
The Growth of Species

Module 2 • i2P • Biodiversity



The world becomes full of organisms that have what it takes to become ancestors. That, in a sentence, is Darwinism.

- Richard Dawkins



A LOT OF LIFE

It is said that the number of species of fish in the Amazon exceeds the number found in the entire Atlantic Ocean (see: [fish](#)). In fact the biological wealth of the tropical rain forests of the world is so rich that they are thought to be home to roughly half of the world's species; how many however remains unclear. Regardless of the ultimate number, there is agreement that a wealth of biodiversity is of collective benefit to all life on Earth.

But was the Earth always so rich in life? The simple answer appears to be no. Most concur that there was not always life on Earth. If so, how did all these life forms come to be? Depending on one's cultural heritage or religion this question may be answered in a variety of manners. Some people feel that life was created by a greater being, or was the product of supernatural forces. Others embrace a scientific explanation for the creation of life.

Definition:

Species

A species is a population of organisms that can, and normally does, interbreed successfully with one another but not with members of other populations.

see: [species](#)

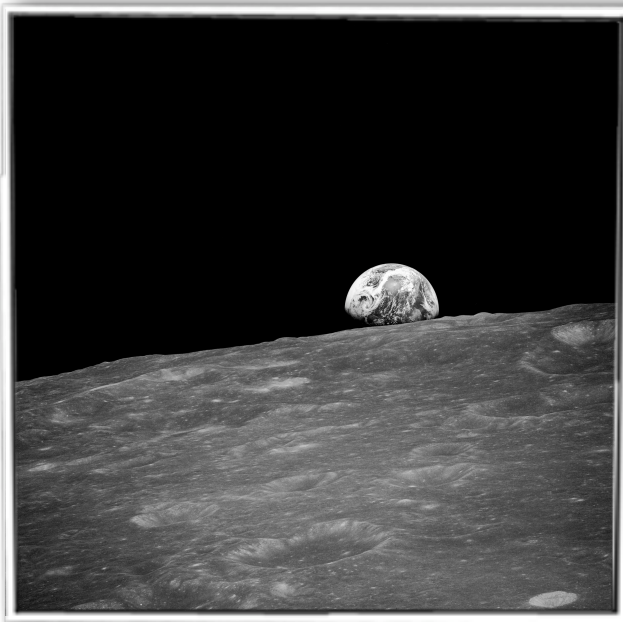


Figure 1: The first photo ever taken of the Earth-rise, during the Apollo 8 expedition to the moon (source: [Frank Borman](#)).

AGE OF THE EARTH

According to scientists the Earth is 4.54 billion years old. This age is calculated by measuring the amount of radioactive decay in the most ancient rocks on Earth, a technique called radiometric dating (see: [radiometric](#)). Radiometric dating can also be used to date the fossil record, thereby establishing when specific species of life lived on the planet. In this manner scientists have reconstructed a history of life on Earth. This history traces the record of life found in rock from the first appearance

of single celled organisms about 3.8 billion years ago, to the arrival of early man 200 million years ago. What the fossil record tells us is that from its inception almost 4 billion years ago life has gradually become more complex and diverse over time. The growth of biodiversity however has been punctuated by periodic mass extinctions, followed by renewed growth of species, culminating in the millions of life forms found today (see: [extinction](#)).

Did You Know?

The age of the world and life on Earth is established by analyzing rocks.

see: [Ask a Rock](#)



THE ORIGIN OF SPECIES

Although scientists can estimate the age of life on Earth, what is less clear from the fossil record is how life started and how the planet came to be home to so many millions of different species. Was each form of life created individually, or did they arise from each other? For years these questions were a great source of debate. In the past 150 years however consensus has emerged among scientists that biological diversity can be explained by the process of Natural Selection.

