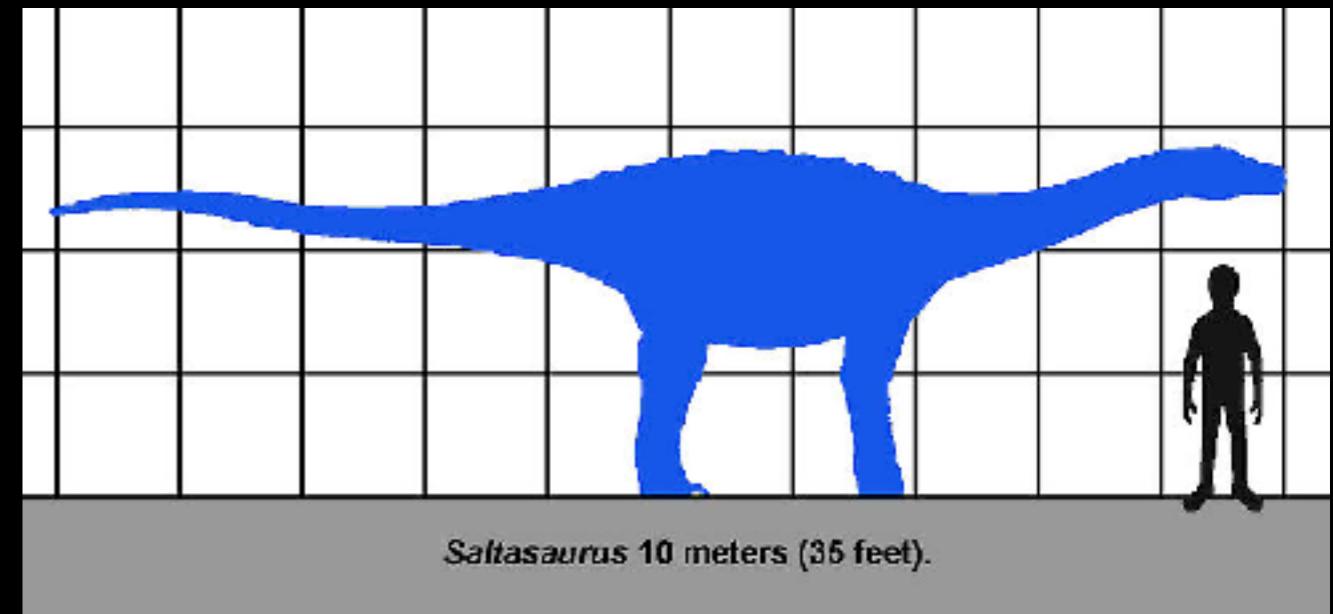


Nemegtosaurus

Pencil-like teeth; similar to Diplodocids

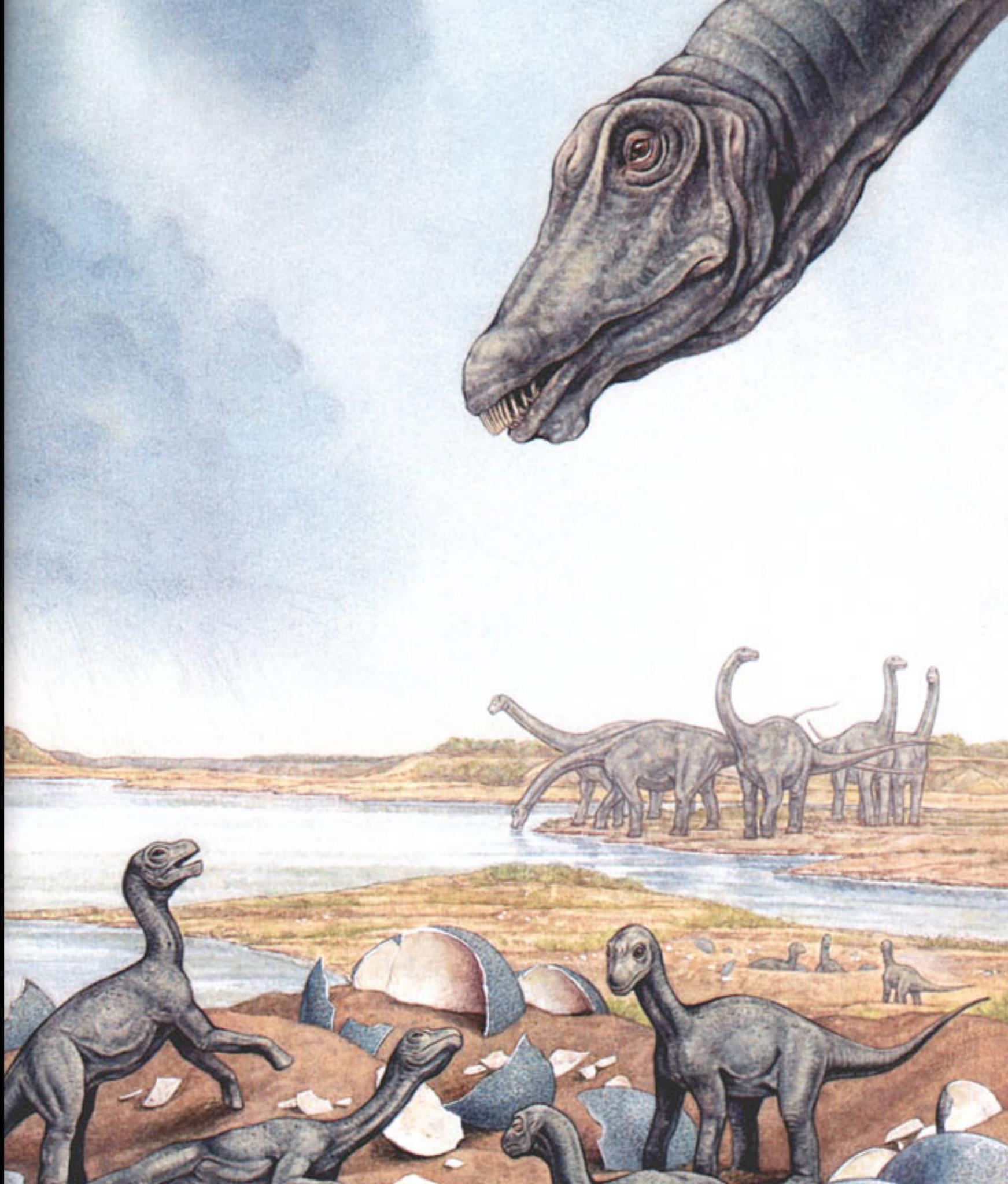
Probably convergent evolution (the rest of body is very different)

Titanosaurids: *Saltasaurus*

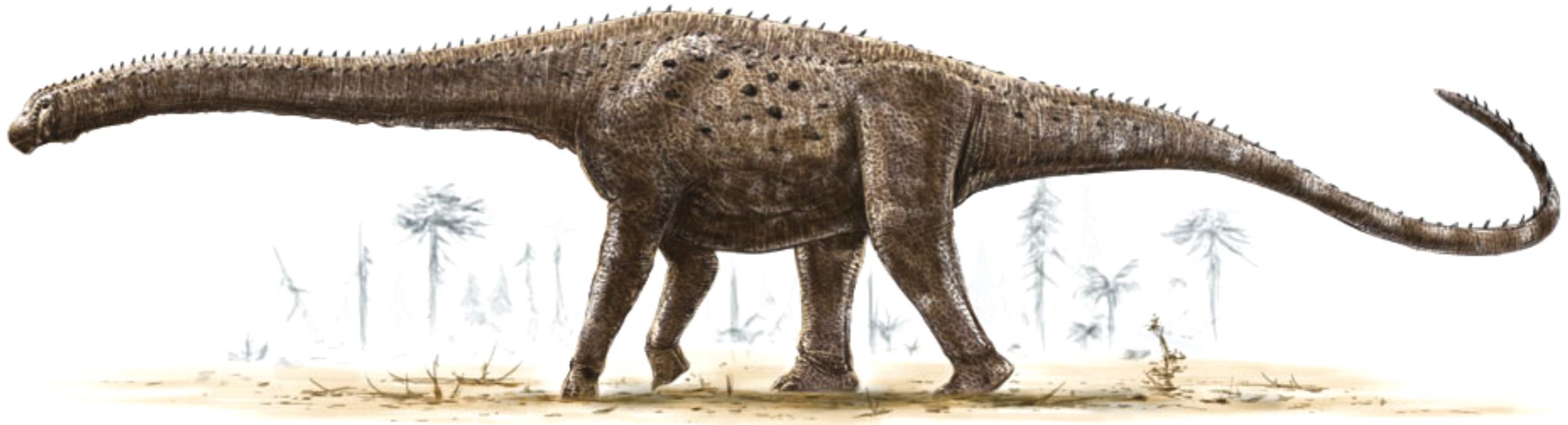


Saltasaurus egg

Nesting ground; implies herding
One of the only lines of evidence for sauropod reproduction

