The Theory of Biological Evolution

The Theory of Evolution, defined:

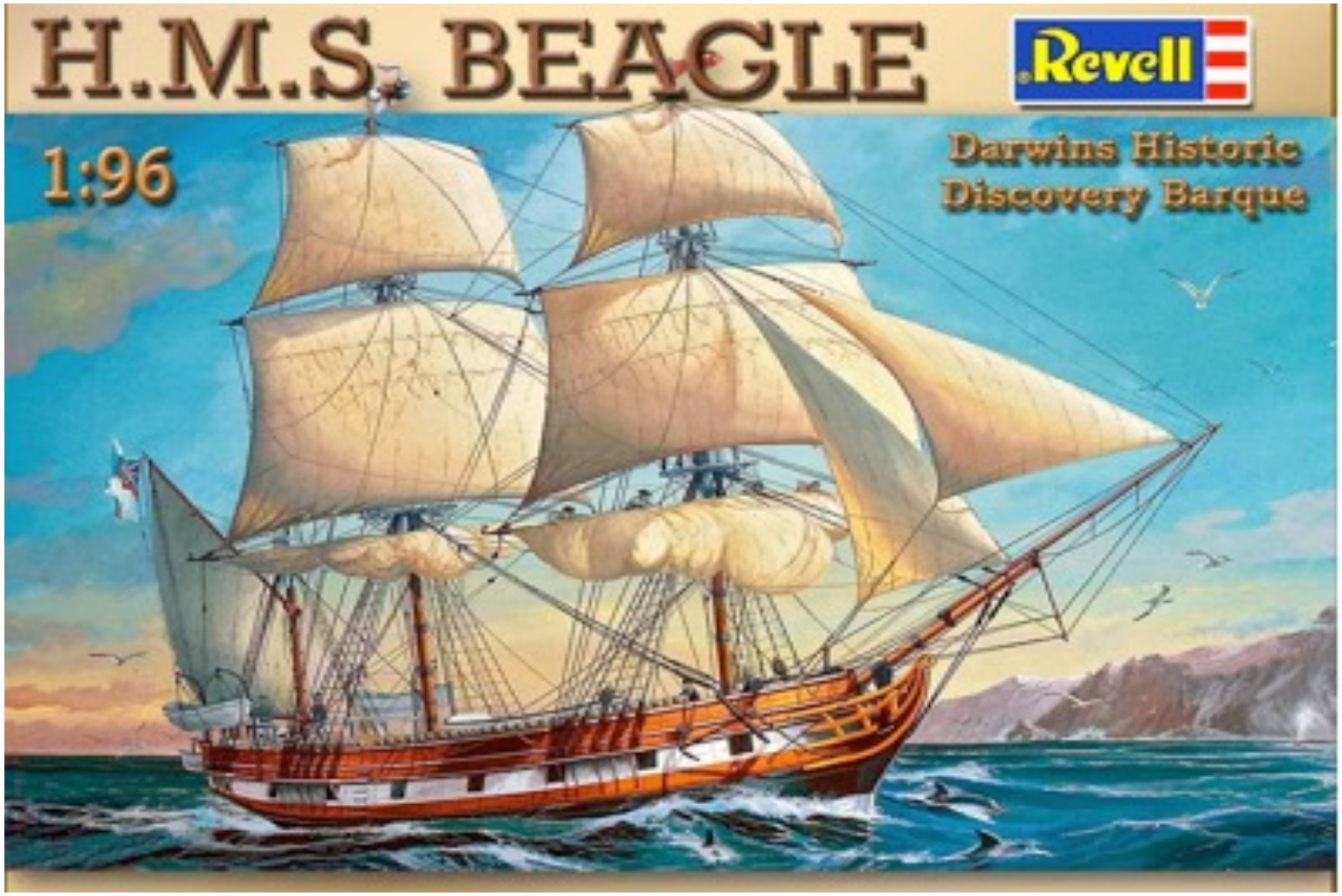
"All living species are descendants of ancestral species and are **different** from present day ones due to the cumulative change in the **genetic composition** of a population"

- Sooo in a nutshell, **populations** of living things look and behave differently because over time, their DNA has changed… *but how?*

Charles Darwin (1809-1882)

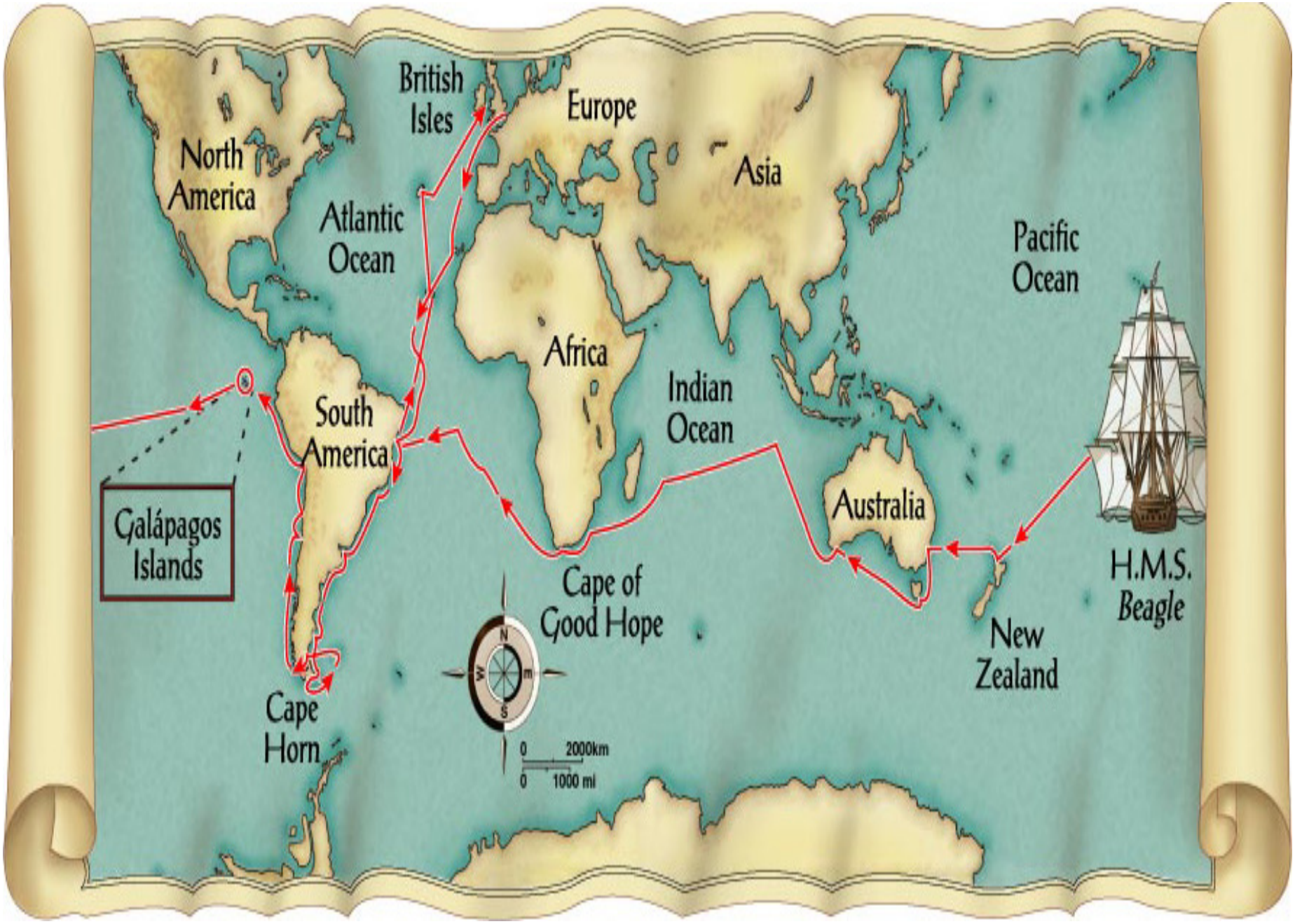
- Father of the theory of Evolution
- Suggested that **natural selection** is the mechanism by which species evolve over geologic time.
- Proposed **Descent with Modification**:
  - *All organisms on Earth are related through some unknown ancestral type that lived long ago.*

