



The History of Life



© NASA



www.fossilmuseum.net/Fossil-Pictures/Ammonites/Ammonite-5/Ammonite-5-1024.jpg



The Fossil Record



Fossils provide a record of life forms that once existed in the past



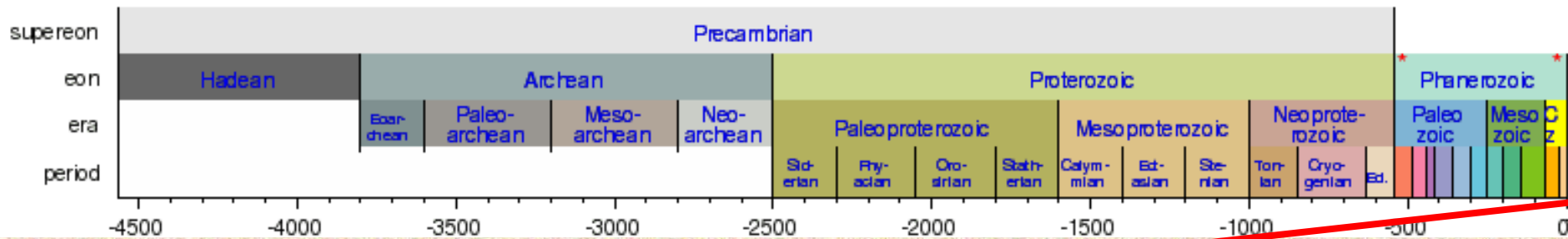
www.discoveringfossils.co.uk/royalty_free_photos_fossil_hunting_collecting.jpg



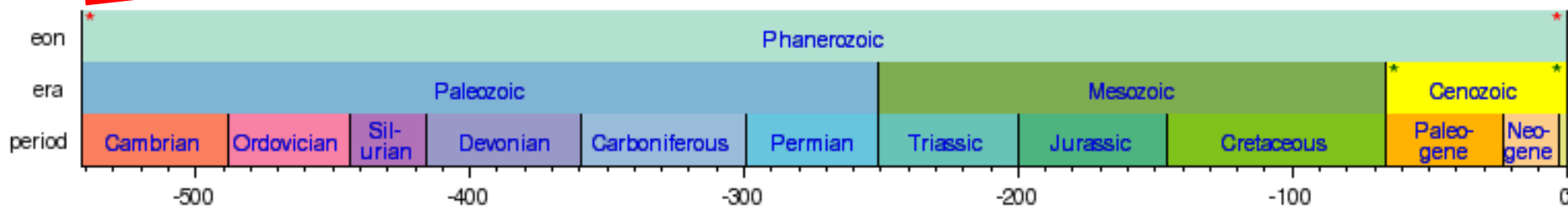
Geological Time

The whole geological timescale

http://en.wikipedia.org/wiki/Geologic_time_scale



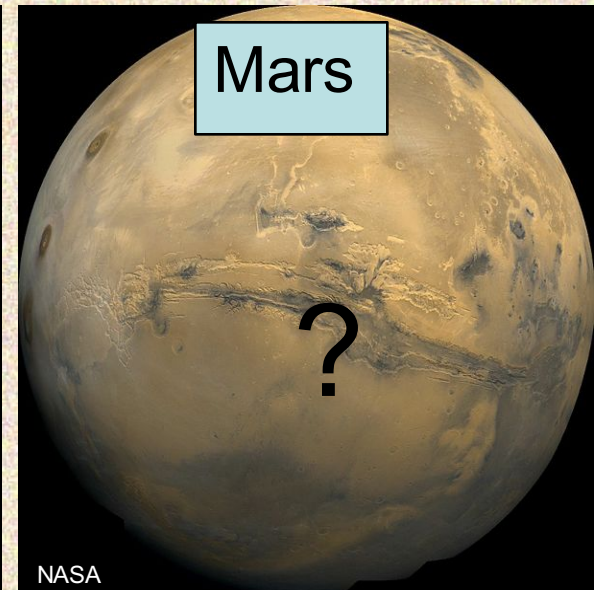
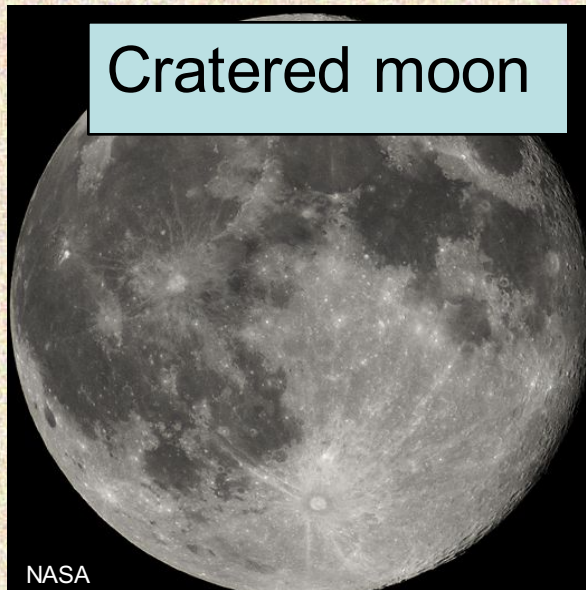
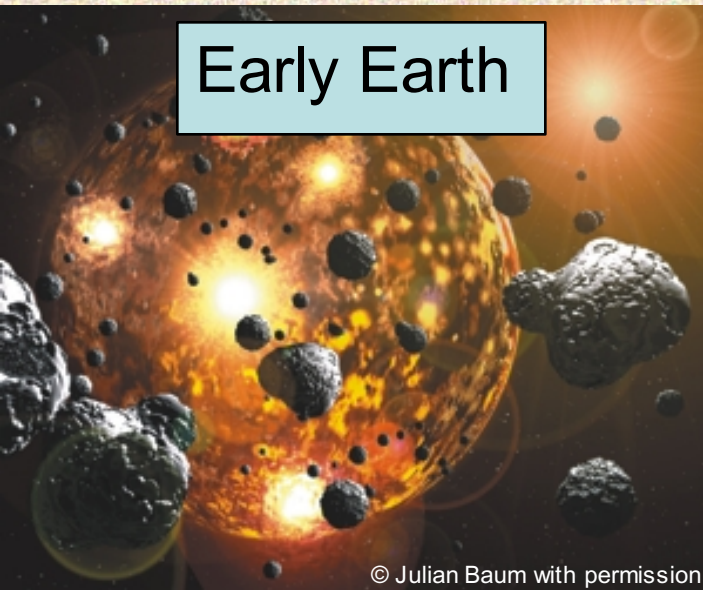
The Phanerozoic in detail



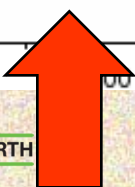
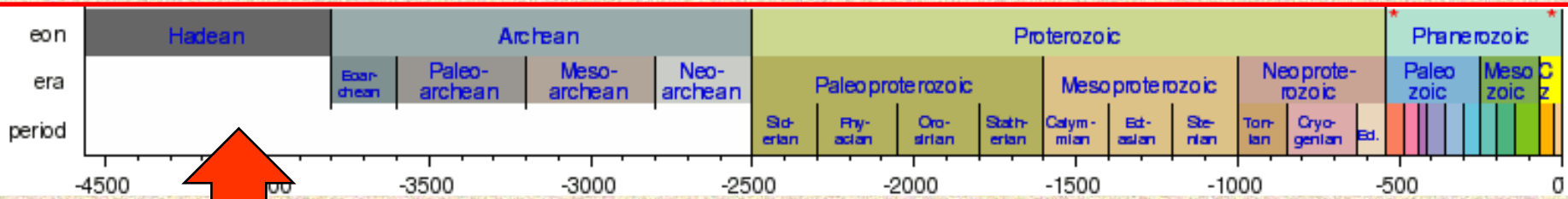
The study of fossils in the context of the 4500 million years of geological time allows us to piece together the History of Life



In the Sea (1): Bombardment



During its early history, the Earth was bombarded by meteorites. Such inhospitable conditions probably prevented life from evolving.



