

1,000,000,000 – One Billion Years Ago

- Geology
 - Fordham Gneiss – a metamorphic rock – is forming and will underlie a portion of the future New York City.
 - The Earth's landmasses form one huge supercontinent, Rodinia.

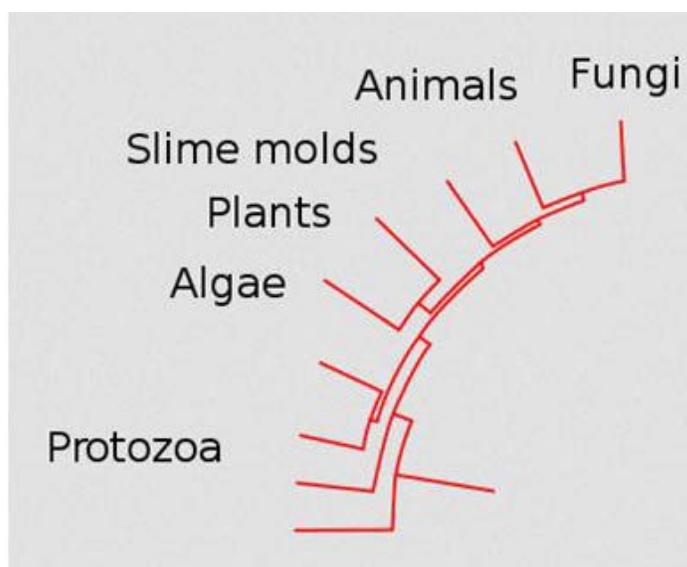


Supercontinent Rodinia

Image by Zina Deretsky used courtesy of the National Science Foundation.

- Biology
 - There are no plants or animals. Among the eukaryotic single-celled organisms, some groups are becoming different. Descendants of five of these groups will survive into the 21st Century and become the **Protozoa**, the **Plants & Algae**, the **Slime Molds**, the **Animals**, and the **Fungi**.

Tree of Life for Eukaryotes



Adapted from image released into the public domain by its author, Tim Vickers at the wikipedia project.

- Climate / Atmosphere
 - Cyanobacteria have been releasing oxygen into the oceans for over a billion years and have raised its concentration in the atmosphere from near zero to somewhat less than 2%; not enough oxygen for humans to survive for more than a few minutes. In the 21st Century, oxygen concentration in the atmosphere will be 21%.
 - The Earth spins so fast that each day – sunrise to sunrise – is 18 hours.



900,000,000 – Nine Hundred Million Years Ago

- Geology
 - Supercontinent Rodinia remains stable.
- Biology
 - Some eukaryotic organisms have become colonial; each cell is identical to the others. Increased oxygen levels in the atmosphere assist in supplying the higher energy requirements for these organisms. A choanoflagellate colony like the one pictured below will not only give rise to 21st Century choanoflagellates, but will also give rise to all multicellular true animals: sponges, fish, lizards, kangaroos, beetles, people, etc.



Choanoflagellate Colony

Image released into the public domain by its author, Dhzanette at the English Wikipedia project.



- Climate / Atmosphere
 - Oxygen in the oceans is outgassing into the atmosphere at a greater rate but the atmospheric concentration is still less than 3%.



800,000,000 – Eight Hundred Million Years Ago

- Geology
 - The portion of Earth's crust that corresponds to Death Valley sits astride the equator. Adjacent to it is crust that will become part of Antarctica!



Death Valley, California (viewed from the Int'l Space Station)

This photo is in the public domain courtesy of NASA



750,000,000 – Seven Hundred Fifty Million Years Ago

- Geology
 - The Earth orbits around its sun in a year (a solar year) and the sun orbits around the center of the Milky Way Galaxy approximately every 250,000,000 years (a galactic year). In other words, there are only three “galactic years” from this time to the 21st Century.



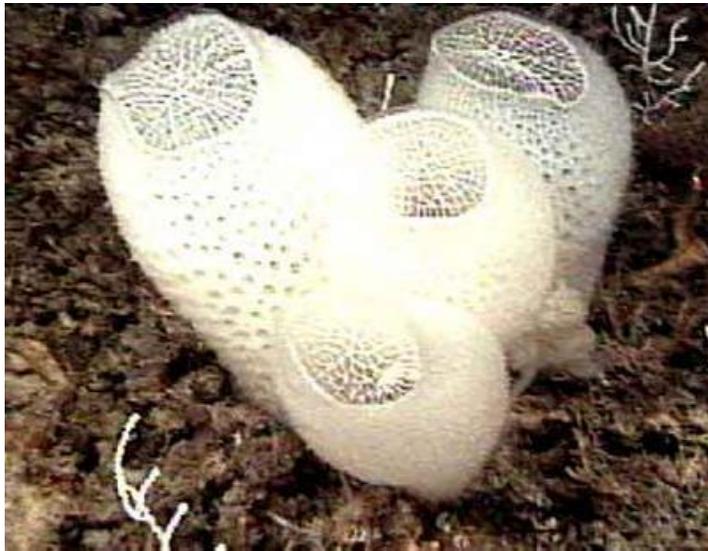
Milky Way Galaxy (our home)
Image in the public domain, courtesy of NASA.



700,000,000 – Seven Hundred Million Years Ago

- Biology

- At this time, 100 million years after choanoflagellates began living in simple colonies, sponges exist as more sophisticated colonies. In sponges, individual unspecialized cells develop to perform specific functions as they mature. Some mature cells resemble choanoflagellates and wave flagella to move water through tiny channels; some capture nutrient bits floating in the water; others specialize in holding the colony securely to rocks; some wander like amoeba as they secrete collagen to make the colony stiff in shape; some become skin cells. Sponges are true multicellular animals with differentiated cells.



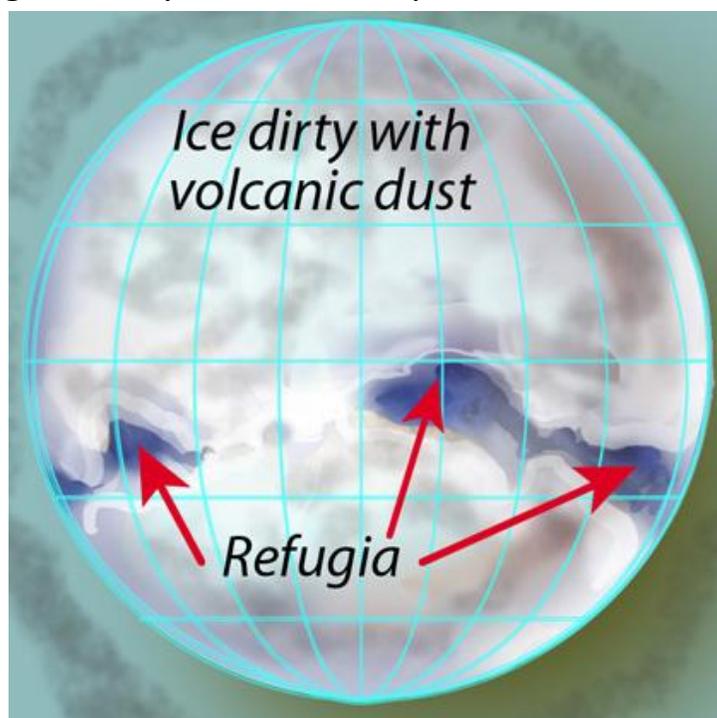
Sponges

Image courtesy the U.S. National Oceanic and Atmospheric Administration.



- Climate

- The surfaces of the world's oceans have been frozen nearly solid for 20 million years with only limited exposed water [refugia]. The entire planet appears as a giant dirty snowball in space.



“Snowball Earth”

Image by Zina Deretsky used courtesy of the National Science Foundation.



670,000,000 – Six Hundred Seventy Million Years Ago

- Climate

The Earth is a global hot-house and the oceans are hospitable to life – except for species that failed to adapt to the warmth. The Sturtian Glaciation ended about 10 million years previously.

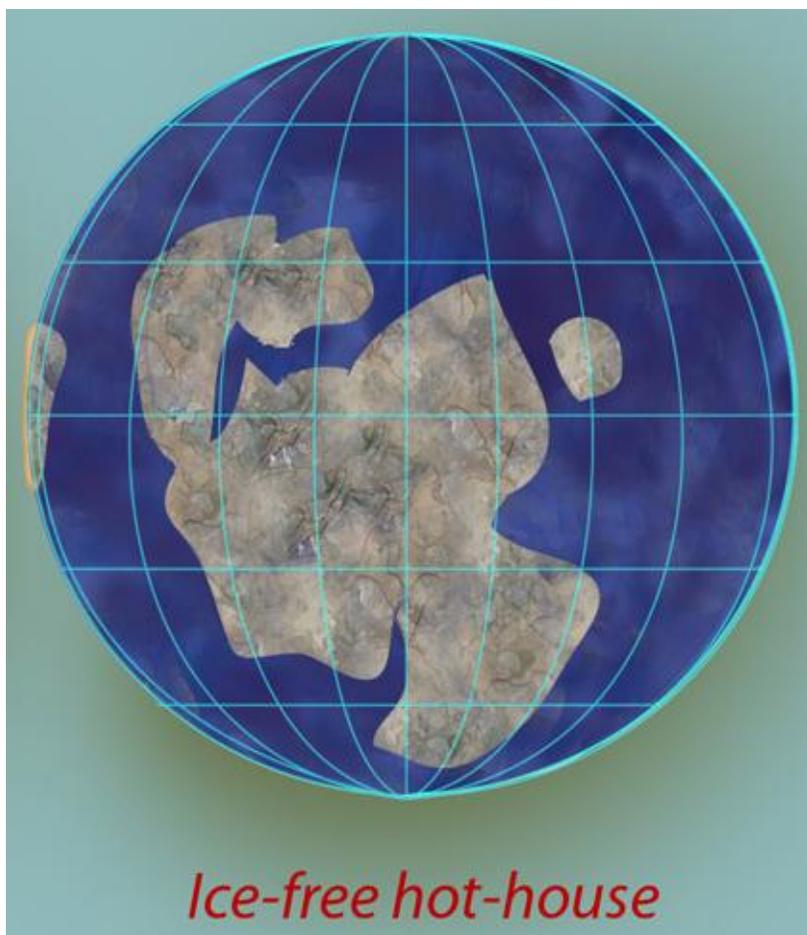


Image by Zina Deretsky used courtesy of the National Science Foundation.

- Biology

Jellies (medusas) and sea anemones (cnidarians) are the most complex animals on the planet.

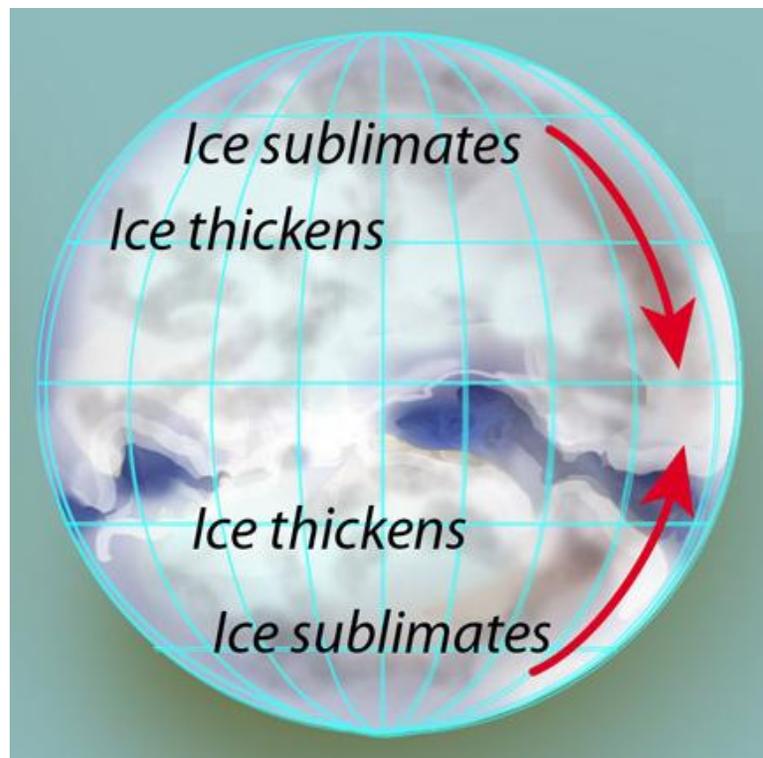


Sea Anemone

Image © Mutsu-sango. Use permitted under Creative Commons license.