Voyage of the Beagle



Voyage of Beagle

- **Dates:** February 12th, 1831
- **Captain:** Charles Darwin
- **Ship**: H.M.S. Beagle
- **Destination:** Voyage around the world.
- **Findings:** evidence to propose a revolutionary hypothesis about how life changes over time


British Isles
Europe
North America
Asia
Atlantic Ocean
Pacific Ocean
Africa
Indian Ocean
South America
Australia
Galápagos Islands
H.M.S. Beagle
Cape of Good Hope
New Zealand
Cape Horn
N
W
E
S
0 2000km
0 1000 mi

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?

Living Organisms and Fossils

- Darwin collected the preserved remains of ancient organisms, called **fossils**.
- Some of those fossils resembled organisms that were still alive today.

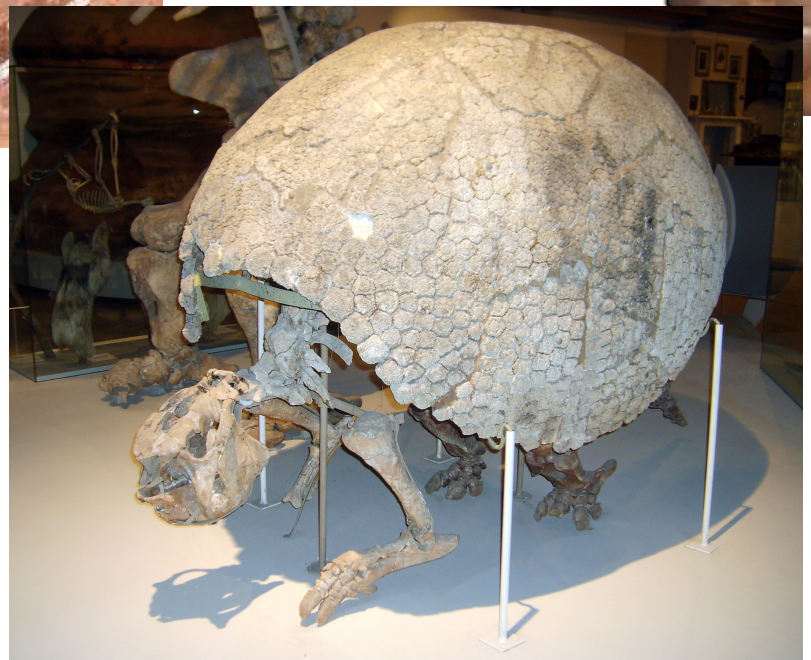
Living Organisms and Fossils

- Others looked completely unlike any creature he had ever seen.

- As Darwin studied fossils, new questions arose.
  - Why had so many of these species disappeared?

  - How were they related to living species?

Fossils

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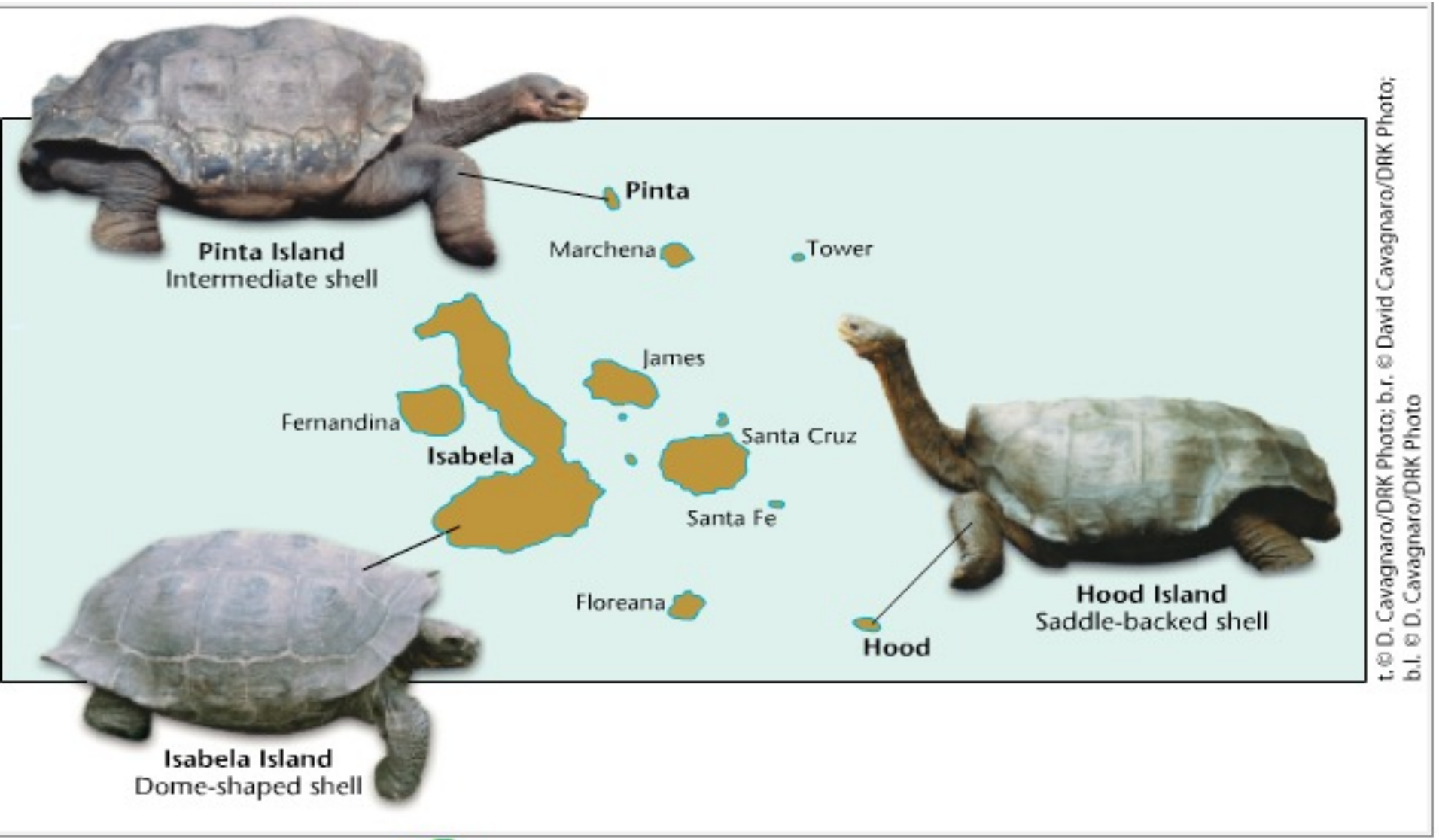
The Galapagos Island

- 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.



