Slender Giants

The unique and bizarre morphology of brachiosaurid sauropods

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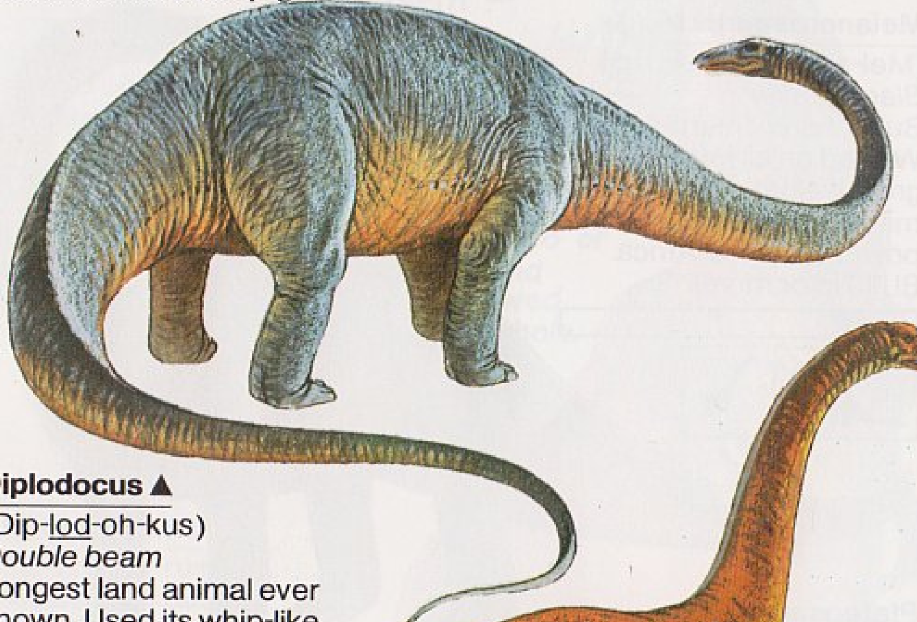
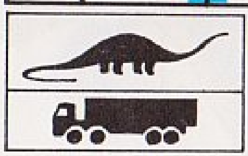
Sauropods

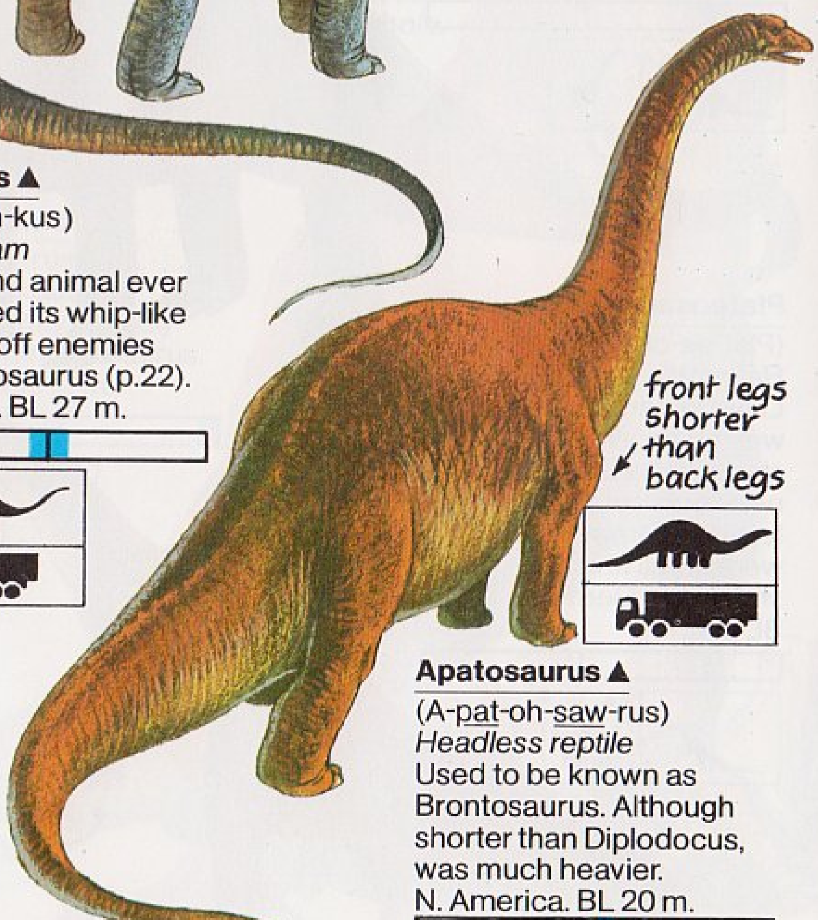
Sauropods lived in Jurassic and Cretaceous times. They had huge bodies, long necks and even longer tails. They could feed only on soft plants as their teeth were weak and peg-like.



Diplodocus ▲

(Dip-lod-oh-kus)
Double beam
Longest land animal ever known. Used its whip-like tail to fend off enemies such as Allosaurus (p.22). N. America. BL 27 m.



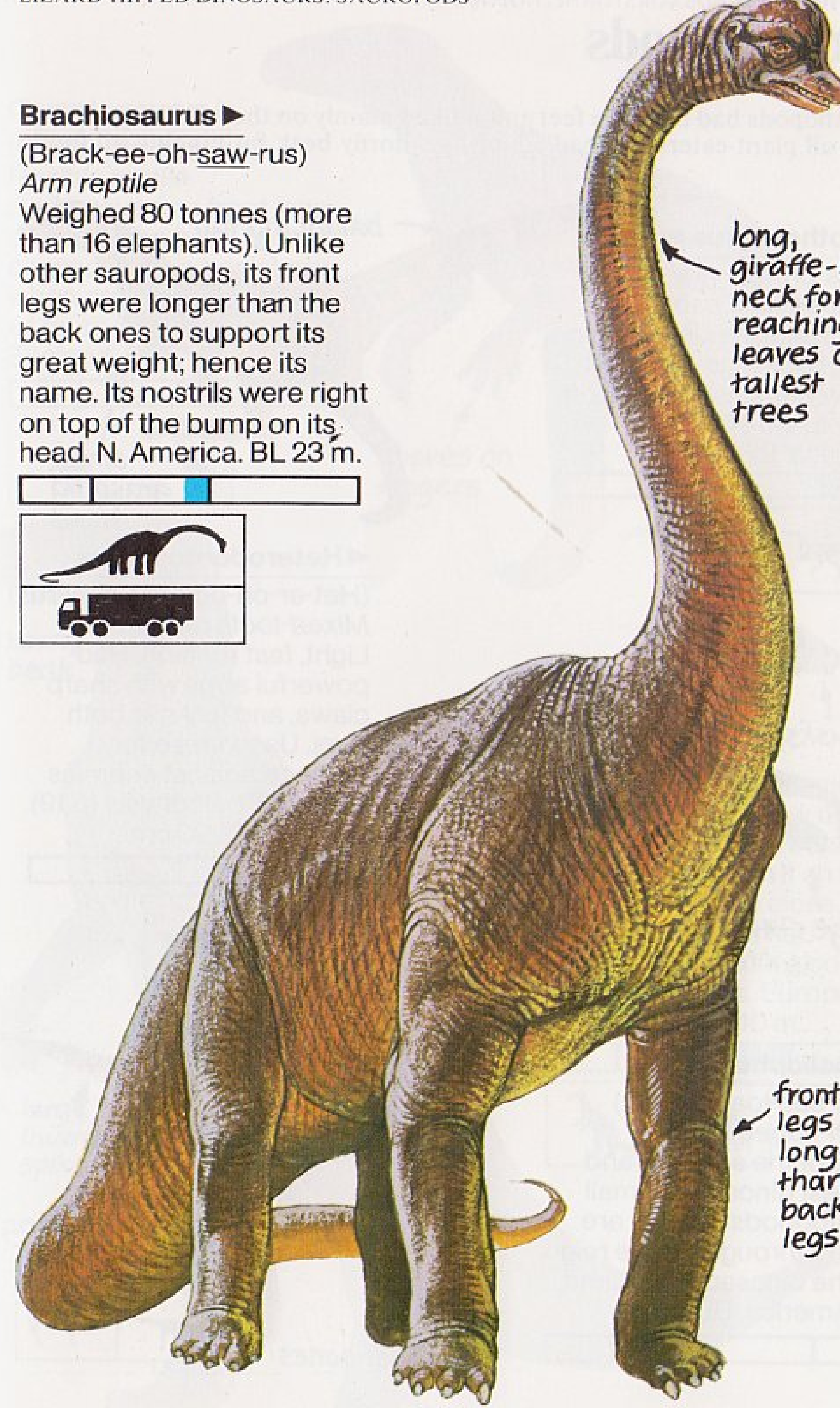


Apatosaurus ▲

(A-pat-oh-saw-rus)
Headless reptile
Used to be known as Brontosaurus. Although shorter than Diplodocus, was much heavier. N. America. BL 20 m.

Brachiosaurus ▶

(Brack-ee-oh-saw-rus)
Arm reptile
Weighed 80 tonnes (more than 16 elephants). Unlike other sauropods, its front legs were longer than the back ones to support its great weight; hence its name. Its nostrils were right on top of the bump on its head. N. America. BL 23 m.



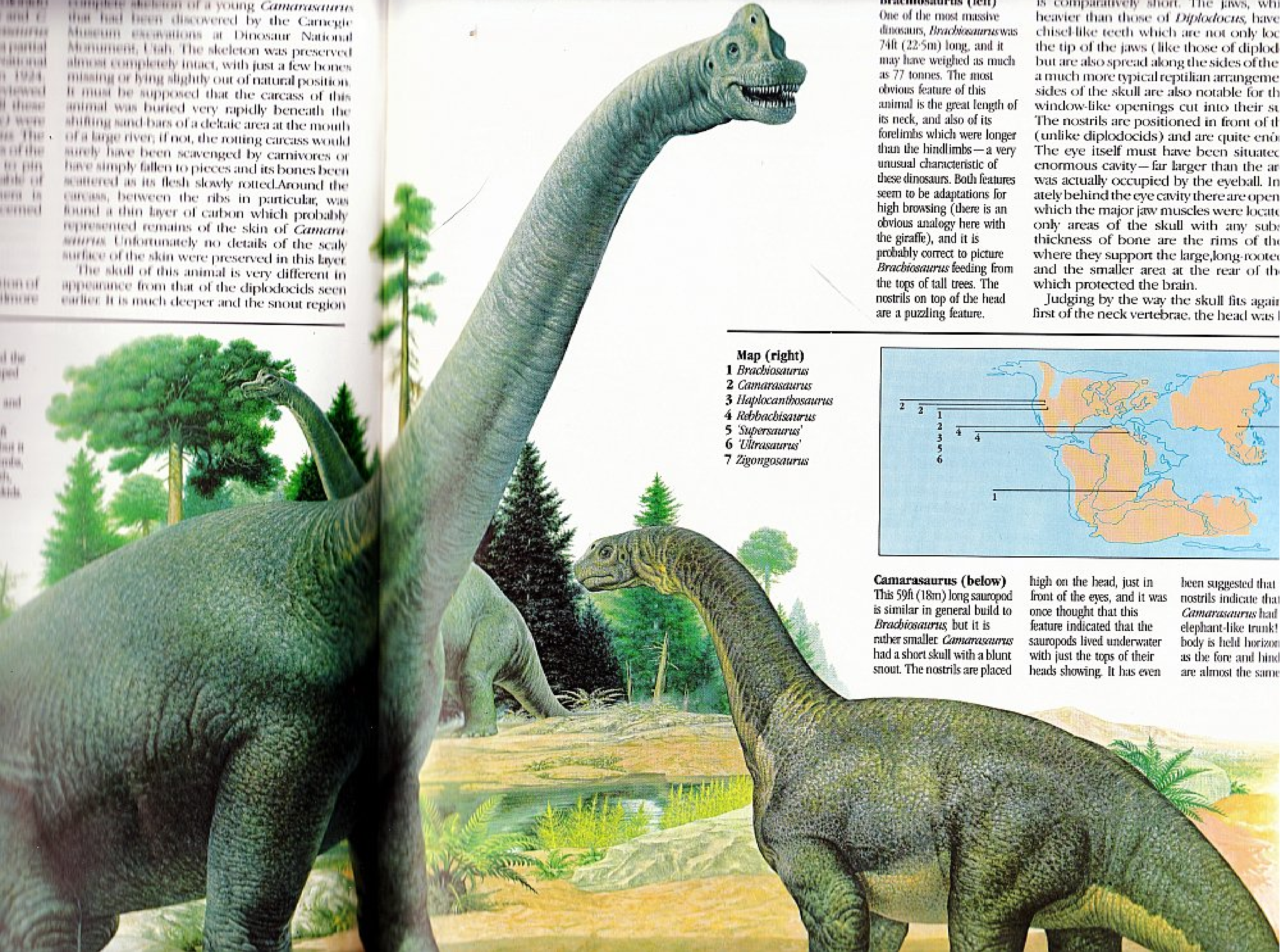
complete skeleton of a young *Camarasaurus* that had been discovered by the Carnegie Museum excavations at Dinosaur National Monument, Utah. The skeleton was preserved almost completely intact, with just a few bones missing or lying slightly out of natural position. It must be supposed that the carcass of this animal was buried very rapidly beneath the shifting sand-bars of a deltaic area at the mouth of a large river; if not, the rotting carcass would surely have been scavenged by carnivores or have simply fallen to pieces and its bones been scattered as its flesh slowly rotted. Around the carcass, between the ribs in particular, was found a thin layer of carbon which probably represented remains of the skin of *Camarasaurus*. Unfortunately no details of the scaly surface of the skin were preserved in this layer.

The skull of this animal is very different in appearance from that of the diplodocids seen earlier. It is much deeper and the snout region is comparatively short. The jaws, whi[ch are] heavier than those of *Diplodocus*, have chisel-like teeth which are not only loc[ated at] the tip of the jaws (like those of diplod[ocids]) but are also spread along the sides of the [jaws in] a much more typical reptilian arrangeme[nt. The] sides of the skull are also notable for th[e] window-like openings cut into their su[rface.] The nostrils are positioned in front of th[e eyes] (unlike diplodocids) and are quite eno[rmous.] The eye itself must have been situated [in an] enormous cavity—far larger than the ar[ea that] was actually occupied by the eyeball. Im[medi]ately behind the eye cavity there are open[ings in] which the major jaw muscles were locate[d. The] only areas of the skull with any subs[tantial] thickness of bone are the rims of the [jaws] where they support the large, long-rooted [teeth,] and the smaller area at the rear of th[e skull] which protected the brain.

Judging by the way the skull fits again[st the] first of the neck vertebrae, the head was [...]

Brachiosaurus (left)
One of the most massive dinosaurs, *Brachiosaurus* was 74ft (22·5m) long, and it may have weighed as much as 77 tonnes. The most obvious feature of this animal is the great length of its neck, and also of its forelimbs which were longer than the hindlimbs—a very unusual characteristic of these dinosaurs. Both features seem to be adaptations for high browsing (there is an obvious analogy here with the giraffe), and it is probably correct to picture *Brachiosaurus* feeding from the tops of tall trees. The nostrils on top of the head are a puzzling feature.

Map (right)
1 *Brachiosaurus*
2 *Camarasaurus*
3 *Haplocanthosaurus*
4 *Rebbachisaurus*
5 *'Supersaurus'*
6 *'Ultrasaurus'*
7 *Zigongosaurus*



Camarasaurus (below)
This 59ft (18m) long sauropod is similar in general build to *Brachiosaurus*, but it is rather smaller. *Camarasaurus* had a short skull with a blunt snout. The nostrils are placed high on the head, just in front of the eyes, and it was once thought that this feature indicated that the sauropods lived underwater with just the tops of their heads showing. It has even been suggested that [the] nostrils indicate that *Camarasaurus* had [an] elephant-like trunk! [The] body is held horizon[tal] as the fore and hind[limbs] are almost the same [...]

ll-preserved the material l factors relating to the of life of sauropods will

('posterior cavity tail') is uropod from Mongolia. on of *Opisthocoelicaudia* 1965 during a Polish- to the Gobi Desert. The d evidently been buried disintegrate; however the neck was recovered lena Borsuk-Bialynicka,

accordance with the

predator not *Vulcanodon.*

like that c in its gen vertebrae and the c spines to (ligament dividual s have swo which ind powerful l shape and resemble are fused

Family Tre

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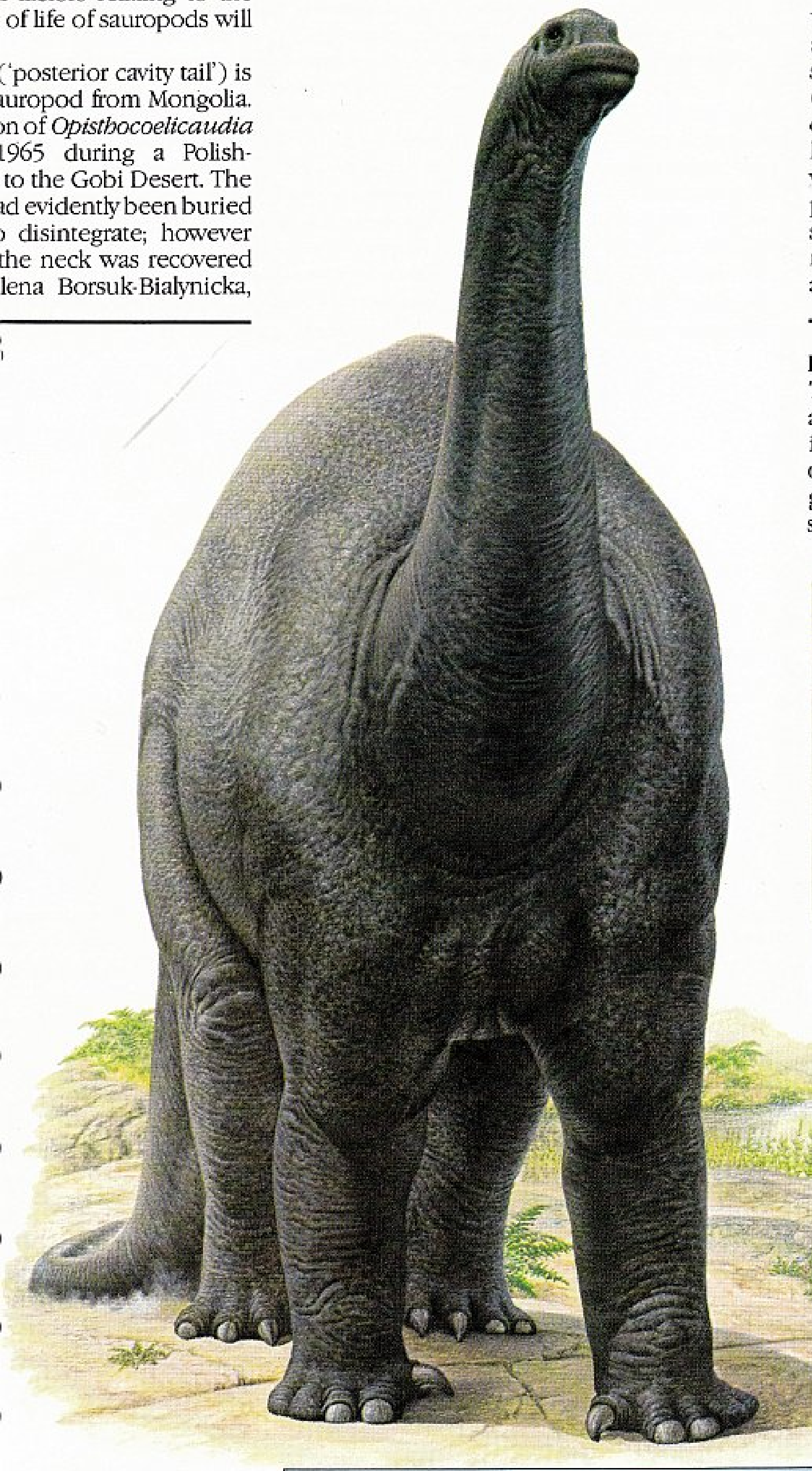


Time Chart (left)

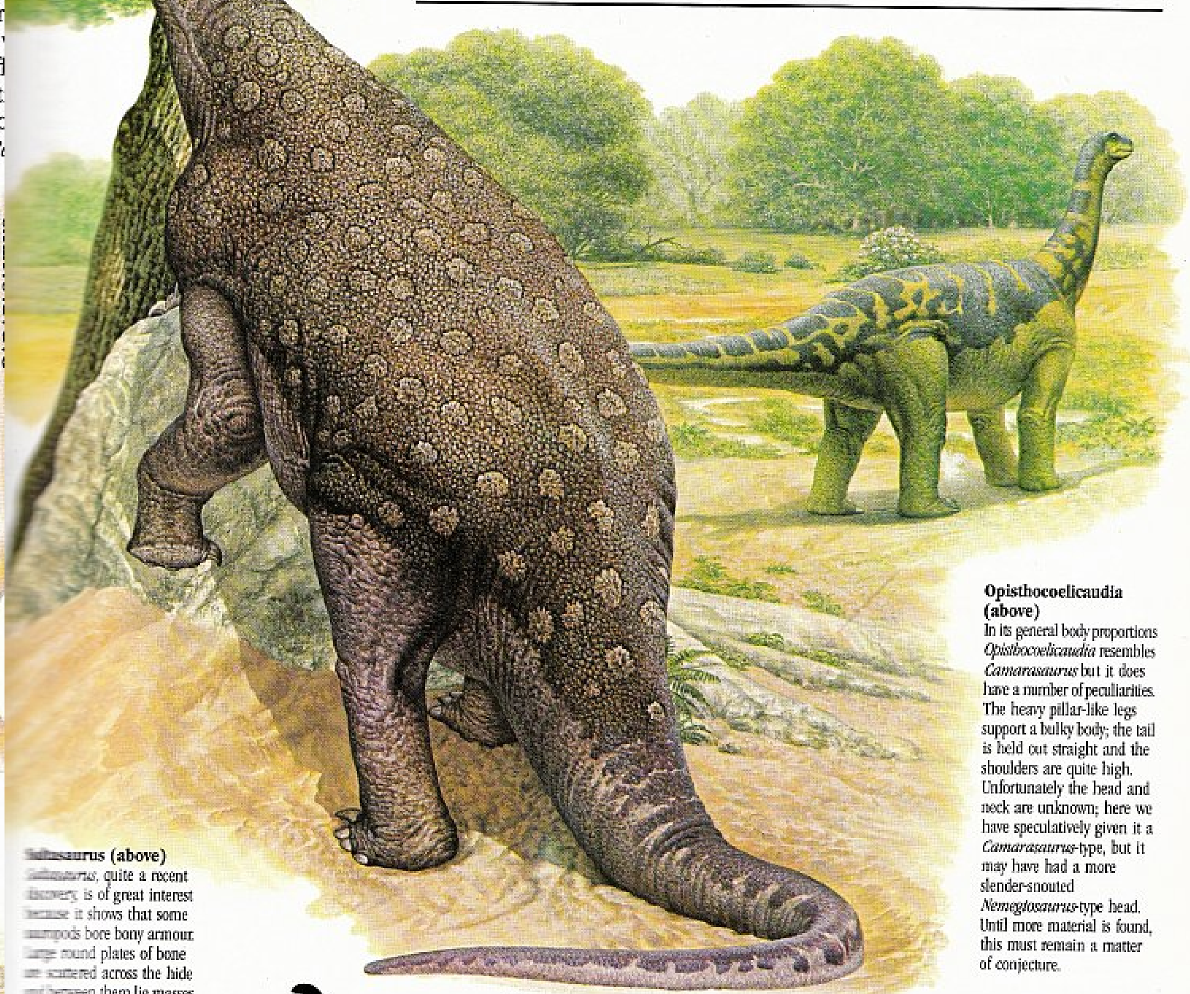
Barapasaurus and

tail as preserved consists of 34 vertebrae. These bear chevrons which are similar to those of *Camarasaurus* rather than the skid-like chevrons characteristic of diplodocids. The curious feature of the tail vertebrae, which is responsible for the tongue-twisting name of this creature, is the fact that the front end of each has a large hemispherical dome which fits into a deep socket on the rear of the preceding vertebra. The joints between the vertebrae are, as a consequence, remarkably strong. By contrast, the joints between the tail bones of most sauropods are much more simple, having practically flat surfaces. Borsuk-Bialynicka also noted that the spines of the tail vertebrae were exceptionally swollen and roughened for the attachment of powerful muscles and ligaments equivalent to those noted in the back. The forelimbs and hindlimbs are characteristically stout and pillar-like to carry the great weight of these creatures. The number of clawed toes on

In terms of limb proportions, a factor that Jack McIntosh and David Berman consider of importance in at least some sauropods, the humerus is reported to be about three-quarters of the length of the femur. This falls mid-way between typical diplodocid and typical camarasaurid limb proportions.

