

**May 30, 2022**

## **News and notes**

I will be on a road trip starting May 31 and ending June 11, so next week's posting (June 6) will be somewhat abbreviated. Here are some news items that I thought were interesting.

## **Geopolitics**

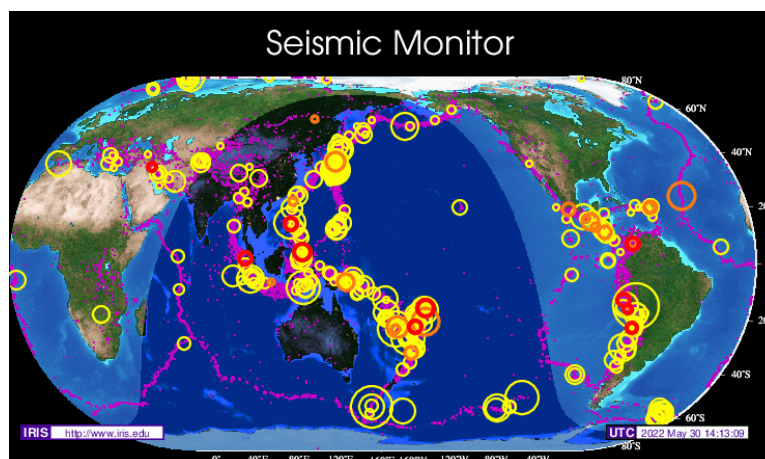
The war in Ukraine continues. Remembering that all wars involve deception, here are a few sites to observe changes in the war:

- Daily updates at the [Institute for the Study of War](#).
- [Live Map](#); regular updates to the changes in the on-the-ground situation.
- Oryx: [Assessments of battlefield losses](#).

## **Research**

- [Geology researchers are investigating the Shebandowan greenstone belt](#).
- Milankovitch cycles: [Persistent influence of precession on northern ice sheet variability since the early Pleistocene](#); behind a paywall, Phys.org summary [here](#).
- From The Conversation, Nature: [How plate tectonics, mountains and deep-sea sediments have maintained Earth's 'Goldilocks' climate](#).
- [Evolution of Earth's tectonic carbon conveyor belt](#); behind a paywall, Phys.org summary [here](#).
- Geomorphology: [Where rivers jump course](#); behind paywall, Eureka Alert summary [here](#).
- Geological timescale: [Astronomical tuning of the Aptian stage and its implications for age recalibrations and paleoclimatic events](#).