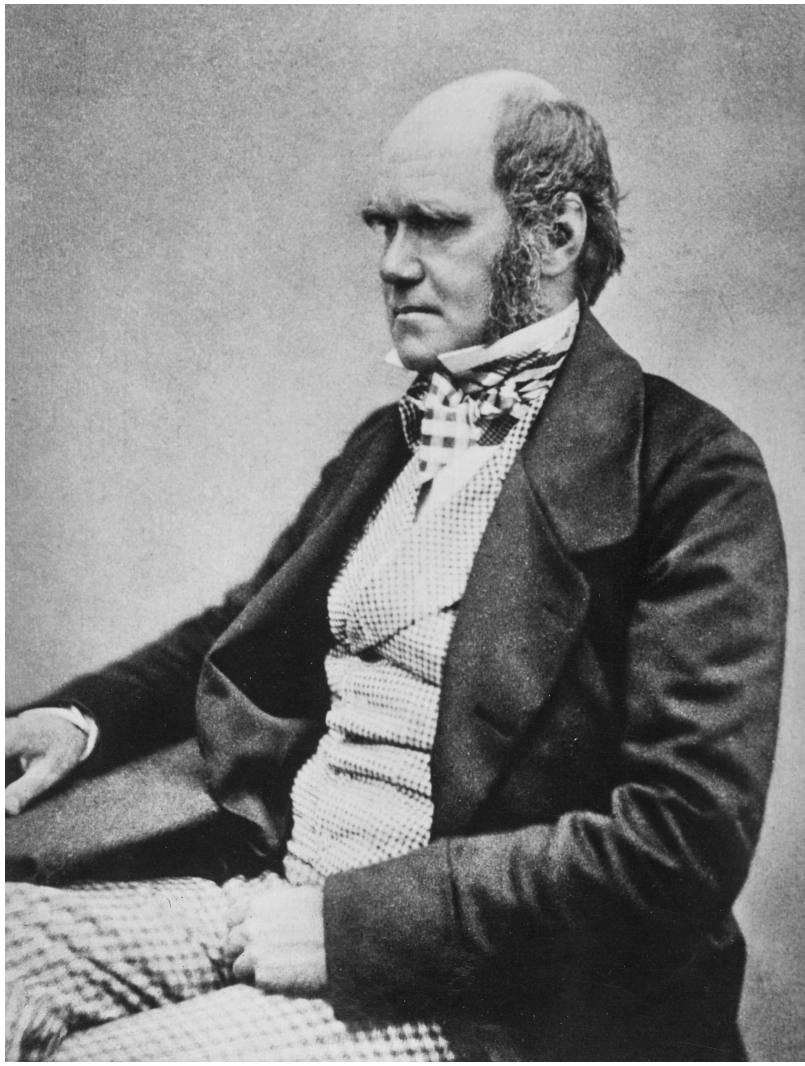
Variation Among Tortoises Darwin observed that the characteristics of many animals and plants varied noticeably among the different Galápagos Islands. Among the tortoises, the shape of the shell corresponds to different habitats. The Hood Island tortoise (right) has a long neck and a shell that is curved 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
- Marine Iguanas

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



History of the Theory

- **Evolutionary theory** was developed through many generations of scientists interpreting **new evidence** to refine and expand our understanding of biological change across time.
  - Darwin and Wallace (Evolution)
  - Gregor Mendel (Genetics)
  - Franklin, Watson & Crick (Genetics)

The Nuts and Bolts of Evolution

- **Evolution**: A cumulative change in the inherited characteristics of population.
- **Population**!! Is what changes.
- **Evolution is like a tree** – many branches emerged from a common beginning, some branches died off (extinction), others branched multiple times (present-day diversity)

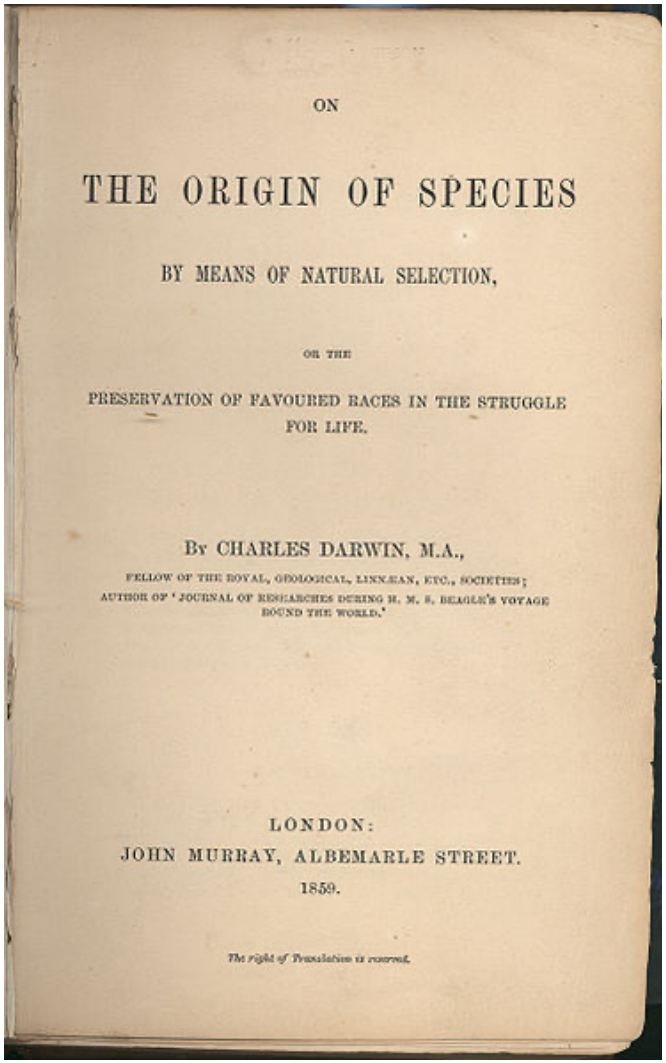
The Nuts and Bolts of Evolution

- The great diversity of living organisms is the result of over 3.5 billion years of evolution, filling every available **niche** with life forms.
- **Niche**: The area within a habitat occupied by an organism OR the ecological role of an organism within its community.
  - *"I've found my niche in society, I am a social worker"*
  - *"The arctic fish have found their niche in cold waters due to the adaptations in their cell membranes"*

The Origin of Species

Darwin developed two main ideas:

- Evolution explains life's **unity and Diversity**
- **Natural selection** is a cause of adaptive evolution



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

The right of Translation is reserved.