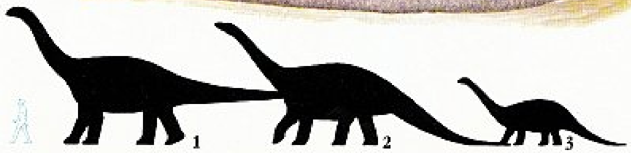
Biology and Probable Habits

The well-preserved nature of the limb and girdle bones of *Opisthocoelicaudia* allowed Borsuk-Bialynicka to attempt muscular restorations of both fore and hindlimbs. This showed that, unusually, there was little or no evidence for the massive and powerful muscles which run along the sides of the tail and insert upon the hindlimb (caudi-femoralis muscle). This is a muscle which almost always provides the main source of power for the stride in dinosaurs and most other reptiles. In *Opistho-*

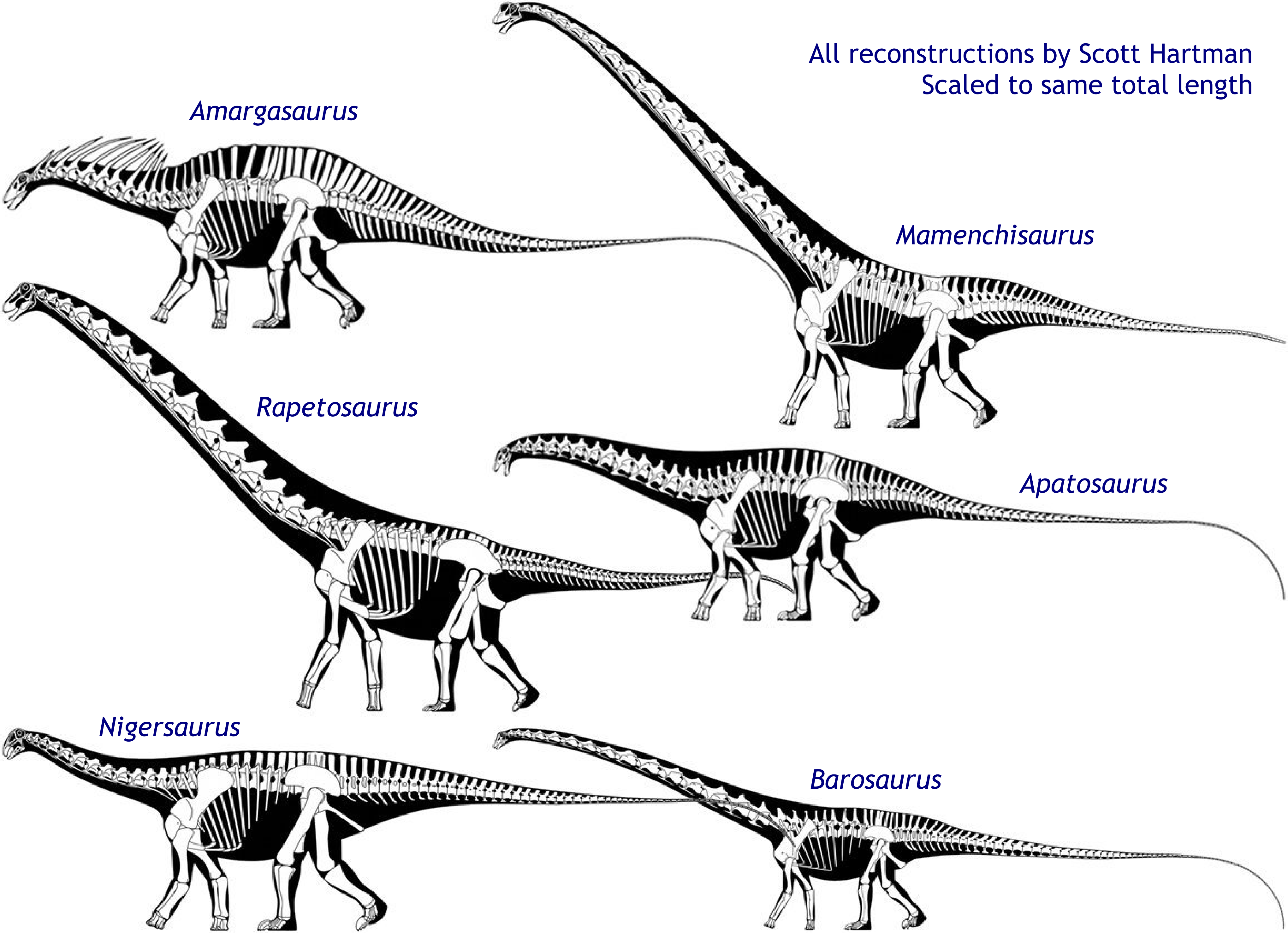


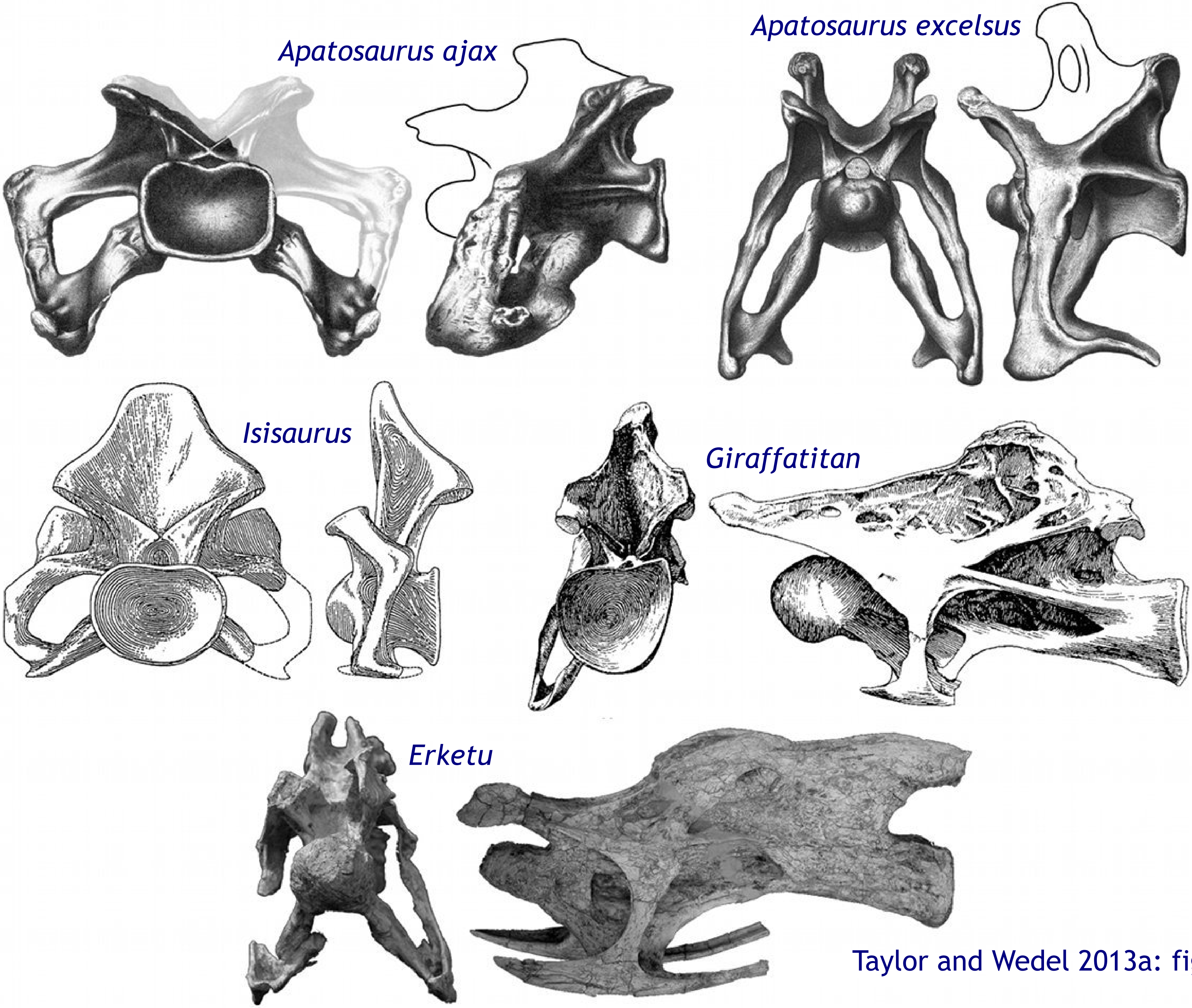
Saltasaurus (above)
Saltasaurus, quite a recent discovery, is of great interest because it shows that some sauropods bore bony armour. Large round plates of bone are scattered across the hide and between them lie masses of small nodules. As shown the tail was flexible and could have supported the body when *Saltasaurus* reared on its back legs in its efforts to obtain food.

Opisthocoelicaudia (above)
In its general body proportions *Opisthocoelicaudia* resembles *Camarasaurus* but it does have a number of peculiarities. The heavy pillar-like legs support a bulky body; the tail is held out straight and the shoulders are quite high. Unfortunately the head and neck are unknown; here we have speculatively given it a *Camarasaurus*-type, but it may have had a more slender-snouted *Nemegtosaurus*-type head. Until more material is found, this must remain a matter of conjecture.



Comparative Sizes (left)
1 *Opisthocoelicaudia*: l. 39ft (12m)
2 *Saltasaurus*: l. 39ft (12m).
3 *Vulcanodon*: l. 21ft (6·5m)

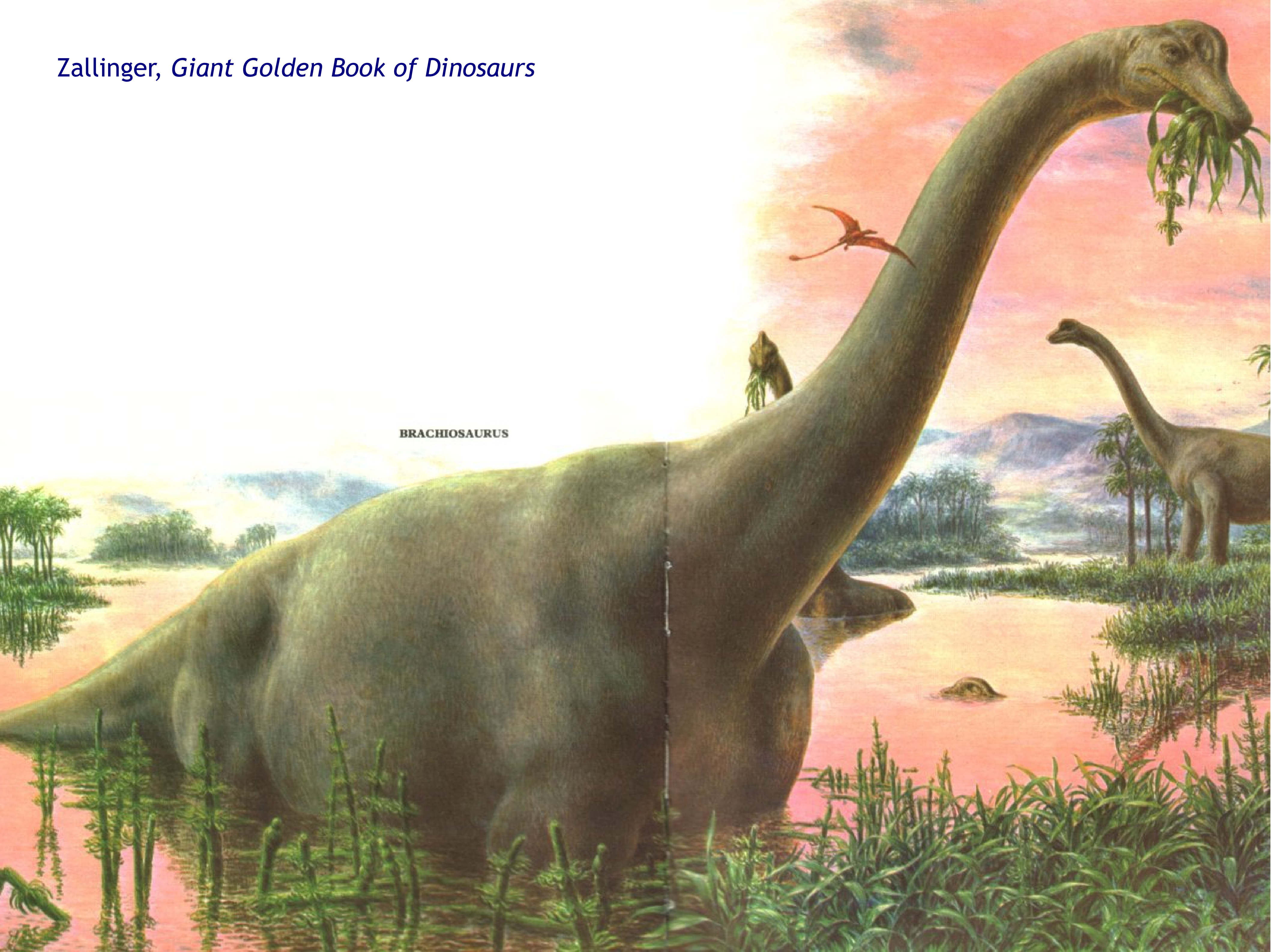

All reconstructions by Scott Hartman
Scaled to same total length
Amargasaurus
Mamenchisaurus
Rapetosaurus
Apatosaurus
Nigersaurus
Barosaurus