## **Volcanoes, Earthquakes and Geohazards**

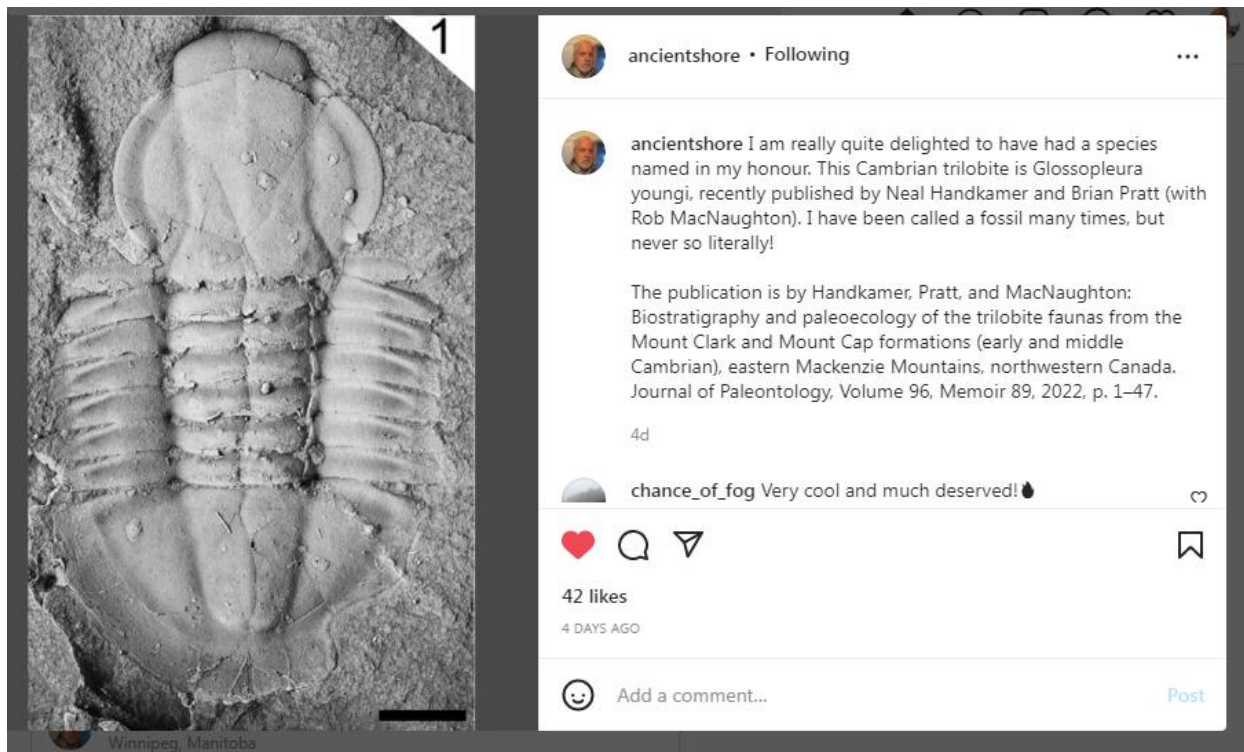


[Link](#)

- From Phys.org: [NASA images reveal 'Sharkcano' eruption, where sharks live near active underwater volcano.](#)
- Kilauea: [Fractional crystallisation of eclogite during the birth of a Hawaiian Volcano](#); Phys.org summary [here](#).
- [High water content of arc magmas recorded in cumulates from subduction zone lower crust](#); behind a paywall, Phys.org summary [here](#).
- [Tsunami excitation in the outer wedge of global subduction zones](#); Phys.org summary [here](#).
- [A Multi-Proxy Approach Using Zircon \(U-Th\)/He Thermochronometry and Biomarker Thermal Maturity to Robustly Capture Earthquake Temperature Rise Along the Punchbowl Fault, California](#); Phys.org summary [here](#).
- [The Stability and Collapse of Lava Domes: Insight From Photogrammetry and Slope Stability Models Applied to Sinabung Volcano \(Indonesia\).](#)
- From the United States Geological Survey: [M 7.2 Earthquake in Southern Peru.](#)
- [Worldwide Volcano News and Updates.](#)

## Paleontology

Congratulations to [Dr. Graham Young](#), Curator of Geology & Paleontology, [Manitoba Museum](#)



From Graham Young's [Instagram Page](#)

- Birds are dinosaurs! [Fossil biomolecules reveal an avian metabolism in the ancestral dinosaur](#); behind a paywall, Phys.org summary [here](#).
- Rapid evolution of modern birds: [Genetic variance in fitness indicates rapid contemporary adaptive evolution in wild animals](#); behind a paywall, Science Alert summary [here](#).
- [Morphology of Palaeospondylus shows affinity to tetrapod ancestors](#); behind a paywall, Eureka Alert summary [here](#).
- Fossilization: [Biofilms as agents of Ediacara-style fossilization](#).
- [Mayflies as resource pulses in Jurassic lacustrine ecosystems](#).
- "Dragon of Death" [\*Thanatosdrakon amaru\*, gen. et sp. nov., a giant azhdarchid pterosaur from the Upper Cretaceous of Argentina](#) ; behind a paywall, Smithsonian Magazine summary [here](#).
- The Capitol Reef: [Traces of an Ancient Watery World in Capitol Reef Photographed From Space Station](#), more on the [Capitol Reef](#).
- [Yorkicystis](#), the 500 million-year-old relative of starfish that lost its skeleton.