635,000,000 – Six Hundred Thirty-Five Million Years Ago

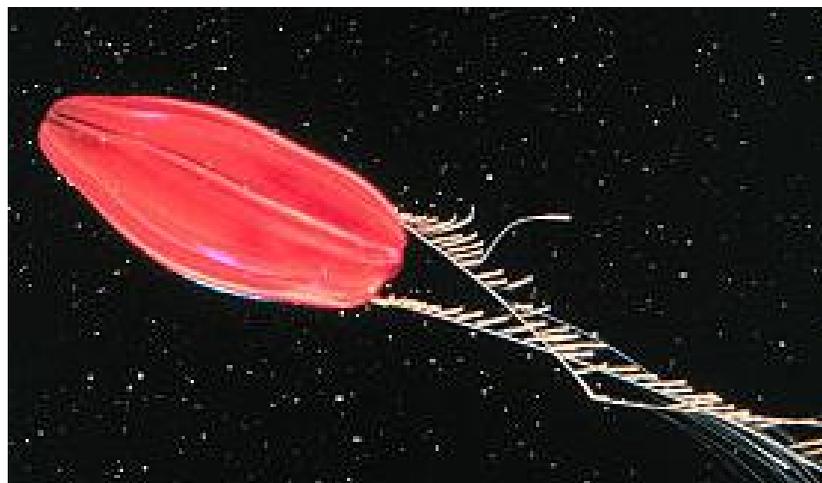
- Climate
 - Once again, the Earth's oceans are mostly frozen over. It has been this way for 15 million years but temperatures are slowly rising. This has been the Marinoan Glaciation; a difficult time for life on Earth.



“Snowball Earth”

Image by Zina Deretsky used courtesy of the National Science Foundation.

- Biology
 - Some organisms resemble sponges but have additional kinds of specialized cells – neurons and muscles; these animals have a nervous system and can move parts of their bodies. Some are attached to rocks while others are free floating and resemble modern comb jellies (Ctenophora). The most recent common ancestor of mammals and Ctenophora lives at this ancient time.



Tortugas Red, a deep sea ctenophore

Image courtesy the U.S. National Oceanic and Atmospheric Administration.

- Geology
 - Beginning of the Ediacaran Period

580,000,000 – Five Hundred Eighty Million Years Ago

- Biology
 - Some animals show “bilateral symmetry;” the left and right sides are mirror-images of each other and the front (anterior) is distinct from the back (posterior).



Flat Worm

Image © Richard Ling. Use Permitted under Creative Commons license.

- Climate
 - The Gaskiers glaciation ended two million years previously. That was the last Snowball Earth period.



540,000,000 – Five Hundred Forty Million Years Ago

- Biology

- *Kimberella* roams the undersea world. Fossils of *Kimberella* are the oldest fossils that show bilateral symmetry, i.e. the left and right sides are mirror-images of each other while the front and back are NOT mirror-images. *Kimberella* might be a very early mollusk (clams, snails, squids, octopuses, chitons, etc.), or maybe not.



Kimberella

Image © Nobu Tamura. Use permitted under Creative Commons license.

- A population of animals has branched off from our ancestors and has descendants living in the 21st Century: echinoderms (sea stars, sea urchins, , etc.). Although adult echinoderms have radial instead of bilateral symmetry, their larval stages are bilaterally symmetrical.

Sea Stars



Image courtesy the U.S. National Oceanic and Atmospheric Administration.

- Climate / Atmosphere

- Oxygen concentration in the atmosphere has reached about 10%. The hardiest humans could survive with this much oxygen for several weeks but probably could not reproduce.

510,000,000 – Five Hundred Ten Million Years Ago

- Biology
 - A large variety of animals live in the oceans. Many of these animals have body plans that will not be seen in later eons. Shown is *Opabinia regalis*, a curious animal that is about 7 centimeters in length.



Opabinia regalis

Image © Nobu Tamura. Use permitted under Creative Commons license.



Opabinia might be an arthropod. Arthropods are animals that have a structural outer covering (exoskeleton) separated into segments. Arthropods of the 21st Century – insects, spiders, centipedes, lobsters, crabs, shrimp, etc. – are their descendants.



- Other bilaterians lack a segmented exoskeleton and their descendants are **all** of the other animals [except for the animals that previously branched off – the cnidarians (jellyfish and sea anemones), Ctenophora (comb jellies), sponges, and choanoflagellates].

500,000,000 – Five Hundred Million Years Ago

- Biology

- Some aquatic creatures do not have much of a head, but they are the first to have a notochord, a primitive version of a backbone. These may be the ancestral group for all animals with an internal skeleton, i.e. vertebrates, including YOU!



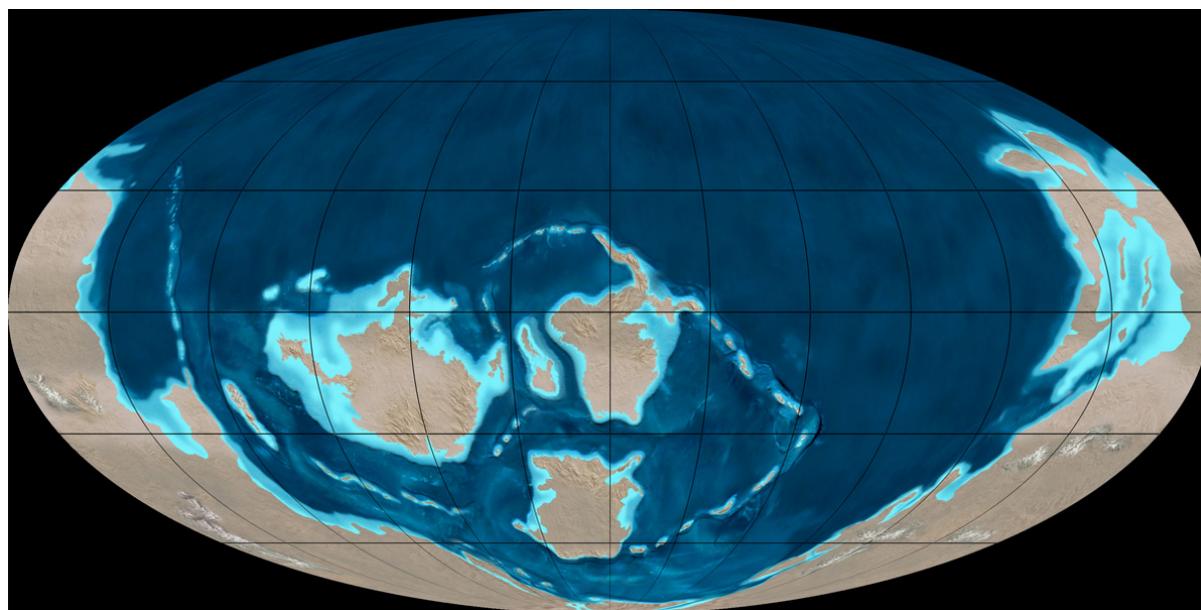
Branchiostoma lanceolatum

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- Geology

- The continents have moved around and will soon form the Pangea Supercontinent. It won't break up for another 300 million years.



Pangea Supercontinent is forming

Map © Ron Blakey, Northern Arizona University, Department of Geology.
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- Climate

- The warm oceans provide excellent conditions for many varieties of life to thrive. The land is barren of multicellular life, however.

460,000,000 – Four Hundred Sixty Million Years Ago

- Biology

- Some fungi succeed in living out of water. They are the first multicellular organisms to inhabit the Earth's continents.
- A population of fish with backbones develops a jaw. Some of these fish branch off from the ancestral line that leads to humans and go on to become modern day sharks.



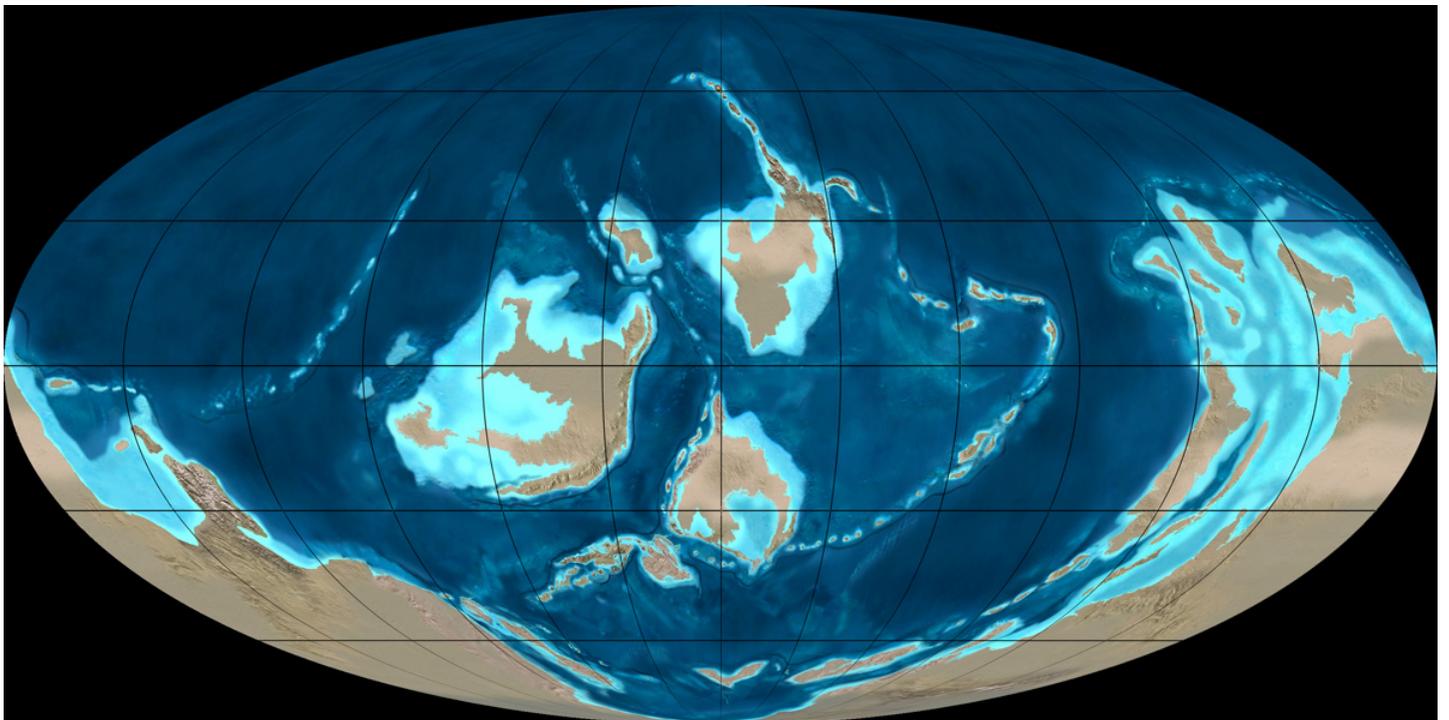
Shark

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- Geology

- This globe diagram shows you where the landmasses are on the entire Earth. The right-hand side of the pictured globe meets the left-hand side. Therefore, the land shown at the extreme right and on the extreme left is centered on 180° longitude.



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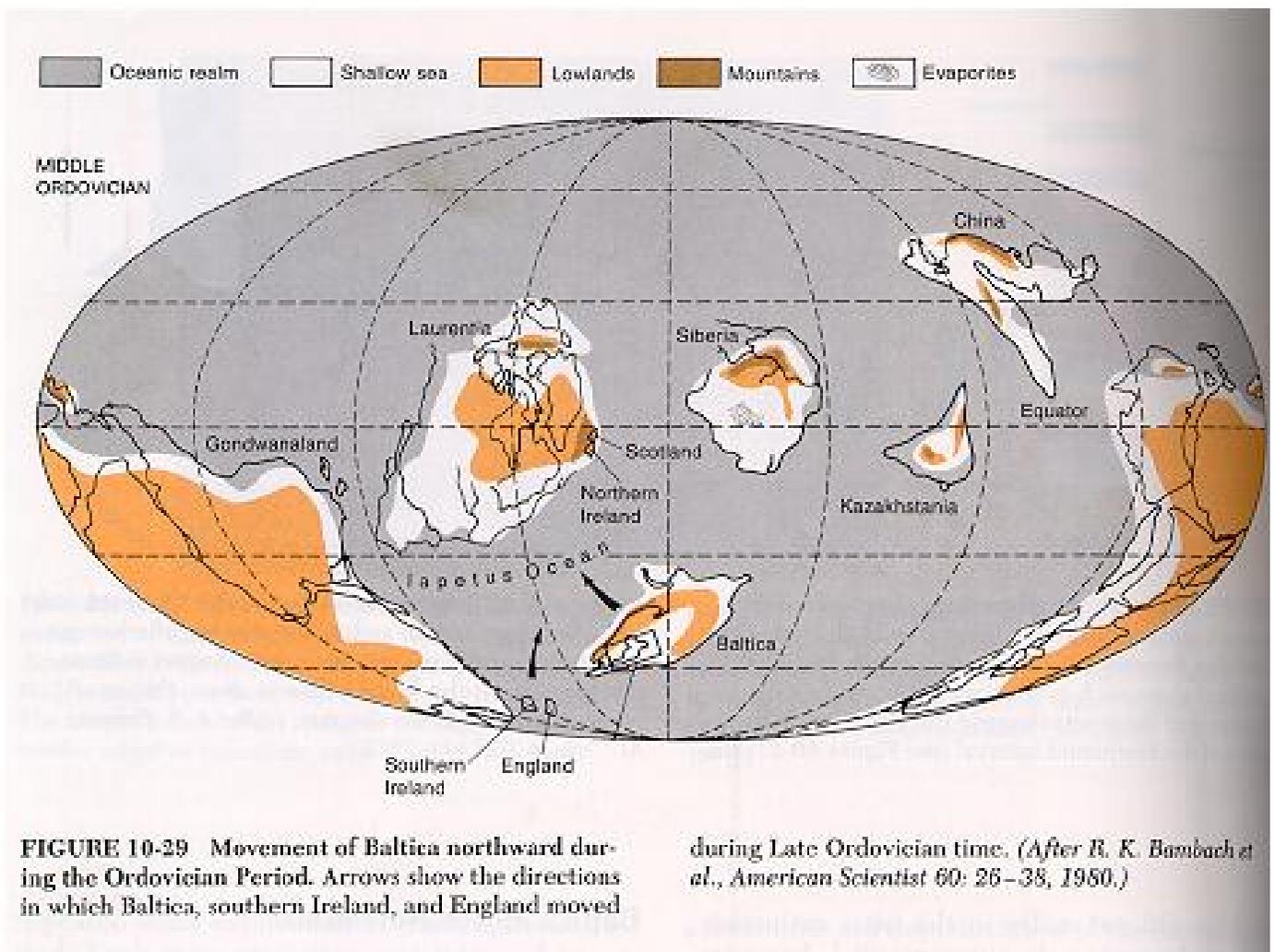
445,000,000 – Four Hundred Forty-Five Million Years Ago

- Biology, Geology, and Climate

The **Ordovician-Silurian Extinction** eliminates 50% of all animal genera.

