18.5A: The Fossil Record as Evidence for Evolution

Fossils tell us when organisms lived, as well as provide evidence for the progression and evolution of life on earth over millions of years.

Learning Objectives

• Synthesize the contributions of the fossil record to our understanding of evolution

Key Points

• Fossils are the preserved remains or traces of animals, plants, and other organisms from the past.
• Fossils are important evidence for evolution because they show that life on earth was once different from life found on earth today.
• Usually only a portion of an organism is preserved as a fossil, such as body fossils (bones and exoskeletons), trace fossils (feces and footprints), and chemofossils (biochemical signals).
• Paleontologists can determine the age of fossils using methods like radiometric dating and categorize them to determine the evolutionary relationships between organisms.

Key Terms

• biomarker: A substance used as an indicator of a biological state, most commonly disease.
• trace fossil: A type of fossil reflecting the reworking of sediments and hard substrates by organisms including structures like burrows, trails, and impressions.
• fossil record: All discovered and undiscovered fossils and their placement in rock formations and sedimentary layers.
• strata: Layers of sedimentary rock.
• fossiliferous: Containing fossils.

What Fossils Tell Us

Fossils are the preserved remains or traces of animals, plants, and other organisms from the past. Fossils range in age from 10,000 to 3.48 billion years old. The observation that certain fossils were associated with certain rock strata led 19th century geologists to recognize a geological timescale. Like extant organisms, fossils vary in size from microscopic, like single-celled bacteria, to gigantic, like dinosaurs and trees.
Permineralization

Permineralization is a process of fossilization that occurs when an organism is buried. The empty spaces within an organism (spaces filled with liquid or gas during life) become filled with mineral-rich groundwater. Minerals precipitate from the groundwater, occupying the empty spaces. This process can occur in very small spaces, such as within the cell wall of a plant cell. Small-scale permineralization can produce very detailed fossils. For permineralization to occur, the organism must be covered by sediment soon after death, or soon after the initial decay process.

The degree to which the remains are decayed when covered determines the later details of the fossil. Fossils usually consist of the portion of the organisms that was partially mineralized during life, such as the bones and teeth of vertebrates or the chitinous or calcareous exoskeletons of invertebrates. However, other fossils contain traces of skin, feathers or even soft tissues.

Trace Fossils

Fossils may also consist of the marks left behind by the organism while it was alive, such as footprints or feces. These types of fossils are called trace fossils, or ichnofossils, as opposed to body fossils. Past life may also leave some markers that cannot be seen but can be detected in the form of biochemical signals; these are known as chemofossils or biomarkers.
The Fossil Record

The totality of fossils, both discovered and undiscovered, and their placement in fossiliferous (fossil-containing) rock formations and sedimentary layers (strata) is known as the fossil record. The fossil record was one of the early sources of data underlying the study of evolution and continues to be relevant to the history of life on Earth. The development of radiometric dating techniques in the early 20th century allowed geologists to determine the numerical or “absolute” age of various strata and their included fossils.

Evidence for Evolution

Fossils provide solid evidence that organisms from the past are not the same as those found today; fossils show a progression of evolution. Fossils, along with the comparative anatomy of present-day organisms, constitute the morphological, or anatomical, record. By comparing the anatomies of both modern and extinct species, paleontologists can infer the lineages of those species. This approach is most successful for organisms that had hard body parts, such as shells, bones or teeth. The resulting fossil record tells the story of the past and shows the evolution of form over millions of years.