The Theory of Natural Selection was developed by British naturalist Charles Darwin. Darwin's parents wanted him to be a physician or a clergyman, but from a young age he

was drawn to the natural world. As a young man Darwin accepted an invitation to join an expedition to South America as a junior naturalist on the sailing ship HMS Beagle. The journey lasted five years and saw the ship circumnavigate the globe. During the journey Darwin made keen geological observations, collected a vast store of fossils and kept fastidious journals. The observations he made during this voyage provided him the evidence to forge the theory of natural selection. Following the expedition Darwin devoted himself to gathering further evidence to support his theory. Finally, 23 years after his voyage Darwin published 'On the Origin of Species', the groundbreaking text that explained the theory of Natural Selection.

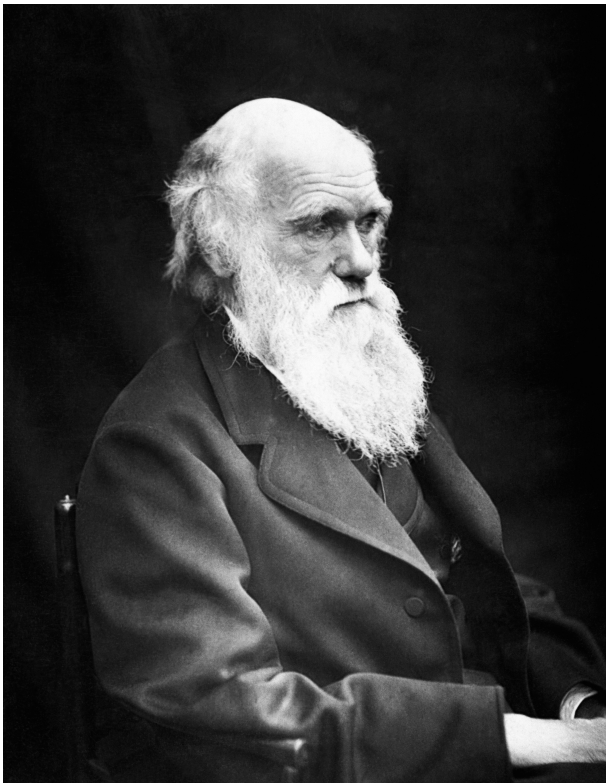


Figure 2: Charles Darwin (1809-1882) in his later years (source: [J. Cameron](#))

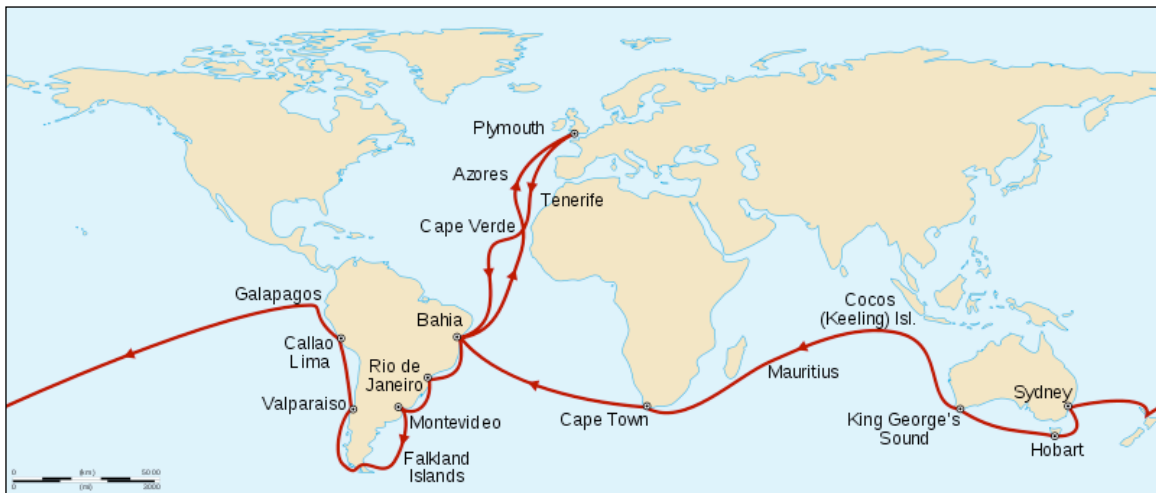


Figure 3: The route of the voyage of the HMS Beagle, 1831 - 1836 (source: [Sémhur](#))