Various possible explanations are hypothesized:

- Glaciers build up and melt, build up and melt, on the huge land mass that has migrated over the South Pole, causing sea levels to drop and rise repeatedly. Each time shallow seas dry up, animals living on the bottom in those shallow waters die.
- A lack of active volcanoes led to a drop in CO₂ that could have caused a significant drop in global temperatures.
- A gamma ray burst from a star within 6,000 light years of the solar system stripped away much of the Earth's ozone, exposing organisms to high doses of ultraviolet radiation.



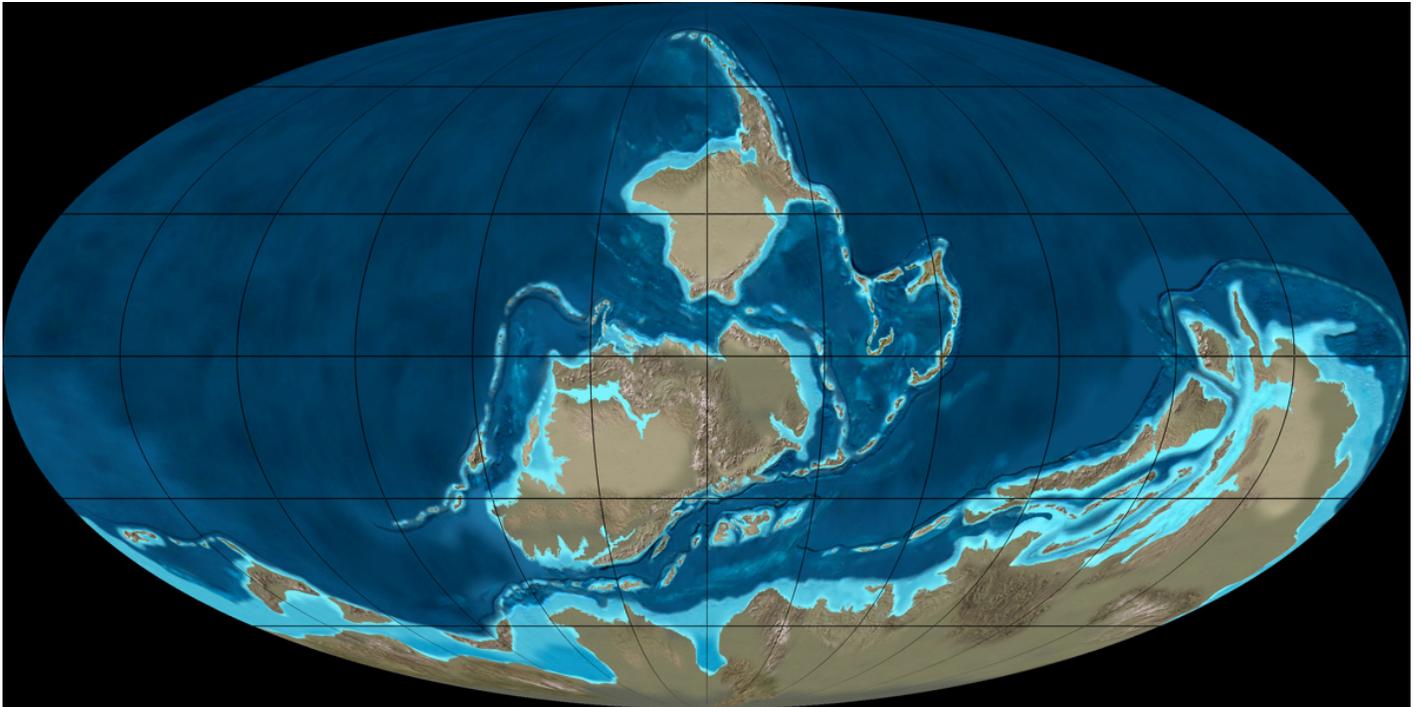
The white areas alternate between being shallow sea and dry land

Image © R.K. Bambach et al., American Scientist



385,000,000 – Three Hundred Eighty-Five Million Years Ago

- Geology
 - The Earth's landmasses are concentrated in three continents. The continent covering the South Pole is the largest and is ice free, yet there are no forests. Most terrestrial organisms are tiny – liverworts, fungi, cyanobacteria, etc.



Map © Ron Blakey, Northern Arizona Univ, Dept of Geology.
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- Biology
 - Our ancestors at this time are lobe-finned fish. The ancestors of other fish have already started on their own separate evolutionary path to the 21st Century. Those fish are the teleost fish and the lungfish. Almost all fish that we catch or raise or keep in an aquarium are teleosts.

This lobe-finned fish has two pairs of fins on the bottom that each have a humerus, ulna, and radius; JUST LIKE YOU! Like your arm bones, that is. You probably don't have fins. This lobe-finned fish is *Eusthenopteron*.



Eusthenopteron

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375,000,000 – Three Hundred Seventy-Five Million Years Ago

- Biology
 - *Tiktaalik* pushes its head up out of the water using its four fin-feet. It looks around by moving its head, breathes some air, scoots a few steps, then drops low and swims off. No vertebrate lives completely out of water – yet. This fish-a-pod animal has a bone structure that is nearly identical to all living land animals. This suggests that some animal very similar to *Tiktaalik* is an ancestor of all terrestrial vertebrates, including – you guessed it – us.



Tiktaalik roseae

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340,000,000 – Three Hundred Forty Million Years Ago

- Climate
 - This is the middle of the Mississippian Glaciation. Ice sheets have advanced across Africa and South America. All of the Earth is chilly due to a reduction in CO₂ and an elevation of oxygen in the atmosphere. Very likely, this is related to the proliferation of terrestrial plant life that remove CO₂ from the air.



Ice sheets on Africa and South America

Image in the public domain courtesy of NASA



310,000,000 – Three Hundred Ten Million Years Ago

- Biology
 - Amphibious carnivores move in and out of water to hunt insects and other arthropods but they need to reënter the water to drink and to reproduce. This *Capetus* is similar to *Tiktaalik* of 55 million years earlier but it is far more capable of getting around on land. *Capetus* might be ancestral to ALL four-legged animals – the tetrapods. That includes lizards, birds, & humans! (¿Four-legged birds and humans? Well, birds’ front legs have been modified into wings and our front legs have also been modified, allowing us to use tools, like spears and the piano.)



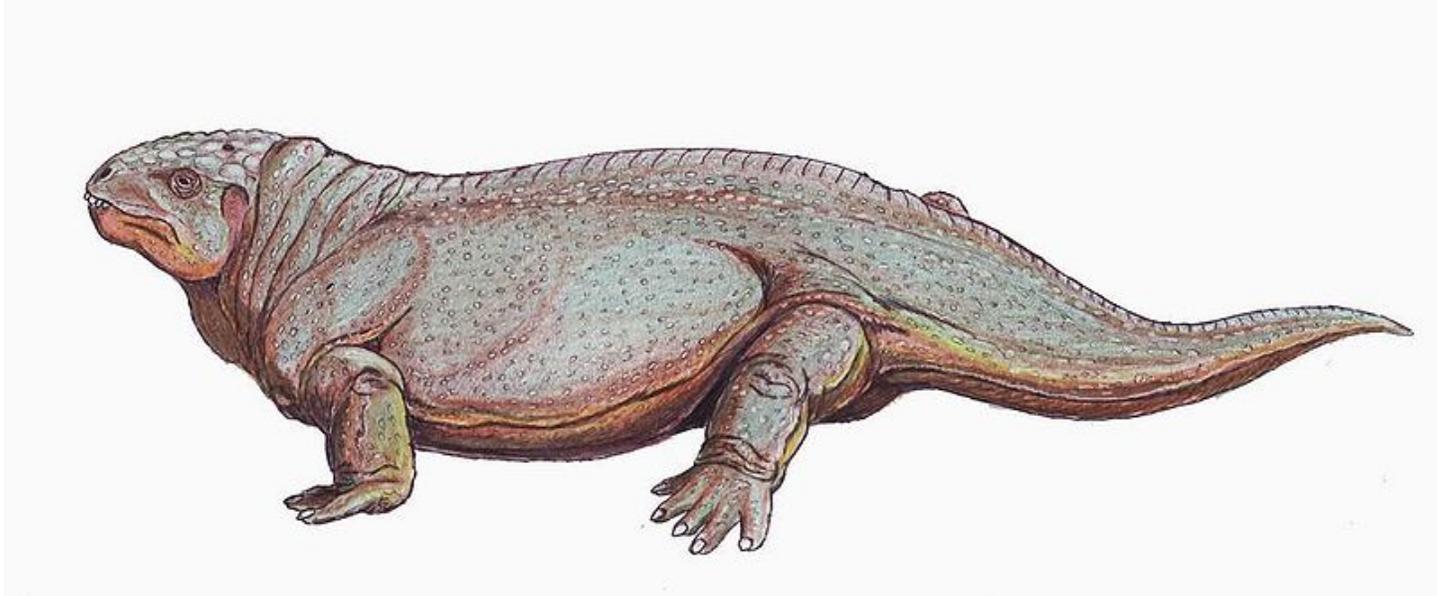
Capetus

ДиБгд released this beautiful illustration into the public domain. From Wikipedia.



290,000,000 – Two Hundred Ninety Million Years Ago

- Biology
 - *Diadectes*, this pudgy tetrapod [four-legged land animal], is one of the first large land vertebrates that can comfortably walk on land; if dragging the tummy can be called comfortable. *Diadectes* is big; up to three meters long and, well, pudgy.



Diadectes

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- At about this time, some tetrapod will become the ancestor of turtles, lizards, alligators, dinosaurs and birds, etc. Another tetrapod will become the ancestor of mammals. This means that our last common ancestor with turtles, birds, etc., lives at about this ancient time.

275,000,000 – Two Hundred Seventy-Five Million Years Ago

- Biology
 - *Dimetrodon* is the fiercest predator here even though it cannot run; but it sure waddles real fast! The huge sail on this 3.5-meter-long animal helps it warm up in the morning and helps keep it cool during the day. It is more closely related to mammals than to dinosaurs!

