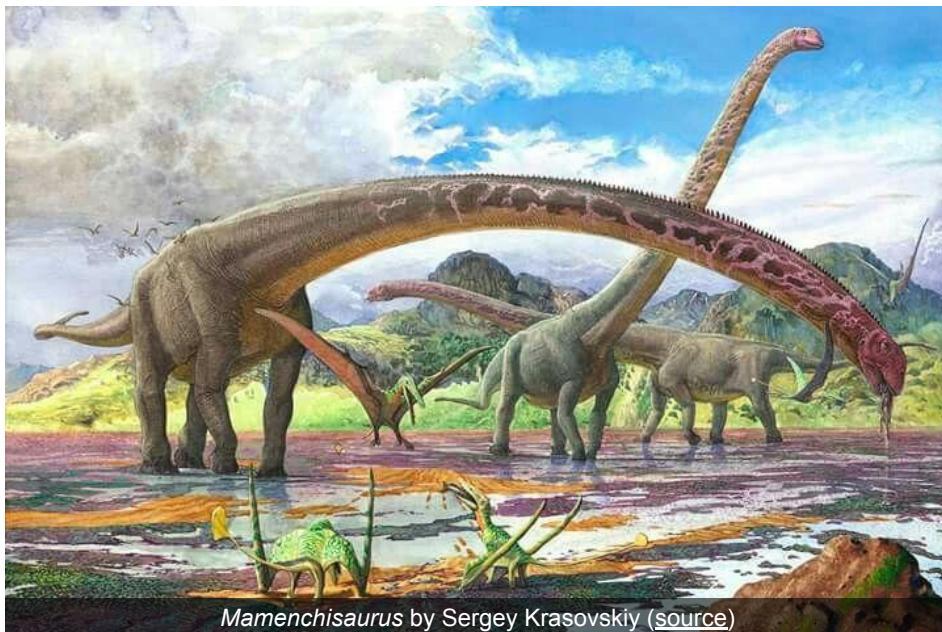
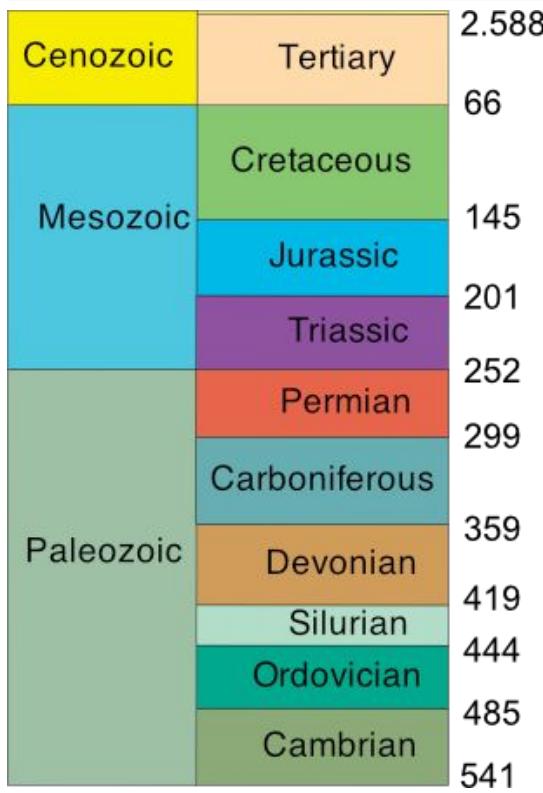


Lecture 13: Jurassic 1



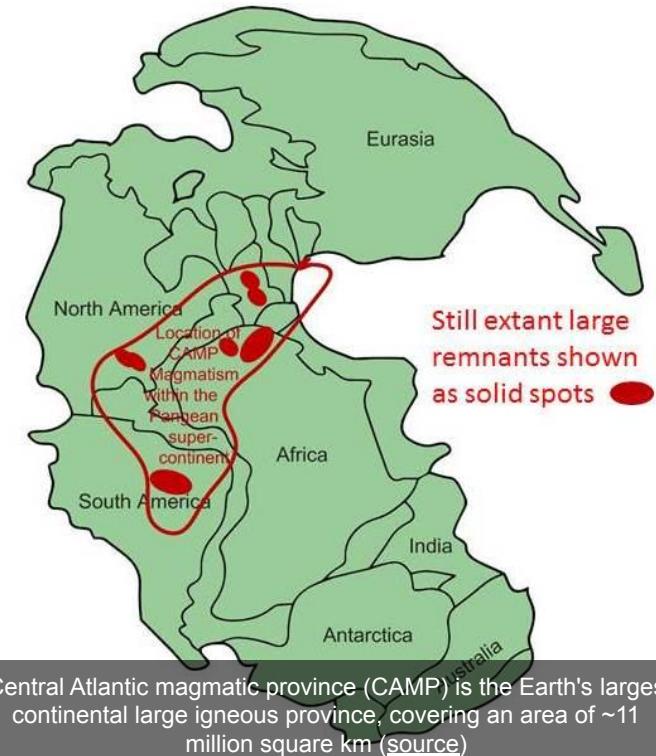
The Jurassic Period



- **Jurassic (201-145 Mya)** Second period of the Mesozoic Era
- ~145 Mya total
- Named after limestone deposits in the Jura Mountains along the French / Swiss border

