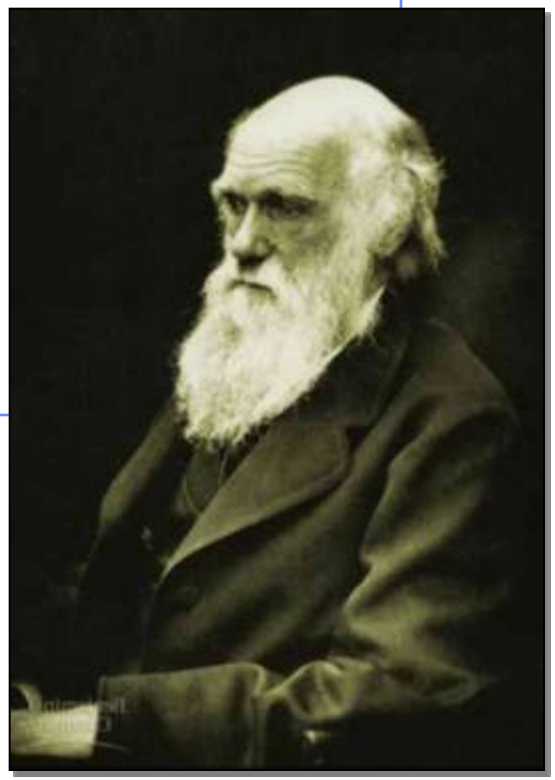
evolution

a journey into where we're from and where we're going

Evolution by Natural Selection



AP Biology

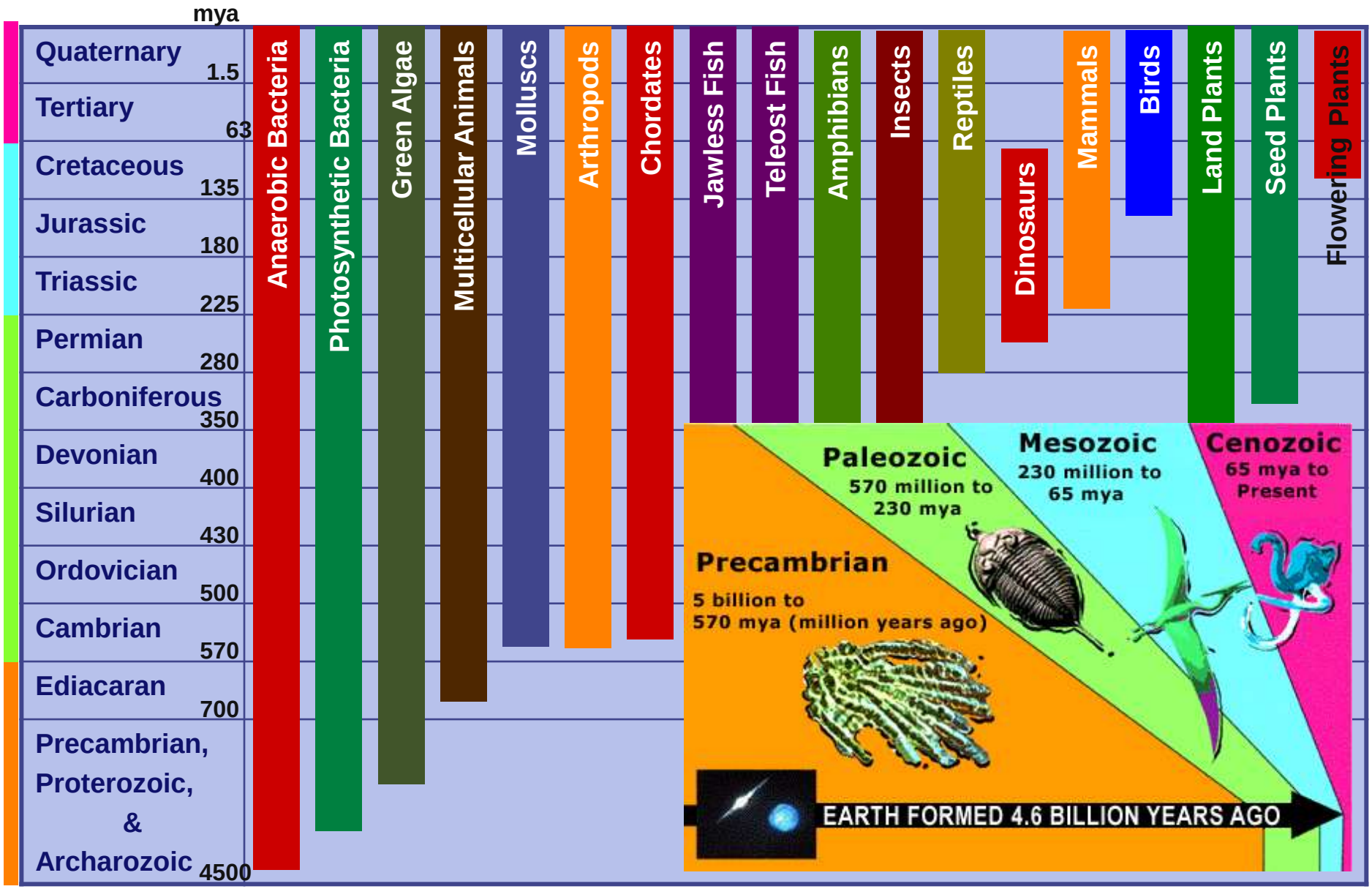
AP Bio

DOCTRINE

The Creation of the Animals 1550

But the Fossil record…

OBSERVATION



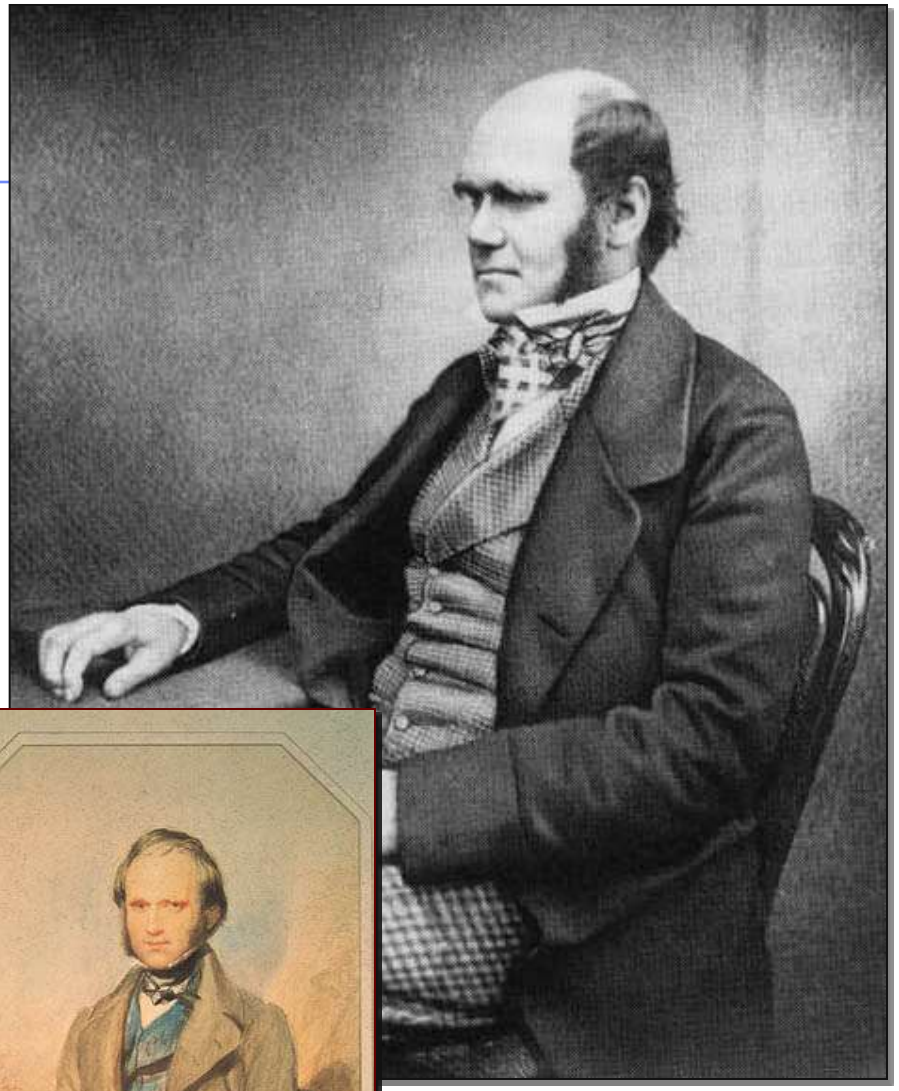
Life's Natural History is a record of Successions & Extinctions

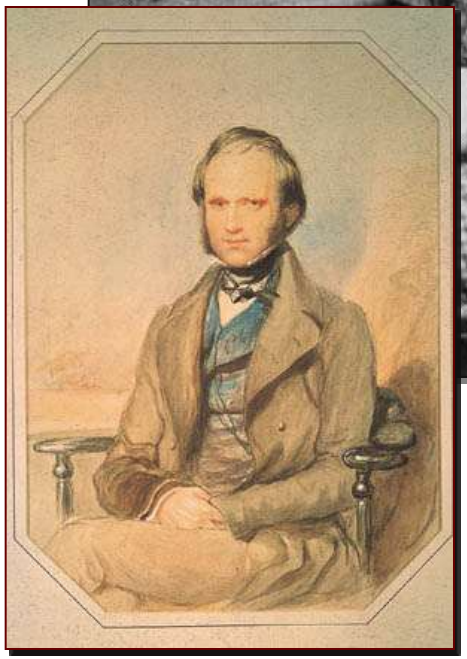
LaMarck

- Organisms adapted to their environments by acquiring traits
  - change in their life time
    - **Disuse**
      organisms lost parts because they did not use them — like the missing eyes & digestive system of the tapeworm
    - **Perfection with Use & Need**
      the constant use of an organ leads that organ to increase in size — like the muscles of a blacksmith or the large ears of a night-flying bat
  - transmit acquired characteristics to next generation

Charles Darwin

- 1809-1882
- British naturalist
- Proposed the idea of evolution by natural selection
- Collected clear evidence to support his ideas