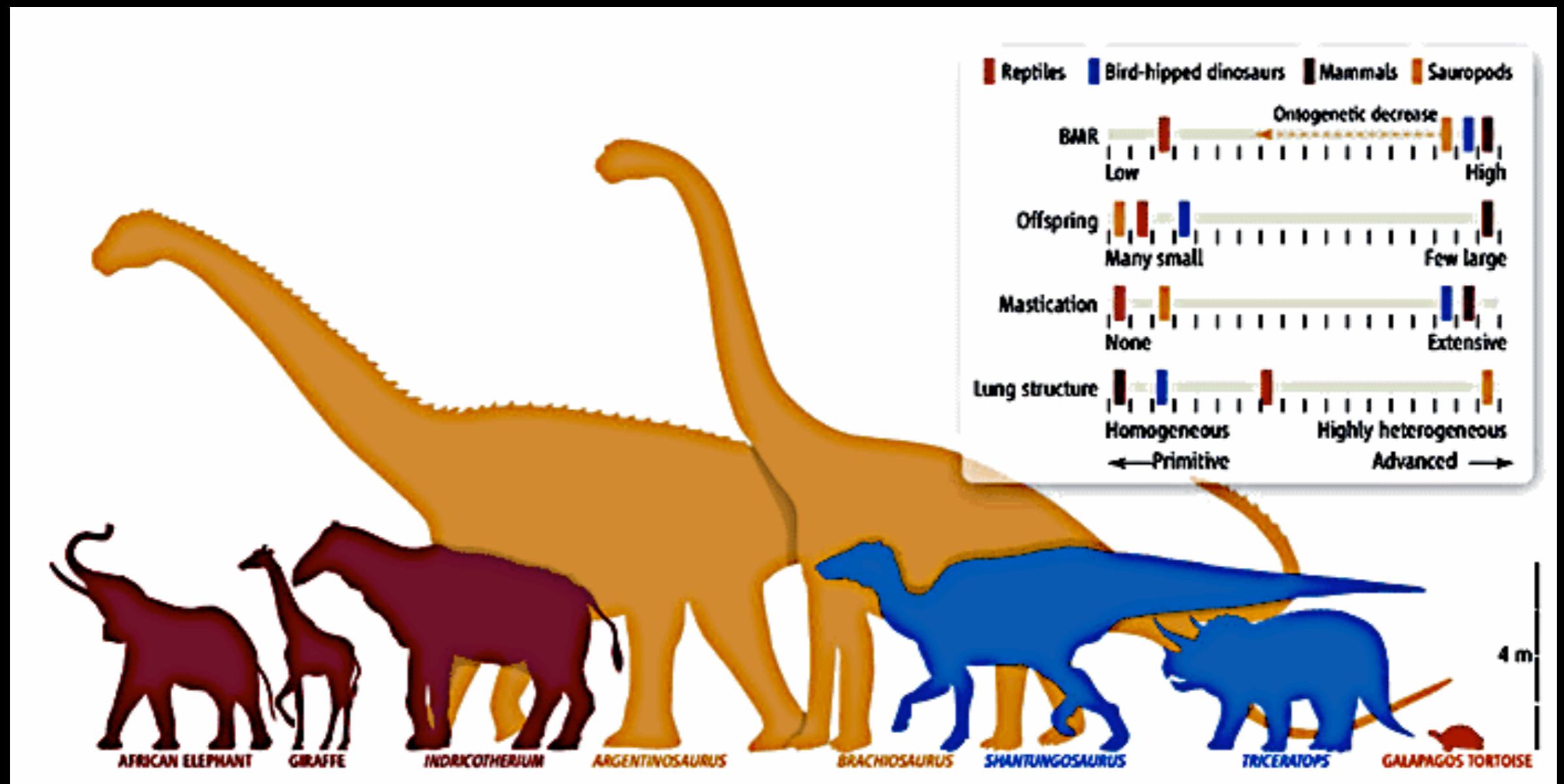


Titanosaurids: *Argentinosaurus*



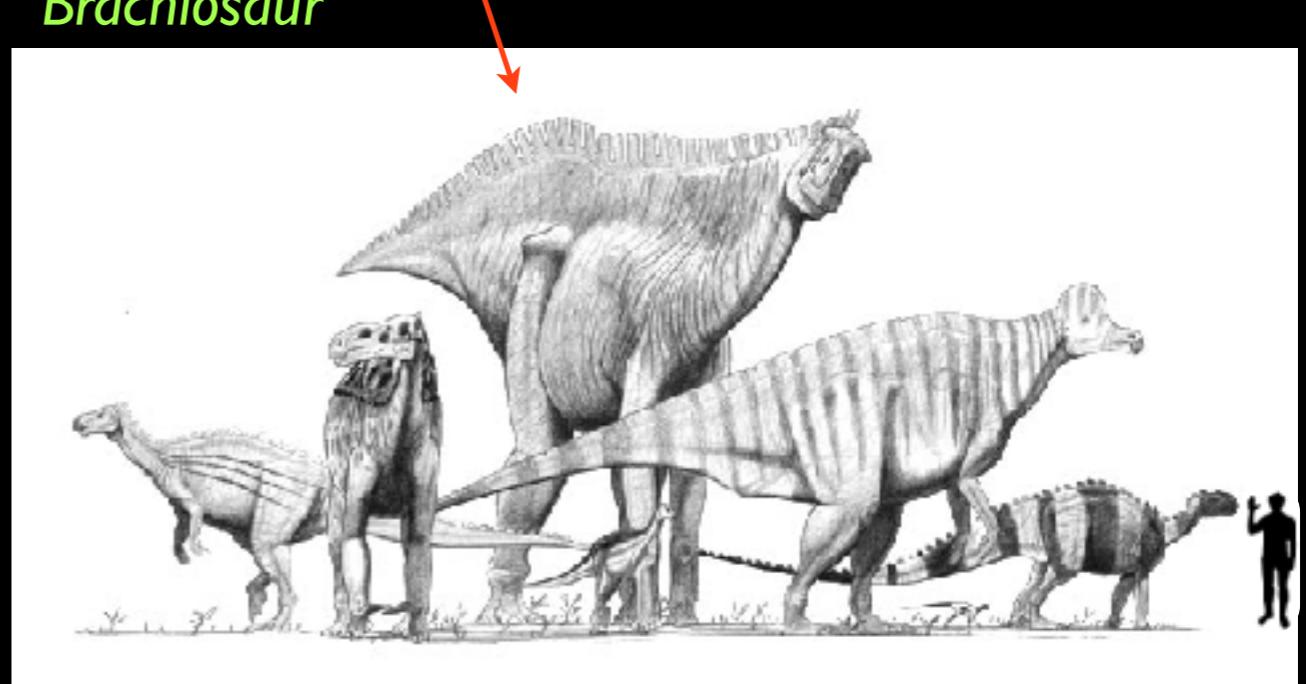
Mid-Cretaceous
21-35 m (72-85 ft) long

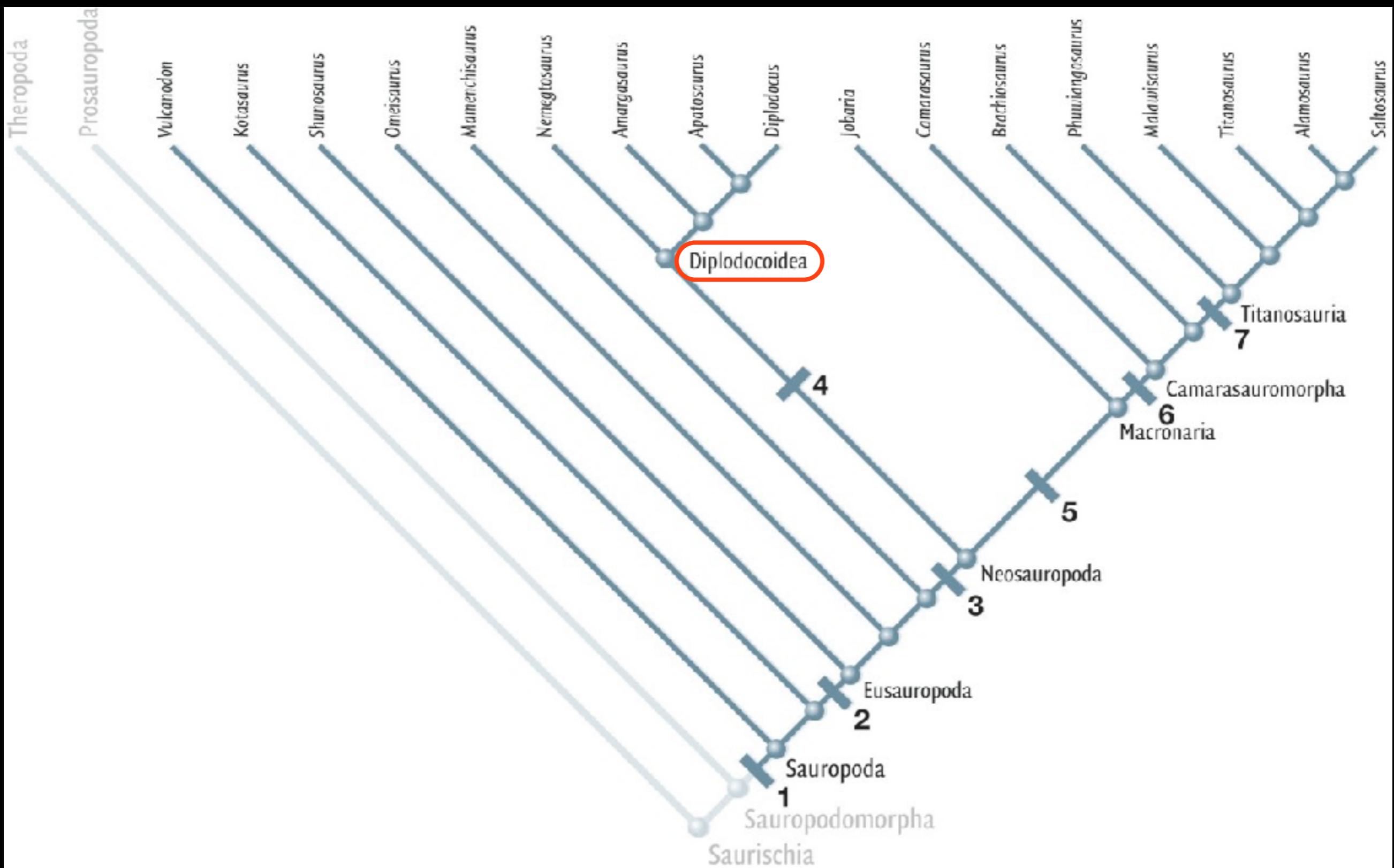




Titanosaur

Brachiosaur





Diplodocid traits

>12 vertebrae +
bifurcate cervical
neural spines

At least 80 caudals

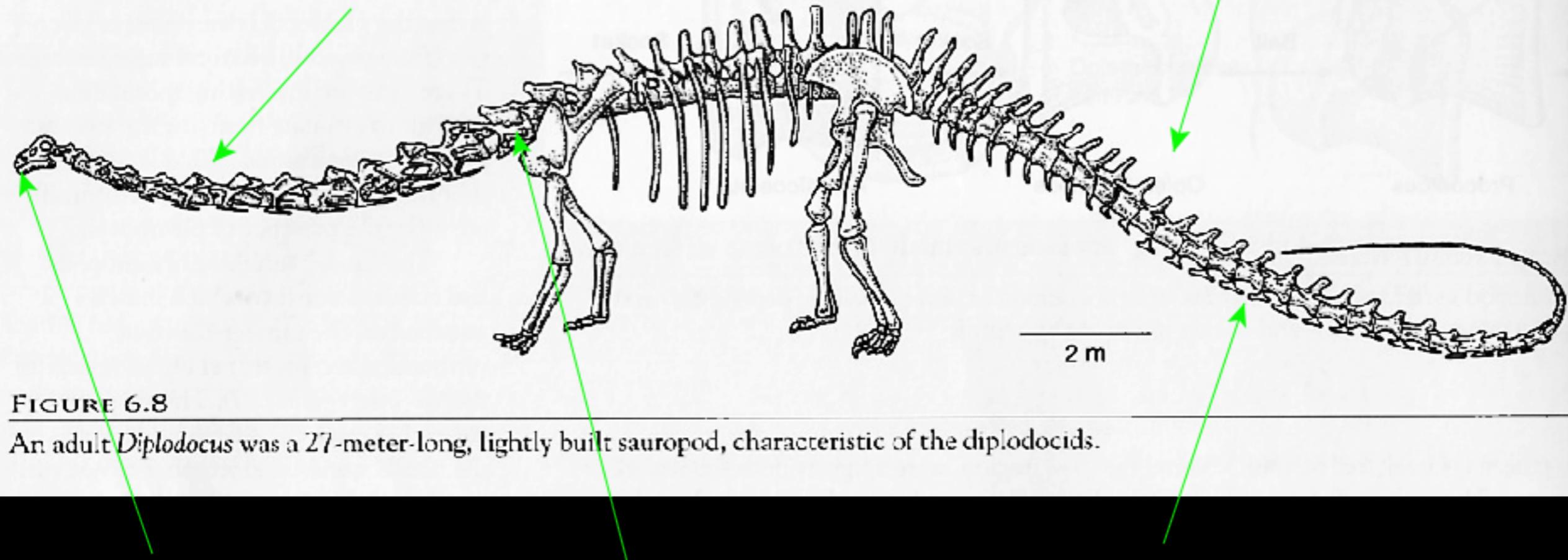


FIGURE 6.8

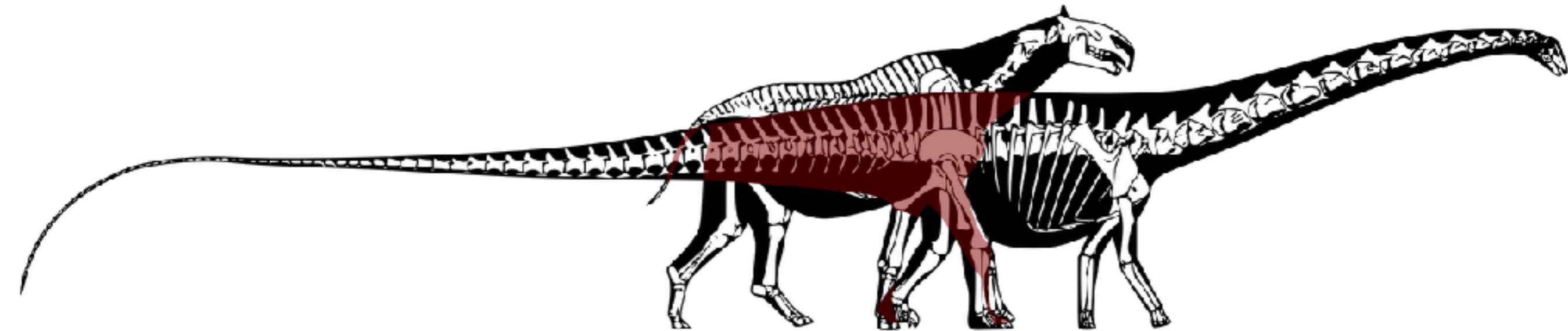
An adult *Diplodocus* was a 27-meter-long, lightly built sauropod, characteristic of the diplodocids.