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



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

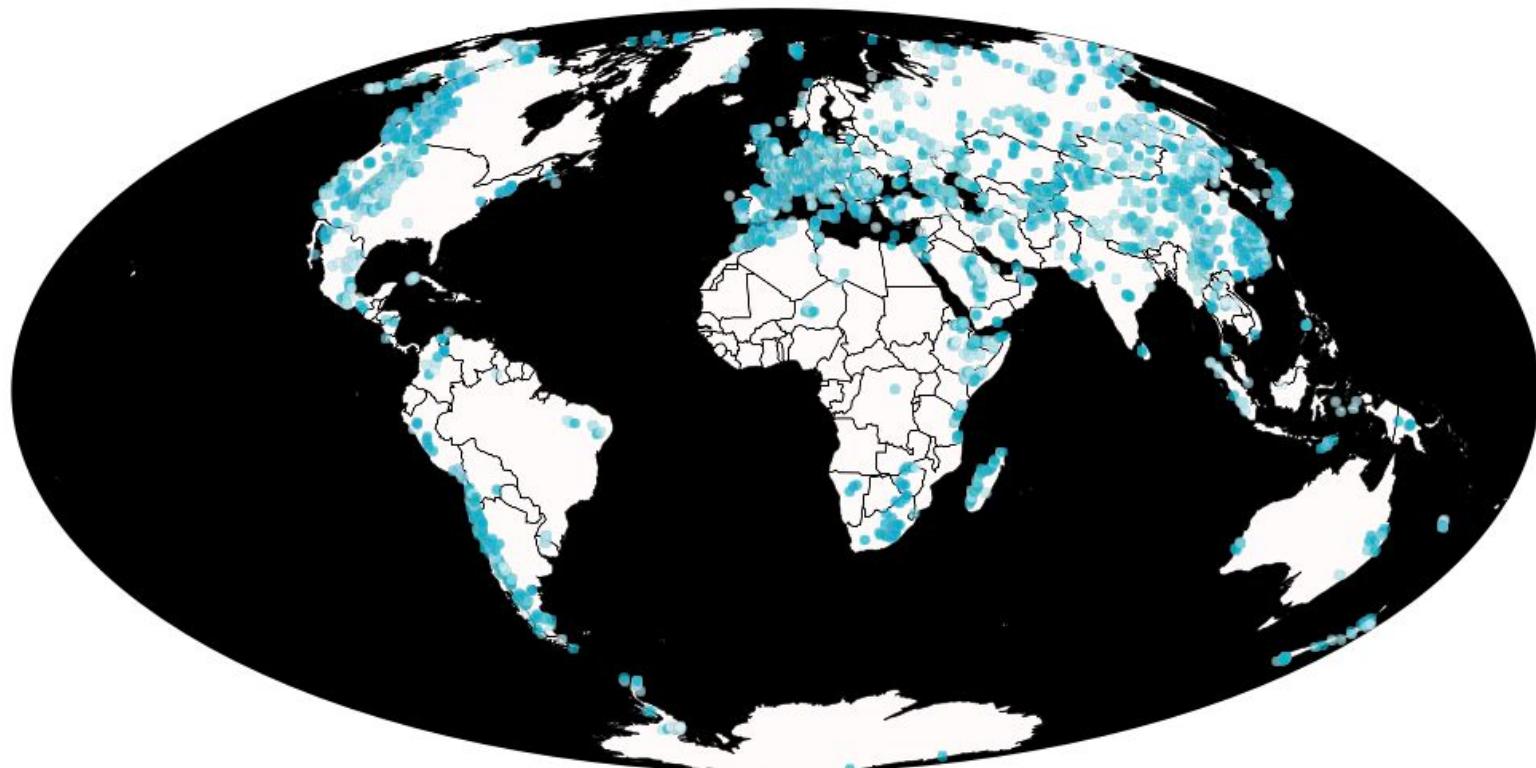
Jurassic winners and losers

- **Crurotarsi:** only the crocodylomorphs survive
- **Synapsids:** only small proto-mammals survive
- True mammals appear in the Jurassic and diversify



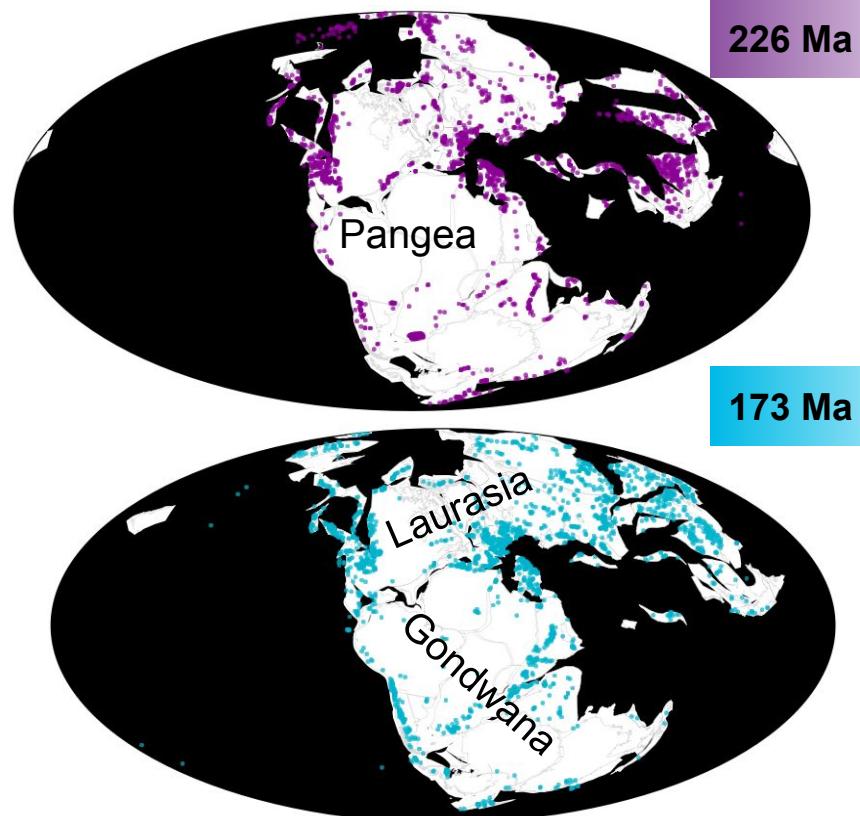
Mammals in a Jurassic forest from the Tiaojishan Formation, by Zhao Chuang ([source](#))