To Darwin, the history of life is like a tree.

→multiple branchings from a common trunk to the tips of the youngest twigs that represent the diversity of living organisms

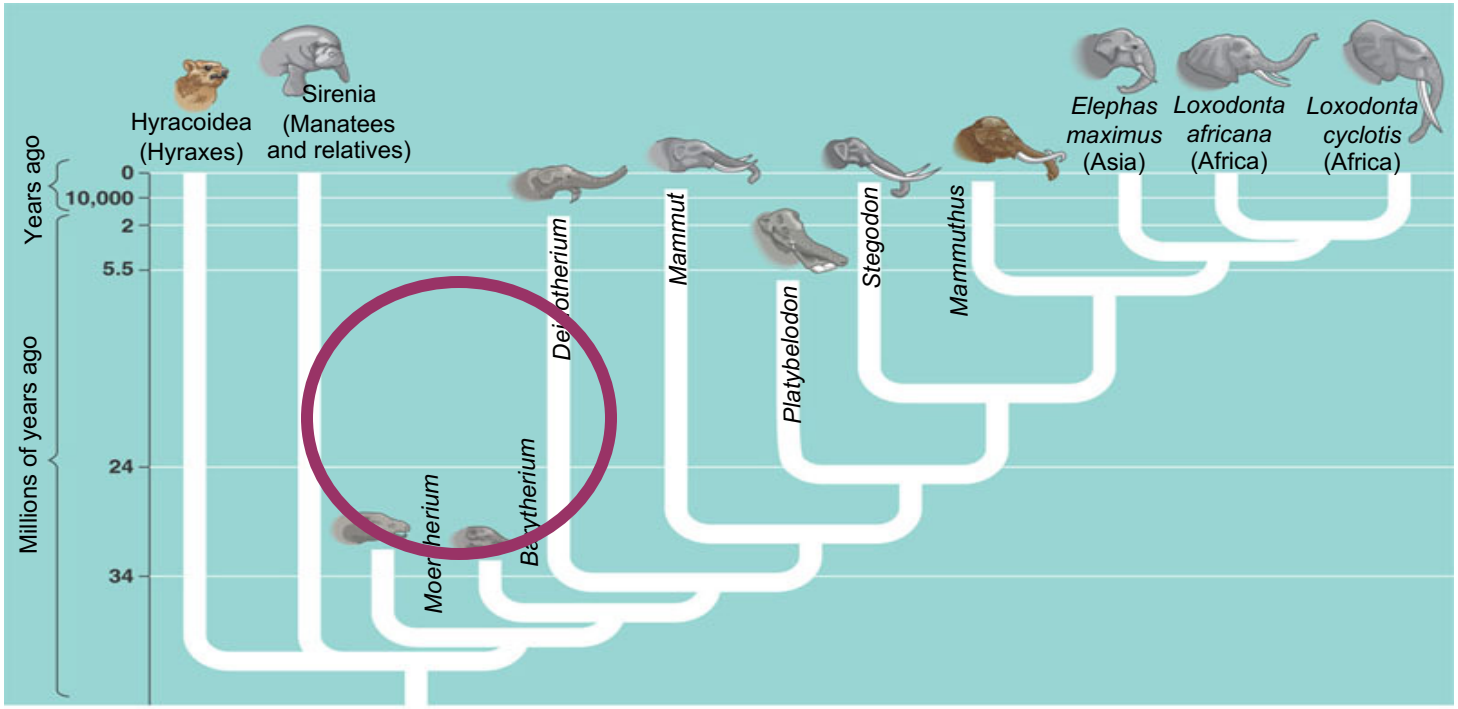


Figure 22.7

The Six Main Points of Darwin's **Theory of Evolution**

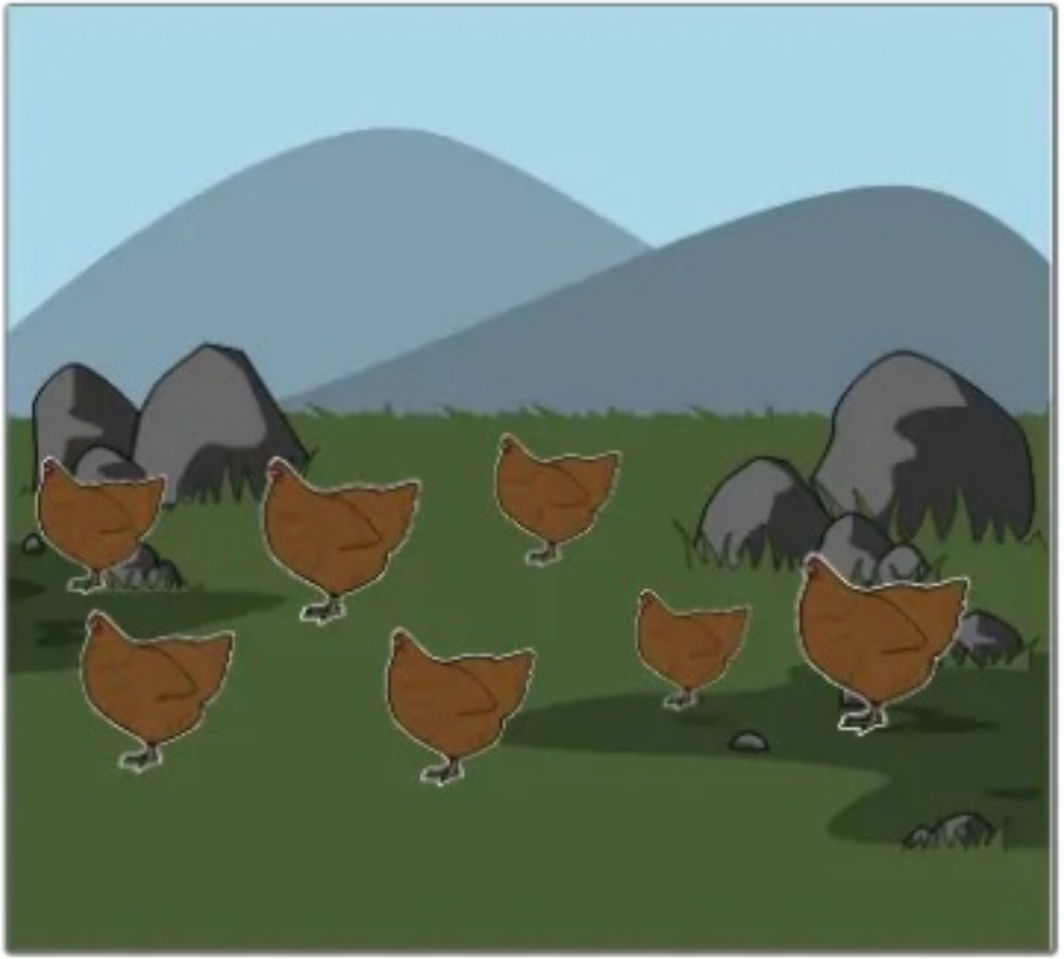
Observations and Inferences

Natural selection does not grant organisms what they "need".