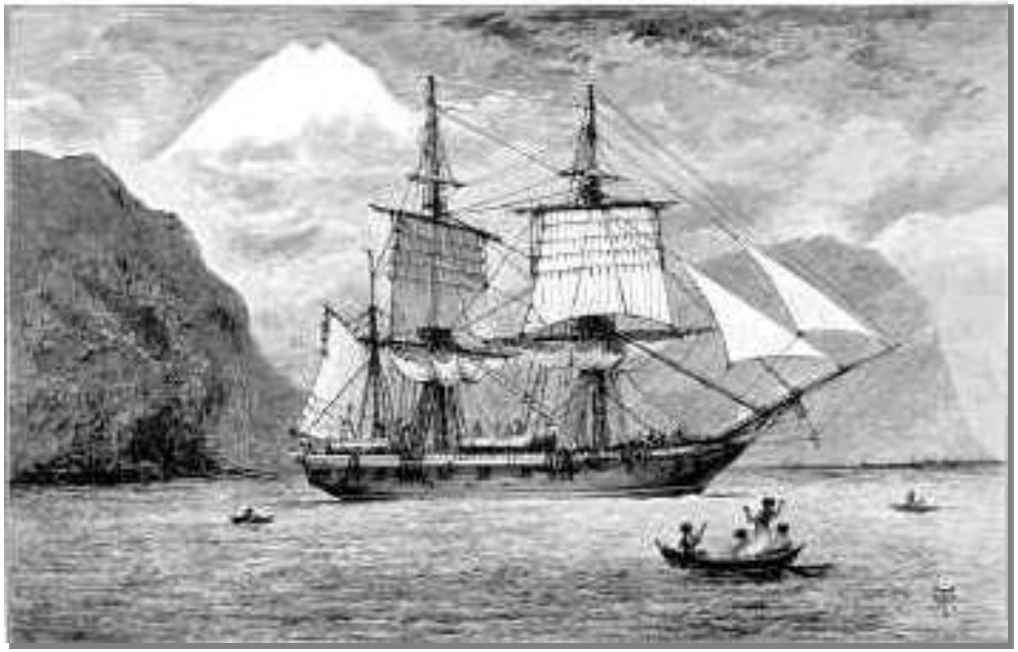




Voyage of the HMS Beagle

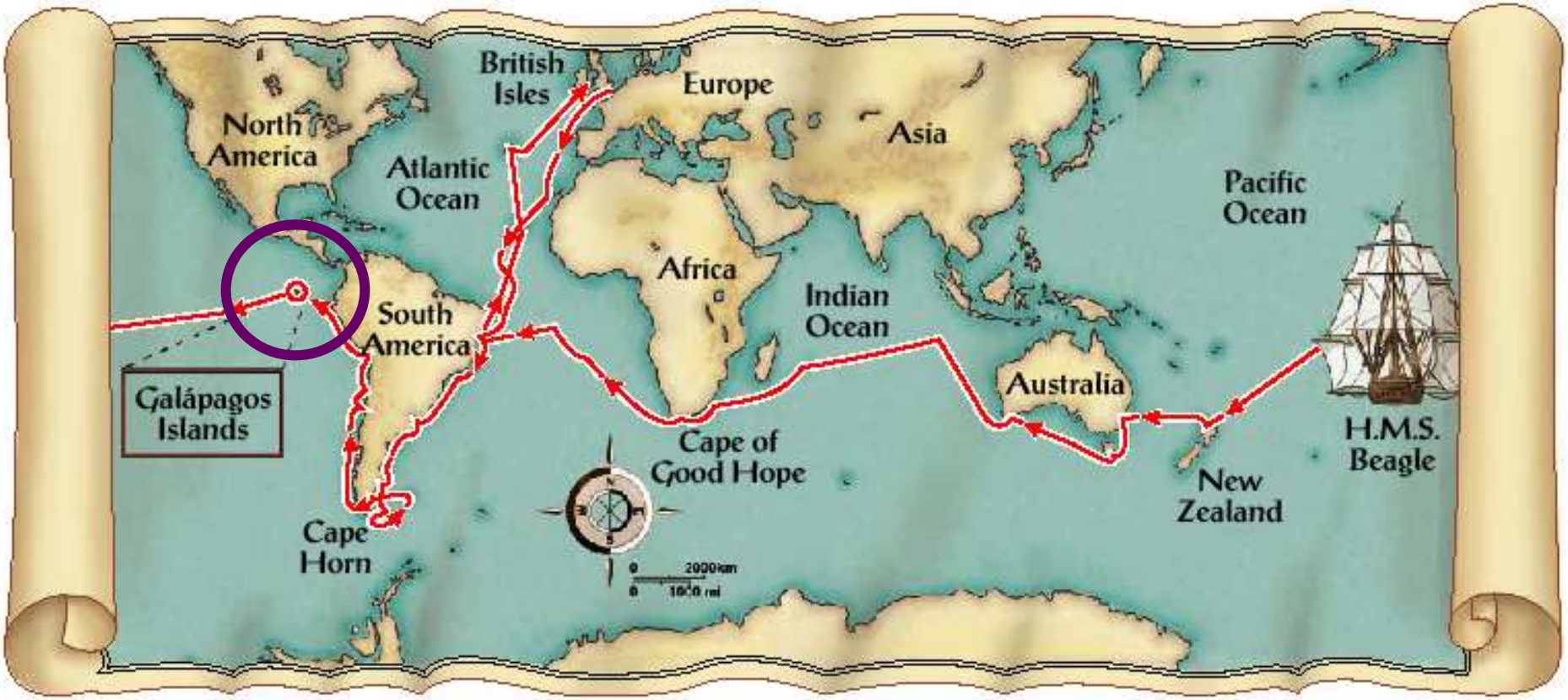
- Invited to travel around the world
  - 1831-1836 (22 years old!)
  - makes many observations of nature
    - main mission of the *Beagle* was to chart South American coastline

Robert Fitzroy



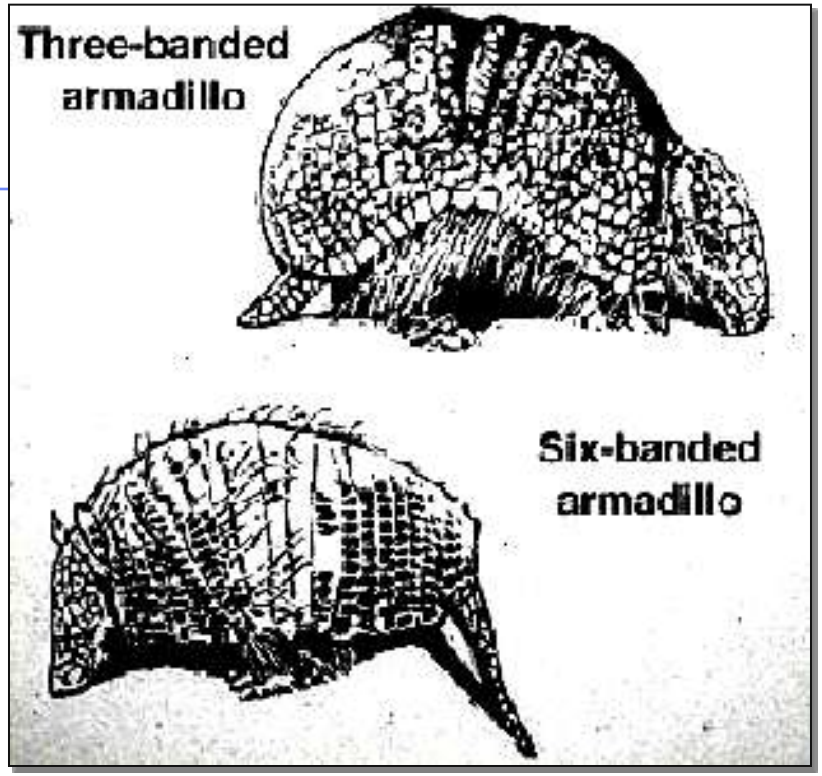
Voyage of the HMS Beagle

- **Stopped in Galapagos Islands**
  - **500 miles off coast of Ecuador**



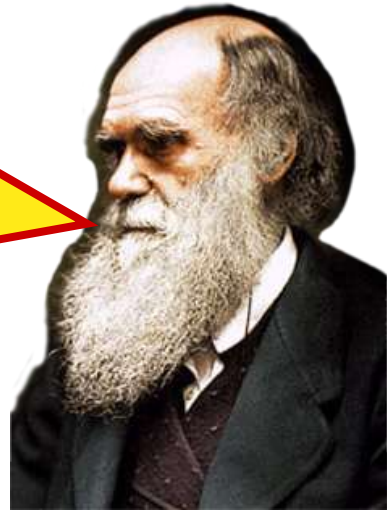
Succession of types

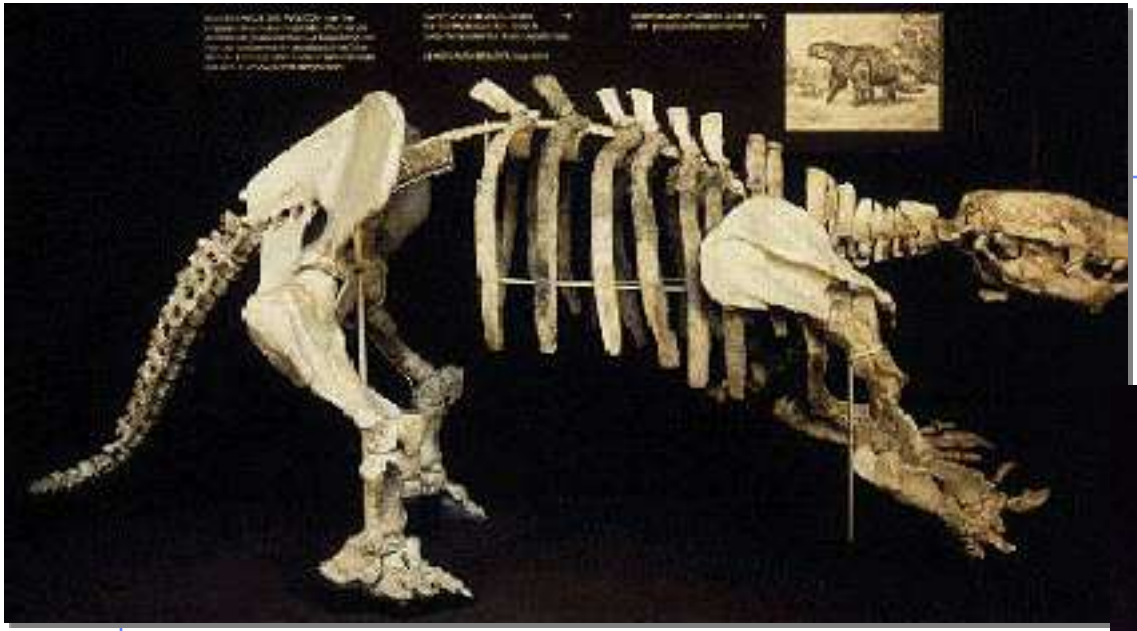
Armadillos are native to the Americas, with most species found in South America.



Glyptodont fossils are also unique to South America.

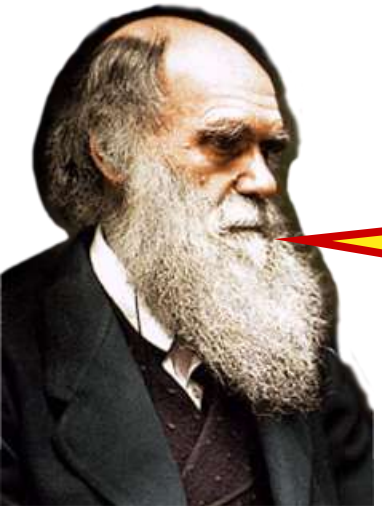
Why should extinct armadillo-like species & living armadillos be found on the same continent?





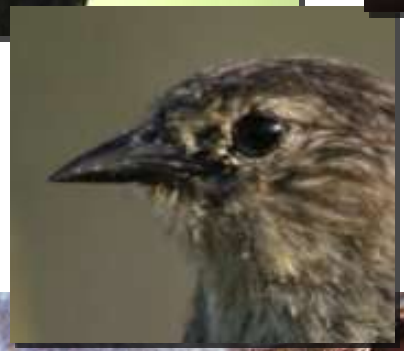
Mylodon *(left)* **Giant ground sloth** *(extinct)*

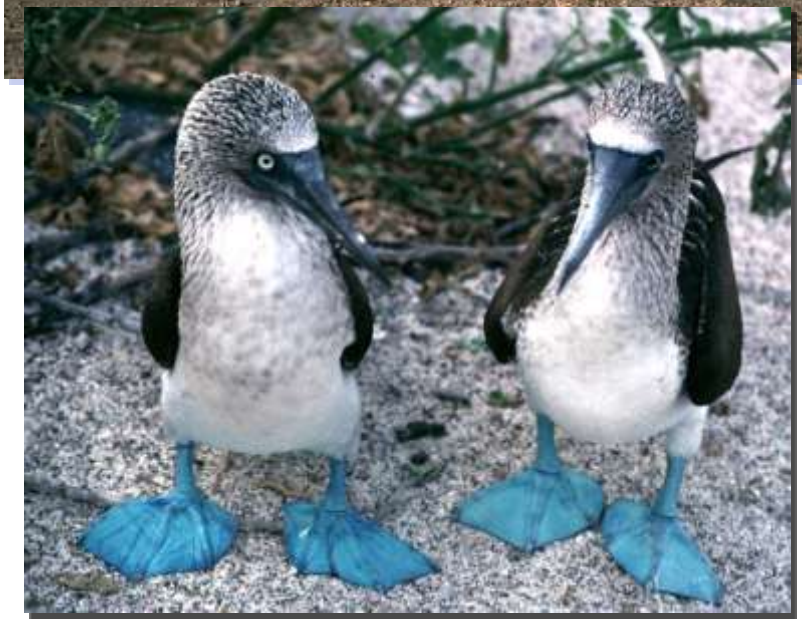
Modern sloth *(right)*

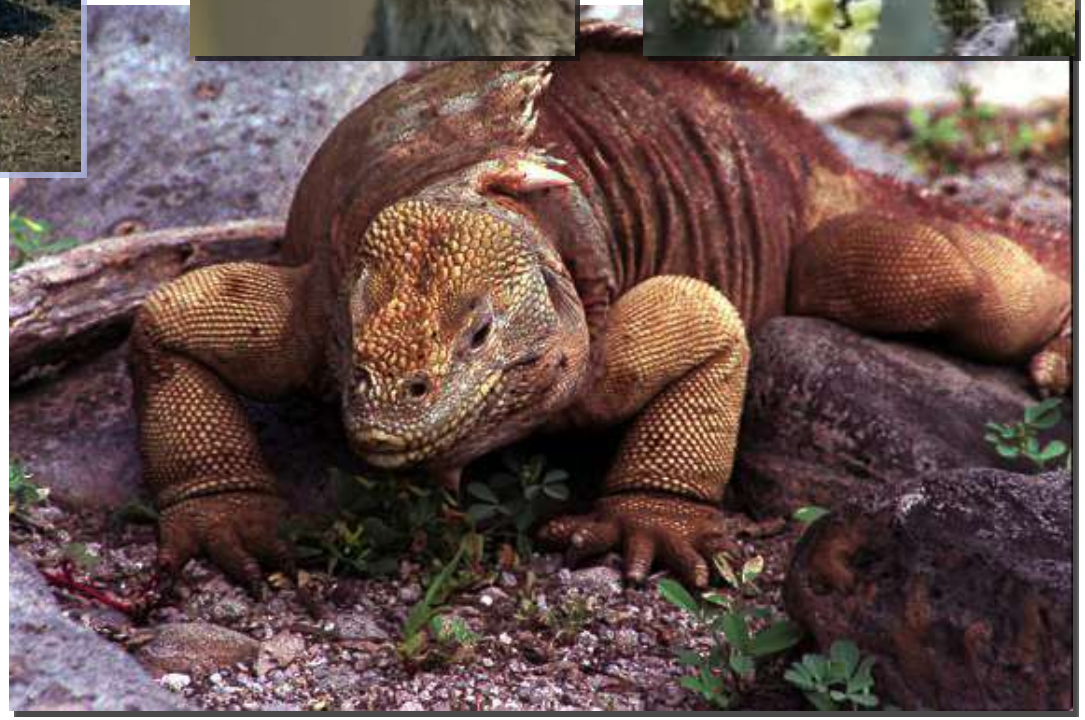


"This wonderful relationship in the same continent between the dead and the living will…throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts."