Relatively long
skulls with peg-like
teeth

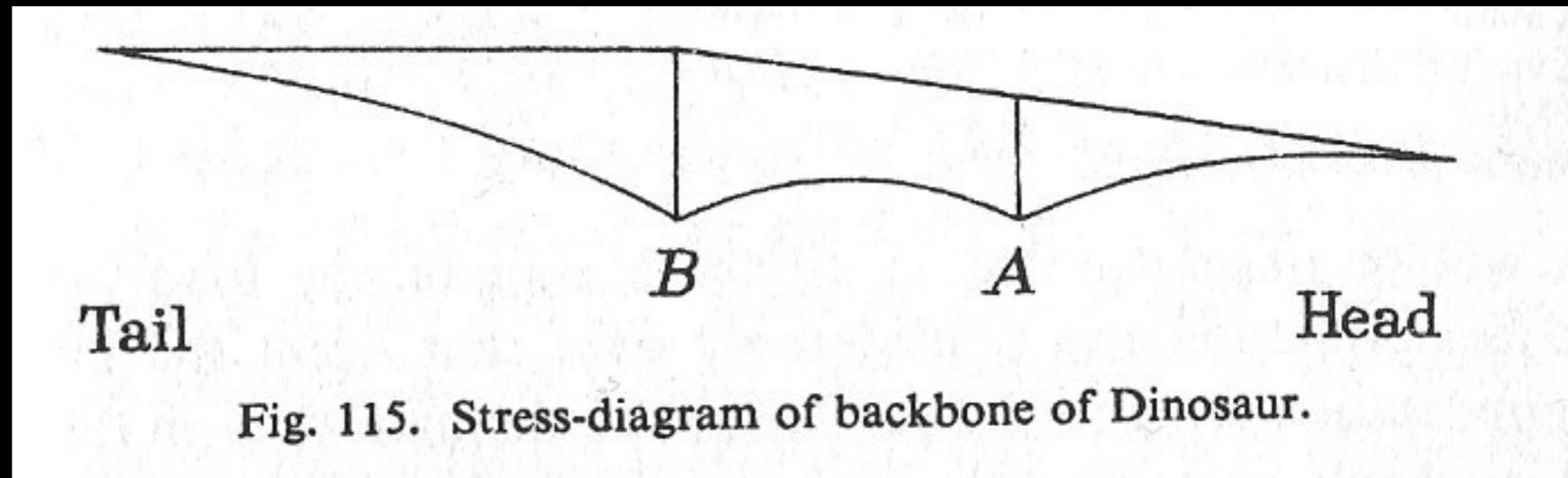
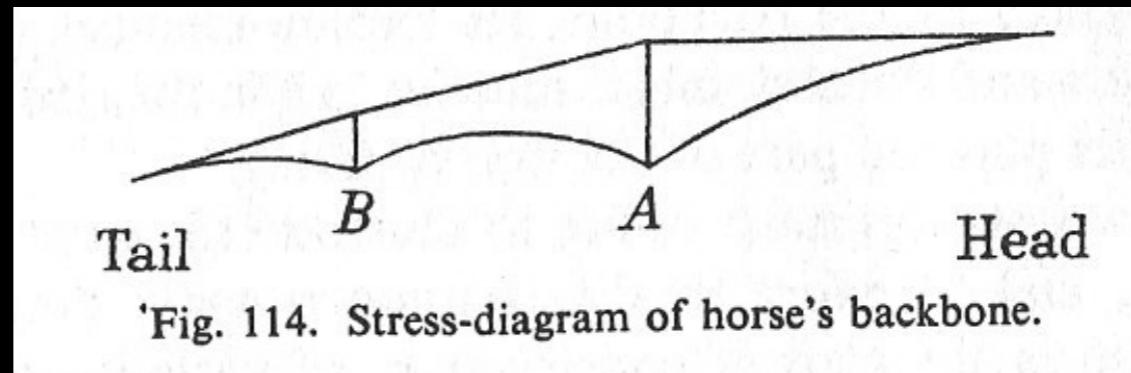
Neck joint
horizontally
oriented

Odd chevrons

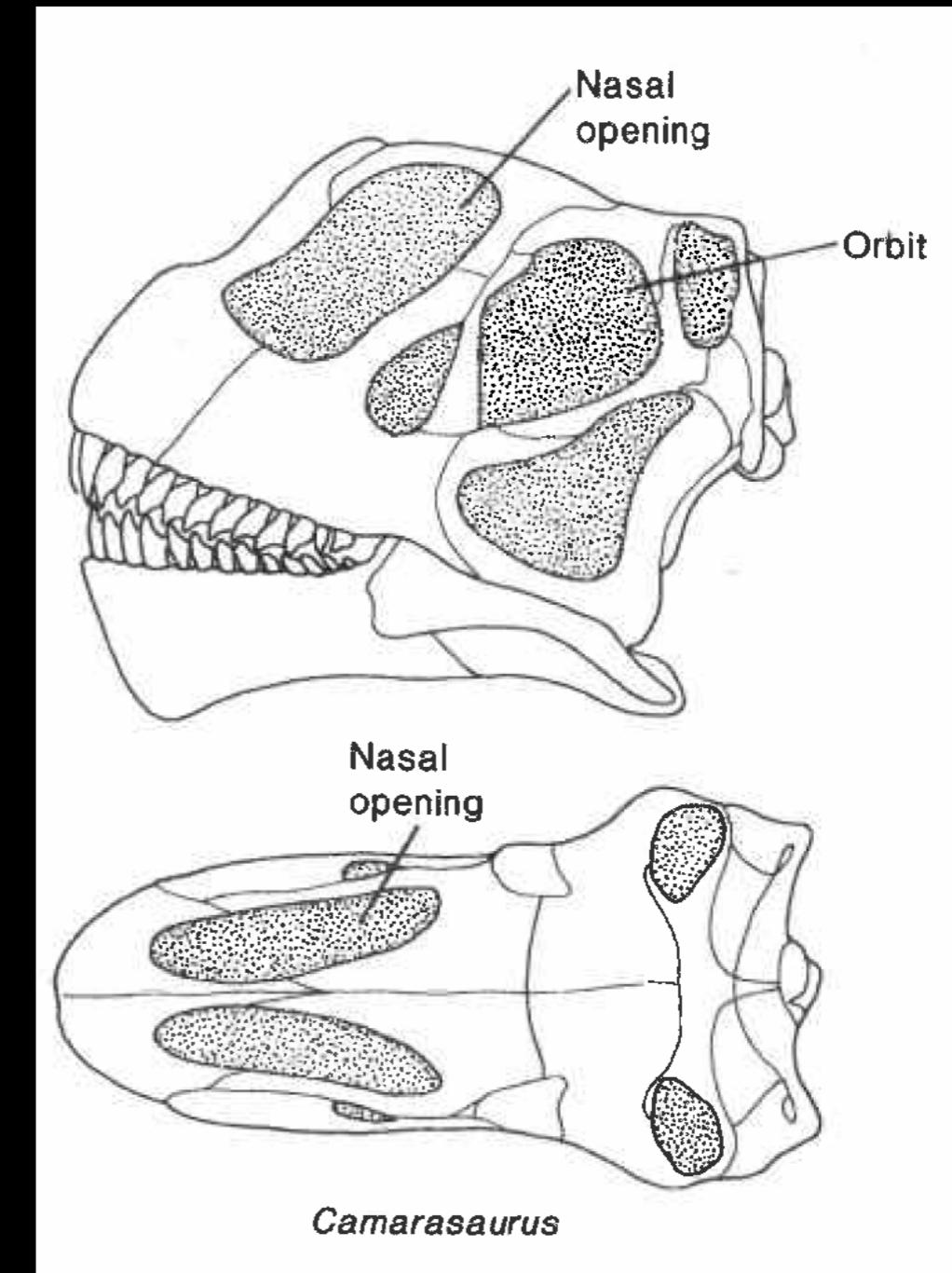
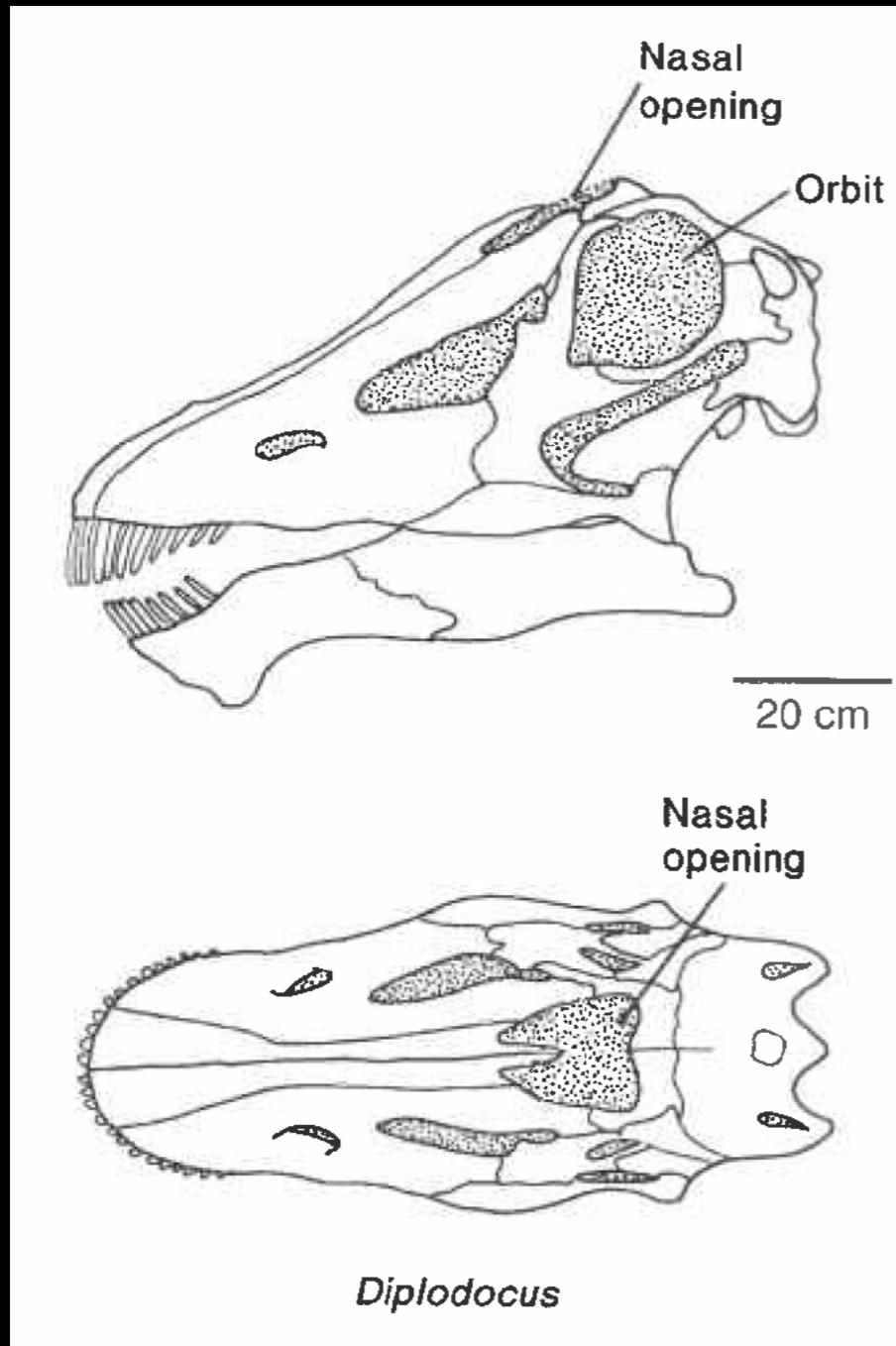
27 m = 90 ft; Blue whale length