### **Environmental Geology and Hydrogeology**

- Using plants to remediate contaminated sites: [Willow can be recommended as a strong candidate for the phytoremediation of cadmium and pyrene co-polluted soil under flooding condition](#).
- [Modelling the economic and social issues related to environmental quality in Nigeria: the role of economic growth and internal conflict](#).
- [Invertebrate metal accumulation and toxicity from sediments affected by the Mount Polley mine disaster](#); Mining.com summary [here](#).

### **Energy and Mining**

- [Editorial: Advances in the Exploration and Development of Unconventional Oil and Gas: From the Integration of Geology and Engineering](#).
- From the United States Energy Information Administration(USEIA): [Memorial Day real gasoline prices highest since 2012, near record levels](#).
- Also from the USEIA: [EIA expects that natural gas production in the Permian Basin will increase in 2022 and 2023](#).
- [OPEC+ Unlikely To Boost Oil Production More Than Planned](#).
- From Mining.com: [Canada's first rare earth producer begins shipping concentrate](#).
- [Origin of the Sokoman Iron Formation, Labrador Trough, Canada](#)., behind a paywall.
- India: [This state has India's largest gold reserves, says Geological Survey of India](#).
- Crooks: [Glencore bribery cases draw in billionaire former executives](#); best quote: "manipulative, fraudulent, and corrupt conduct".

May 30, 2022

## Birds, Dinosaurs and Mammals of the Jurassic Period

The [Jurassic Period](#) is famous for being part of the "Age of Dinosaurs". In this week's posting we'll look at the avian (i.e. birds) and non-avian dinosaurs that lived during the Jurassic as well as the mammals that lived during that time.

### Avian Dinosaurs - Birds

[Birds](#) are dinosaurs and evolved from earlier forms of dinosaur. They first appeared during the Late Jurassic. The present scientific consensus is that birds are a group of [maniraptoran theropod](#) dinosaurs. Make no mistake about it - birds are dinosaurs!

