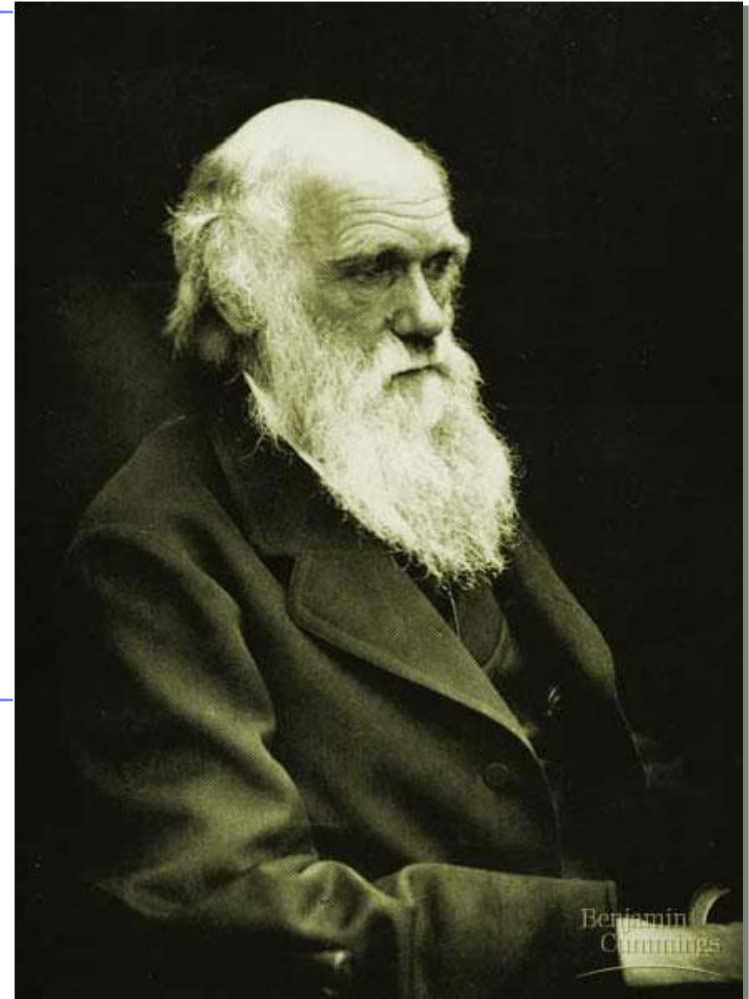




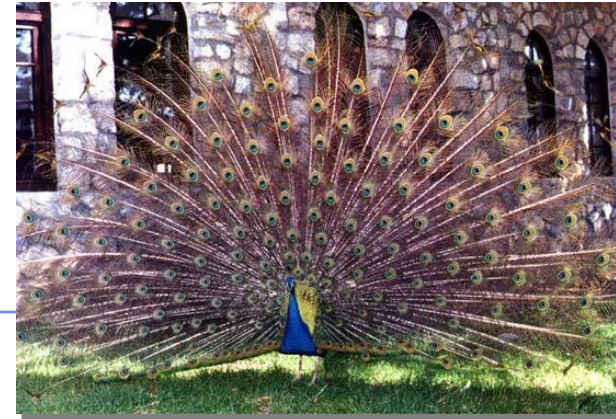
evolution

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

Evolution by Natural Selection



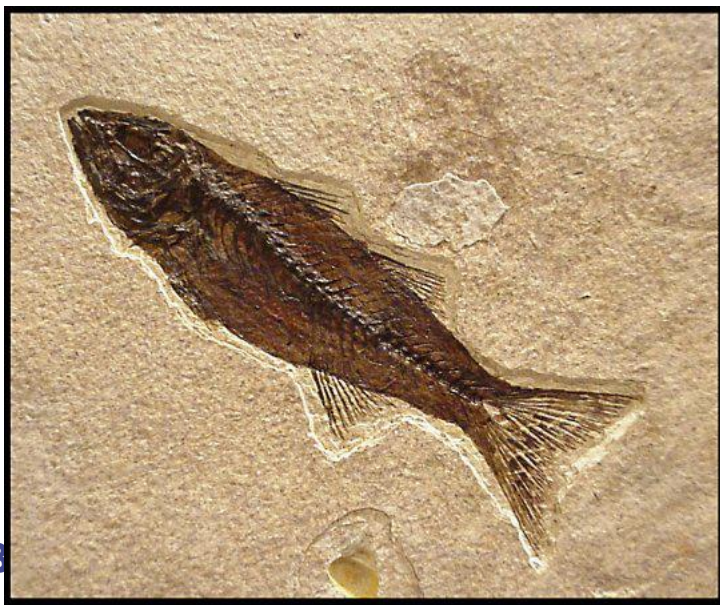
2006-2007