4500-3800 million years ago

http://en.wikipedia.org/wiki/Geologic_time_scale



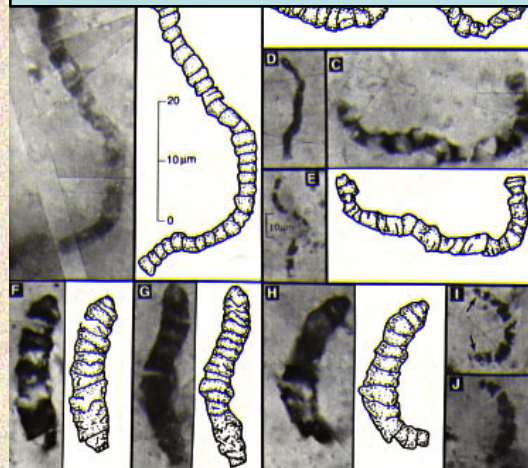
In the Sea (2): First living things

Modern bacterial mounds



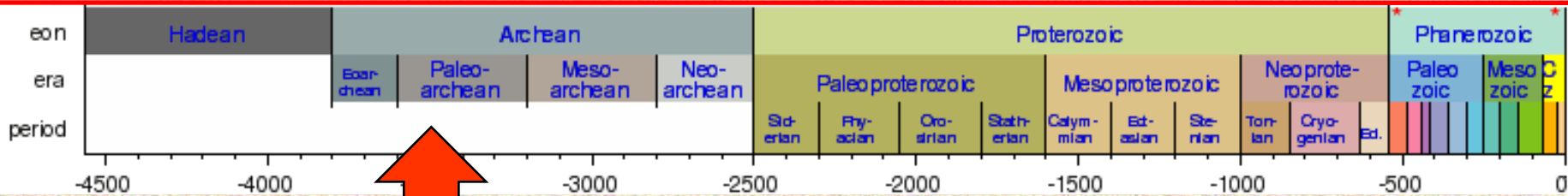
en.wikipedia.org/wiki/Image:Stromatolites_in_Sharkbay.jpg

Fossil bacteria?



www.fas.org/irp/imint/docs/rst/Sect20/A12.html

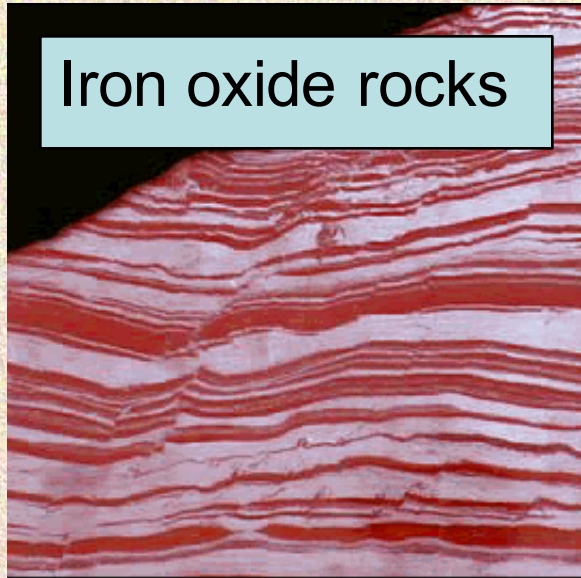
- Life evolved shortly after the bombardment ended, early in Earth History.
- The first living things were simple **bacteria**



3800-3500 million years ago

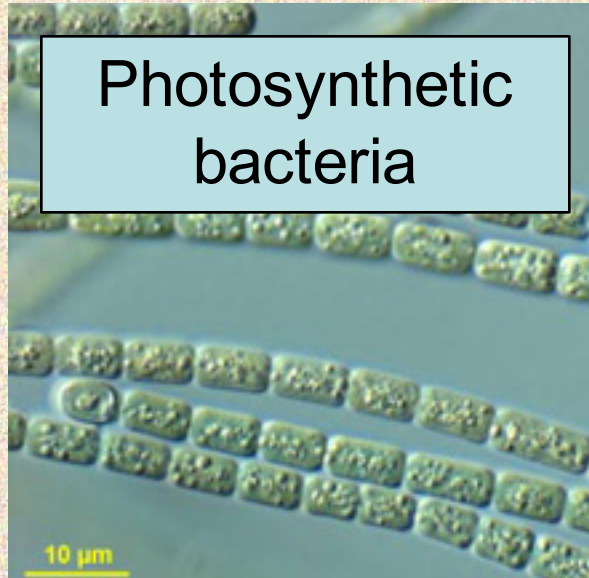
http://en.wikipedia.org/wiki/Geologic_time_scale

In the Sea (3): Oxygen



Iron oxide rocks

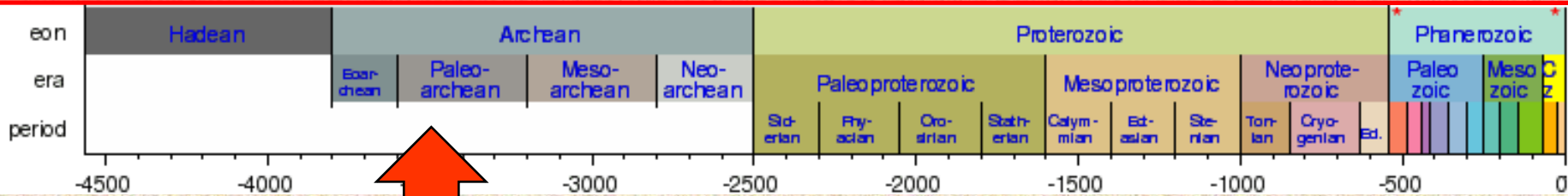
http://www.globalchange.umich.edu/globalchange1/current/lectures/first_billion_years/bif.gif



Photosynthetic bacteria

en.wikipedia.org/wiki/Image:Anabaena_sperica.jpg

- Early photosynthetic bacteria produced oxygen and released it as a waste product.
- This added oxygen to the atmosphere for the first time.



http://en.wikipedia.org/wiki/Geologic_time_scale

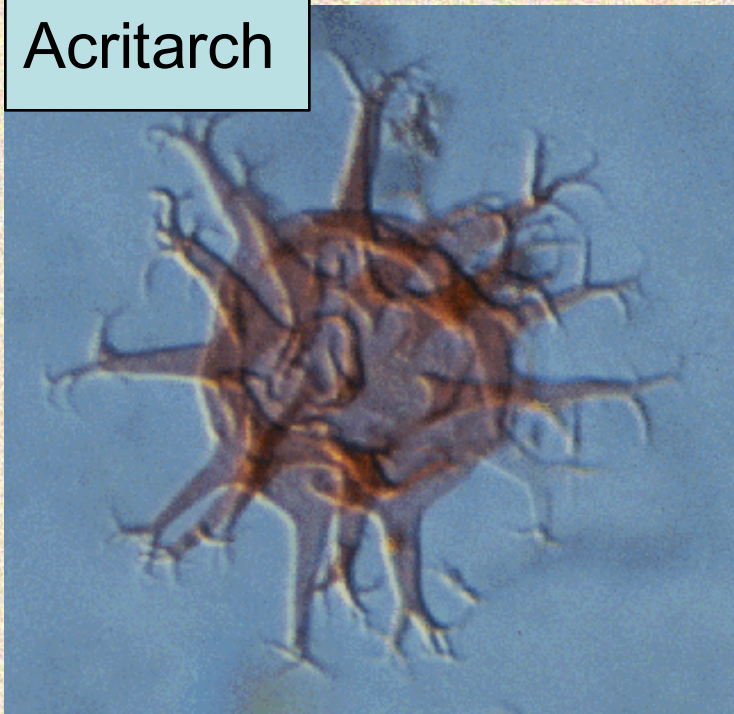


3800-3500 million years ago



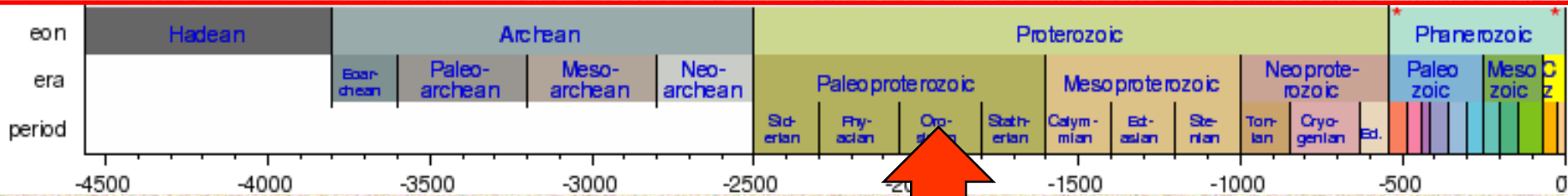
In the Sea (4): Complex cells

Acritarch

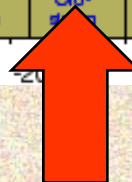


- Two billion years later complex **eukaryote** cells appeared.
- These had compartments with special functions such as energy factories called **mitochondria**.
- Eukaryote cells need oxygen - this explains their late evolution

