Evolution and the Diversity of Life

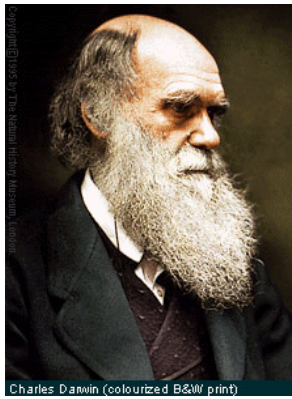
Theory

Theories embody the highest level of certainty for comprehensive ideas in science. Thus, when someone claims that evolution is "just a theory," it's roughly equivalent to saying that the proposition that the Earth circles the sun rather than vice versa is "just a theory."

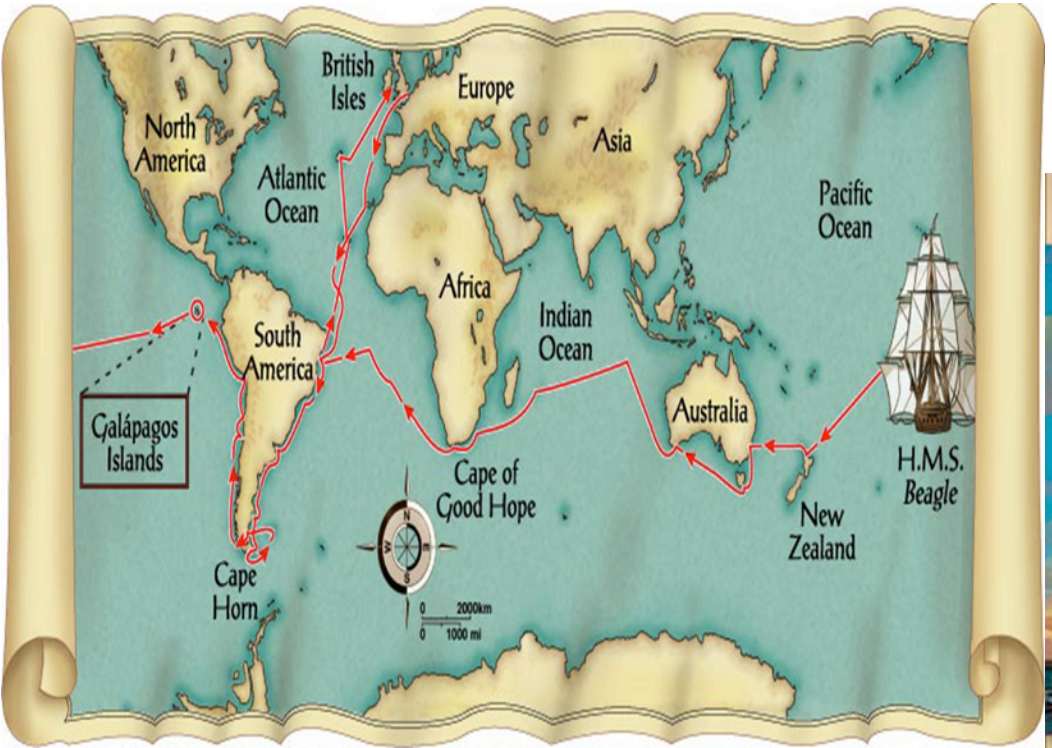
What is Evolution?

In the simplest biological terms evolution is defined as **the change in a population over time**. However, it is much more than that.

Darwin



- Who was Charles Darwin?
- **Charles Darwin** was the first to publish an **explanation** of how species **changed over time**, or **evolved**.



Patterns of Diversity

- Darwin visited Argentina and Australia which had similar grassland ecosystems.
  - those grasslands were inhabited by very different animals.
  - neither Argentina nor Australia was home to the sorts of animals that lived in European grasslands.

Patterns of Diversity

- Darwin posed challenging questions.
  - Why were there no rabbits in Australia, despite the presence of habitats that seemed perfect for them?
  - Why were there no kangaroos in England?