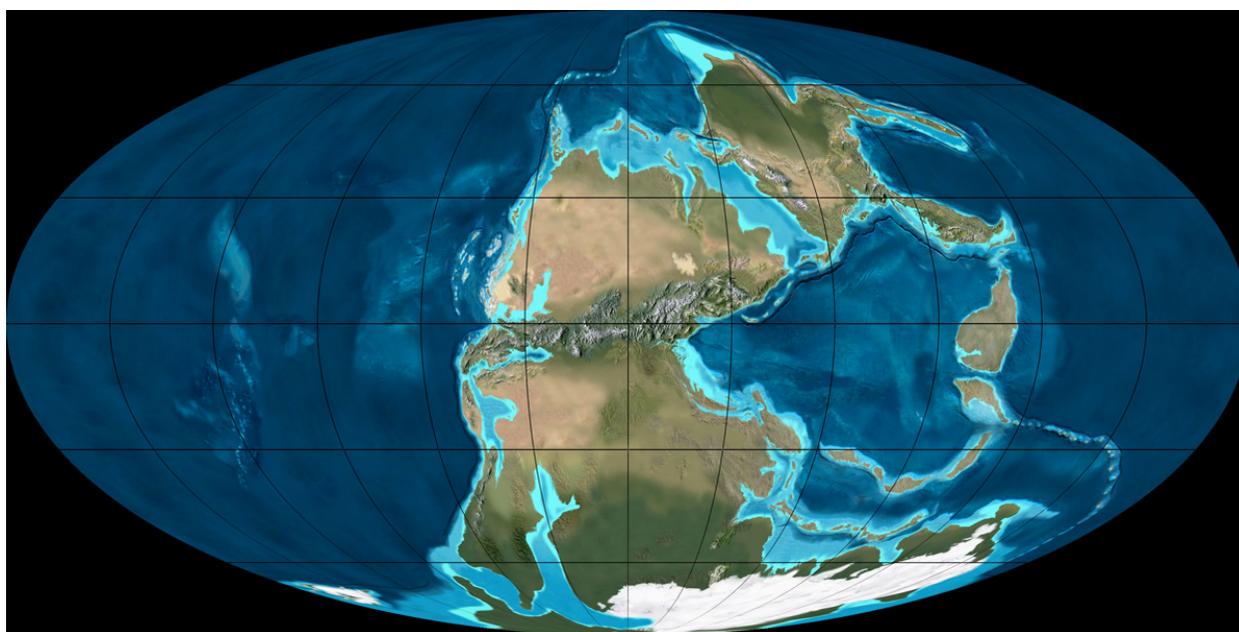


Dimetrodon loomisi

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- Geology
 - The largest land mass extends to the South Pole. The land mass to the north and east is Asia. Since the major masses are so close, we commonly call everything here the “supercontinent” of Pangea.



Pangea Supercontinent

Map © Ron Blakey, Northern Arizona Univ, Dept of Geology. Use permitted by Ron Blakey for educational, non-profit, non-commercial purposes.
<http://jan.ucc.nau.edu/~rcb7/globaltext2.html> accessed May 2012.



252,000,000 – Two Hundred Fifty-Two Million Years Ago

- Biology
 - This is during the **End Permian Extinction**. We do not yet know for certain what triggers this “Great Dying” but CO₂ levels are extremely high; this can prevent most marine organisms from forming shells. About 95% of marine species and 70% of terrestrial vertebrate species have recently become extinct. Without much biodiversity, it will take a great span of time for life to recover.



Fossil Solitary Horn Corals

Photo by Shanan Peters, University of Wisconsin-Madison. Used courtesy of Dr. Peters, the University of Wisconsin, and the National Science Foundation.



230,000,000 – Two Hundred Thirty Million Years Ago

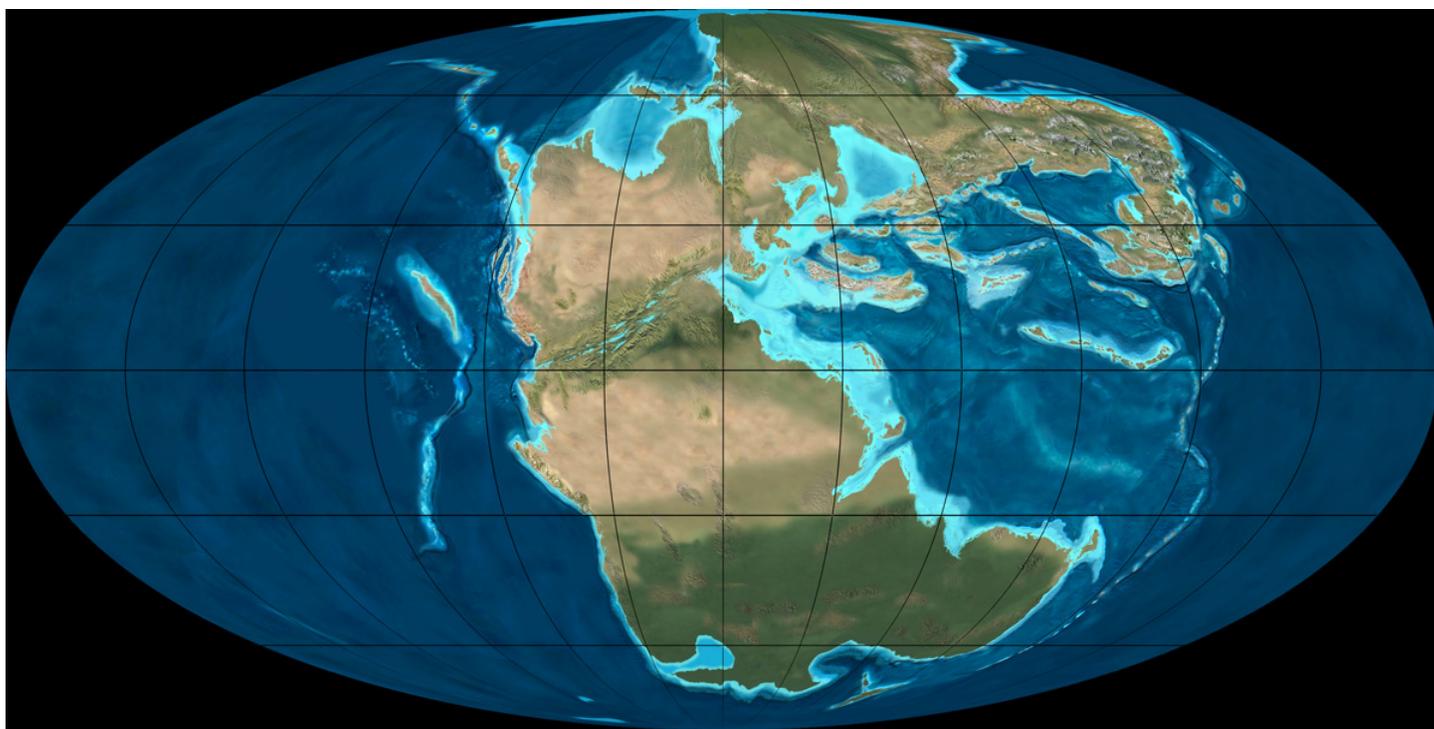
- Biology
 - *Eoraptor* 's revolutionary hip anatomy allows it to run swiftly on two feet. It catches prey with sharp claws. It is only about one meter long but it may be the first of all the dinosaurs.



Eoraptor lunensis

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- Geology
 - For the last time, it is possible to walk to all of the major landmasses across the supercontinent of Pangea. You can see rifts forming that will separate North America from the southern land mass.



Map © Ron Blakey, Northern Arizona Univ, Dept of Geology. Use permitted by Ron Blakey for educational, non-profit, non-commercial purposes. <http://jan.ucc.nau.edu/~rcb7/globaltext2.html> accessed May 2012.

205,000,000 – Two Hundred Five Million Years Ago

- Biology

- Long before, some insects had adapted to flying, but now, for the first time, some vertebrates succeed in adapting to flight. *Dimorphodon macronyx* is a very early pterosaur with some wicked-looking teeth. Its wingspan is about 1.4 meters – roughly the same as a Red-Tailed Hawk of the 21st Century. Pterosaurs are reptiles, not dinosaurs, and will be around for another 135 million years. Some will have 10-meter wingspans. If we watched this *Dimorphodon* long enough, we might settle the dispute about what it eats – fish, insects, amphibians, or maybe it simply eats whatever it wants!



Dimorphodon macronyx

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175,000,000 – One Hundred Seventy-Five Million Years Ago

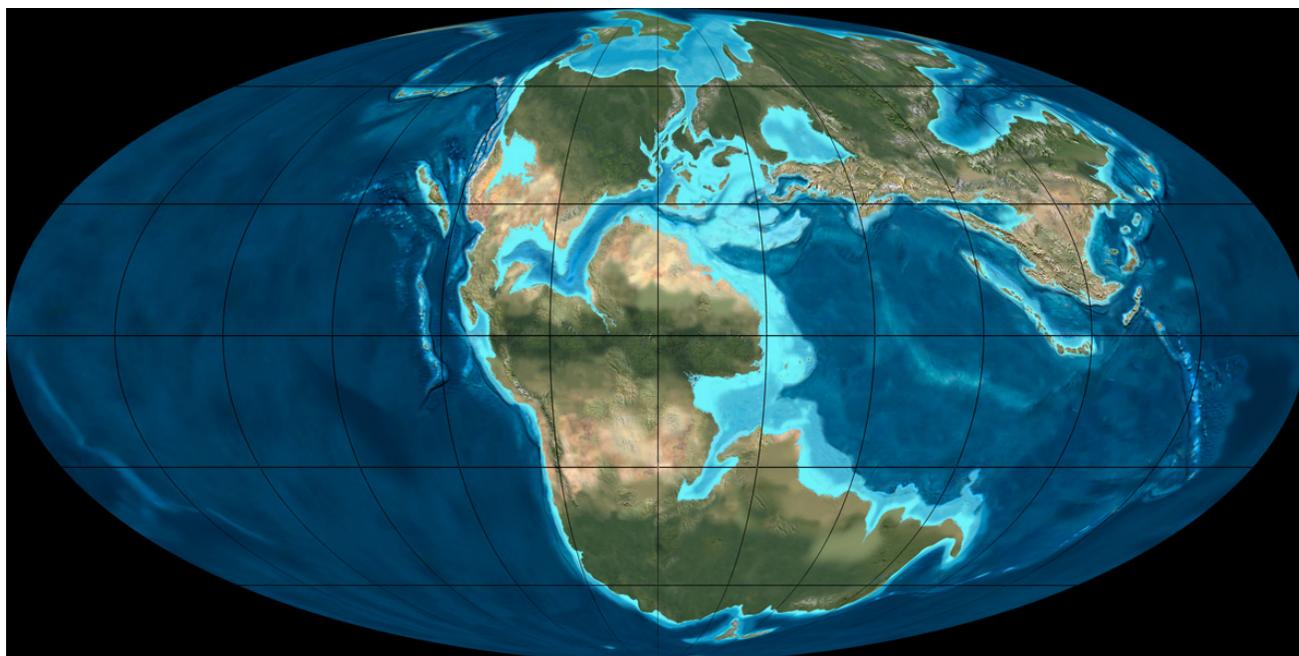
- Biology
 - Little *Morganucodon* lays eggs, but when the pups hatch, they lick the mother's belly fur, wet with milk from mammary glands. This first mammal is ancestral to all mammals, including echidnas, duck-billed platypuses, koalas, and you.



WWW.SEIRIM.NET

Drawing by Cristóbal Aparicio Barragán, downloaded from Photobucket 17 February 2011. Use permitted under the Photobucket.com Terms of Agreement.

- Geology
 - The large blob extending almost to the South Pole will become Africa [center], South America [to the left], India and Madagascar [one grid line south and east of center], and Australia [further southeast]. Animals can walk from there to North America. That land bridge will soon cease to be, separating North and South America for the next 172 million years.



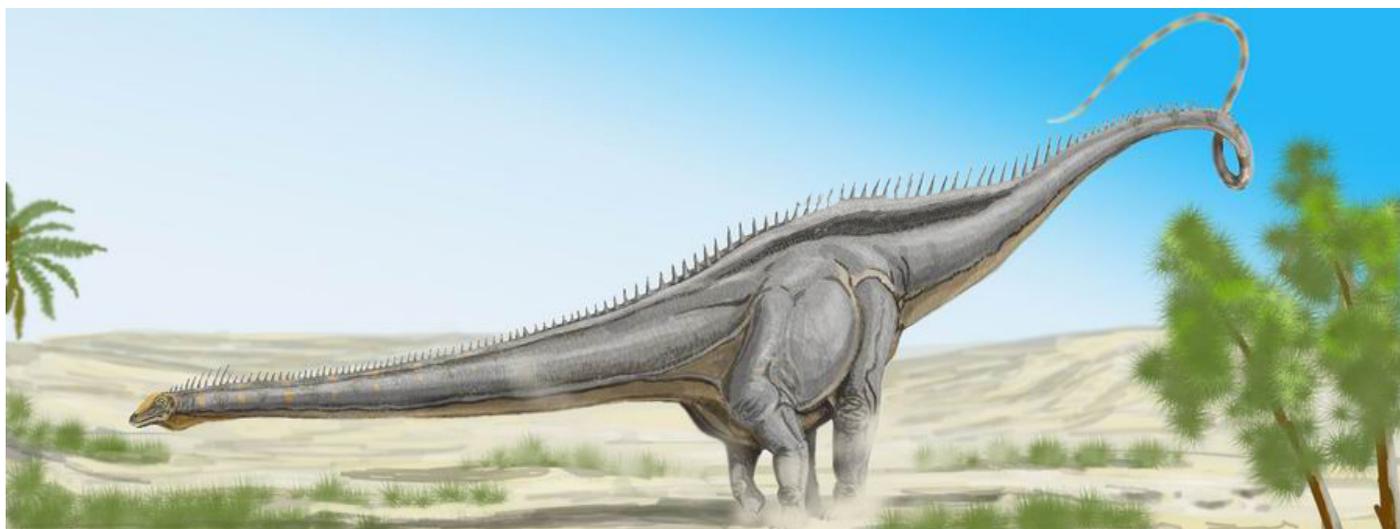
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150,000,000 – One Hundred Fifty Million Years Ago

- Biology

- Over 10,000 kilograms and over 30 meters long, this giant, *Diplodocus hallorum*, can strip foliage from an entire tree branch in a single motion. ¿Why is such a long neck an advantage? Maybe to reach into a dense forest to feed without first bothering to stomp it to smithereens! Maybe to launch rocks into low Earth orbit! Maybe you will figure it out and become famous.



