

1 **GLY/MFC 137: The Dinosaurs**

2 **Scientific Method**

- Science is a way of understanding the physical universe. It is a set of tools by which to explore the world.
- Uses the method of testing hypotheses
 - ❖ Observations of natural phenomena lead to possible explanations (hypotheses)
 - ❖ These hypotheses must be falsifiable (i.e., there must be some test which can demonstrate that the hypothesis is untrue)
 - ❖ Until the hypothesis is tested, it is only considered a speculation

3 **Theory**

- ❖ If the hypothesis survives a test (or tests) of falsification, it is tentatively (or provisionally) accepted (keeping in mind that additional tests might potentially overturn the hypothesis)

- ❖ A hypothesis that has undergone severe testing and survived, has wide acceptance in the scientific community and can be successfully used to predict the results of future tests is called a theory.
-

4 **Publication**

- Science proceeds by publication of ideas in a public arena.
- ❖ Allows others to check the original scientist's observations
- ❖ Allows others (including later generations) to independently test the hypotheses
- ❖ Allows ideas to be widely transmitted

5 **Dinosauria**

The word "Dinosauria" (and hence "dinosaur") was coined in 1842 by Sir Richard Owen

Greek deinos "fearfully great" (i.e., not just big, but SCARY BIG!), and sauros "lizard"

Note: hundreds of books to the contrary, Owen did not say Dinosauria meant "terrible lizard"

6 

7 

- People have long known about Dinosaur tracks, but they were completely misidentified -

The tracks to the left were known as

"Noah's Raven"

8 

- The first published record of a dinosaur bone was in Robert Plot's *Natural History of Oxfordshire* published in 1677.

He called it the "capita Femoris inferiora" or part of a thigh bone from just above the knee joint, and he thought that it was the petrified bone of an elephant that had come to England during the Roman occupation.

9 

- In 1728 a posthumous catalog of the geologic collection of John Woodward showed a portion of a dinosaur limb bone. This is the earliest discovered dinosaur bone that is still accounted for (i.e. it's still labeled and in a museum).
- There were several other discoveries of what we now know are dinosaur bones, but most were lost and/or not formally published

10 

- ❖ First major published dinosaur discovery, was in Britain, by Reverend William Buckland:
 - *Megalosaurus* ("big lizard")
 - Formally described it in 1824
 - Thought it to be a giant version of the modern monitor lizard

11 

12 

- ❖ Next major discovery, in the Weald region of southern England, by husband and wife team Dr. Gideon and Mary Ann Mantell:
 - Teeth were leaf-shaped, reminiscent of the modern Iguana, a primarily herbivorous reptile
 - Called it *Iguanodon* ("iguana tooth")
 - Formally described it in 1825
 - Imagined it to be an immense version of the iguana lizard

13 

14 

15 

16 

17 

❖ Third major discovery, also in the Weald region and also by the Mantells:

- Very large spikes were found arranged along the skeleton: first evidence of giant armored reptiles
- Called it *Hylaeosaurus* (“lizard of the Weald”) described in 1833
- Pictured it as a giant spiky lizard

18 

19 

- In 1841, Sir Richard Owen gave public talks about the fossil reptiles of Britain. Concluded that Megalosaurus, Iguanodon, and Hylaeosaurus formed their own distinct group. Proposed the name Dinosauria (“fearfully great lizards”) for this group when he wrote up talk (in 1842)
- In the 1850s at the Great Exposition’s Crystal Palace Benjamin Waterhouse Hawkins sculpted Megalosaurus, Iguanodon, and Hylaeosaurus (and some other non-dinosaurs) under Owen’s guidance. Dinosaurs became popular subjects for popular science, political cartoons, etc.