The Galapagos Island

- The smallest, lowest islands were hot, dry, and nearly barren-Hood Island-sparse vegetation

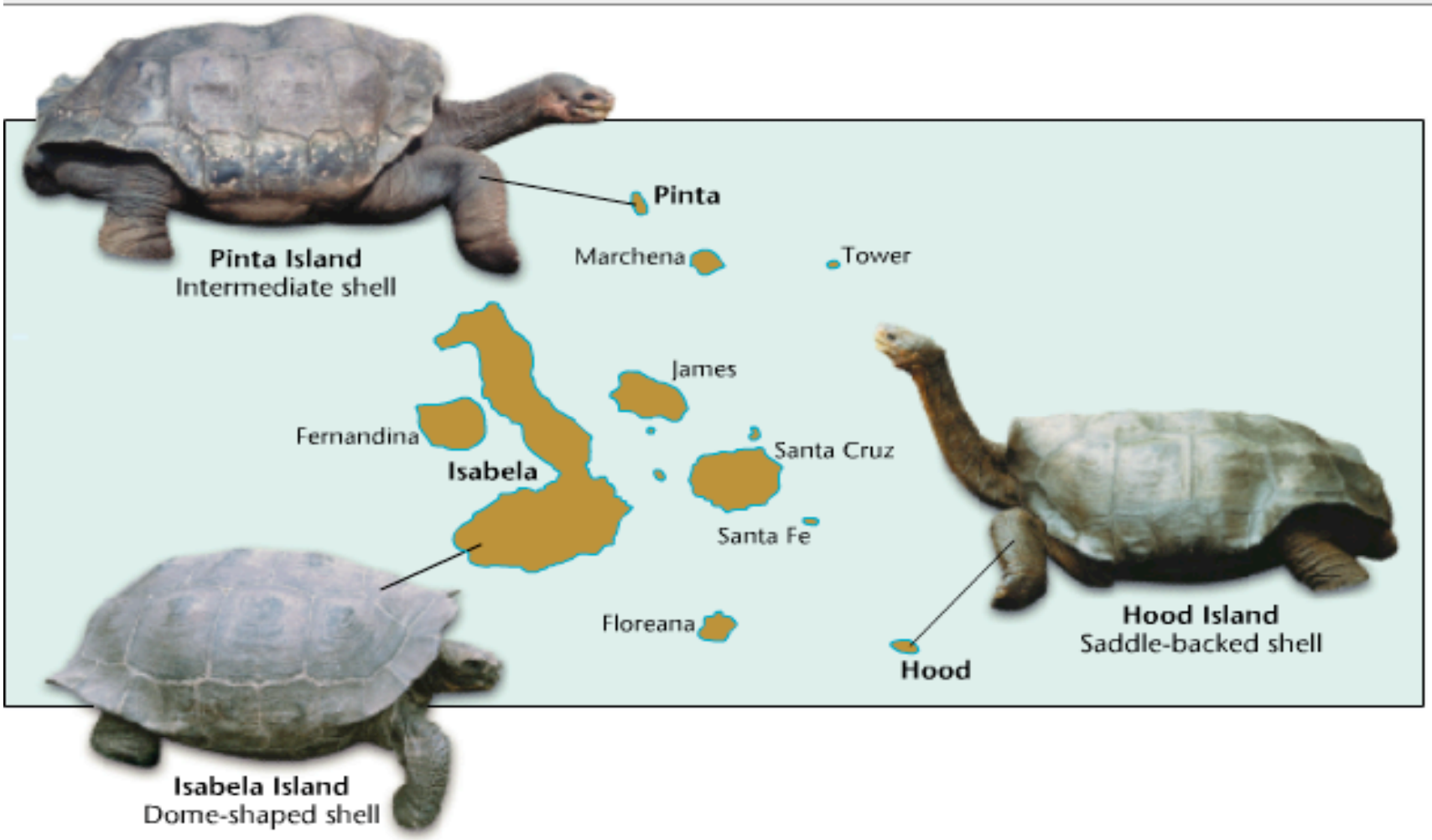
- The higher islands had greater rainfall and a different assortment of plants and animals-Isabela- Island had rich vegetation.

The Galapagos Island

- Darwin was fascinated in particular by the land tortoises and marine iguanas in the Galápagos.

- Giant tortoises varied in predictable ways from one island to another.

- The shape of a tortoise's shell could be used to identify which island a particular tortoise inhabited.