Taylor and Wedel 2013a: fig. 7

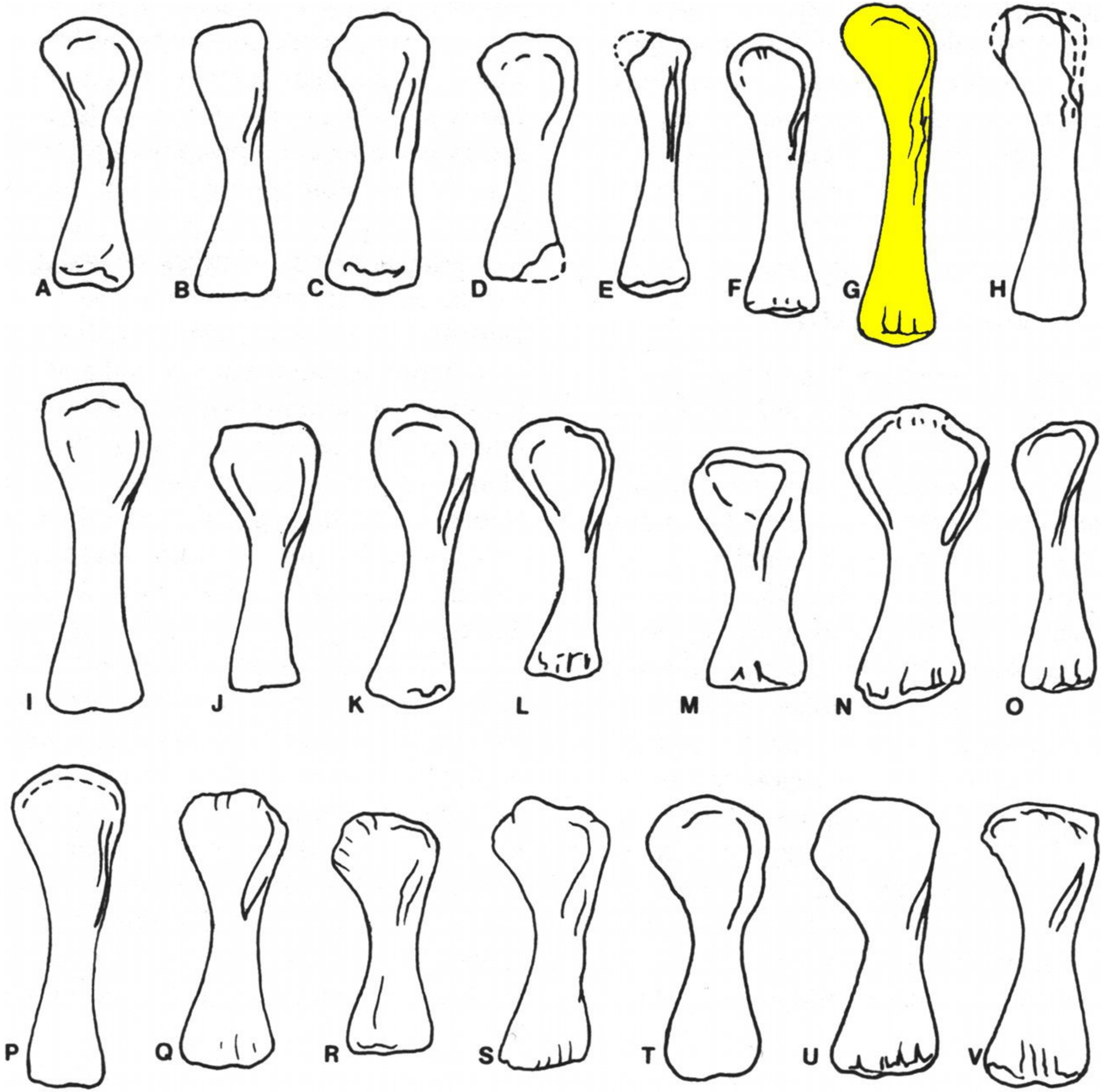

Nigersaurus
Nicholls 2013

Zallinger, *Giant Golden Book of Dinosaurs*



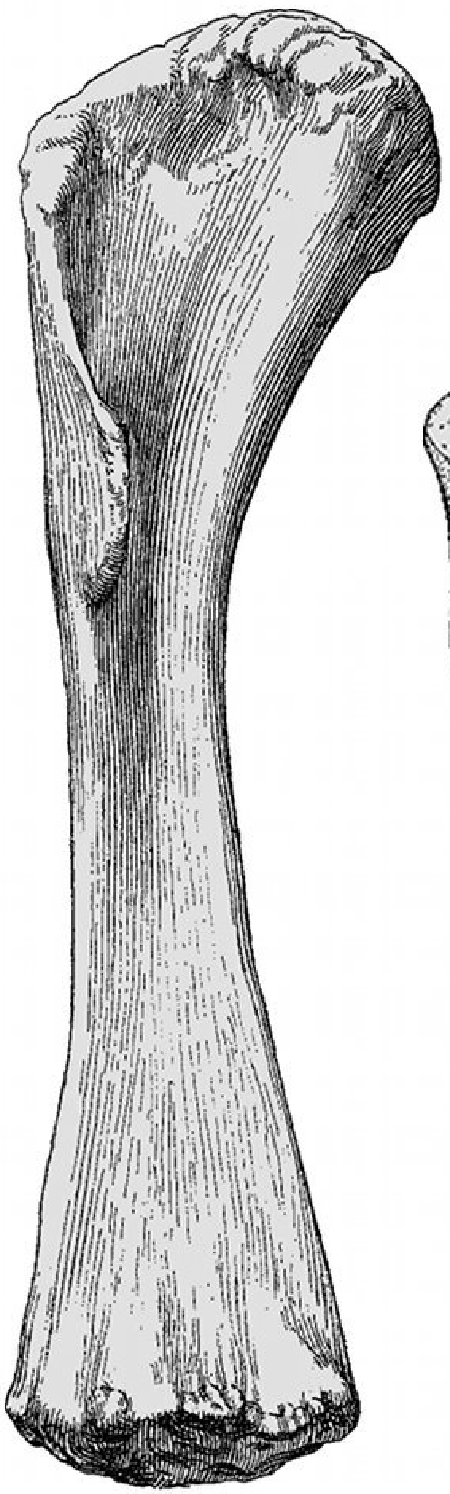
Photograph by
Tristan Savatier

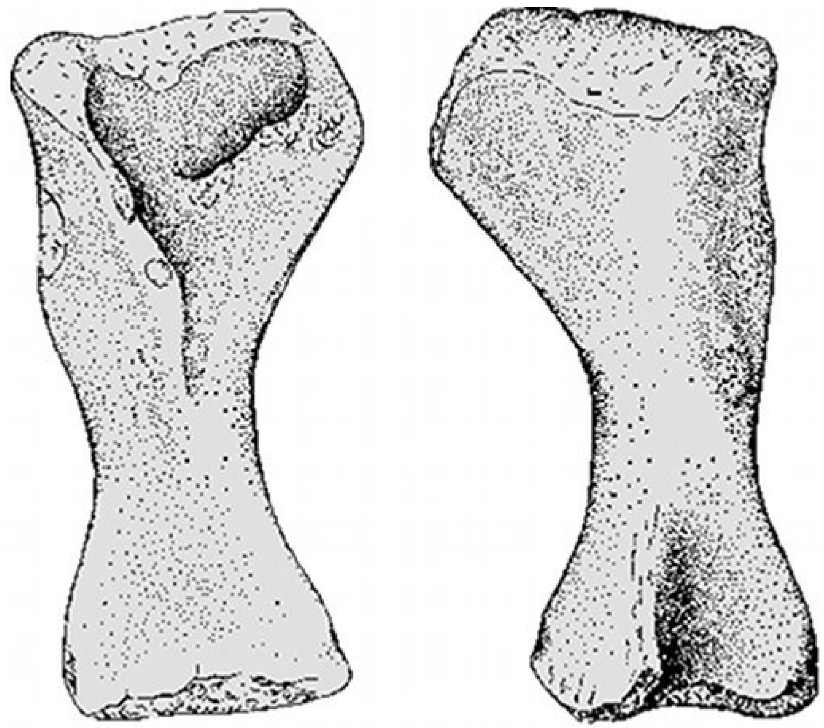
Photograph by
Heinrich Mallison

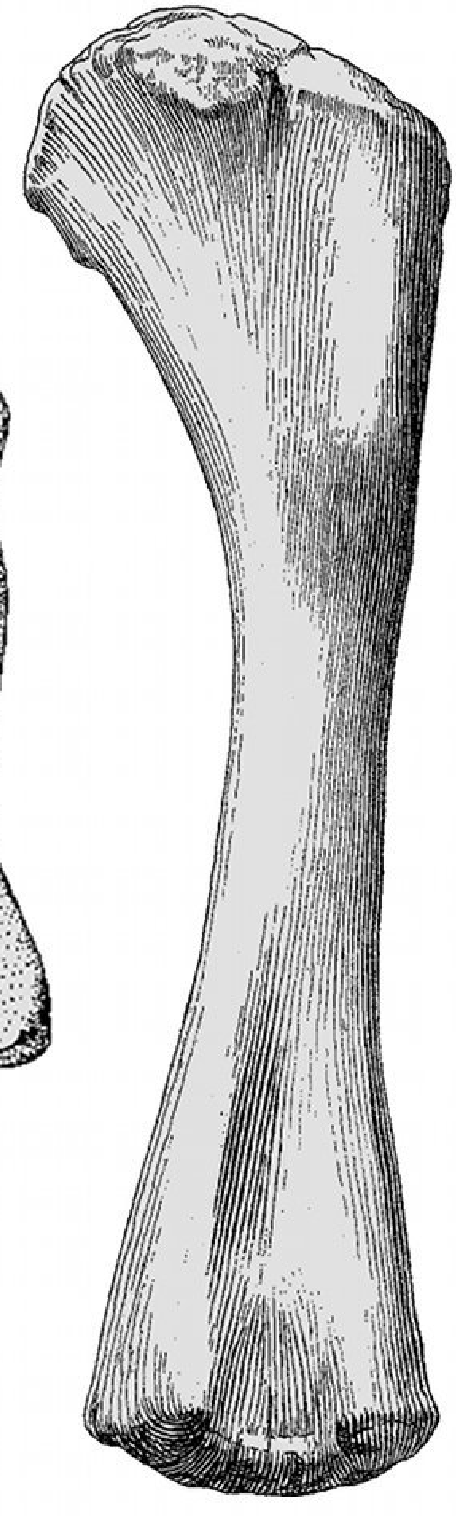


McIntosh 1990:
Fig. 16.10

Giraffatitan and *Opisthocoelicaudia* humeri.







Humerus vs. femur in brachiosaurs

Giraffatitan

Brachiosaurus

Surprising, as brachiosaurs carry *more* weight on forelimbs

Alexander 1989: fig. 5.4

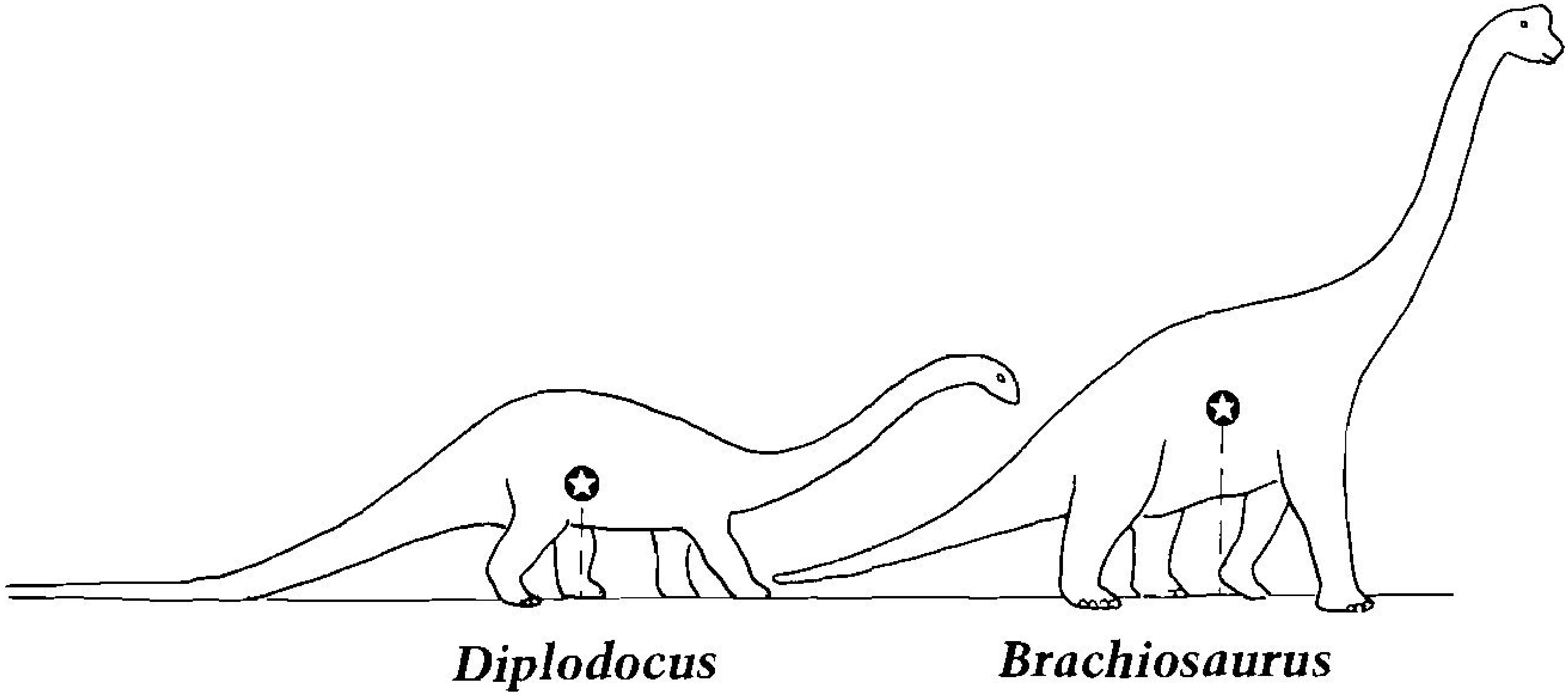
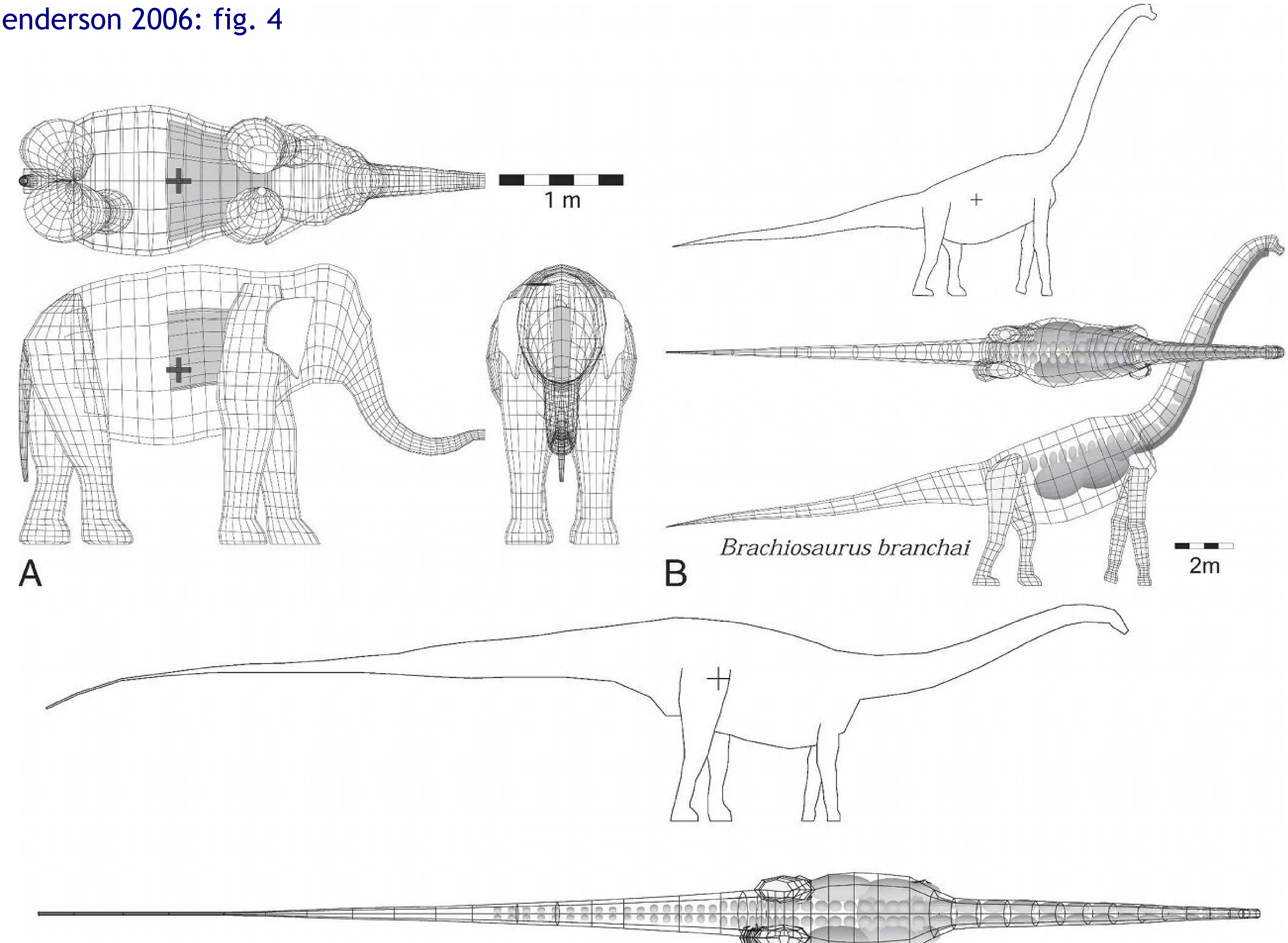


FIGURE 5.4. Outlines of dinosaurs, showing the positions of their centers of gravity.

Surprising, as brachiosaurs carry *more* weight on forelimbs

Henderson 2006: fig. 4



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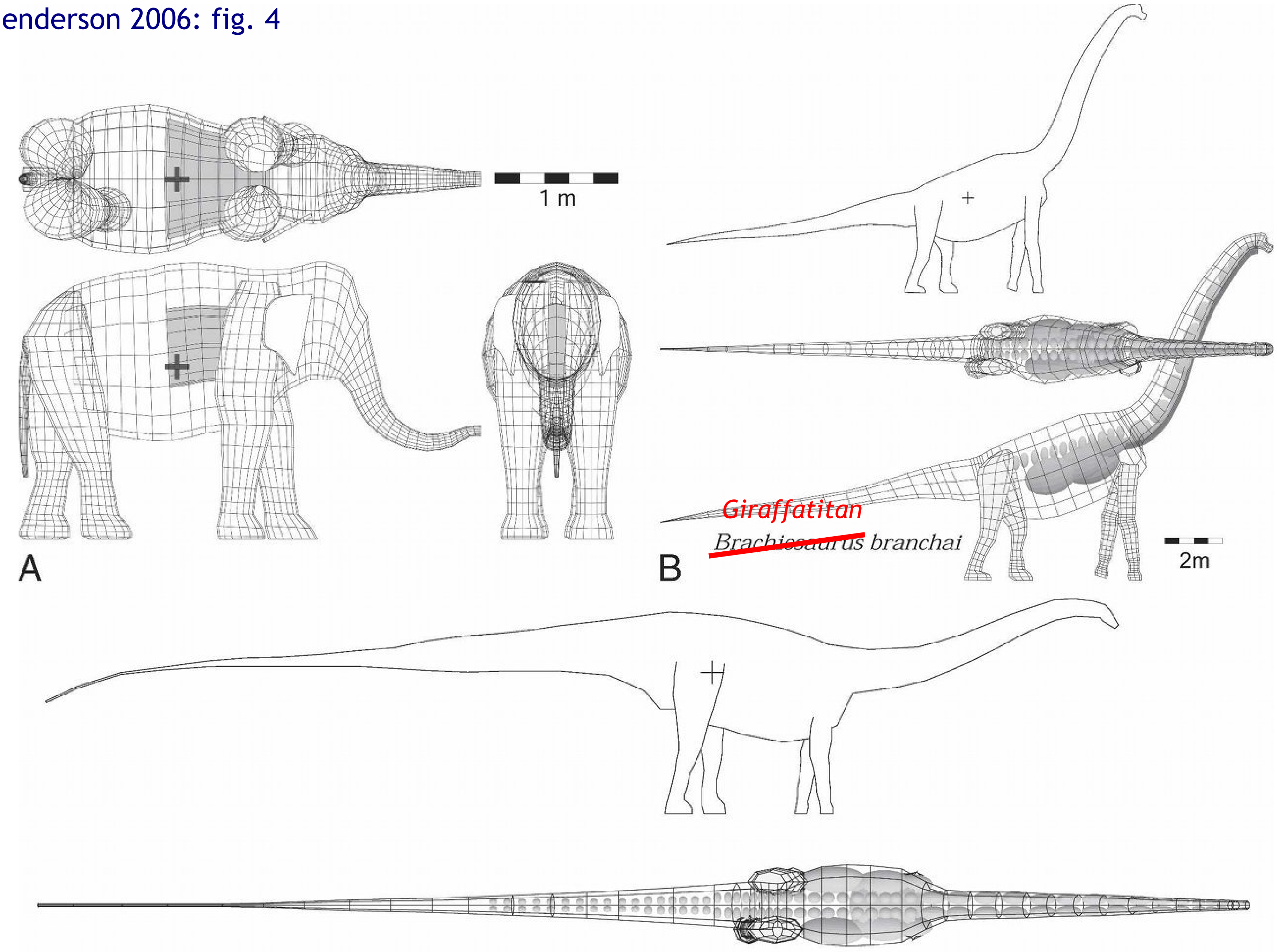
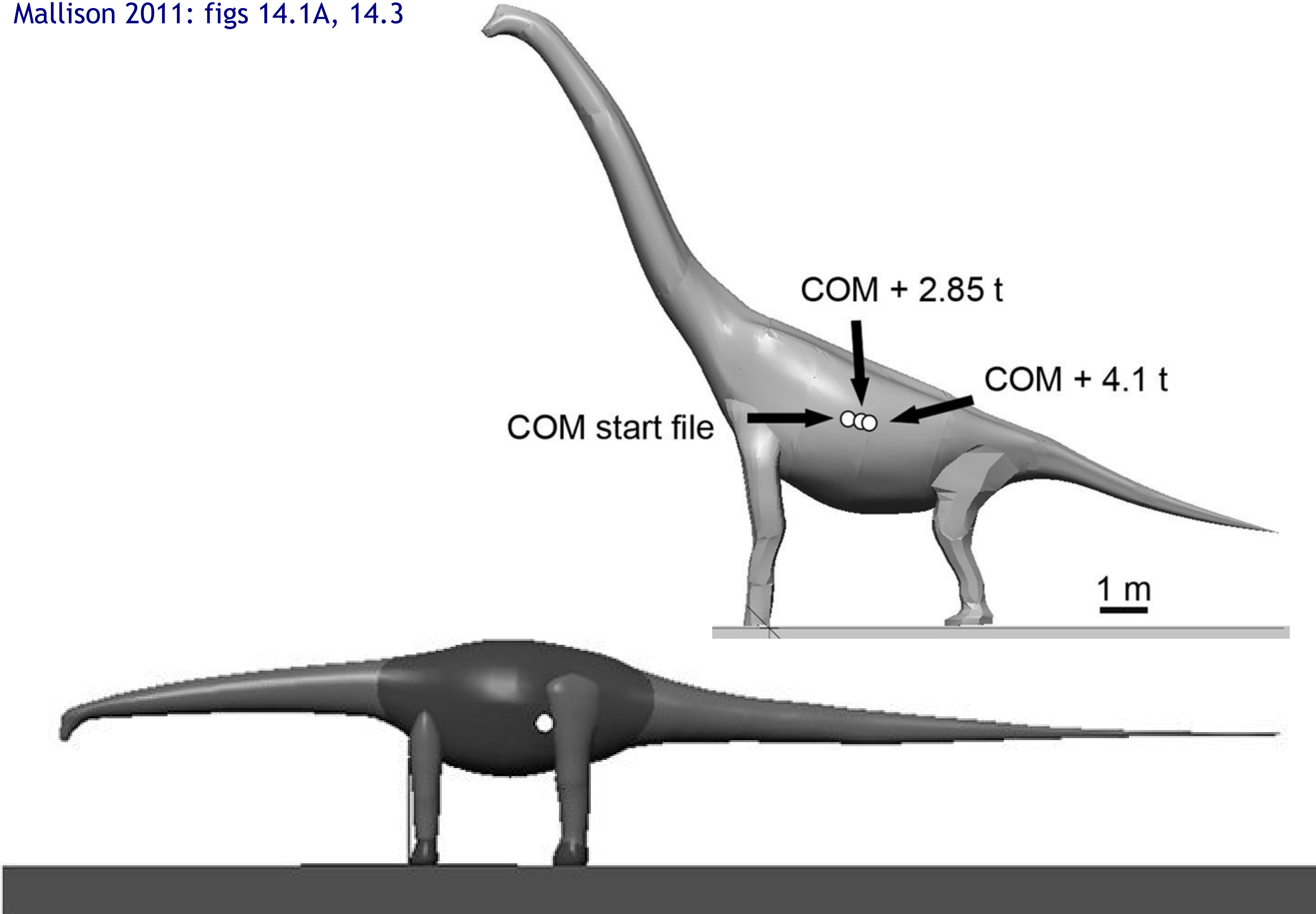


