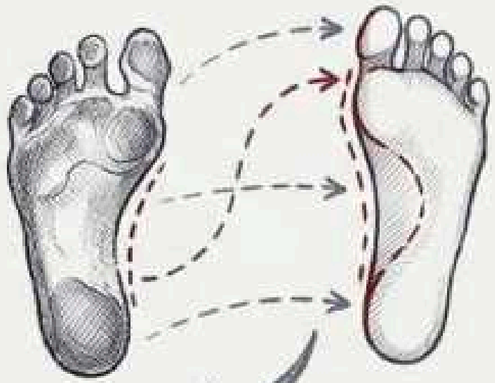
Species and the History of Life

¶ 3.1

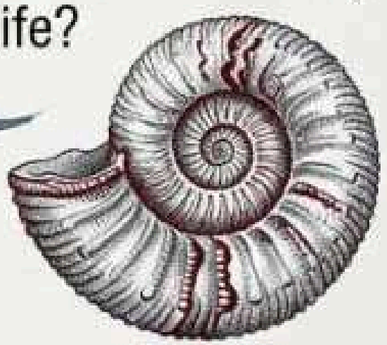
Origins

What do fossils tell us, including about our own origins?



Deep Time

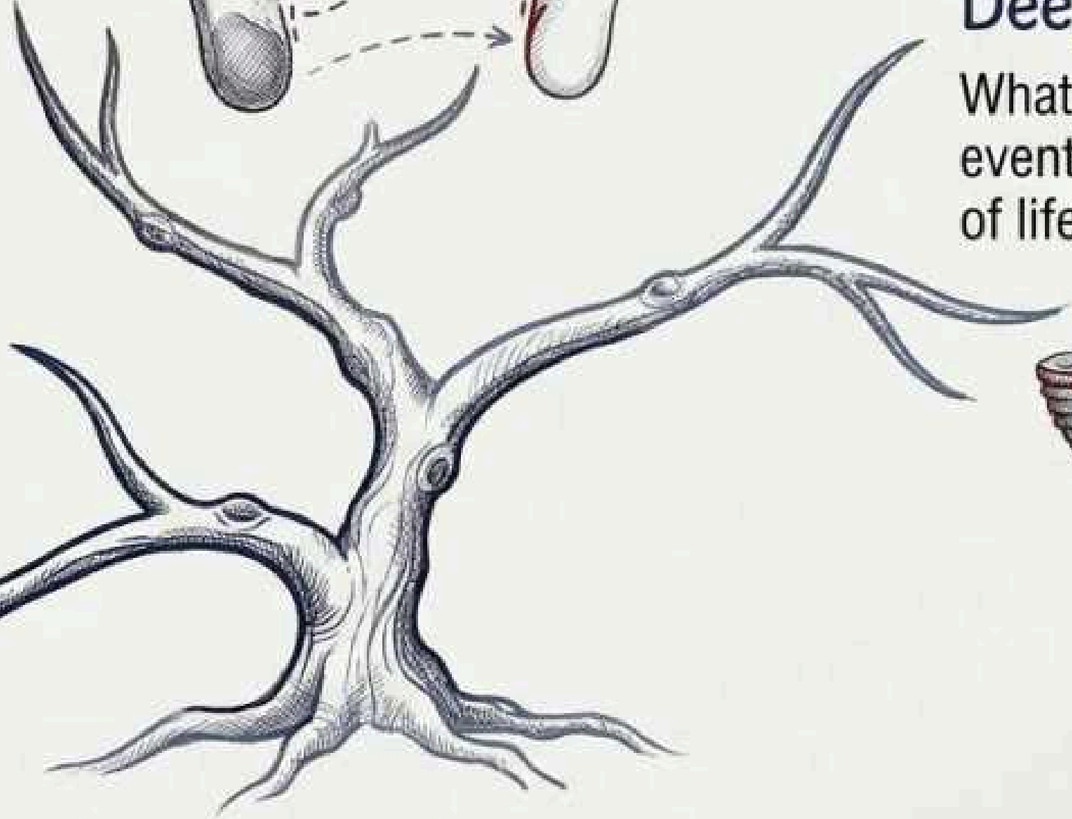
What are the major events in the history of life?



Mechanisms

What is a species, and how do new species arise?





The Biological Species Concept

¶ 3.2



Horse

+



Donkey

=



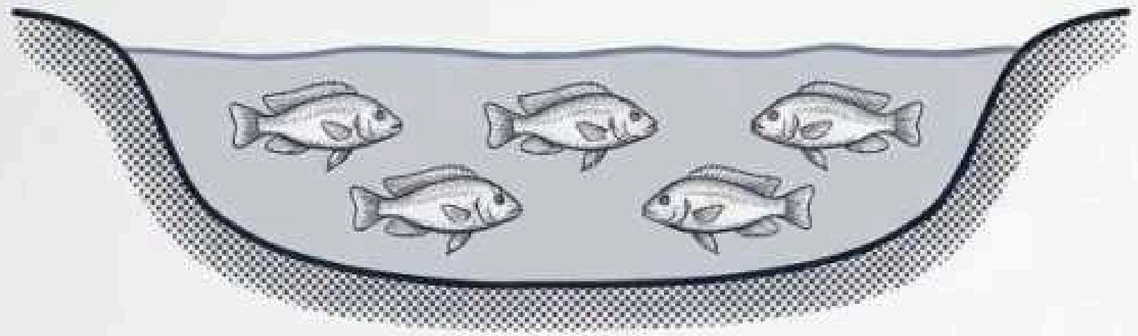
STERILE OFFSPRING

Distinct Species.