NATURAL SELECTION

Natural selection is defined as the process by which an organism that is best suited to its environment will survive and pass on its beneficial traits in increasing numbers to the following generations. Those organisms less suited to the environment will be eliminated (see: [selection](#)). Darwin gathered evidence demonstrating the slow appearance, and

Years Before Present Day	Life Form
3.8 billion years	First appearance of life (bacteria and archaea).
900 million	First multicellular life
800 million	Thin plate-like creatures evolve. They are approximately 1 millimeter across and consist of only three layers of cells. It is suggested that they may be the last common ancestors of all animals
580 million	Earliest known fossils of animals such as jellyfish date back to near this time
530 million	First animal with a backbone
385 million	Oldest fossil of a tree
130 million	First flowering plant
6 million	Humans evolve from closest relative the chimpanzee

Table 1: The timeline of appearance of life on Earth according to the geological record (source: [timeline](#)).

disappearance, of species (see: [new species](#)). He also recognized that organisms produce more offspring than survive to reproduce, and proposed that this would result in a 'struggle for existence'; a competition for resources. His theory stated that those most suited to their environment would survive, as opposed to those with less advantageous characteristics. Darwin wrote:

"Natural selection acts only by taking advantage of slight successive variations; it can never take a great and sudden leap, but must advance by short and sure, though slow steps (see: [Darwin](#))."

The classic illustration of Natural Selection is the example of the Peppered Moth in Northern England.



Figure 4: A peppered moth (source: [Olaf Leillinger](#)).

Moths in Northern England come in a variety of shades from light to dark. Traditionally light coloured moths were dominant as they blended in better with the light coloured bark of the local trees, and were hidden from predators like birds. However during the Industrial Revolution there was a lot of manufacturing in the area, and soot from the factories darkened the bark of the trees.

This meant that the dark colored moths became harder to see, and they began to survive in greater number. Thus those moths with the gene for dark color were 'selected' for survival by the changing properties of the habitat (see lovely photos of moths that illustrate this principle: [peppered moths](#)). Through this process of natural selection the population of dark coloured moths became dominant.

Student Exercise

Artificial Selection

Read like about how the Chihuahua, Pekinese, Great Dane and Saint Bernard all arose from the same species, the Grey Wolf which was first domesticated about 15,000 years ago.

see: [how new species form](#)

THE BIRTH OF BIODIVERSITY

When the theory of Natural Selection is applied to life forms surviving over millions of years through changing habitats, it is evident that environmental forces will gradually select preferred traits in a manner that new species will be created. To better understand this let us contemplate a scenario.

Suppose that two groups of the same species of bird become physically separated. One group is living on a

windswept island off the coast of South America where they were blown in a storm, while the original group of birds remains in its traditional rainforest habitat on the mainland. Over time the different habitats the two groups of birds occupy will favor different traits that support the respective survival of each group. The birds in the rainforest will continue to feed on grubs and insects that are plentiful. The birds stranded on the island where their traditional food source is missing will have to adapt to eating water grubs living in the tidal pools along the shoreline. Those birds

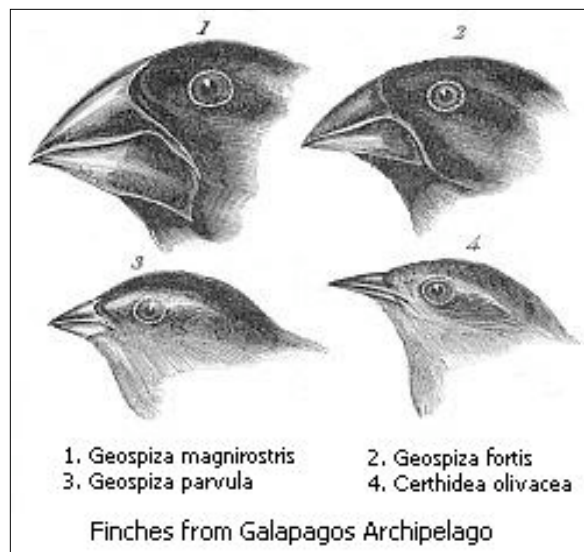


Figure 5: Darwin's finches or Galapagos finches - demonstrating the changes wrought by Natural Selection (source: [John Gould](#)).