Unique species



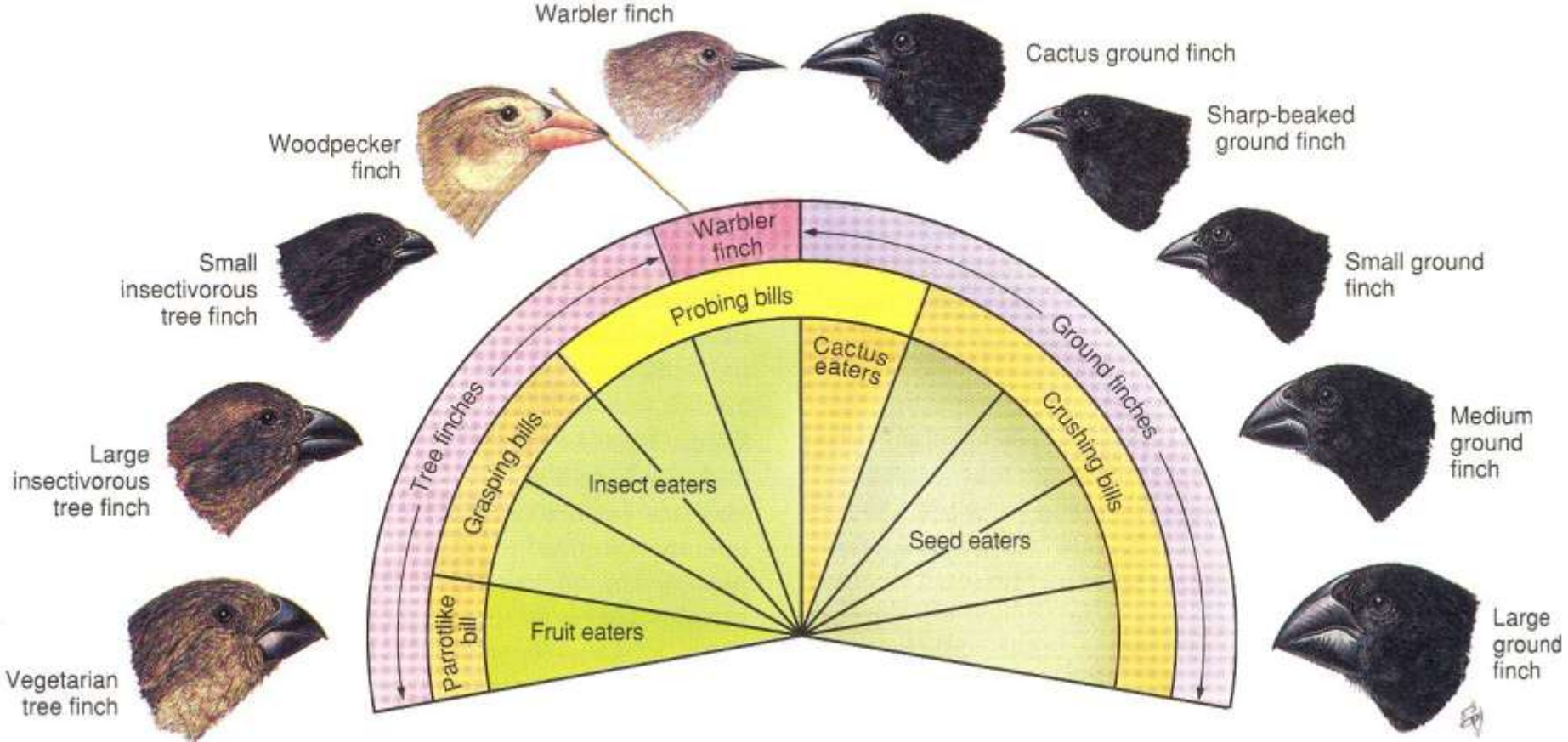




Darwin found… birds

Collected many different birds on the Galapagos Islands.

Thought he found very different kinds…



But Darwin found… a lot of *finches*

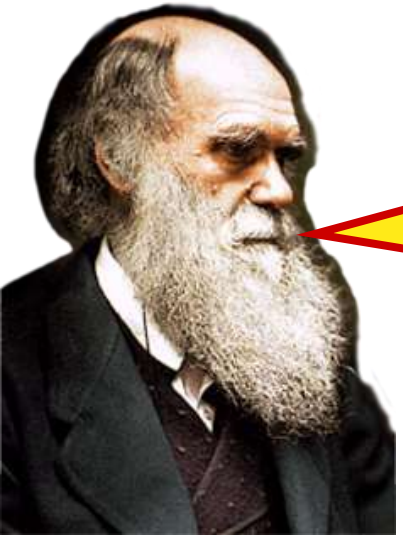
Darwin was amazed to find out:

***All* 14 species of birds were finches…**

***But* there is only *one* species of finch on the mainland!**

Large Ground Finch

Small Ground Finch



How did one species of finches become so many different species now?