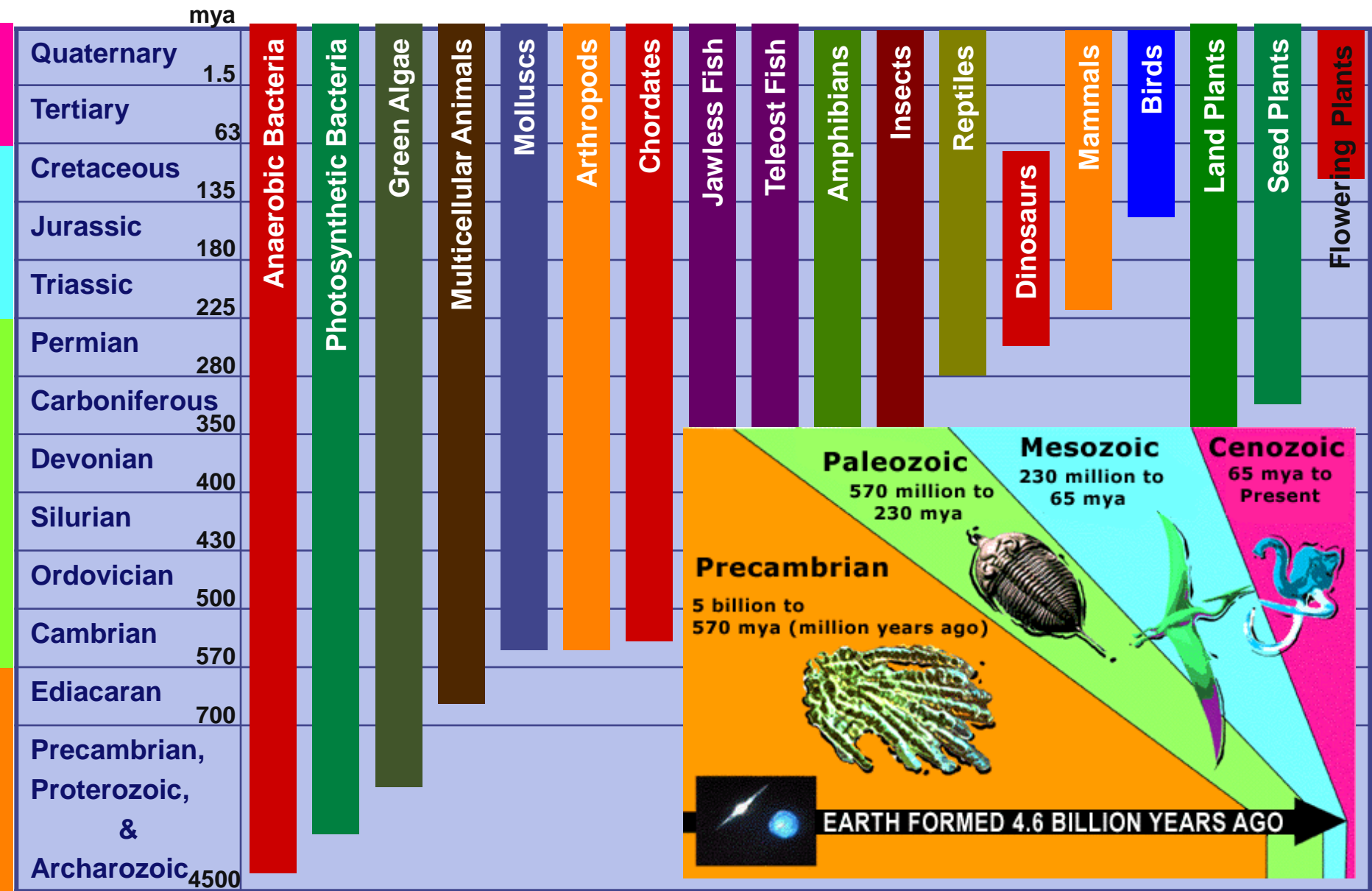


**"Nothing in biology
makes sense except in
the light of evolution."**

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

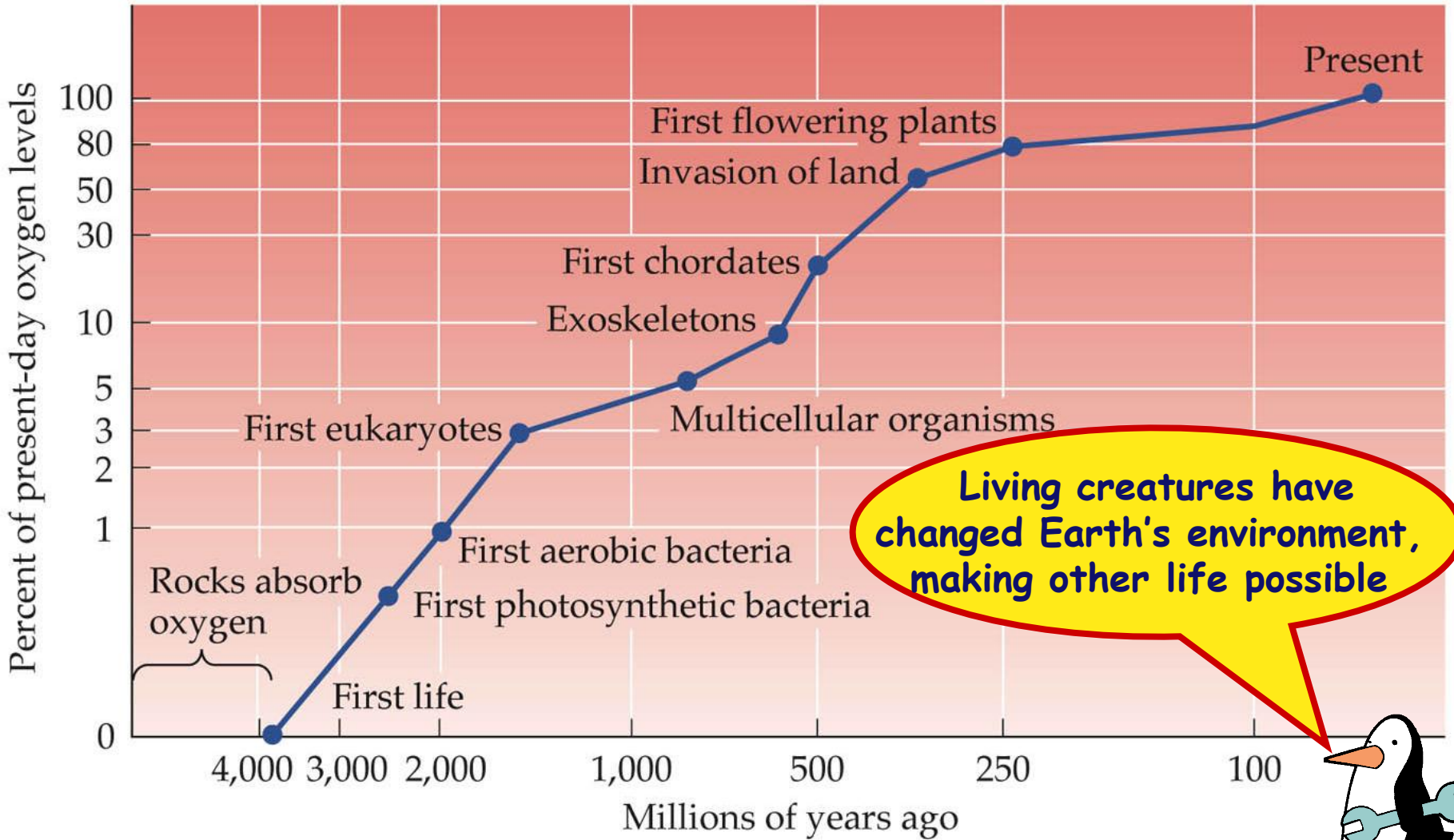
The Fossil record shows...