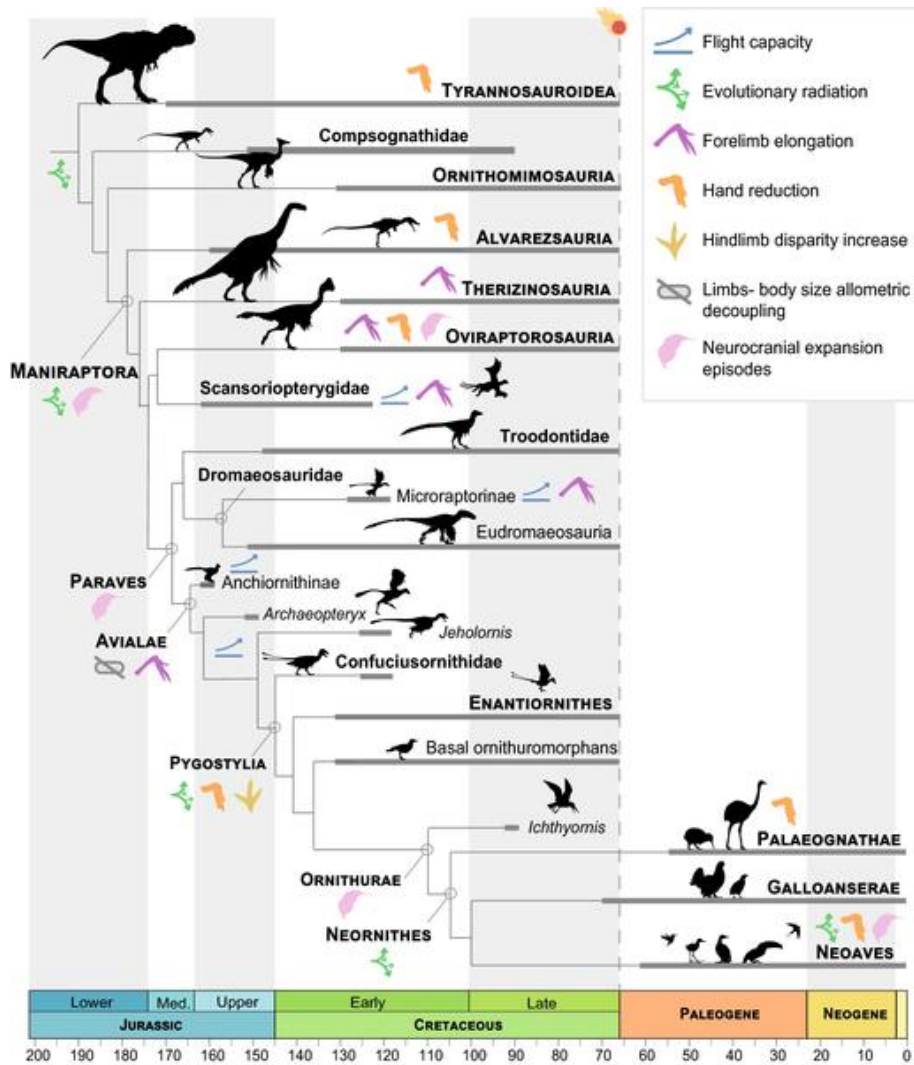


Figure 1 - Dinosaur Macroevolution

Credit: [Nebreda, Fernández & Marugán-Lobón, 2021](#)

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The details of bird evolution [are still being worked out](#) from the fossil record and genetic profile of modern birds. Figure 1, above, shows the most likely relationship between birds and other dinosaurs. Here are a few examples of avian dinosaurs from the Jurassic:

### ***Archaeopteryx***



**Figure 2 - *Archaeopteryx lithographica* Fossil**  
**Credit: [Wolfgang Sauber](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license**

One of the first avian dinosaur fossils ever found was [Archaeopteryx](#). [Hermann von Meyer](#) found the [first Archaeopteryx fossil](#) in 1861 in the [Solnhofen Limestone](#). The Solnhofen Limestone is a [lagerstätte](#), i.e. a formation with exceptionally good fossil preservation.

Since the initial finding by von Meyer, a single feather, the Solnhofen Limestone has yielded other fossils of *Archaeopteryx*. There are [currently total of 12](#) specimens.

About 50 cm in length, *Archaeopteryx* was about the size of a modern raven. It had feathers like modern birds, but teeth and a bony tail like the other dinosaurs of the time. Fossils of *Archaeopteryx* are among the earliest to show the asymmetric profile of [flight feathers](#), suggesting that it was capable of flight or [at least gliding](#). However, it lacked a bony breastbone and could not have been a strong flyer. Researchers have recently found the remains of [melanosomes](#) in the original feather specimen from 1861 and it appears that overall colour of *Archaeopteryx* was black.

The genus *Archaeopteryx* has two recognised species: *A. lithographica* and *A. siemensii*. While no longer considered the ancestor of modern birds, it is closely related to those ancestors. At least 10 other names for the genus exist in the literature, but the modern consensus has reduced them to only two.



**Figure 3 - The First *Archaeopteryx* Fossil**  
**Credit: [H. Raab \(User: Vesta\)](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license**



**Figure 4 - Reconstruction of *Archaeopteryx***  
**Credit: [Durbed](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license**

## ***Anchiornis***



**Figure 5 - *Anchiornis huxleyi***  
**Credit: [Bjoertvedt](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license**

Paleontologist Xu Xing and his team first described the fossil remains of *Anchiornis* in [a paper published in 2009](#). They found the fossil itself in [Late Jurassic](#) rocks of the in the [Tiaojishan Formation](#) of Liaoning, China. The fossil was of a small avian dinosaur with a wingspan of about 50 cm and a body length of about 40 cm. However, like Archaeopteryx, it did not have a breast bone so it probably could not fly by flapping its wings. So it was probably a glider. It did, however, have long legs suitable for running. Gastric pellets preserved with the fossils showed that *Anchiornis* [ate lizards and fish](#).