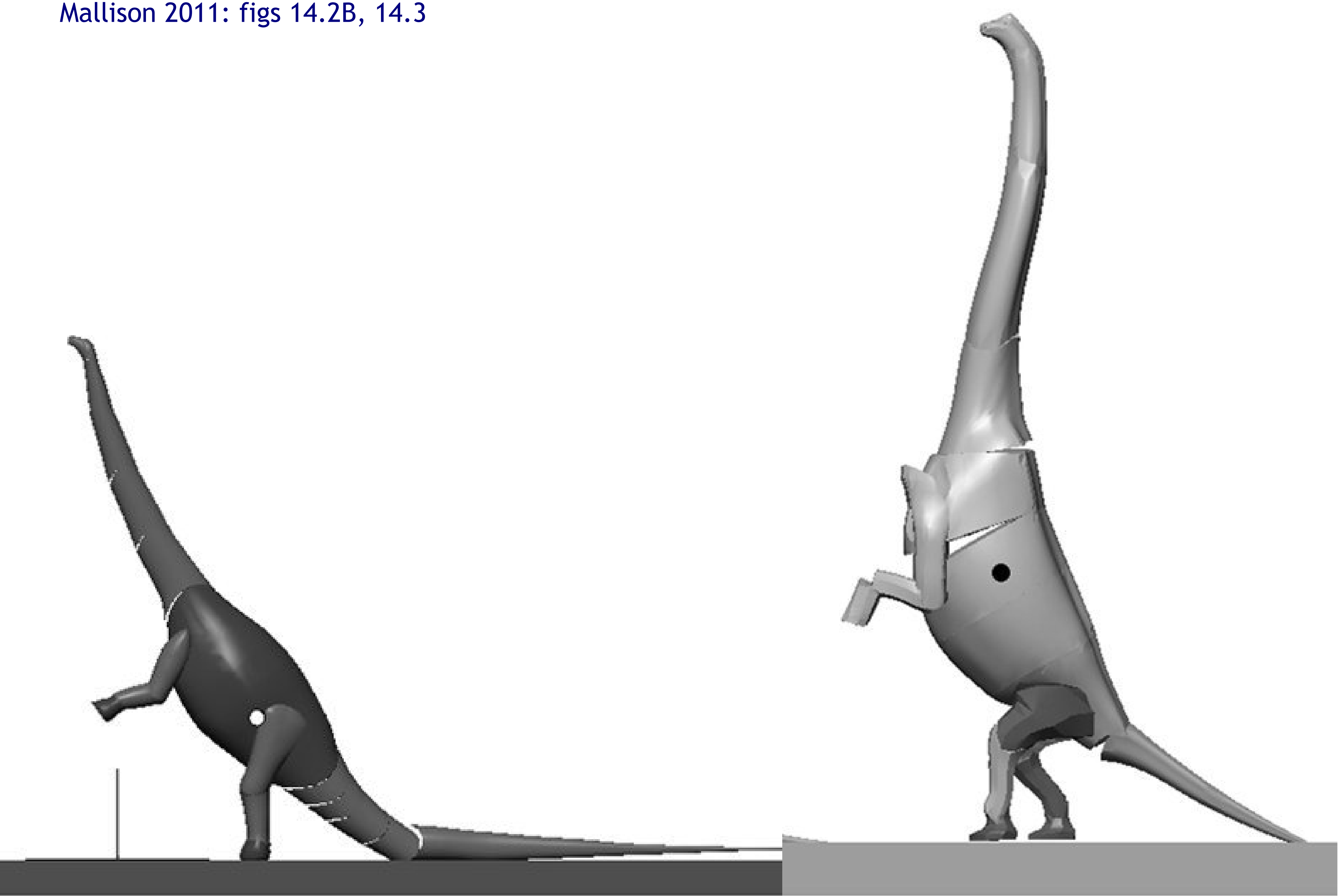
Surprising, as brachiosaurs carry *more* weight on forelimbs

Mallison 2011: figs 14.1A, 14.3



Surprising, as brachiosaurs carry *more* weight on forelimbs

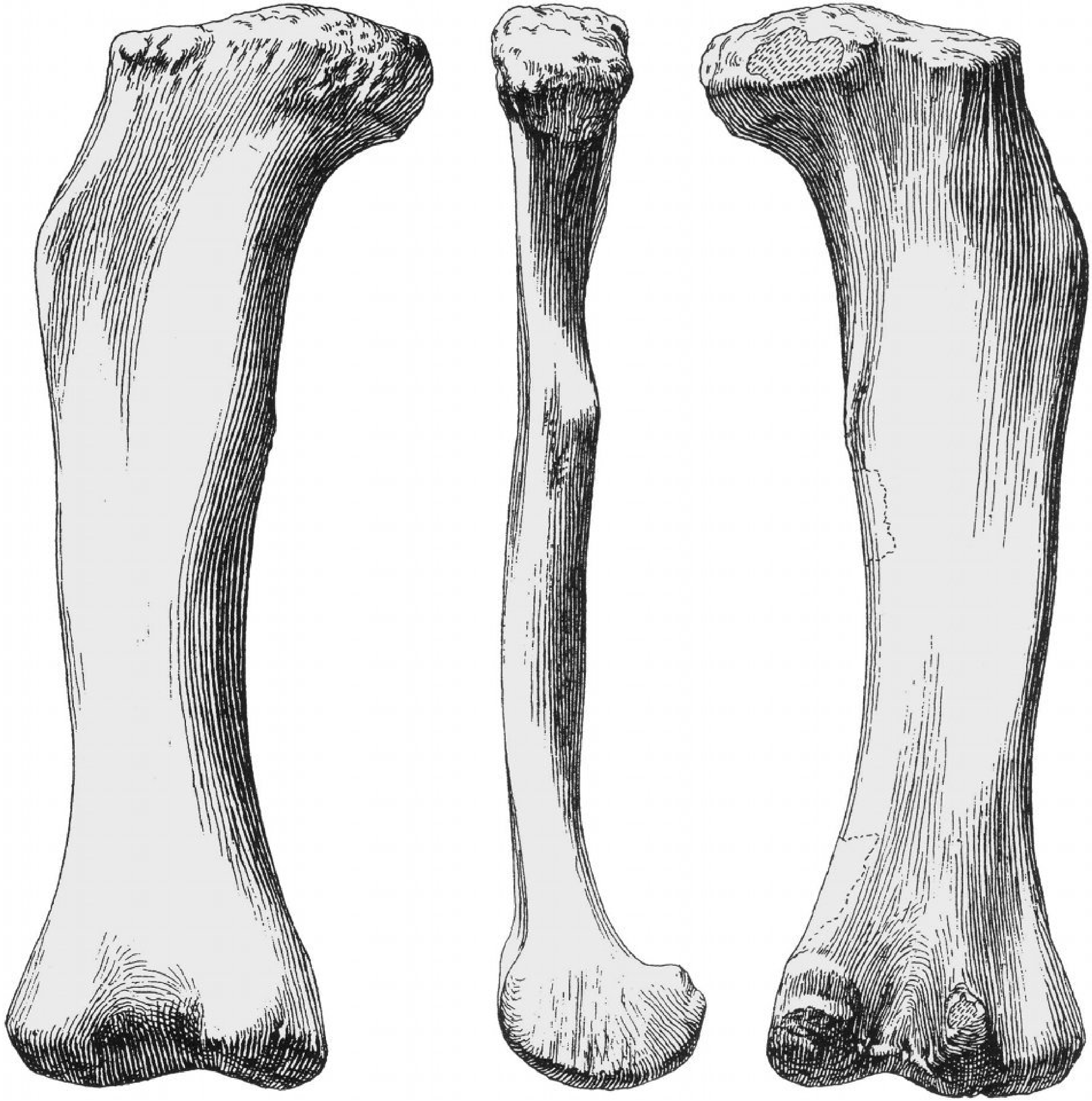
Mallison 2011: figs 14.2B, 14.3



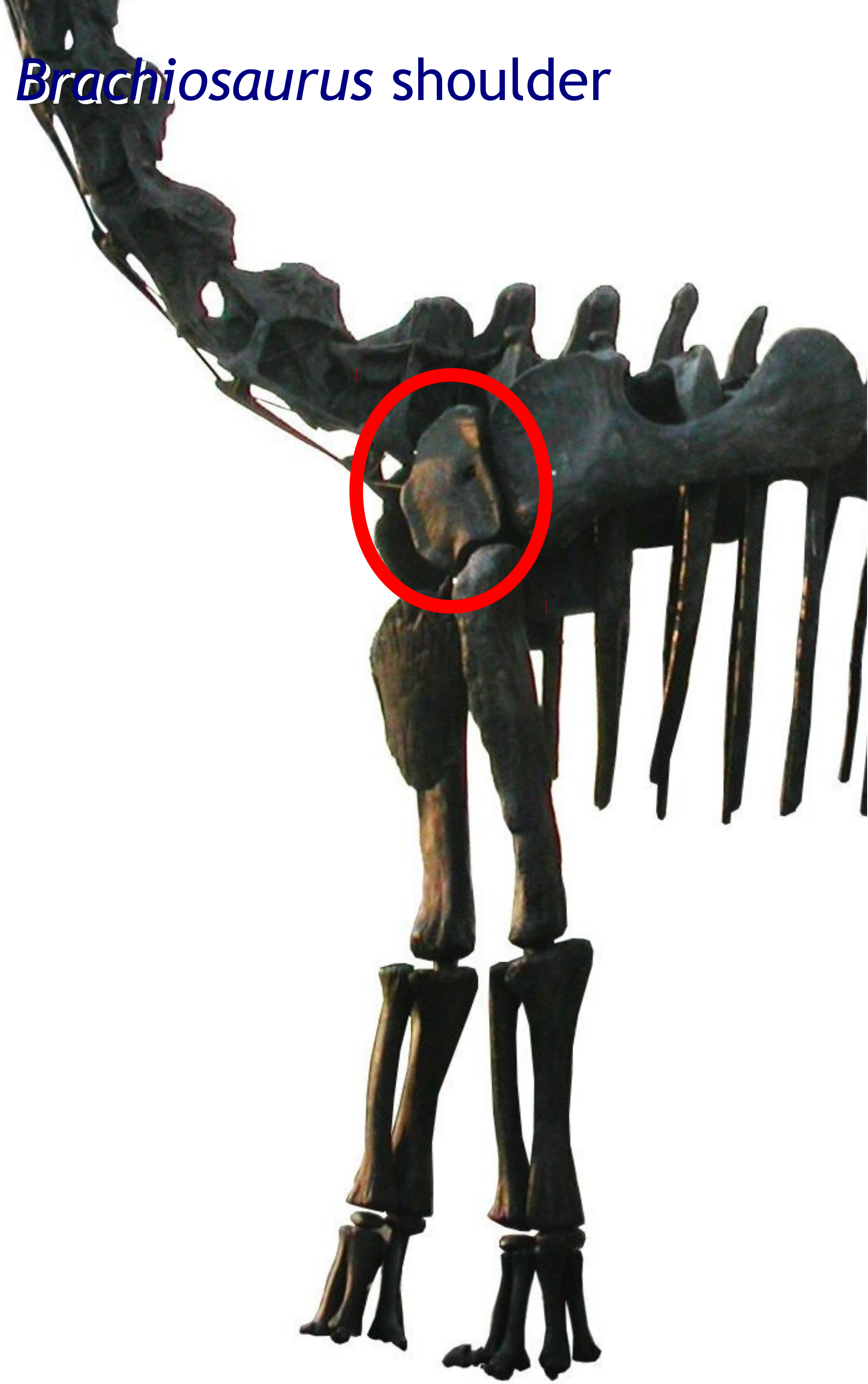
Anatomy of a champion:

eccentricity of femur in *Giraffatitan*

Janensch 1961: beilage A.



Unique laterally deflected glenoid in *Brachiosaurus* shoulder



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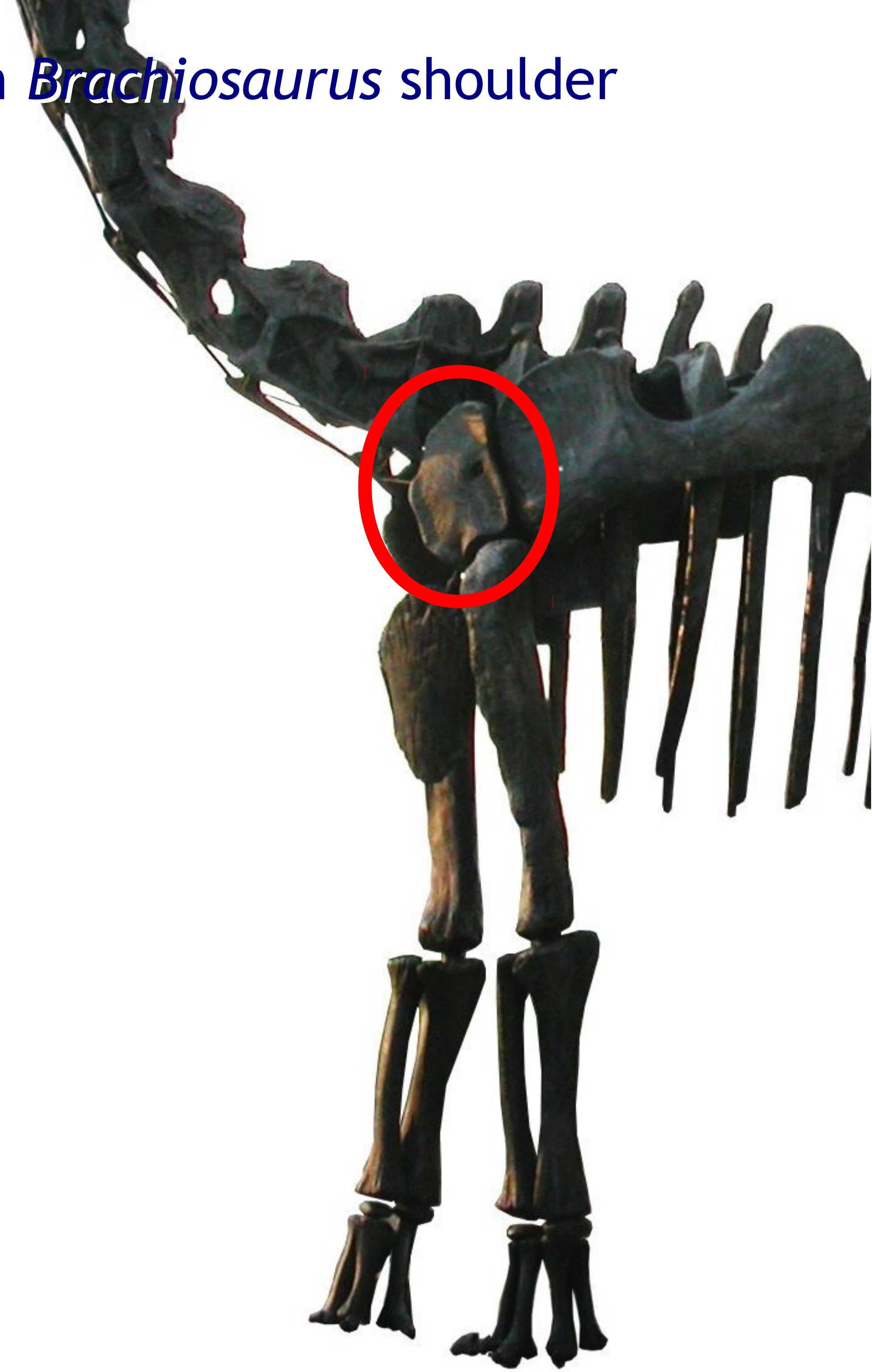