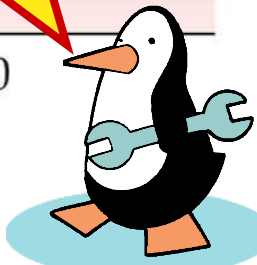


Life's Natural History is a record of Successions & Extinctions

Life has changed & changed the Earth



Living creatures have changed Earth's environment, making other life possible



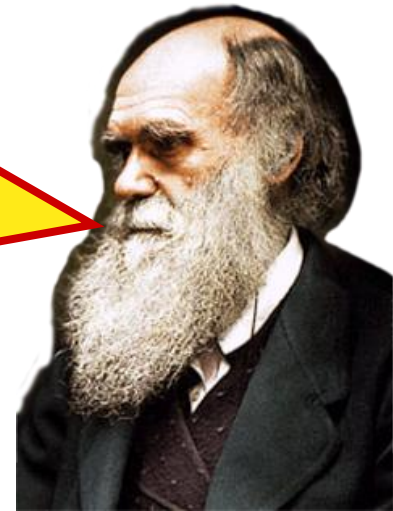
Succession of types

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

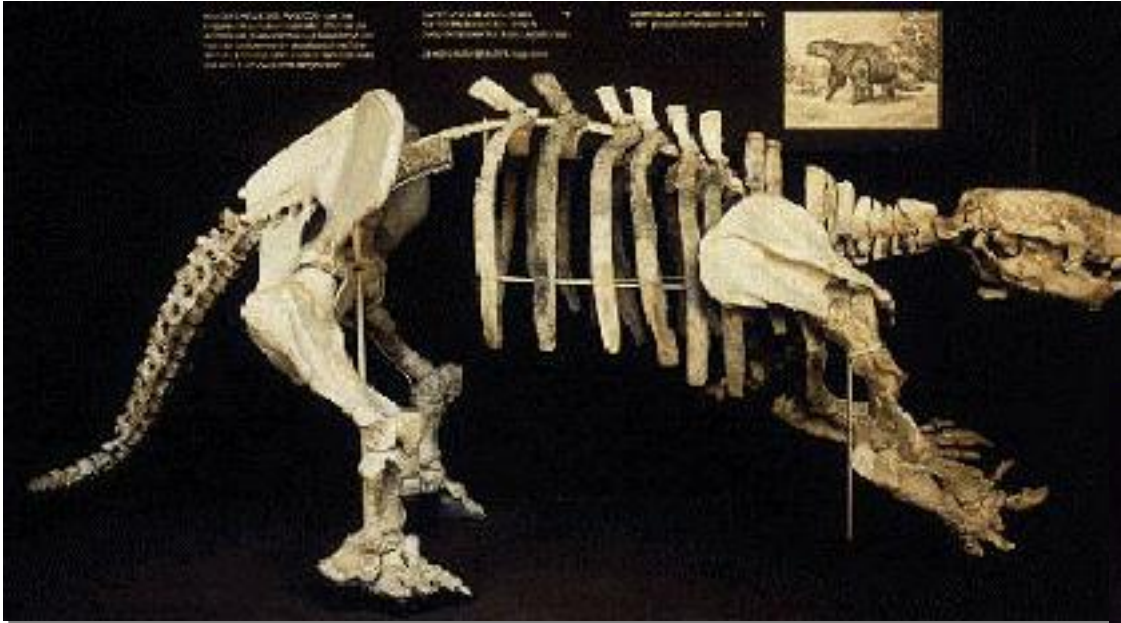


Glyptodont fossils are also unique to South America.

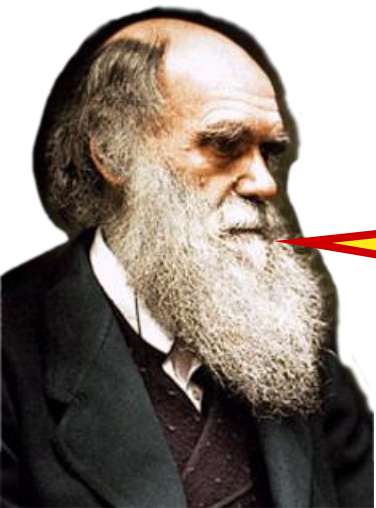
Why should extinct armadillo-like species & living armadillos be found on the same continent?



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.