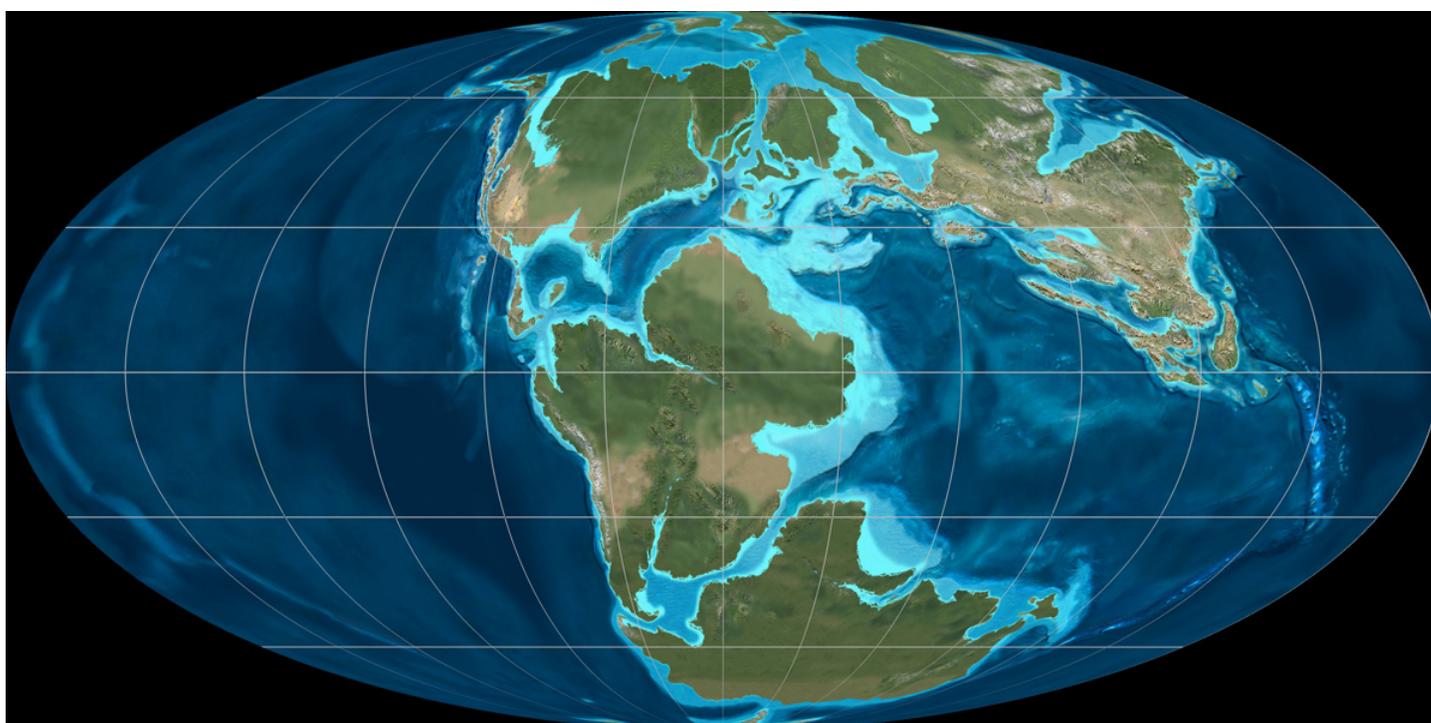
Diplodocus hallorum

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- Geology

- The landmasses that will become South America and Antarctica are fairly obvious at this time. ¿Can you pick out Africa and Greenland?

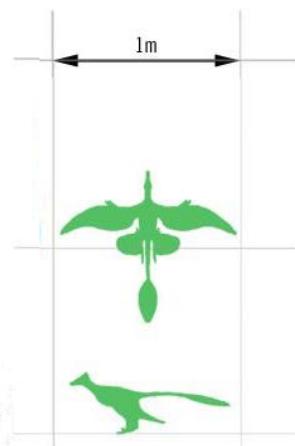


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120,000,000 – One Hundred Twenty Million Years Ago

- Biology
 - That “bird” has teeth! It also has wings on its feet as well as on its arms. It's a microraptor, a small dinosaur. They are rather common but the four-wing layout won't be successful in the long run.

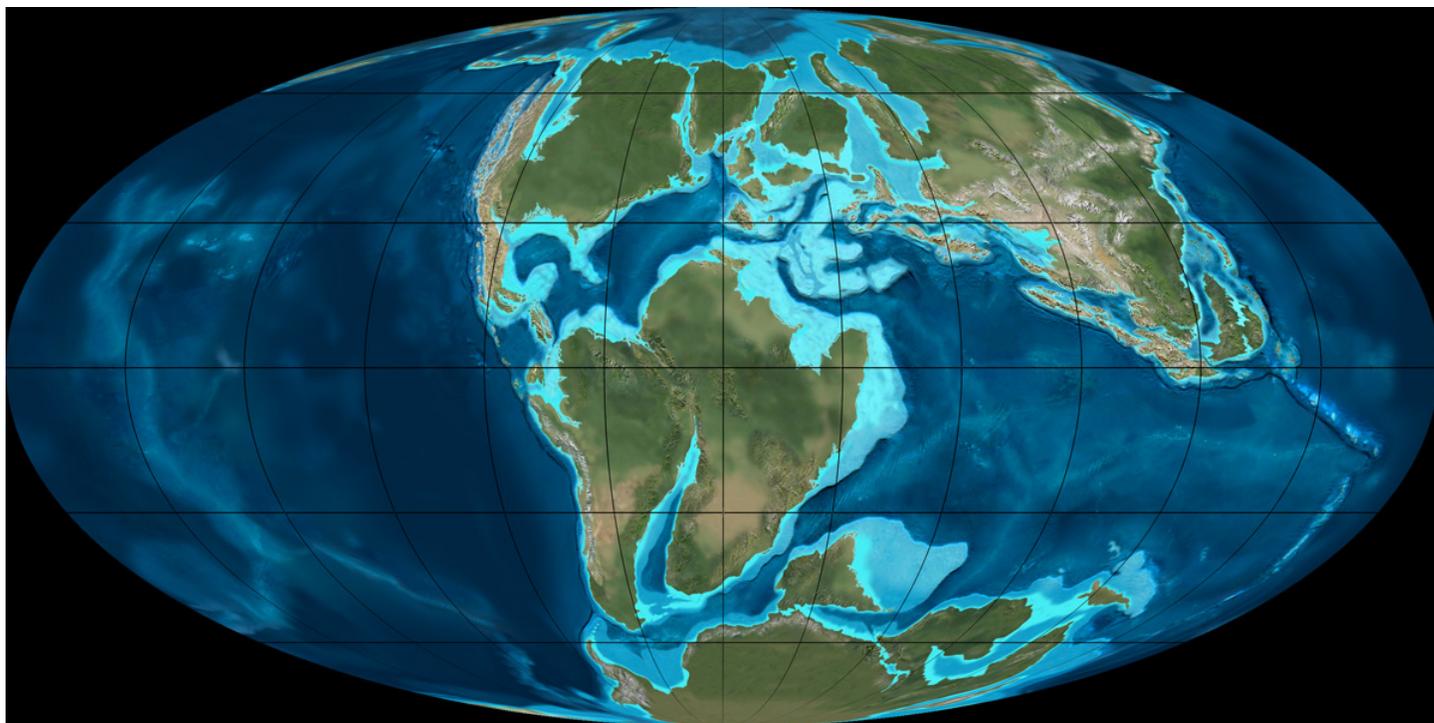


Microraptor

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- Geology
 - The larger southern land mass is splitting in two as the southern Atlantic Ocean widens. The two will become Africa and South America. India and Madagascar are a single mass that has just separated from Antarctica.



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90,000,000 – One Hundred Million Years Ago

- Biology

- These are “duck-billed” hadrosaurs. Unlike other dinosaurs, they walk on all fours. They run on just their two hind legs, however. *Shantungosaurus* is 15 meters long but the earlier hadrosaurs were smaller, like the five-meter-long *Probactrosaurus*. They are herbivorous and some have chambers in their heads to make distinctive calls.

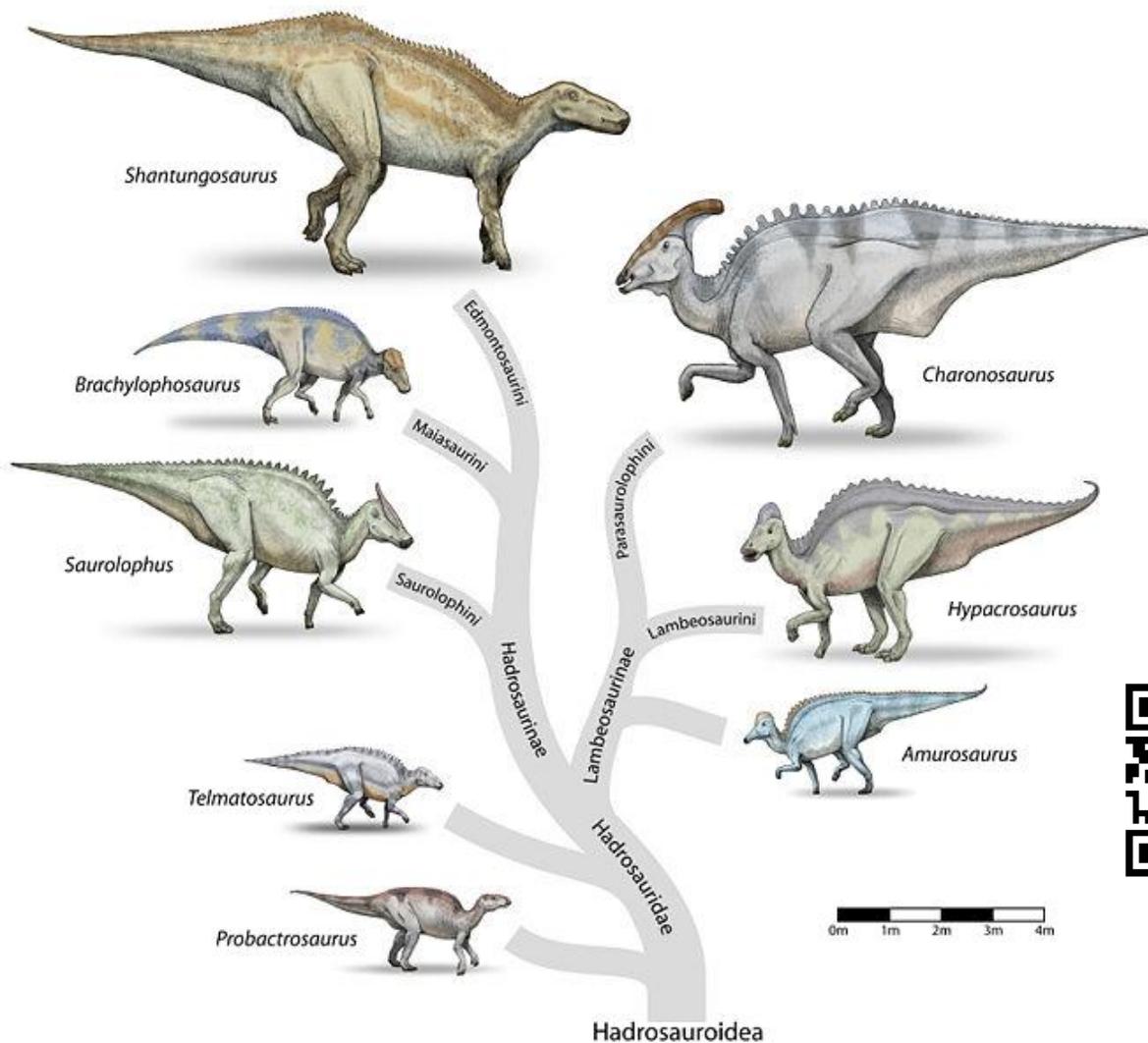
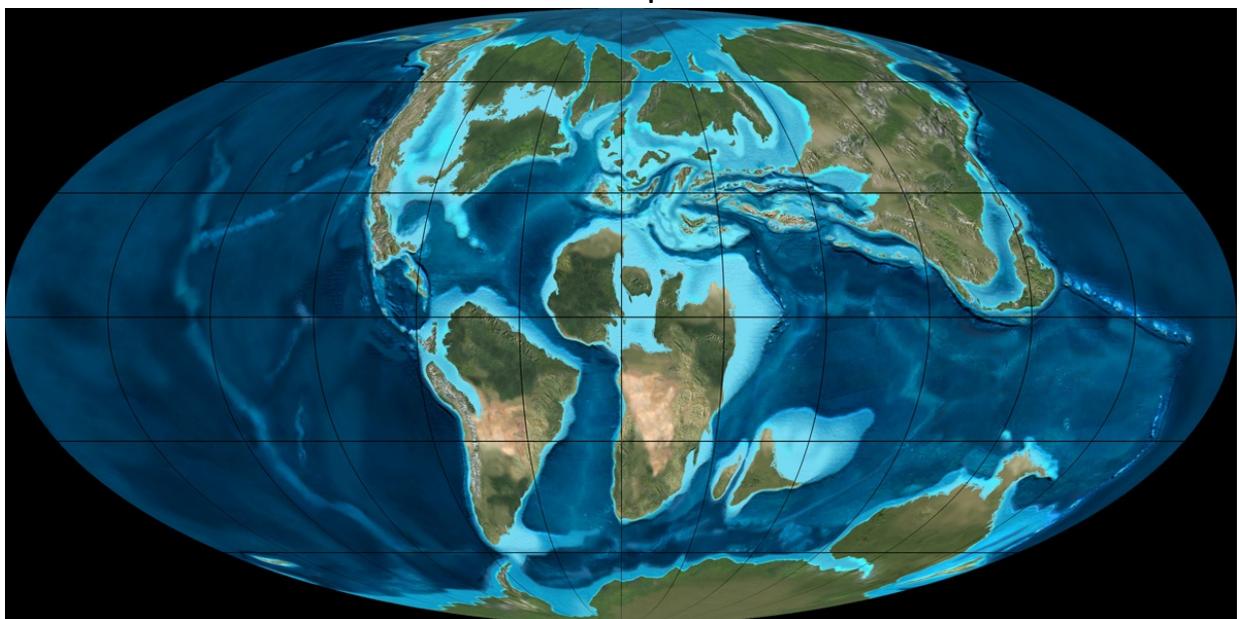