www.cushmanfoundation.org/resources/images/slide16.gif



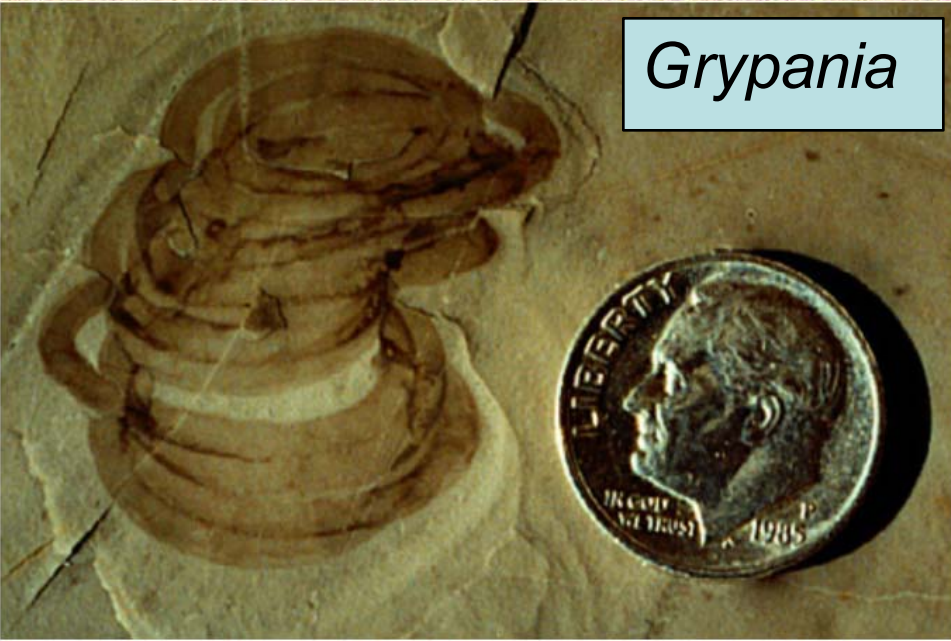
1900 million years ago



http://en.wikipedia.org/wiki/Geologic_time_scale



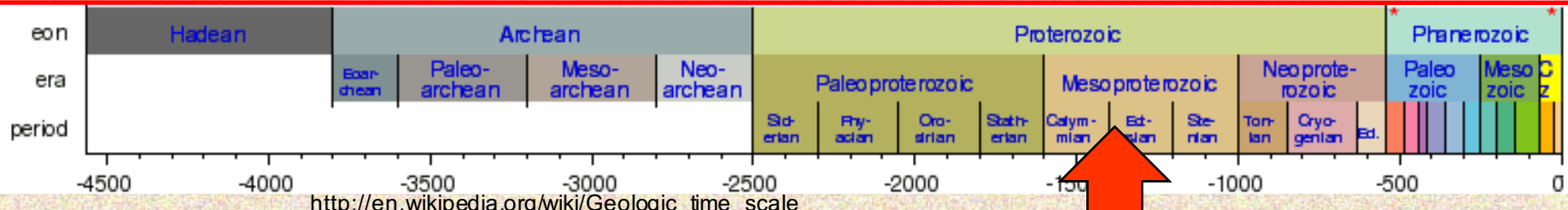
In the Sea (5): Multicellular life



Grypania

- After another **half billion** years many-celled life appeared
- *Grypania* was a coiled tube, 2 mm wide and up to 5 cm long

© Bruce Runnegar with permission



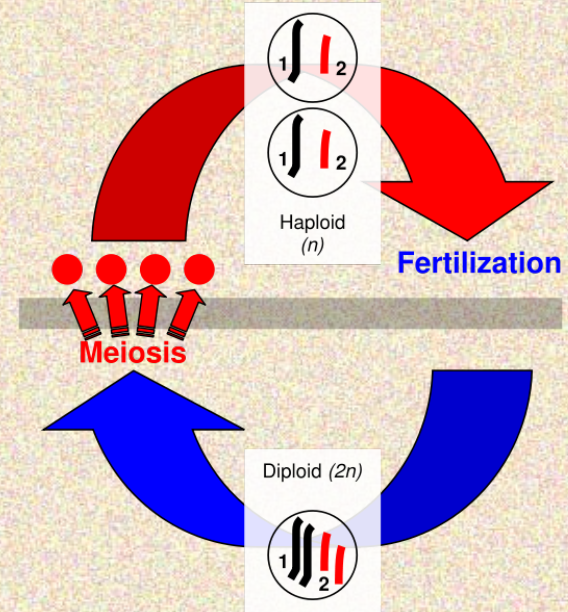
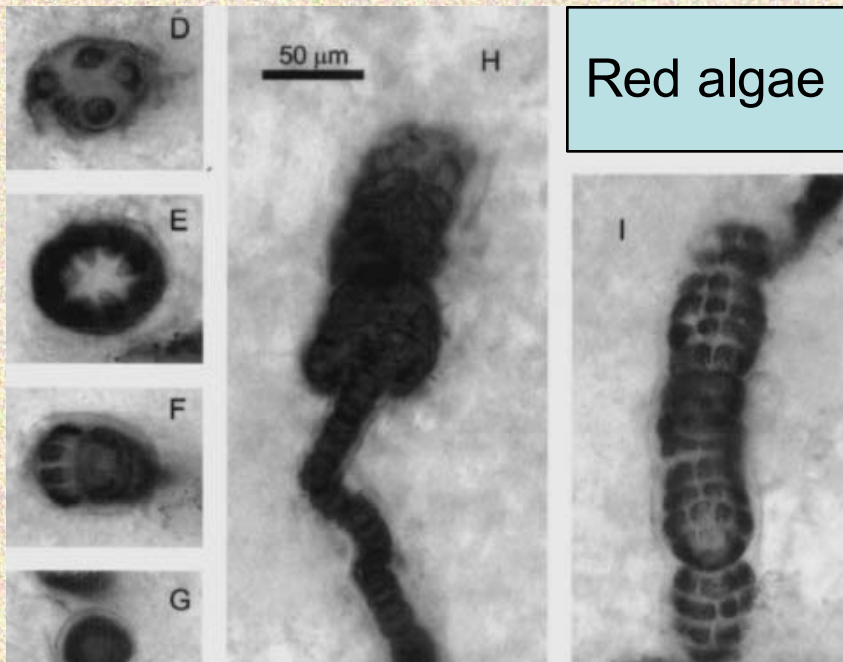
http://en.wikipedia.org/wiki/Geologic_time_scale

1400 million years ago



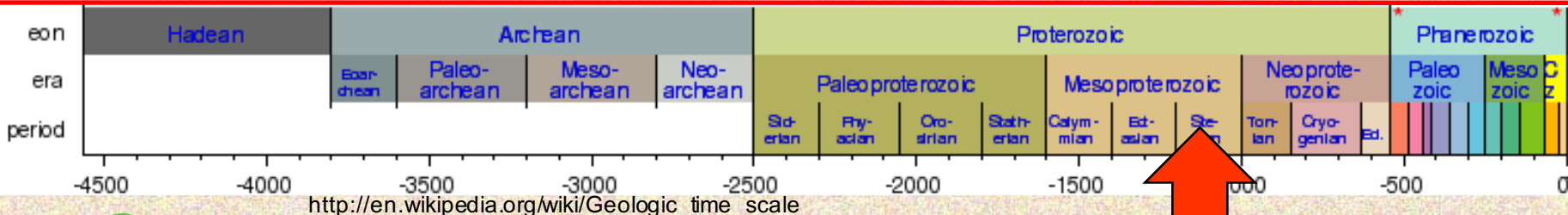
In the Sea (6): Biology's Big Bang!

evolution.berkeley.edu/evolibrary/images/bangiomorpha1.jpg



en.wikipedia.org/wiki/Image:Sexual_cycle.svg

A short time later, 1200 mya, algae evolved sexual reproduction



http://en.wikipedia.org/wiki/Geologic_time_scale

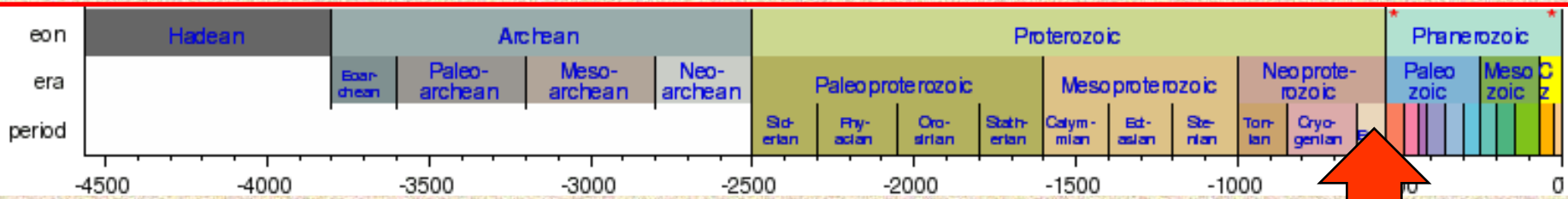
1200 million years ago



In the Sea (7): Ediacara Evidence



By 630 mya, the familiar kingdoms of animals, plant and fungi had evolved. The Ediacara fauna of this time interval were strange bizarre organisms from the dawn of animal life