The distribution of Jurassic fossils

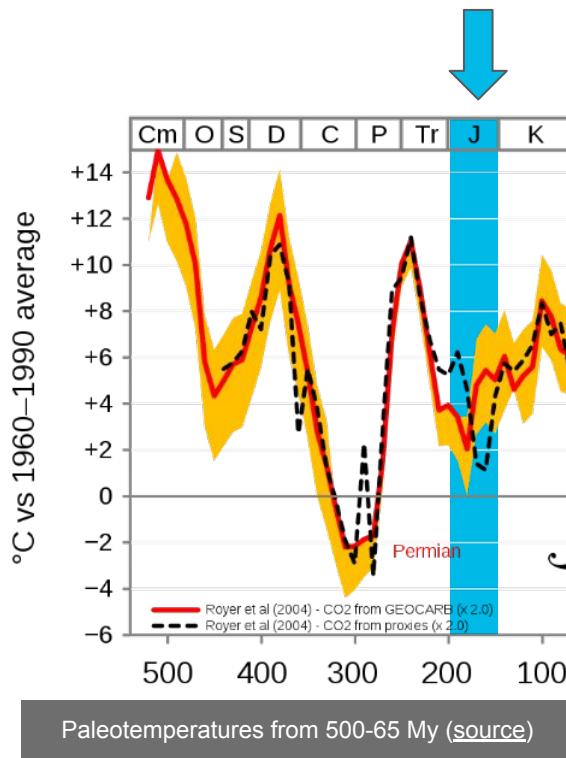


Reconstruction of the Jurassic world

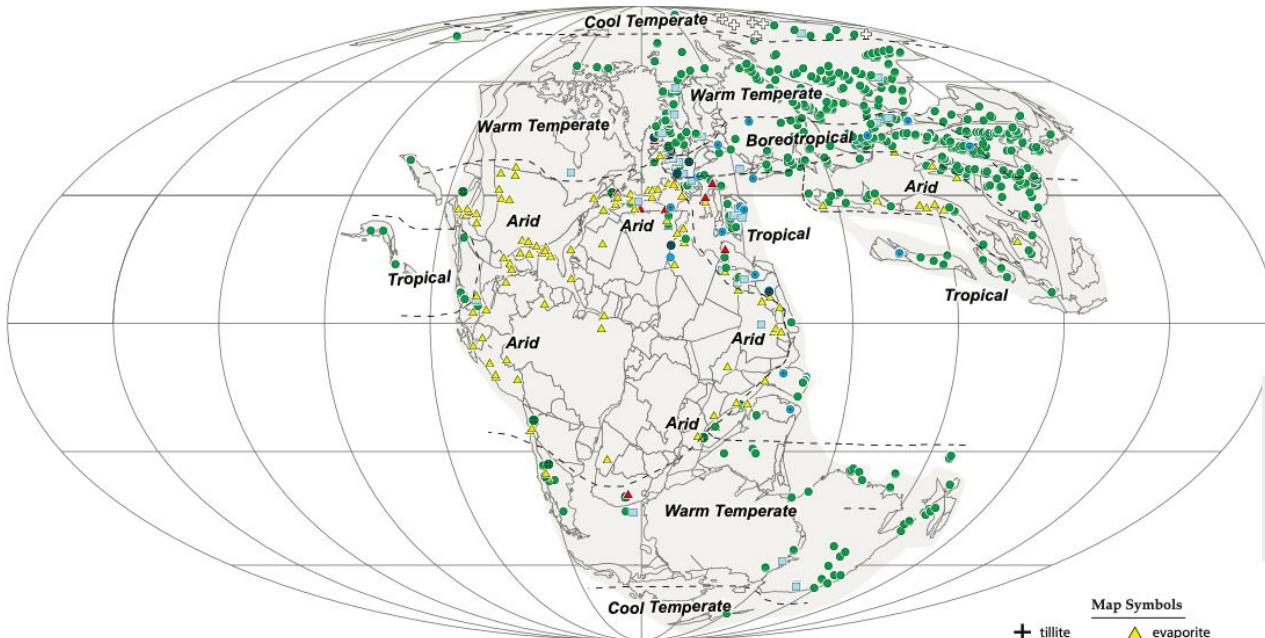
- Pangea starts rifting back into northern and southern supercontinents, in part from the end-Triassic volcanism
- The southern supercontinent, **Gondwana**, consists of the previous continents as before
- The northern continent, **Laurasia**, includes Euramerica plus modern-Asia



Jurassic paleoclimate



Jurassic paleoclimate



Map 19 Early and Middle Jurassic

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

Jurassic oceans



Jurassic ocean by Nikolay Zverkov ([source](#))

