Update: The date of the earliest multicellular fossils is corrected to 1.2 billion years

**14 Generalizations about the fossil record.**

- Reading: Same as for lectures 12 and 13.

**Generalizations about the fossil record**

- Many important transitional forms are known.
  - Origins of multicellularity: fossils 1.2 billion years old are clearly multicellular.
  - Fish to terrestrial amphibians: *Tiktaalik roseae*, which is derived from lobe-finned fishes, has fins and gills but also partially developed front and back legs. It is an earlier fossil than *Acanthostega*, which is mentioned in the text.
  - Dinosaurs to birds: Impressions of feathers have been found on fossil dromaeosaurs that did not have fully developed wings and could not fly.
  - Reptiles to mammals: Mammals arose from cynodonts, a group that diverged from early reptiles in the late Paleozoic.
  - Apes to man: Early hominids shared many characteristics with modern chimpanzees and gorillas.
  - Although many transitional forms have been found, most of them were probably not ancestral to modern groups. It is very difficult to be sure that a fossil species is ancestral to a later fossil species or a modern species. Only when the fossil record is relatively complete, as it is for hominids, can we be confident that a fossil species is ancestral. *Homo erectus* was an ancestor of *H. sapiens* and of *H. neanderthalensis*. *Ardipithecus ramidus* was probably an ancestor of *H. sapiens*. In contrast, *Archaeopteryx* was probably not an ancestor of modern birds. Instead, it was descended from the same ancestor as modern birds but left no living descendants.

- Mosaic evolution
  - Transitional forms are usually a mixture of primitive and derived characteristics.
  - One example is provided by *Archaefructus* fossils (125 mya), an early Angiosperm. They have a mixture of primitive and derived characteristics. One species has anthers and seeds inside closed carpels but lacks petals and sepals.
  - Another example is *Archaeopteryx*, which had a bony tail, teeth and claws similar to those of dinosaurs but feathers and wings similar to those of modern birds.

- Rare and unpredictable events have been very important.
  - The Permian and Cretaceous extinctions caused by geological or astronomical events. They created the opportunities for the adaptive radiation of new dominant flora and fauna. If those mass extinctions had not occurred, the history of life would have been very different.

- Our understanding of the broad features of the history has been stable for a long time.
  - Although Darwin and later scientists have emphasized the imperfection of the fossil record and there are still big gaps in the fossil record of many groups, our understanding of the large scale patterns of evolution has not changed much in the past 100 years.
Lecture 14

Biogeography

Principles

- Darwin and Wallace were the first to say that the geographic distribution of a group is determined by where they originated and their capacity for dispersal.
- What is new is the role of continental drift, which creates and eliminates barriers to dispersal. Although the theory was proposed in 1915 by Wegener, it was not widely accepted until the late 1950s when evidence of sea floor spreading was obtained. Before then, the lack of a plausible mechanism caused most people to reject it.

Continental movement and sea level changes have been of major importance for many group.

- Some taxonomic groups are restricted to the southern continents that were part of Gondwanaland (Africa, South America, Australia and islands formerly connected to them, including New Guinea, New Zealand, and Tasmania) because they arose after Pangaea split into Gondwanaland and Laurasia about 180 mya.
- Knowledge of continental drift indicates the times of vicariant events and hence times of origin of different groups. Ratite birds (ostriches, emus cassowaries) are found on all the southern continents, which implies that the group arose before the breakup of Gondwanaland. The southern beech (Nothofagus) is found on all the southern continents except Africa, which implies that they arose after Africa separated from the rest of Gondwanaland. Until 2 mya, marsupials were present in all the southern continents except New Zealand and Africa, which implies that they probably arose after New Zealand and Africa separated from the rest of Gondwanaland.

Questions

Which statement best describes why early hominids provide an example of mosaic evolution?

a. There was more than one species of Australopithecus present at the same time.
b. Both Australopithecus and Homo species were present at the same time.
c. Early Australopithecus species had small brains and were bipedal.
d. Early hominids diverged from other large primates about 6 mya.
e. All fossils of early hominid species have been found in Africa.

Which statement best explains why ratite birds are native only to South America, Africa, Australia and New Zealand?

a. The common ancestor of ratites lived in Europe.
b. The common ancestor of ratites was a cynodont.
c. The common ancestor of ratites lived about 50 million years ago.
d. The common ancestor of ratites lived in Gondwanaland.
e. The common ancestor of ratites survived the Cretaceous extinction.

Which of the following genera is not an early member of a group that has living descendants?

a. Archaeopteryx
b. Australopithecus.
c. Acanthostega
d. Hallucigenia.
e. Archaeaeructus.