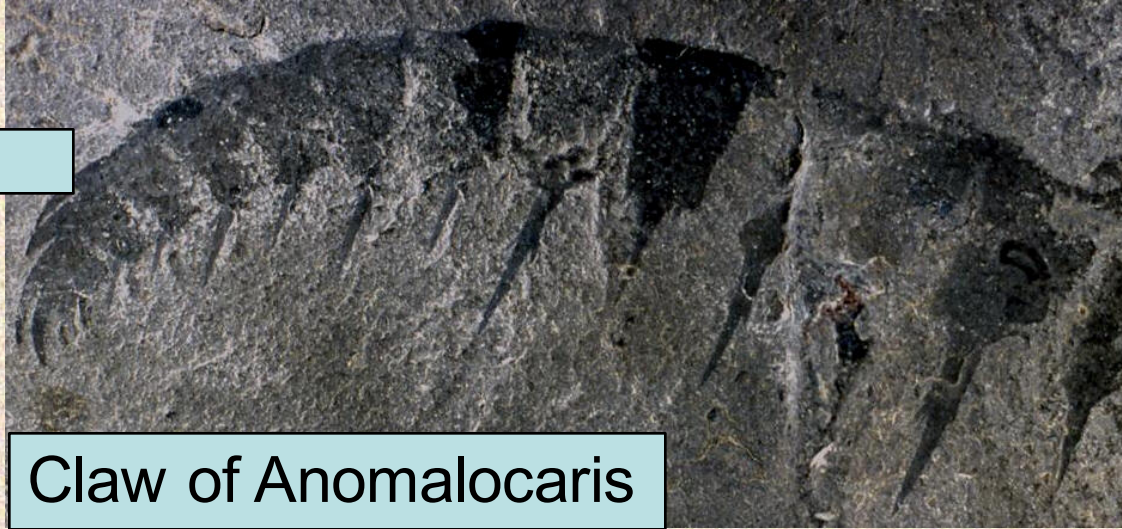
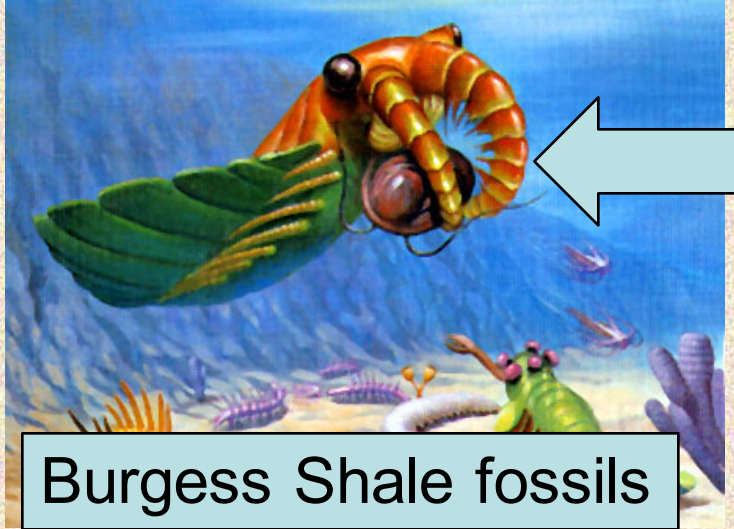
http://en.wikipedia.org/wiki/Geologic_time_scale

630-542 million years ago



Beginnings (8): Diversity explodes

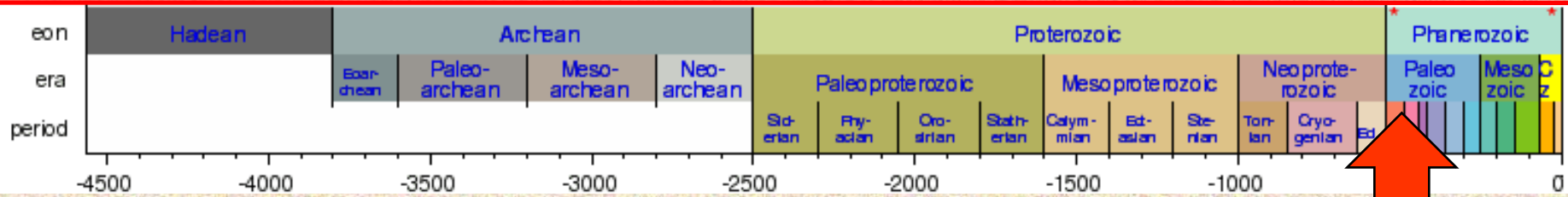
palaeo.gly.bris.ac.uk/palaeofiles/lagerstatten/Burgess/Anomalocarishunts.jpg www.newarkcampus.org/professional/osu/faculty/jstjohn/Cool Fossils/Anomalocaris-canadensis.jpg



Burgess Shale fossils

Claw of Anomalocaris

Around 542 mya, several fossil sites show that the diversity of animal life on Earth dramatically exploded over a short time.



http://en.wikipedia.org/wiki/Geologic_time_scale

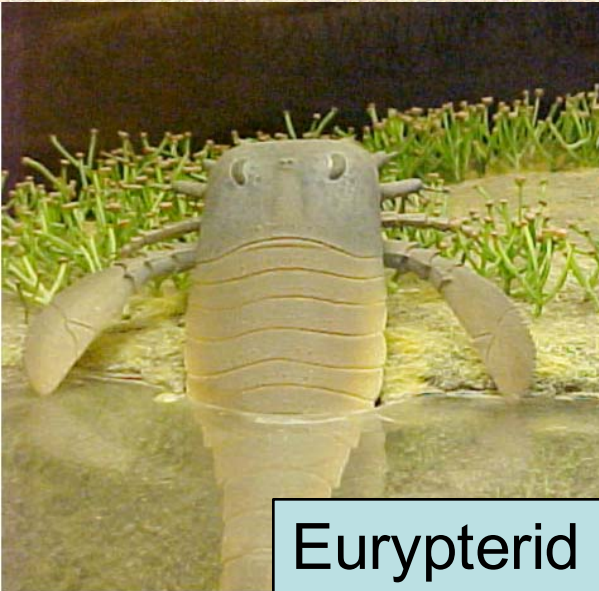
542-515 million years ago



Onto Land (1): Making tracks

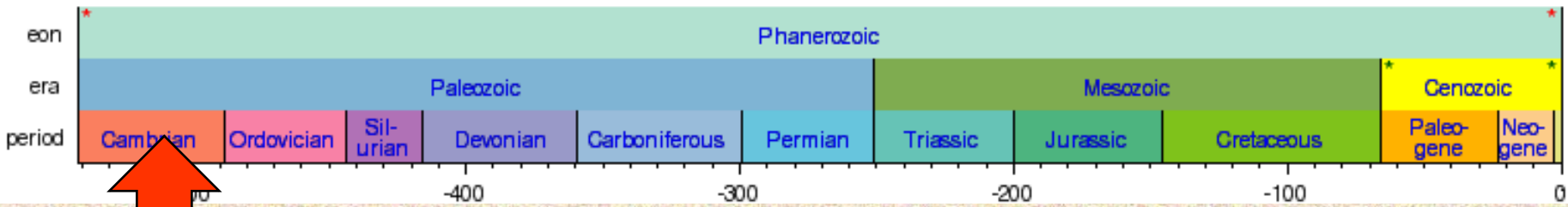


© Simon Braddy



Eurypterid

- Around 500 mya, tracks in ancient coastal dunes show that some marine animals started to make **temporary visits** to the sea shore to feed or mate

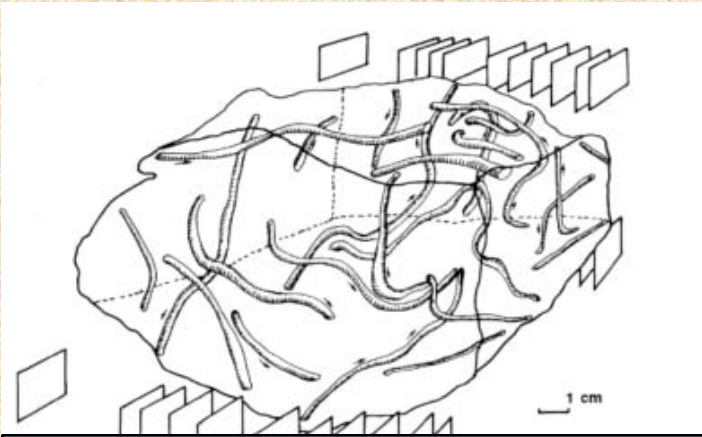


500 million years ago

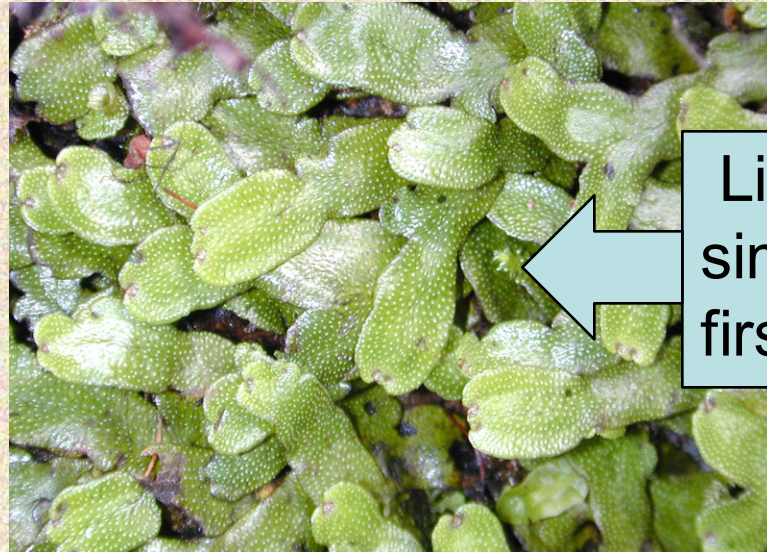
http://en.wikipedia.org/wiki/Geologic_time_scale

