

Evolution & Prehistoric Oceans COVID VERSION

Evolution

- Chemical evolution of the organic molecules, bipolymers and systems of chemical reactions were first necessary to form the first protocells took about one billion years.
- Biological evolution is the change in a population's genetic makeup through successive generations.
 - microevolution describes the small genetic changes that occur in a population
 - macroevolution describes long-term, large-scale evolutionary changes among groups of species

Natural Selection

- The process of natural selection occurs when some individuals of a population have genetically based traits that cause them to better survive and produce offspring. This trait is called an adaptation, or adaptive trait.
- The concept of natural selection was developed by Charles Darwin in 1846. Natural selection is based on three conditions: natural variability of the trait within a population, the trait is heritable and the trait leads to differential reproduction.

Extinction

- When environmental conditions change, a species may either evolve or become extinct. 99% of all species that have ever existed on Earth are now extinct. Inevitably, some species disappear at some low rate called background extinction. (1-10 species per year)
- An abrupt rise in extinction rates above the background level is classified as a mass extinction.
 - There have been five major mass extinction events in the earth's history. The largest was the Permian, 250 million years ago, with the disappearance of 90% of all marine species. The last mass extinction was the Cretaceous, 65 million years ago, marking the end of the dinosaurs.
- Paleontologists study fossils to learn about the earth's history. Fossils remains of plants or animals from a previous geological time that provide clues for climate, geologic events, and evolution

Precambrian Era (4.6 BYA – 570 MYA)

- 4.6 BYA - The Earth was formed. Early atmosphere was water vapor, carbon dioxide, nitrogen
- 4.2 BYA – Ocean formed as the planet cooled and water vapor condensed
- 3.6 BYA - The first evidence of life, cyanobacteria
- 2.5 BYA - Oxygen began to accumulate in the atmosphere

Paleozoic Era (570 MYA – 248 MYA)

- 490 MYA - brachiopods, cephalopods and trilobites dominate
- 443 MYA – 354 MYA - The Devonian Period is known as the “Age of Fishes”
- By the end of the Paleozoic, the supercontinent Pangaea was formed and some species began to move onto land
- 250 MYA - Large scale climatic changes led to the Permian extinction, wiping out 90% of marine species.

Mesozoic Era (248 MYA – 65 MYA)

- The Mesozoic Era is known as the “Age of Reptiles” as reptiles (dinosaurs) dominate the land.
- 200 MYA – Pangaea breaks up and continents begin to move to their current locations
- In the oceans, a wide variety of fish and cephalopod species feed on a growing variety of plankton. Reptiles return to the sea to exploit the resources. Examples include Plesiosaurs and Ichthyosaurs.
- Teleosts (modern ray-finned fishes) appear towards the end of the Mesozoic
- 65 MYA - The Mesozoic ended with the Cretaceous extinction event. It was caused by a large asteroid hit off the Yucatan Peninsula in the Gulf of Mexico

Cenozoic Era (65 MYA – Present)

- The Cenozoic is known as the “Age of Mammals” with mammals replacing reptiles as the dominant land animals.
- In the oceans, diversity continued to increase. The first marine mammals appear 50 MYA, evolving from the land mammal *Ambulocetus*.
- Humans evolved 2.5 MYA, with modern *Homo sapiens* appearing 250,000 years ago. Modern humans began significantly impacting the oceans only in the last 200 years, primarily through overfishing and pollution.

Marine Organisms of the Day

1. Coelacanths (*Latimeria chalumnae* and *Latimeria menadoensis*): With only two extant species, coelacanths are known as "living fossils" and were only discovered recently (1998). They can grow to be over 2 meters long, and have unique hollow spine fins.

https://www.youtube.com/watch?v=4jl_txxYQEA (2:00-3:00) and

<https://www.youtube.com/watch?v=MunowVfXOuY> (0:30)

2. Atlantic Horseshoe Crab (*Limulus polyphemus*): Despite the name, horseshoe crabs are more closely related to spiders than crabs. They evolved 250-500 million years ago with blood containing hemocyanin (as opposed to our hemoglobin) which turns their blood blue when exposed to oxygen.

<https://www.youtube.com/watch?v=e8KlAmtlu1E> (3:16)

3. Megalodon (*Carcharodon megalodon*): Megalodon was one of the most powerful predators in history. Its phylogeny was similar to a great white, but megalodon grew to be almost 60 feet long.

<https://www.youtube.com/watch?v=Spo8vkrJFRo> (2:37)

4. Trilobites (Order Trilobita): Trilobites are an ancient class of Arthropod that consisted of more than 20,000 species. They were a dominant group in the Paleozoic Era and they were particularly important in the development of the concept of punctuated equilibrium by Gould and Eldridge.

<https://www.youtube.com/watch?v=-iXalNPd64E> (2:45)

5. Nautilus (Family Nautilidae): There are six extant species of Nautilus and they are often considered living fossils since they have remained relatively unchanged in 500 millions years. They are most closely related to squid and octopus, though those groups have obviously lost the external shell that is evident in the Nautilus.

<https://www.youtube.com/watch?v=PlheRYcm6sI> (4:11)

6. Plesiosaur (Order Plesiosaurus): Plesiosaurs, which are often mistakenly called dinosaurs, are prehistoric marine reptiles that lived at the same time as dinosaurs. Species in this genus ranged from 2 meters to 20 meters in length and they all lived in shallow seas along continental shelves.

<https://youtu.be/mkw593Qa19U> (3:22)

7. Helicoprion (*Helicoprion sp.*): The genus of Helicoprion sharks are known for their bizarre tooth whorls which looked like buzzsaws. These spirals of teeth were most likely located in the throat, though some renderings have placed these strange structures on the bottom jaw. The exact placement is unclear because the cartilage skeleton of a shark does not fossilize well.

<https://www.youtube.com/watch?v=0lfZxoCgMEc> (3:12)

Finding Nemo Clips for This Exam

4 – Field Trip