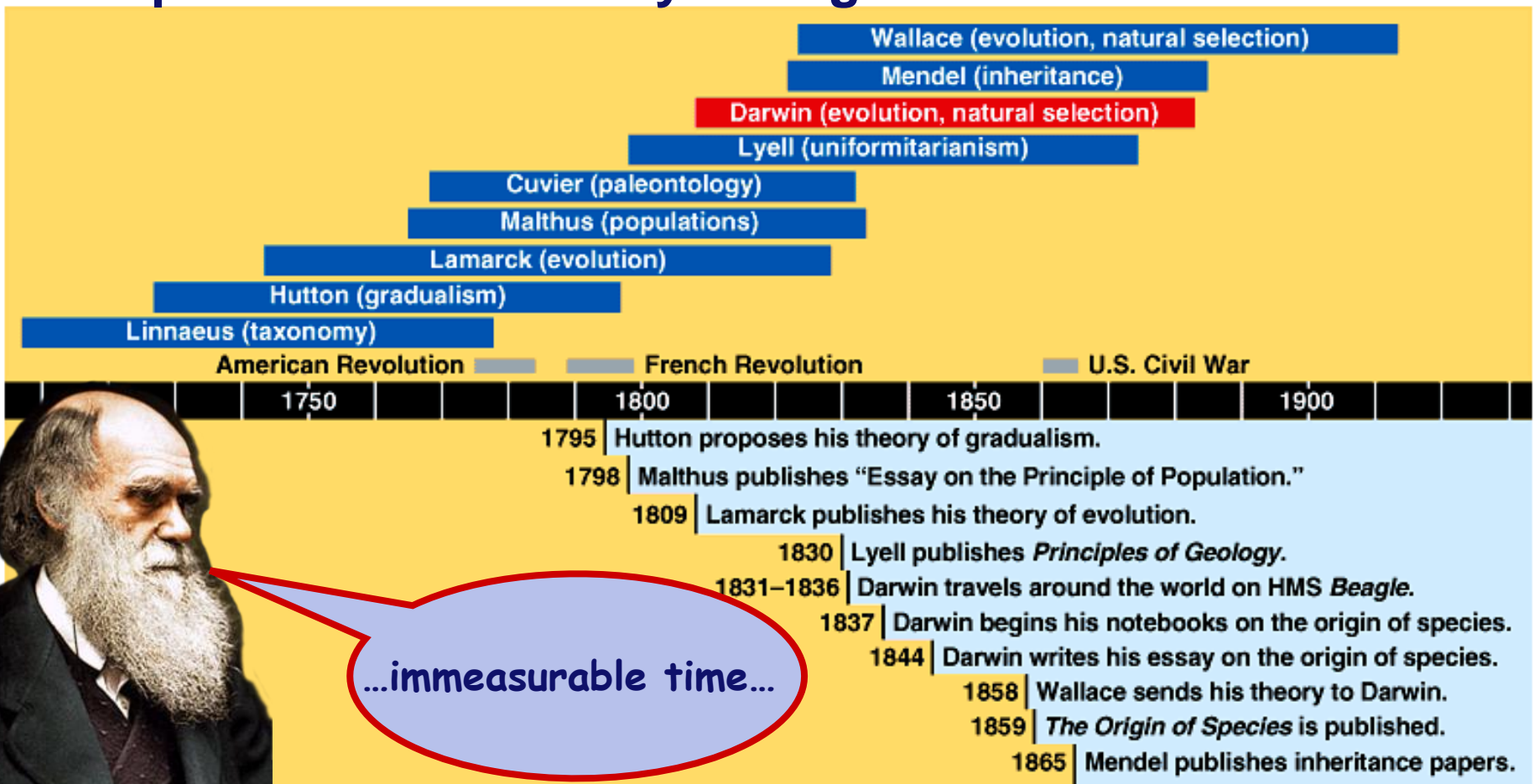
LaMarck



- Organisms adapted to their environments
 - ◆ through **acquired** traits
 - ◆ change in their life time
 - **Use & 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

In historical context

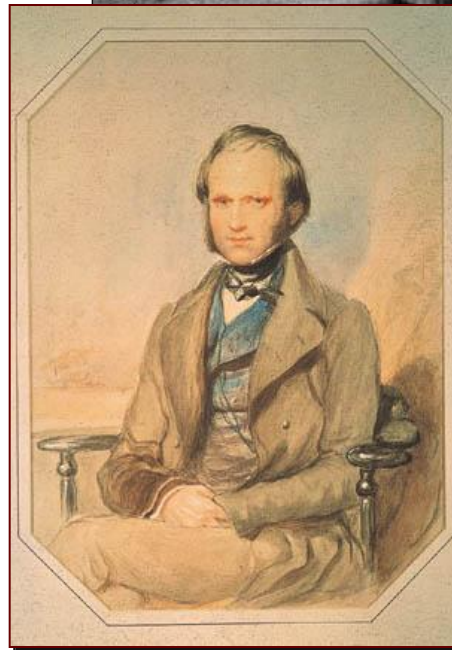
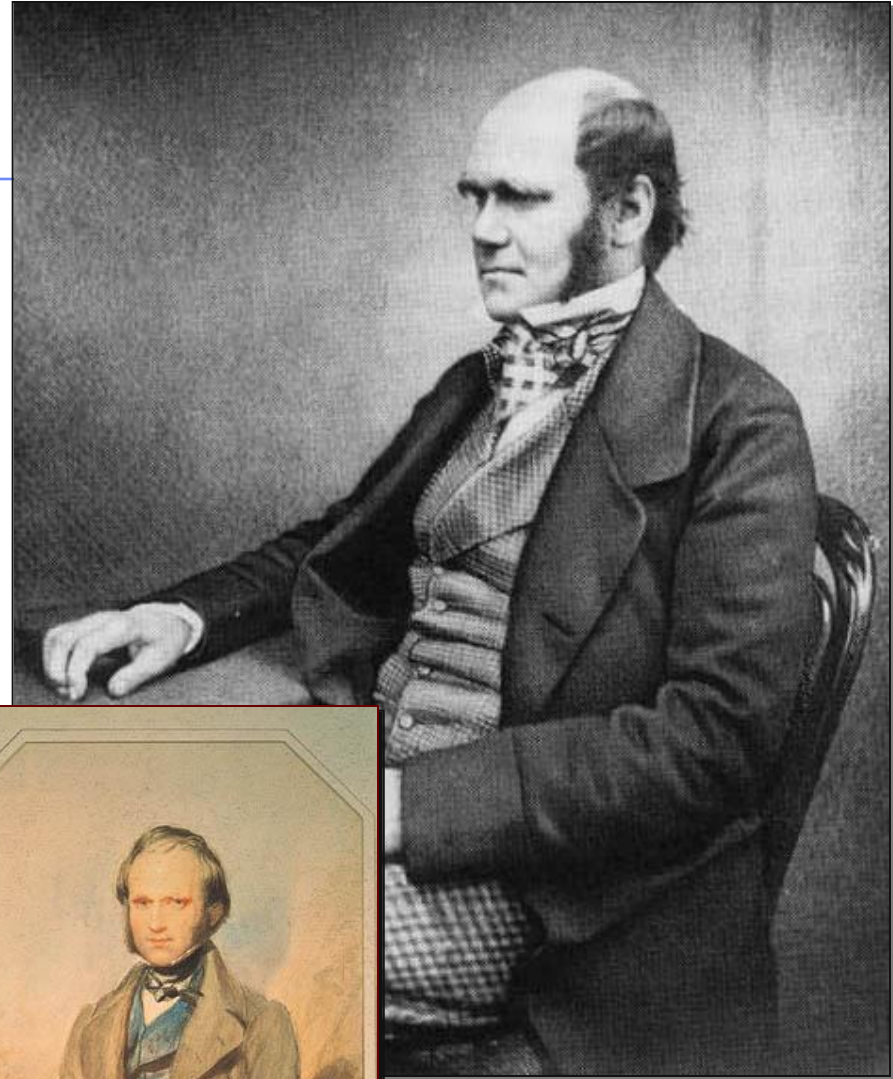
- Darwin did not originate the idea of evolution
- Geologic theories of Earth's age & history cleared the path for evolutionary biologists



...immeasurable time...