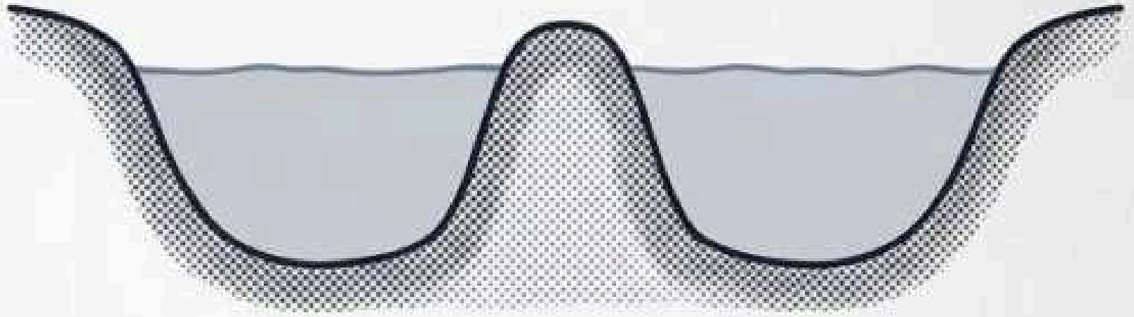
Ernst Mayr's rule: A species is a group of populations whose members can interbreed and produce fertile offspring, and are reproductively isolated from other groups.

Allopatric Speciation: The Cichlid Engine

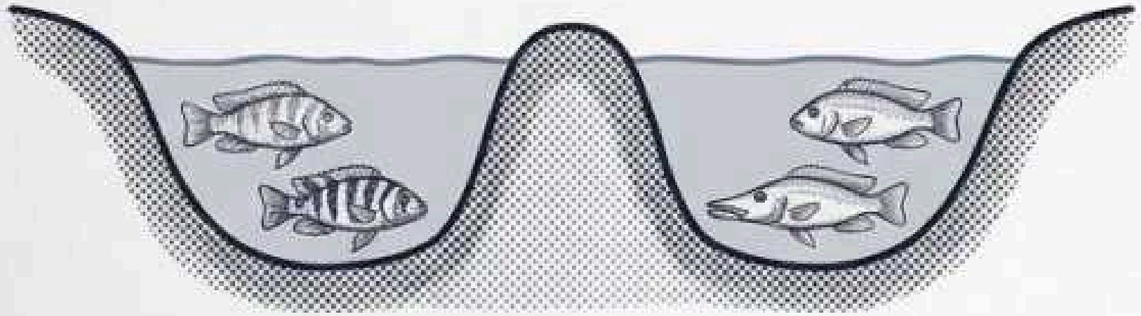
¶ 3.3



1. Single Population

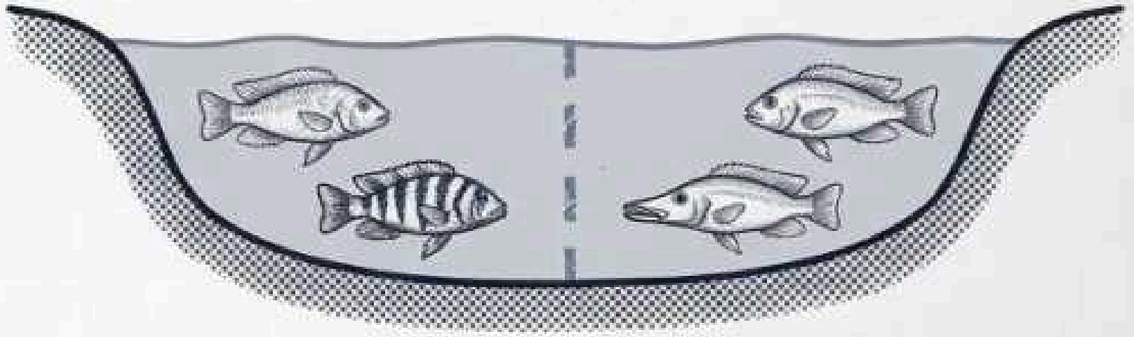


2. Geographic Barrier



3. Divergent Evolution

Populations evolve differently over ~20,000 years.



4. Reproductive Isolation

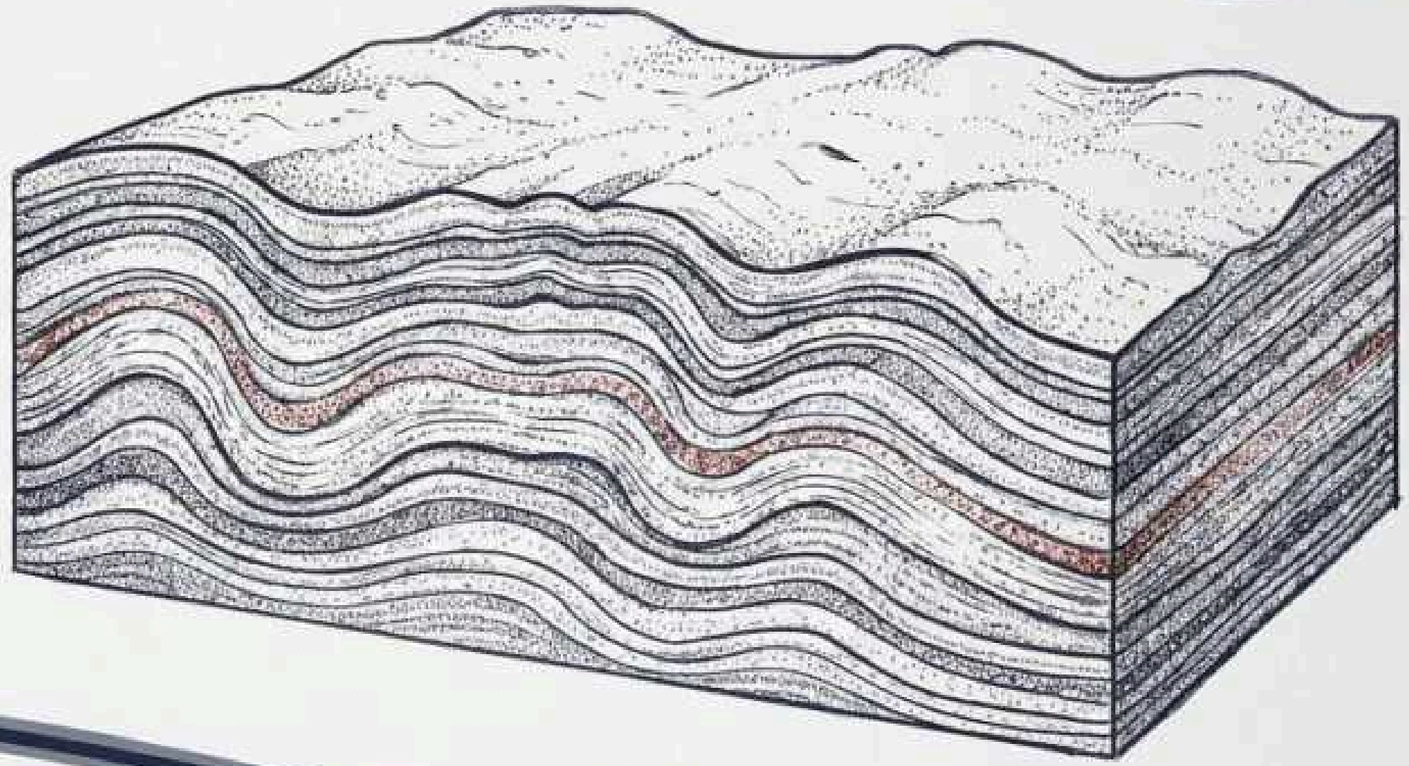
Populations can no longer interbreed.