20 

21 

First North American discoveries in 1855:

- Dinosaur teeth found by explorers in western territories (now Montana):
 - Described in 1856 by first American vertebrate paleontologist Joseph Leidy
 - Recognized some to be similar to Iguanodon, others to be similar to Megalosaurus, still others to be some sort of lizard. Leidy named them:
 - *Deinodon* (“terrible tooth”)
 - *Trachodon* (“rough tooth”)

22 

In 1858, first major North American dinosaur fossil:

- Discovered near Haddonfield, New Jersey
- Described by Leidy, who named it *Hadrosaurus* (“heavy lizard”)
- Teeth and bones were similar to Iguanodon, but **fossil was more complete**
- Front leg was much smaller and more slender than hindlimb, indicating it was bipedal (two legged)

- Suggested that Iguanodon was bipedal, too

23 

24  **Great Dinosaur Rush**

25 

- ❖ A personal rivalry developed between Cope and Marsh
 - fueled by rapid, massive digs
 - rush to name each species first

- only interested in getting as many bones as possible—little care or record of actual digs
- rushed publications with poor quality—mistakes made because names often based on only a few bones

- The vast numbers of fossils discovered formed the central collections of major museums, including some of the first complete dinosaur fossils.

26  **era of imperial paleontology**

- Most famous expeditions:
 - o American Museum of Natural History expeditions: the Central Asiatic Expeditions of the 1920s

 - o From 1907-1912, German expedition to Tendaguru, German East Africa (now Tanzania)

- Various digs in other parts of the world by other museums (e.g., Germans in Egypt, various U.S. and Canadian museums in Alberta, etc.)

27 

- In 1960s, John Ostrom of Yale University:
 - Reinterpreted horned and duckbill dinosaurs as sophisticated feeders
 - In 1964, discovered Deinonychus (“terrible claws”) (named in 1969) - Sickle-like claw on foot indicated active leaping predator
 - Later comparisons between Deinonychus and the primitive bird Archaeopteryx caused Ostrom to revive idea that dinosaurs were bird ancestors

28 

- 1970s: Beginning of the Dinosaur Renaissance. New (or revived) topics of dinosaur research:
 - Were they cold-blooded or warm-blooded?
 - Did they have complex family structures?
 - How did they communicate?
 - How were the different types of dinosaur related?
 - What was the relationship between dinosaurs & birds?

- How did the dinosaurs go extinct?
- New discoveries from many parts of the world
Now discoveries made from every continent

29 Fossils

- (from Latin *fossilium* "that which is dug up") are the physical remains of past life and its activities preserved in the rock record.
- The only physical evidence of ancient organisms. Only direct data for knowledge of past life
- Paleontology, the study of ancient life and their remains (fossils).
- Vertebrate Paleontology, the study of ancient backboned animals, including dinosaurs

30 Types of dinosaur fossils:

- Isolated bones and teeth
- Skeletons, in varying degrees of completeness
- Footprints and trackways
- Skin impressions and Feathers
- Mineralized soft tissue (muscles, intestines, possible heart)
- Eggs (some with embryos) and nests
- Coprolites (fossilized feces)

31 Taphonomy

taphos = "burial" + *nomous* = "law"

The study of how fossils are formed.

The scope of taphonomic research can be conveniently summarized as:

- The manner and cause of death of organisms
- Processes of decay and decomposition
- Transportation of fossils or potential fossils
- Burial of remains
- Diagenesis (conversion into rock) of remains

32

- Because fossils are preserved in rock, need to understand basics of geology.
- Rocks (naturally occurring cohesive solids comprised of one or more minerals or mineraloids) are generated in one of three primary manners (basis of rock classification):
 - Igneous
 - Metamorphic
 - Sedimentary


33  **Rock Types**

34  **Igneous Rocks**

35 

36  **Metamorphic Rocks**

- Metamorphic rocks are rocks that have been substantially changed from their original igneous, sedimentary, or earlier metamorphic form.
- Metamorphic rocks form when rocks are subjected to high heat, high pressure, hot mineral-rich fluids or, more commonly, some combination of these factors. **BUT THEY HAVE NOT BEEN MELTED !**

37  **Metamorphic Rocks**

38  **Sedimentary Rocks**

- Sedimentary rocks are formed from pre-existing rocks (sediment) and/or pieces of once-living organisms. They form from deposits that accumulate on the Earth's surface which become compacted to form rock layers.