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

- Travels around the world
 - ◆ 1831-1836
 - ◆ makes many observations of natural world
 - main mission of the *Beagle* was to chart South American coastline

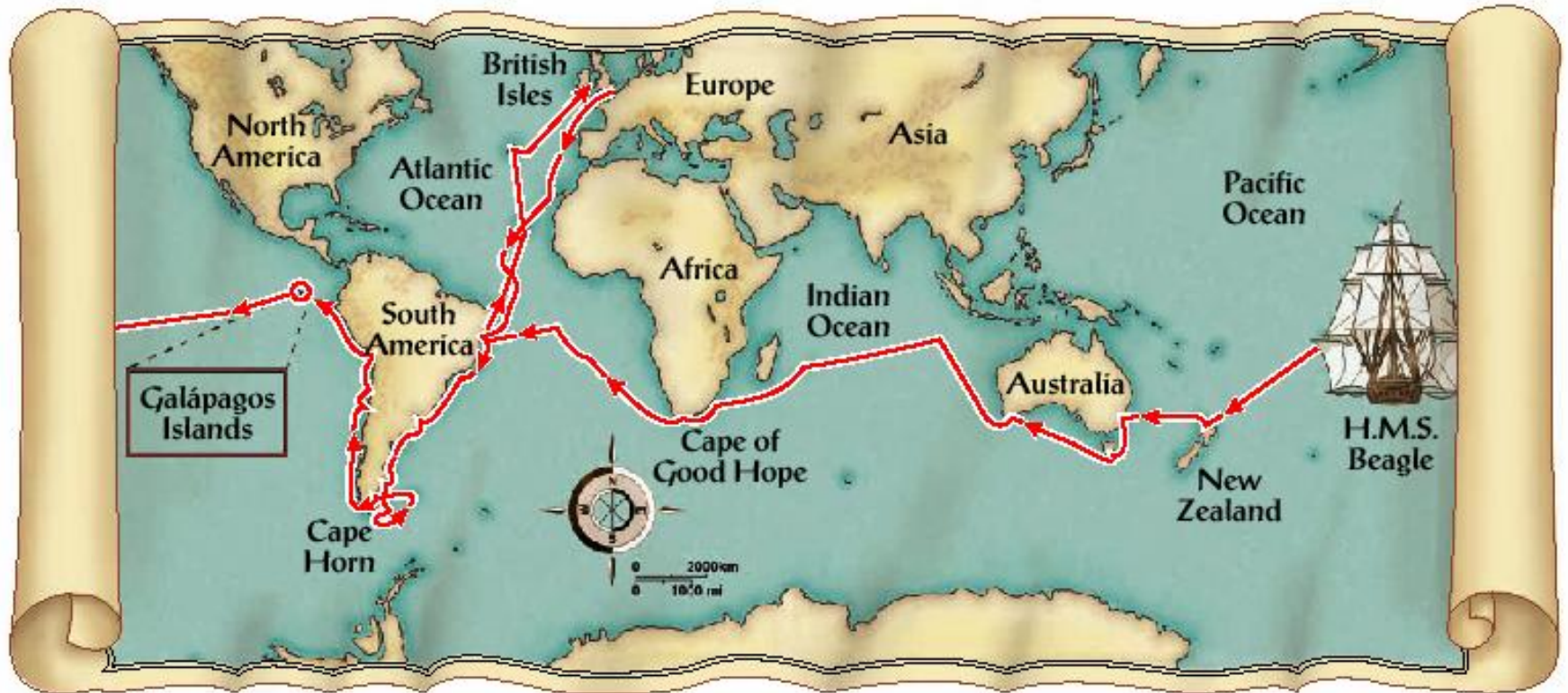


Robert Fitzroy



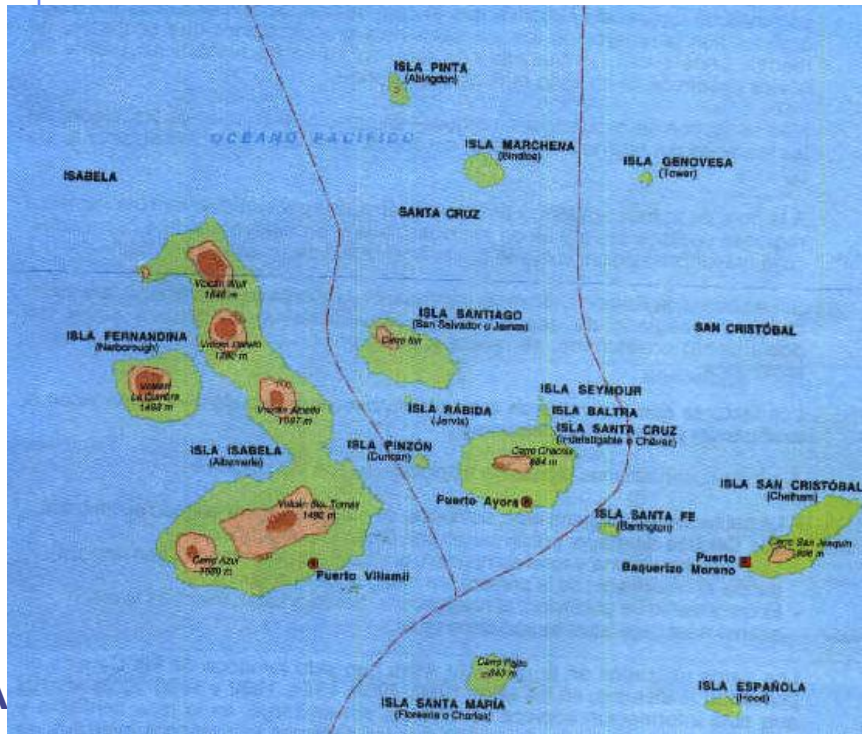
Voyage of the HMS Beagle

- Stopped in Galapagos Islands



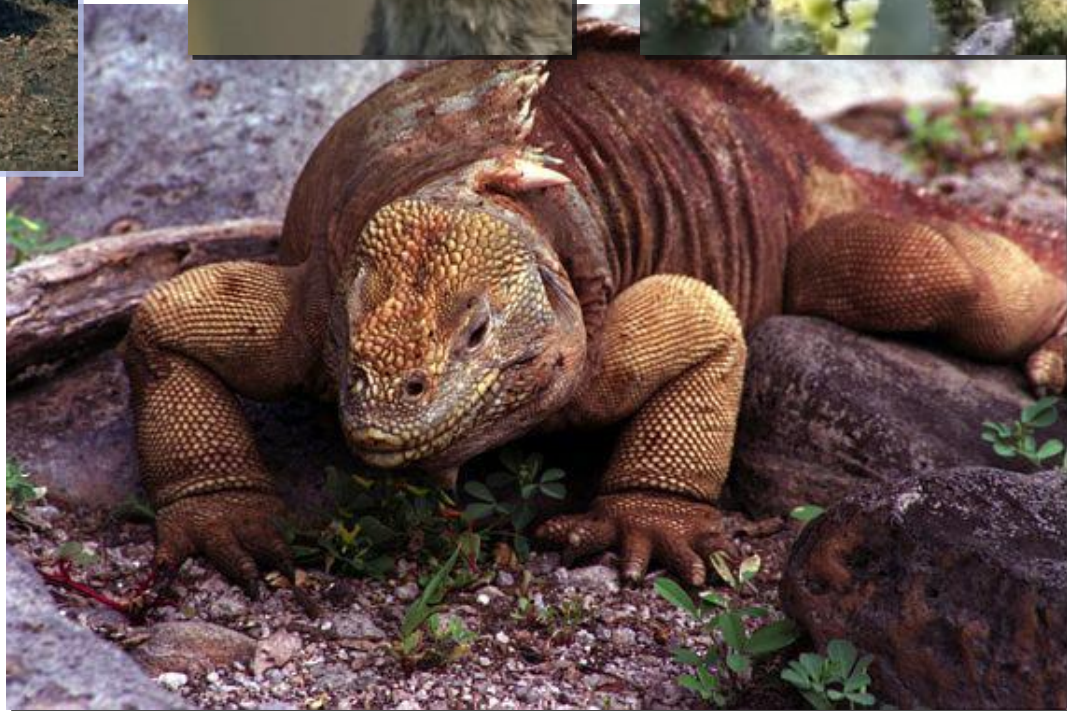
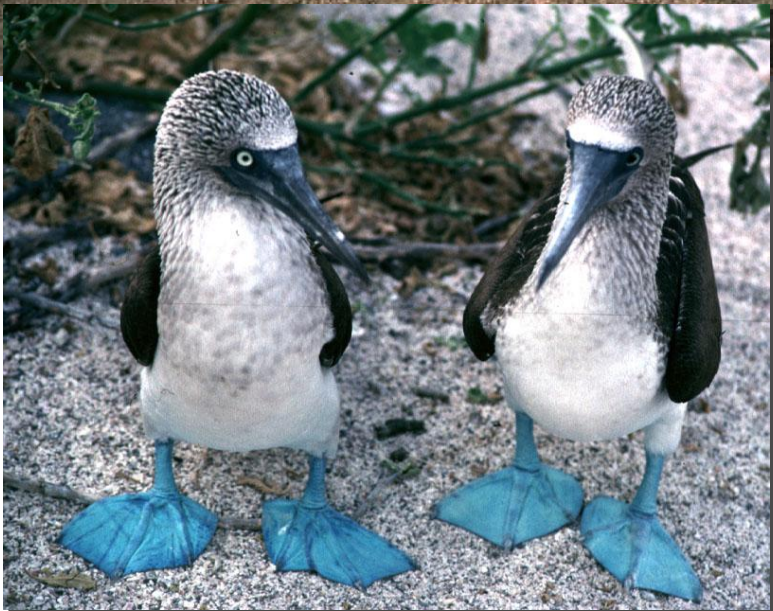