Lake Victoria alone contains hundreds of uniquely evolved cichlid species demonstrating this phenomenon.

The Origins of a Single-Celled World

¶ 3.4

For most of Earth's history, life was strictly single-celled. Stromatolites represent the first fossilized proof of this early microbial reign.



4.54 Billion Years Ago
Earth Formed



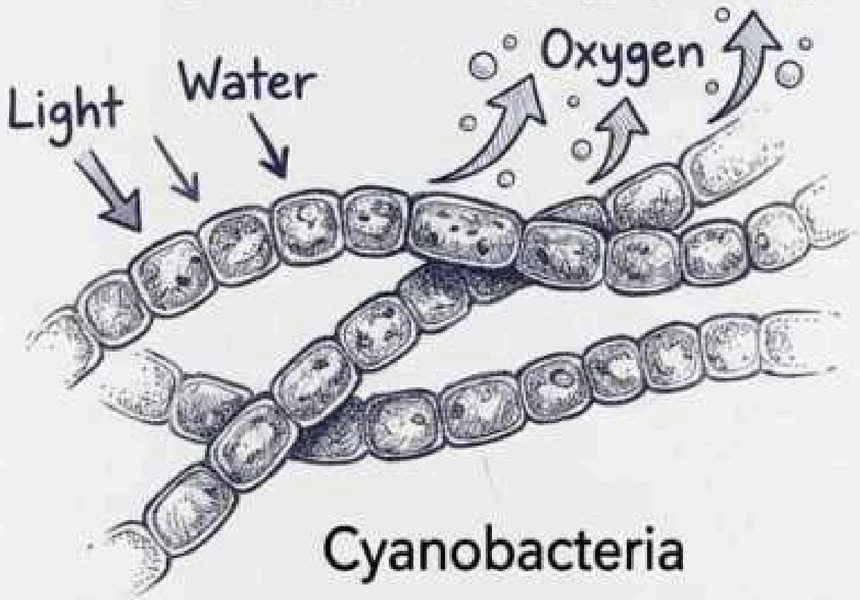
3.5 Billion Years Ago
Oldest Accepted Life