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- Geology

- Africa and South America have separated.



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66,000,000 – Sixty-Six Million Years Ago

- Biology
 - A pair of *Tyrannosaurus rex* hunt for their next meal. These formidable carnivores are huge: 4 meters tall at the hips, 12 meters long, and weigh 6.8 metric tonnes.

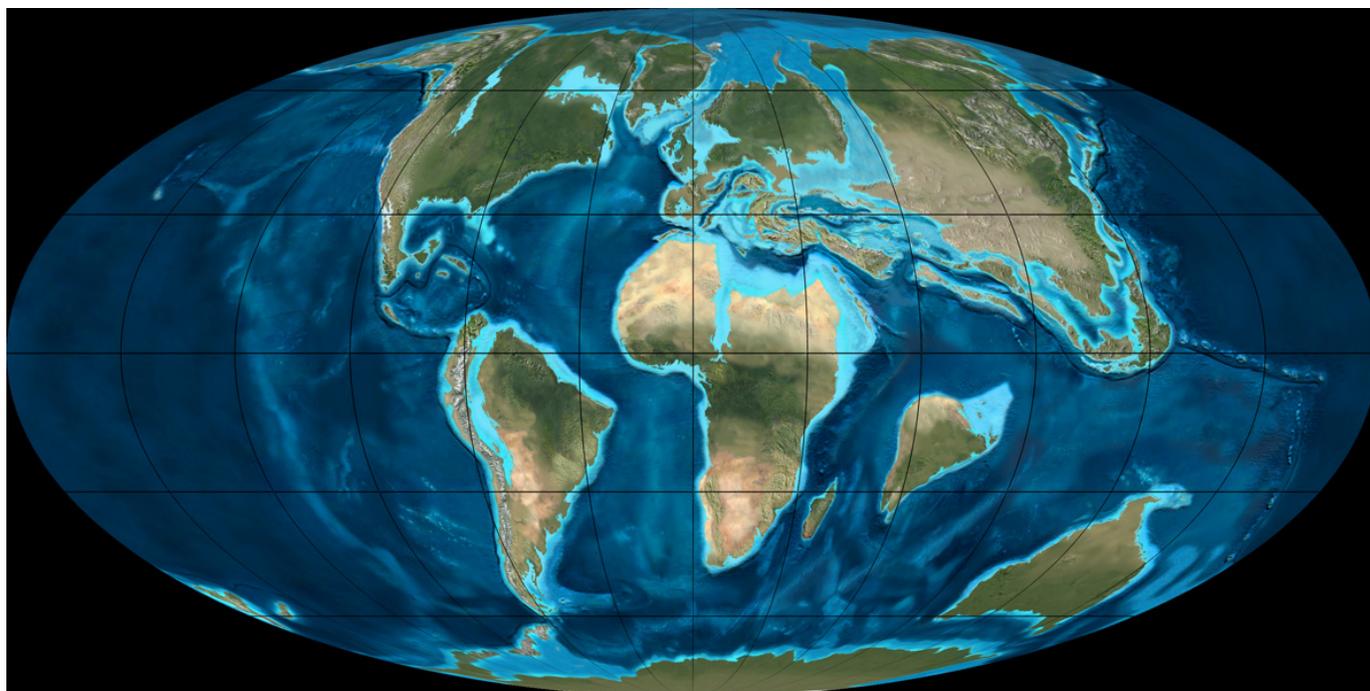


Tyrannosaurus rex

Image released into the public domain 1 January 2009 by its creator, Ryanz720



- Geology
 - India is in the middle of the Indian Ocean. Africa and South America are almost bisected by ocean gulfs. Much of Antarctica has a temperate climate.



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65,000,000 – Sixty-Five Million Years Ago

- Biology, Geology, Climate: The **Cretaceous-Paleogene Extinction**
 - A 10-kilometer-wide bolide (comet or asteroid) named “Chicxulub” strikes the Earth. Impact debris ignites fires globally and blocks sunlight from reaching the surface for at least two years. Shock waves, heat, 300-meter tsunamis, and winds immediately destroy all terrestrial life within thousands of kilometers of the impact.
 - The impact perturbs climate systems with long-term effects that may be worse than the immediate, direct consequences of the impact. Ocean circulation ends abruptly for at least tens of thousands of years, devastating terrestrial and marine ecosystems.



A few examples of species extinction:

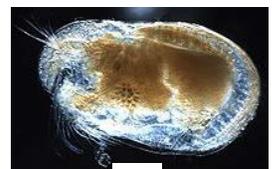
- a) 54% of diatom species
- b) most foraminifera species
- c) most ostracode species
- d) 60% of coral species
- e) 35% of echinoderm species
- f) 100% of ammonite species
- g) 100% of mosasaur species
- h) 100% of plesiosaur species
- i) 100% of pterosaur species
- j) 100% of non-avian dinosaur species
- k) 99.9% of avian dinosaur species
- l) most mammalian species



a



b



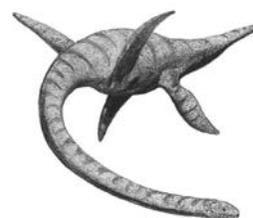
c



f



g



h



i

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This “Billion-Year Walk” begins at the **Rotary Nature Center**

on Lake Merritt near the corner of Perkins Street and Bellevue Avenue

63,000,000 – Sixty-Three Million Years Ago

- Biology

- The earliest mammal that feeds its fetuses internally by use of a placenta arose at this time and all 21st Century placental mammals are descended from it. (Placental mammals include whales, bats, cats, rats, giraffes, wolves, buffalo, squirrels, hippos, not to mention YOU!) It probably resembled this *Protungulatum donnae*. Non-placental mammals are the monotremes – they lay eggs; and the marsupials – they raise helpless infants in an exterior pouch. Monotremes in the 21st Century are platypuses and echidnas. Marsupials in the 21st Century are the opossums, kangaroos, koalas, Tasmanian devils, etc.



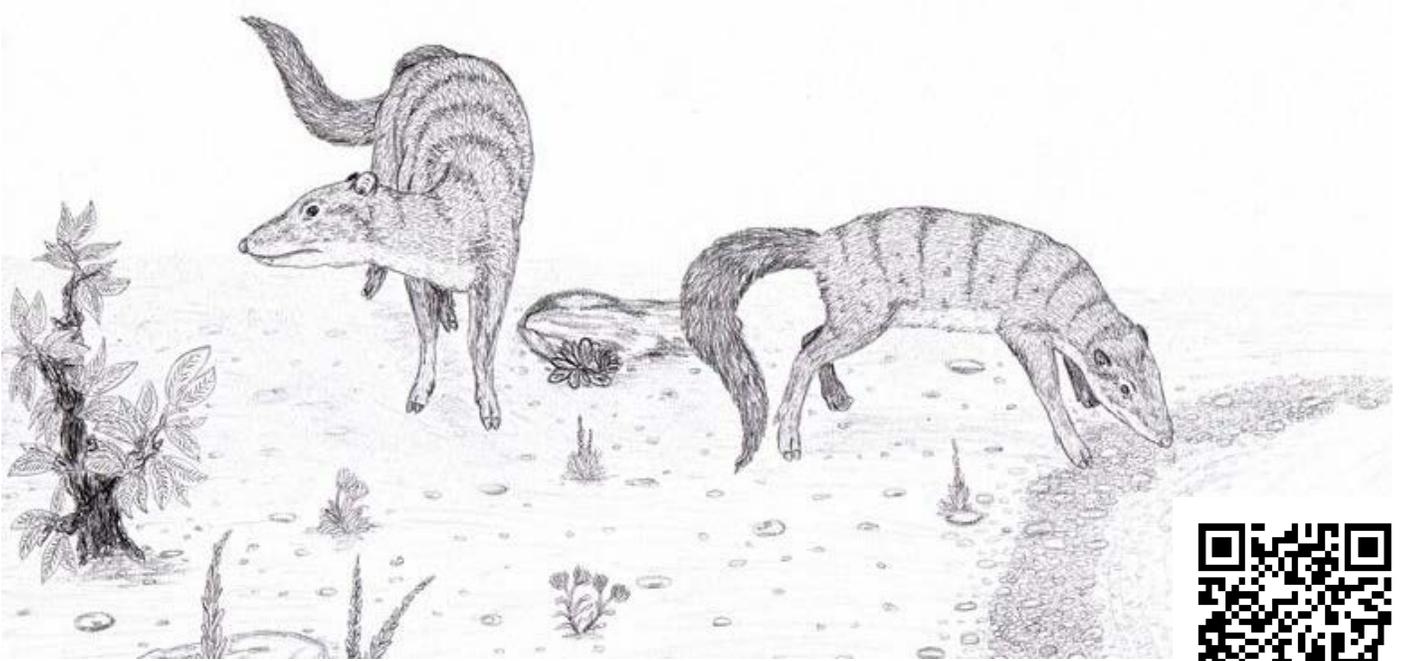
Protungulatum donnae

Artwork by Carl Buell. Copyright 2013 The New York Times Company



50,000,000 – Fifty Million Years Ago

- Biology
 - *Indohyus* is an herbivorous placental mammal with thick fur and dense heavy bones. It dives into water when scared and stays submerged with the help of its heavy bones and insulating fur. This behavior and its inner ear resembling that of whales suggest that it might be an ancestor of whales!