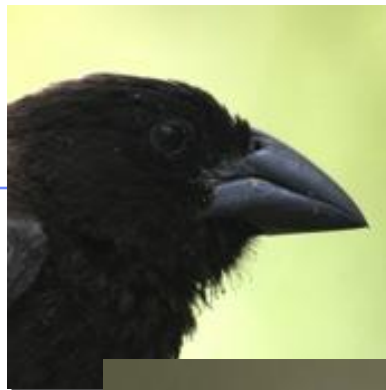
Galapagos

Of relatively recent volcanic origin most of animal species on the Galápagos live nowhere else in world, but they resemble species living on South American mainland.



500 miles west of mainland

Unique species



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

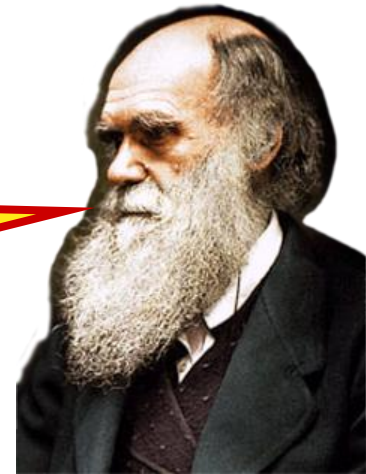
Finch?

Photo - JPEG decompressor are needed to see this picture.

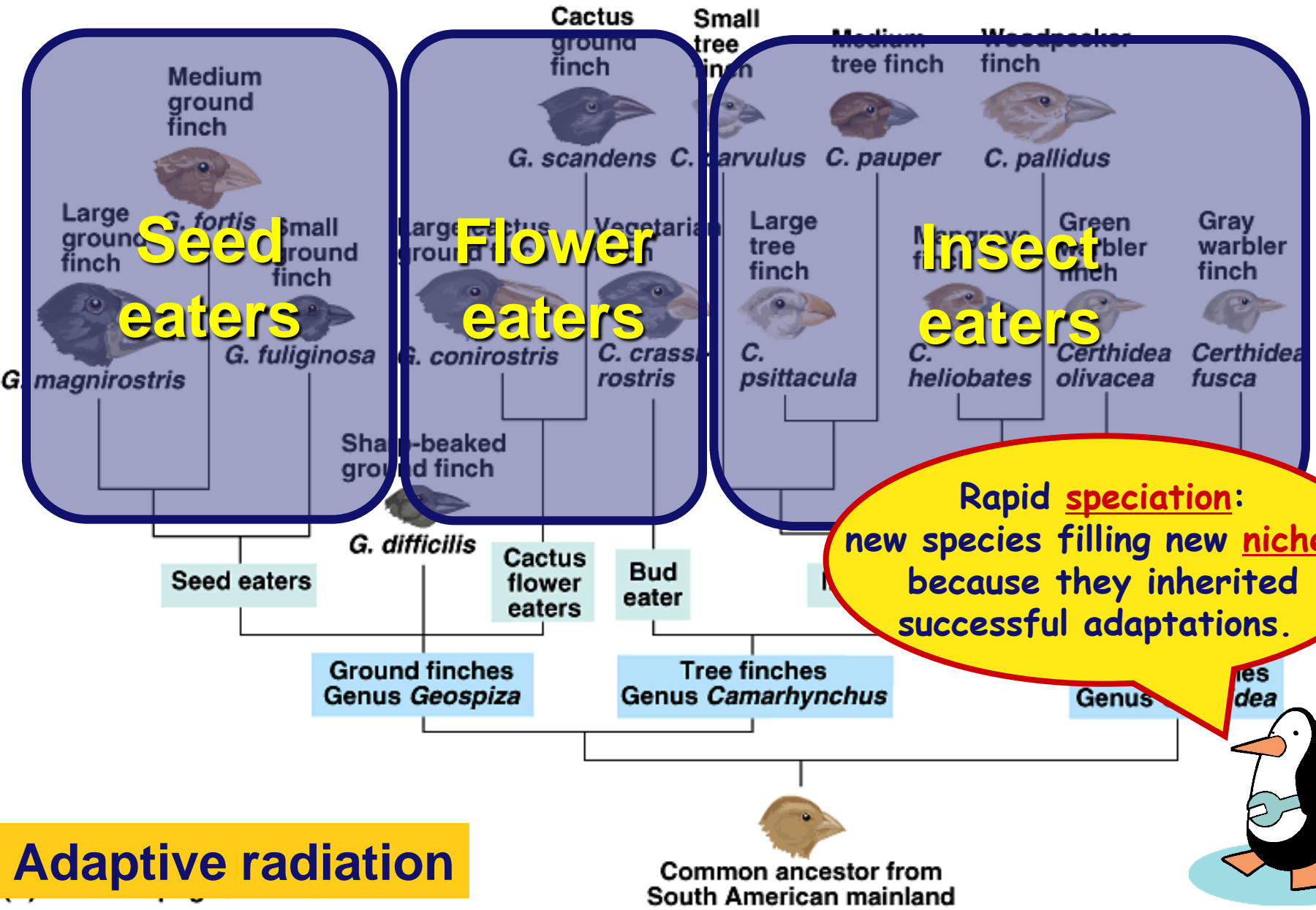
Sparrow?