Onto Land (2): Permanent residents

upload.wikimedia.org/wikipedia/commons/4/41/Liverwort.jpg

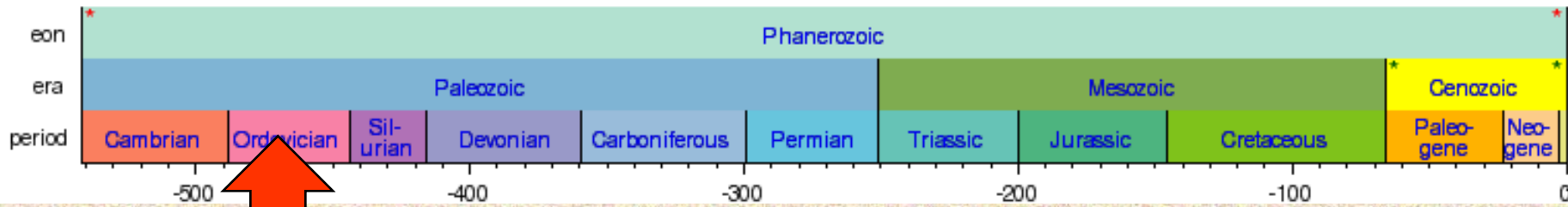


Ancient worm burrows



Liverworts similar to the first plants

Worms and primitive plants started to colonize the land, 460 mya



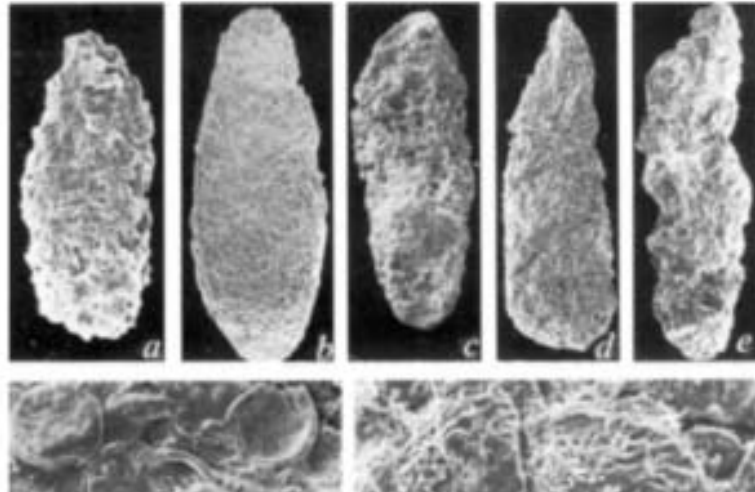
460 million years ago

http://en.wikipedia.org/wiki/Geologic_time_scale

Onto Land (3): A taste for Plants



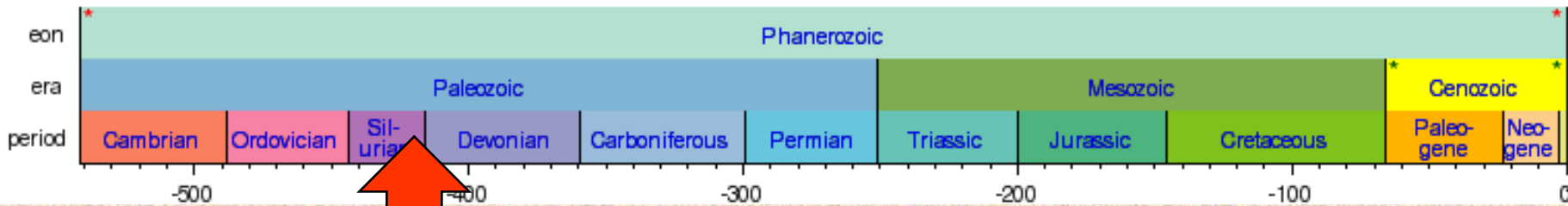
Fossil millipedes



Fossil poo contains plants

Analysis of fossil poo shows that animals started to eat plants, 420 mya

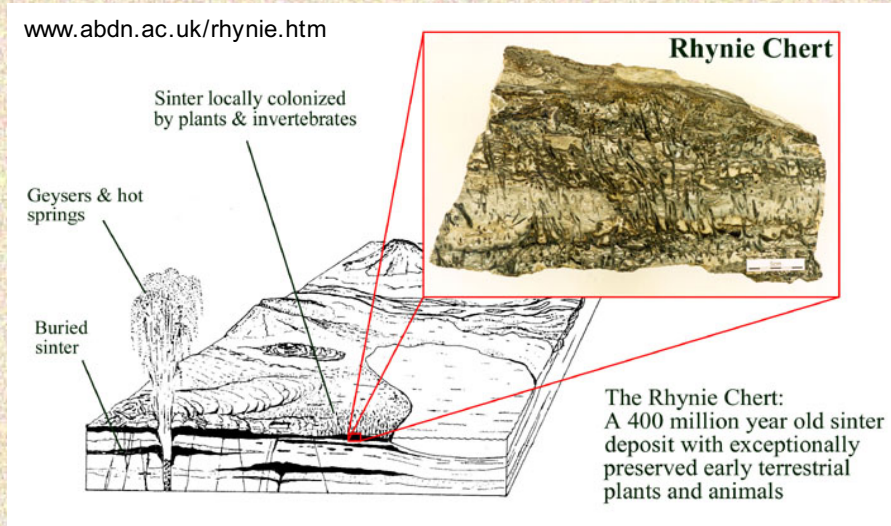
Millipedes and their poo in the Ludlow Bone Bed of Shropshire



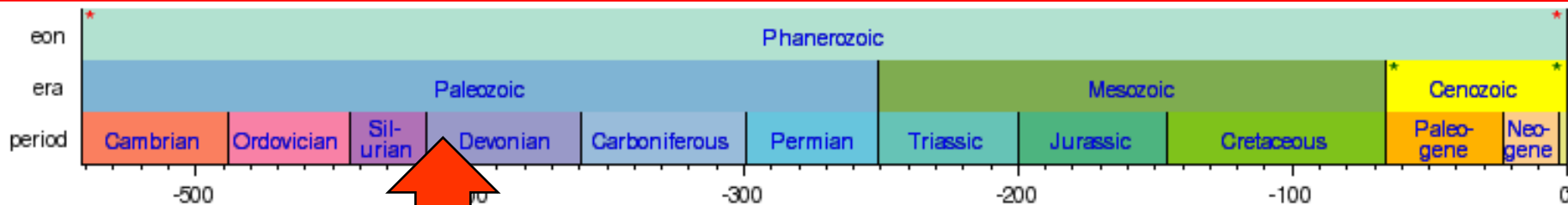
420 million years ago

http://en.wikipedia.org/wiki/Geologic_time_scale

Onto Land (4): Time Capsule



Around 400 mya, a **whole land ecosystem** became a time capsule at Rhynie in Scotland when a volcanic hot spring erupted.



400 million years ago

http://en.wikipedia.org/wiki/Geologic_time_scale



Onto Land (5): First Forests

www.ucmp.berkeley.edu/seedplants/progymnosperms.html

www.seedbiology.de/evolution.asp



Tree trunks

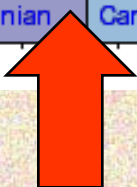
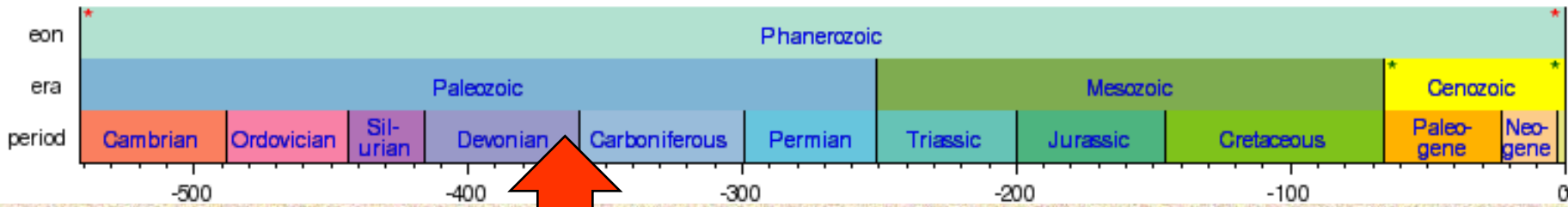


Large leaves



Seeds

Forests were born 380 mya as plants grew trunks, leaves and seeds for the first time