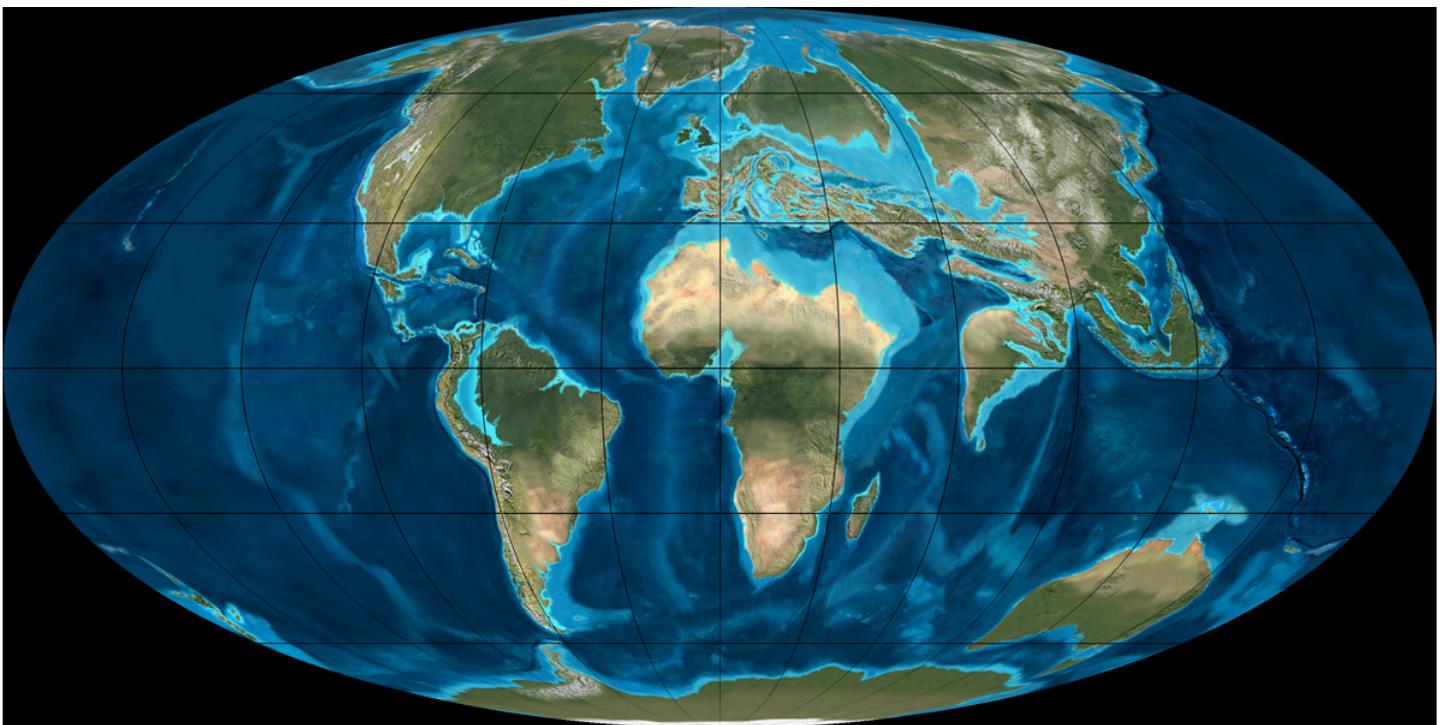
Indohyus

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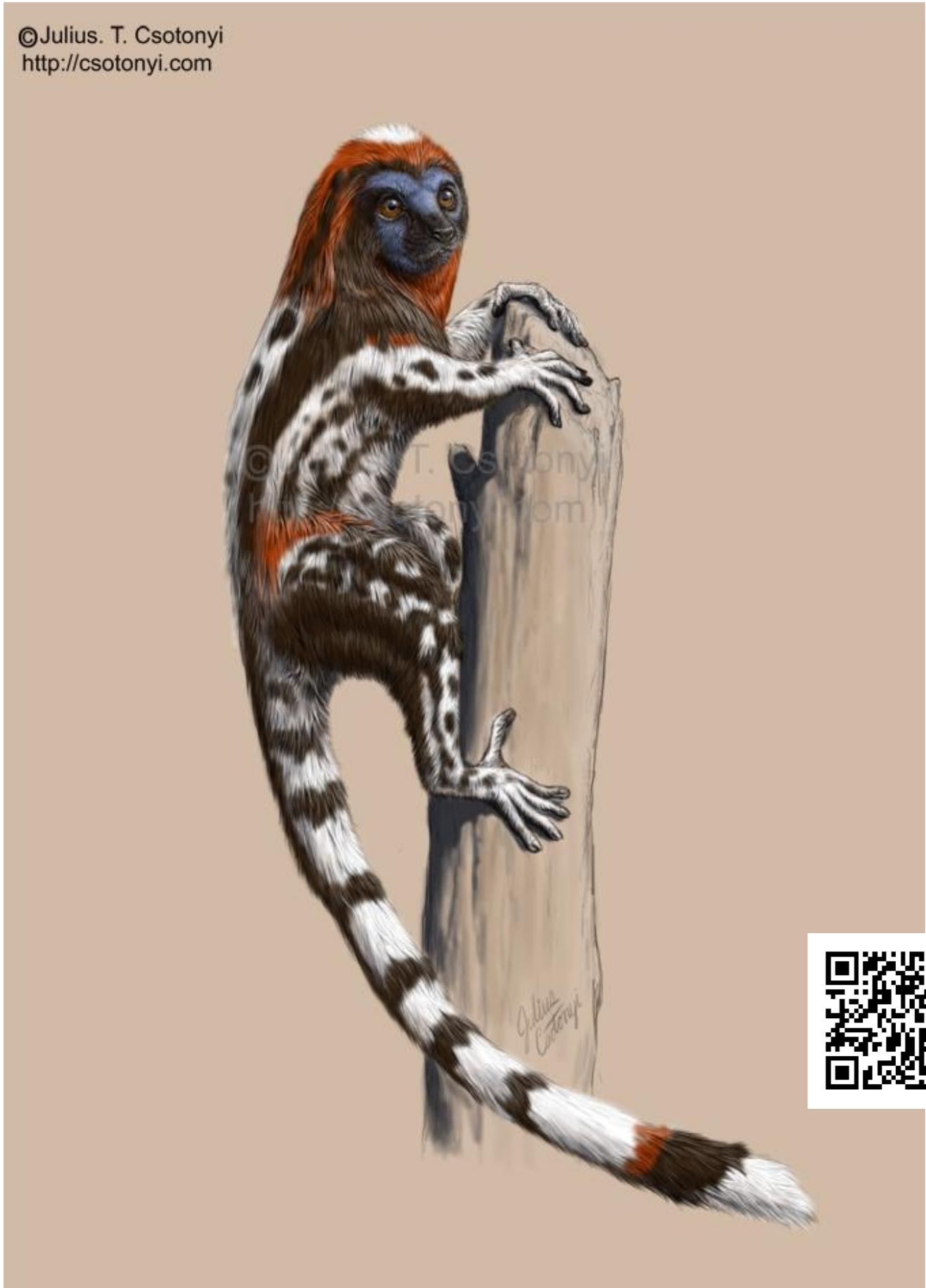
- Geology
 - Southern Europe and the Middle East are an extensive archipelago. India has not yet slammed into Asia. Australia is pretty close to Antarctica.
¿What other differences from the 21st Century world can you find?



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47,000,000 – Forty-Seven Million Years Ago

- Biology
 - *Darwinius masillae* easily leaps through the trees. She's 58 cm long but less than half that without her tail. She might be an ancestor of ours or, more likely, one of her distant arboreal cousins claims that distinction.

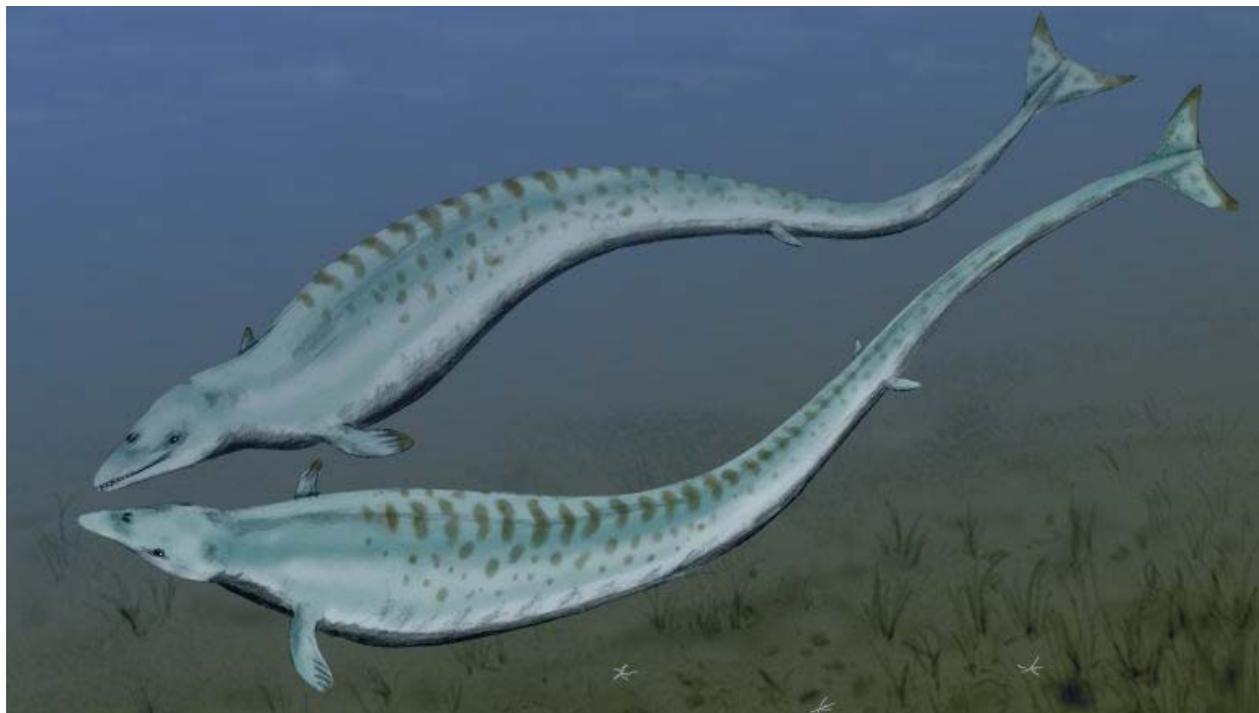


Darwinius masillae

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35,000,000 – Thirty-Five Million Years Ago

- Biology
 - *Basilosaurus* is a marine mammal and an effective predator. Its fins look half-way between legs and the fins of fish. Its nostrils are back from the tip of its snout. *Basilosaurus* is likely an ancestor to whales.



Basilosaurus

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- *Aegyptopithecus* is a primate that might be ancestral to apes [including YOU] and to Old World Monkeys like baboons, macaques, and langurs. Descendants of the Old World Monkey kept their tails while the ape descendants lost theirs over time.



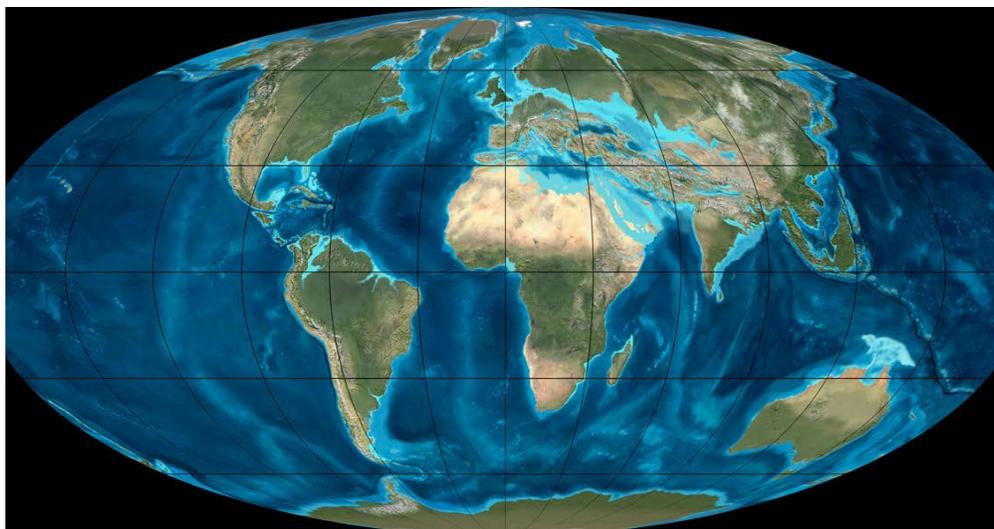
Aegyptopithecus

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32,000,000 – Thirty-two Million Years Ago

- Geology
 - There's an inland sea covering much of where Europe will be. Much of northeast Africa is submerged and Africa is quite close to South America.



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- Climate
 - A cooling trend creates a mild climate that favors the evolution of grasses. The resulting grasslands create environments especially favorable to the development of mammalian herbivores. The ancestors of horses, deer, camels, and elephants adapt to take advantage of this new food source.