1. **Overproduction***

- Most species produce far more offspring than are needed to maintain the population.
- Species populations remain more or less constant ("stable") because a small fraction of offspring live long enough to reproduce.

Overproduction



Overproduction is when a species create to many offspring to survive. In this picture we see 7 chickens but there were 12 5 of them died due to limited resources not enough available to feed them all.

2. **Competition***

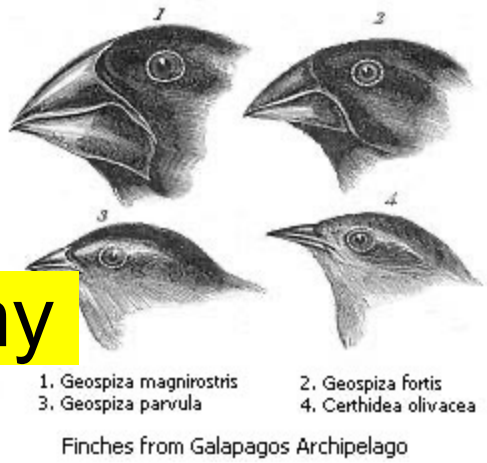
- Living space and food are limited, so offspring from each generation must compete among themselves in order to live.

- Only a small fraction can possibly survive long enough to reproduce.

Competition

Competition is when species fight over resources or a habitat. Competition can happen between two different species and in a single species due to overpopulation.

3. **Genetic Variation***



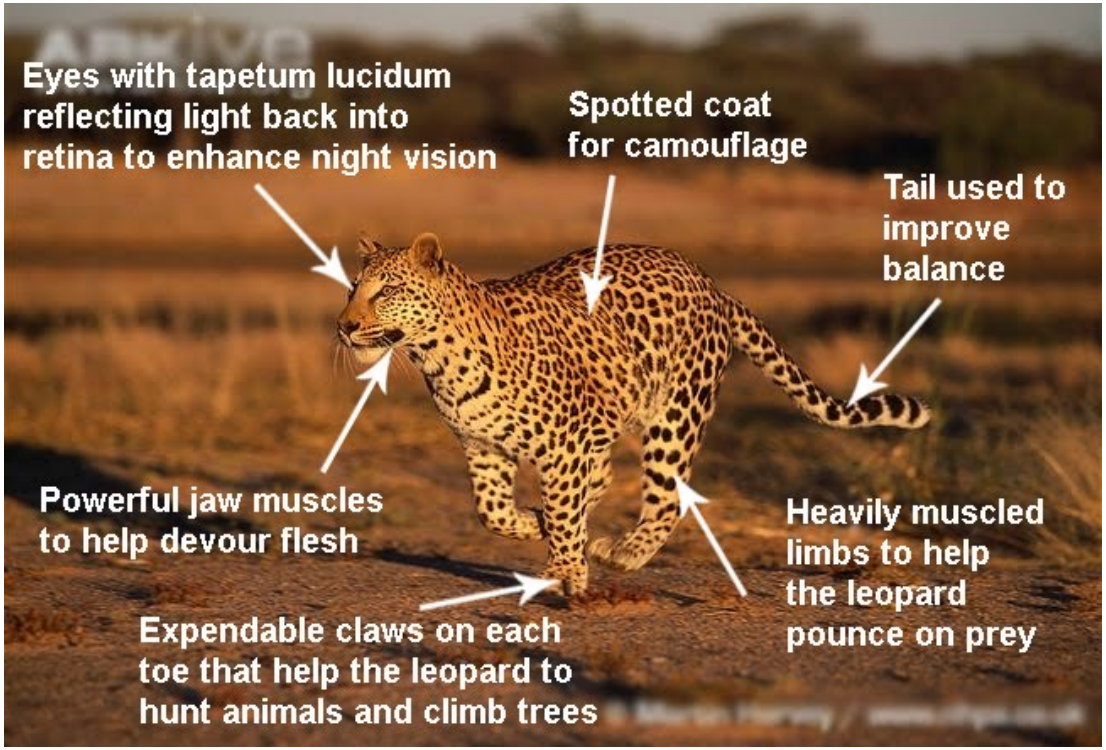
- Characteristics in individuals in any species are not exactly alike.
  - Ex: Differences for *Homo sapiens* (humans) can be exact size or shape of body, strength in running, or resistance to disease.
- These differences are considered to be the variations ***within*** a species. *What causes slight variations between individuals?*

Variation

Variation is when animals in a species don't turn out like the others. In this picture you can see that there are some bats that are brown and other lighter and others darker and this is because of variation.

4. Adaptation

An adaptation is an **inherited trait** that **increases** an organisms' chance of survival and reproduction in a given environment.



Adaptation

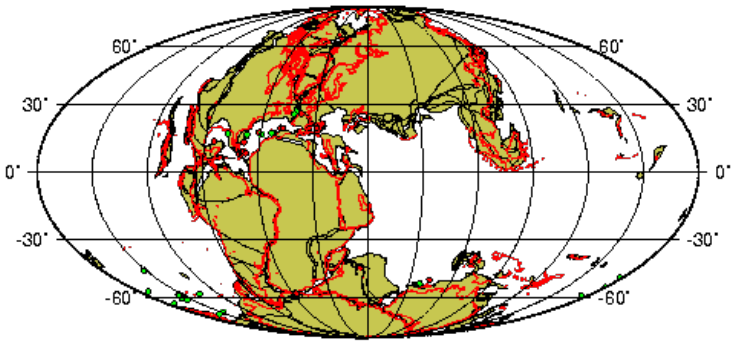
An individual may inherit a genetic trait that increases the chance of survival. In this picture it shows how an organism has adapted to its environment by changing to the color of its terrain the others do not blend in and would be easier to spot.