Based on a [study of the melanosomes](#) preserved in the fossils, *Anchiornis*' body was dark grey and the face had rufous speckles.



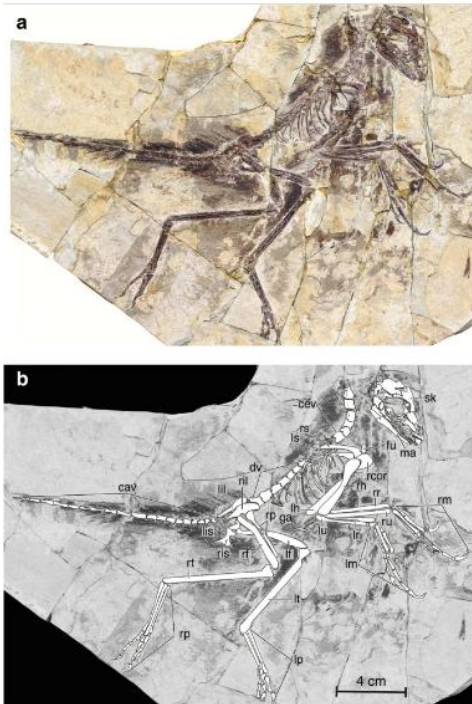
**Figure 6 - Reconstruction of *Anchiornis huxleyi***  
**Credit: Nobu Tamura, Creative Commons Attribution-Share Alike 3.0 Unported license**

There is only one species of *Anchiornis*, the type species *A. huxleyi*. The fossil genus, *Anchiornis*, derives from a Greek word meaning "near bird", while the species name, *huxleyi*, refers to the paleontologist [Thomas Henry Huxley](#), a.k.a. "Darwin's Bulldog".

### ***Eosinopteryx***

Another fossil found in the Late Jurassic Tiaojishan Formation, *Eosinopteryx* was [first described by the team of Dongyu Hu, Lianhai Hou, Lijun Zhang & Xing Xu](#). Found in rocks that were older than those where *Archaeopteryx* was found, *Eosinopteryx* (Greek for "dawn China feather") is known from a single fossil specimen, given the species name *E. brevipenna*.

The fossil of *Eosinopteryx* shows a [troodontid](#) theropod about 30 cm long [with feathers](#) and a short snout. It may not have been capable of flight. I think that the reconstruction makes it look like the original "[angry bird](#)".



(a) Photograph and (b) line drawing. cav, caudal vertebrae, cev, cervical vertebrae; dv, dorsal vertebrae; fu, furcula; ga, gastralia; lf, left femur; lh, left humerus; lil, left ilium; lis, left ischium; lm, left manus; lp, left pes; lr, left radius; ls, left scapula; lt, left tibia; lu, left ulna; ma, mandible; rcor, right coracoid; rf, right femur; rh, right humerus; ril, right ilium; ris, right ischium; rm, right manus; rp, right pes; rr, right radius; rs, right scapula; rt, right tibia; ru, right ulna; sk, skull.