39  **Clastic Sediment**

- Formed of fragments of weathered rocks or ash/dust - Sand, clay, & boulders are examples.
- Clastic sedimentary rocks are named according to the sizes of the particles.
- Clast = Greek for "fragment" or "piece"

40  **Clastic Sediment**

- Formed of fragments of weathered rocks or shells - Sand, clay, boulders and shell fragments are examples.
- Clastic sedimentary rocks are named according to the sizes of the particles.

41  **Clastic Sedimentary Rocks**

42  **Chemical Sedimentary Rocks**

- Chemical sedimentary rocks are formed by chemical precipitation. This process begins when water traveling through rock dissolves some of the minerals, carrying them away from their source. Eventually these minerals are re-deposited when the water evaporates away or when the water becomes over-saturated.

43  **Evaporites**

44  **Biologic Sedimentary Rocks**

- Biologic sedimentary rocks form from once-living organisms. They may form from accumulated carbon-rich plant material (coal) or from deposits of animal shells.
- Limestone & dolomite are formed from the shells and other hard body parts of marine organisms such as clams, coral, oysters, and microscopic organisms like

diatoms.

45 

46 Chemical Sedimentary Rocks

- Chemical sedimentary rocks are formed by chemical precipitation. This process begins when water traveling through rock dissolves some of the minerals, carrying them away from their source. Eventually these minerals are re-deposited when the water evaporates away or when the water becomes over-saturated.

47 Biologic Sedimentary Rocks

- Biologic sedimentary rocks form from once-living organisms. They may form from accumulated carbon-rich plant material (coal) or from deposits of animal shells.
- Limestone & dolomite are formed from the shells and other hard body parts of marine organisms such as clams, coral, oysters, and microscopic organisms like diatoms.

48 

49 Sedimentary Environments

- Marine - Ocean/Sea

- Non-marine (or terrestrial)
 - fluvial
 - lacustrine
 - eolian
 - deltaic

50 Fluvial - Rivers and Streams

51 Flood Plains

52 “Fluvial” Rocks

River Channel

Sandstone

Conglomerate

Siltstone

Floodplain

Sandstone,

Siltstone

Clay

53 Conglomerate > 2 mm

54 Sandstone 2mm - 1/16 mm

- 55 Siltstone 1/16 mm - 1/256 mm
- 56 Lacustrine - Lake
- 57 Clay < 1/256 mm in diameter
- 58 Eolian - wind blown
- 59 Deltaic - where fluvial meets lacustrine or marine
- 60 Geologic Time
- Relative Time verses Absolute Time
 - Absolute Time is based on radiometric dating (using radioactive decay to determine the exact age of a sample)
 - Relative Time is based on establishing the relative order of events without knowing the duration of each event or the amount of time lapsed between events
- 61 1. Principle of Original Horizontality
- 62 Principle of Cross-Cutting Relationships
- 63
- 64
- 65 Law of Fossil Succession
- 66
- 67 Unconformity
- Represents an interruption in the deposition of sediment - no material is deposited and possibly some rock layers may have been eroded
- 68
- 69 Correlation
- 70
- 71 **Absolute Time**
Radioactive Decay
- 72 Electron Capture
- 73 Uranium Decay
- 74 Half-life
- The time required for one-half of the nuclei in a sample to decay
- 75
- 76 Geologic Time Scale

- Divided into FOUR major time units:
 - EONS - largest division there are 4 eons
 - ERAS -
 - PERIODS -
 - EPOCHS - smallest block of time only the most recent era is divided into epochs

77 EONS

- HADEAN - 4.6 to 3.8 billion years ago
- ARCHEAN - 3.8 to 2.5 billion years ago
- Proterozoic - 2.5 Ba to 544 million years ago
- Phanerozoic - 544 Ma to now

78 Archean

- Means “ancient”
- Earth was not completely formed yet
- Earliest life - one celled organisms

79 Proterozoic

- Meaning “revealed life”
- stable continents first appeared and began to accrete (glomb together)
- the first abundant fossils of living organisms, mostly bacteria
- first evidence of oxygen build-up in atmosphere

80 Phanerozoic

- Means “visible life”
- the most recent eon
- divided into three ERAS
 - Paleozoic “ancient life”
 - Mesozoic “middle life”
 - Cenozoic “recent life”

81