5. **Natural Selection***

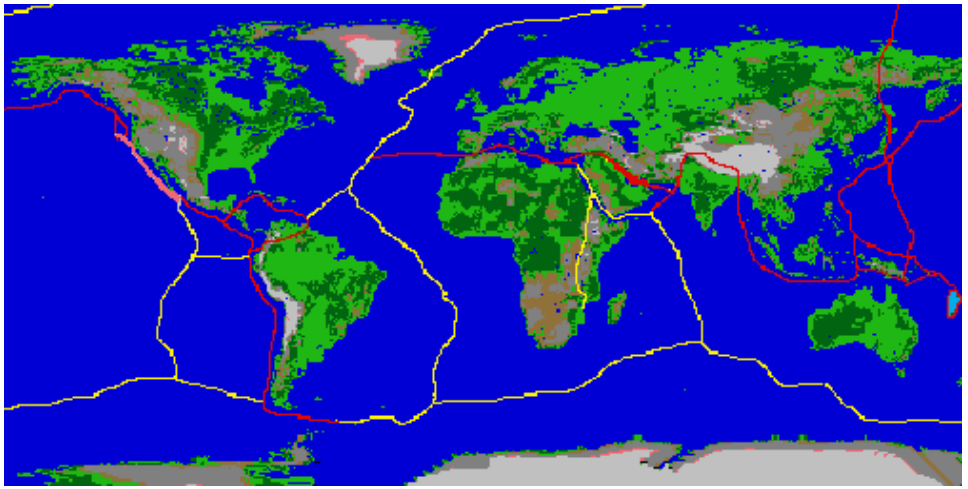
- **Nature**/environment **selects** for living organisms with better suited **inherited** traits to survive and reproduce.
- Offspring inherit these better traits, and **as a whole** the population improves *for that particular environment*.

5. **Natural Selection**, cont.

- Natural Selection does not move in a pre-determined direction! The changing earth determines what will and can survive.



150 My Reconstruction



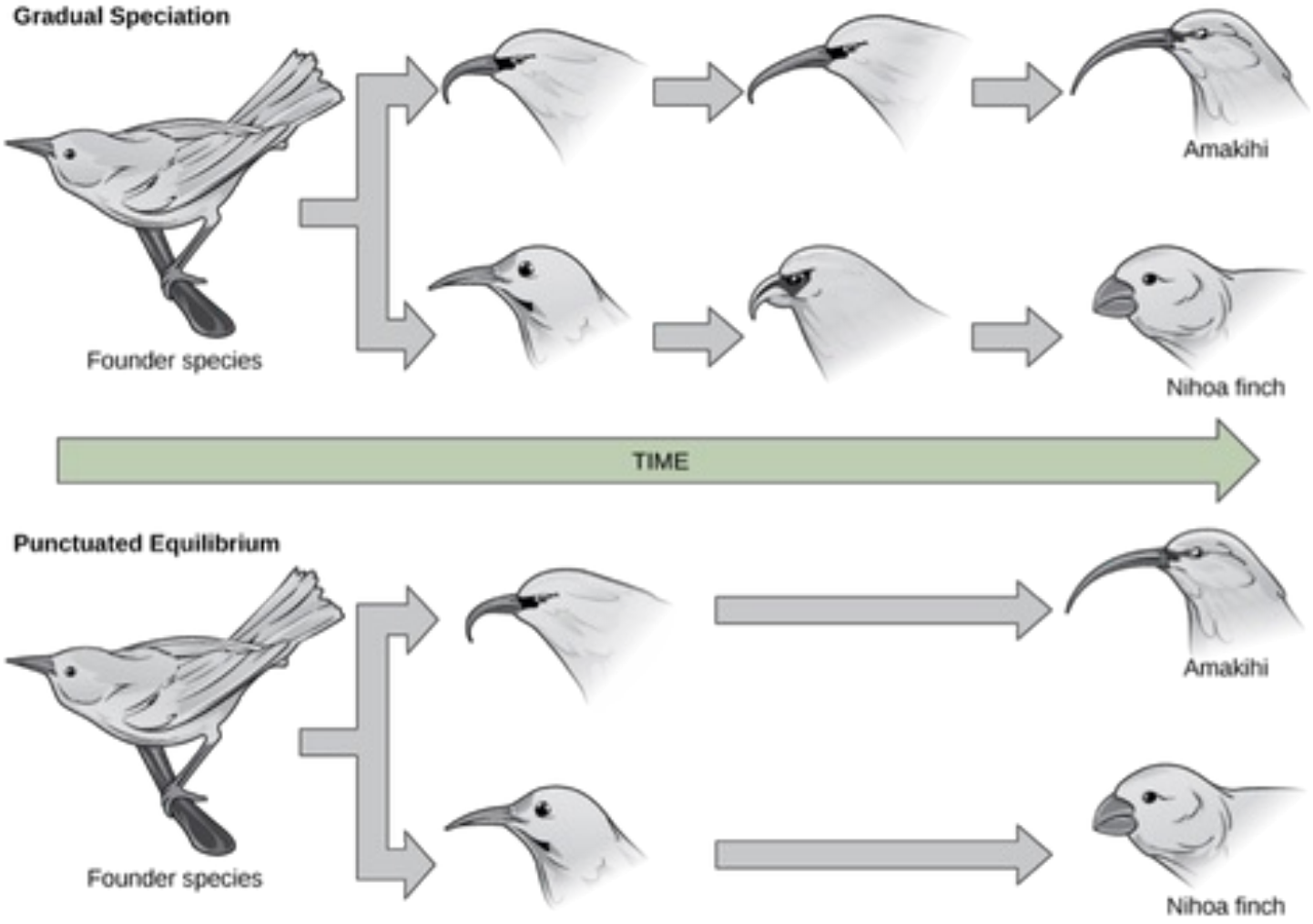
Natural Selection

When an animal acquires a favorable are more likely to survive and produce offspring which will inherit the favorable trait. In this picture you can see an organism where some have longer legs and necks so they can reach the leaves in the taller trees since the other does not have longer legs and a long neck it will not be able to feed