Why were the finches so different now?

Warbler?



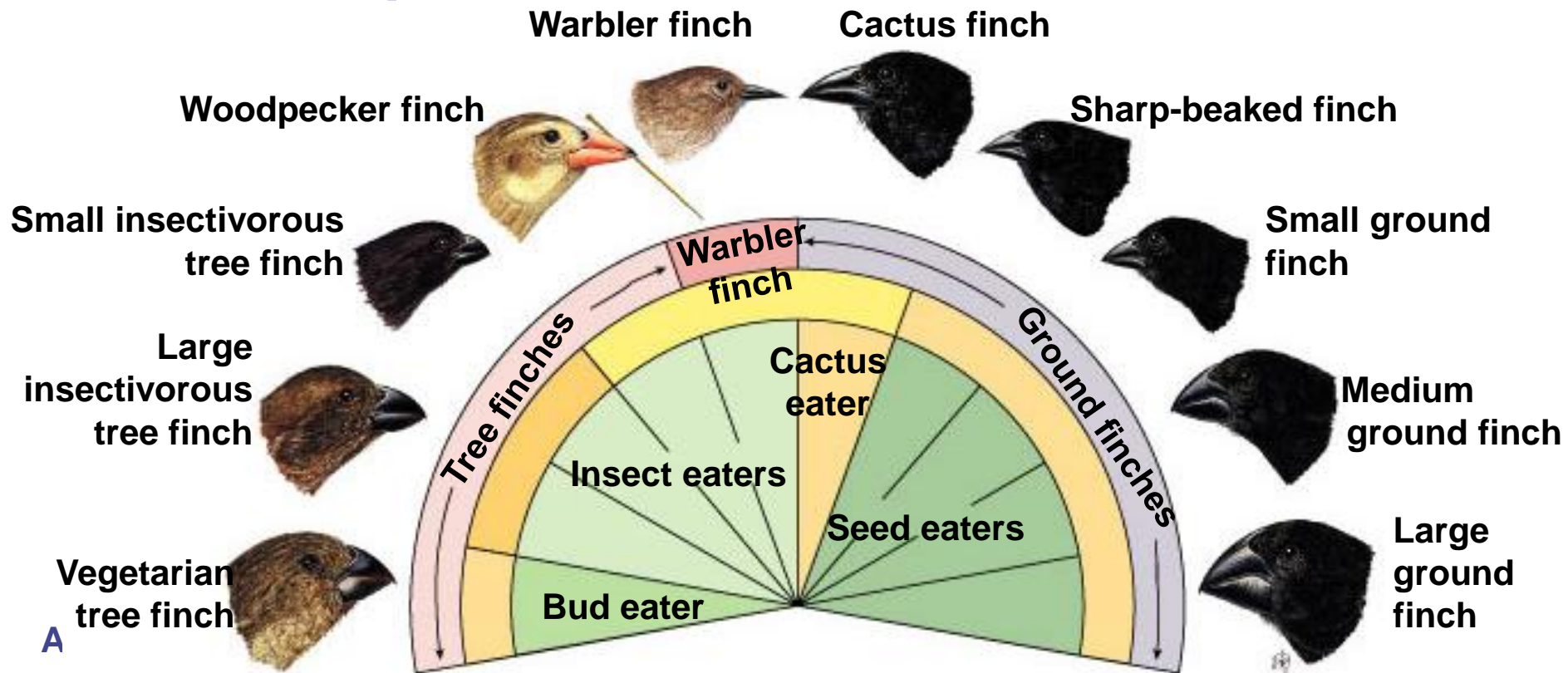
Correlation of species to food source



Darwin's finches

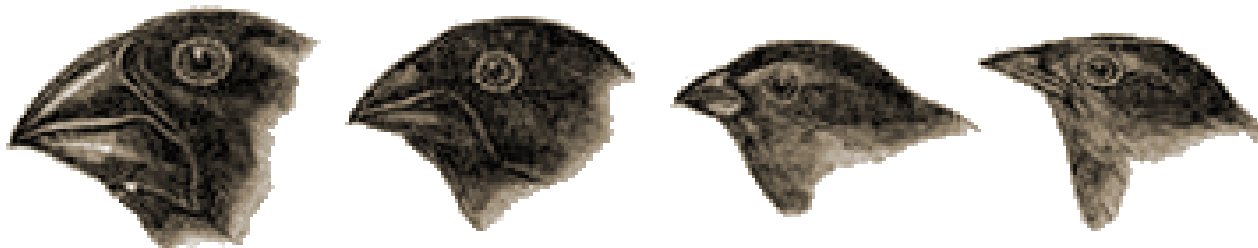
■ Differences in beaks

- ◆ associated with eating different foods
- ◆ adaptations to foods available on islands

