

Lecture 17: 6 Nov 2018

Andrew The Fossil Record

1. Making Fossils

- (a) Our direct view of the past. Walking downhill is traveling in time
- (b) A world without fossils: the incompleteness of phylogenetic analysis done using solely extant taxa
- (c) The gap between crocodiles and birds is available via the fossil record
- (d) Tectonic plates: either splitting or colliding - dynamic earth
- (e) The Geological Cycle
 - i. Magma cools and forms igneous rocks to metamorphic rocks. All rocks erode which results in sediments, which accumulates and eventually compacts to form sedimentary rock. In sedimentary rocks is where we find fossils
- (f) The Process of Fossilization
 - i. Erosion and exposes part of rock that could have fossils. Somehow the bones have turned to rock.
 - ii. Four modes of fossilization
 - A. Freezing: mammoths - can recover tissue and DNA from that frozen samples
 - B. Amber: mineralized excretion of tree sap.
 - C. Replacement: fossil sandwiched in rock with slow percolation of water through porous sedimentary rock. It's slowly dissolving away the organic material of the bones. The organic material is replaced with mineral material. Molecule by molecule
 - D. Casts: negative impressions of hard parts. This may be internal (cast) or external (mold)
 - iii. Exceptional Preservation: Lagerstätten (super preserved fossil deposit)
 - A. Archaeopteryx is a protobird - dino bird

2. Hard to preserve

- (a) Hard parts only - lose all soft parts (can be the most interesting)
- (b) Taxonomically biased therefore in the fossil record - fluffy things won't show up
- (c) Also ecologically biased - orgs living in sedimentary environments
- (d) Not a random sampling of the tree of life

- (e) Limited anatomical snapshots: missing large parts of the fossil. We just have bones and sometimes not all of them
- (f) Stratigraphic Incompleteness
 - i. Don't have constant deposition of sedimentary material - i.e. years of droughts and then a year of tsunami which could deposit a meter of sediment which could be laid down over many many years but in this case would be in one day
 - ii. Pull of the Present: fossils from a billion years ago can 1) erode away, 2) fall into the ocean. Whereas more recent fossils will be more likely to survive
 - iii. Therefore the past can be underrepresented.
- (g) How to identify species?
 - i. Go on morphology alone
- (h) Dating is difficult too
 - i. Half lives don't work with fossils because they are in sedimentary rocks.

3. Extinction

- (a) Spindle diagram of tetrapods
- (b) Mass Extinction Events: rate of extinction ramps up
 - i. K-T Boundary: dinos. Not the biggest one
 - ii. End-Permian is the biggest. 95% of known species went extinct
 - iii. Mass Extinction is a newer idea
 - iv. What are the geological column. Clear transition in the rocks. If transition is global then can be one of the boundaries. Oftentimes associated with mass extinction events. 500 mya.
 - v. No single explanation of mass extinction causes
 - vi. K/T Boundary, Iridium Anomaly: Iridium does not normally occur on Earth. Rains down from space at a very slow rate. Around 65 mya there was a massive spike in iridium, why? Bolide. Theory was a prediction there'd be a crater and they finally found it. Kicks up enormous amount of stuff into the jet stream and then the planet is disrupted. Photosynthesis is greatly impacted and therefore the rest of the food chain.
 - vii. Huge tsunamis and volcanos at the same time. Might be that two bad things happen at one. K/T Boundary.
 - viii. Mammals and dinosaurs coinhabited for a long time. Elimination of dinos allowed mammals to expand and evolve into bigger creatures.

4. Origin of Major Groups

Cambrian Explosion Microbes for first 3 billion years. Then multicelled life eventually formed. Ediacaran ocean reconstruction 542 mya Burgess Shale: explosion of life. 65,000 distinct animals were found in that small area. Uniquely perfect place for fossilization. Even soft bodied creatures were preserved. Pikaia: first known cordate (vertebrate phylum), first ancestor Tiktaalik: walking fish in Devonian 375 mya. The first tetrapod. First issue is support and gravity becomes harder. Ray fins has really thin bones which is handy for swimming but poor for standing. Lobed finned fish, somewhat weight bearing. Precursors of Tiktaalik