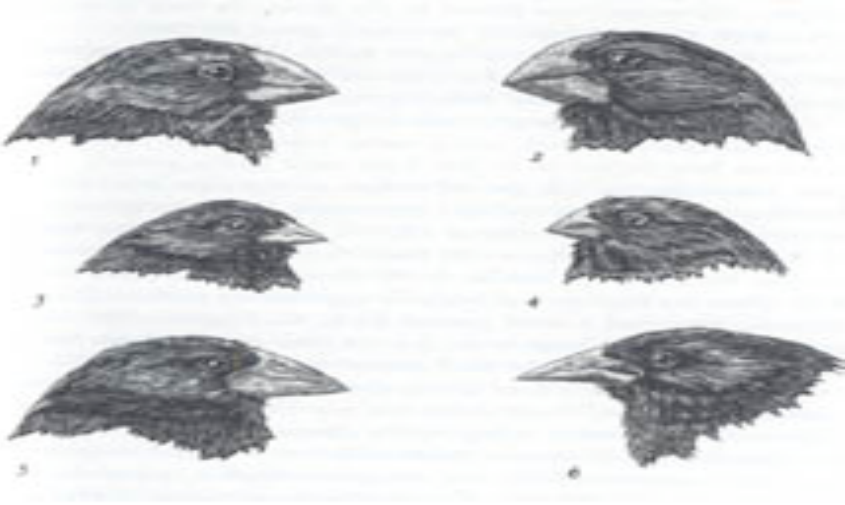


Variation Among Tortoises Darwin observed that the characteristics of many animals and plants varied noticeably among the different Galápagos Islands. Among the tortoises, the shape of the shell corresponds to different habitats. The Hood Island tortoise (right) has a long neck and a shell that is curved and open around the neck and legs, allowing the tortoise to reach the sparse vegetation on Hood Island. The tortoise from Isabela Island (lower left) has a dome-shaped shell and a shorter neck. Vegetation on this island is more abundant and closer to the ground. The tortoise from Pinta Island has a shell that is intermediate between these two forms.

Animals found in the Galapagos

- Land Tortoises
- Darwin Finches
- Blue-Footed Booby
- Marine Iguanas

Animals

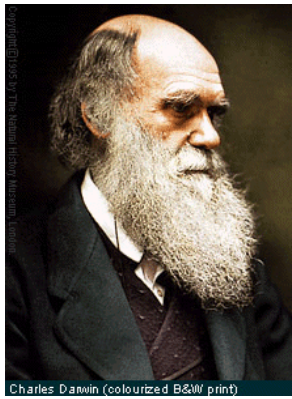


The Journey Home

- Darwin Observed that characteristics of many plants and animals vary greatly among the islands

- **Hypothesis:** Separate species may have arose from an original ancestor

Darwin



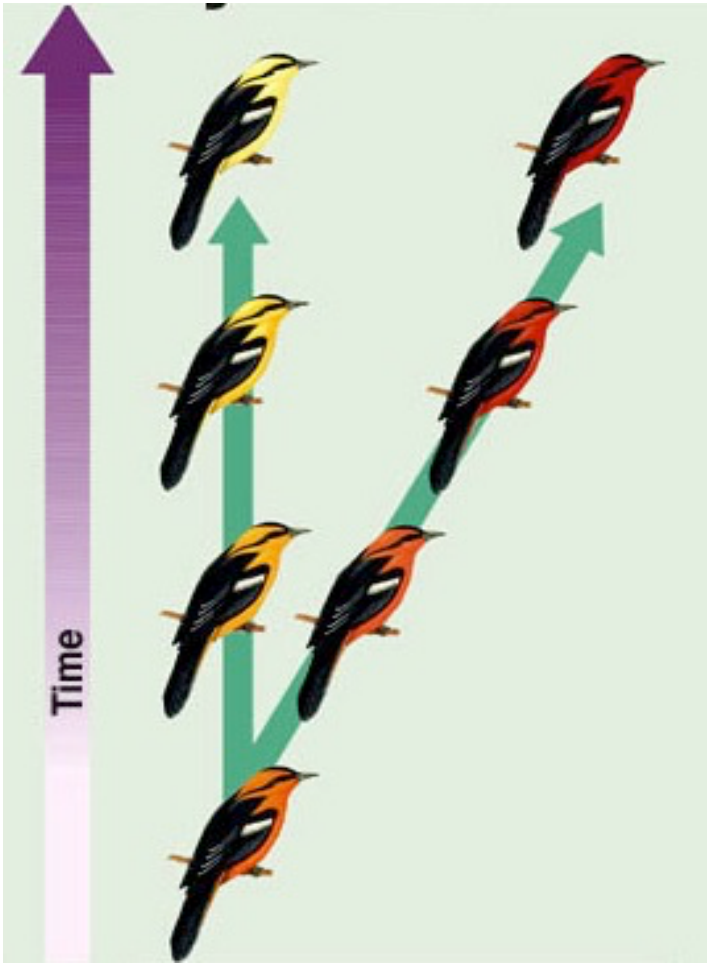
- Darwin Knew:
- Many species produce large numbers of offspring
- These species had not overrun the earth
- Individuals struggle to survive – not all survive and reproduce