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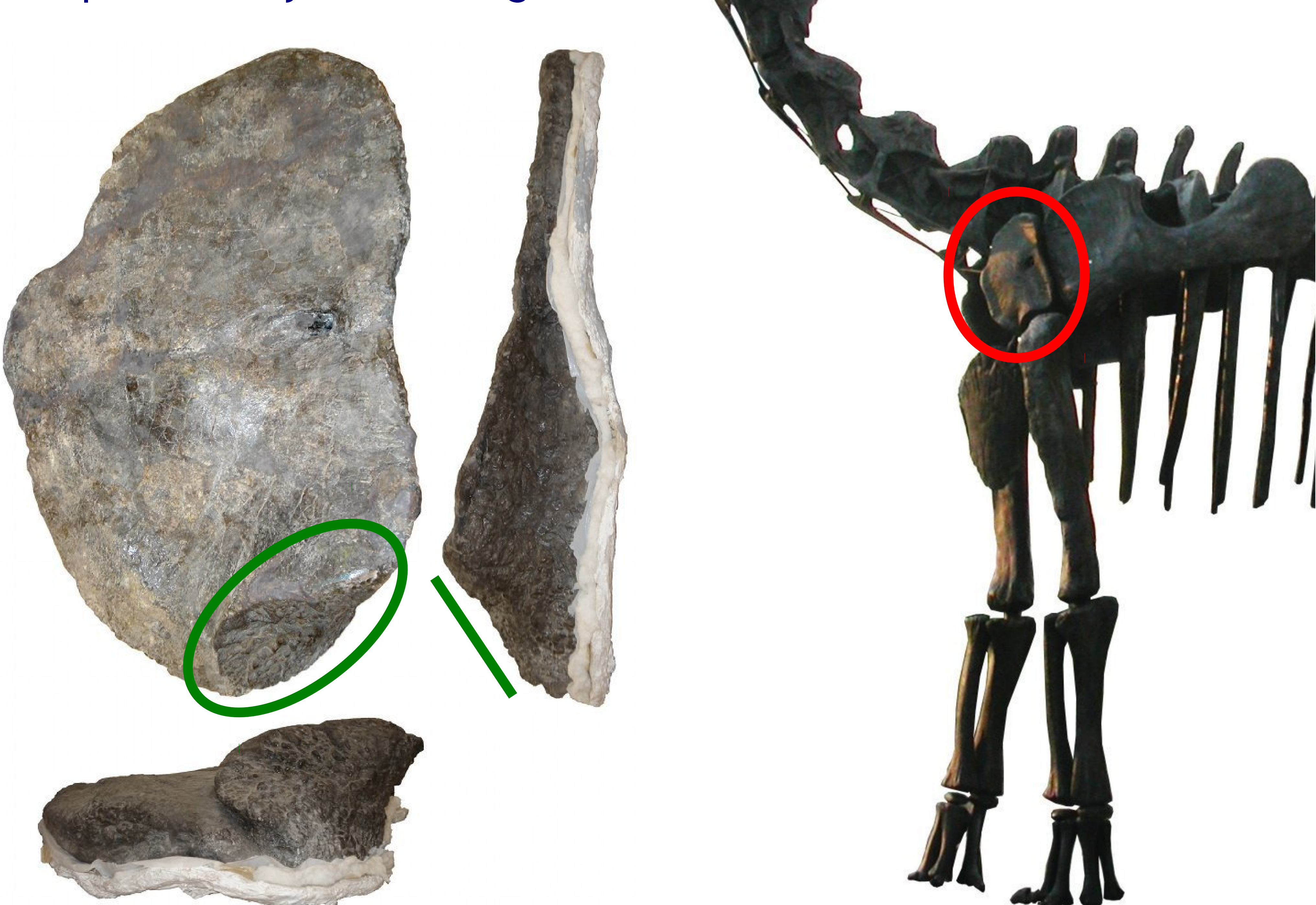
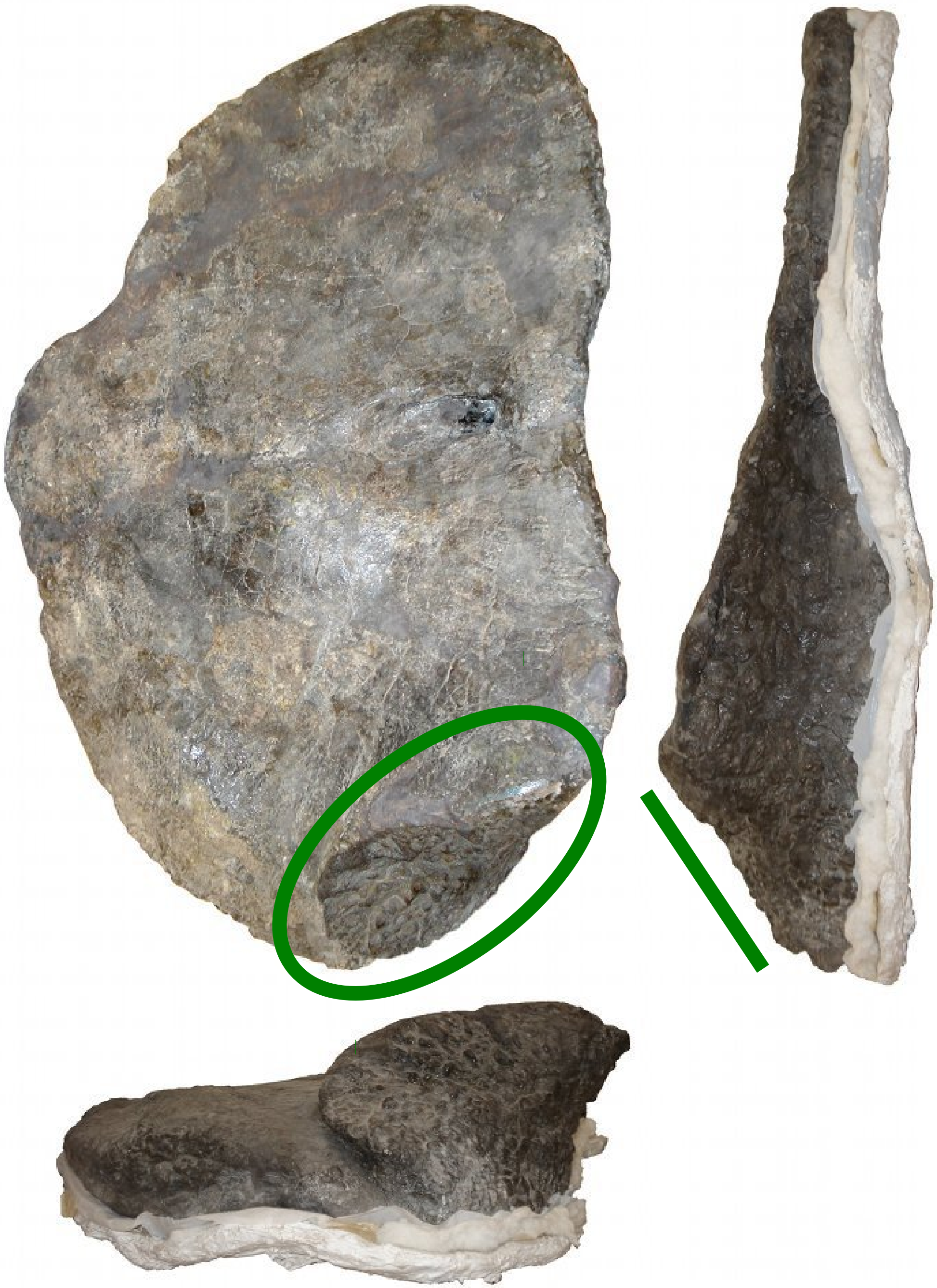
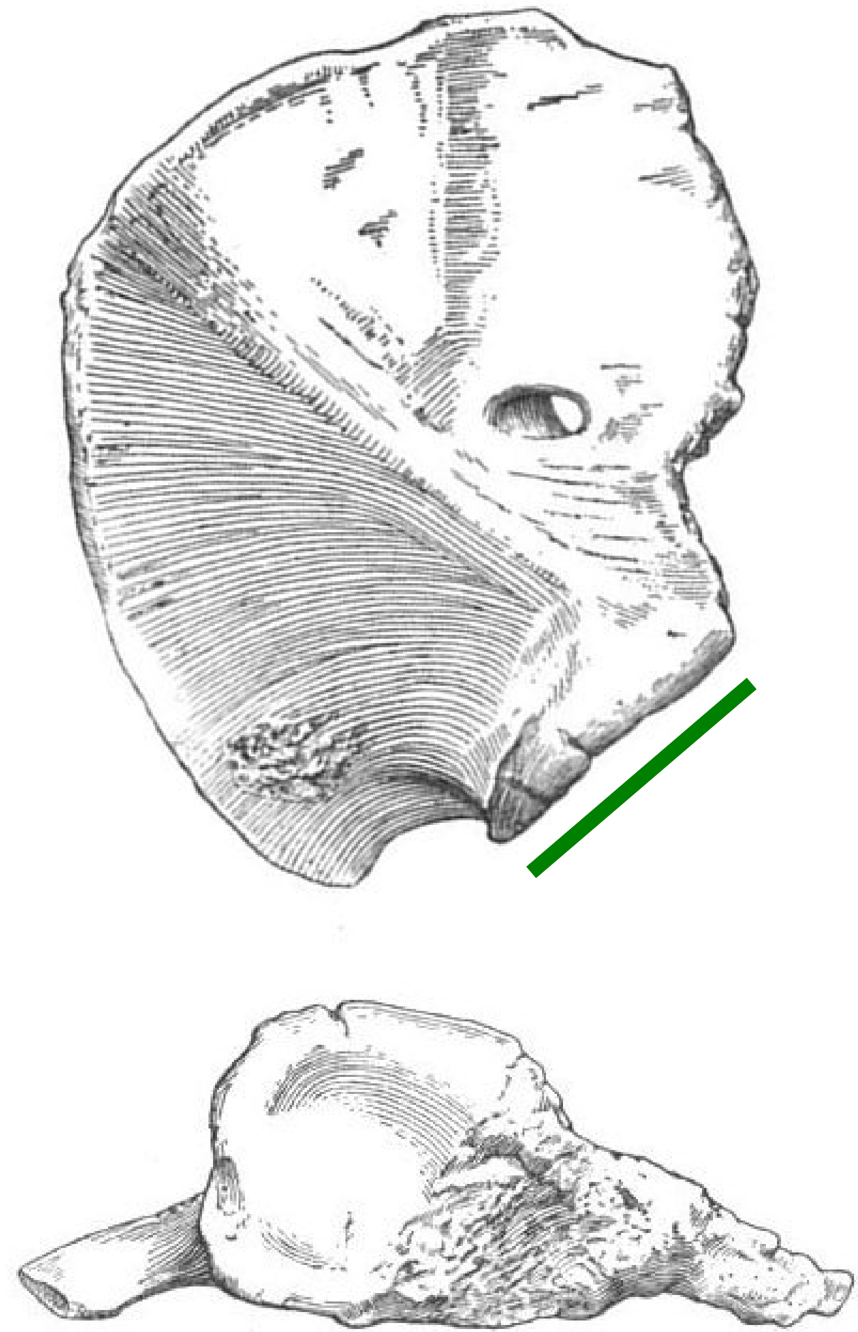
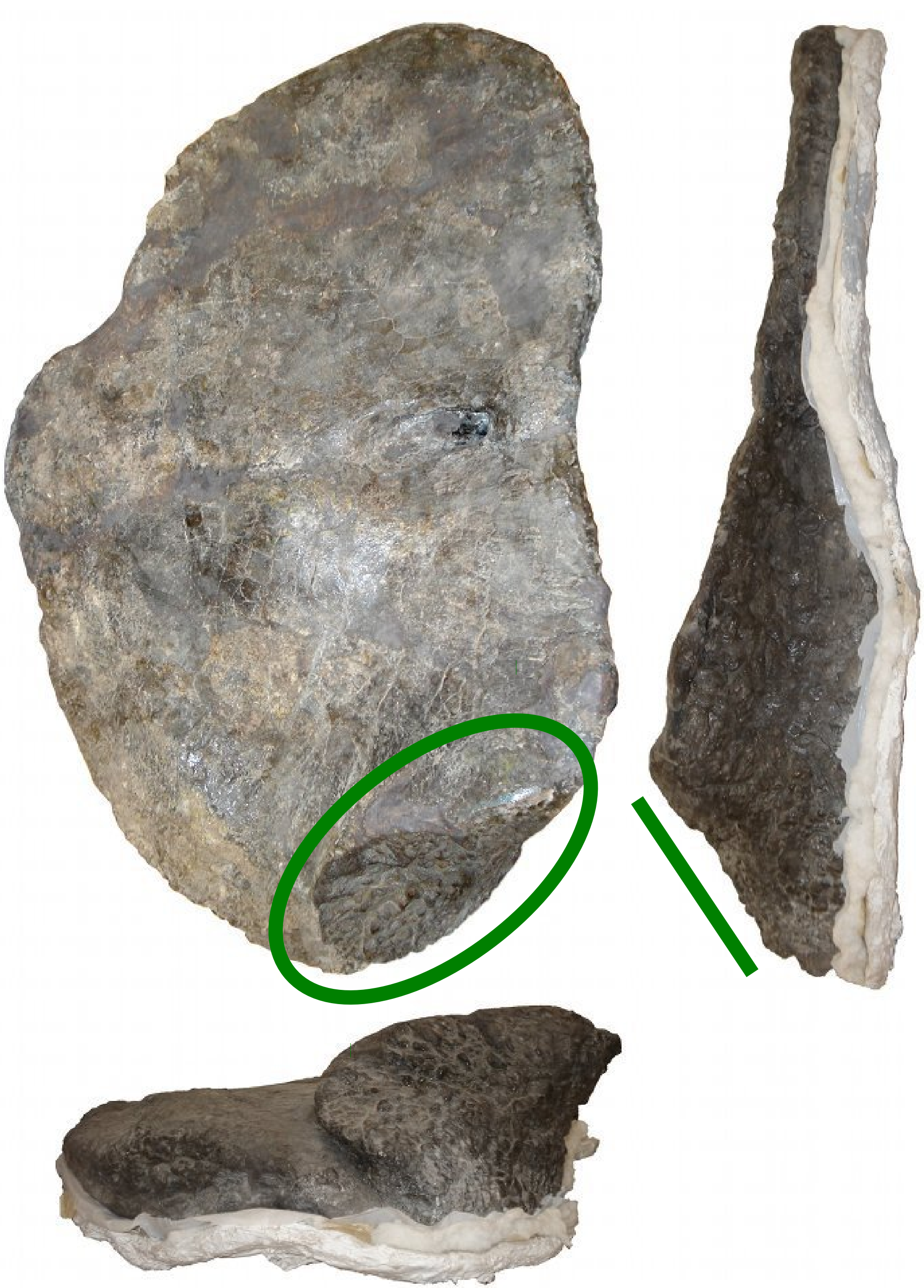


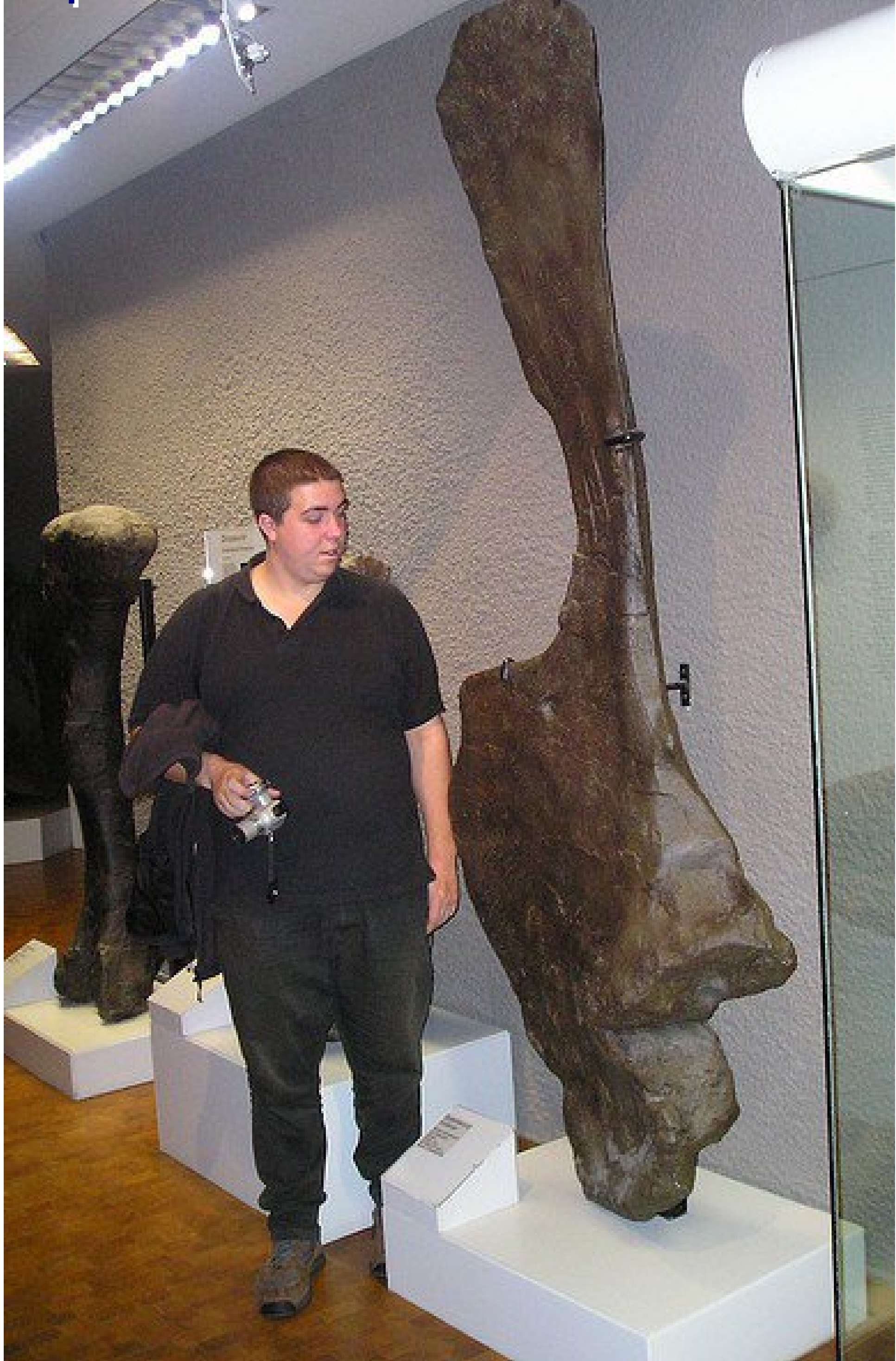
Unique laterally deflected glenoid in *Brachiosaurus* shoulder



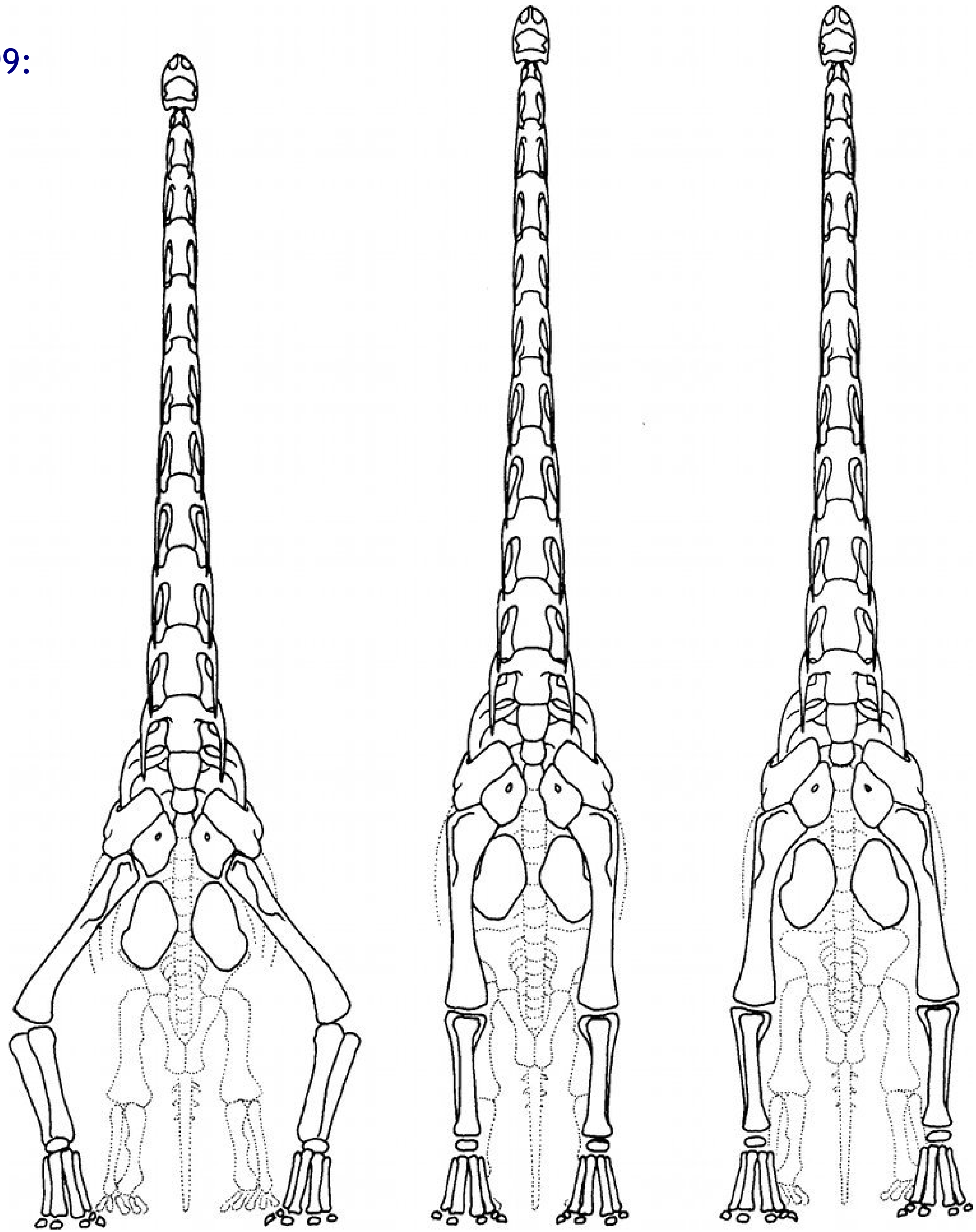


… which is not in the “*Ultrasauros*” scapulocoracoid





Christian et al. 1999:
fig. 4



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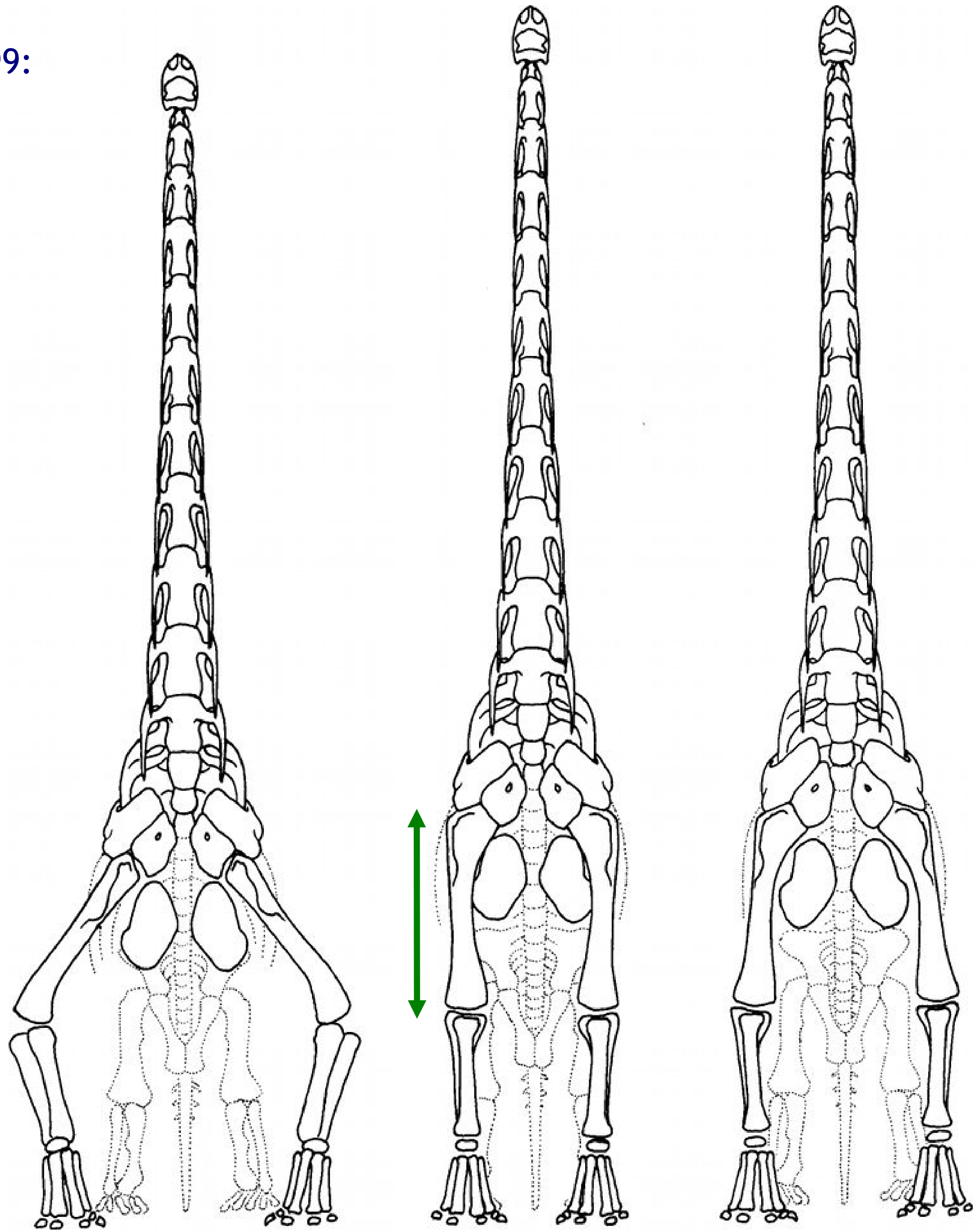