380-370 million years ago

http://en.wikipedia.org/wiki/Geologic_time_scale

Onto Land (6): Amphibians

en.wikipedia.org/wiki/Image:Panderichthys_BW.jpg



Panderichthys

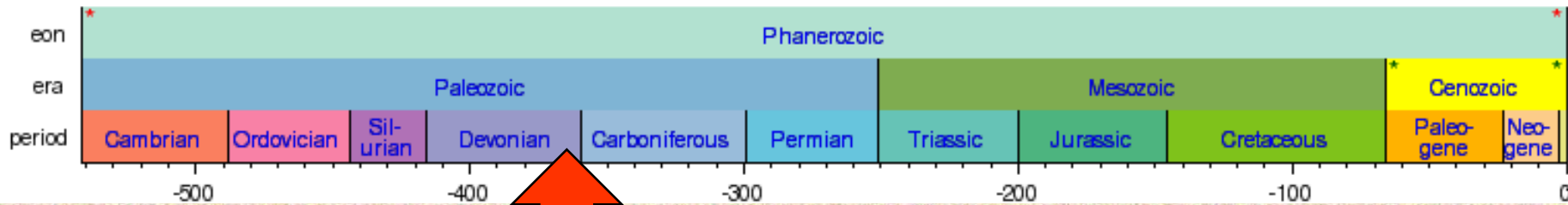
- Also around 380 mya certain fish evolved limbs and lungs for life on land



Ichthyostega

- The first land-dwelling amphibians retained many fishy characteristics

en.wikipedia.org/wiki/Image:Ichthyostega_BW.jpg



http://en.wikipedia.org/wiki/Geologic_time_scale

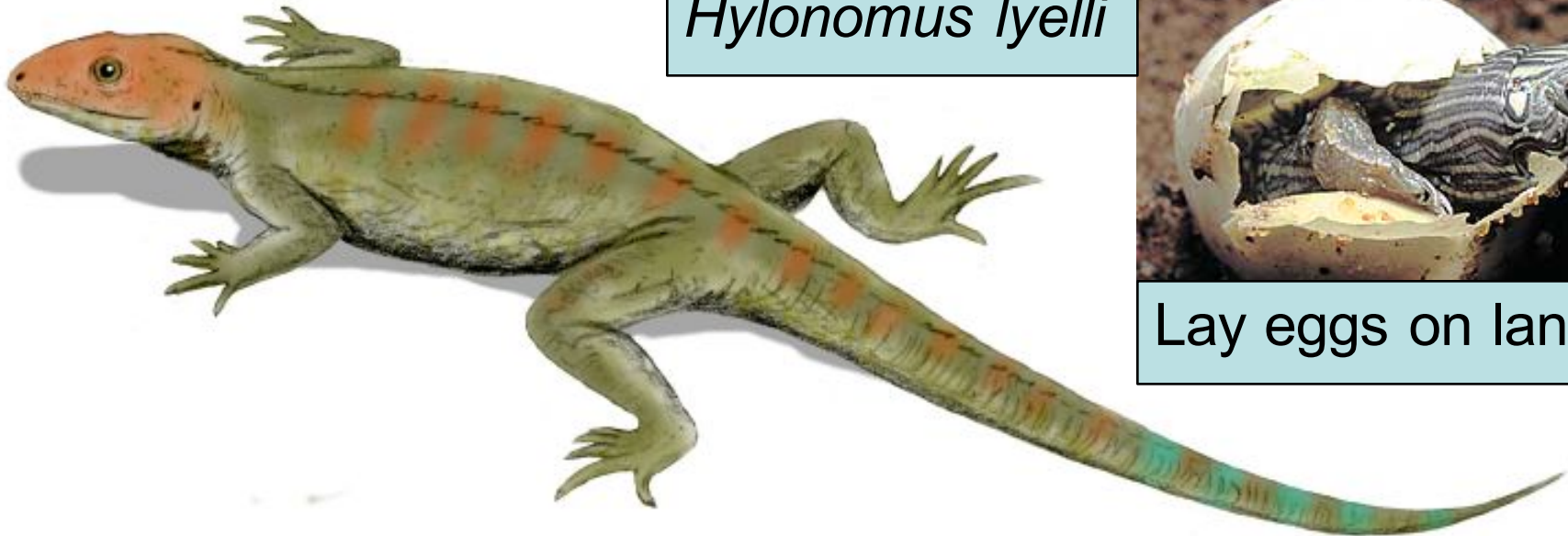
380-365 million years ago



Onto Land (7): Reptiles

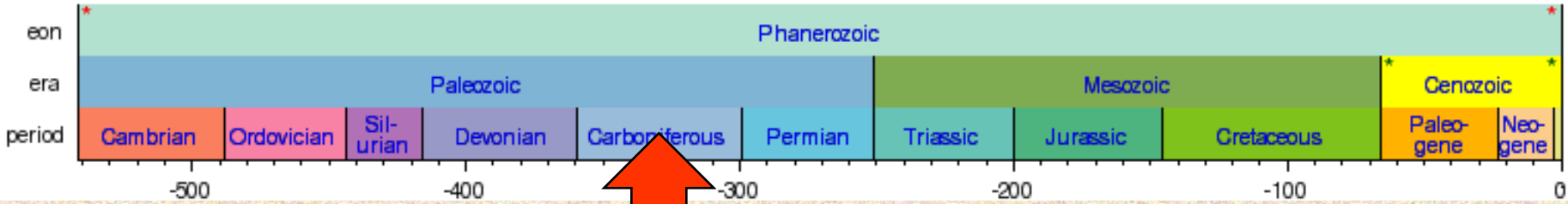
http://upload.wikimedia.org/wikipedia/commons/5/56/Hylonomus_BW.jpg

Hylonomus lyelli



Lay eggs on land

Bones found in Canada show that reptile evolved, 315 mya



315 million years ago

http://en.wikipedia.org/wiki/Geologic_time_scale



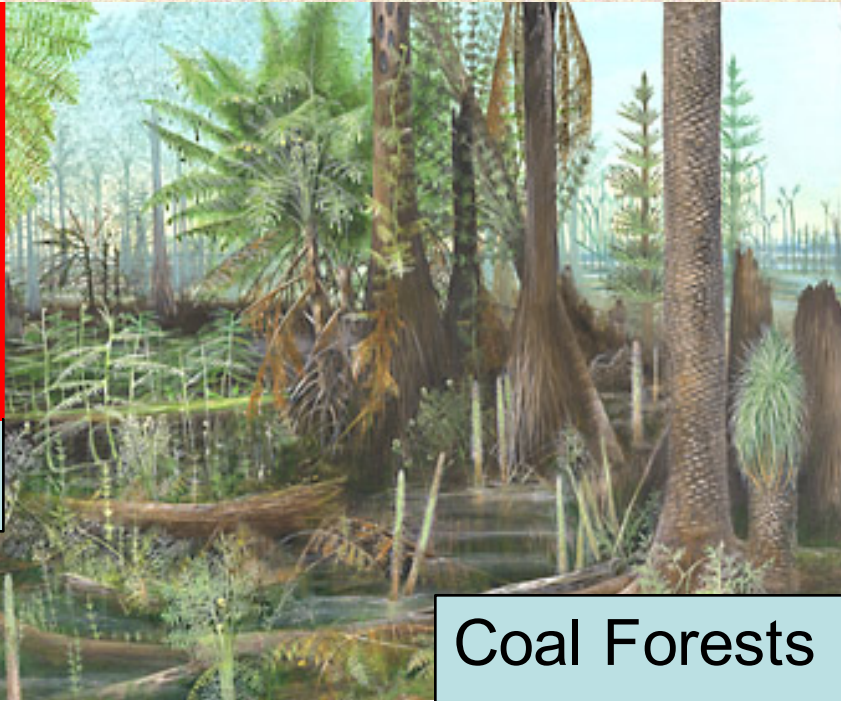
Onto Land (8): First Rainforests

www.mnh.si.edu/highlight/riola/images/calhoun.jpg



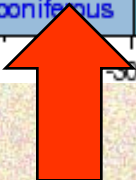
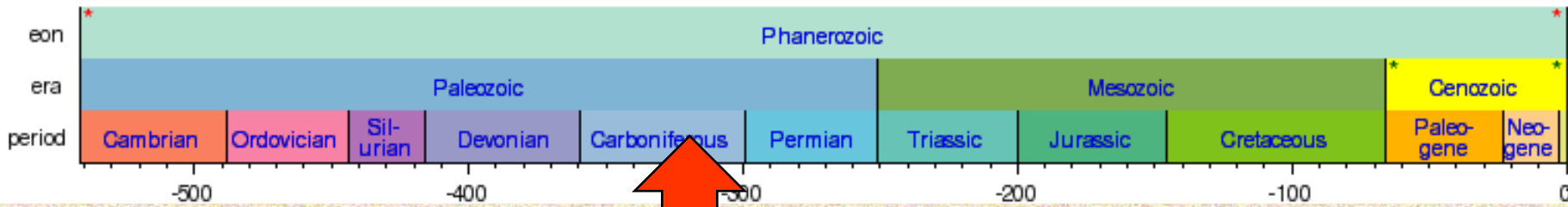
© Howard Falcon-Lang

Fossil plant



Coal Forests

Around 300 mya, coal seams in North America and Europe show that the first tropical rainforests had evolved.