- Large **diapsids** evolve to feed on fish, ammonites, & each other
- Giant fish specialized in filter feeding



ammonites are an important Mesozoic **index fossil**

New groups of dinosaurs



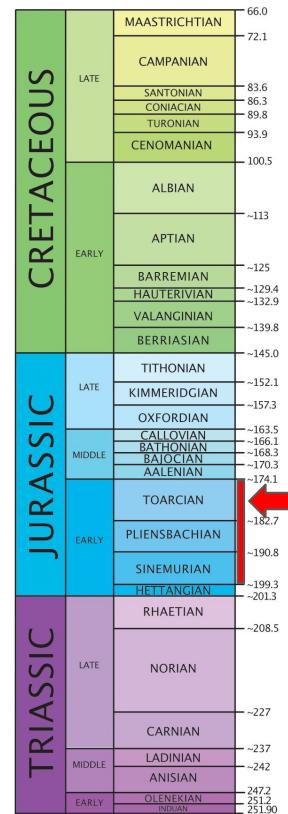
Cryolophosaurus by Fabio Pastori ([source](#))

- **Theropods** get larger and evolve into many new species through the Jurassic
- Many crested theropods in the early/mid Jurassic

Key Taxon: *Dilophosaurus*



Jurassic Park (1993) © Universal ([source](#))



Key Taxon: *Dilophosaurus*

Dilophosaurus

Greek: “di” = two; “lopho” = crested;
“saurus”=lizard



Three great clades of dinosaurs

ornithischians

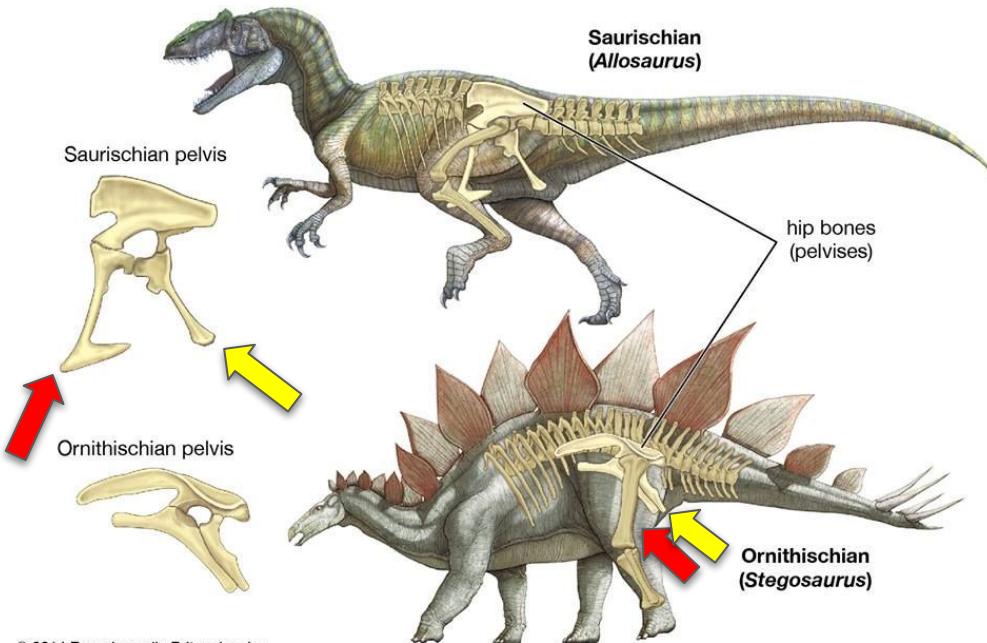
(clade **Ornithischia**)

Greek: “ornith” = bird; “ischia” = hip

- Unlike the **theropods** and **sauropods**, definitive ornithischians do not appear until the Jurassic
- Morphologically diverse plant eaters



Ornithischian traits



© 2014 Encyclopædia Britannica, Inc.

Ornithischian skeleton by *Encyclopedia Britannica* ([source](#))

- Backwards, pointing ischium and pubis bones in the pelvis
- Predentary bone in skull (which becomes a bony beak in many groups)



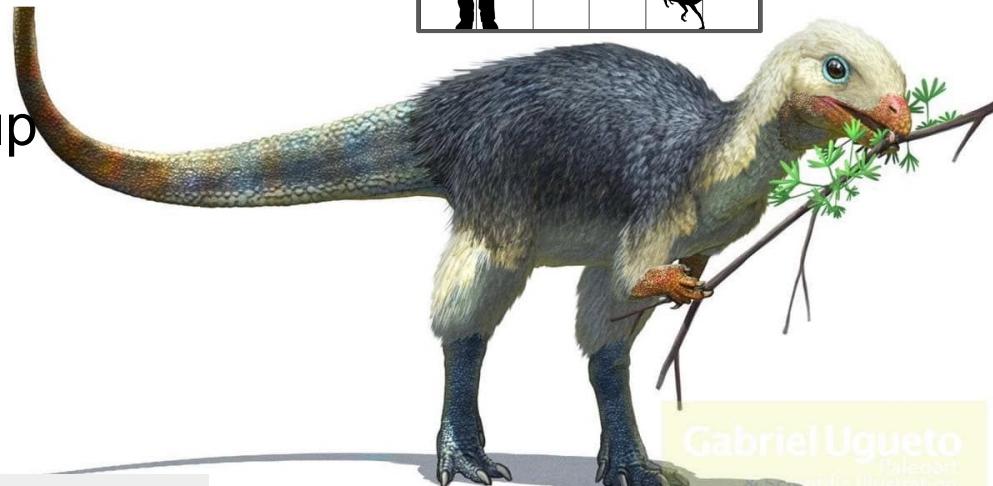
Heterodontosaurus
skull ([source](#))