The Great Oxidation Event

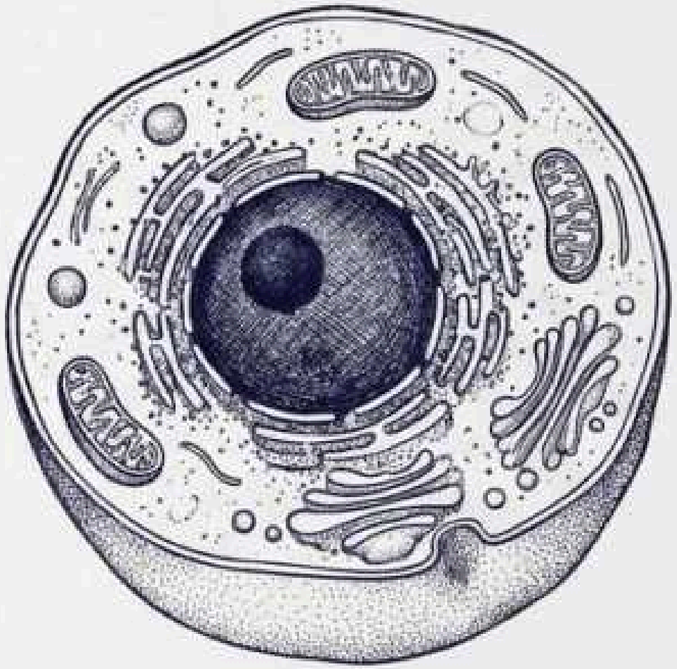
¶ 3.5

2.4 Billion Years Ago

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$



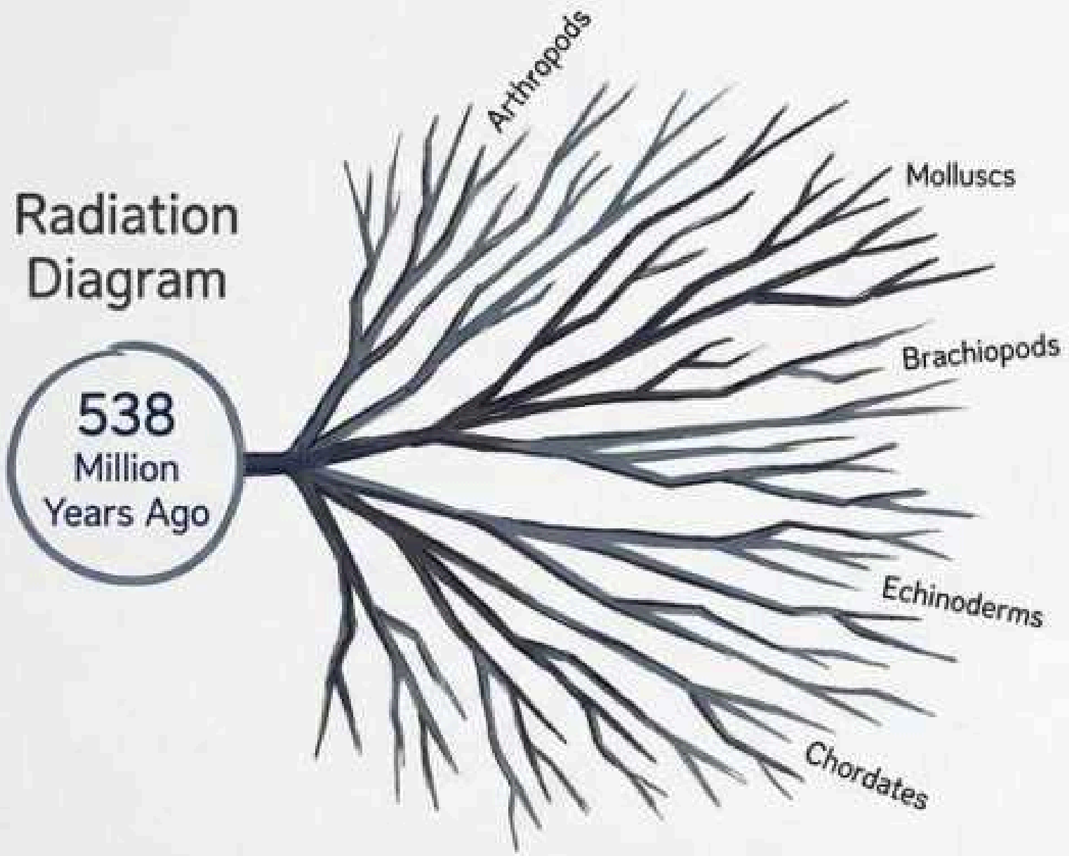
1.8 Billion Years Ago



Oxygen saturation makes complex life possible. Eukaryotes (cells with nuclei) appear, paving the way for multicellular animals much later.

The Cambrian Explosion

¶ 3.6

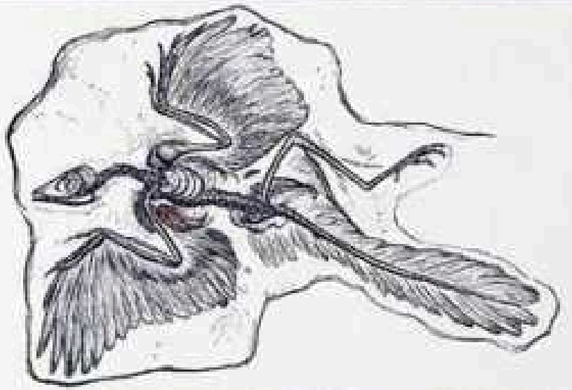
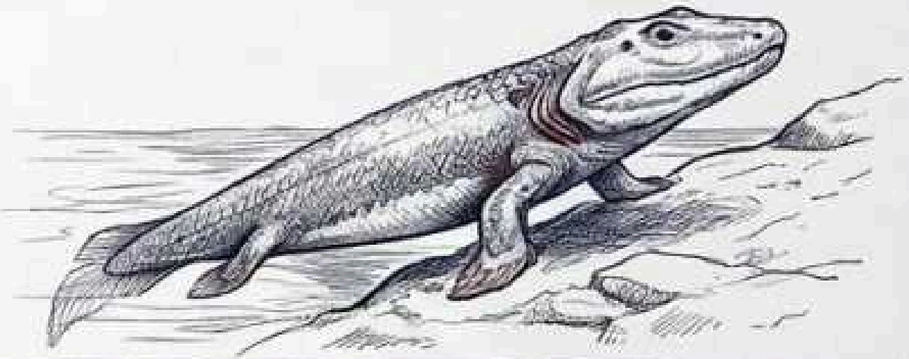




The 1909 discovery of the Burgess Shale in Canada revealed this explosive burst of evolution, preserving the soft-bodied Cambrian animals in breathtaking detail.