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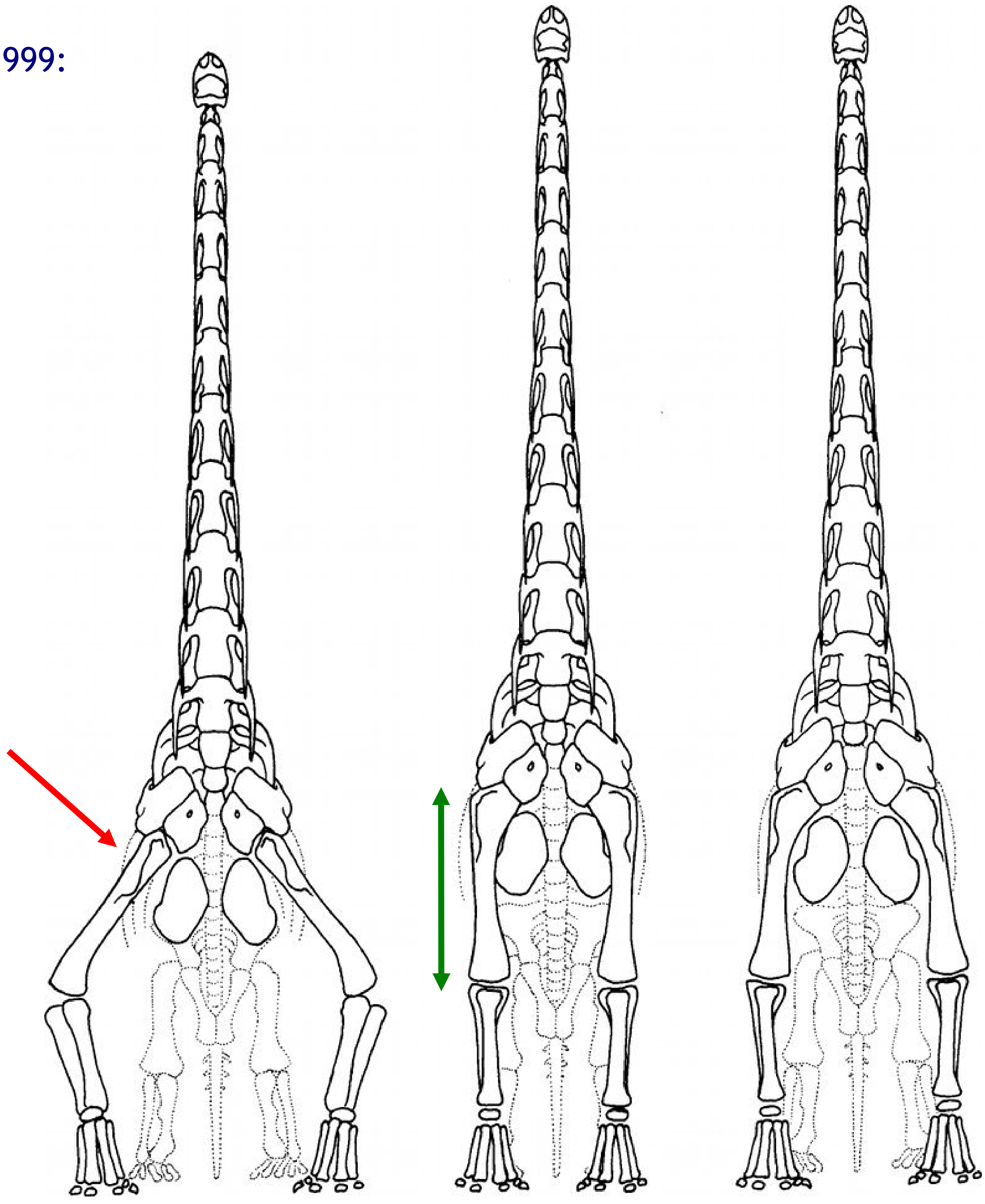
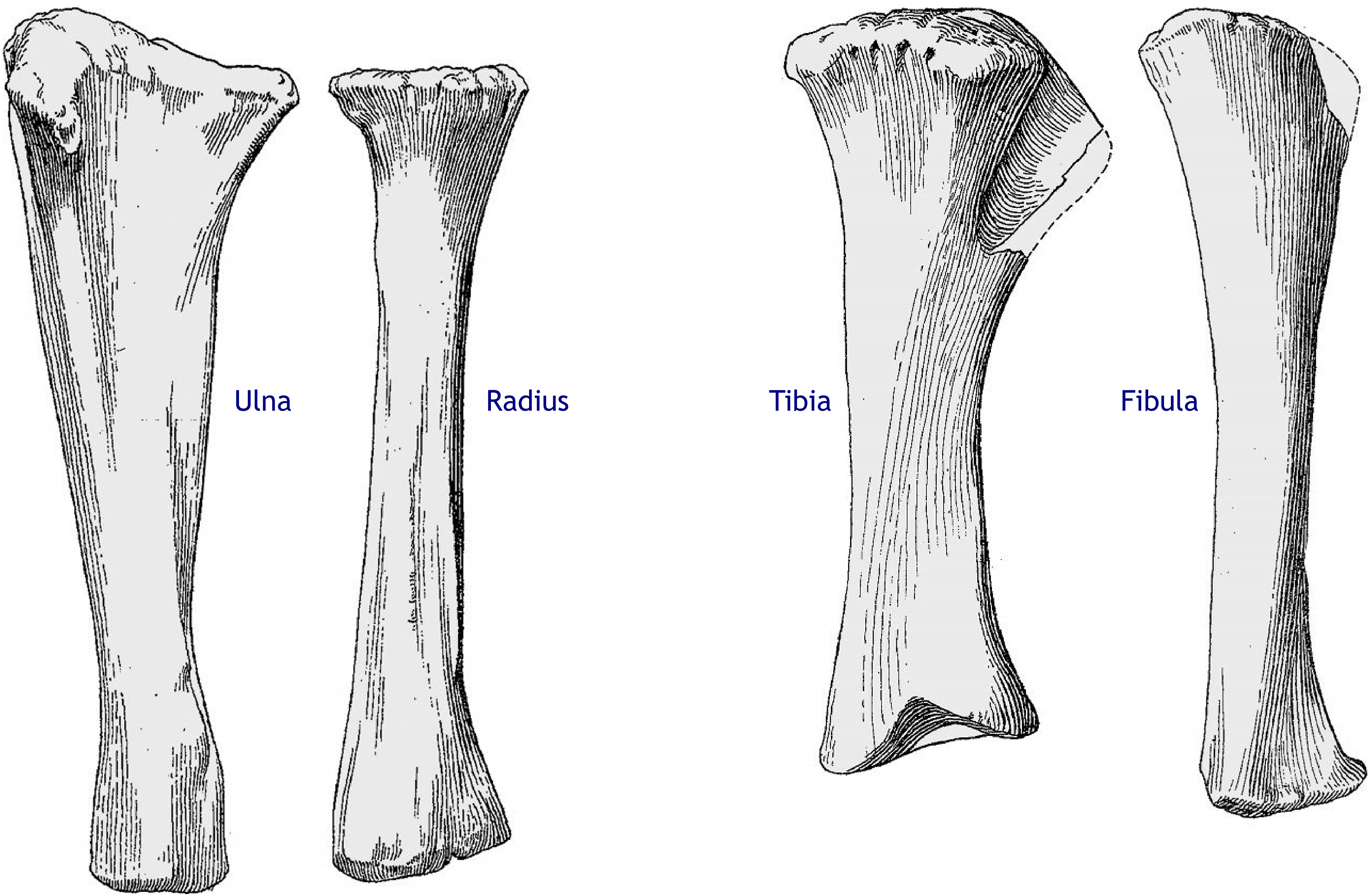
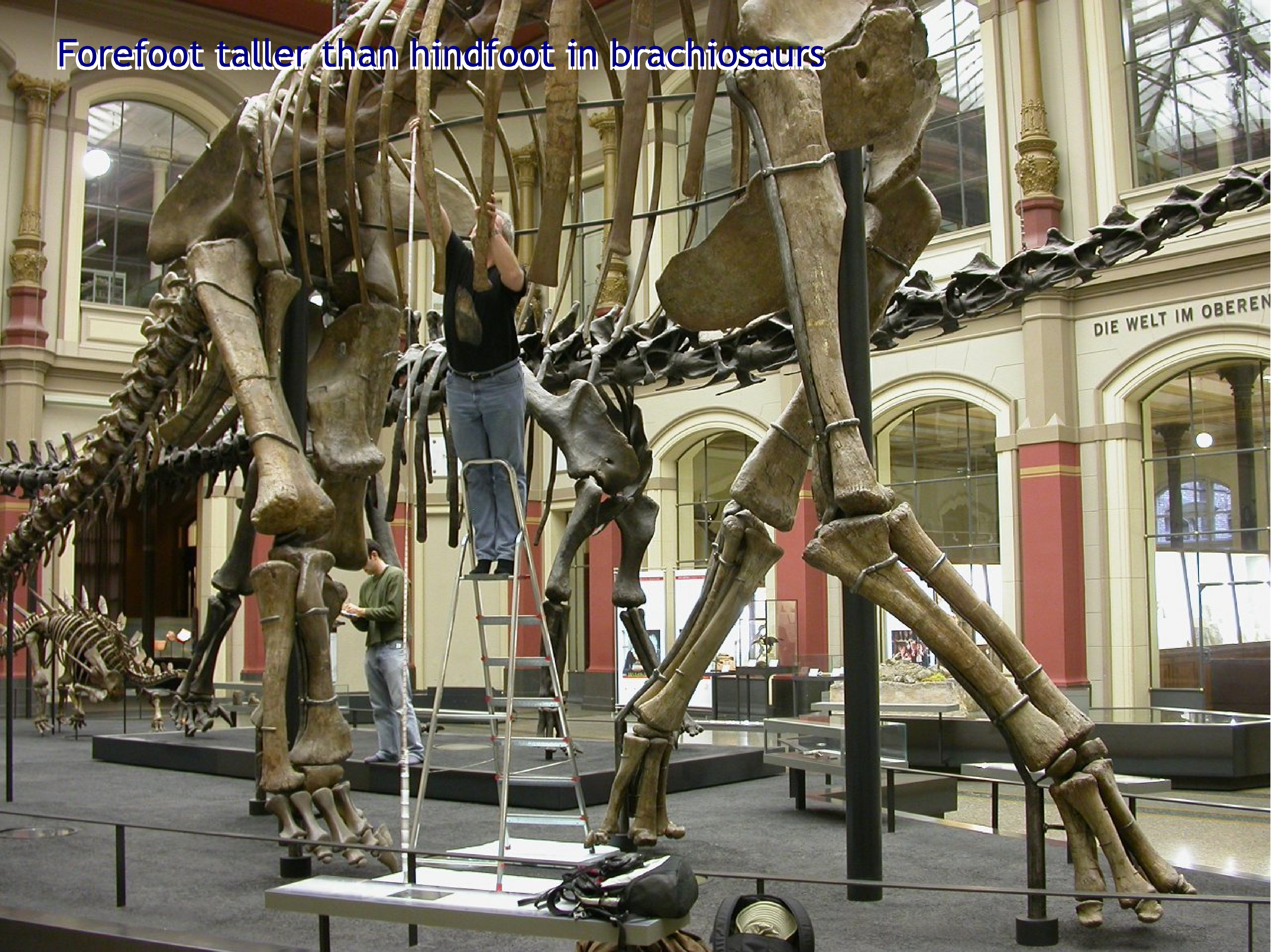


Humerus longer than femur in brachiosaurs

Lower forelimb longer than lower hindlimb in brachiosaurs

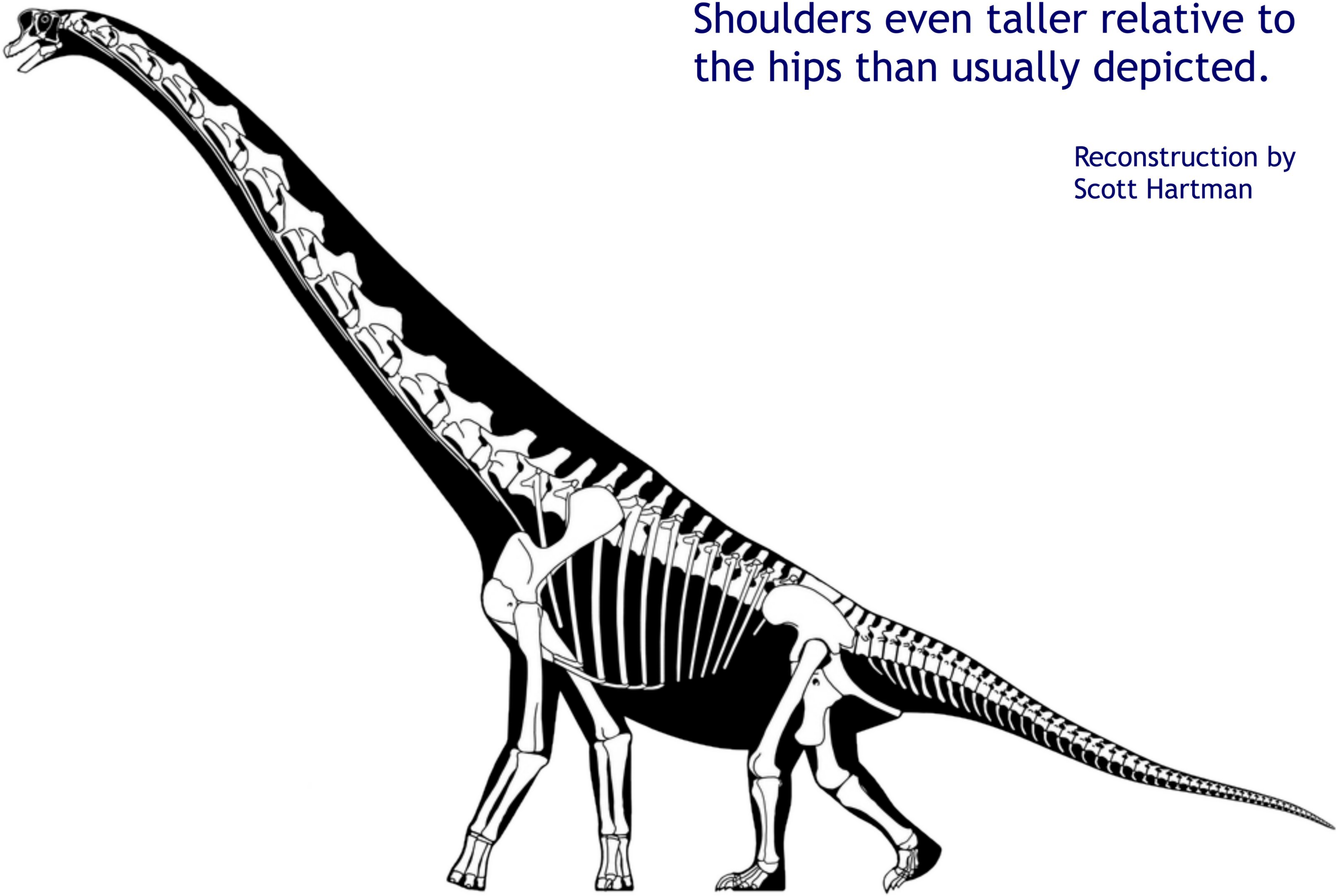



Forefoot taller than hindfoot in brachiosaurs
DIE WELT IM OBEREN

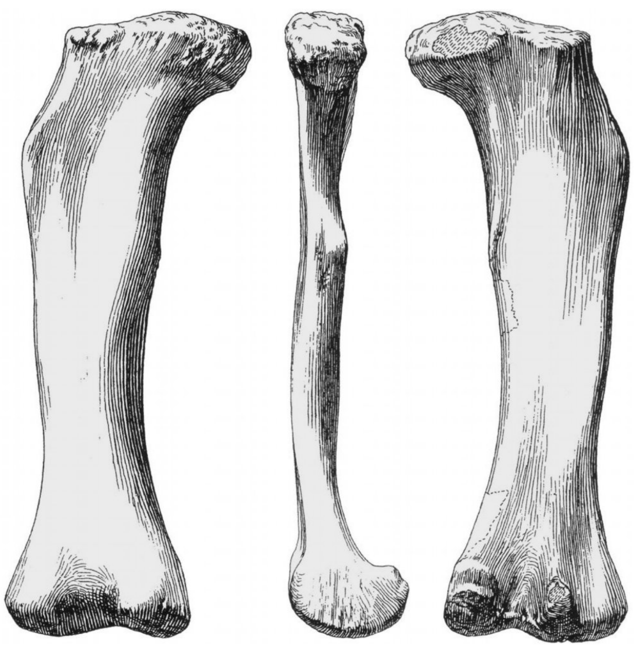
Forefoot taller than hindfoot in brachiosaurs

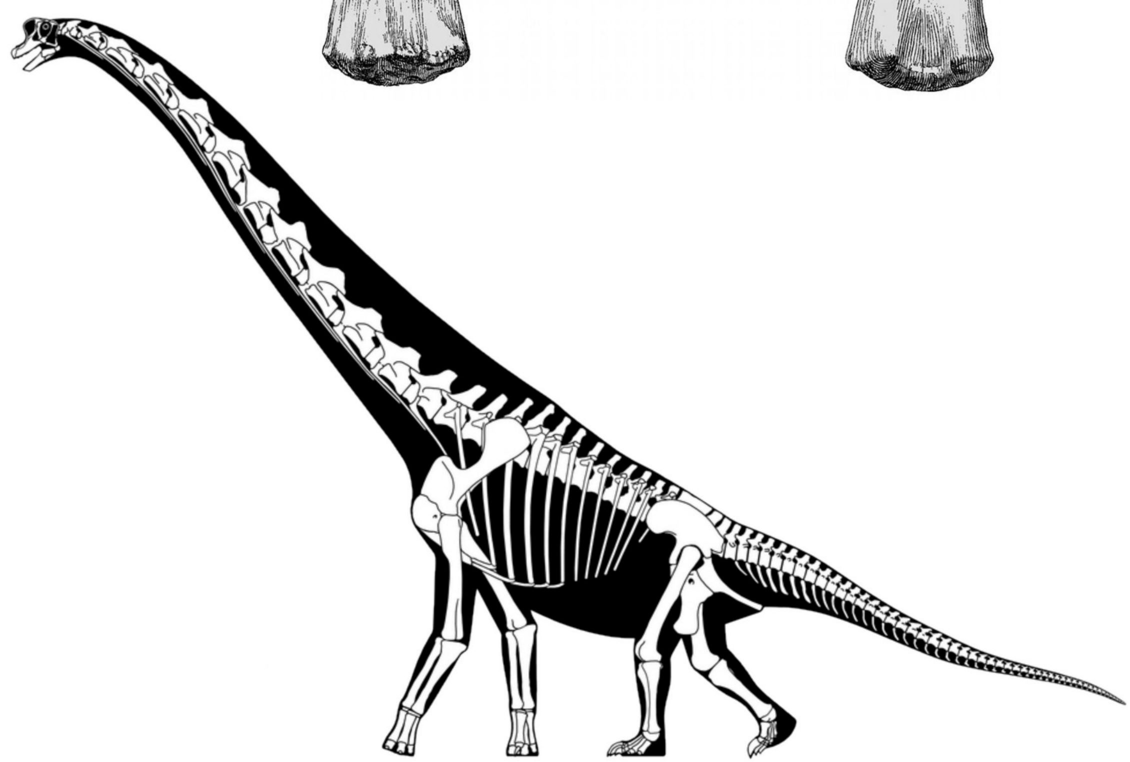
Shoulders even taller relative to the hips than usually depicted.

Reconstruction by
Scott Hartman



Why were brachiosaurs so goshdarned weird?





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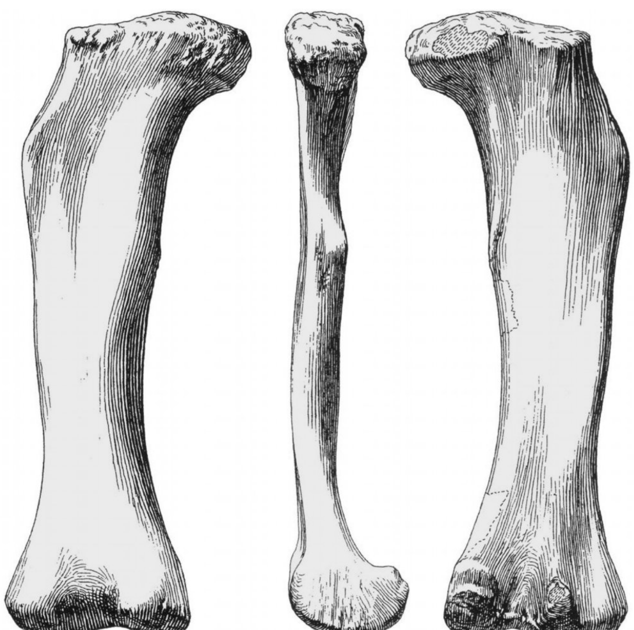
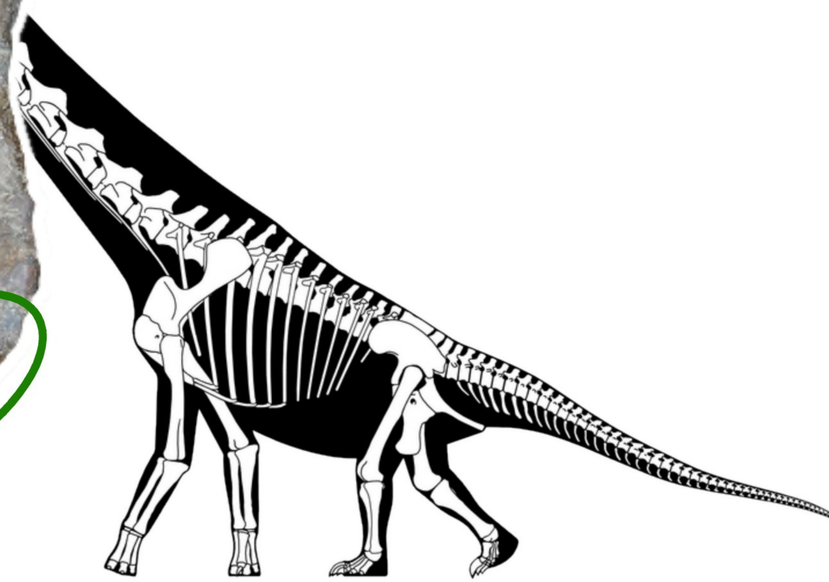
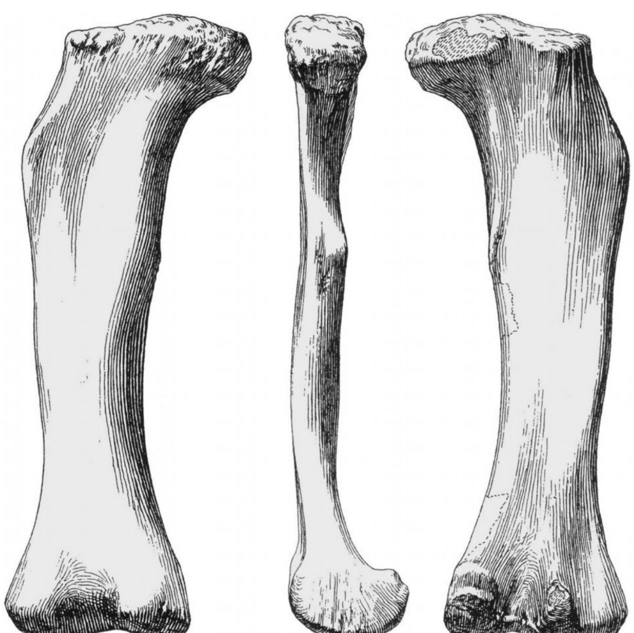
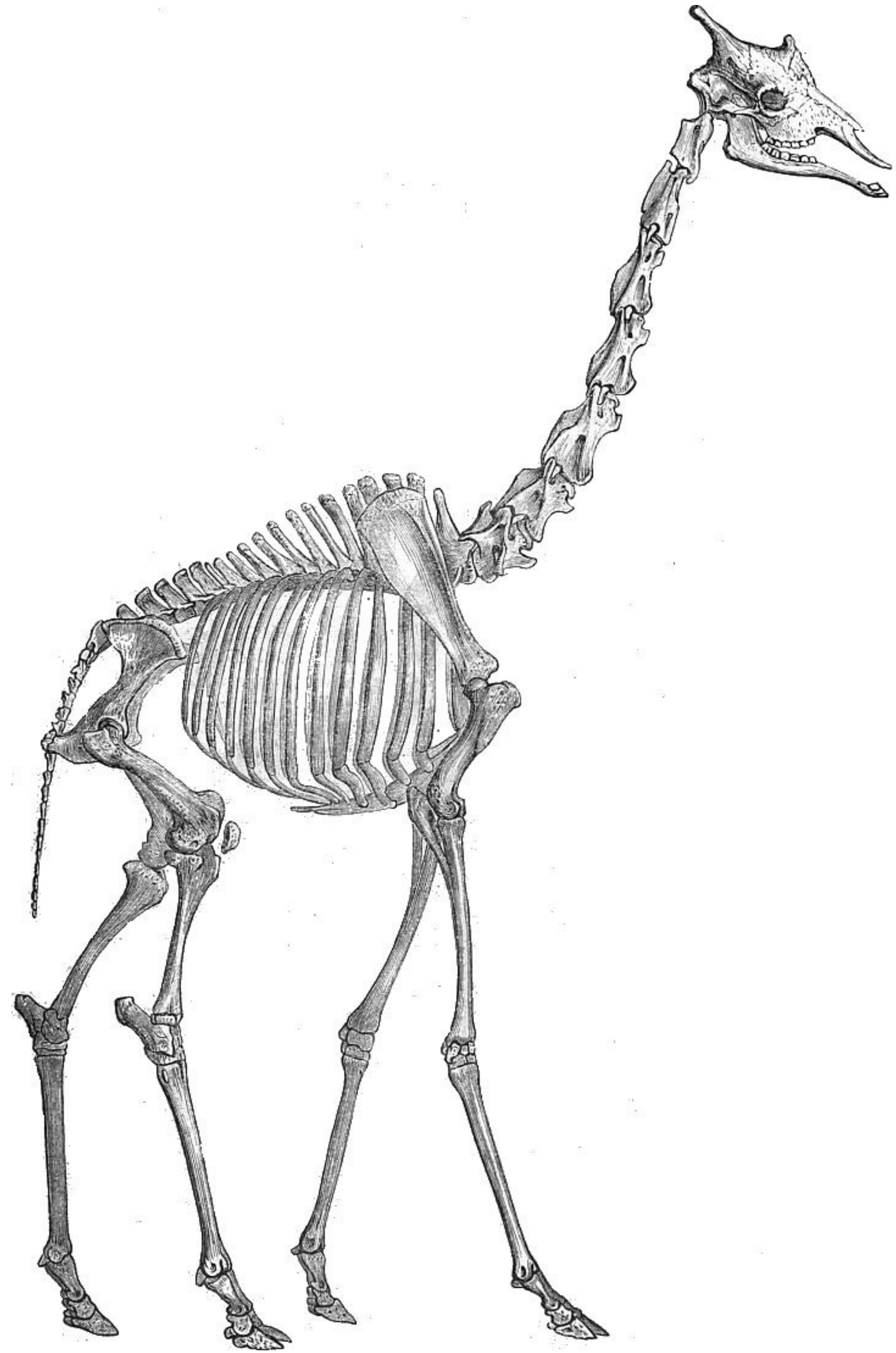




Is this all part of a single functional complex?