Key Taxon: *Lesothosaurus*

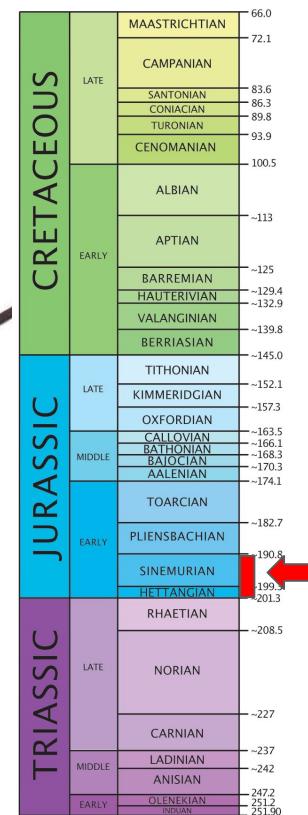
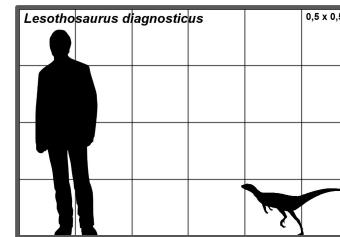
Lesothosaurus

“Lesotho” = A south African country; Greek:
“saurus”=lizard

- Found in the Karoo supergroup of Africa
- Leaf shaped teeth, large eyes



Lesothosaurus by Gabrielle Uguero ([source](#))

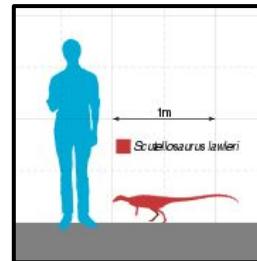


Godefroit, Pascal, et al. "A Jurassic ornithischian dinosaur from Siberia with both feathers and scales." *Science* 345.6195 (2014): 451-455.

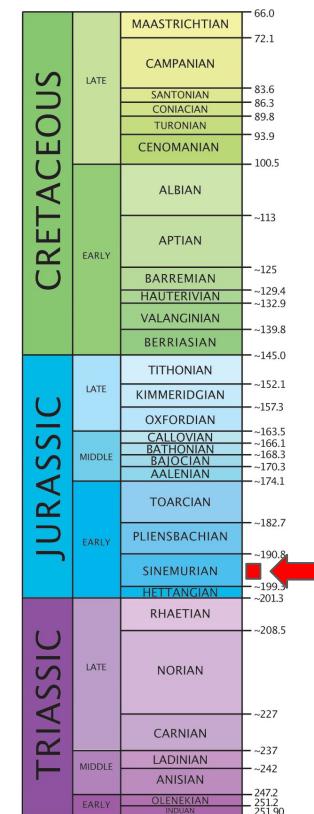
Key Taxon: *Scutellosaurus*

Scutellosaurus

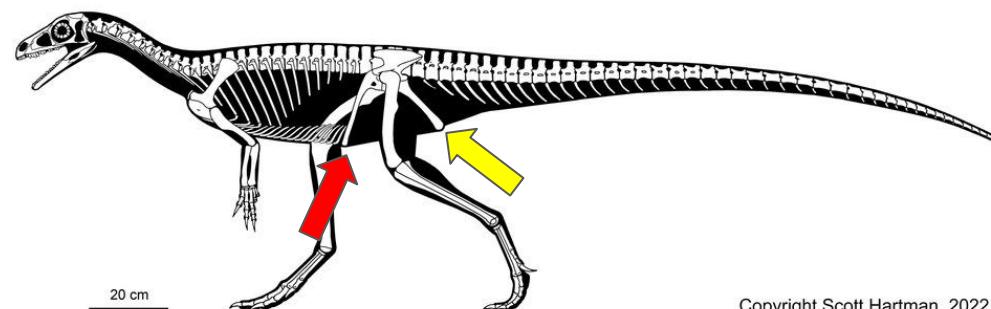
Greek: “scutello” = little-shielded; “saurus”=lizard



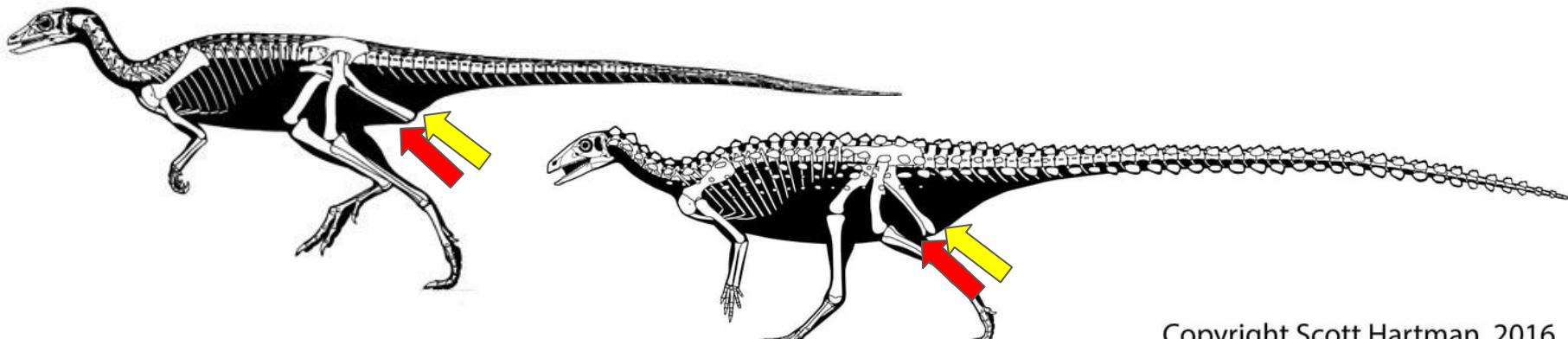
- Found in Arizona
- Short forelimbs and very long tail suggest it could walk on hind legs