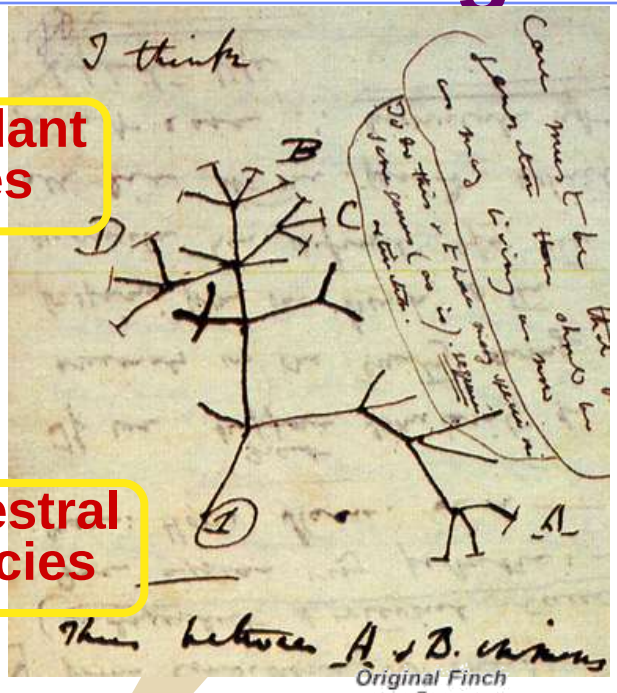
Warbler Finch

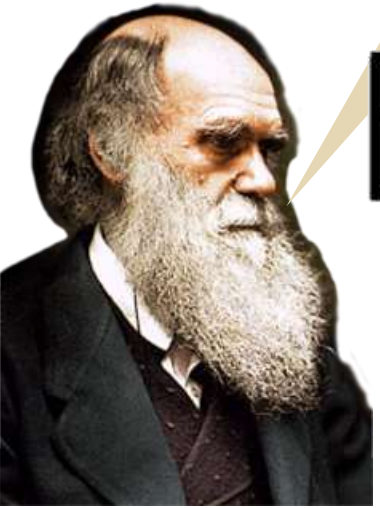
Veg. Tree Finch

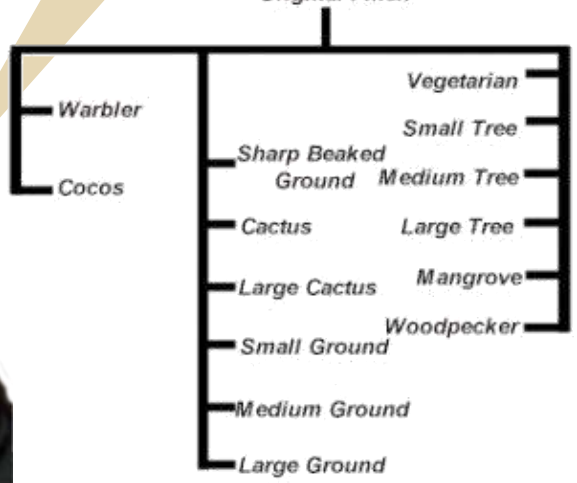
Tree Thinking

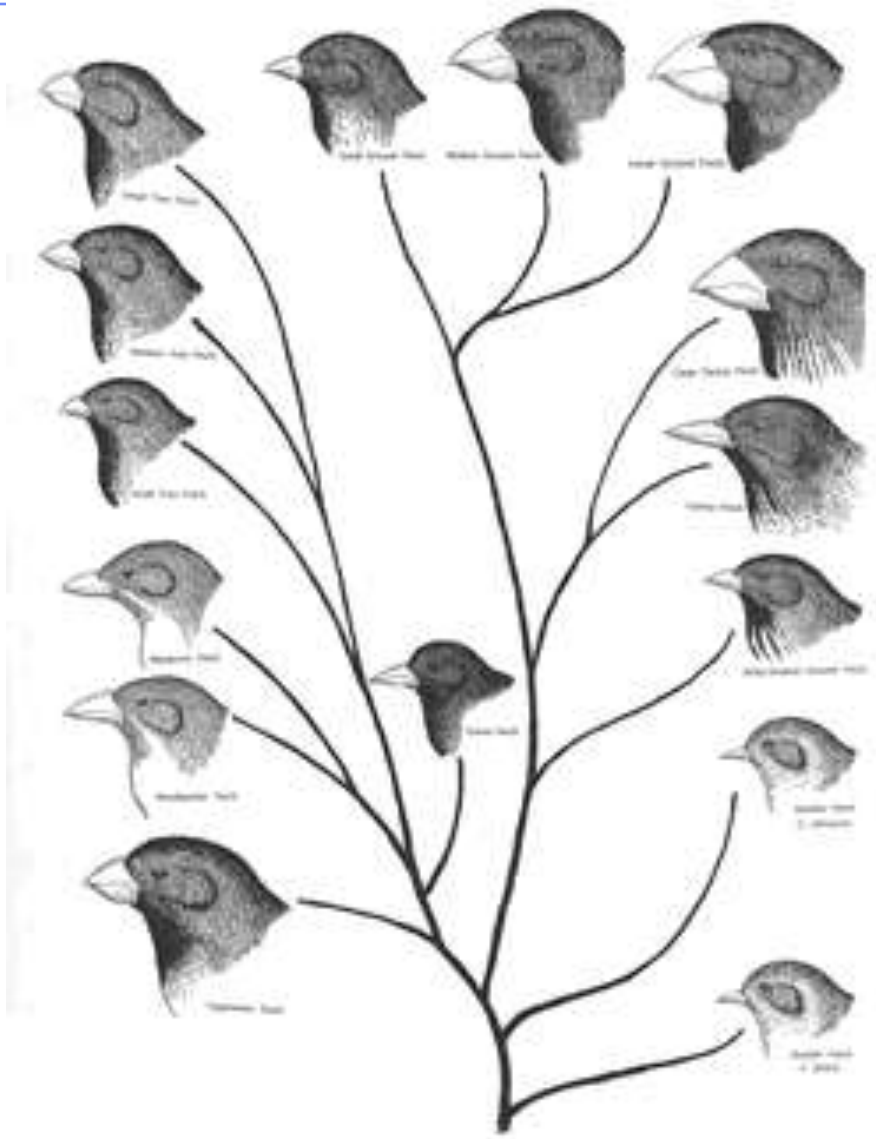
Descendant species

Ancestral species

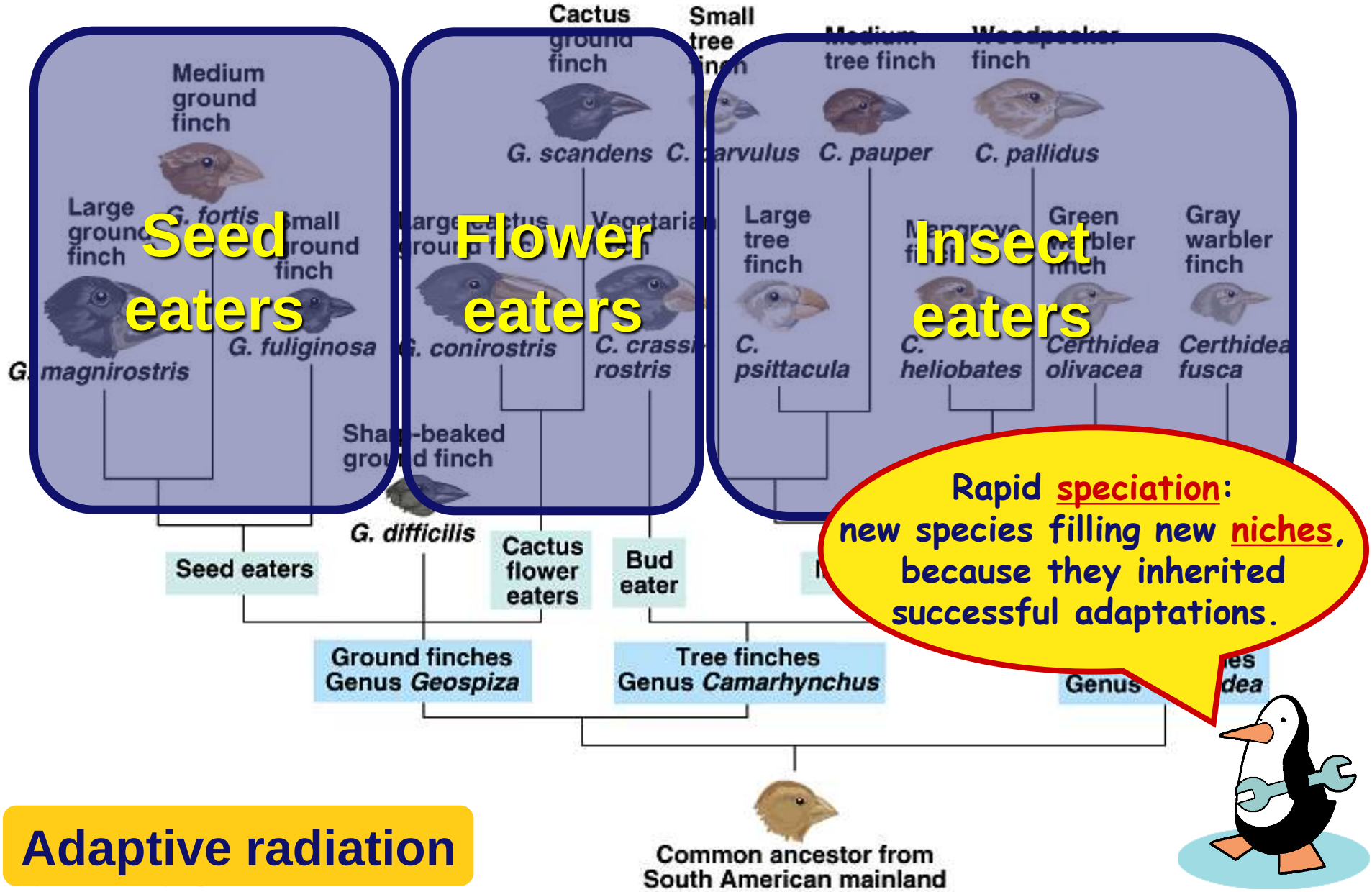








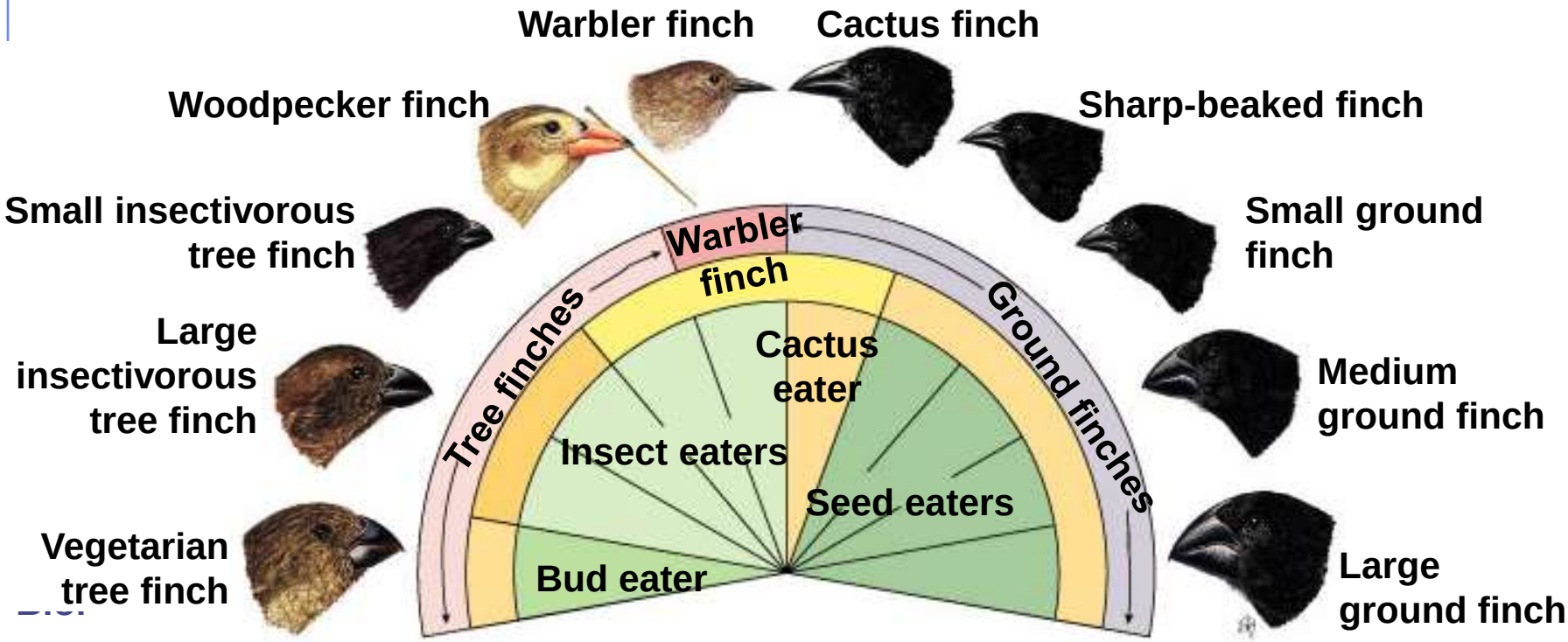
Correlation of species to food source



Adaptive radiation

Darwin's finches

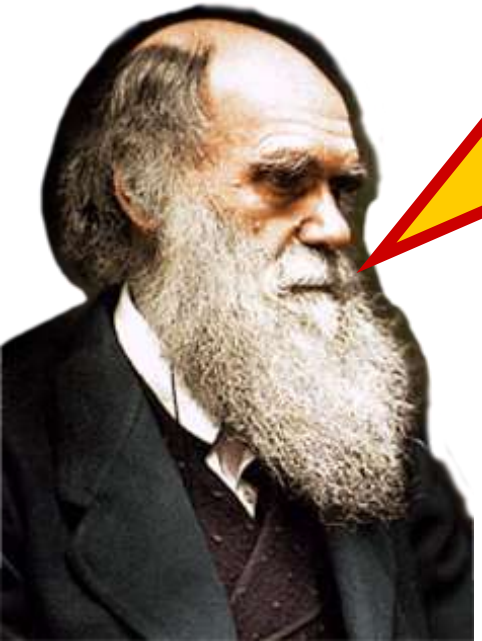
- **Differences in beaks**
  - associated with eating different foods
  - survival & reproduction of beneficial adaptations to foods available on islands

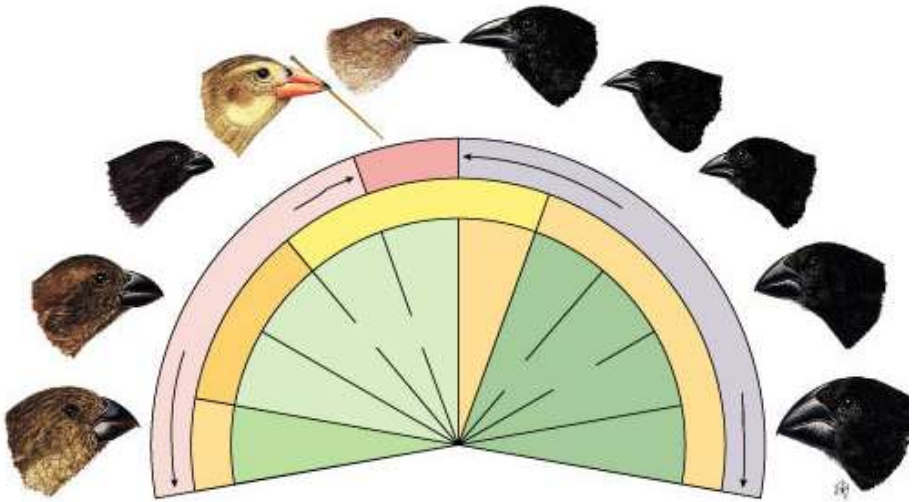


Darwin's finches

- **Darwin's conclusions**
  - small populations of original South American finches landed on islands
    - variation in beaks enabled individuals to gather food successfully in the different environments
  - over many generations, the populations of finches changed anatomically & behaviorally
    - accumulation of advantageous traits in population
    - emergence of different species

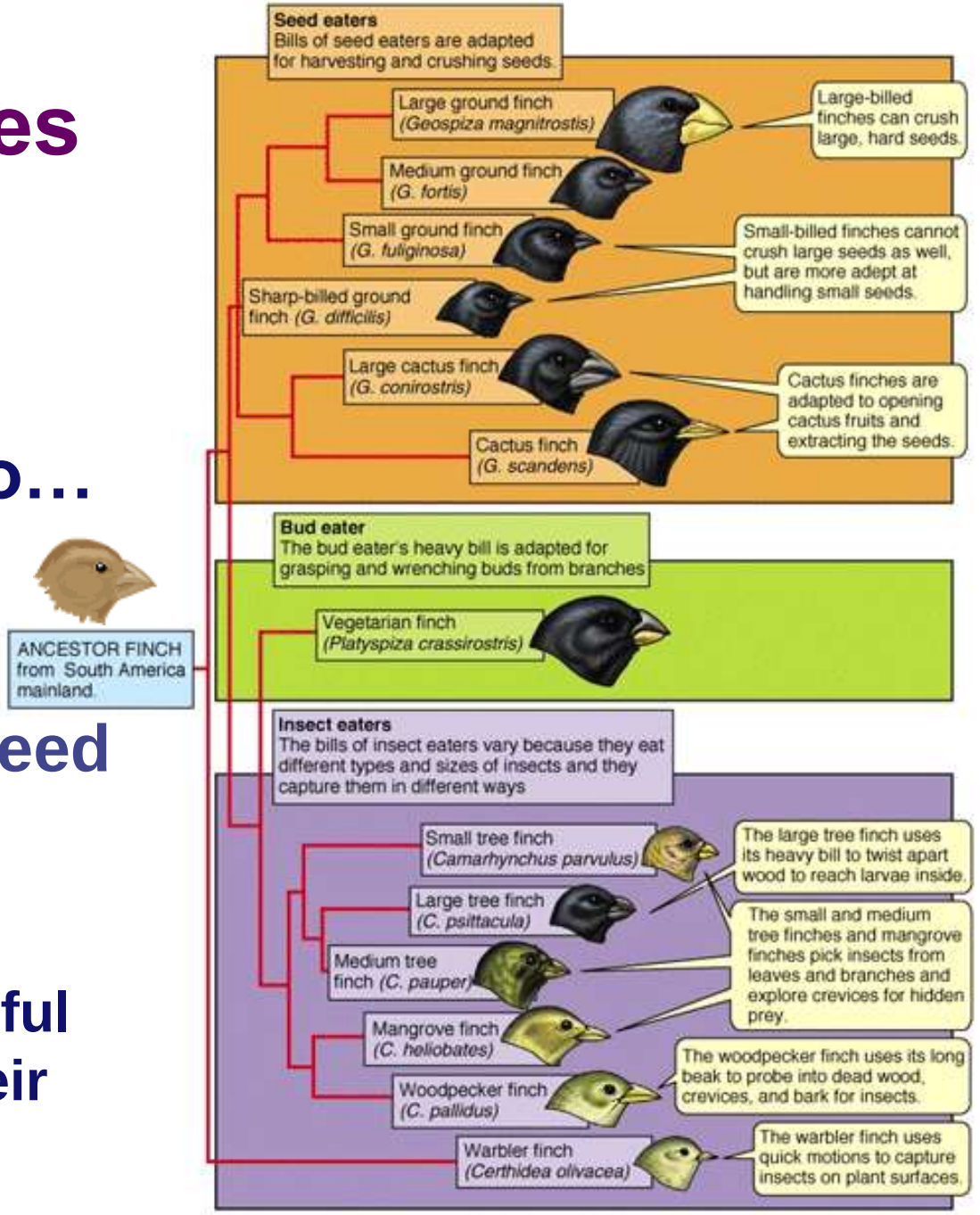
Seeing this gradation &
diversity of structure in
one small, intimately related group of birds,
one might really fancy that
from an original paucity of birds
in this archipelago,
one species has been taken &
modified for different ends.