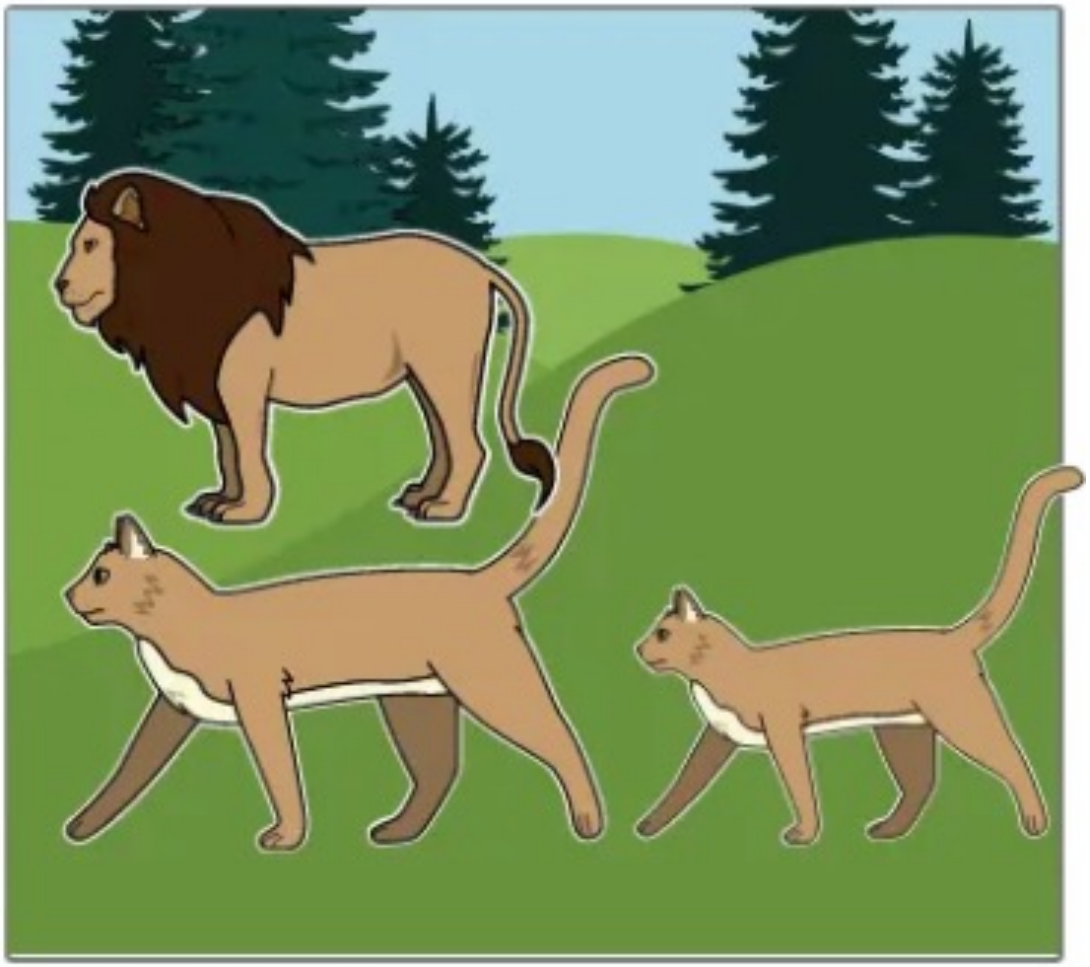
6. **Speciation**

- Over many generations, favorable adaptations (in a *particular* environment) gradually accumulate in a species and "bad" ones (in a *particular* environment) disappear.
- Eventually, accumulated changes become so great, the result is a **new species**.
- Formation of a new species is called "Speciation" and it takes *many, many* generations to do.

Speciation


Gradual Speciation
Amakihi
Founder species
Nihoa finch
TIME
Punctuated Equilibrium
Amakihi
Founder species
Nihoa finch

Speciation



Favorable adaptations gradually accumulate and unfavorable adaptations will disappear over many generations. In this picture we see the cat start to get bigger and bigger and make many adaptations to where it creates a whole different species.

The four factors*

1. Overproduction
2. Competition
3. Genetic Variation
4. Natural Selection

Biological Evolution is a consequence of these 4 factors - they work together to impact any living population

Which one of **Darwin's Six Points** do the following pictures show?

Diagram 1

Competition or Overpopulation

Diagram 2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Variation

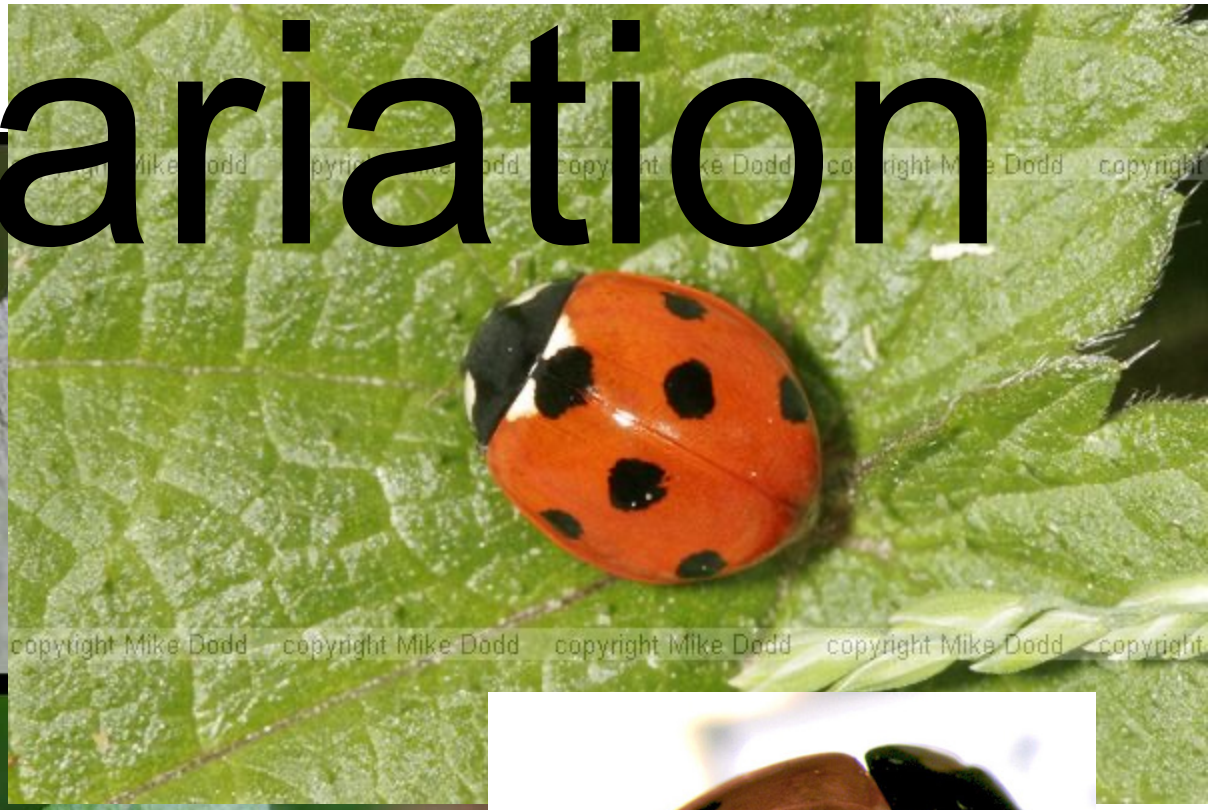
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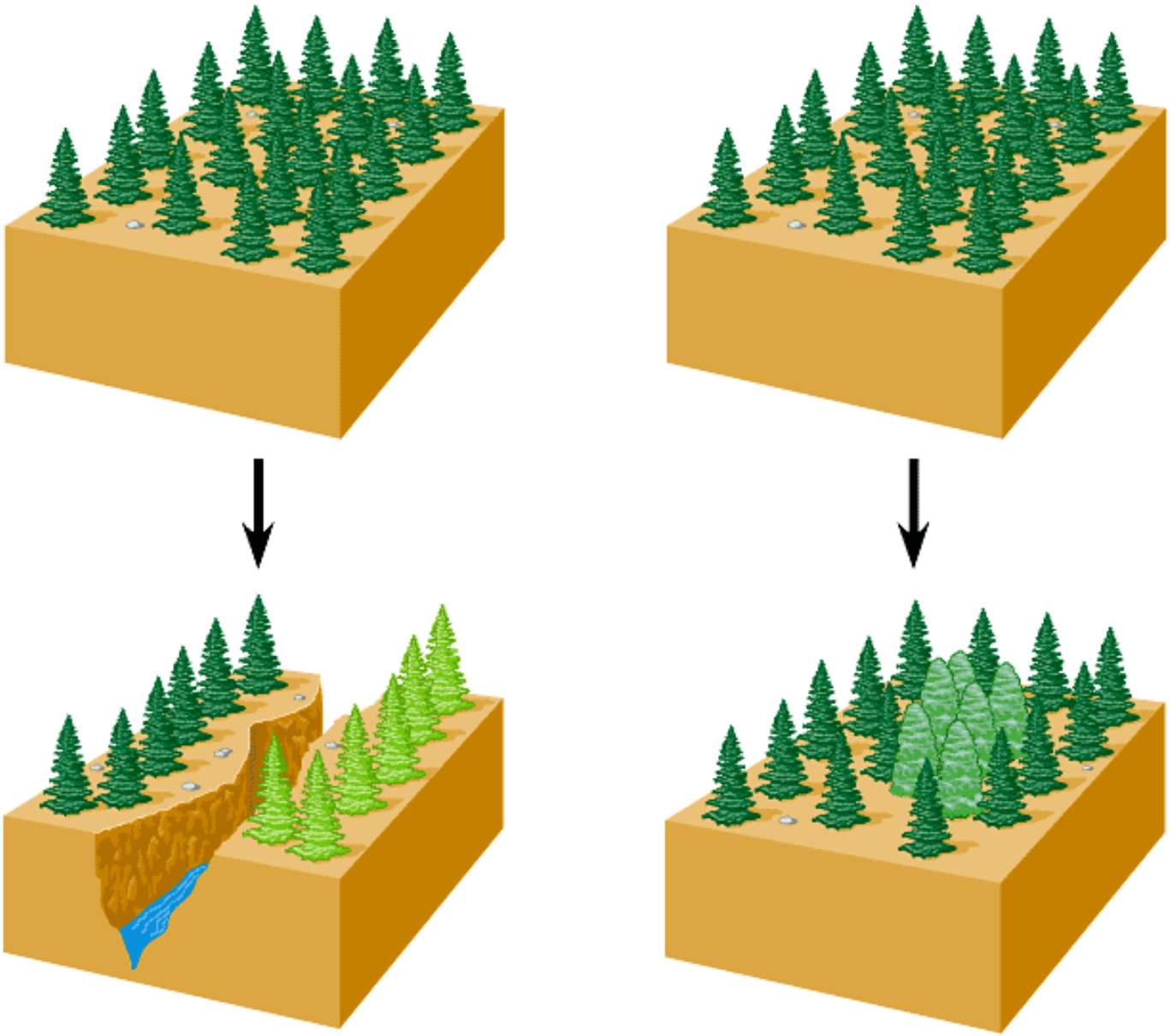
Diagram 3