Eoraptor vs. *Lesothosaurus* vs. *Scutellosaurus*



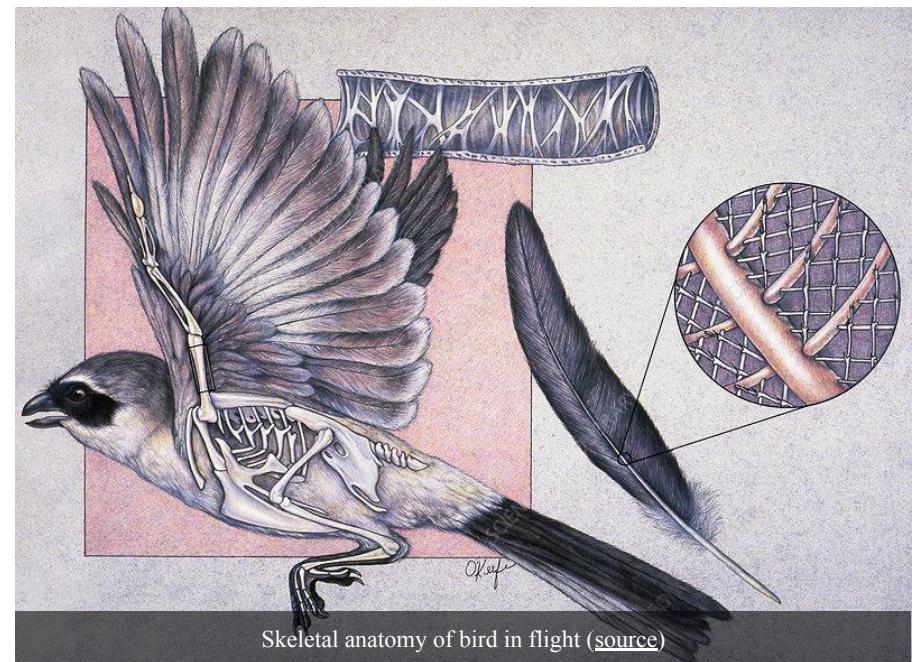
Copyright Scott Hartman, 2022.



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The first birds are found in the Jurassic

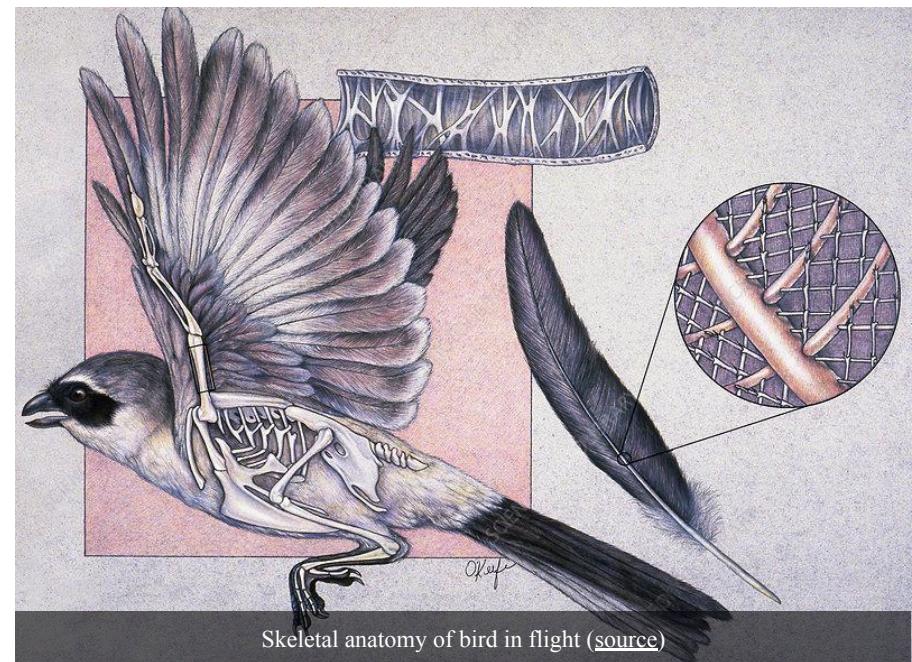
- **Birds:** a clade of endothermic diapsids with feathers
- The most successful group of flying vertebrates, with >9,000 species
- Adaptations for flight



Skeletal anatomy of bird in flight (source)

The first birds are found in the Jurassic

- **Birds:** a clade of endothermic diapsids with feathers
- The most successful group of flying vertebrates, with >9,000 species
- Adaptations for flight: toothless beaks, hollow bones, air sacs, pygostyle,



Skeletal anatomy of bird in flight (source)