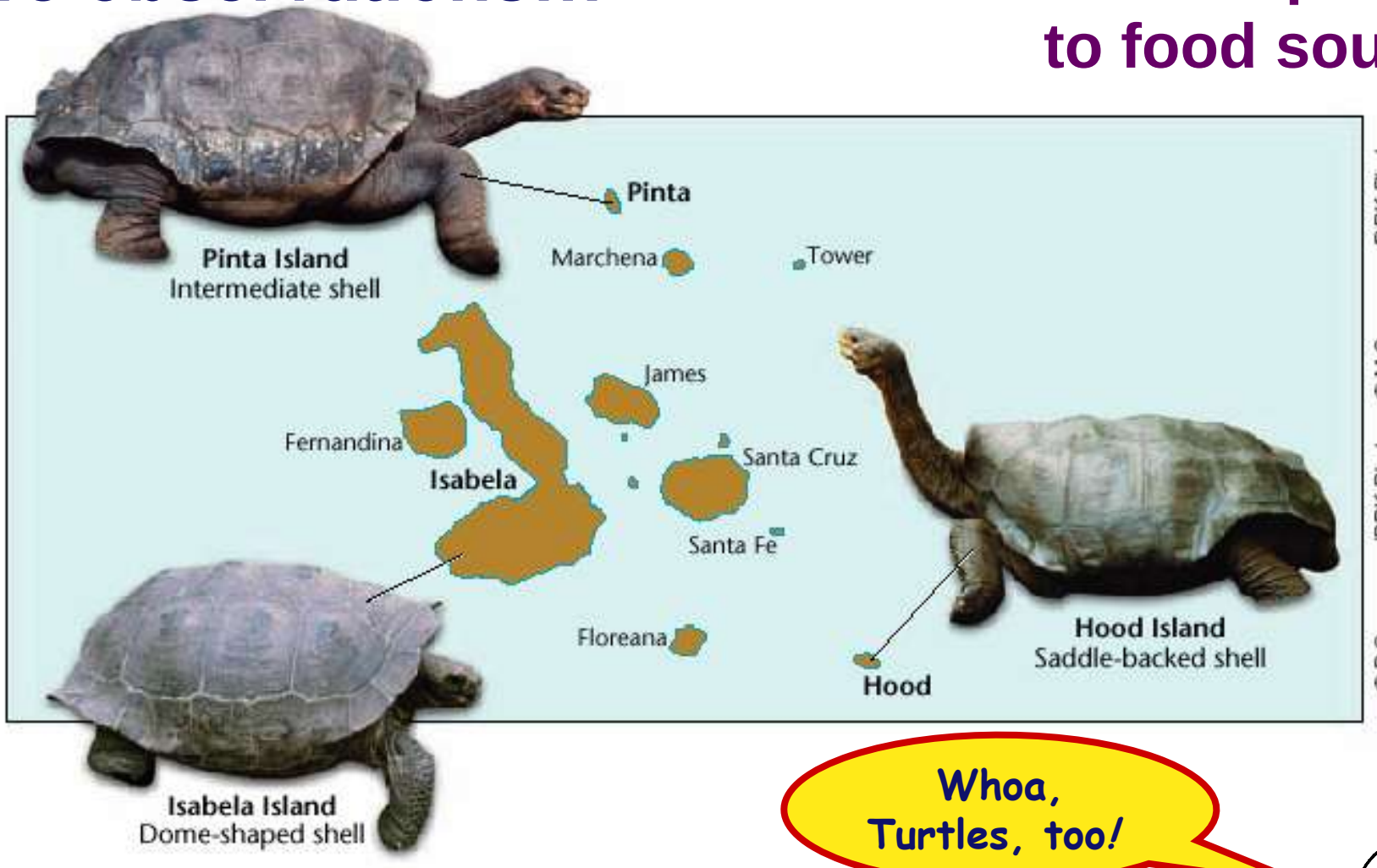
Darwin's finches

- Differences in beaks allowed some finches to…
  - successfully compete
  - successfully feed
  - successfully reproduce
    - pass successful traits onto their offspring



More observations…

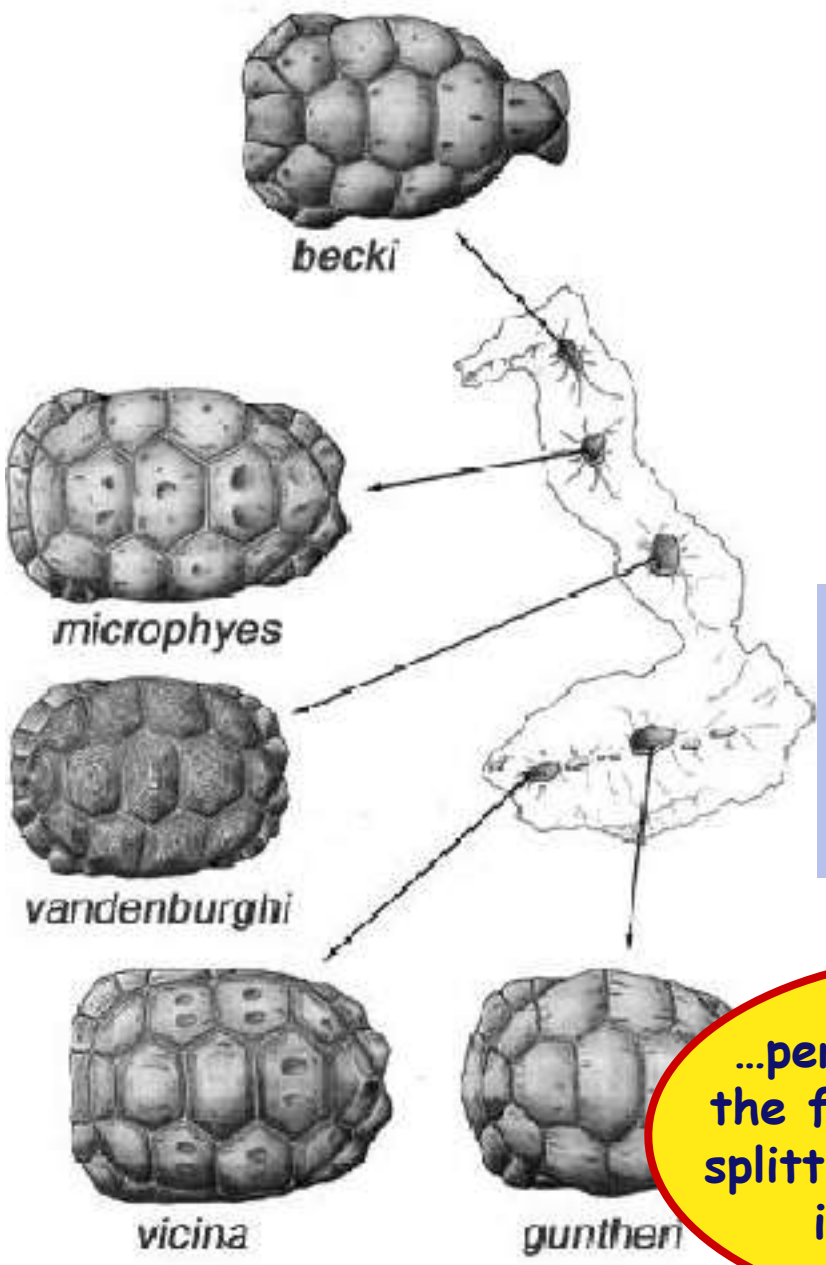
Correlation of species to food source



Whoa, Turtles, too!

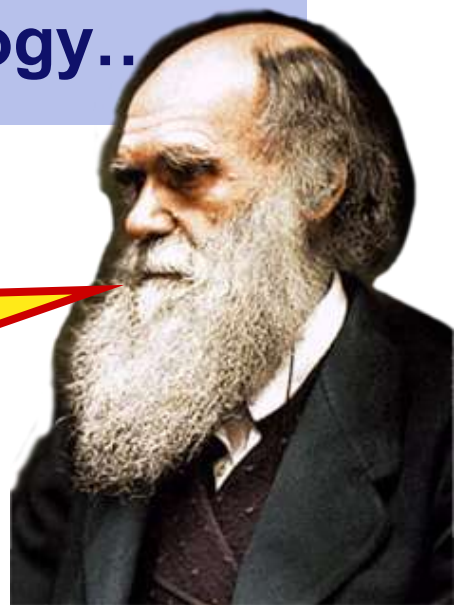
Variation Among Tortoises Darwin observed that the characteristics of many animals and plants varied noticeably among the different Galápagos Islands. Among the tortoises, the shape of the shell corresponds to different habitats. The Hood Island tortoise (right) has a long neck and a shell that is curved 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 close the ground. The tortoise from Pinta Island has a shell that is intermediate between these two forms.

AF

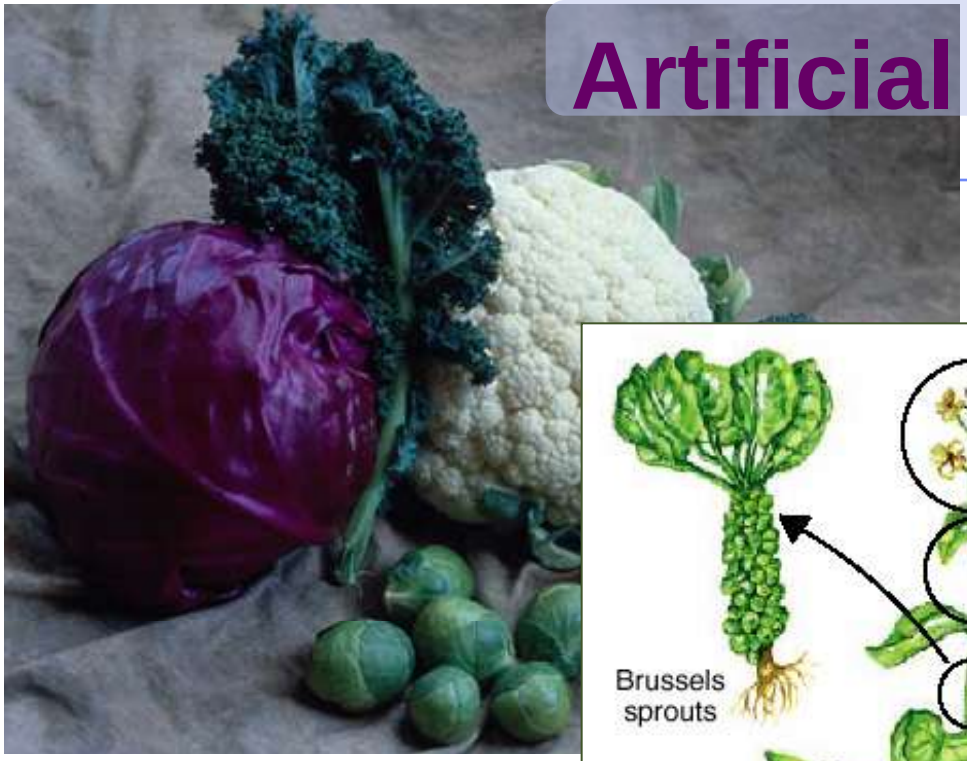


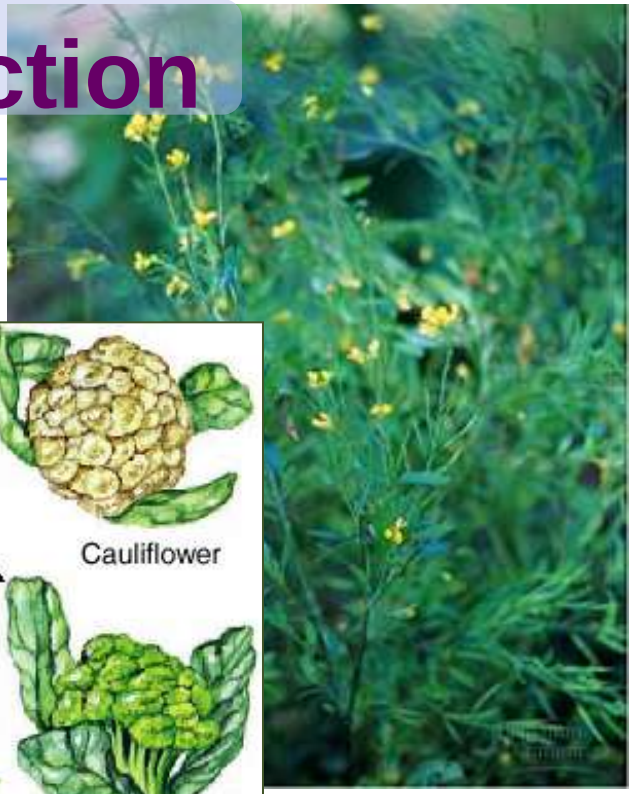
Many islands also show distinct *local* variations in tortoise morphology…

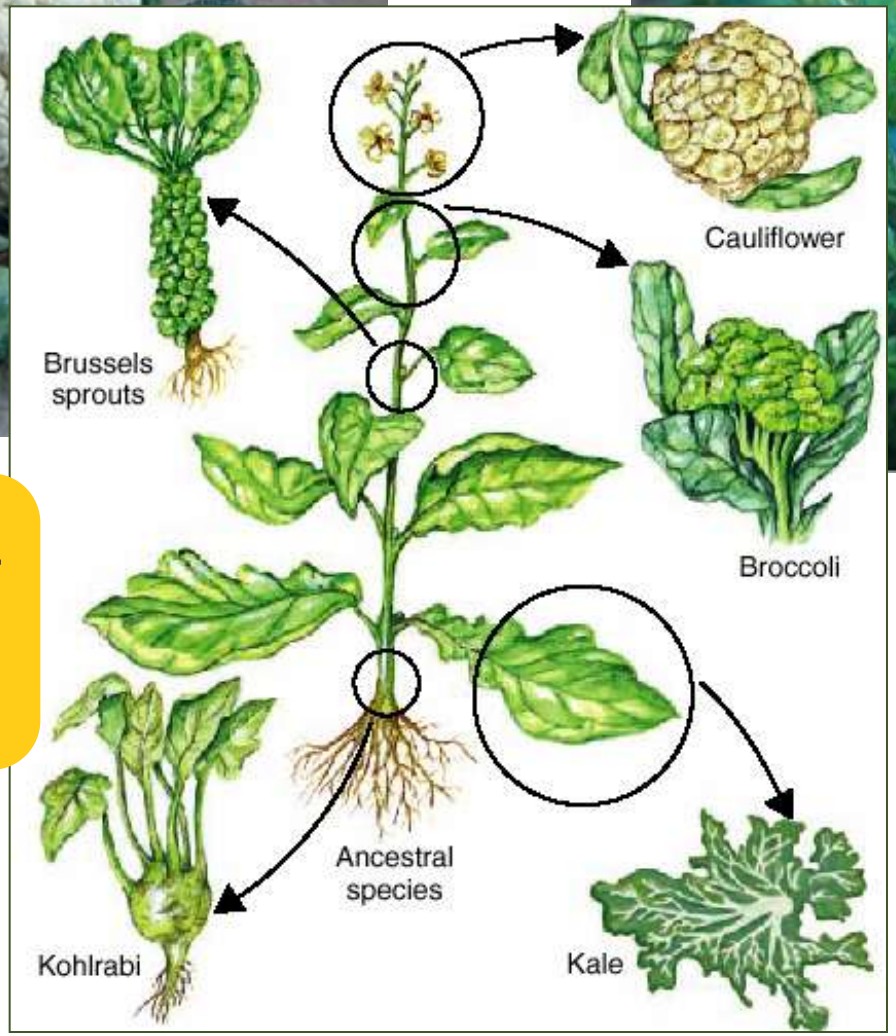
…perhaps these are the first steps in the splitting of one species into several?