Transitional Forms: The Fossil Bridge

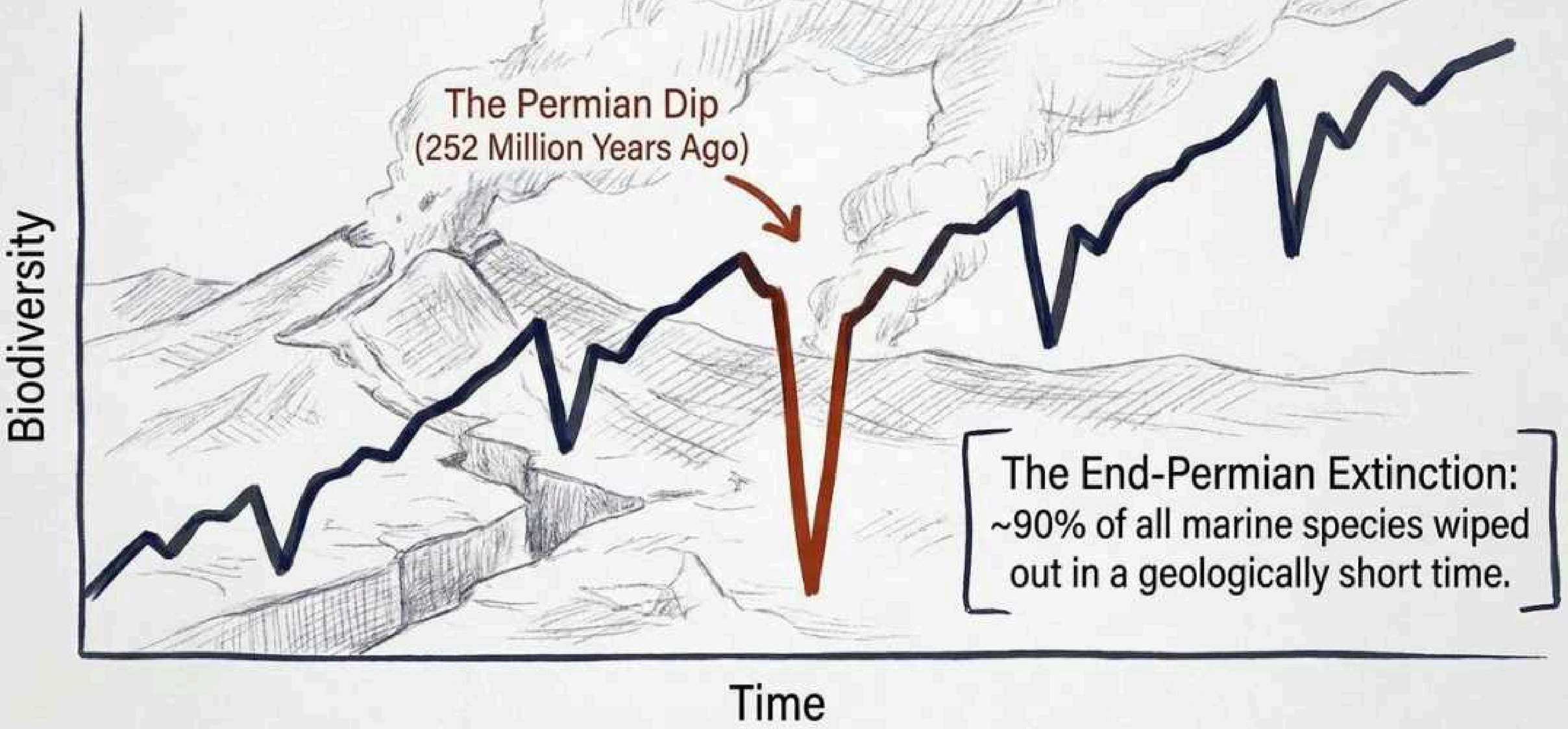
¶ 3.7

Organism	Ancestral Traits	Derived Traits	Visual Evidence
Archaeopteryx Discovered 1861, Germany	Dinosaur teeth, claws, bony tail	Bird feathers and wings	
Tiktaalik Discovered 2004, Canadian Arctic - 375M yrs old	Fish gills and scales	Tetrapod four-legged limbs and lungs	

Discovered just two years after Darwin's *Origin of Species*, *Archaeopteryx* provided the exact transitional proof his theory predicted.