Maximum stress
centered over
haunches

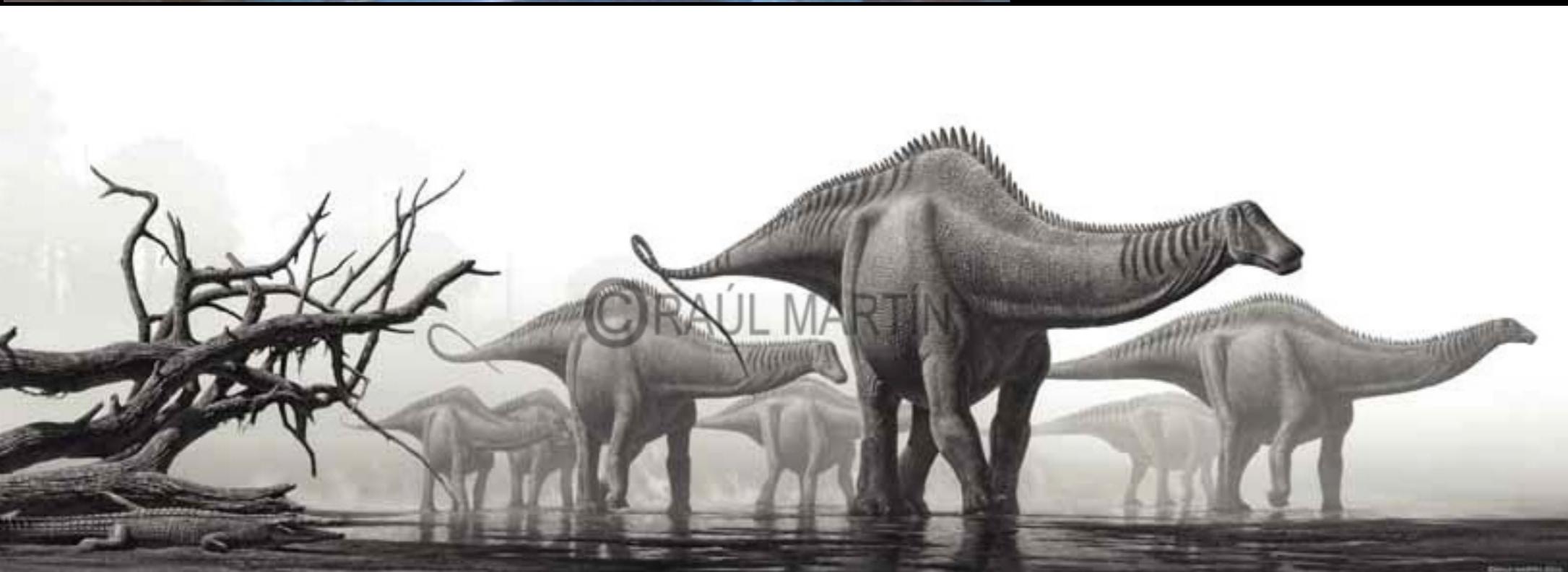


Diplodocids



Long sub-rectangular skulls
Fully retracted Nares (on roof of skull)

Diplodocids: *Apatosaurus*



Diplodocids: *Barosaurus*



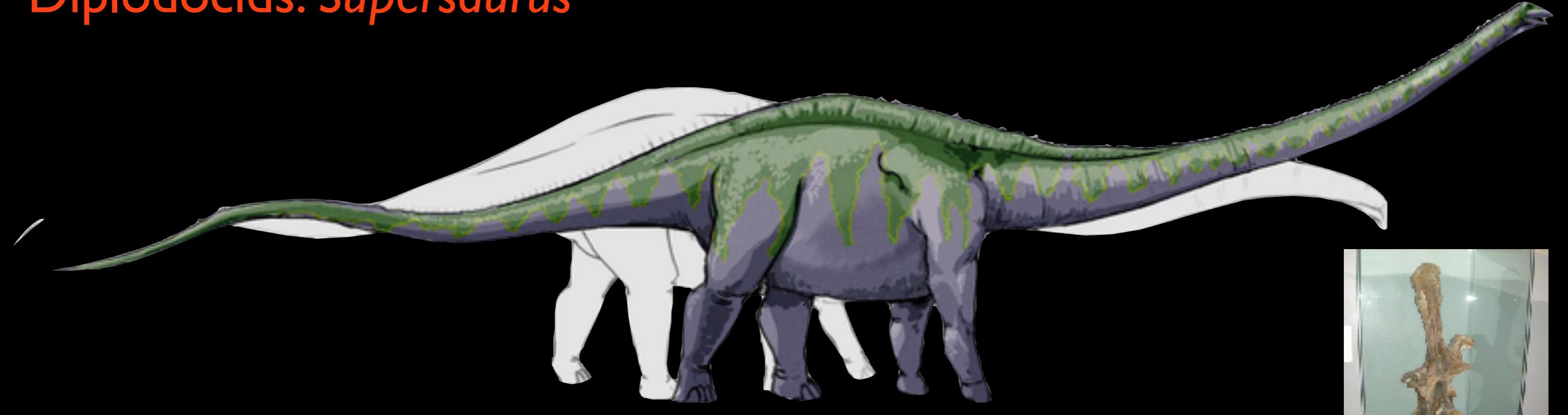
Late Jurassic

26 m (86 ft) long

Compared to Diplodocus, longer neck and shorter tail

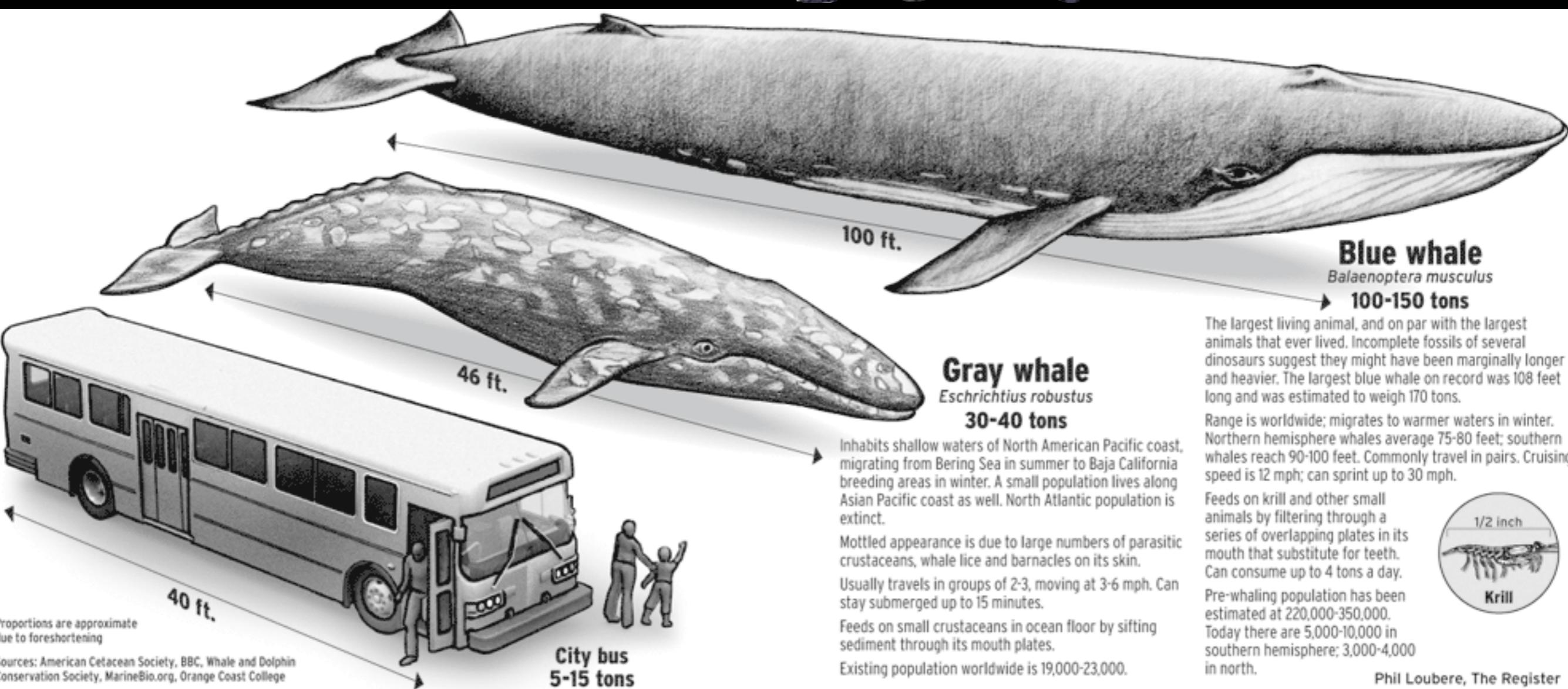
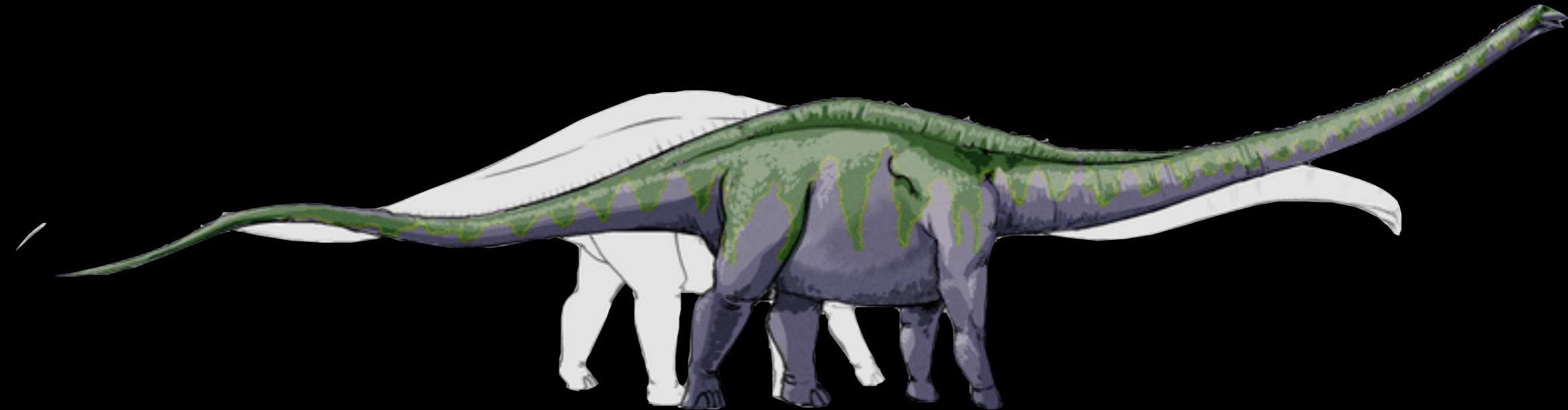