Artificial selection





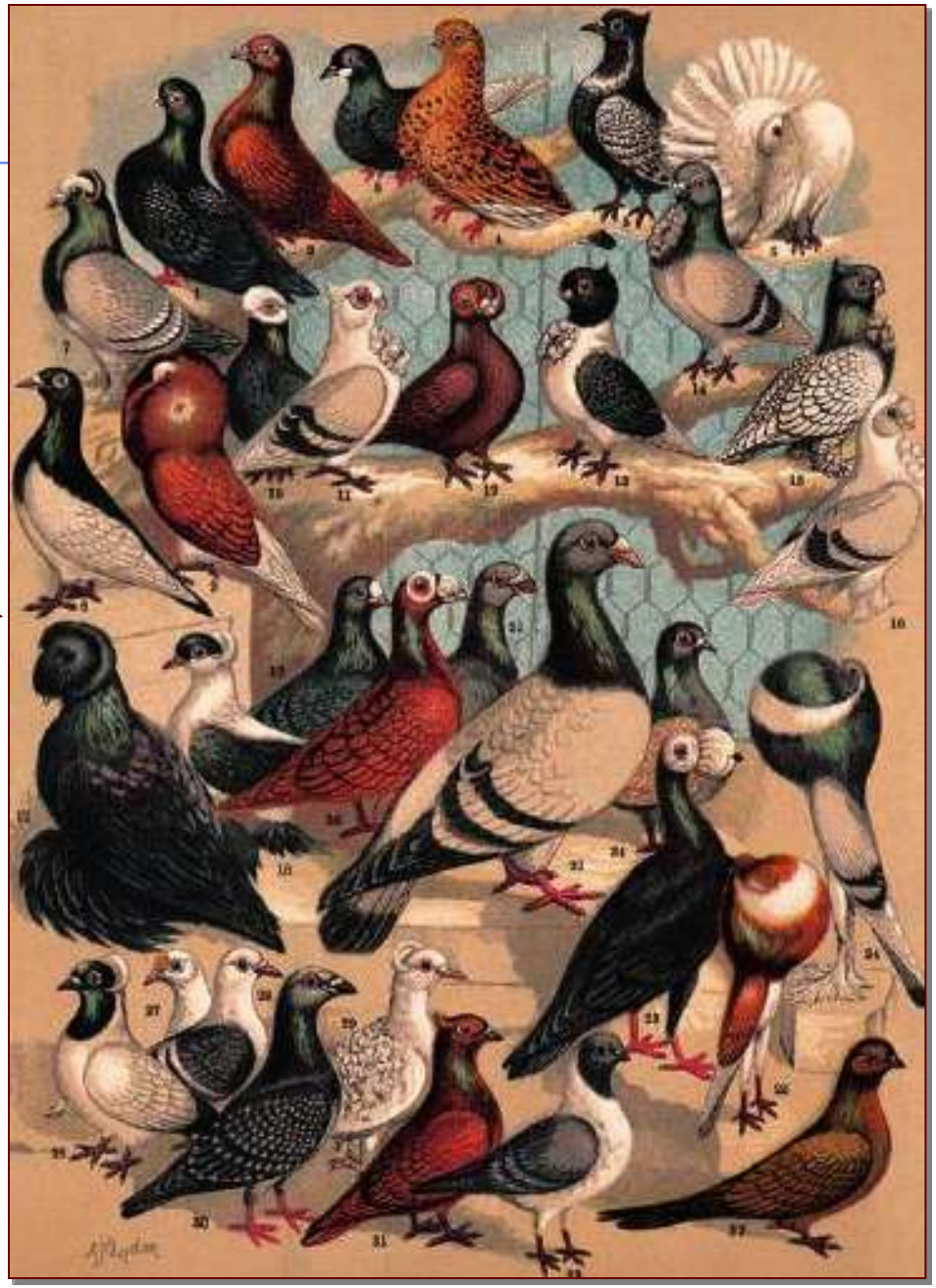


This is not just a process of the past…

It is all around us today

Selective breeding

the raw genetic material (variation) is hidden there

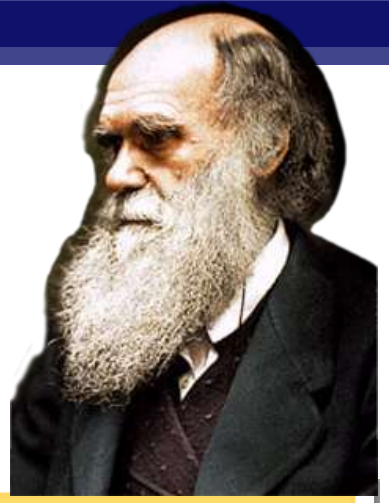


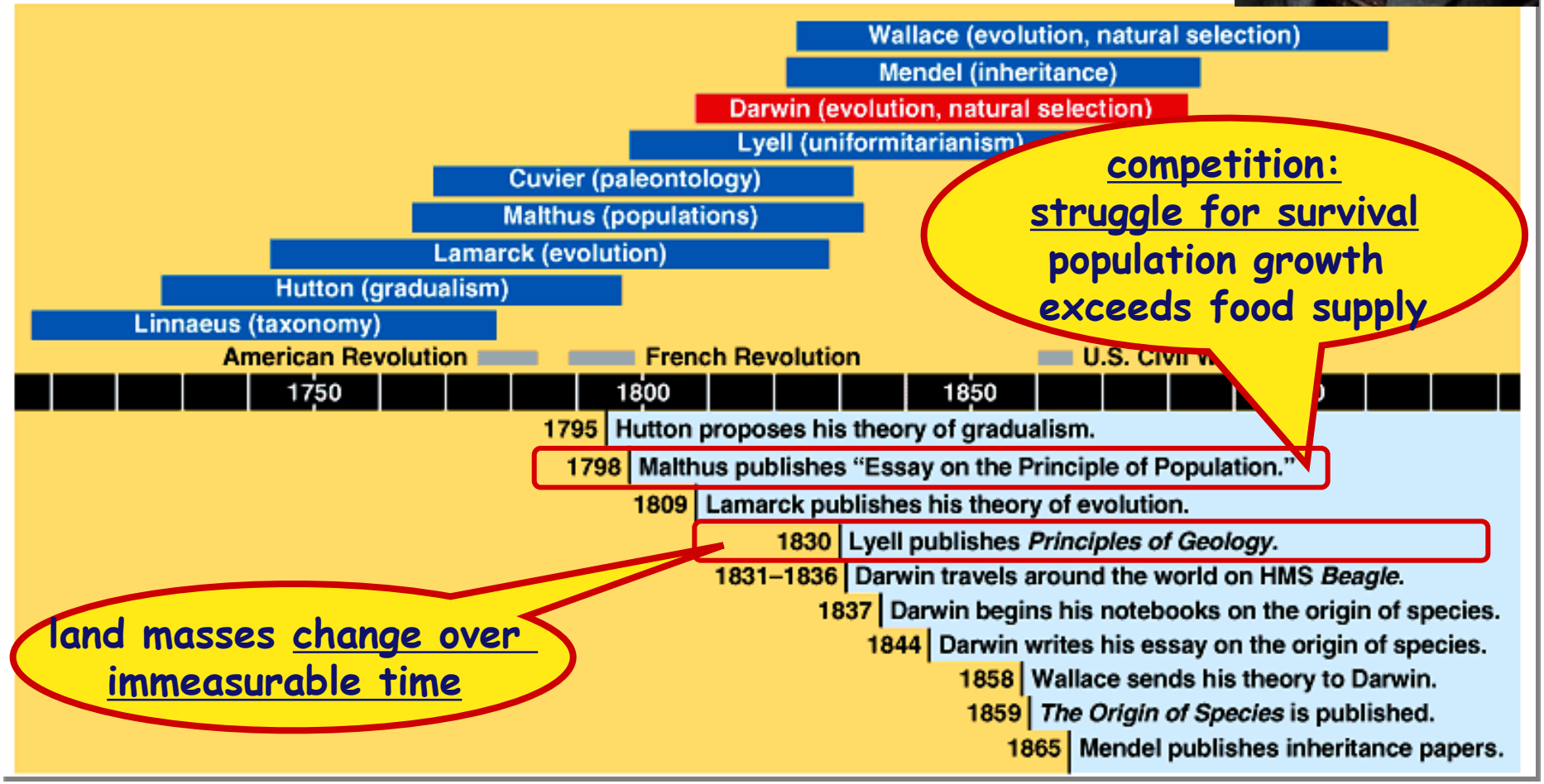
Selective breeding

Hidden variation can be exposed through selection*!*

In historical context

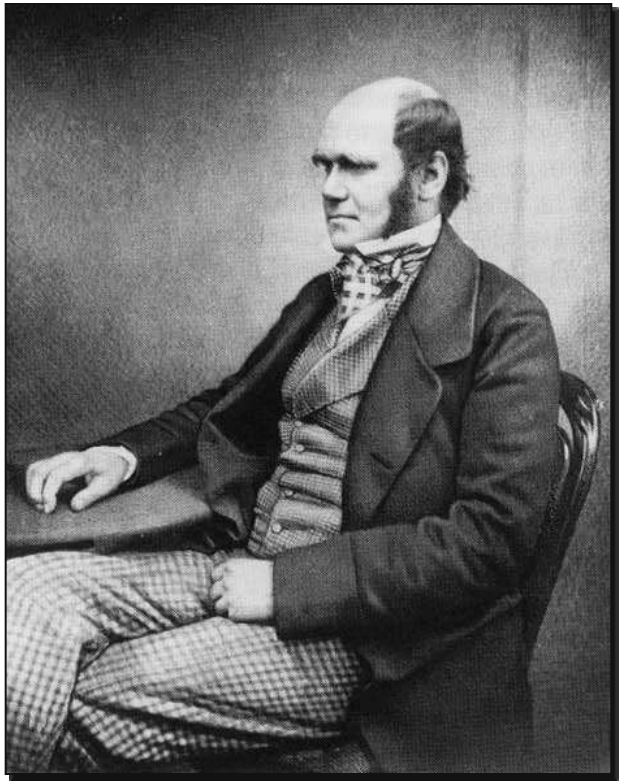
- Other people's ideas paved the path for Darwin's thinking





A Reluctant Revolutionary

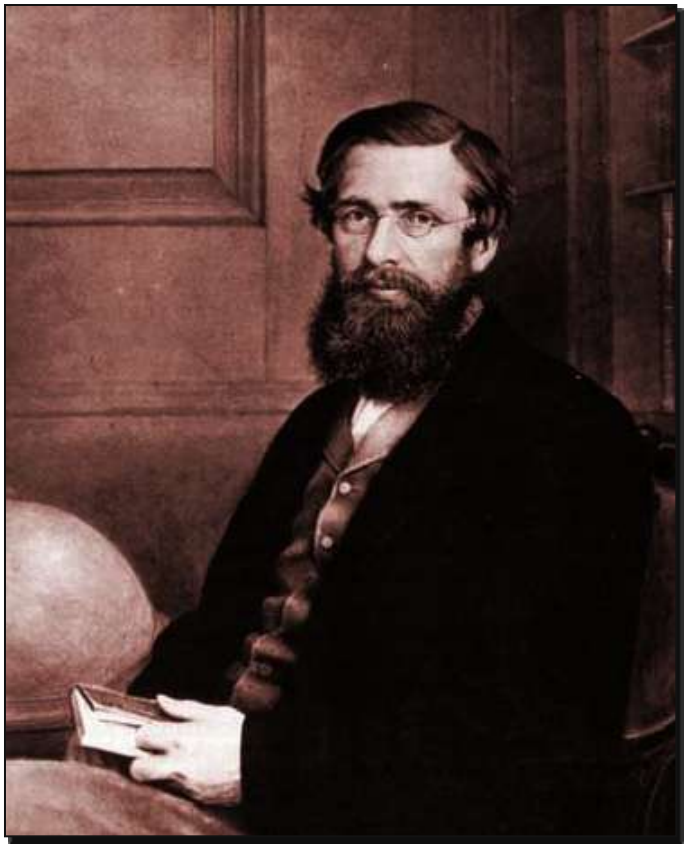
- **Returned to England in 1836**
  - **wrote papers describing his collections & observations**
  - **long treatise on barnacles**
  - **draft of his theory of species formation in 1844**
    - **instructed his wife to publish this essay upon his death**
    - **reluctant to publish but didn't want ideas to die with him**



And then came the letter….

Then, in 1858, Darwin received a letter that changed everything…

Alfred Russel Wallace
a young naturalist working in the East Indies, had written a short paper with a new idea. He asked Darwin to evaluate his ideas and pass it along for publication.



The time was ripe for the idea!

1858 ON THE TENDENCY OF VARIETIES TO DEPART INDEFINITELY FROM THE ORIGINAL TYPE

by Alfred Russel Wallace written at Ternate, February, 1858
Instability of Varieties supposed to prove the permanent distinctness of Species

ONE of the strongest arguments which have been adduced to prove the original and permanent distinctness of species is, that varieties produced in a state of domesticity are more or less unstable, and often have a tendency, if left to themselves, to return to the normal form of the parent species; and this instability is considered to be a distinctive peculiarity of all varieties, even of those occurring among wild animals in a state of nature, and to constitute a provi… originally created distinct species.