The Rhythm of Destruction

¶ 3.8

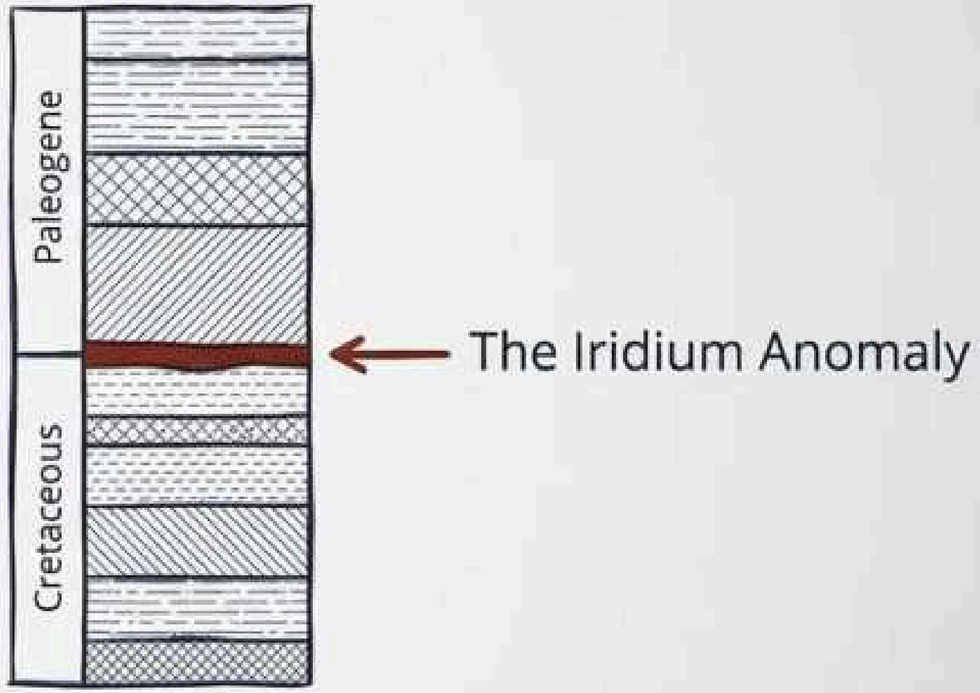


The Cretaceous Culprit

¶ 3.9



Stratigraphic Column

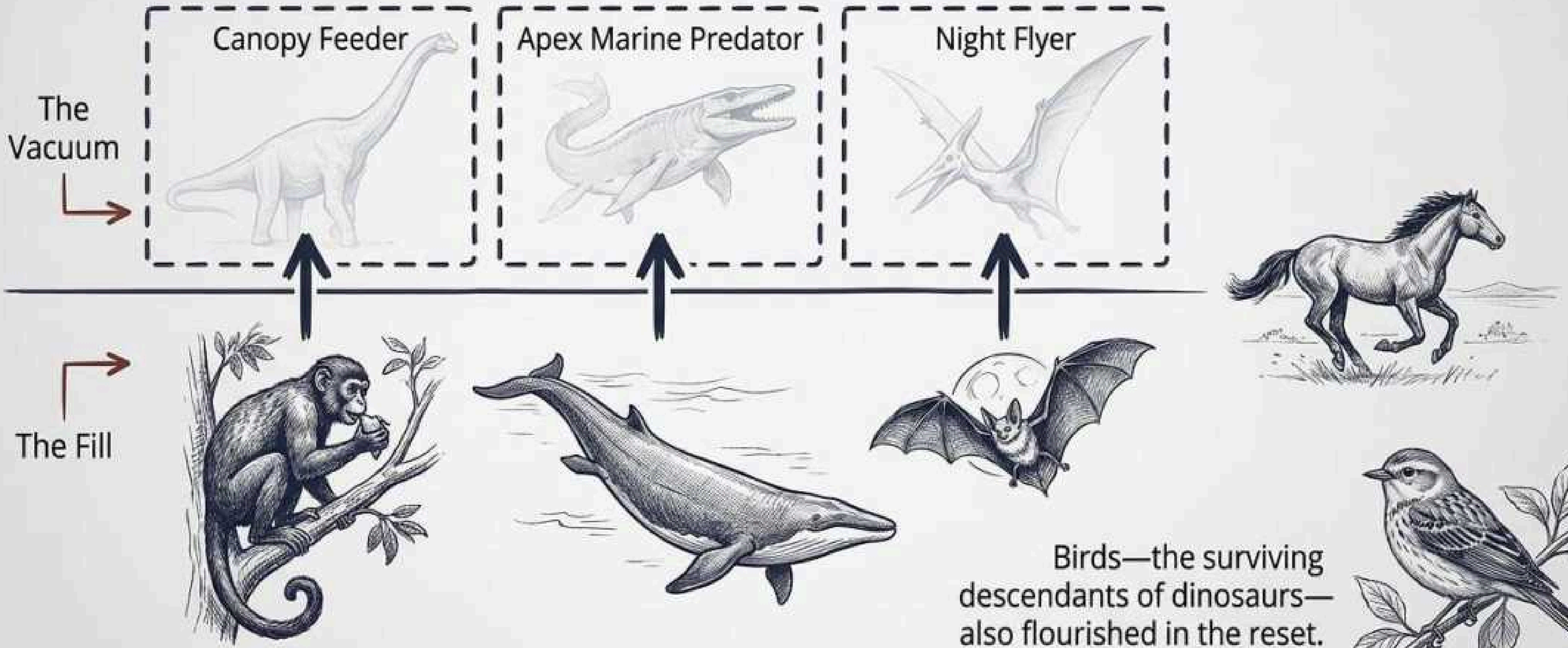


In 1980, Luis and Walter Alvarez identified this global Iridium layer (rare on Earth, common in asteroids), perfectly dating the impact to the end of the non-bird dinosaurs 66 million years ago.

Extinction as an Evolutionary Catalyst

¶ 3.10

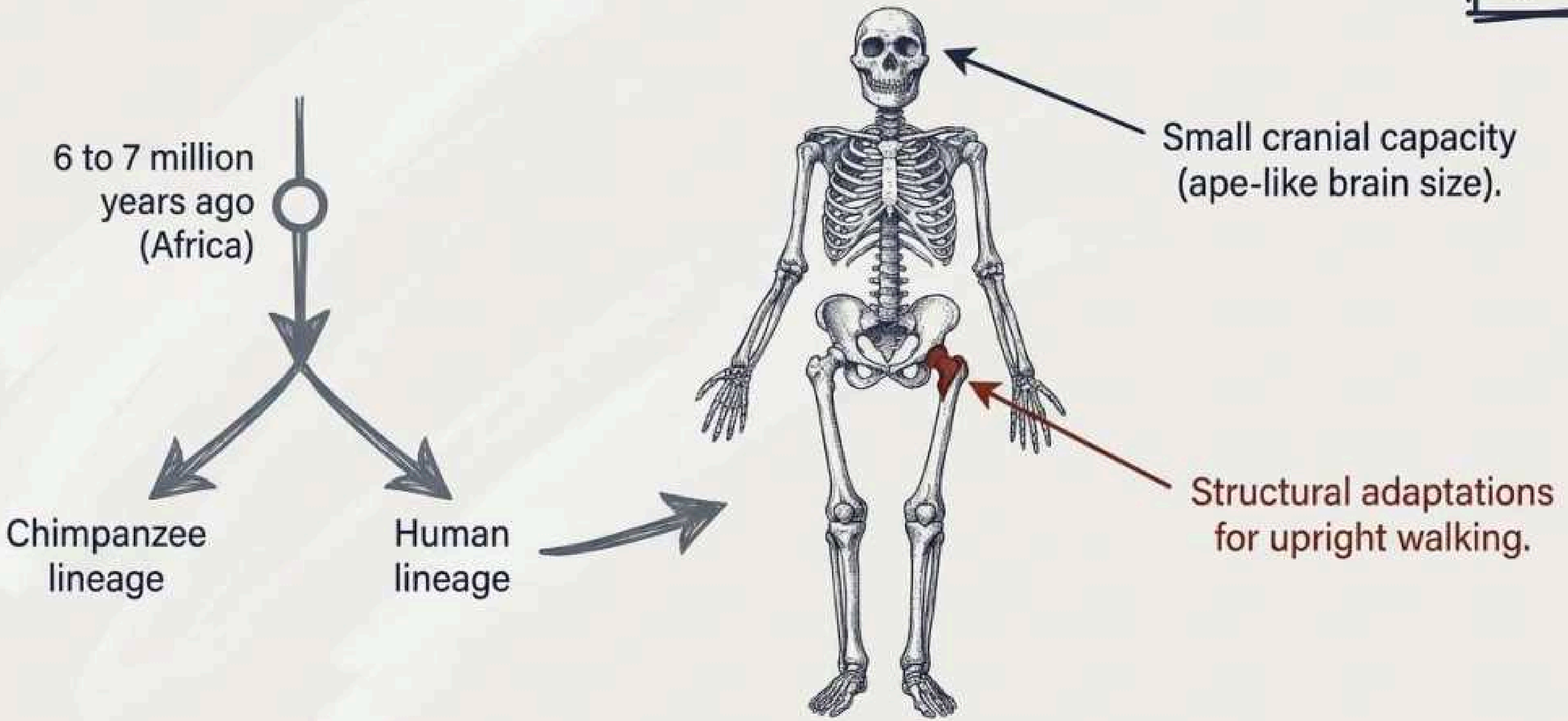
The Vacuum and the Fill



Birds—the surviving descendants of dinosaurs—also flourished in the reset.