Diplodocids: *Supersaurus*

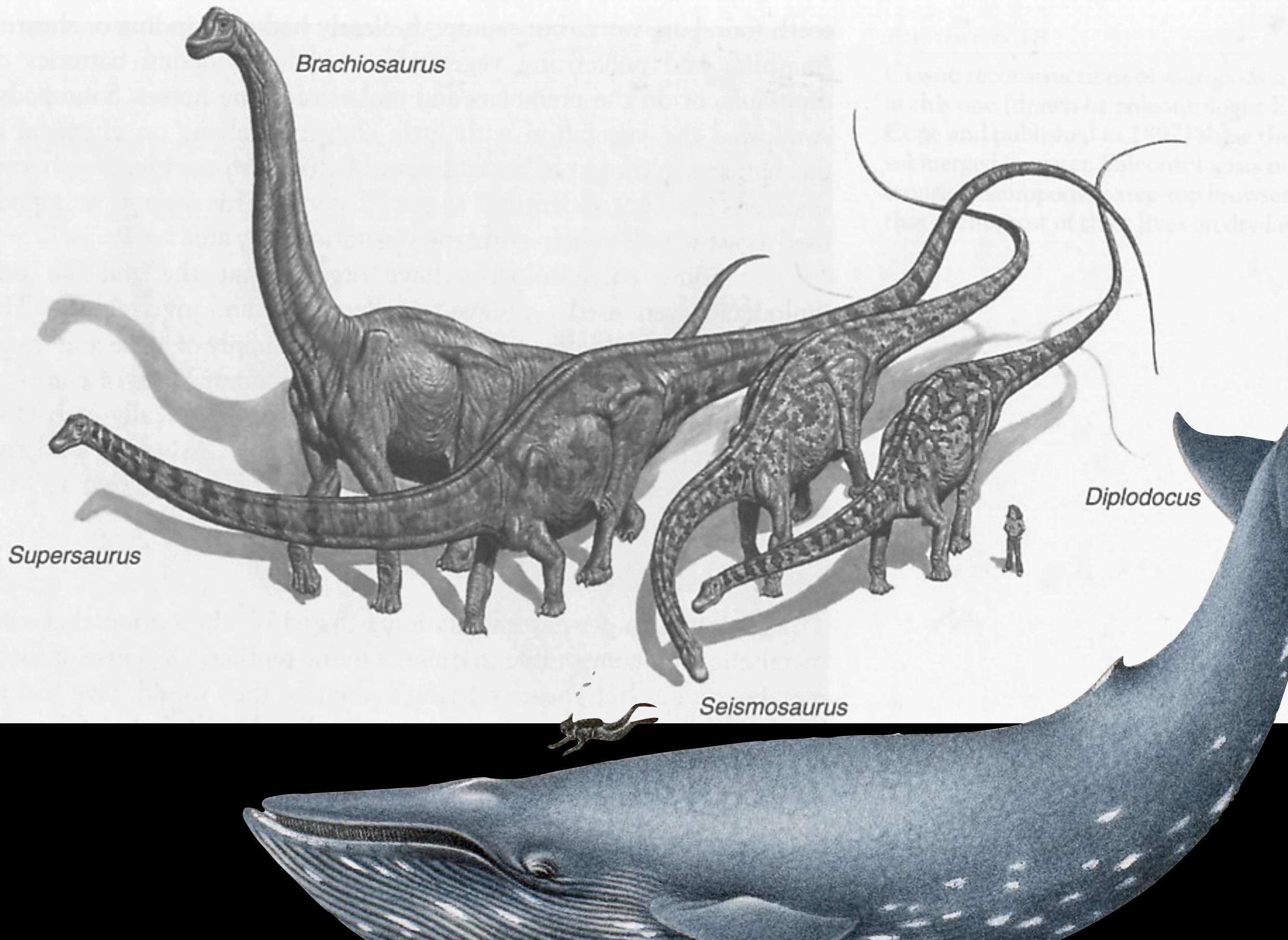


Late Jurassic
25-30 m (80-100 ft) long

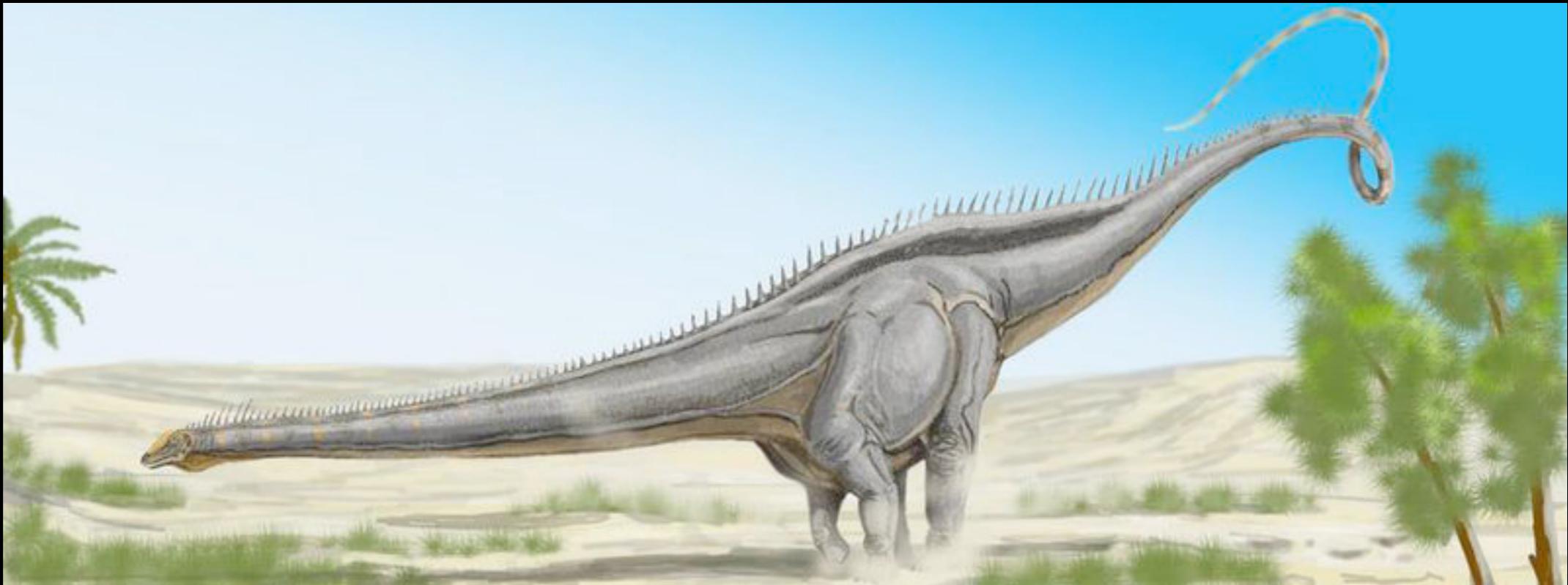




Phil Loubere, The Register



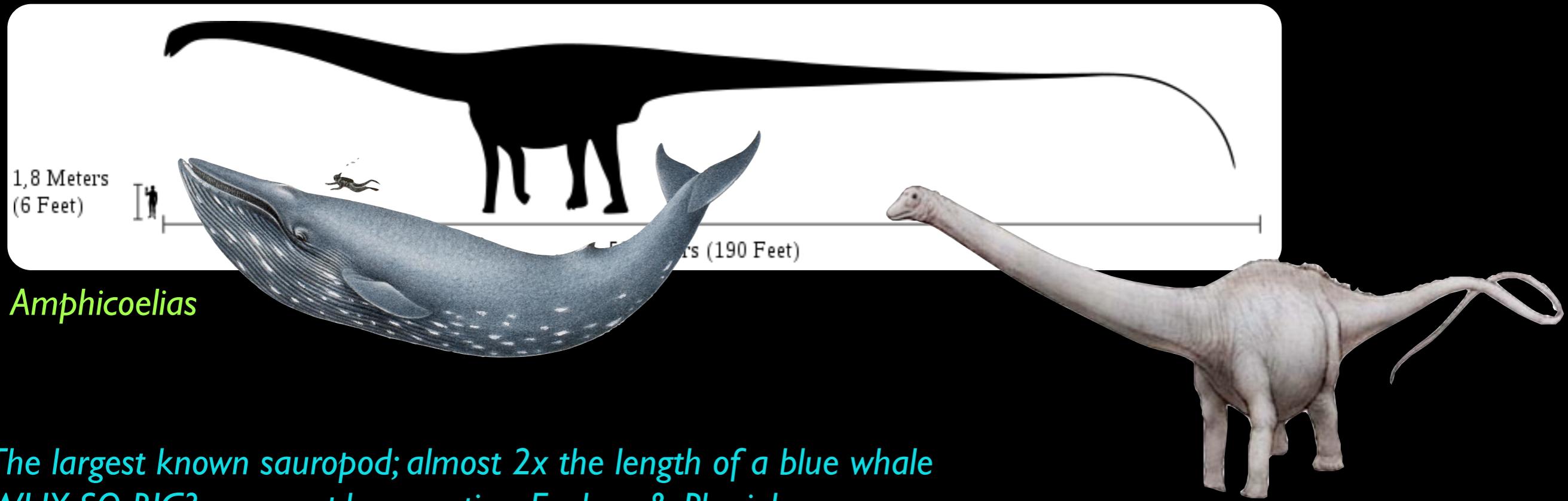
Diplodocids: *Diplodocus*



Late Jurassic
54 m (177 ft) long
*Compared to *Diplodocus*, longer neck and shorter tail*



*Double-beamed
chevrons*



The largest known sauropod; almost 2x the length of a blue whale
WHY SO BIG? ... a complex question. Ecology & Physiology

Sauropods attained large body size in the latest Triassic / early Jurassic...

i.e. quickly

Very large body size is found among Diplodocids, Titanosaurs,

Brachiosaurids

Benefits include

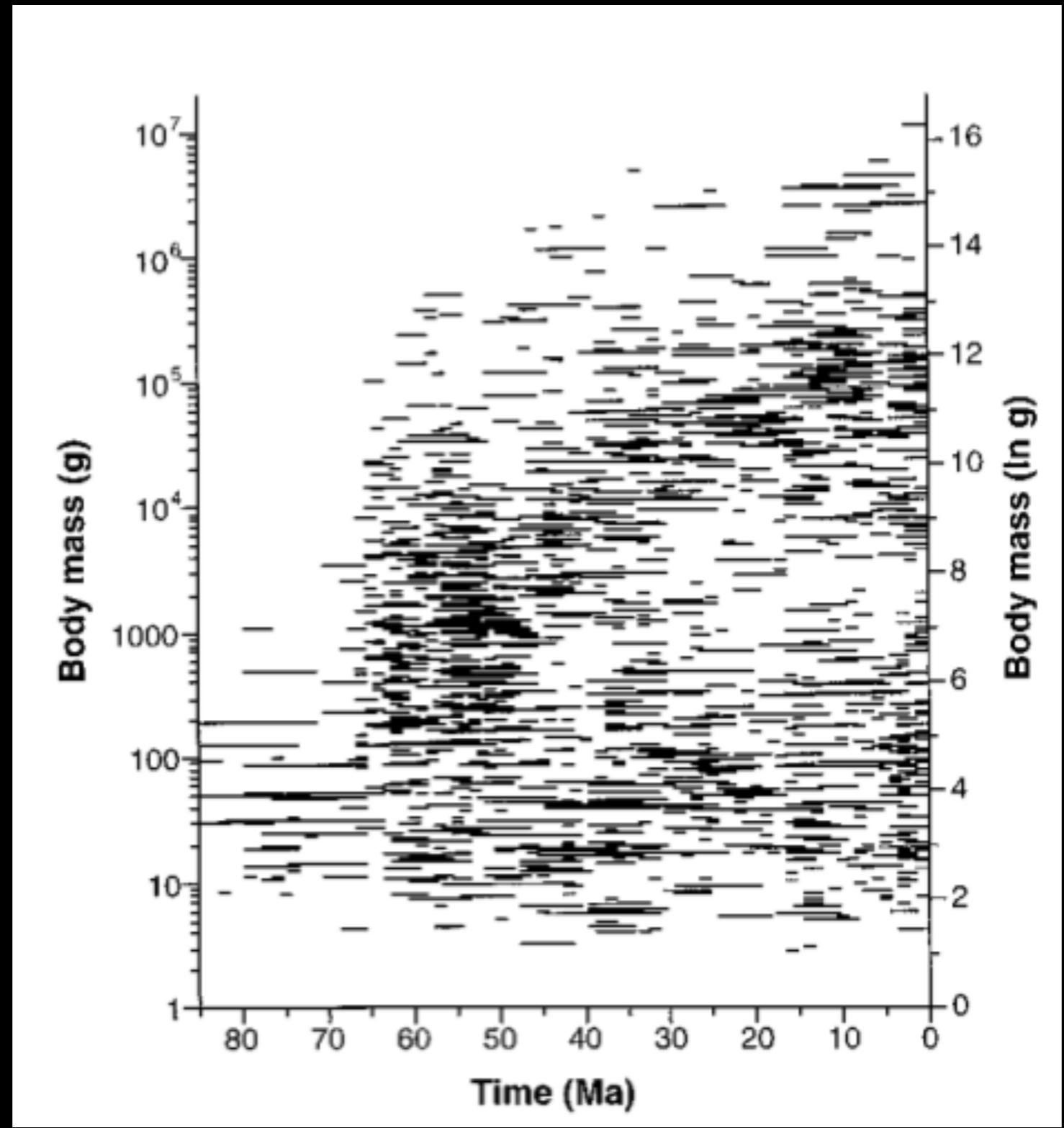
Obtain food that is out of reach for other animals

Greater ability to digest low-nutrient foods

Higher metabolic efficiency

Escape from predation

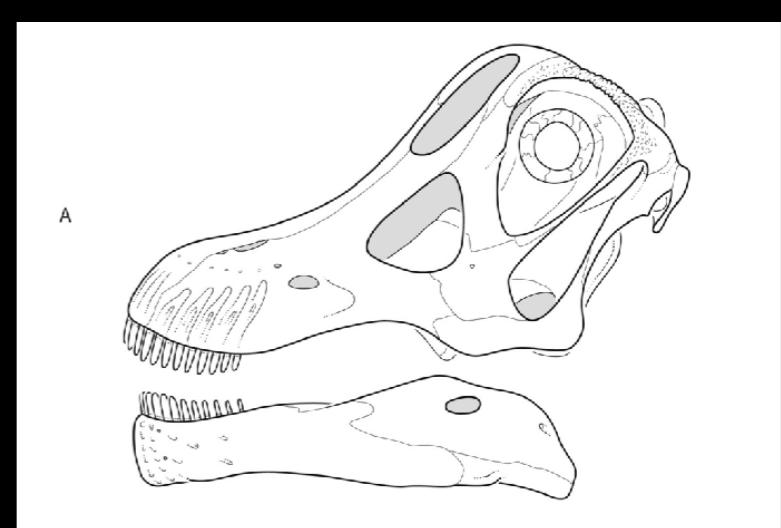
Cope's Rule: Animals tend to increase in body size over evolutionary time



Cope's Rule and the evolution of large body size
Advantages of large body size? Disadvantages?