Did You Know?

Scientists have discovered wild cats in the Amazon, such as the Jaguar that imitate the call of their intended victim, a small monkey. This skill has enabled this predators to better adapt and survive in their environment.

see: [Jaguar](#)

with traits that allow them to better adapt to this new diet will survive. If the two groups of birds remain completely separated they will gradually become less and less alike and in time will become two separate species.

It is in this gradual manner, on a species by species basis over millions of years, that scientists

believe that the Earth's plentiful biodiversity came to be.

EXTINCTION

Since the first appearance of life on Earth some 3.8 billion years ago, there has been perpetual growth of new species. Yet this has not resulted in the constant expansion of biodiversity and number of species, because the creation of new species is continually offset by the extinction of others. The same natural forces that propel the formation of new species also push others to extinction.

Scientists estimate that a vast majority, fully 98% of all species that ever lived on Earth, are now extinct (see: [history of extinction](#)). On average an

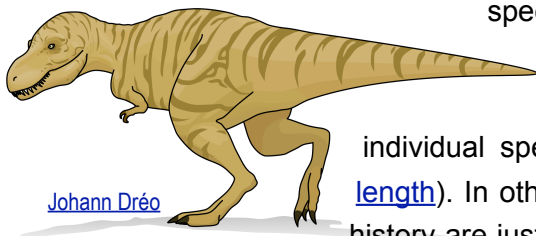
individual species lasts a few million years before becoming extinct (see: [length](#)). In other words those species alive at any point in time in the Earth's history are just a snapshot of species that will most likely, through the process of natural selection, either evolve into a new species or become extinct.

Yet the fossil record reveals that extinction has not always occurred at a steady rate over the course of life on the planet. In fact there appear to have been five periods of mass extinction, when up to 80 percent of all species present on the Earth died over a short period of time. The cause of these extinctions is addressed in more detail in Module 8.

Irrespective of cause, the mass extinctions led to enormous loss in biodiversity. These events in the Earth's history involved a profound alteration of ecosystems such that many species were unable to adapt to and survive the habitat change. Perhaps the most famous such example is the sudden extinction of the dinosaurs 65 million years ago. Often such

For a fascinating review of how the fossil record has revealed the growth of biodiversity and impact of periodic extinctions

see: [extinction](#)

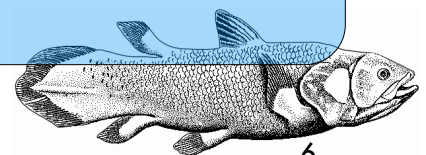


[Johann Dréo](#)

Did You Know?

The Coelacanth is called the living fossil. This species of elusive fish, long thought to be extinct, is believed to have been alive 65 million years ago, when dinosaurs roamed the Earth.

see: [coelacanth](#)