320-290 million years ago

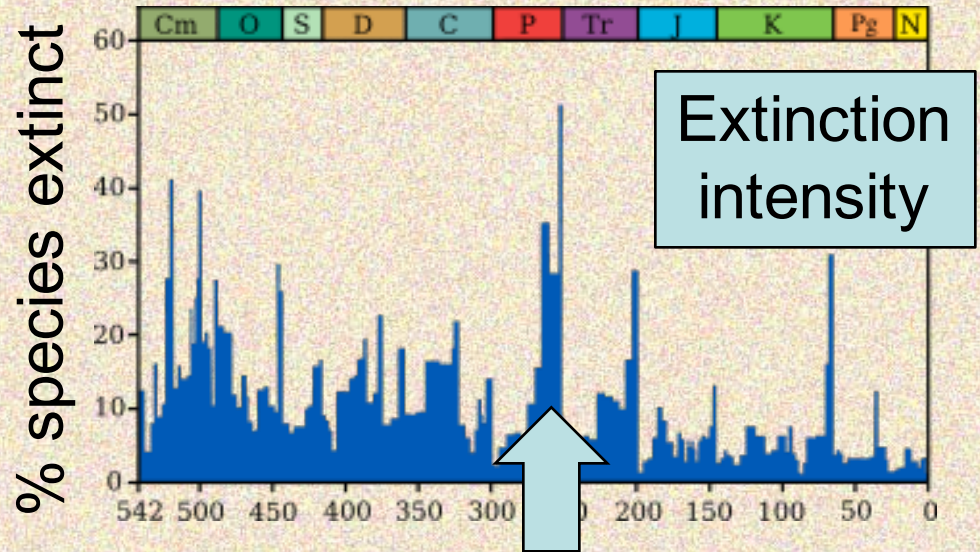
http://en.wikipedia.org/wiki/Geologic_time_scale



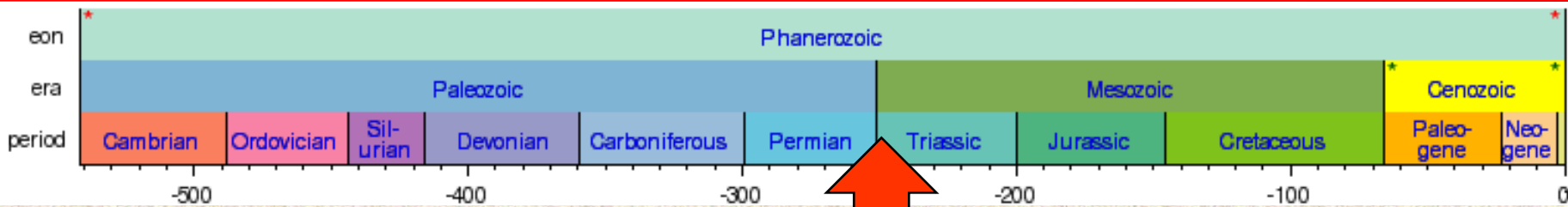
Boom & Bust? (1): The Great Dying



upload.wikimedia.org/wikipedia/commons/0/01/Pahoehoe_fountain_original.jpg



Life nearly died in a massive wave of extinction around 251 mya in the largest of the so-called “Big Five” mass extinctions

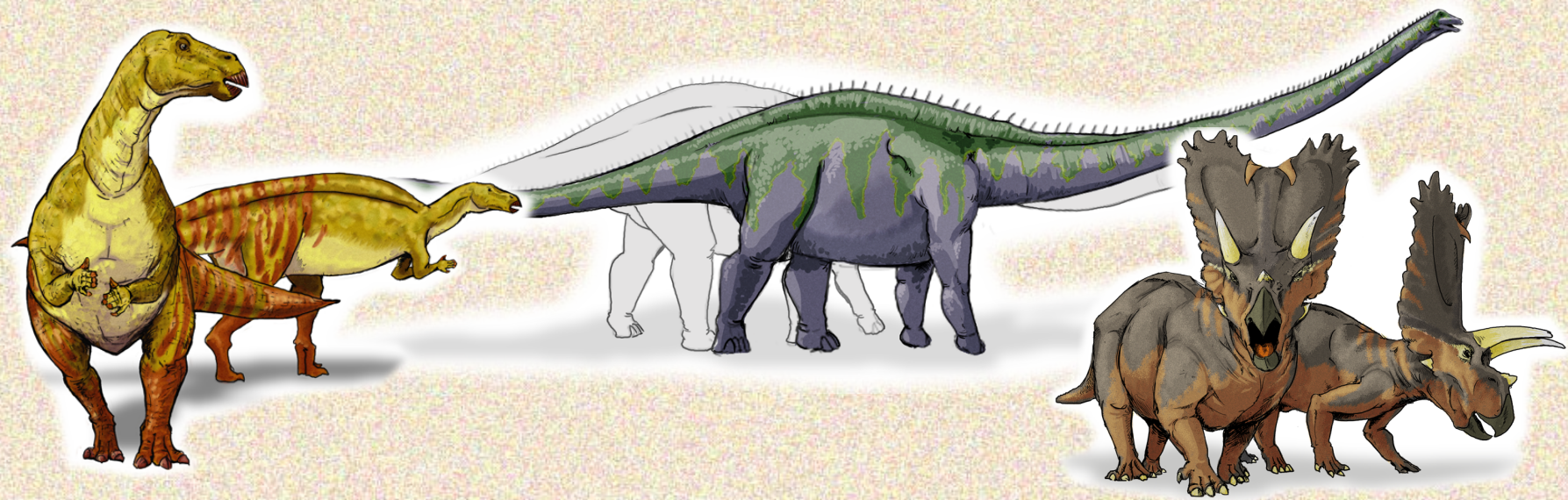


251.4 million years ago

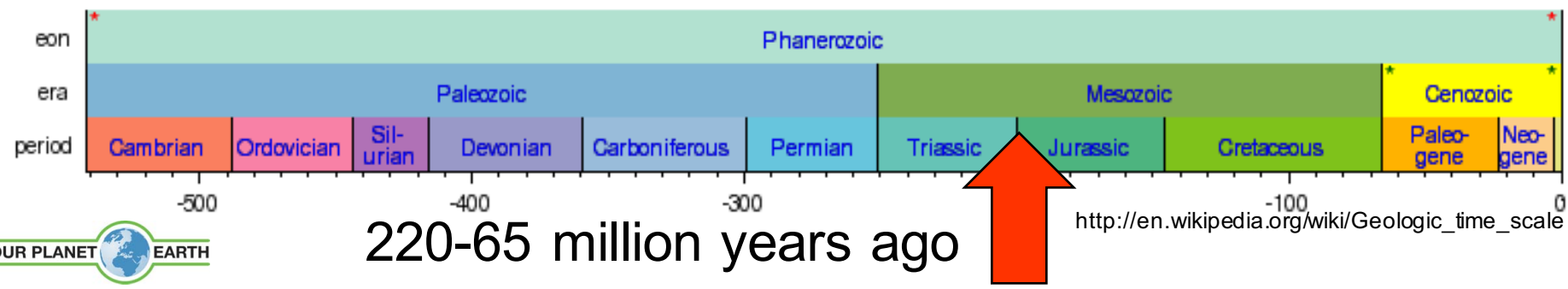
http://en.wikipedia.org/wiki/Geologic_time_scale



Boom & Bust? (2): Dinosaurs



About 220 mya, shortly after the extinction, dinosaurs appeared. These reptiles dominated the land for the next 150 myrs!