Natural Selection

- Darwin proposed the idea of natural selection to explain how species change over time
- Natural Selection – a mechanism for change in populations occurs when organisms with certain variations survive reproduce and pass their variations to the next generation.
- "Survival of the fittest"

Common Descent with Modification

- **Darwin proposed that organisms descended from common ancestors**
- **Idea that organisms change with time, diverging from a common form**
- **Caused evolution of new species**



Descent With Modification

- **Takes Place Over Long Periods of Time**
- **Natural Selection Can Be Observed As Changes In**
  - **Body Structures**
  - **Ecological Niches**
  - **Habitats**

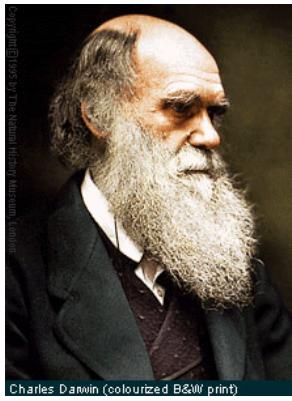
Descent With Modification

- **Implies**
  - **All Living Organisms Are Related**
  - **Single Tree of Life**
    - **DNA, Body Structures, Energy Sources**
- **Common Descent**
  - **All Species, Living & Extinct, Were Derived From Common Ancestors**

Descent

- **Descent with Modification**-Each living organism has descended, with changes from other species over time
- **Common Descent**- were derived from common ancestors

Darwin Explains Natural Selection



- In nature organisms produce more offspring than can survive (frog= thousands of eggs)
- Individuals with certain variations survive in their environment passing those variations(traits) on to the next generation
- Over time offspring with certain variations (traits) make up most of the populations and may look entirely different from their ancestors