**Figure 7 - *Eosinopteryx***

**Credit: [Figure 1 in Godefroit et al, 2013](#)**



**Figure 8 - Reconstruction of *Eosinopteryx***

**Credit: [El fosilmaníaco, Creative Commons Attribution-Share Alike 3.0 Unported license](#)**

## Non-Avian Dinosaurs

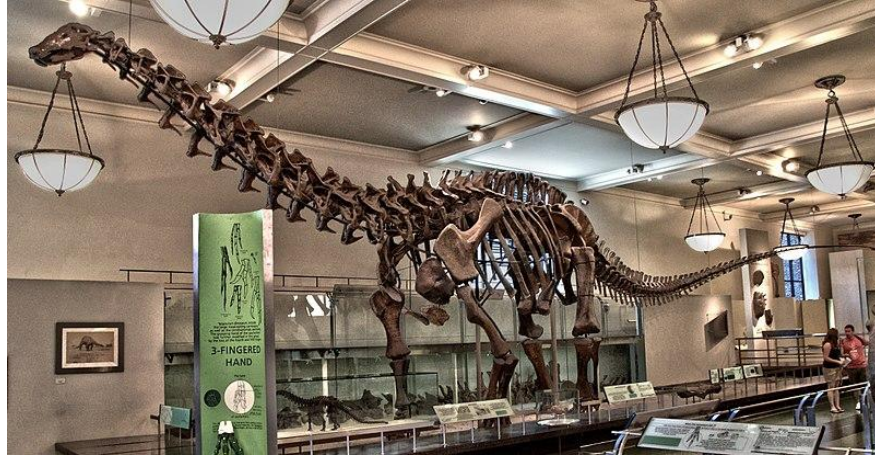
Among the thousands of dinosaurs species that [probably existed](#) in the [Mesozoic](#), we only know of about 800. I am only going to discuss a handful in this blog.

There are broad categories of non-avian dinosaurs from the Jurassic include:

- [Apatosaurinae](#)
- [Ceratosauria](#)
- [Diplodocinae](#)
- [Huayangosauridae](#)
- [Megalosauridae](#)
- [Somphospondyli](#)
- [Turiasauria](#)

Let's look at three examples.

## ***Apatosaurus***



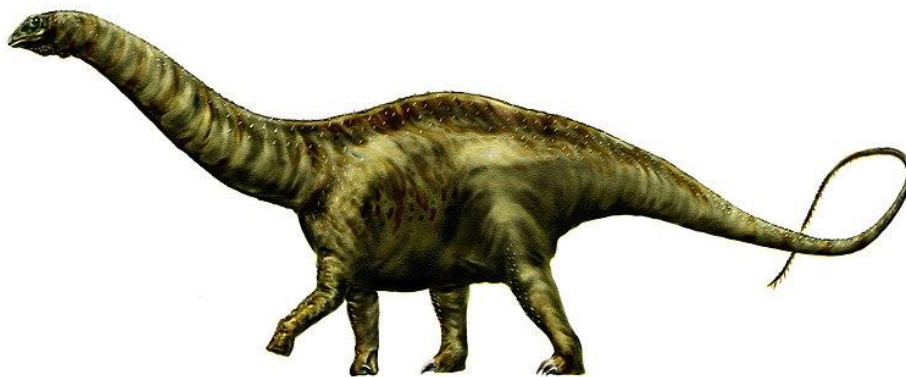
**Figure 9 - *Apatosaurus* Skeleton, [American Museum of Natural History](#), New York City**

**[Credit: ScottRobertAnselmo, Creative Commons](#)**

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Found as part of the [Great Dinosaur Hunt](#) of late 19th Century, [Othniel Charles Marsh](#) was the first to describe and name *Apatosaurus* in 1877, giving it the name *A. ajax*. William H. Holland found and named a second species, *A. louisae*, in 1916.

Both species of *Apatosaurus* were found in the Upper Jurassic [Morrison Formation](#) of modern-day Colorado, Oklahoma, New Mexico, Wyoming, and Utah in the United States. The Morrison Formation is composed of mudstone, sandstone, siltstone, and limestone. Most of the fossils occur in the siltstone and sandstone beds. The depositional environment was shallow marine and alluvial.



**Figure 10 - *Apatosaurus* Reconstruction**

**[Credit: Durbed, Creative Commons](#)**

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*Apatosaurus* was a huge [sauropod](#) dinosaur. [The fossil specimens suggest](#) that it was 21–22.8 m long and had a mass of 16.4–22.4 tonnes. It was a herbivore that frequented the rivers and flood plains where the Morrison Formation was deposited.

