18.5E: The Fossil Record and the Evolution of the Modern Horse

LEARNING OBJECTIVES

- Analyze the fossil record to understand the evolution of horses

Fossils provide evidence that organisms from the past are not the same as those found today, and demonstrate a progression of evolution. Scientists date and categorize fossils to determine when the organisms lived relative to each other. The resulting fossil record tells the story of the past and shows the evolution of forms over millions of years.

Case Study: Evolution of the Modern Horse

Highly detailed fossil records have been recovered for sequences in the evolution of modern horses. The fossil record of horses in North America is especially rich and contains transition fossils: fossils that show intermediate stages between earlier and later forms. The fossil record extends back to a dog-like ancestor some 55 million years ago, which gave rise to the first horse-like species 55 to 42 million years ago in the genus *Eohippus*.

The first equid fossil was found in the gypsum quarries in Montmartre, Paris in the 1820s. The tooth was sent to the Paris Conservatory, where Georges Cuvier identified it as a browsing equine related to the tapir. His sketch of the entire animal matched later skeletons found at the site. During the H.M.S. Beagle survey expedition, Charles Darwin had remarkable success with fossil hunting in Patagonia. In 1833 in Santa Fe, Argentina, he was “filled with astonishment” when he found a horse’s tooth in the same stratum as fossils of giant armadillos and wondered if it might have been washed down from a later layer, but concluded this was “not very probable.” In 1836, the anatomist Richard Owen confirmed the tooth was from an extinct species, which he subsequently named *Equus curvidens*.

The original sequence of species believed to have evolved into the horse was based on fossils discovered in North
America in the 1870s by paleontologist Othniel Charles Marsh. The sequence, from *Eohippus* to the modern horse (*Equus*), was popularized by Thomas Huxley and became one of the most widely known examples of a clear evolutionary progression. The sequence of transitional fossils was assembled by the American Museum of Natural History into an exhibit that emphasized the gradual, “straight-line” evolution of the horse.

Figure 1: *Horse evolution*: This illustration shows an artist’s renderings of species derived from fossils of the evolutionary history of the horse and its ancestors. The species depicted are only four from a very diverse lineage that contains many branches, dead ends, and adaptive radiations. One of the trends, depicted here, is the evolutionary tracking of a drying climate and increase in prairie versus forest habitat reflected in forms that are more adapted to grazing and predator escape through running.

Since then, as the number of equid fossils has increased, the actual evolutionary progression from *Eohippus* to *Equus* has been discovered to be much more complex and multibranched than was initially supposed. Detailed fossil information on the rate and distribution of new equid species has also revealed that the progression between species was not as smooth and consistent as was once believed.

Although some transitions were indeed gradual progressions, a number of others were relatively abrupt in geologic time, taking place over only a few million years. Both anagenesis, a gradual change in an entire population’s gene frequency, and cladogenesis, a population “splitting” into two distinct evolutionary branches, occurred, and many species coexisted with “ancestor” species at various times.

### Adaptation for Grazing

The series of fossils tracks the change in anatomy resulting from a gradual drying trend that changed the landscape from a forested habitat to a prairie habitat. Early horse ancestors were originally specialized for tropical forests, while modern horses are now adapted to life on drier land. Successive fossils show the evolution of teeth shapes and foot and leg anatomy to a grazing habit with adaptations for escaping predators.

The horse belongs to the order Perissodactyla (odd-toed ungulates), the members of which all share hoofed feet and an odd number of toes on each foot, as well as mobile upper lips and a similar tooth structure. This means that horses share a common ancestry with tapirs and rhinoceroses. Later species showed gains in size, such as those of *Hipparion*, which existed from about 23 to 2 million years ago. The fossil record shows several adaptive radiations in the horse lineage, which is now much reduced to only one genus, *Equus*, with several species. Paleozoologists have been able to piece together a more complete outline of the modern horse’s evolutionary lineage than that of any other animal.

### Key Points

- A dog-like organism gave rise to the first horse ancestors 55-42 million years ago.
- The fossil record shows modern horses moved from tropical forests to prairie habitats, developed teeth, and grew in size.
• The first equid fossil was a tooth from the extinct species *Equus curvidens* found in Paris in the 1820s.

• Thomas Huxley popularized the evolutionary sequence of horses, which became one of the most common examples of clear evolutionary progression.

• Horse evolution was previously believed to be a linear progress, but after more fossils were discovered, it was determined the evolution of horses was more complex and multi-branched.

• Horses have evolved from gradual change (anagenesis) as well as abrupt progression and division (cladogenesis).

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**Key Terms**

• **cladogenesis**: An evolutionary splitting event in which each branch and its smaller branches forms a clade.

• **equid**: A member of the horse family.

• **anagenesis**: Evolution of a new species through a large scale change in gene frequency so that the new species replaces the old, rather than branching to produce an additional species.