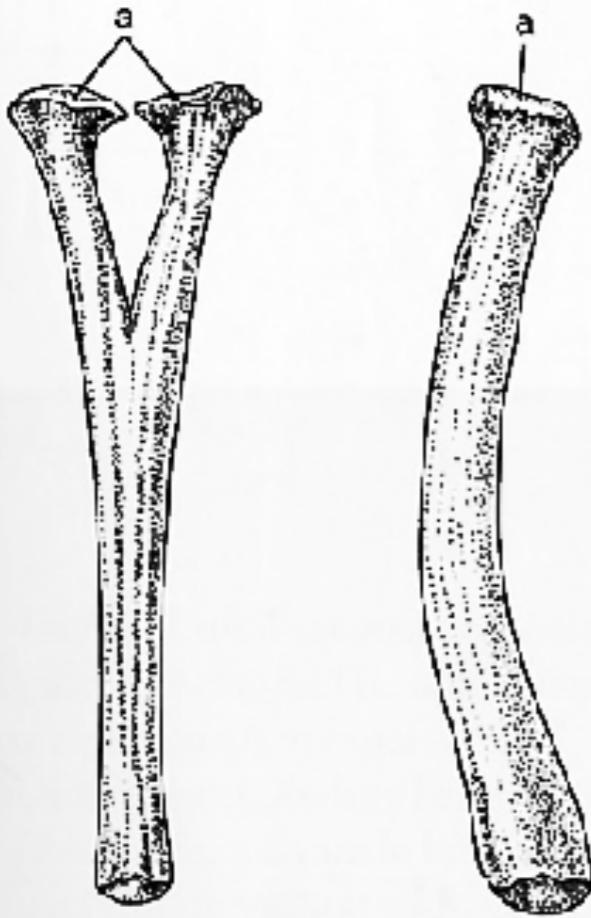


Diplodocid



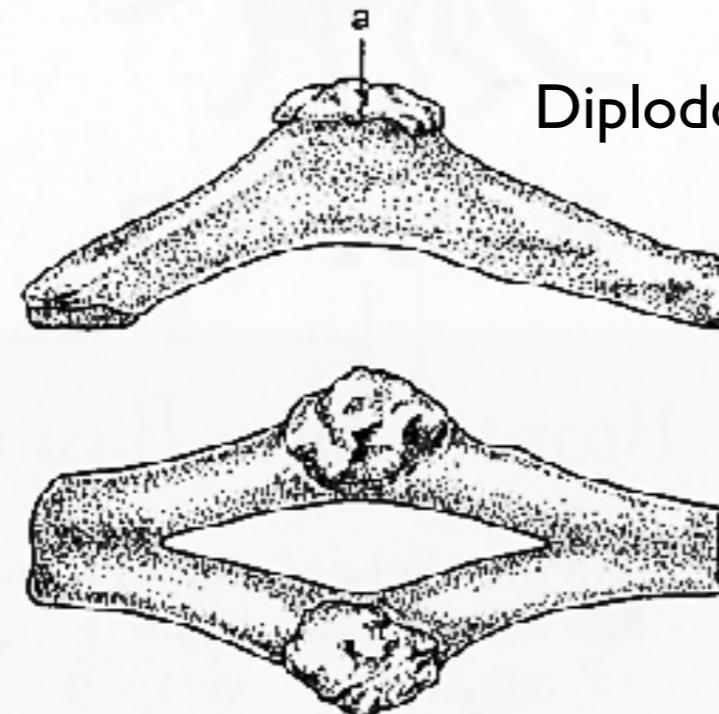
Titanosaur

Diplodocid Tails: strange chevrons...

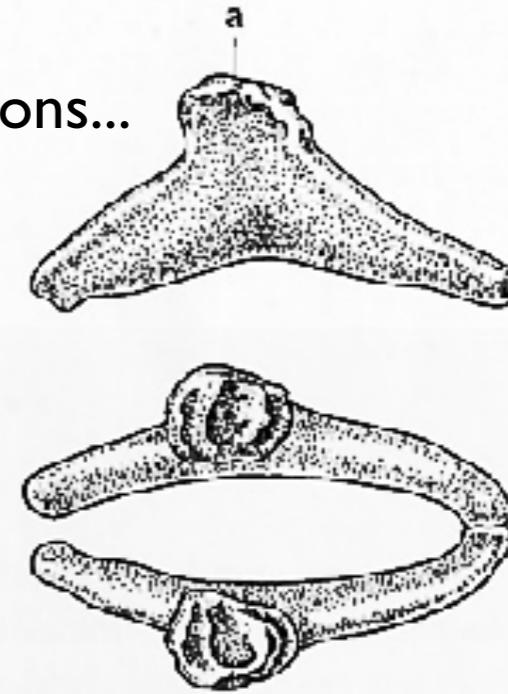


Camarasaurus
chevrons

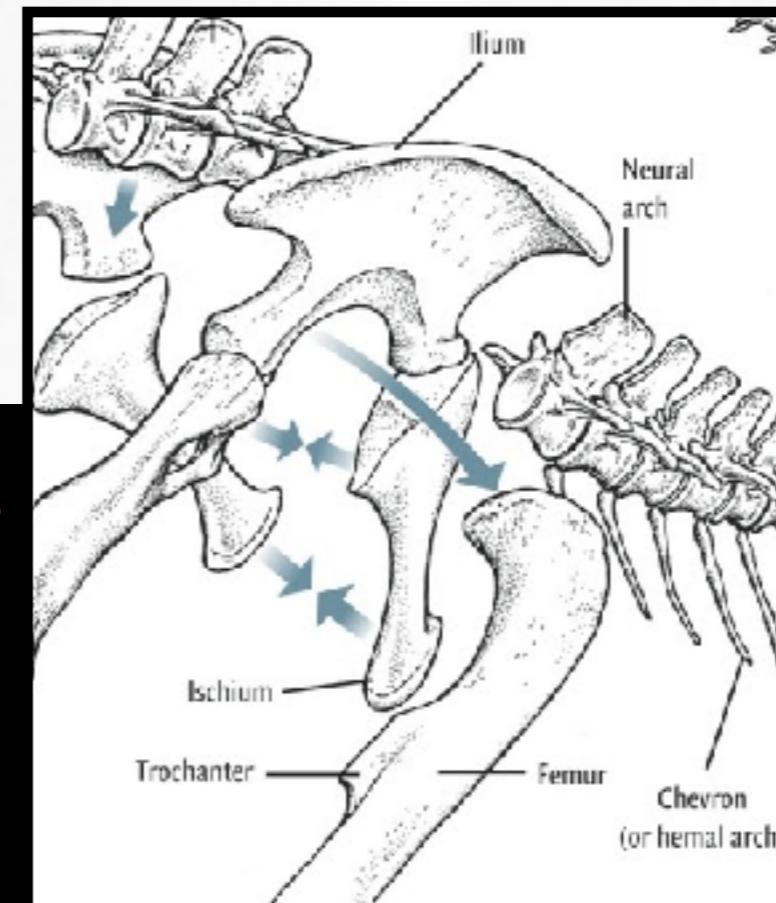
a = articular surface (where chevron connects
to the body of the vertebra)



Diplodocus chevrons...

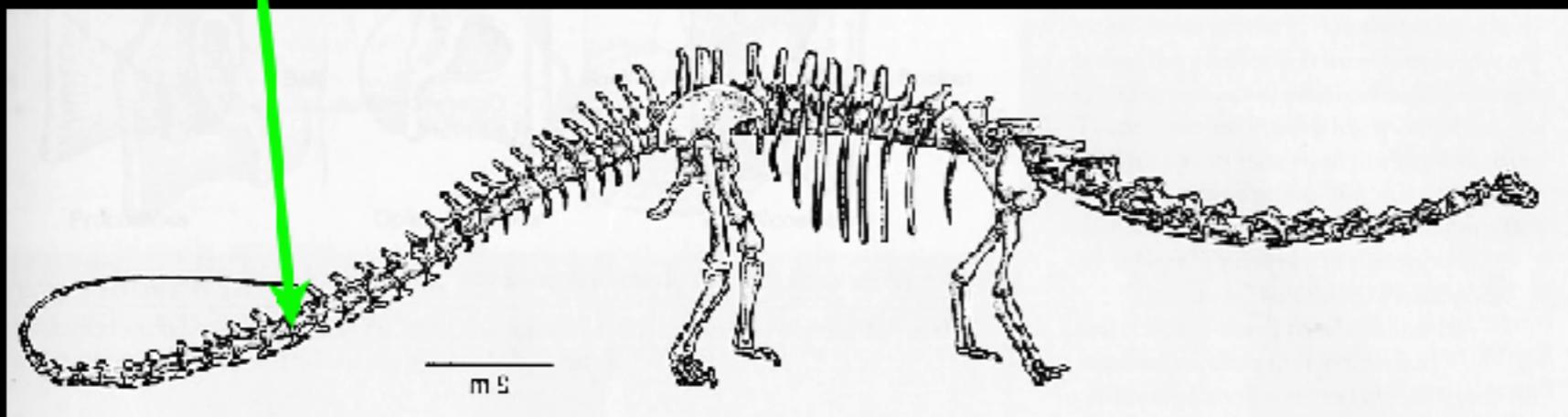


Recall...





An explanation
for odd mid-
caudal
chevrons?





Tail variations involve and increase in tail vertebrae from 44 - 80 (Apatosaurus & Diplodocus)

Why?