Diversity and disparity of artiodactyls

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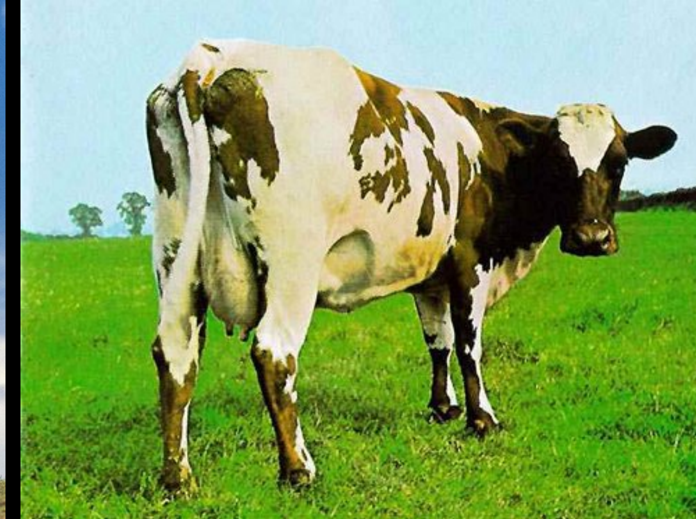
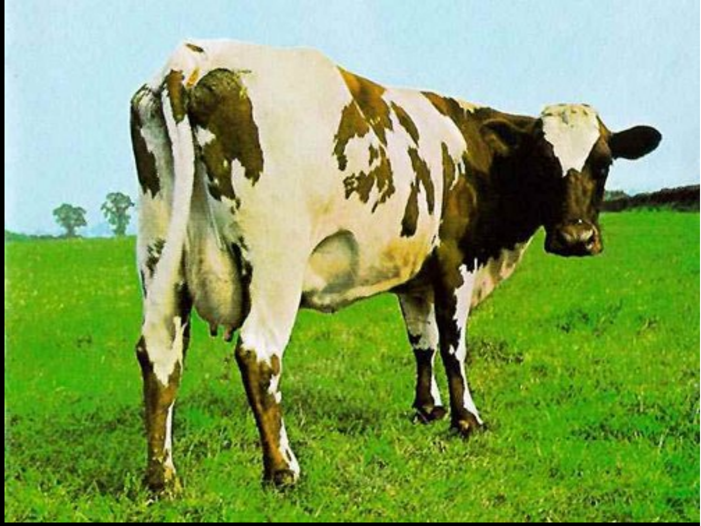
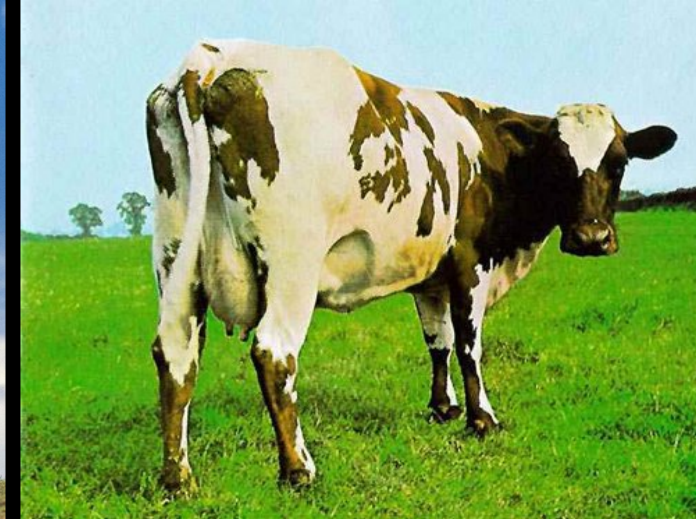
  

Diversity and disparity of artiodactyls



nd disparity of artiodactyls





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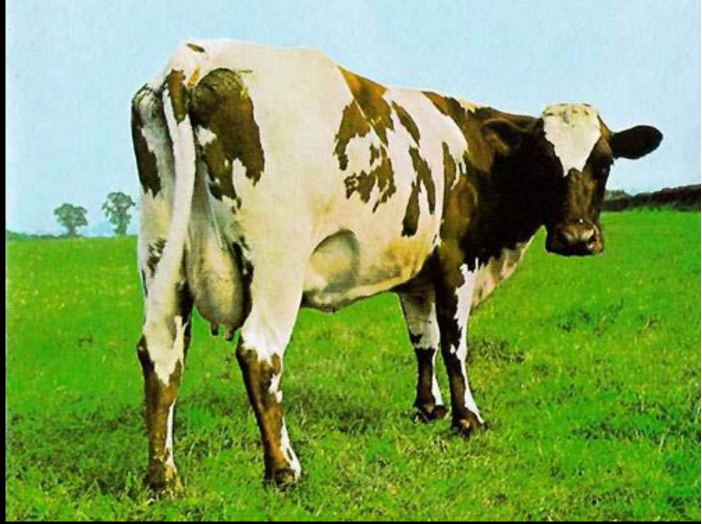
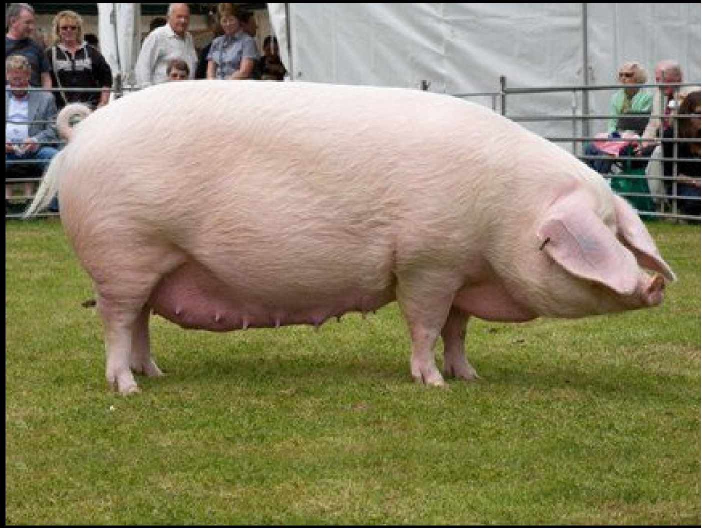
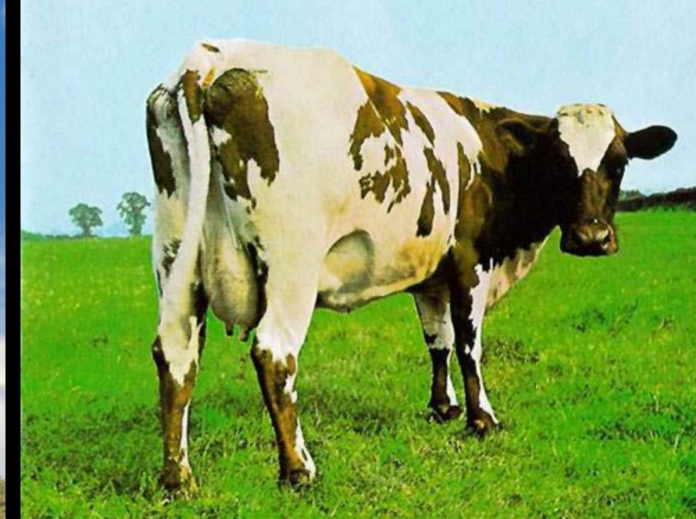
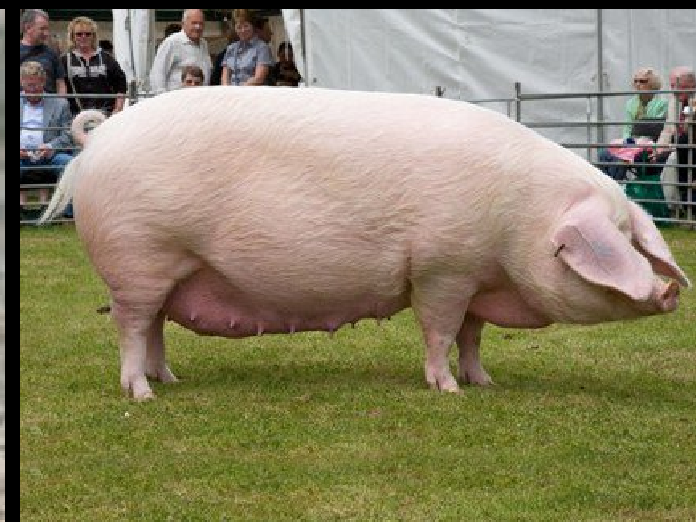


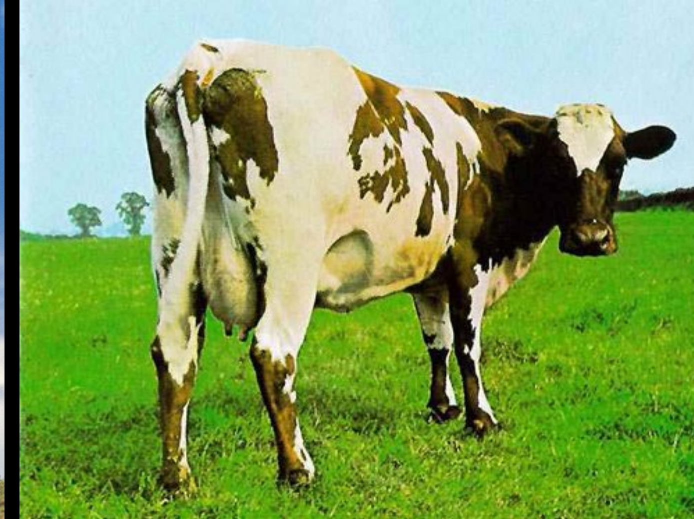



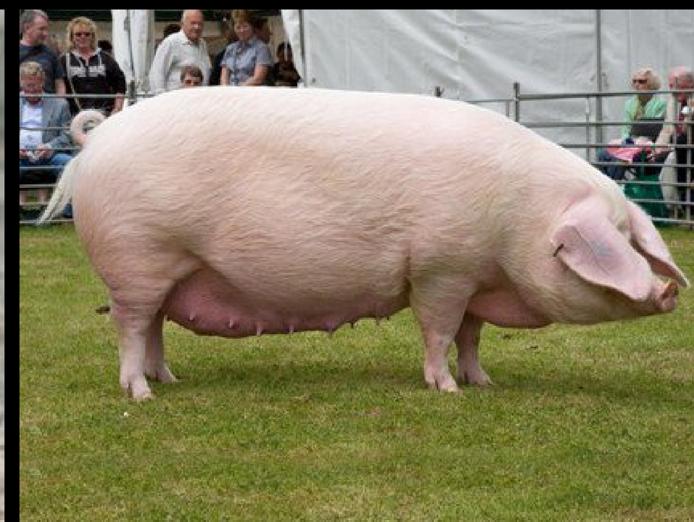




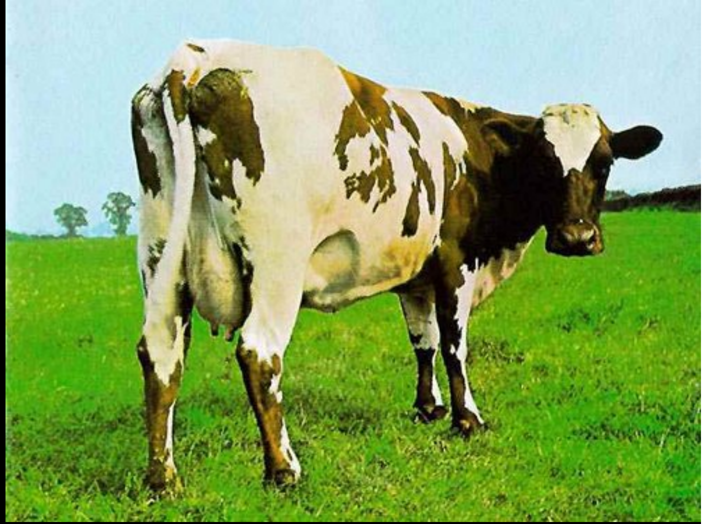



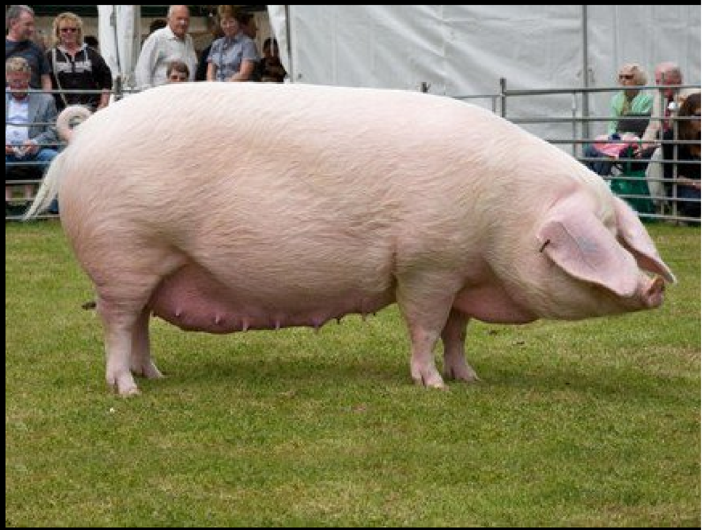


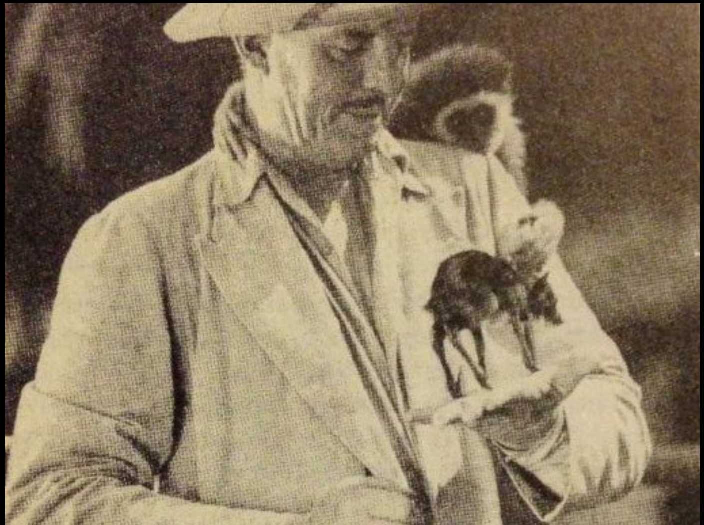







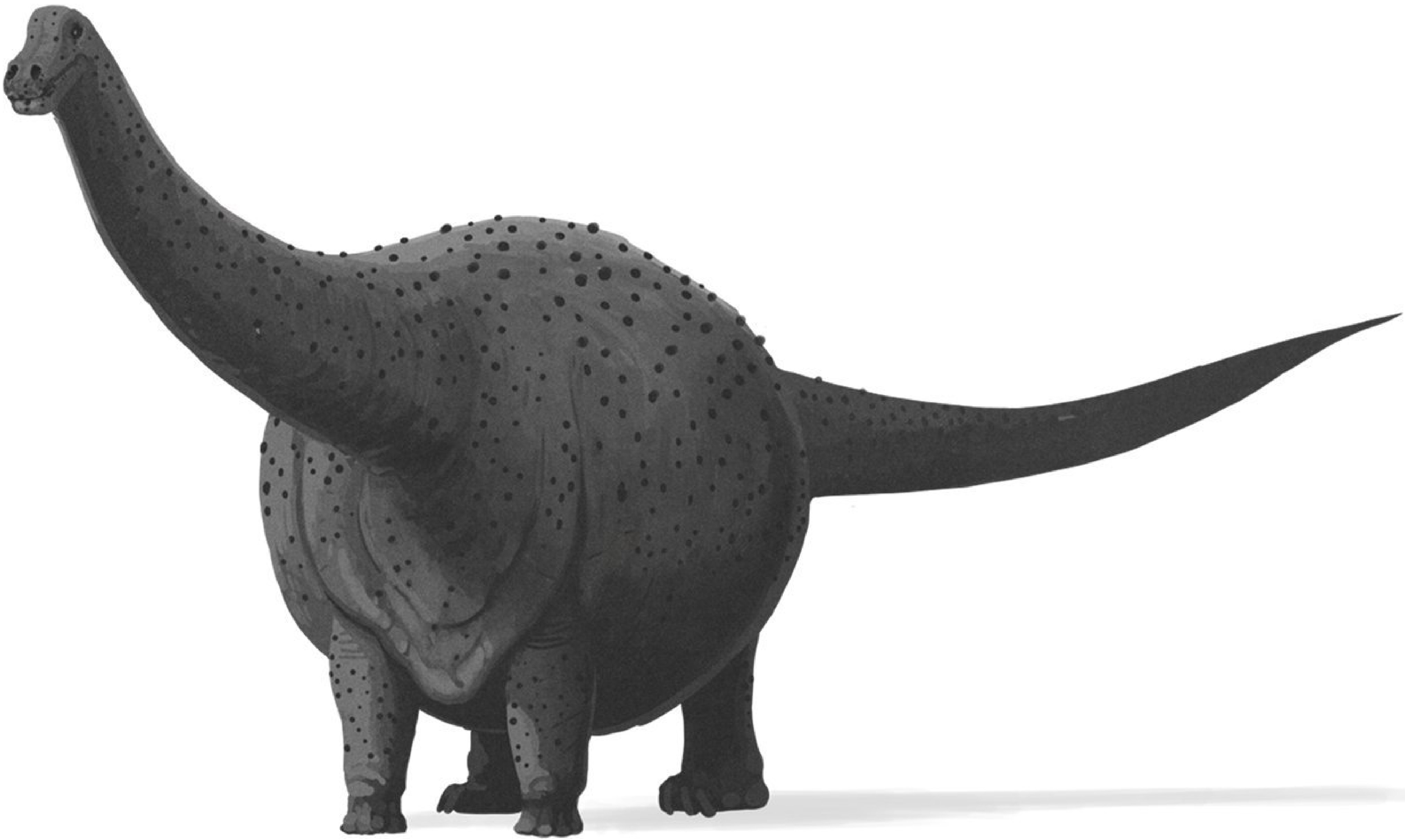





[cetacean needed]