### ***Ceratosaurus***



**Figure 11 - *Ceratosaurus* Skeleton**

**Credit: [Richie D.](#), [Creative Commons Attribution 2.0 Generic](#) license**

Another discovery by O. C. Marsh during the Great Dinosaur Hunt was [Ceratosaurus](#). Found in 1884 in the Late Jurassic Morrison Formation near Garden Park, Colorado, Marsh gave the initial specimen the species name *C. nasicornis*.

Since Marsh's initial discovery, two additional species, *C. dentisulcatus* and *C. magnicornis*, were described in 2000 from two fragmentary skeletons from the [Cleveland-Lloyd Quarry](#) of Utah and from the vicinity of Fruita, Colorado. Specimens have also been reported from [Portugal](#), [Tanzania](#), [Uruguay](#), and [Moutier, Switzerland](#).



**Figure 12 - *Ceratosaurus* Reconstruction**

**Credit: [Nobu Tamura](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license**

*Ceratosaurus* was a large bipedal dinosaur, 400 to 900 kg in mass and 6 - 9 m long. It was a predator that lived in the alluvial environment in which the Morrison Formation was deposited.

### ***Barosaurus***



Another fossil from the Morrison Formation and the Great Dinosaur Hunt, [Barosaurus](#) was first found by Ms. E. R. Ellerman, the postmistress of Pottsville, South Dakota. In 1889, O. C. Marsh and [John Bell Hatcher](#) of Yale University excavated Ms. Ellerman's find and gave it the species name *Barosaurus lentus*. Other examples of *Barosaurus* have also been found in South Dakota. Some samples from Africa were tentatively assigned to *Barosaurus* but these are no longer considered valid classifications.

**Figure 13 - Barosaurus, American Museum of Natural History**  
**Credit: Thomas Quine, Creative Commons**  
**Attribution 2.0 Generic license**

Another big brute, *Barosaurus* was a giant, long-tailed, long-necked, plant-eating sauropod dinosaur. The fossils suggest the animal was 25 to 27 m long and about 12 to 20 tonnes in mass.

### **Jurassic Mammals**

While numerous dinosaurs, both avian and non-avian, wandered about the Jurassic landscape, [Mammaliaformes](#) also diversified and flourished during that time. Generally small, the Jurassic Mammaliaformes included groups such as:

- [Morganucodonta](#),
- [Docodonta](#),
- [Eutriconodonta](#),
- [Dryolestida](#),
- [Haramiyida](#), and
- [Multituberculata](#).

Let's look at three of these.

### ***Megazostrodon***

An genus of basal mammaliaforms belonging to the order Morganucodonta, [Megazostrodon](#) fossils were found in rocks from the [Late Triassic](#) to the [Early Jurassic](#). The paleontologist, Ione

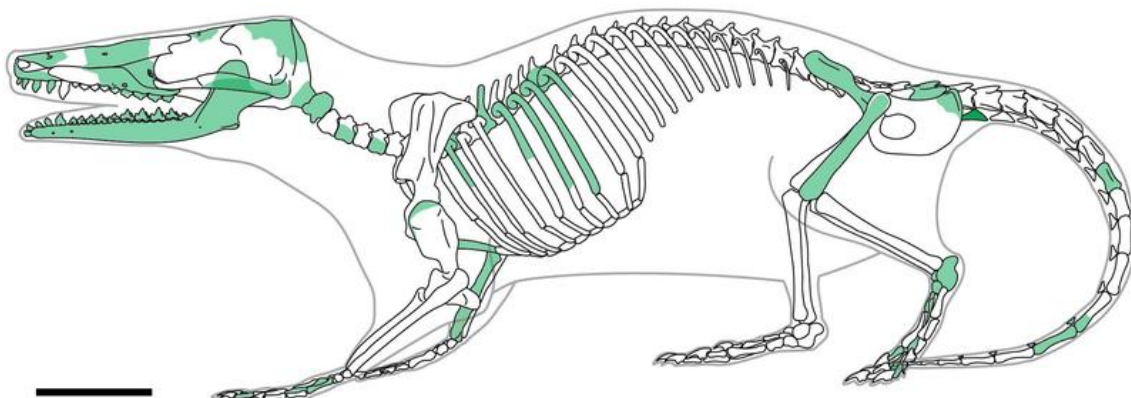
Rudner found the first fossil of *Megazostrodon* in 1966 in the Early Jurassic [Elliot Formation](#) of Lesotho. Later, in 1968, A.W. Crompton and F.A. Jenkins Jr. [described the find](#) in scientific literature and named the species, *M. rudnerae* after Ms. Rudner. In 2015, M. Debuyschere, E. Gheerbrant & R. Allain [found a second species](#) of the genus, *M. chenali*, in Late Triassic rocks near Saint-Nicolas-de-Port, France.