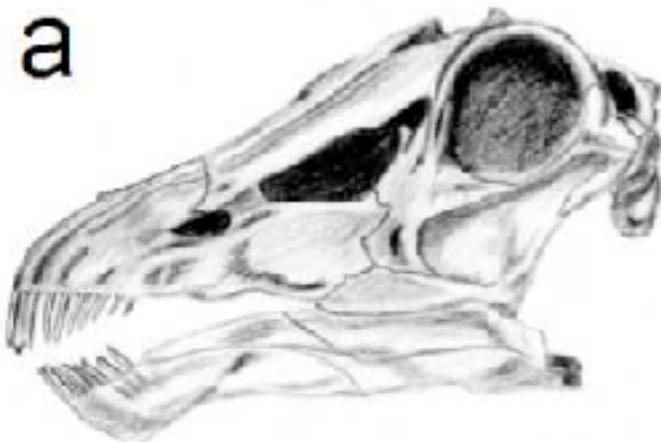


Accessories



Accessories

a



b



Classical rendering

c

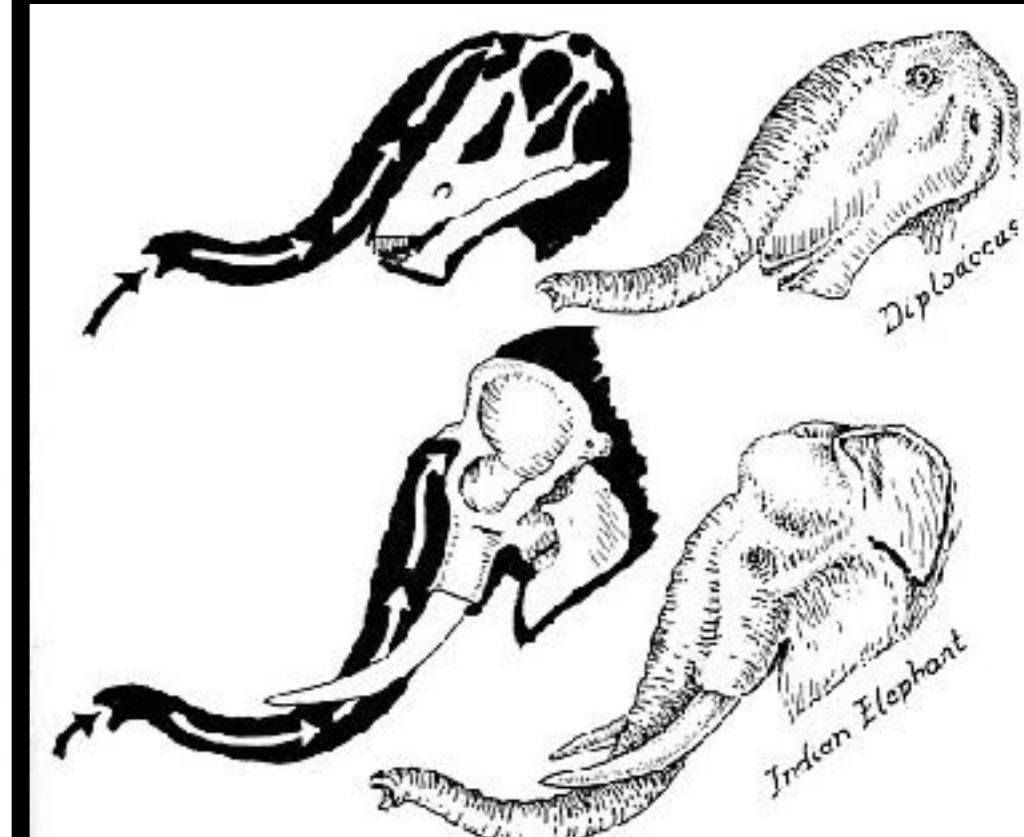


Hypothesized trunk

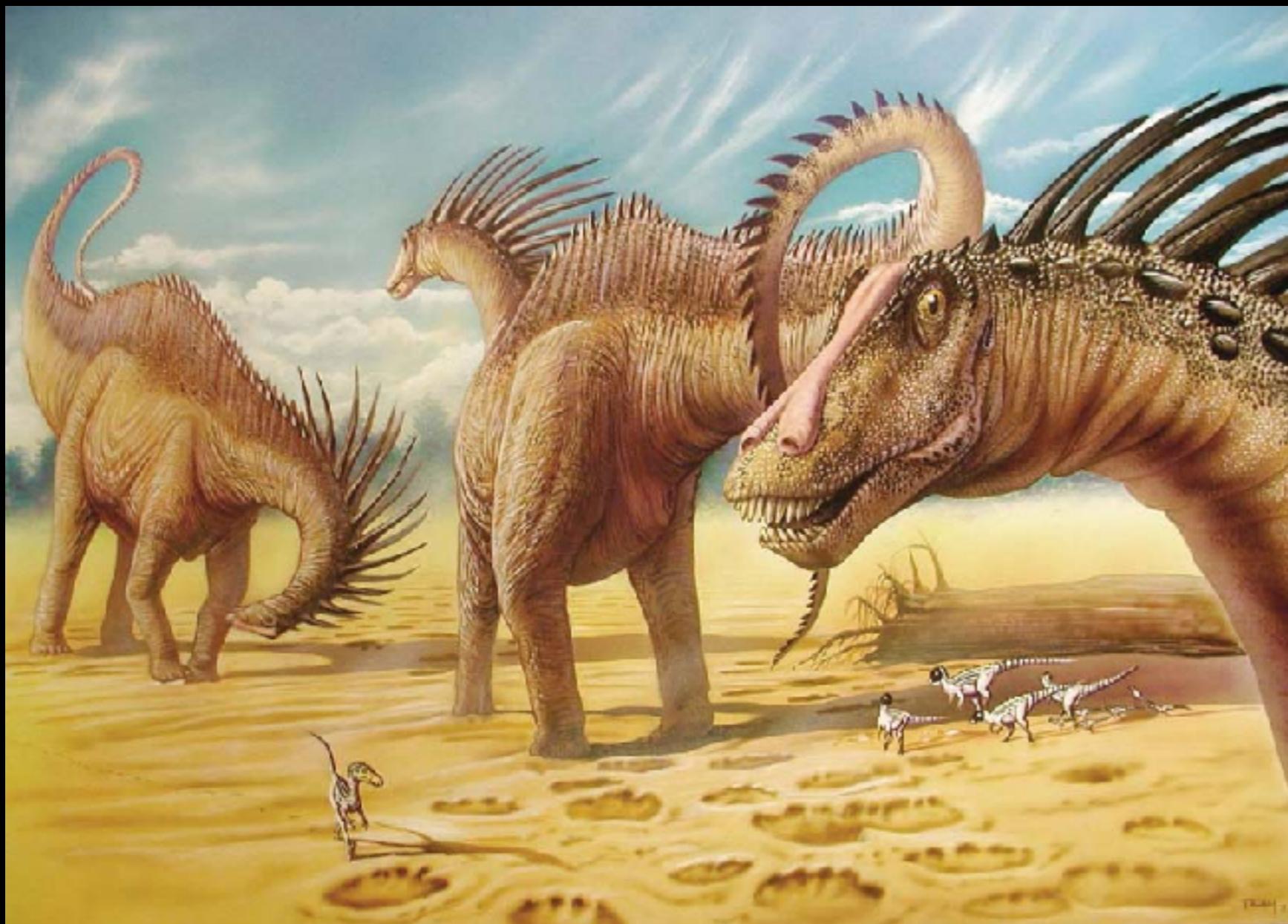
d



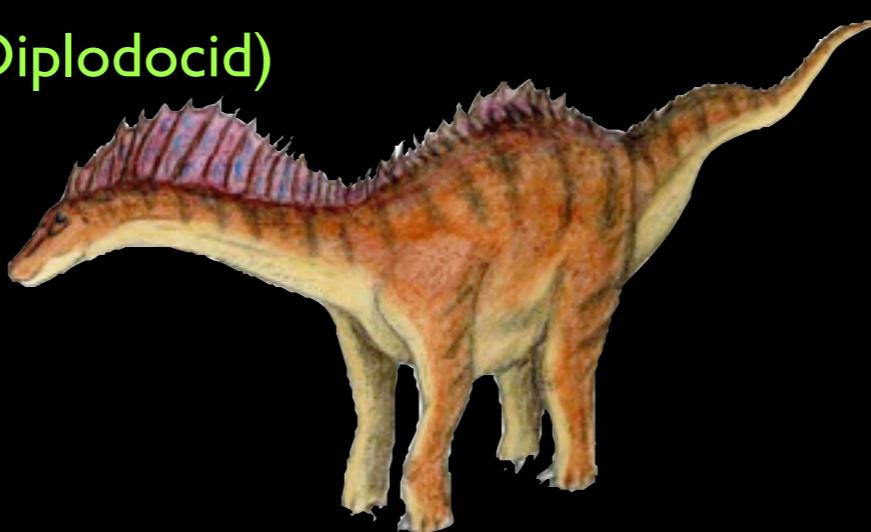
Modern depiction w/ resonating chamber



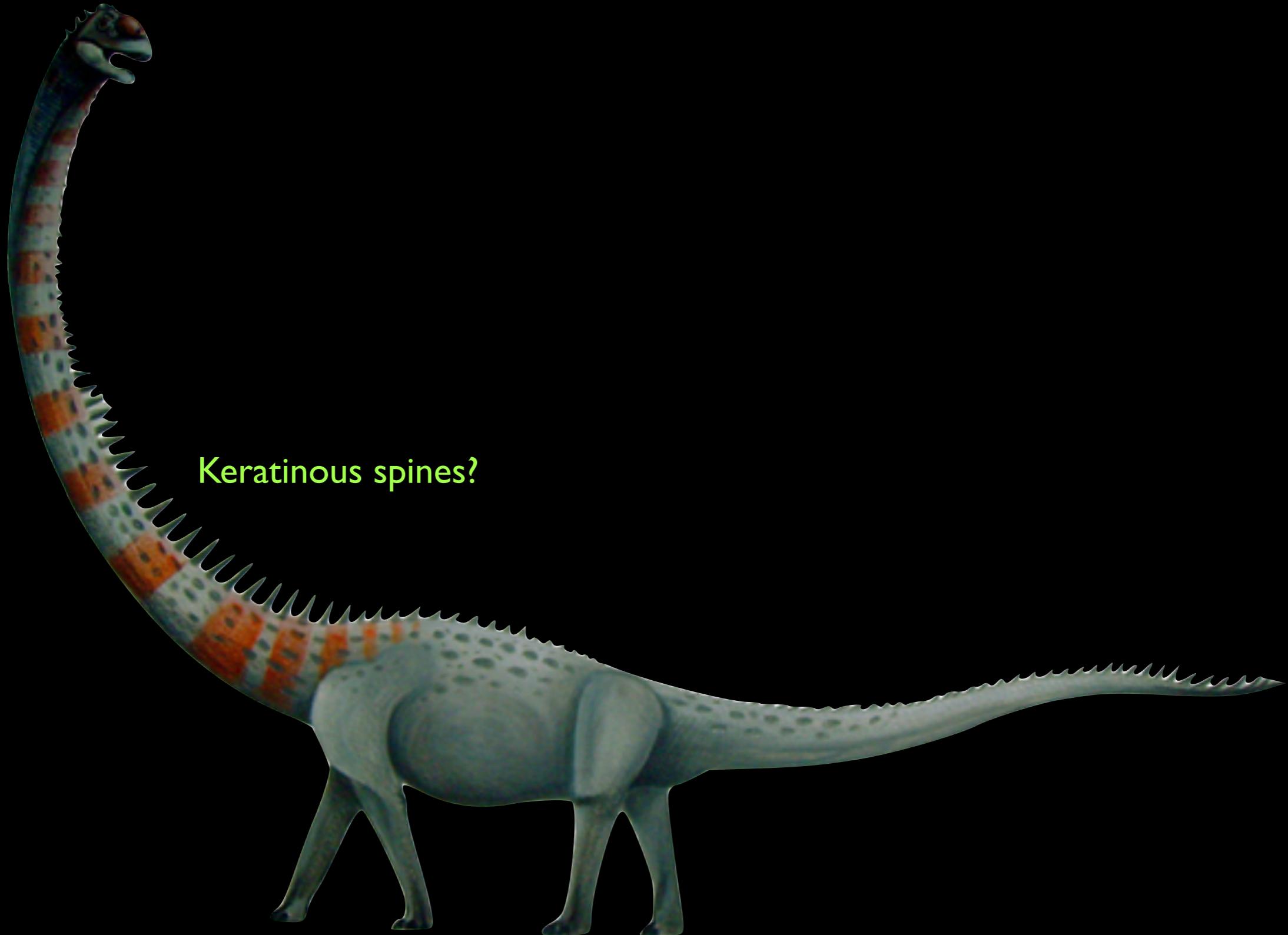
Accessories



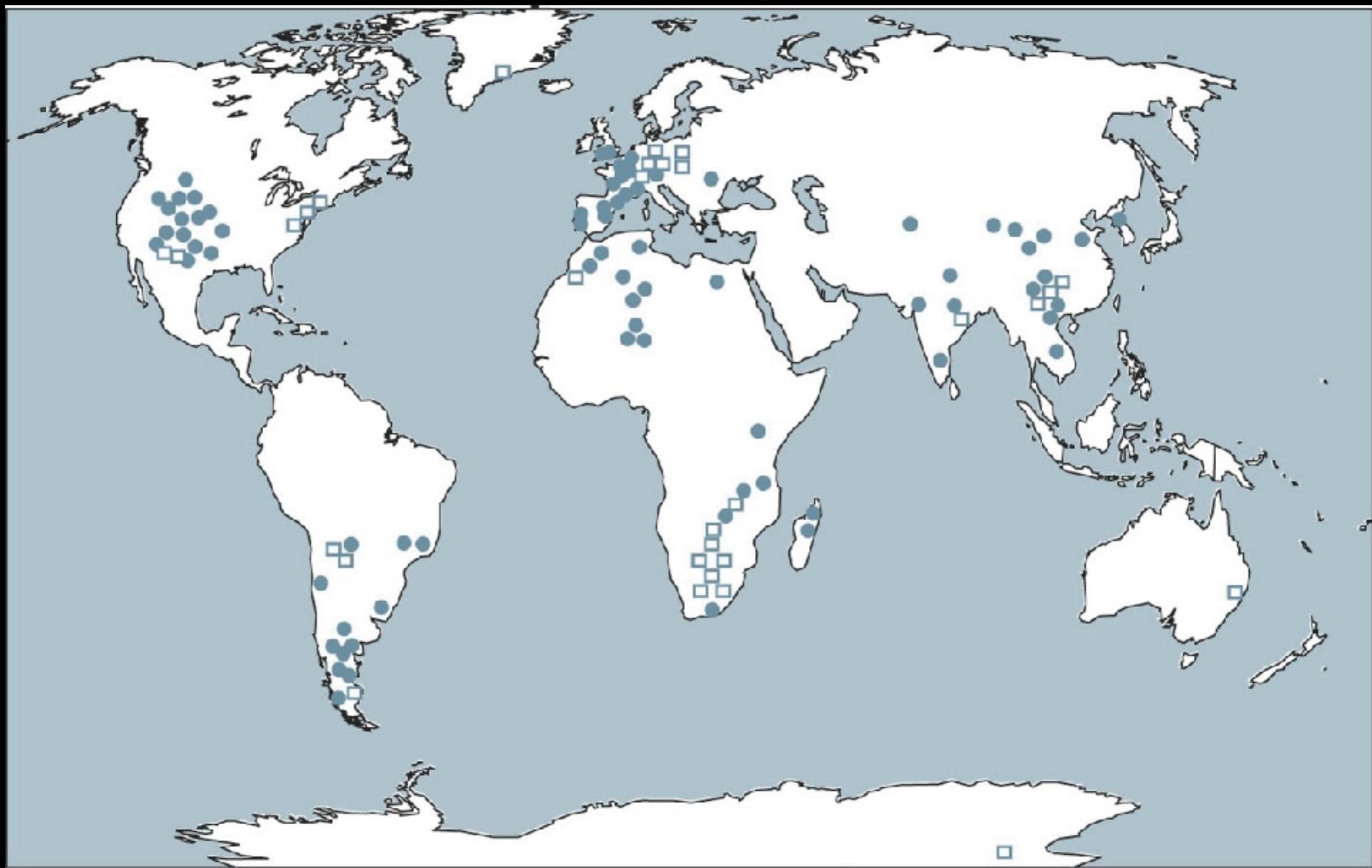
Vertebral spines: Amargasaurus (Diplodocid)



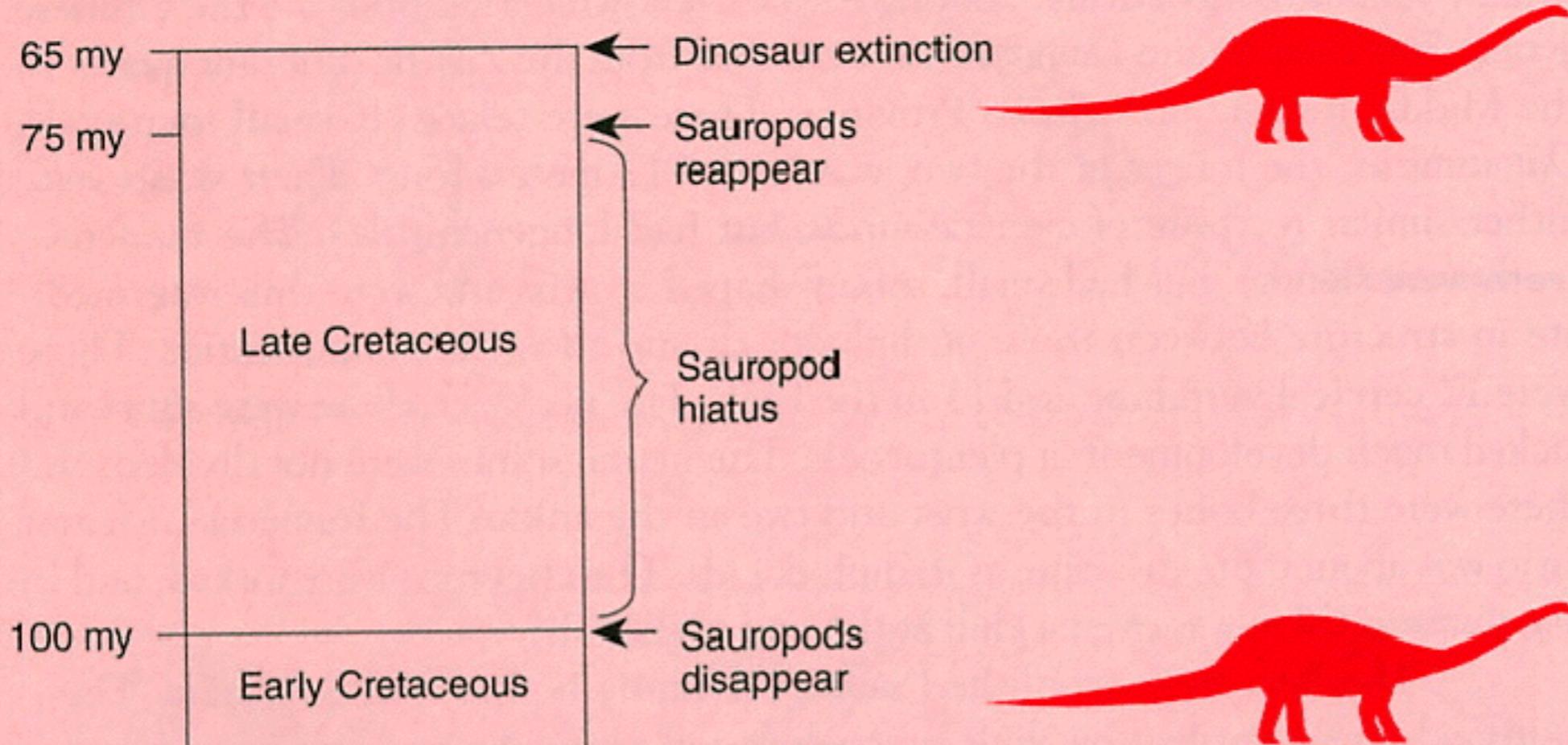
Accessories



Sauropod Lifestyles



The Sauropod Hiatus



BOX FIGURE 6.3

The sauropod hiatus lasted 25 million years.

"The start of the sauropod hiatus is interpreted as the result of a genuine continent-wide extinction, coincident with the