Survival of the Fittest

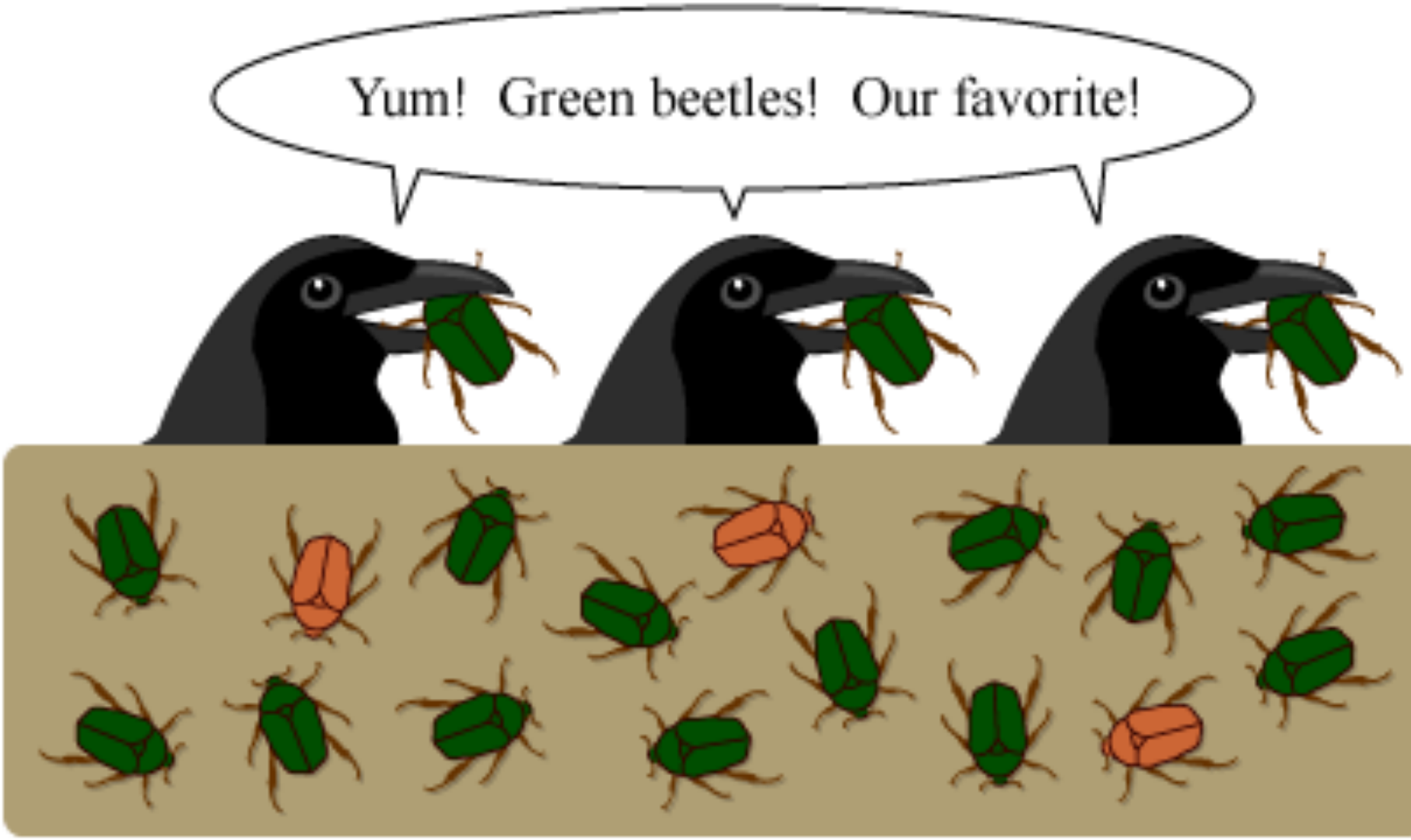
- **Fitness Is Central To The Process Of Evolution**
- **Individuals With Low Fitness**
  - **Die**
  - **Produce Few Offspring**