The Human Branch: Walking Before Thinking

¶ 3.11

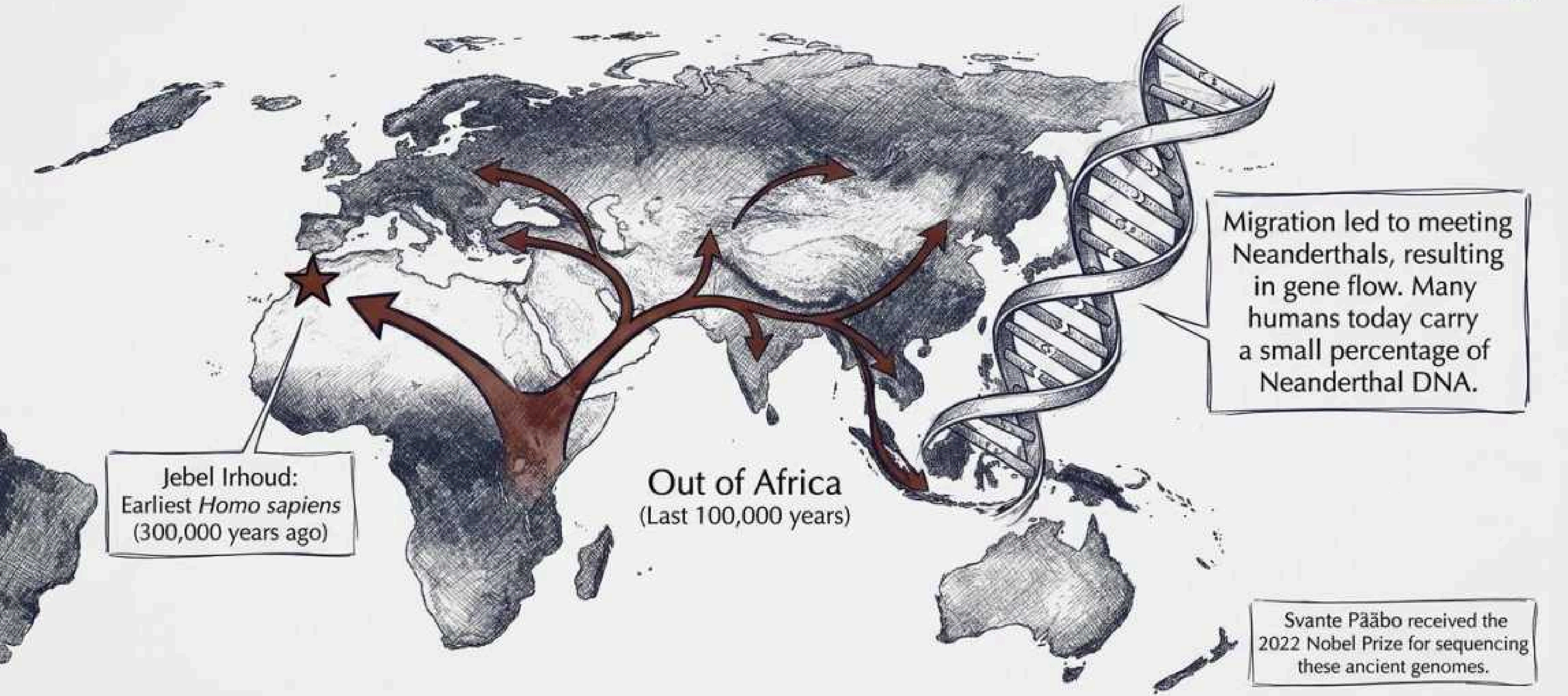


Lucy, 3.2 million years old, Ethiopia (1974)

Core Insight: Fossils prove that our ancestors evolved bipedalism long before they developed large brains.