In the absence of scarcity of facts and observ… argument has had great weight with natur… prejudiced belief in the stability of spec… "permanent or true varieties,"- races … differ so slightly (although constan… of the other. Which is the variety … determining, except in those rar… unlike itself and resembling the … "permanent invariability of spe… have strict limits, and can neve… it, which, from the analogy of … certainly proved.

It will be observed that this argu… state of nature are in all respects a… are governed by the same laws as re… the present paper to show that this ass… nature which will cause many varieties t… variations departing further and further from … domesticated animals, the tendency of varieties t…

The Struggle for Existence.

ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

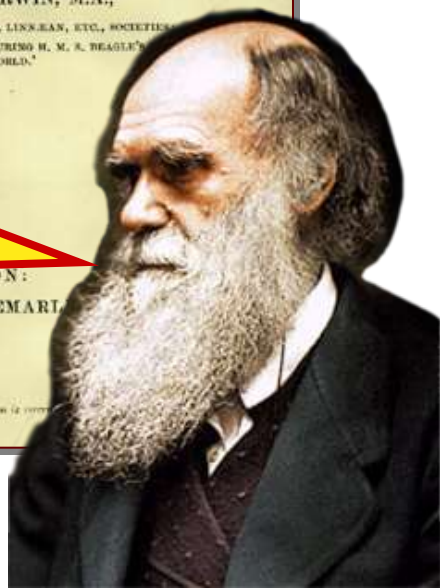
By CHARLES DARWIN, M.A.,

…LLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES; …OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S … ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARL…
1859.

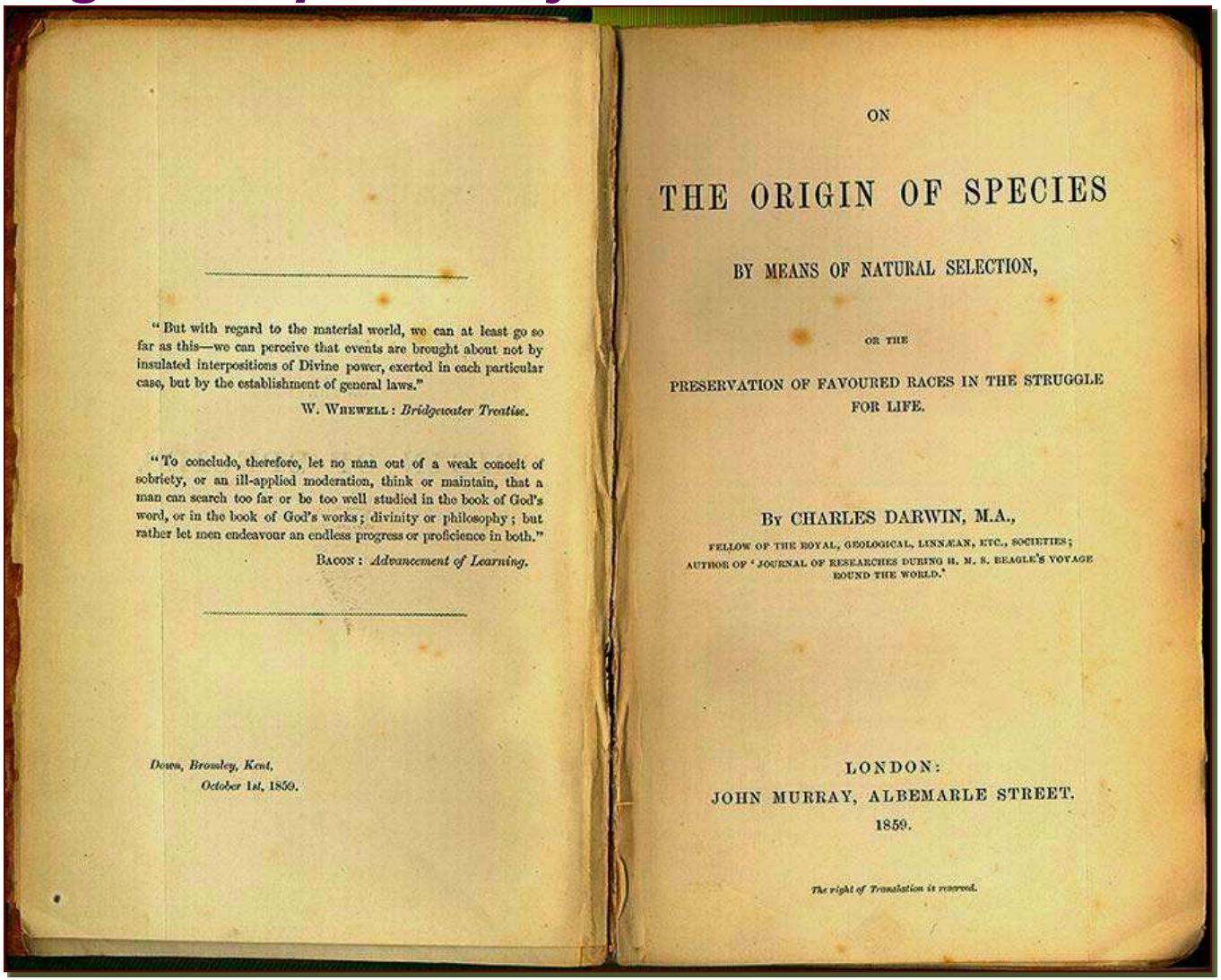
The right of Translation is …

To Lyell—
Your words have come true with a vengeance… I never saw a more striking coincidence…so all my originality, whatever it may amount to, will be smashed.



November 24, 1859, Darwin published

"On the Origin of Species by Means of Natural Selection"



"But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws."

W. Whewell: *Bridgewater Treatise.*

"To conclude, therefore, let no man out of a weak conceit of sobriety, or an ill-applied moderation, think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficience in both."

Bacon: *Advancement of Learning.*

Down, Bromley, Kent,
October 1st, 1859.

ON

THE ORIGIN OF SPECIES

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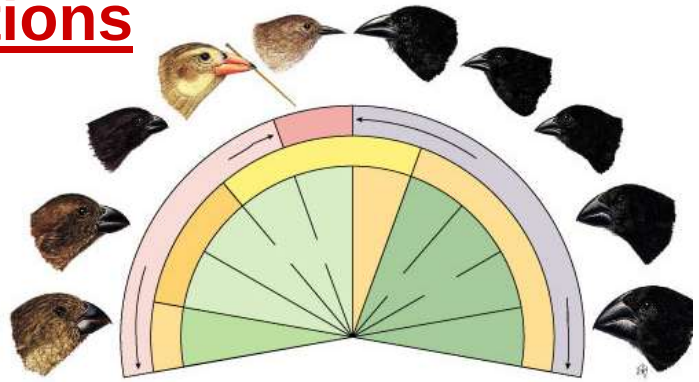
LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

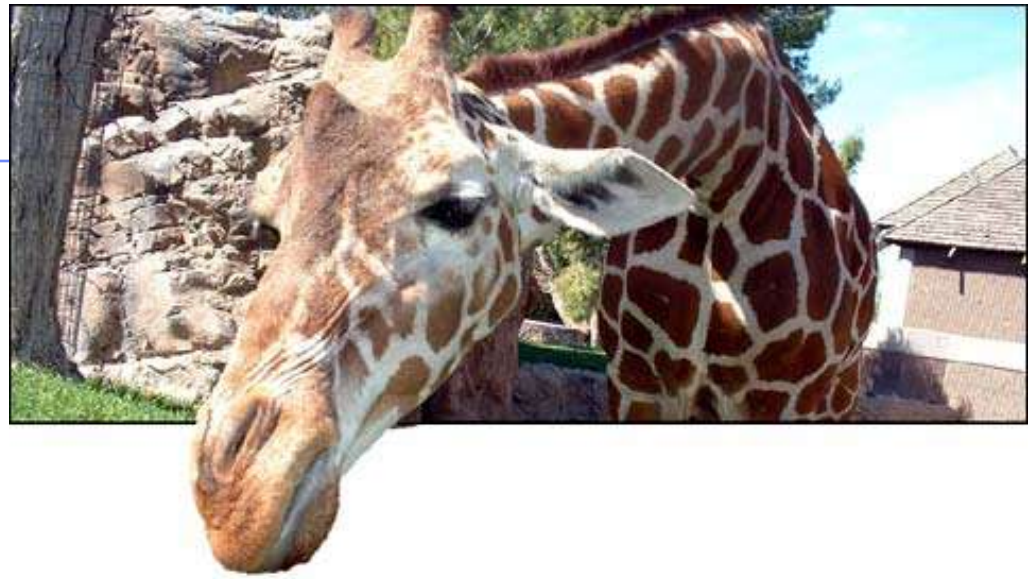
Essence of Darwin's ideas

- **Natural selection**
  - **variation** exists in populations
  - **over-production of offspring**
    - more offspring than the environment can support
  - **competition**
    - for food, mates, nesting sites, escape predators
  - **differential survival**
    - successful traits = **adaptations**
  - **differential reproduction**
    - adaptations become more common in population



LaMarckian vs. Darwinian view

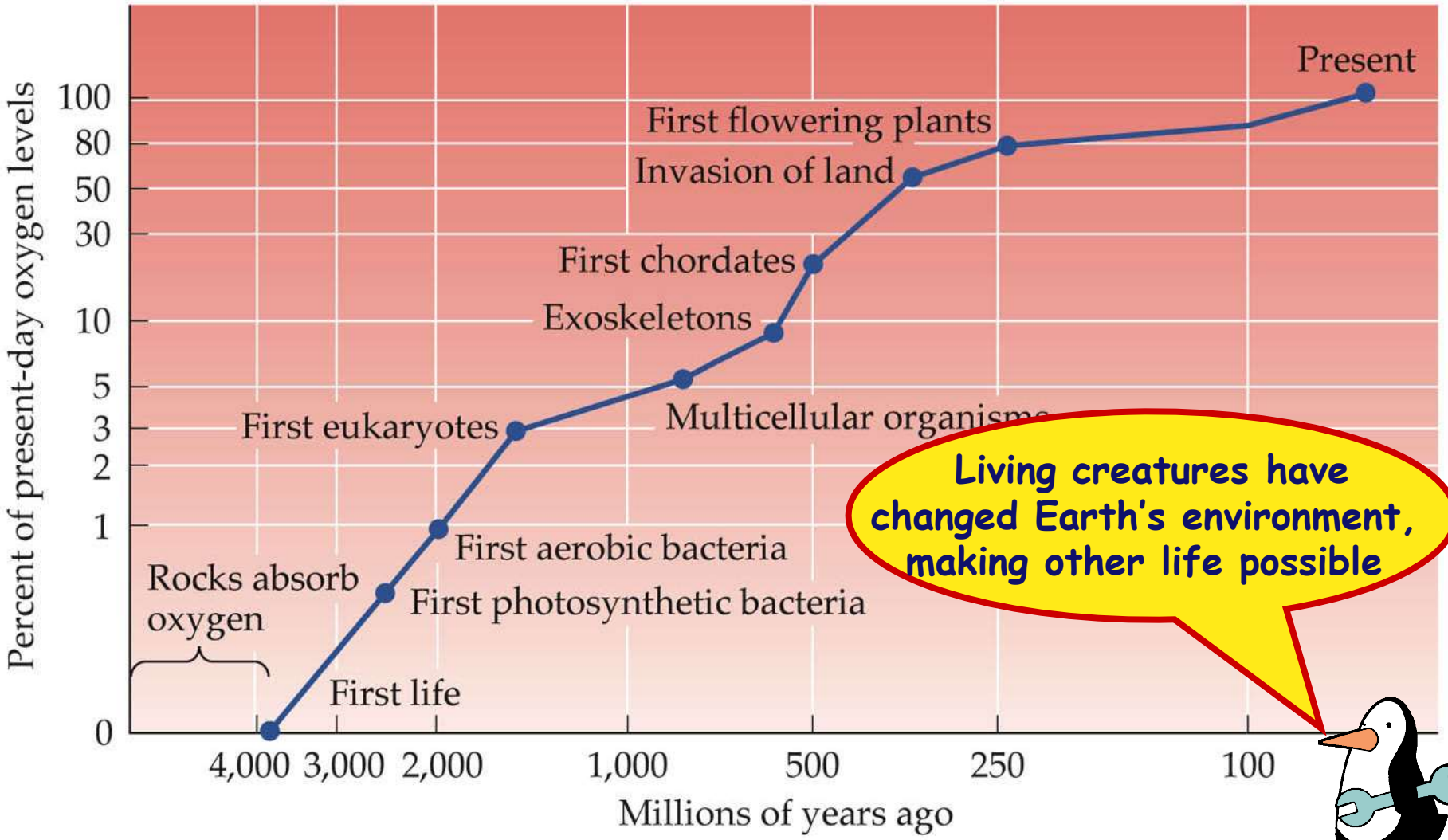
- LaMarck
  - in reaching higher vegetation giraffes stretch their necks & transmits the acquired longer neck to offspring
- Darwin
  - giraffes born with longer necks survive better & leave more offspring who inherit their long necks



Stick your neck out…
Ask Questions!

