Omeisaurus
Late Jurassic

Mamenchisaurus
Late Jurassic

19 elongate vertebrae
Camarasauromorpha
Camarasauromorpha

Bifid (forked or split)

Transverse process

Centrum

Opisthocoelous centrum

10 cm

Neural spine

Neural arch

Pleurocoel
Camarasauromorpha

18 m (60 ft) long

Camarasaurus
Brachiosaurids

16 m (52 feet) tall

Brachiosaurus
Brachiosaurids
Brachiosaurids: an interesting physical problem...
Titanosaurids
Titanosaurids: primarily in the Cretaceous

Alamosaurus

~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
Diplodocid traits

Figure 6.8
An adult Diplodocus was a 27-meter-long, lightly built sauropod, characteristic of the diplodocids.

27 m = 90 ft; Blue whale length
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
Gray whale
*Eschrichtius robustus*

30-40 tons

Inhabits shallow waters of North American Pacific coast, migrating from Bering Sea in summer to Baja California breeding areas in winter. A small population lives along Asian Pacific coast as well. North Atlantic population is extinct.

Mottled appearance is due to large numbers of parasitic crustaceans, whale lice and barnacles on its skin.

Usually travels in groups of 2-3, moving at 3-6 mph. Can stay submerged up to 15 minutes.

Feeds on small crustaceans in ocean floor by sifting sediment through its mouth plates.

Existing population worldwide is 19,000-23,000.

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Blue whale
*Balaenoptera musculus*

100-150 tons

The largest living animal, and on par with the largest animals that ever lived. Incomplete fossils of several dinosaurs suggest they might have been marginally longer and heavier. The largest blue whale on record was 108 feet long and was estimated to weigh 170 tons.

Range is worldwide; migrates to warmer waters in winter. Northern hemisphere whales average 75-80 feet; southern whales reach 90-100 feet. Commonly travel in pairs. Cruising speed is 12 mph, can sprint up to 30 mph.

Feeds on krill and other small animals by filtering through a series of overlapping plates in its mouth that substitute for teeth.

Can consume up to 4 tons a day.

Pre-whaling population has been estimated at 220,000-350,000. Today there are 5000-10,000 in southern hemisphere, 3000-4000 in north.

Phil Loubere, The Register
Diplodocids: Diplodocus

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

Double-beamed chevrons
Diplodocid Tails: strange chevrons...

Camarasaurus chevrons
a = articular surface (where chevron connects to the body of the vertebral)

Diplodocus chevrons...

Recall...
An explanation for odd mid-caudal chevrons?
Tail variations involve and increase in tail vertebrae from 44 - 80 (Apatosaurus & Diplodocus). Why?
Contact between tail and solid object at this velocity $\Rightarrow$ damage!

Speed of sound = 350 m/s

Apatasaurus tail snap simulation

**Figure 6.** Distal tail tip velocity versus time from one simulation for the reconstructed tail of *Apatosaurus* CM 3018.
Supersonic Diplodocid tails?

FOR

1. Tail proportions work
2. Extreme thinness and elongation of distal tail vertebrae
3. Unusually long, stiffened vertebrae at the very end of the tail

AGAINST

1. Tail tips highly vulnerable to damage on impact
2. No poppers found in the fossil record!

“It is pleasant to think that the first residents of Earth to break the sound barrier were not humans.”
Accessories
Accessories

a  b  c  d
Hypothesized trunk  Classical rendering  Modern depiction w/ resonating chamber

Diploodon

Indian Elephant
Accessories

Vertebral spines: *Amargasaurus* (Diplodocid)
Accessories

Keratinous spines?
The Sauropod Hiatus

65 my  Dinosaur extinction
75 my  Sauropods reappear

Late Cretaceous

Sauropod hiatus

100 my  Sauropods disappear

Early Cretaceous

Box Figure 6.3
The sauropod hiatus lasted 25 million years.
Apatosaurus
Herding?

Ecosystem Engineers
Dinosaur Thermoregulation: hot or not?
Early depiction of *Megalosaurus*
Fig. 6.10 Two models for the replacement of mammal-like reptiles, basal archosaurs, and rhynchosaurids by dinosaurs: (a) a competitive replacement scenario; (b) an opportunistic mass extinction replacement model.

Dinosaurs appeared at about the same time as mammals (160-170 Ma)
Dinosaurs took over at the start of the Mesozoic
Competitive Edge
vs.
Luck of the draw (Opportunistic)
Bakker argued that Dinosaurs were competitively superior to therapsids (including early mammals). Therefore, they had to be warm-blooded animals.

SA => square function
Volume => cubed function
Plot\left[ y = x^2, y = x^3, \{x,0,10\}\right]
Some Terminology... all animals regulate temperature; it’s just a matter of HOW

Ectothermic Poikilotherm

FUNCTIONALLY homeothermic

Ectothermic Homeotherm

Endothermic Homeotherm

Endothermic Poikilotherm
Not just Temperature control; these ‘lifestyles’ describe the whole of metabolic processes.
The Million Dollar Question: Were dinosaurs endothermic or ectothermic or something else entirely???
Dinosaur Metabolism: The evidence

1) Anatomy
2) Diet
3) Hearts
4) Brains
5) Bone Histology
6) Growth and LAGS
7) Ecology / Zoogeography
8) Chemistry
9) Noses
Dinosaur Metabolism: The evidence

1) Anatomy
Dinosaur Metabolism: The evidence

2) Diet

Figure 5. Brachylophosaurus in palatal view. Modified from Weishampel & Horner (1990)
Dinosaur Metabolism: The evidence

3) Hearts
Dinosaur Metabolism: The evidence

4) Brains
Dinosaur Metabolism: The evidence

5) Bone histology