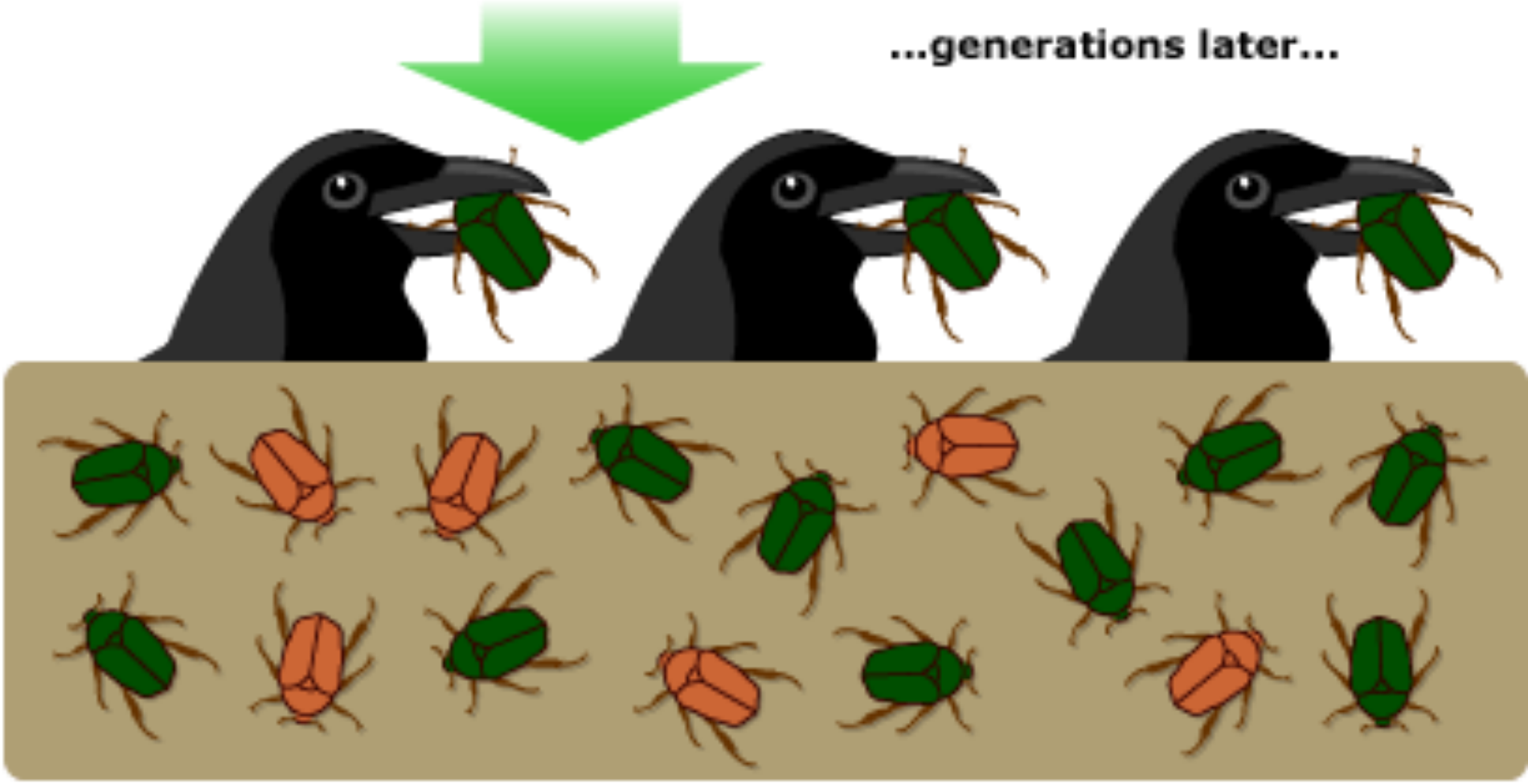
Survival of the Fittest

AKA Natural Selection

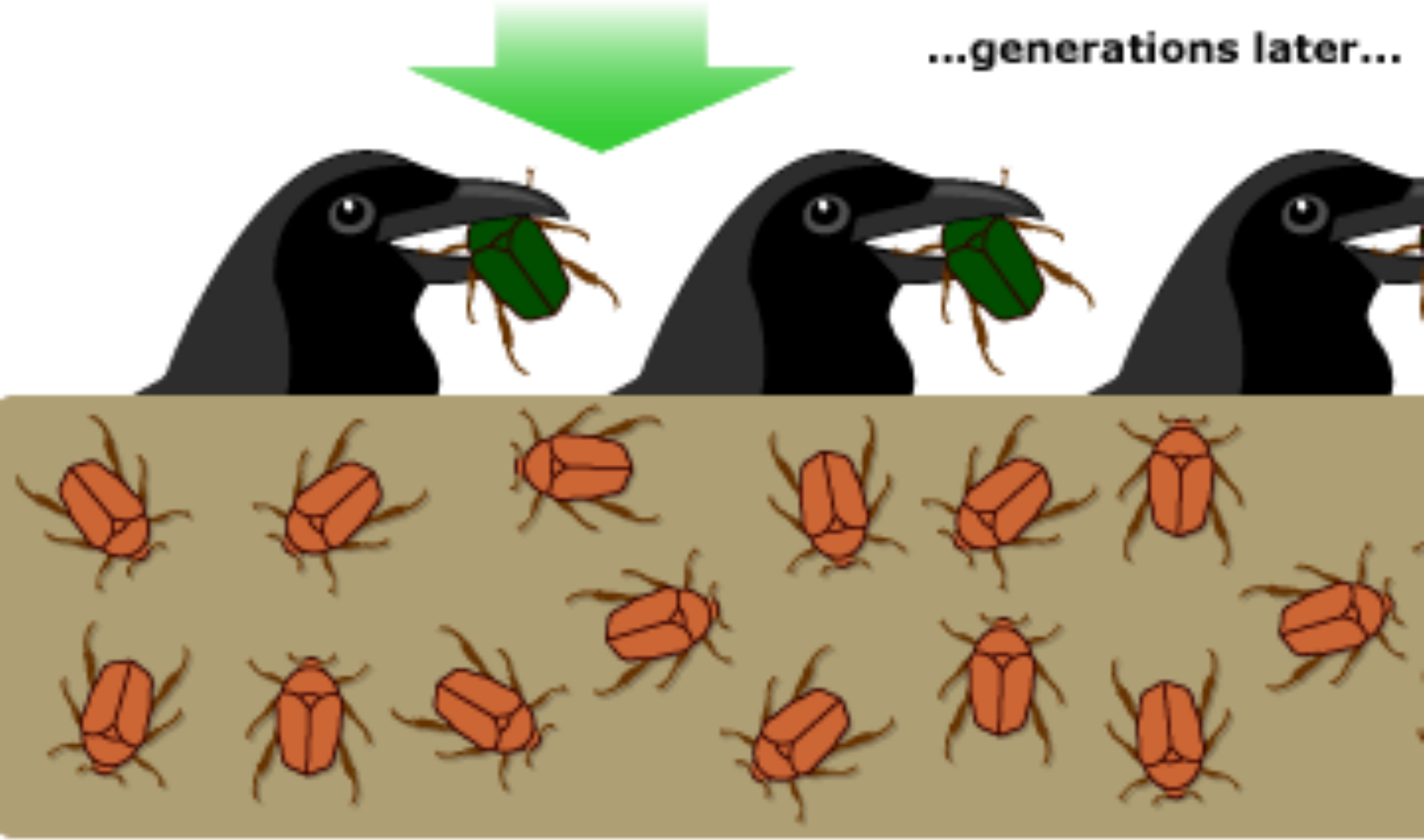
Natural Selection

Natural selection, in a nutshell:




...generations later...

Natural selection, in a nutshell:

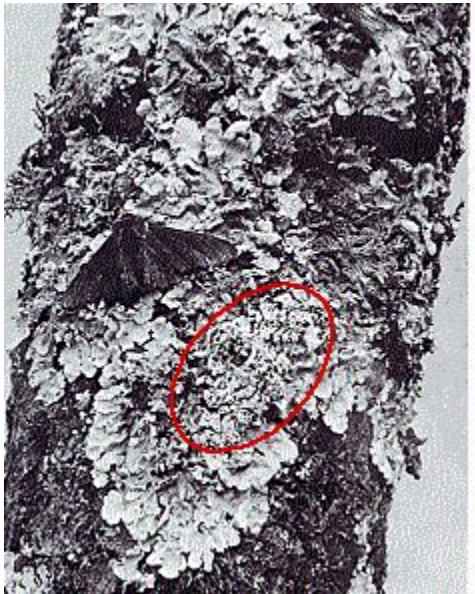


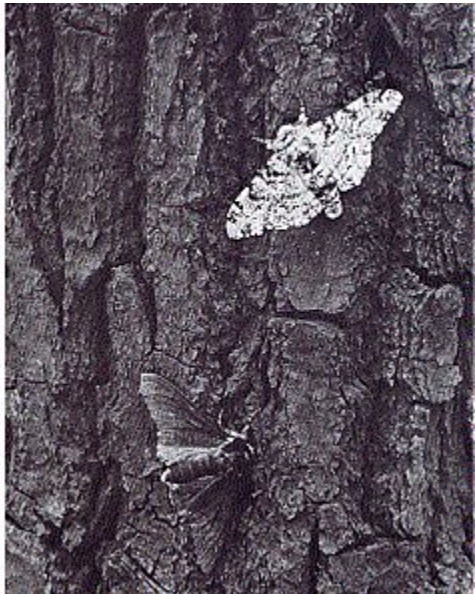
Green beetles have been selected against, and brown beetles have flourished.

http://evolution.berkeley.edu/evolibrary/article//bergstrom_02

Peppered Moth Example

- Originally White
- Now more black than white
- Causes
  - Industrial Pollution
    - Soot covered trees
  - Industrial Melanism





Interpreting Evidence after Darwin

- **Problem: Evolutionary processes are difficult for human to observe directly (thousands of yrs vs. 80+ human yrs)**
- **Short scale of human life spans make it difficult to comprehend evolutionary processes that occur over millions of years**
- **Evolution is more commonly defined by modern biologists as any change in the gene pool of a population**