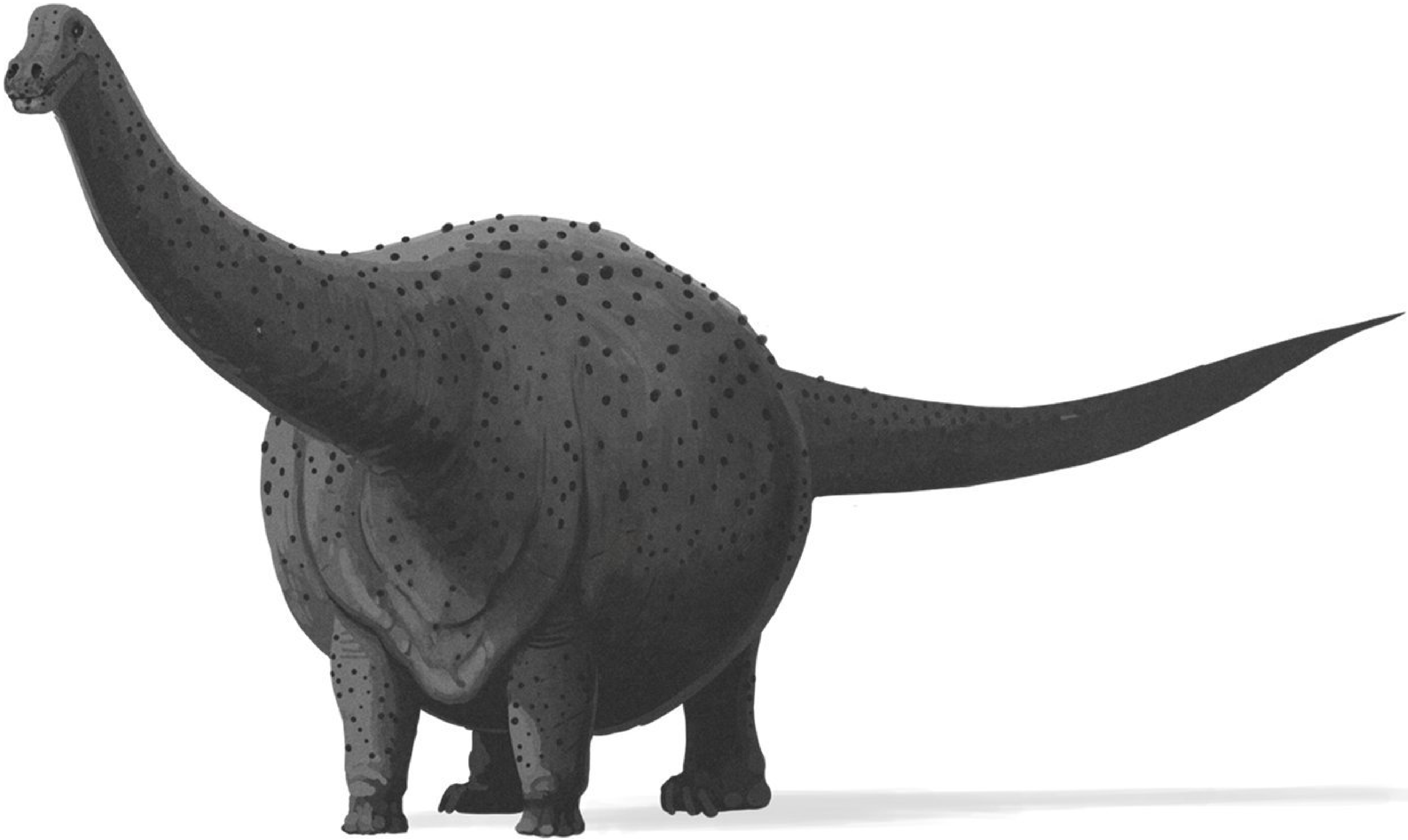
Opisthocoelicaudia

Art by John Conway



Obesethocoelicaudia

Art by John Conway

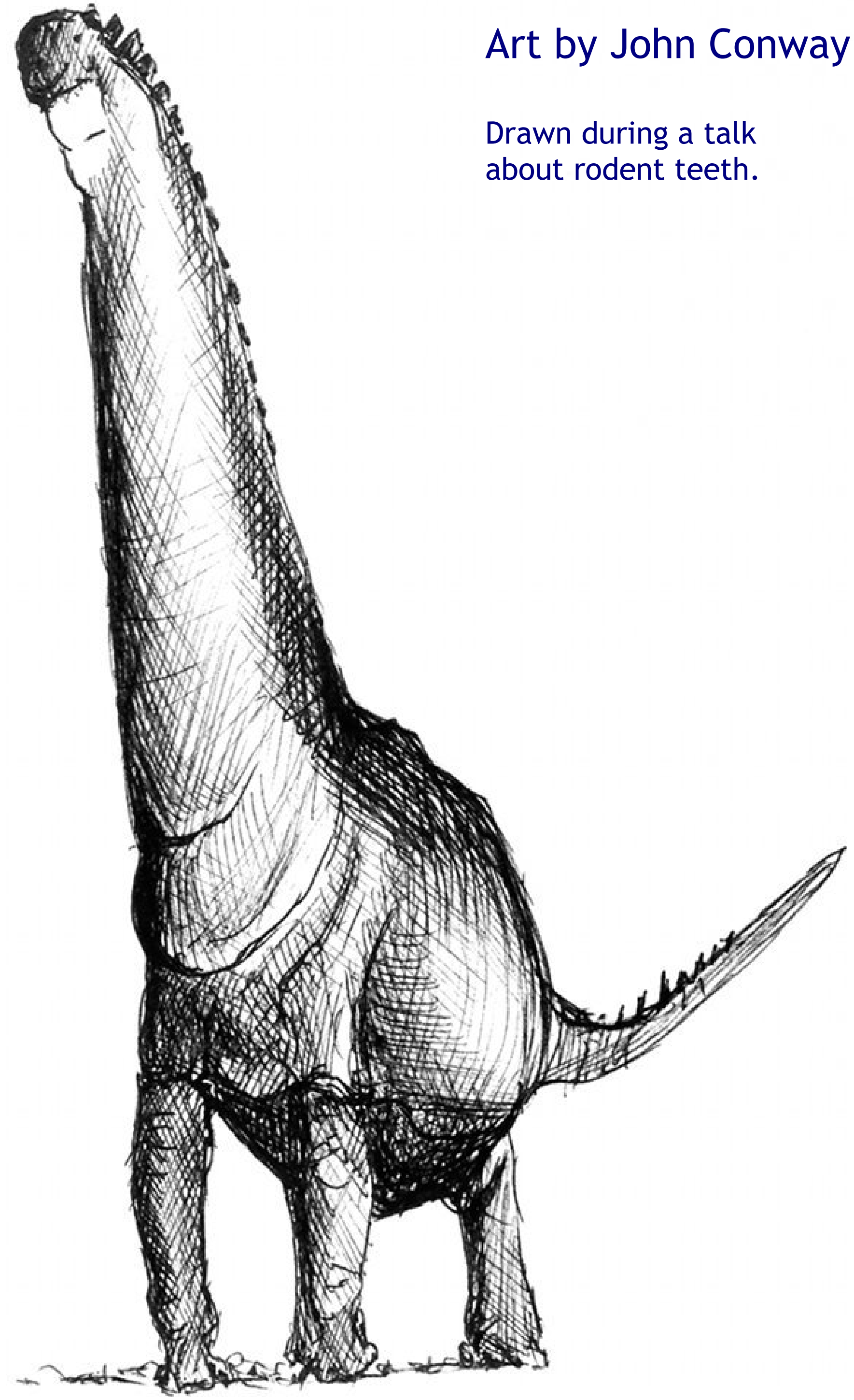



DIE WELT IM OBEREN JURA

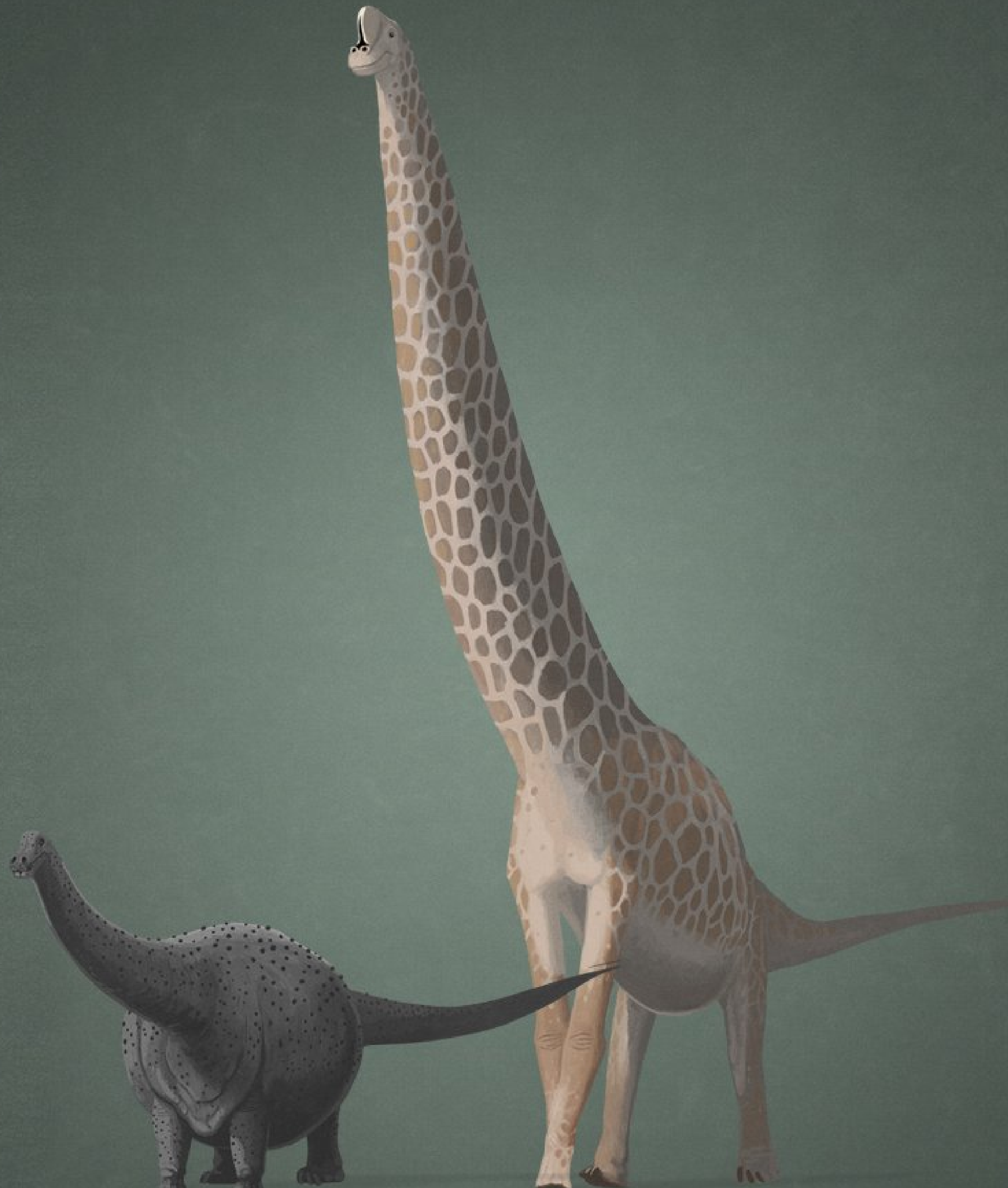

Art by John Conway

Art by John Conway

Drawn during a talk
about rodent teeth.



Questions



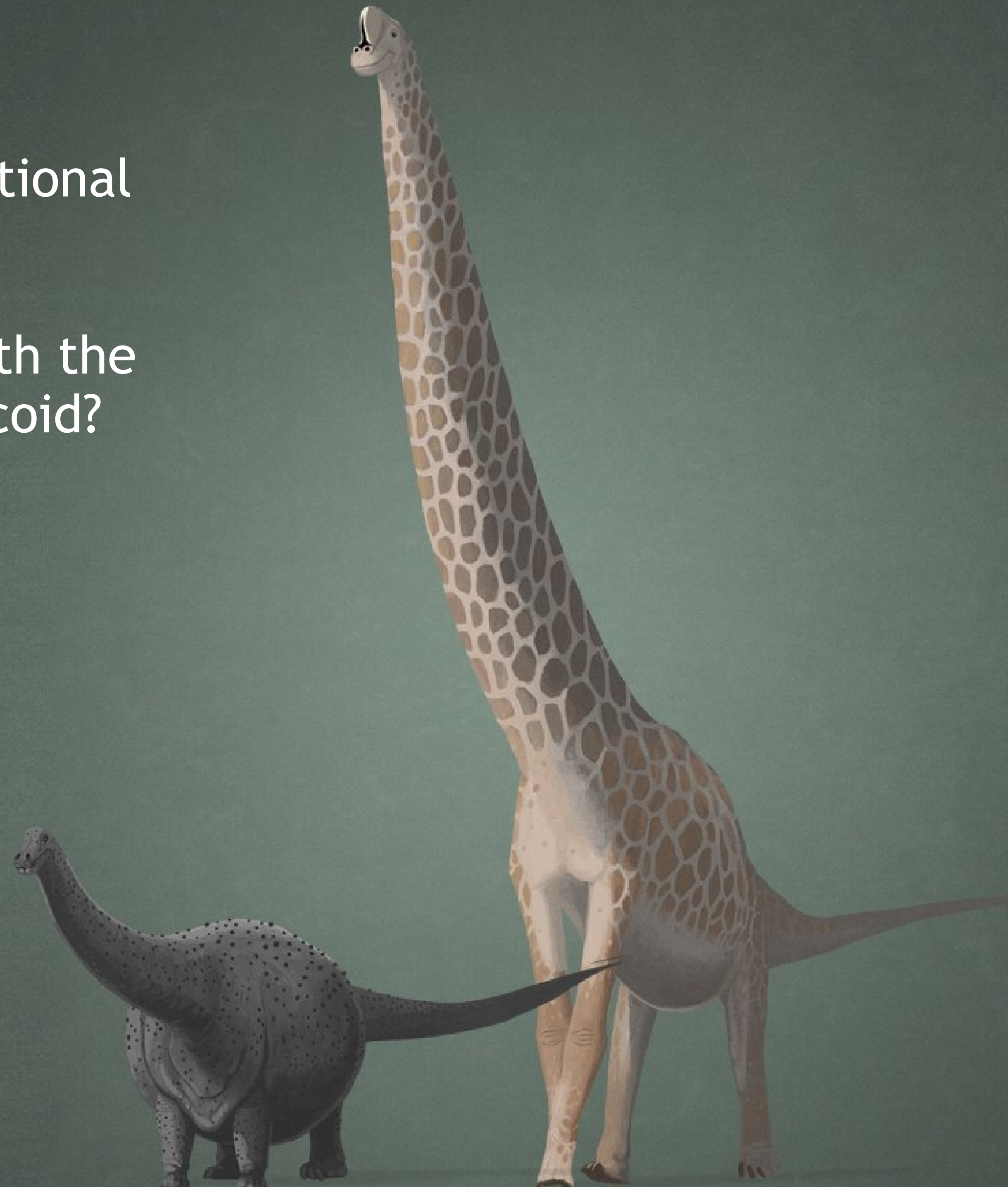
Questions

1. What does the functional complex add up to?

Questions

1. What does the functional complex add up to?

2. What is the deal with the *Brachiosaurus* coracoid?



Slender Giants

The unique and bizarre morphology of brachiosaurid sauropods

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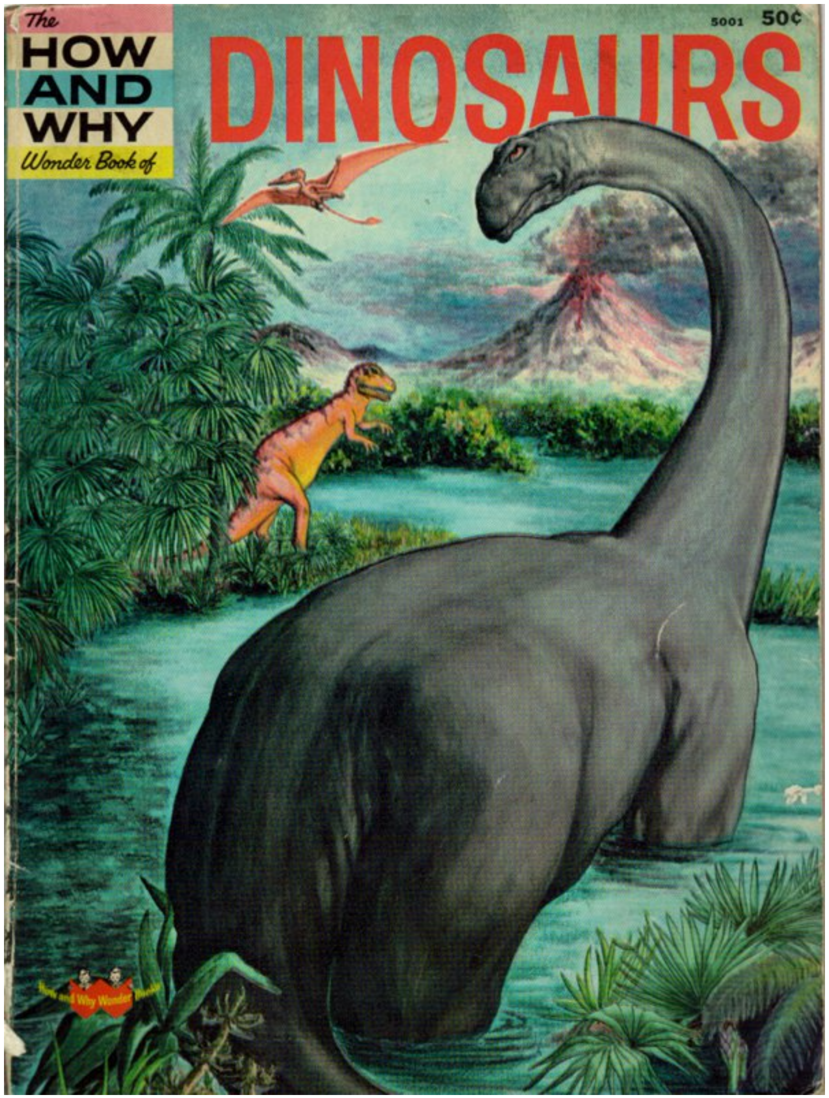
The
HOW
AND
WHY
Wonder Book of
5001
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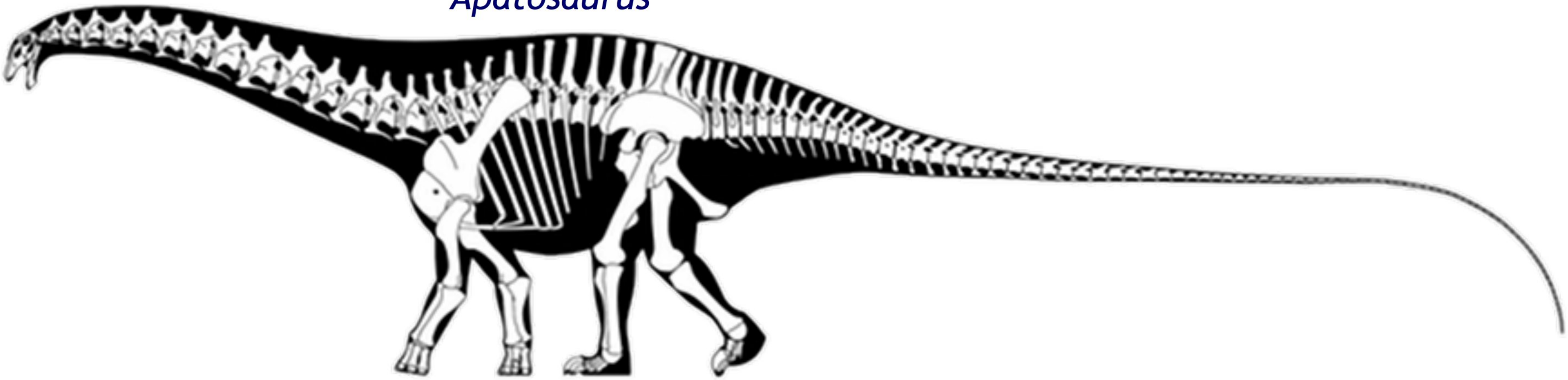
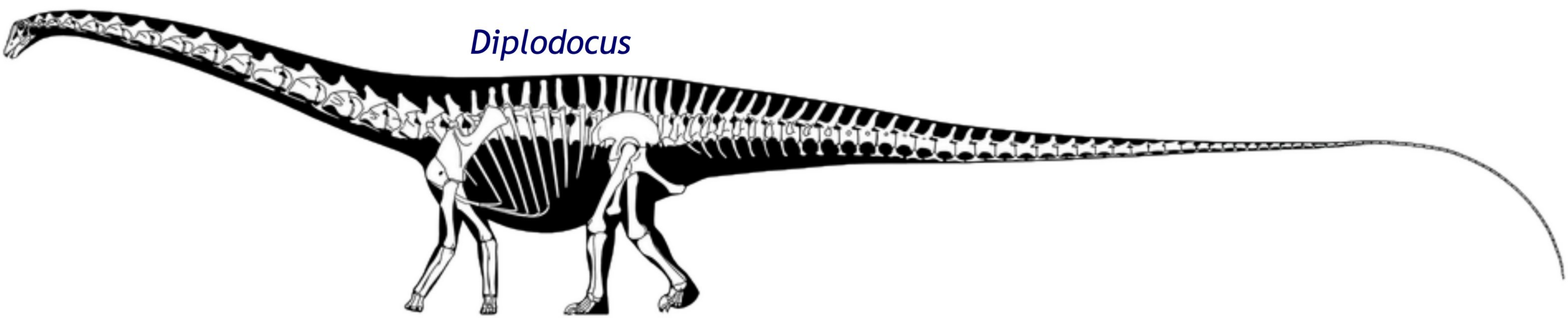
DINOSAURS

All reconstructions
by Scott Hartman

Apatosaurus



Diplodocus



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Brant Bassam
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