**Figure 14 - *Megazostrodon* Reconstruction**  
**Credit: [Ghedoghedo, Creative Commons Attribution-Share Alike 4.0 International license](#)**

*Megazostrodon* resembled modern day rodents in size, about 10 to 12 cm long (most of the length was tail). It had the heterodont dentition of modern mammals, with incisors, canines, premolars and molars. Fossils of *Megazostrodon* indicate that it had fur, whiskers, paws, and ears that stuck out. Its diet was probably small insects and whatever else it could catch.

### ***Borealestes***



**Figure 15 - *Borealestes***  
**Credit: [Panciroli et al, 2021, Creative Commons Attribution-Share Alike 4.0 International license](#)**

A small [docodontan](#), the first fossils of [Borealestes](#) came from the Middle Jurassic [Kilmaluag Formation](#) on the Isle of Skye, Scotland. Dr Michael Waldman [found the first fossil of Borealestes](#) during a school field trip he was leading on the Isle of Skye in 1971. He named the species *Borealestes serendipitus* ("northern rogue" and the serendipity by which it was found). In 2003, researcher Denise Sigogneau–Russell [described a second species](#) of *Borealestes*, *B. mussettae*, found in the Middle Jurassic [Forest Marble Formation](#) of Oxfordshire, England. In 2021, a third species, *B. cuillinensis*, was also found in the Kilmaluag Formation.

Robbie Burns' description of a "[wee, sleeket, cowran, timorous beastie](#)" probably applies to *Borealestes*.

### ***Volaticotherium***



**Figure 16 - *Volaticotherium* Fossil, [Paleozoological Museum of China](#)  
Credit: [Jonathan Chen, Creative Commons Attribution-Share Alike 4.0 International license](#)**

Birds and [pteroactyls](#) weren't the only thing flying or gliding around the Jurassic landscape, the [eutricodont](#) mammaliaform [Volaticotherium](#) was also taking to the air. About the size of a modern opossum, *Volaticotherium* fossils show a gliding membrane, similar to modern flying squirrels.

There is only [one fossil of Volaticotherium](#), found in the Daohugou bed of the Late Jurassic [Haifanggou Formation](#) of Ningcheng County, Inner Mongolia, China. The Haifanggou Formation was deposited in deltaic and lacustrine environments.

The teeth of *Volaticotherium* had [long, curved, backwards-pointing cusps as well as long canines](#). The dentition suggests a carnivorous diet, probably insects, somewhat like modern bats.



**Figure 17 - *Volaticotherium* Reconstruction**  
**Credit: [Nobu Tamura, Creative Commons Attribution-Share Alike 3.0 Unported license](#)**

## **Winding Up**

While this is only a limited look into the birds, dinosaurs and mammals of the Jurassic, I think that you can see the overall picture. Non-avian dinosaurs filled the ecological niches for large animals while birds and mammals occupied the niches of smaller animals. Birds had not yet achieved fully avian lifestyles but had the beginnings of what they would need for that way of life. Jurassic mammals had many of the features of modern day mammals. Our roots run deep.

## **Standard Caveat**

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.