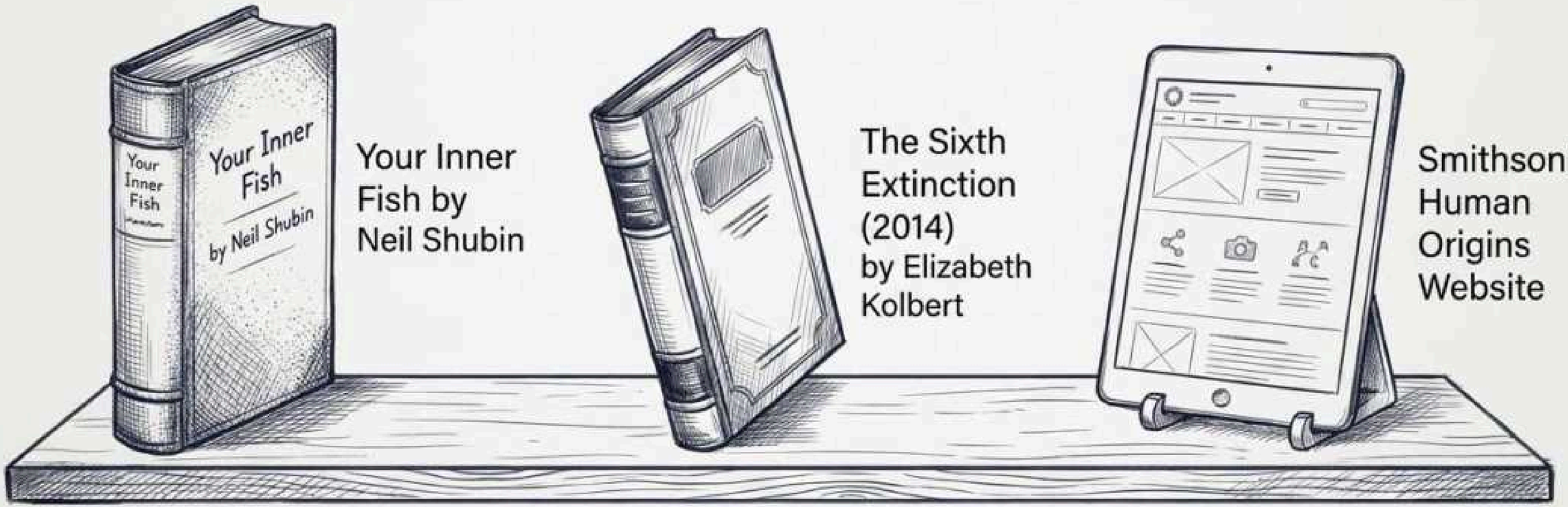
Homo sapiens and the Genetic Legacy

¶ 3.12



The Naturalist's Library: Further Study

¶ 3.13



Your Inner Fish by Neil Shubin

The definitive story of the Tiktaalik discovery and our aquatic ancestry.

The Sixth Extinction (2014) by Elizabeth Kolbert

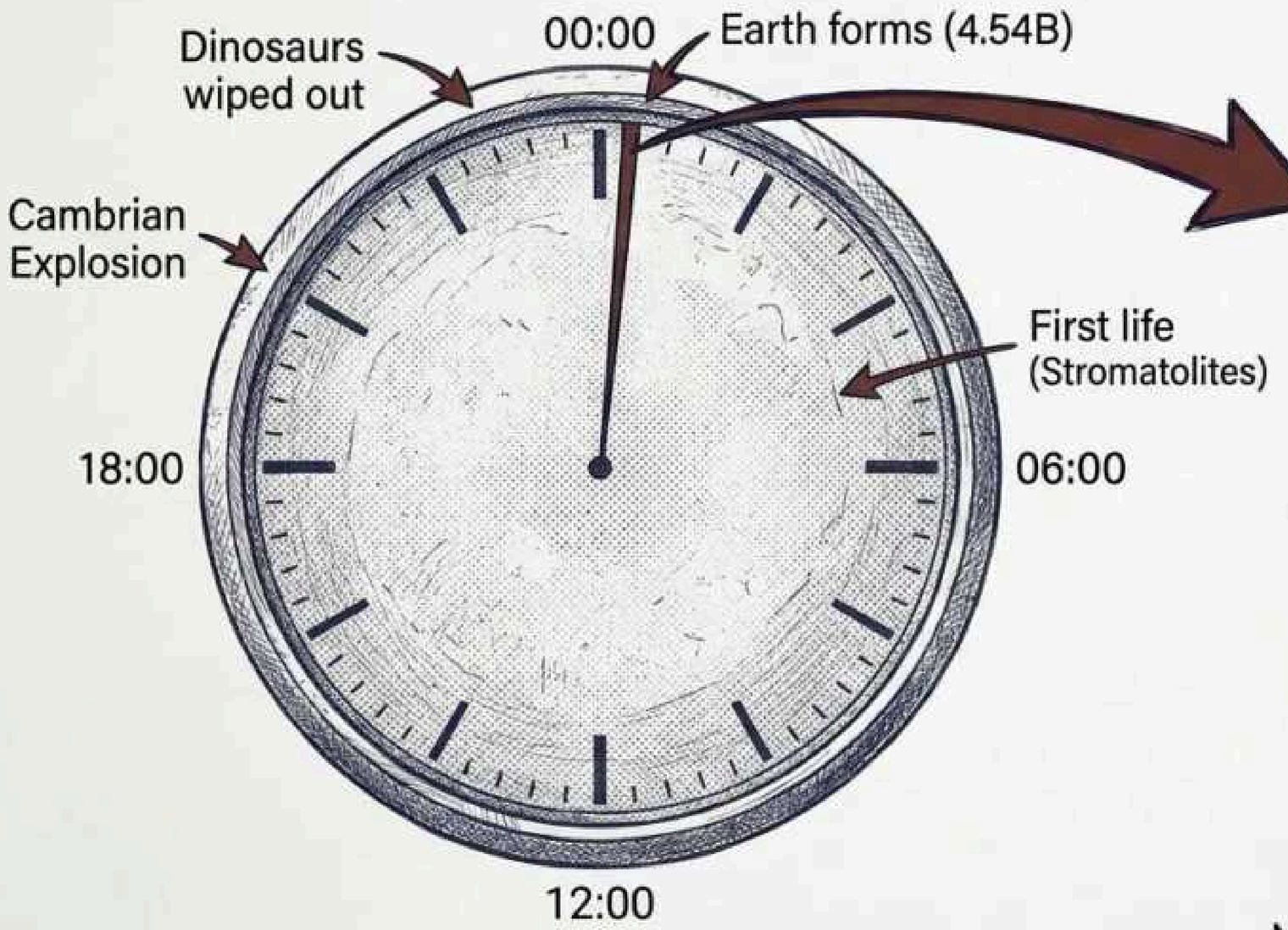
Connecting the deep-time extinctions of the past to the ecological crises of today.

Smithsonian Human Origins Website

An unparalleled free digital portal into the hominid fossil record.

Earth in a Day

¶ 3.14



23:59:58
Homo sapiens appear

Humans are a microscopic fraction of Earth's history.

Next — Lecture 4: Populations and Communities