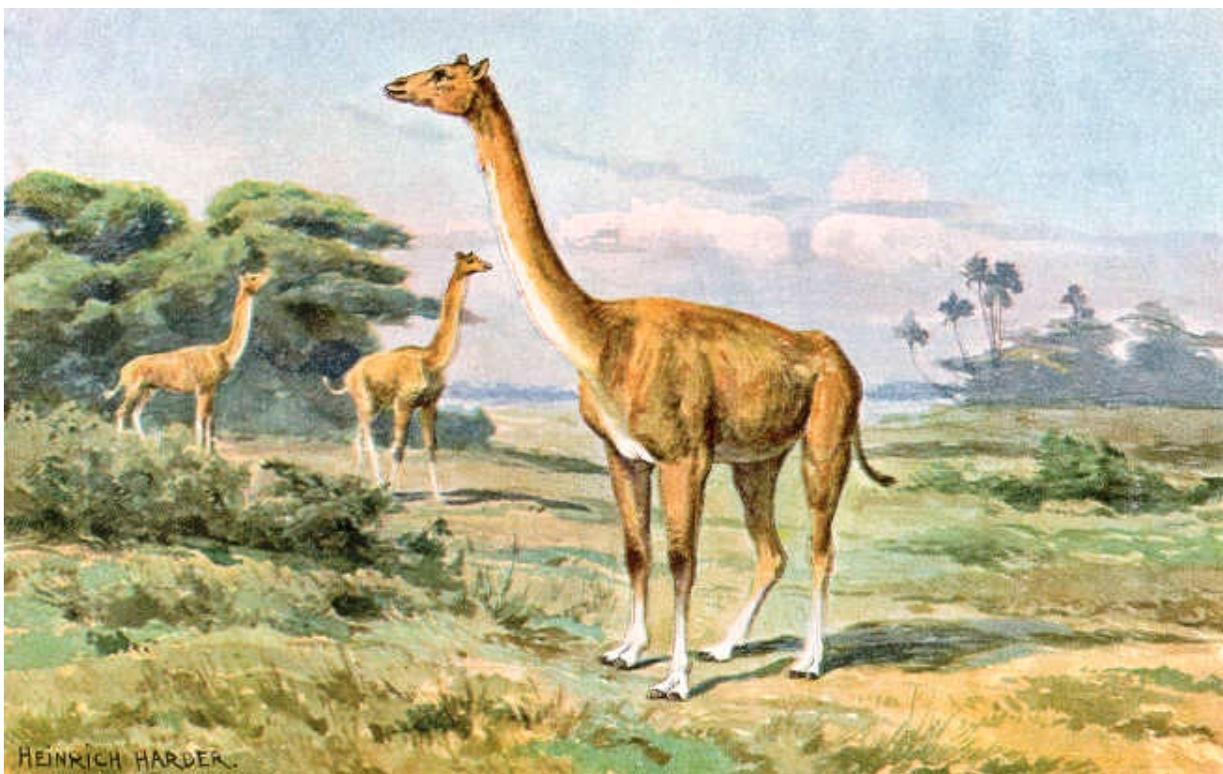
Meshippus

Painting by Heinrich Harder. Copyright expired. From Wikimedia Commons.



19,500,000 – Nineteen Million Five Hundred Thousand Years Ago

- Biology
 - This is a long-necked camel that is not at all closely related to giraffes. *Aepycamelus* (Greek for “high camel”) is a little over half the height of 21st Century giraffes. Its ancestors have looked mostly identical to these individuals for the last million years. *Aepycamelus* will be around for another 14 million years. The human species should be so long lasting!

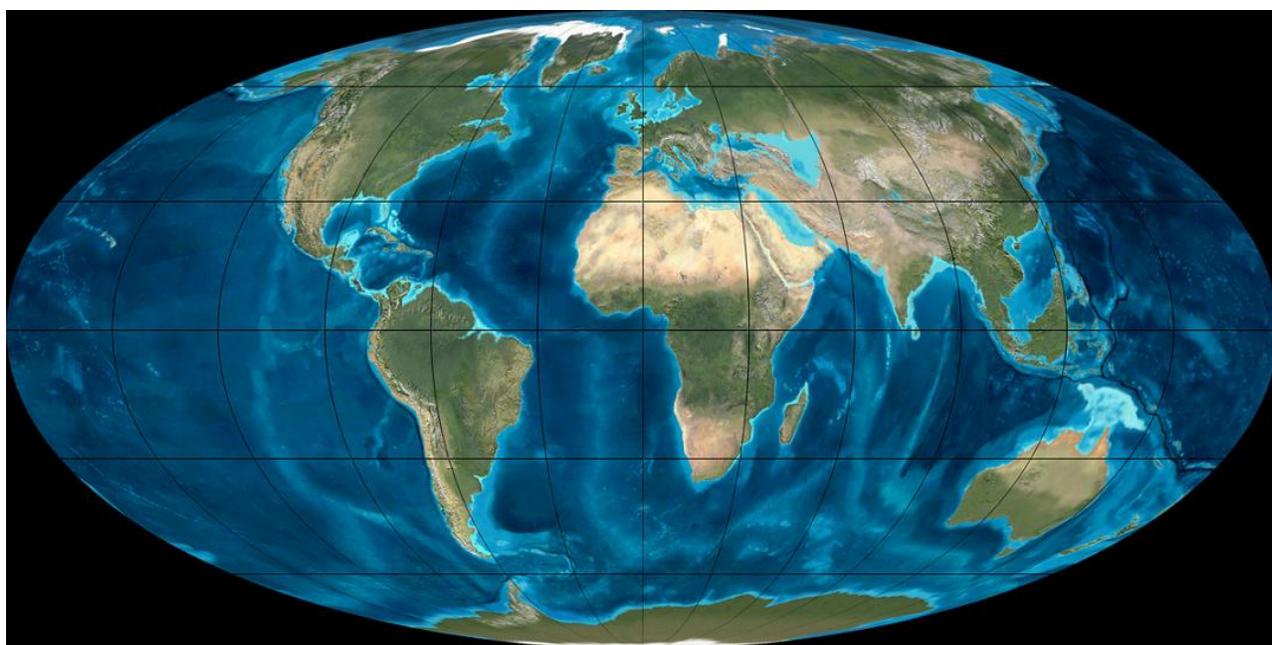


Aepycamelus

This illustration by Heinrich Harder (1858-1935) is in the public domain.
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- Geology
 - The continents are pretty much in the places we expect them to be. But notice that the Red Sea hasn't opened up much and, just to the east, the Persian Gulf is wide and opens to the Mediterranean. Land animals and freshwater fish cannot cross between North and South America – yet.



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14,000,000 – Fourteen Million Years Ago

- Biology
 - We are somewhere in an Asian forest with one of our ancestors that is also ancestral to chimpanzees, gorillas, and orangutans. This is the last common ancestor we have with orangutans. They will now diverge from our lineage.

¿You don't see her? She is probably hiding from predators.



Image by Amanda. From A Passion for Science.



6,500,000 – Six Million Five Hundred Thousand Years Ago

- Biology
 - *Sahelanthropus tchadensis* lives along the forest edge. It may be ancestral to both humans and chimpanzees. Our last common ancestor with the great apes was back a short distance up the path.
 - *Sahelanthropus tchadensis* is more intelligent than anything that has come before.



Sahelanthropus tchadensis

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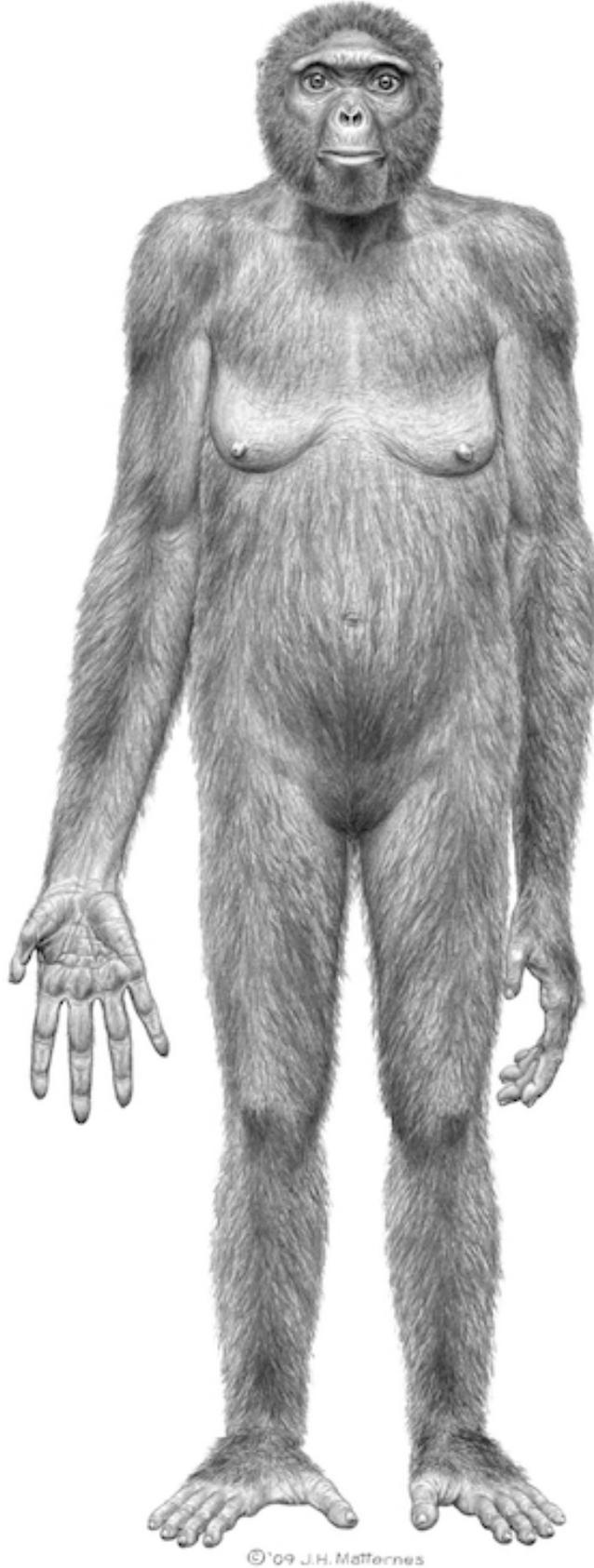
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4,400,000 – Four Million Four Hundred Thousand Years Ago

- Biology

- Ardi [*Ardipithecus ramidus*] is adept at moving through trees to eat fruit. She is also better at walking on the ground than her distant ancestors. Ardi walks about looking for amphibians in the marsh and for lizards on the rocks. She can trust her troop members to shout out for danger – or call her when they find food.
- She might be an ancestor of ours. It's hard to know.



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Ardipithecus ramidus

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3,180,000 – Three Million One Hundred Eighty Thousand Years Ago

- Biology
 - Happily, Lucy spies her buddies. They share food and good times and bad times as they live, love, squabble, gather food, hunt, and die in eastern Africa. We classify them as *Australopithecus afarensis*.

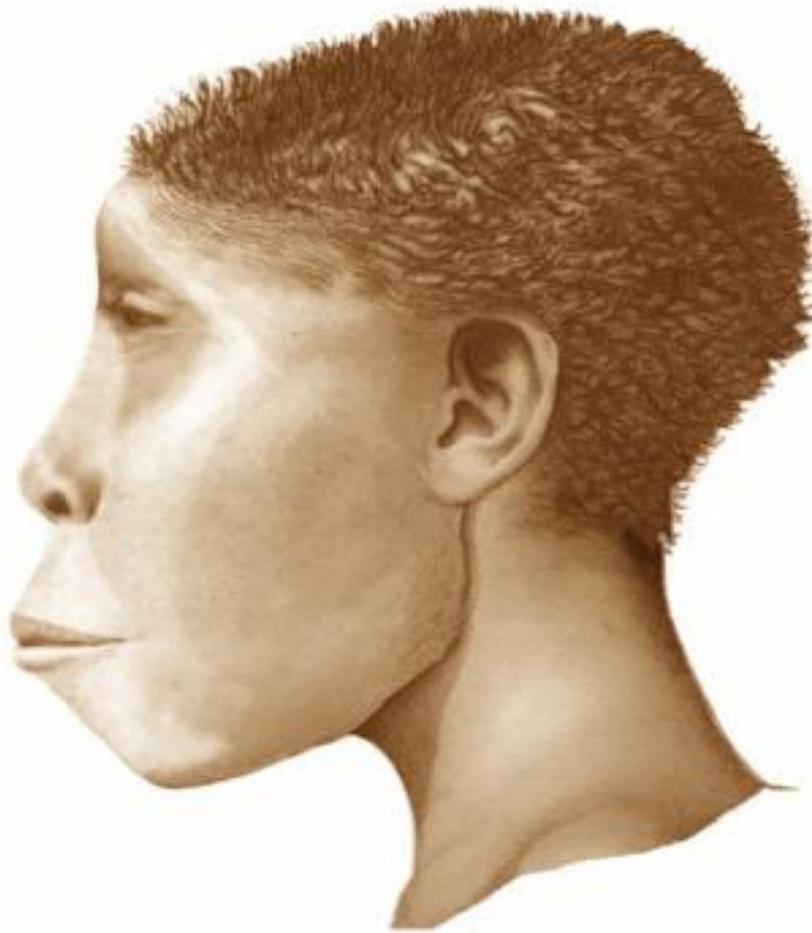


Australopithecus afarensis

Image adapted from photo taken at the CosmoCaixa Barcelona and released into the public domain.

1,600,000 – One Million Six Hundred Thousand Years Ago

- Biology
 - Kamoya Kimeu found the fossilized bones of this 13-year-old boy in rock formed from river silt at Nariokotome near Lake Turkana in eastern Africa. Perhaps he drowned crossing a swollen river. Perhaps his family and friends were very concerned at his disappearance. [We assign these people the species name of *Homo ergaster*.]



13-year-old male *Homo ergaster*

Reconstruction by Nikolas Zalotockyj. Released into the public domain by the artist. From Wikimedia Commons

500,000 – Five Hundred Thousand Years Ago

- Biology
 - This species of hominin living in Africa may be the ancestor to both *Homo sapiens* and *Homo neanderthalensis*. He is called *Homo heidelbergensis* but his friends call him Grom, Son of Gurg. He stands 1.8 meters (6 feet) tall but some of his buddies are two meters tall. Grom is big, strong, and probably smarter than other hominins sharing the planet with him.



Homo heidelbergensis

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