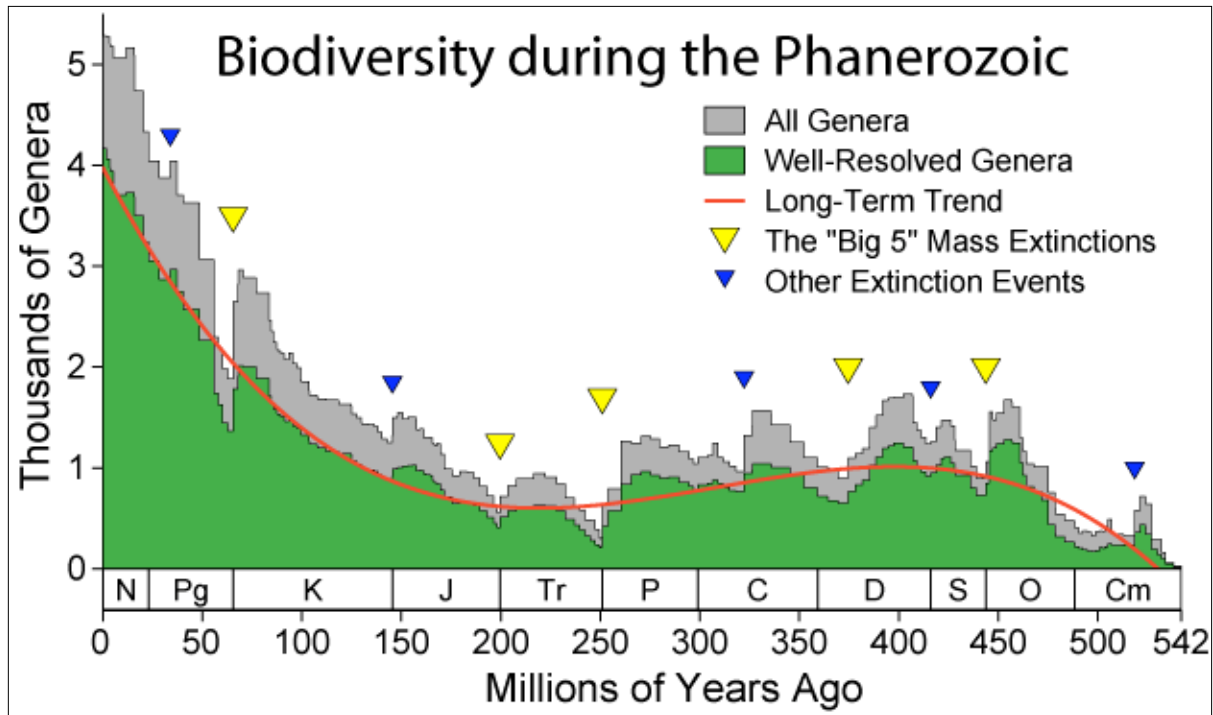


Figure 6: The history of biodiversity through time as revealed by the fossil record. The yellow triangles are the big five mass extinctions. The yellow triangle on the far left indicates when the extinction of the dinosaurs occurred. The red line indicates the long term trend towards greater species and greater biodiversity (source: [extinction](#))

extinctions appear to be related to rapid habitat change that outpaces the ability of species to adapt.

AMAZON NATURAL SELECTION

As we have learned, rainforest are the most densely populated habitats in the world, home to roughly half of all the world's species. Considering the process of Natural Selection, how did the Amazon come to be one of the most diverse and rich habitats in the world? A number of factors are thought to contribute to the biological wealth of Amazonia:

- Rainforests are considered the oldest ecosystem on Earth, thereby providing species who live there a prolonged period during which to diversify into multiple species.
- Liquid water, needed to support all life, is in great abundance in the Amazon, affording great opportunity for life to grow.

Definition:

Phanerozoic:

The Phanerozoic Eon is the period of time during which abundant animal life has existed on Earth. It covers roughly 545 million years and goes back to the time when diverse hard-shelled animals first appeared.

- The warm, humid and predictable climate of the rainforest makes it a very hospitable environment for life forms.
- The vast size of the Amazon Rainforest provides ample resource opportunities for many species.
- The great variety of micro-environments in the rainforest encourages the evolution of countless unique plants and animals (see: [rainforest](#)).



Figure 7: The abundance of water in the Amazon makes it the ideal environment for the development of new species of life (source: [noodle snacks](#))

The Amazon rainforest provides the ideal environment for the creation of species through the process of natural selection. The Amazon has been present for a long time, has a stable and hospitable climate, is rich in water, is vast in size and has many small micro habitats that encourage the slow adaptation of species.

Unfortunately many of these properties are now under assault. Habitat change in the Amazon is now occurring at a rapid rate.

Understanding that natural selection is a slow process, the fundamental question is whether the species of the Amazon will have time to adapt to current rapid change. Indeed the same question holds true for life across the planet. Is the rate at which human activity is causing habitat change outstripping the capacity of natural selection to allow species to accommodate? If so, and mankind does not change its conduct, then the Earth almost certainly will be entering another phase of mass extinction.