Slide & Image Storage

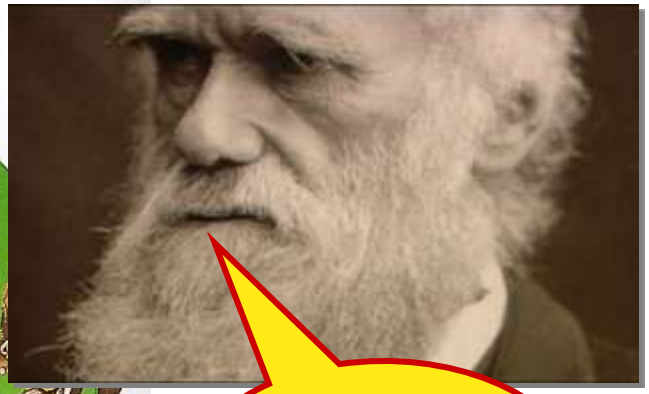
Life has changed over time & in turn has changed the Earth



Evolution as Change Over Time

Evolution!

idea accepted before Darwin



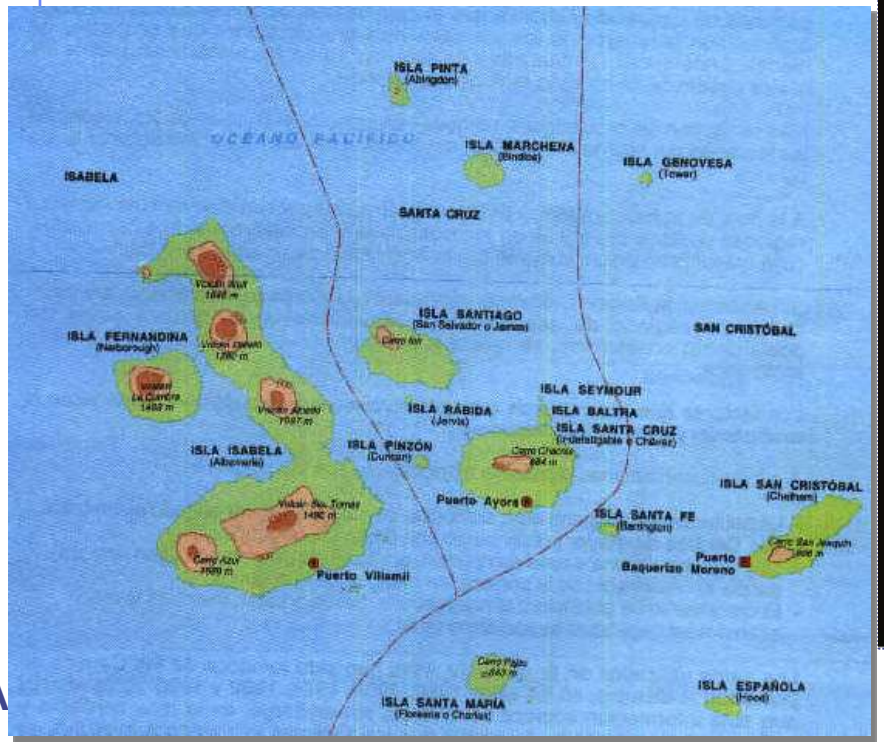
Evolution!

Evolution!

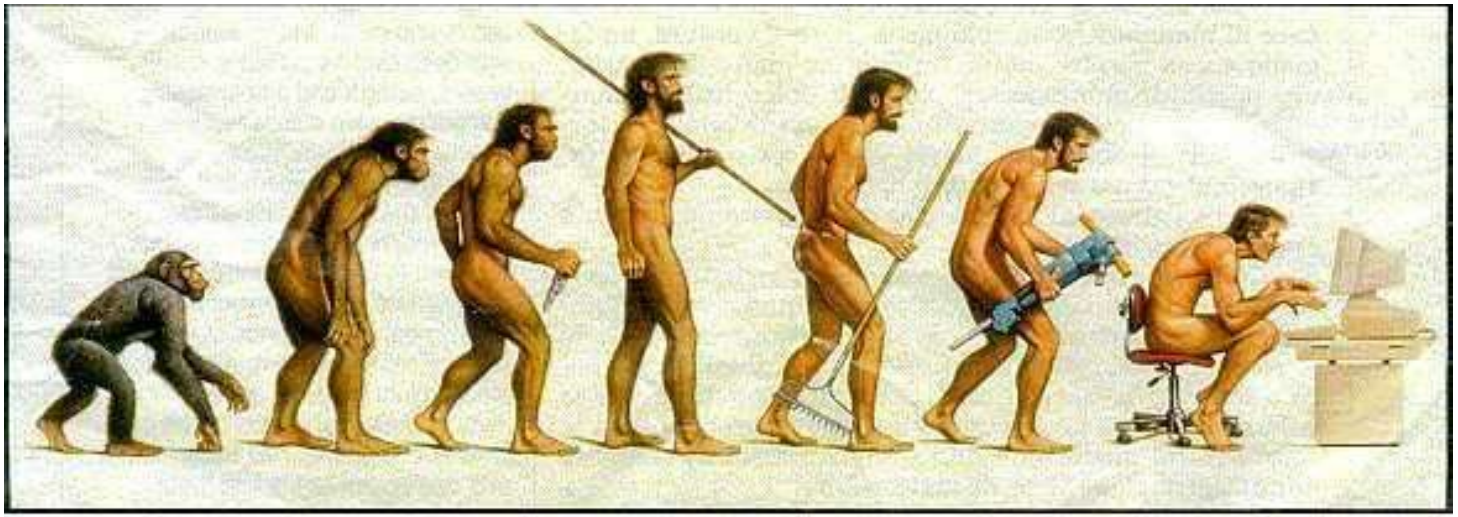
Evolution!

Galapagos

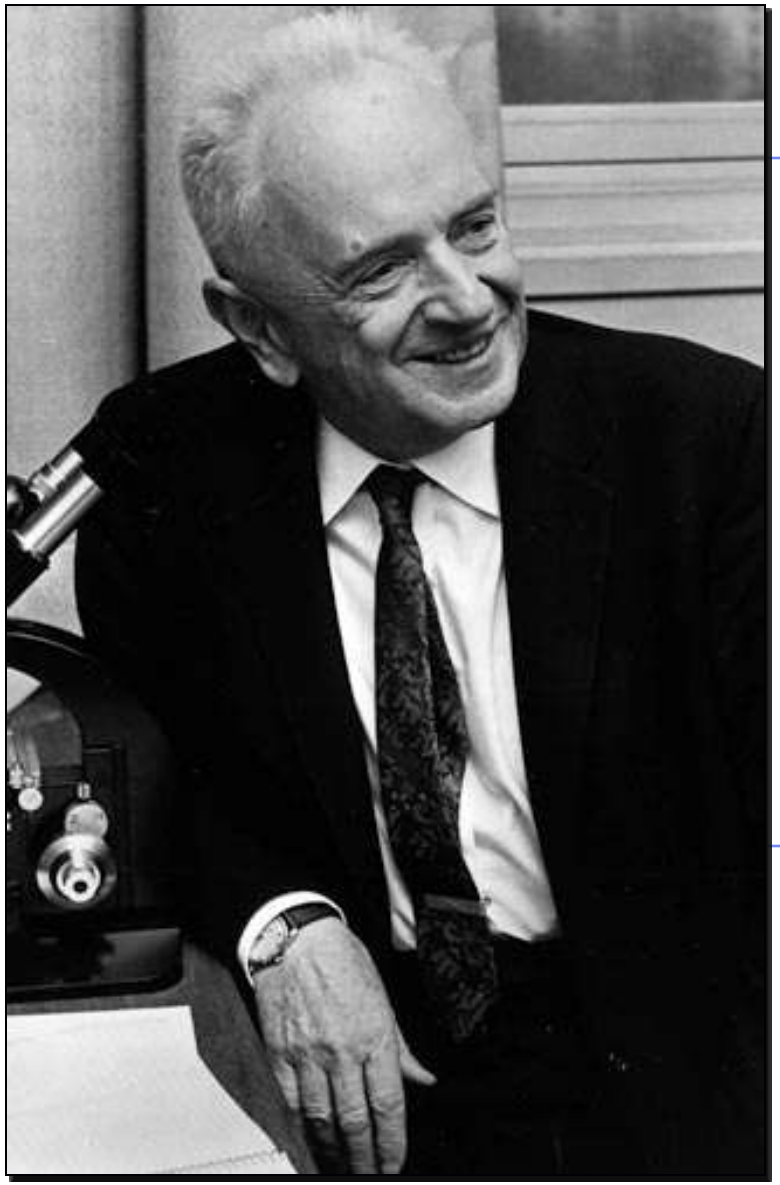
Recent volcanic origin most of animal species on the Galápagos live nowhere else in world, but <u>they resemble species living on South American mainland</u>.

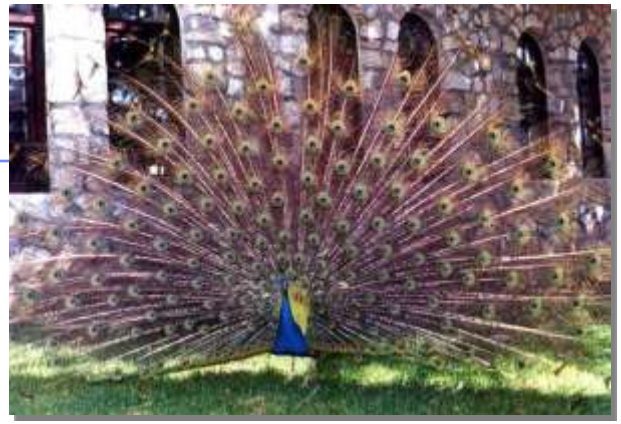


500 miles west of mainland



Coherent explanation of observations

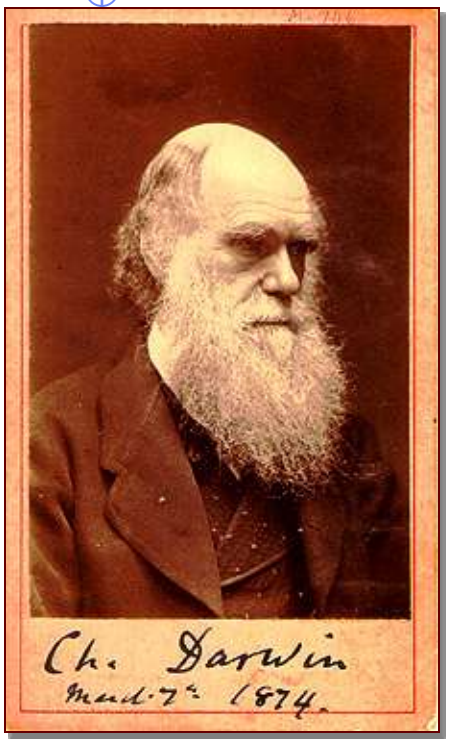




"Nothing in biology makes sense except in the light of evolution."

-- Theodosius Dobzhansky
March 1973
Geneticist, Columbia University
(1900-1975)

Essence of Darwin's ideas



(1) Variation exists in natural populations

(2) Many more offspring are born each season than can possibly survive to maturity

(3) As a result, there is a struggle for existence

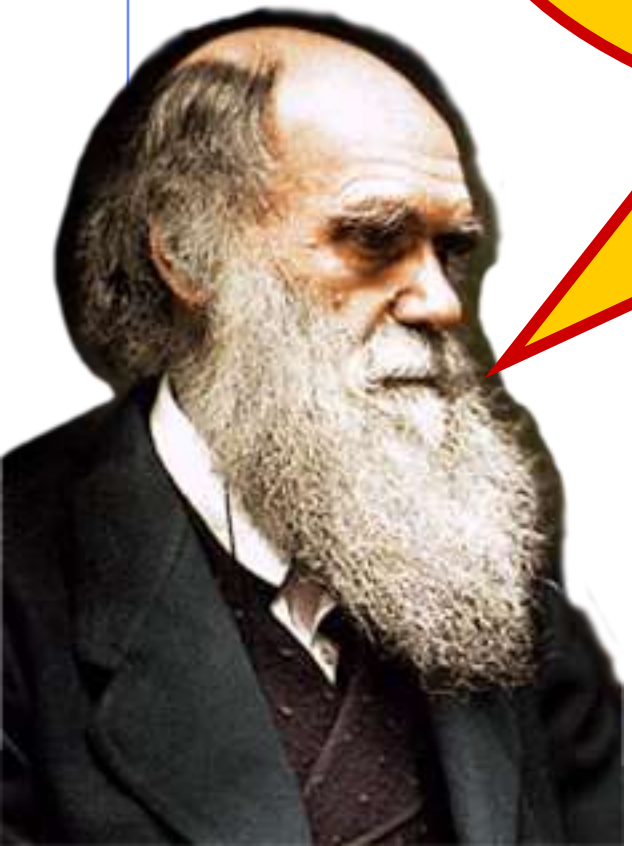
- competition

(4) Characteristics beneficial in the struggle for existence will tend to become more common in the population, changing the average characteristics of the population

- adaptations

(5) Over long periods of time, and given a steady input of new variation into a population, these processes lead to the emergence of new species

Stick your neck out…
Ask Questions*!*



The Birds…

- Galápagos birds
  - 22 of the 29 species of birds on the Galapagos are ***endemic***
    - found only on these islands
  - collected specimens of all
- One particular group…
  - at first, he paid little attention to a series of small birds
  - some were woodpecker-like, some warbler-like, & some finch-like

Darwin's finches

- Darwin was amazed to find out they were ***all*** **finches**
  - 14 species
  - but only ***one*** species on South American mainland
    - 500 miles away
  - all the birds had to originally come from mainland species

Finch? **Sparrow?**

and a
Photo - JPEG decompressor
are needed to see this picture.