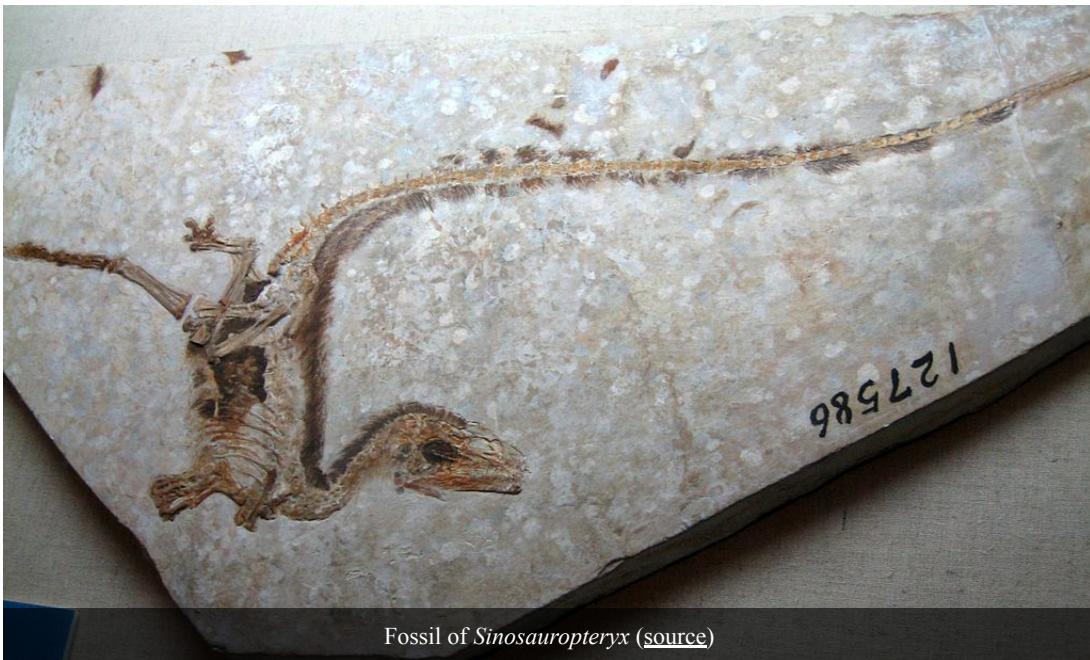
The evolution of birds



Archaeopteryx (source)

- Described in 1861, the late-Jurassic *Archaeopteryx* (~150 Mya) has been the quintessential reptile / bird transitional fossil for >100 years
- The hypothesis that birds descended developed soon after the discovery of *Archaeopteryx*, but it was not popular

When did feathers evolve?



Fossil of *Sinosauropteryx* ([source](#))

- In 1998, *Sinosauropteryx* was recognized as a dinosaur with filamentous (down) feathers
- Many feathered dinosaurs were later recovered from the Cretaceous-age Yixian Formation (~123 Mya)

Chen, P.; Dong, Z.; Zhen, S. (1998). "An exceptionally well-preserved theropod dinosaur from the Yixian Formation of China". *Nature*. 391 (8): 147–152.

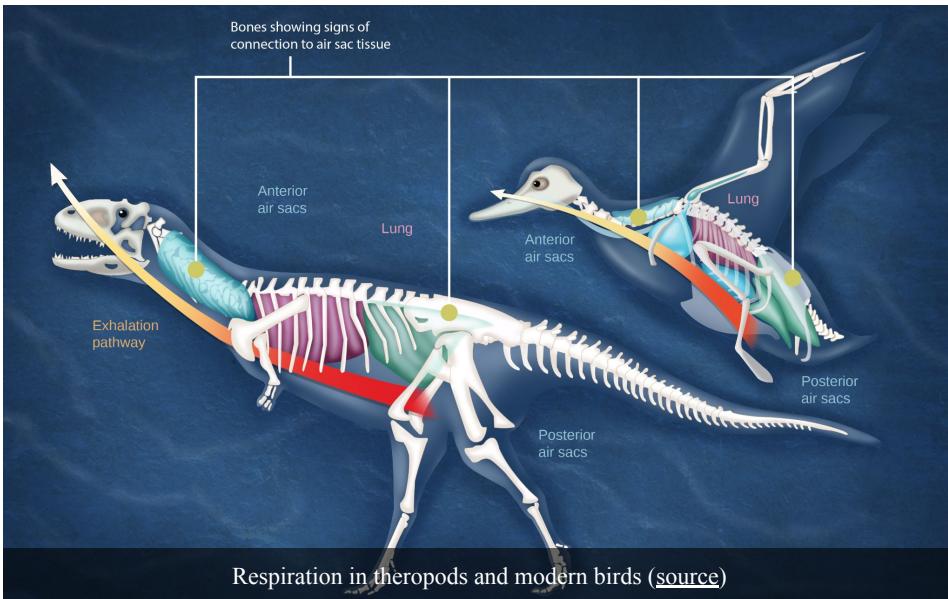
The evolution of birds is a case study in mosaic evolution



Fish mosaic by Kim Larson ([source](#))

- **Mosaic evolution:** evolutionary change takes place in some body parts without simultaneous changes in other parts
- This is a common evolutionary trend seen in the fossil record

The evolution of birds



- The evolution of birds demonstrates **mosaic evolution**
- Hollow bones filled with air sacs keep birds light and helps them fly. But hollow bones already existed in theropod and sauropod dinosaurs.

Feathers in Jurassic dinosaurs

- Juvenile fossil of the megalosaurid *Sciurumimus* (~150 Mya) has filamentous feathers
- Downy coat would have been particularly useful to small theropods, which would lose body heat quickly



Rauhut, Oliver WM, et al. "Exceptionally preserved juvenile megalosauroid theropod dinosaur with filamentous integument from the Late Jurassic of Germany." *Proceedings of the National Academy of Sciences* 109.29 (2012): 11746-11751.

Feathers in Jurassic dinosaurs

- *Epidexipteryx* (~160 Mya) was ~10cm long
- Had a pygostyle which anchored long display feathers



Zhang, Fucheng, et al. "A bizarre Jurassic maniraptoran from China with elongate ribbon-like feathers." *Nature* 455.7216 (2008): 1105-1108.

Experiments in flight

- *Yi* (~164-159 Mya) was a close relative of *Epidexipteryx*
- Evidence of gliding membranes between the long fingers and modified wrist bone
- Small, arboreal dinosaurs were experimenting with flight



Yi by Emily Willoughby ([source](#))



Fossil of *Yi* ([source](#))

Xu, Xing, et al. "A bizarre Jurassic maniraptoran theropod with preserved evidence of membranous wings." *Nature* 521.7550 (2015): 70-73.