appearance of (and perhaps attributable to competition with) advanced ornithischian herbivores, decrease in habitat due to the incursion of the Western Interior Seaway, or both."

Apatosaurus



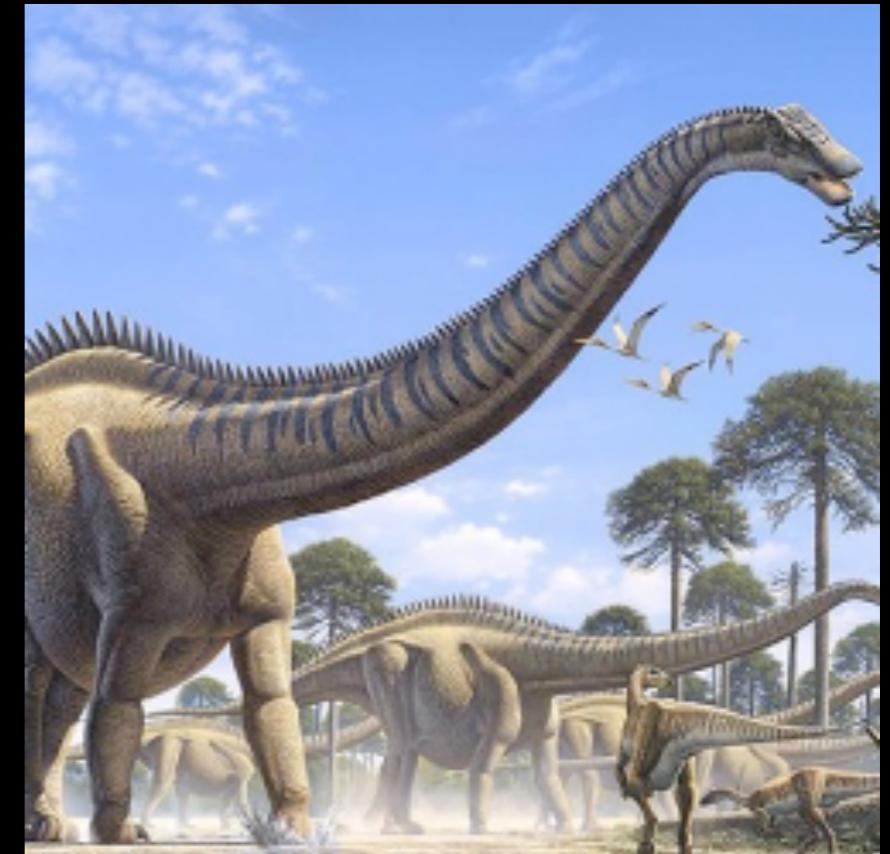


Illustration by Jon Taylor

Hherding?



Shunosaurus
Diplodocus
Camarasaurus



Ecosystem Engineers



Tsavo 1898

- elephants



+ woodlands



Rinderpest

- grazers

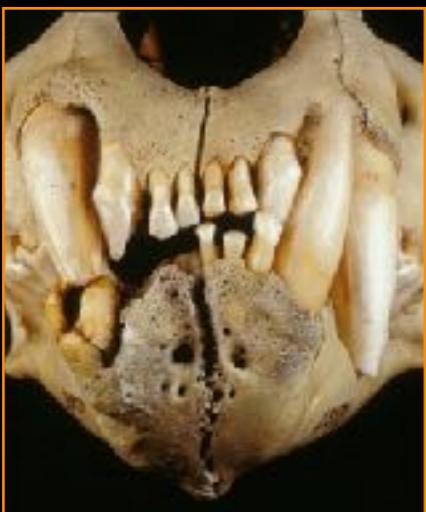


=
hungry lions

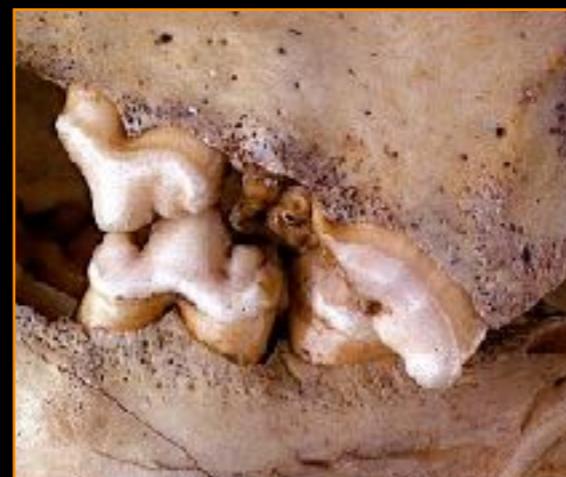
+ droughts



↓
novel
prey?



1st man-eater
FMNH 23970



2nd man-eater
FMNH 23969

Along the Tsavo Railroad: From Slave Trade to Ivory



Less Elephant poaching

Tsavo: 1970



More Elephant poaching

Tsavo: 1994



Tsavo, 1898