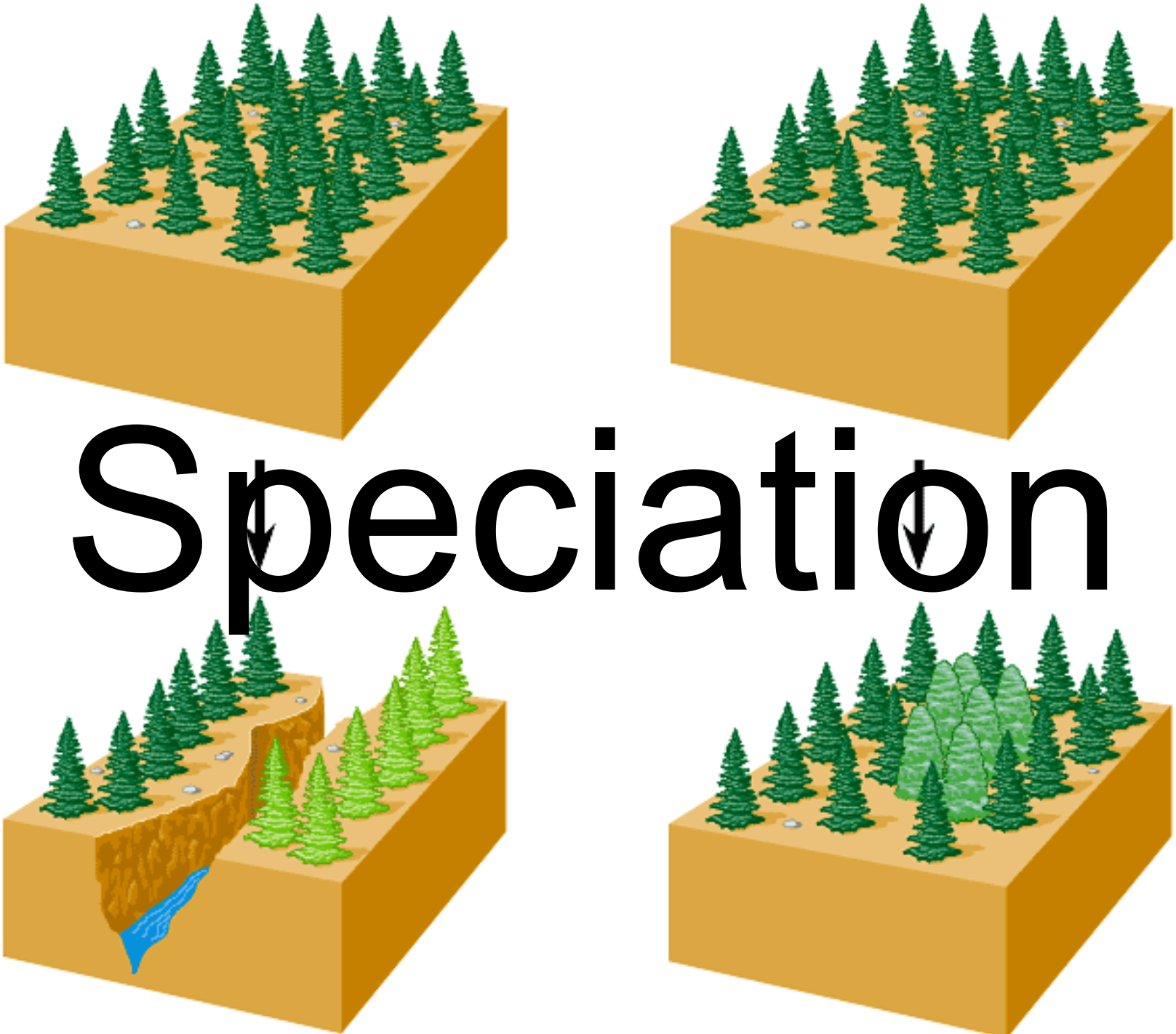

Speciation

Diagram 4

Adaptation