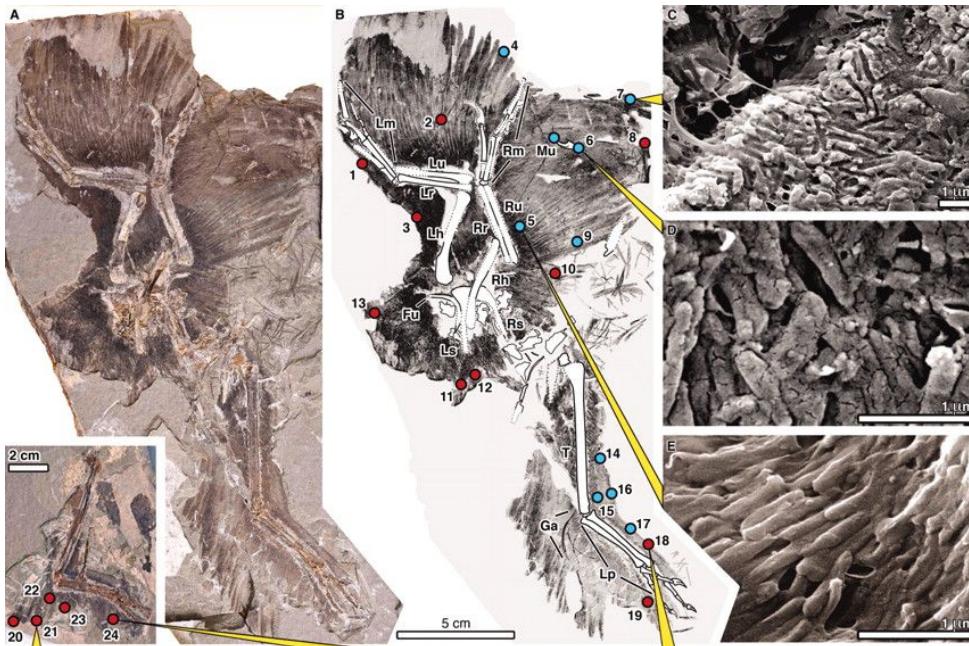
Feathers in Jurassic dinosaurs

- *Anchiornis* (~160 Mya) is known from hundreds of specimens in the Tiaojishan Formation, China
- The wings, legs, and tail supported long but relatively narrow vaned feathers



Fossil wing including the skin outline (white) and remains of the feathers (dark) ([source](#))

Feathers in Jurassic dinosaurs



- Pigment-producing organelles called melanosomes are preserved in some feathers



Reconstruction of colors in *Anchiornis* ([source](#))

Li, Quanguo, et al. "Plumage color patterns of an extinct dinosaur." *science* 327.5971 (2010): 1369-1372.

Flight in Anchiornis



The evolution of birds



- *Archaeopteryx* is now just one of many described feathered dinosaurs.
- Feathers originated early in dinosaur evolved for thermoregulation and display.
- Small, arboreal theropods experimented with gliding, using different combinations of membranes and feathers

Conclusions



Archaeopteryx ([source](#))

- The Jurassic is the time that the three great dinosaur lineages (**theropods**, **sauropods**, and **ornithischians**) diversify
- Differences between the three groups become clearer
- Theropods evolve into proto-birds by the late Jurassic

Next class

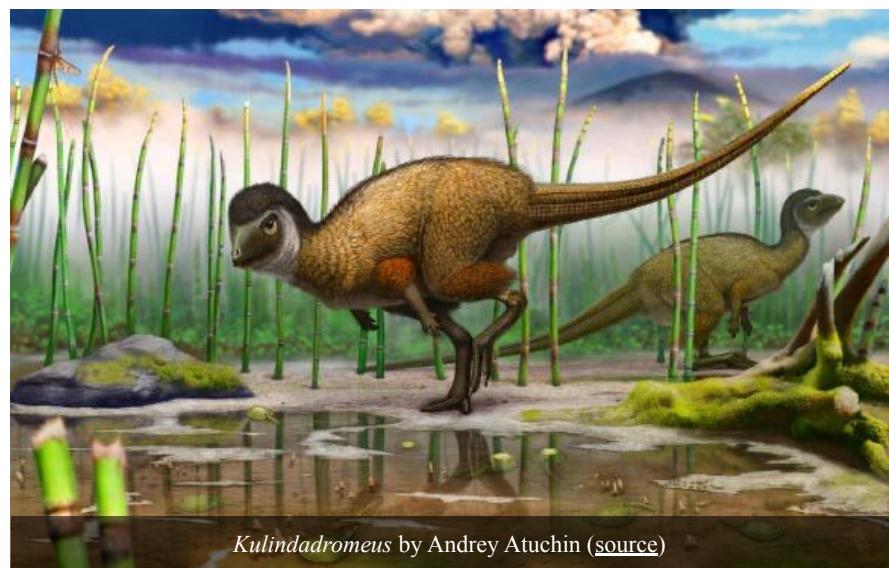


Allosaurus and Stegosaurus by Jaime Chirinos ([source](#))

© JA Chirinos 2018

When did feathers evolve?

- All dinosaurs with unambiguous feathers are theropods
- Several ornithischians, such as *Kulindadromeus*, are covered in filaments
- The **homology** between these coverings is unclear



Kulindadromeus by Andrey Atuchin ([source](#))

Godefroit, Pascal, et al. "A Jurassic ornithischian dinosaur from Siberia with both feathers and scales." *Science* 345.6195 (2014): 451-455.

How old are feathers?