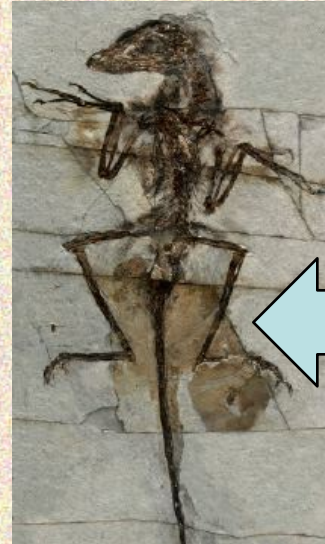
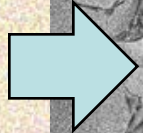
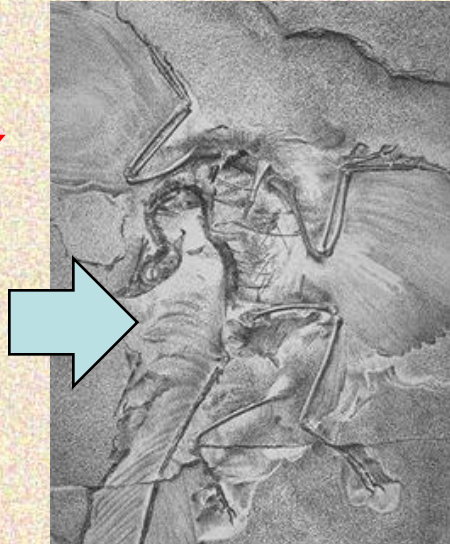


Boom & Bust? (3): Birds

upload.wikimedia.org/wikipedia/commons/d/d6/SArchaeopteryxBerlin2.jpg

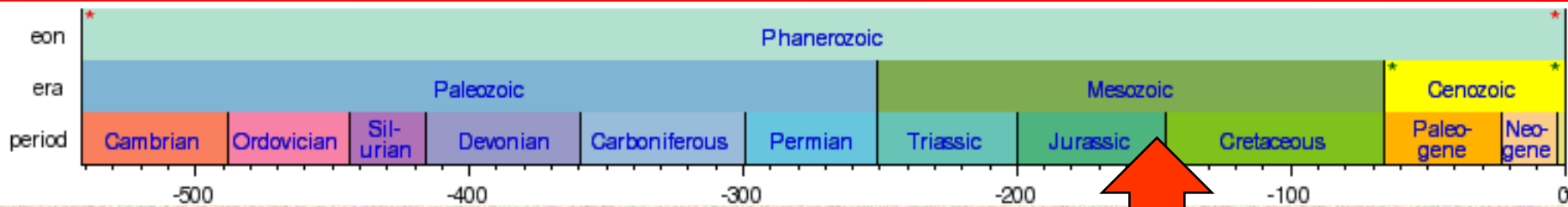
www.dinohunters.com/History/Microraptor.htm

Archaeopteryx is one of the earliest known birds



Microraptor is a small feathered dinosaur

About 155 mya, **birds evolved from dinosaurs**. The similarity between birds and dinosaurs has been recognized for 160 years.



155 million years ago





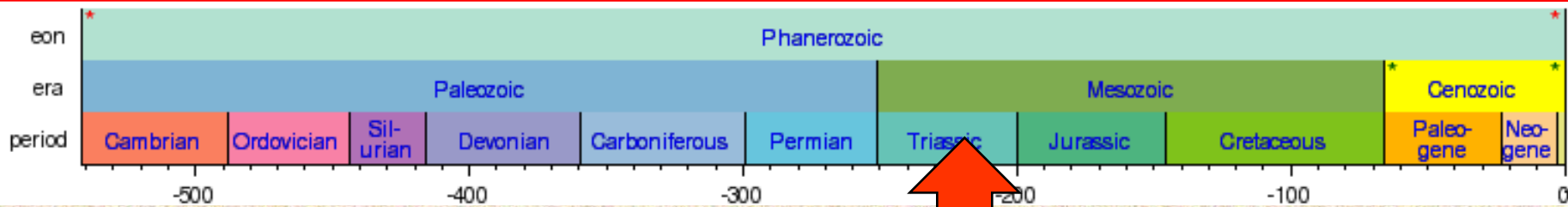
Boom & Bust? (4): Mammals

Yanoconodon

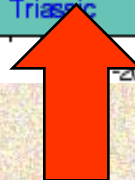


© Nicolle Rager Fuller, National Science Foundation

- Mammals evolved about the same time as the dinosaurs, 220 mya, but lived in their shadow for a 150 million years
- Many were small, **nocturnal** insect-eating animals. The need to be active at night may be why mammals are **warm-blooded**



220 million years ago



http://en.wikipedia.org/wiki/Geologic_time_scale

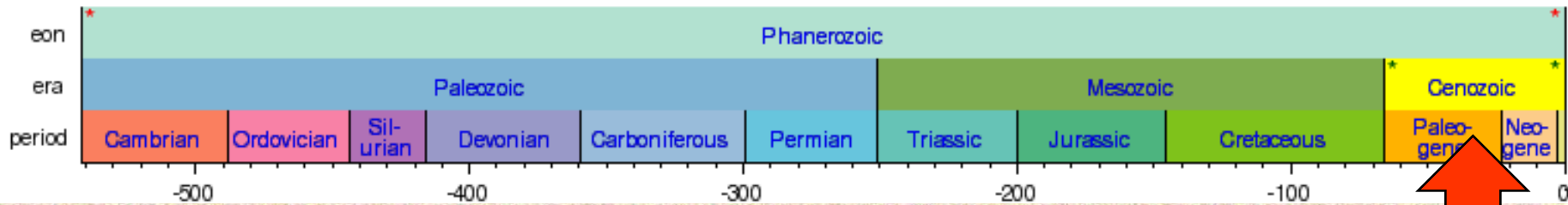


Boom Bust? (6): Grass and Grazers

i.pbase.com/o4/15/700115/1/66410718.sOPB0thD.serengeti2.jpg

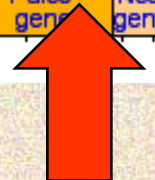


Around 35 mya, climate became cooler and drier and grasslands and grazing mammals became widespread

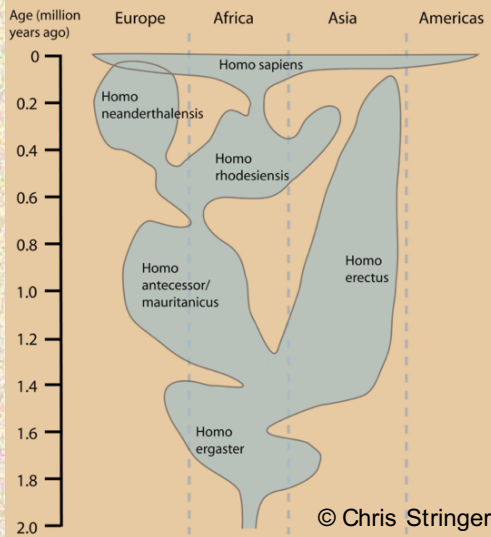


http://en.wikipedia.org/wiki/Geologic_time_scale

35 million years ago



Boom & Bust? (7): Humans



en.wikipedia.org/wiki/Image:Neanderthal_2D.jpg



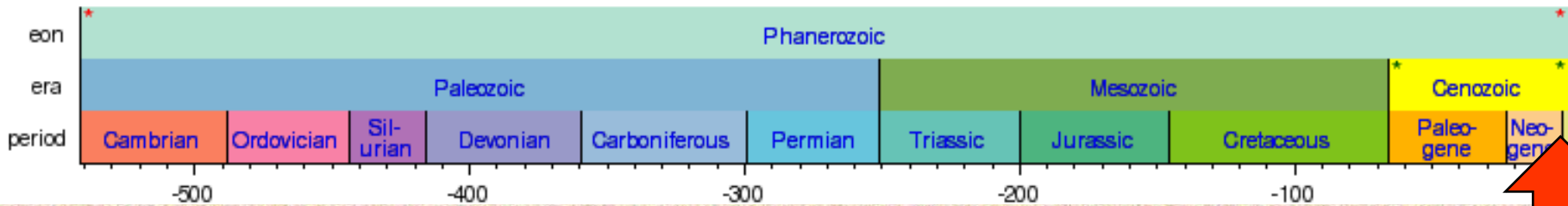
Neanderthal

en.wikipedia.org/wiki/Image:Lascaux2.jpg



Cave art

Around 2 mya, humans evolved. They pioneered the use of fire and tools to control their world, and developed society and culture



http://en.wikipedia.org/wiki/Geologic_time_scale

2 million years ago

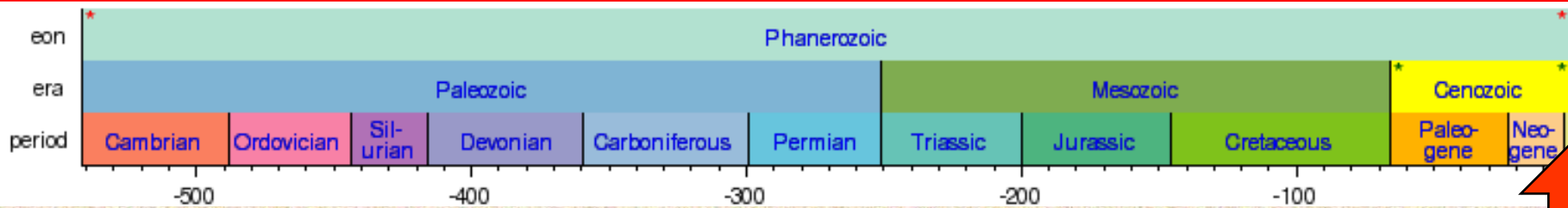


Boom & Bust? (8): Sixth Extinction

NASA



- Following their evolution humans have caused huge species loss, and this has accelerated in since the 19th century
- Are we now in the midst of a sixth mass extinction?



http://en.wikipedia.org/wiki/Geologic_time_scale