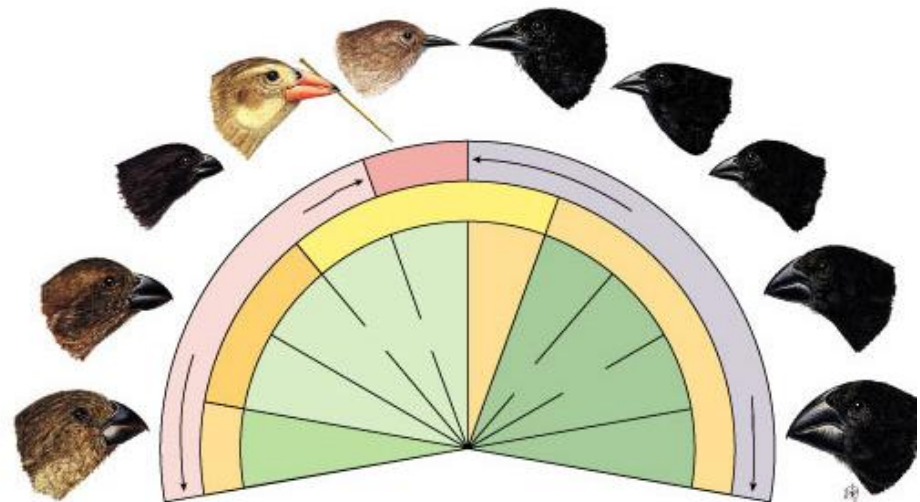
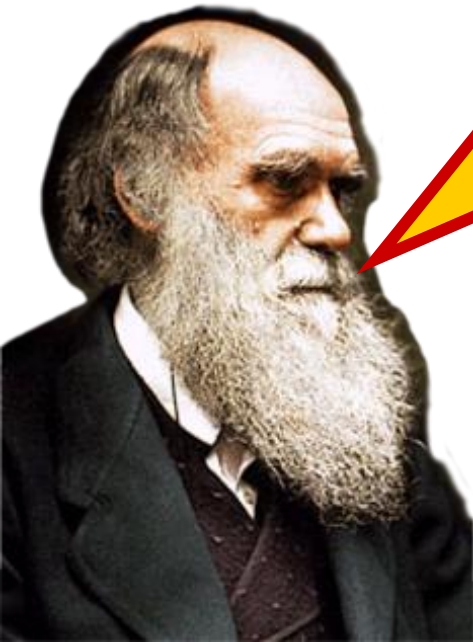


Darwin's finches

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



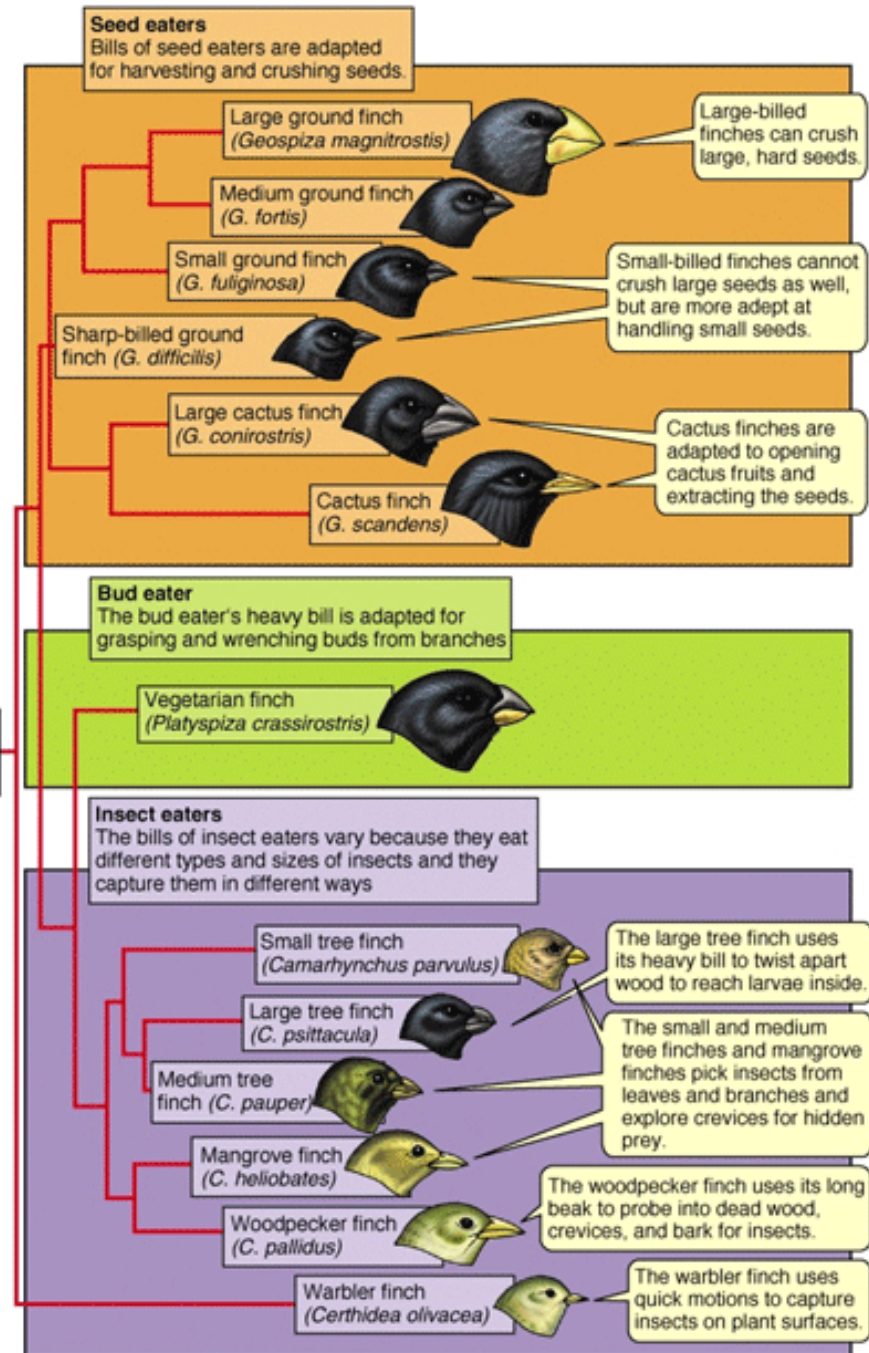
Seeing this gradation & diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species has been taken & modified for different ends.



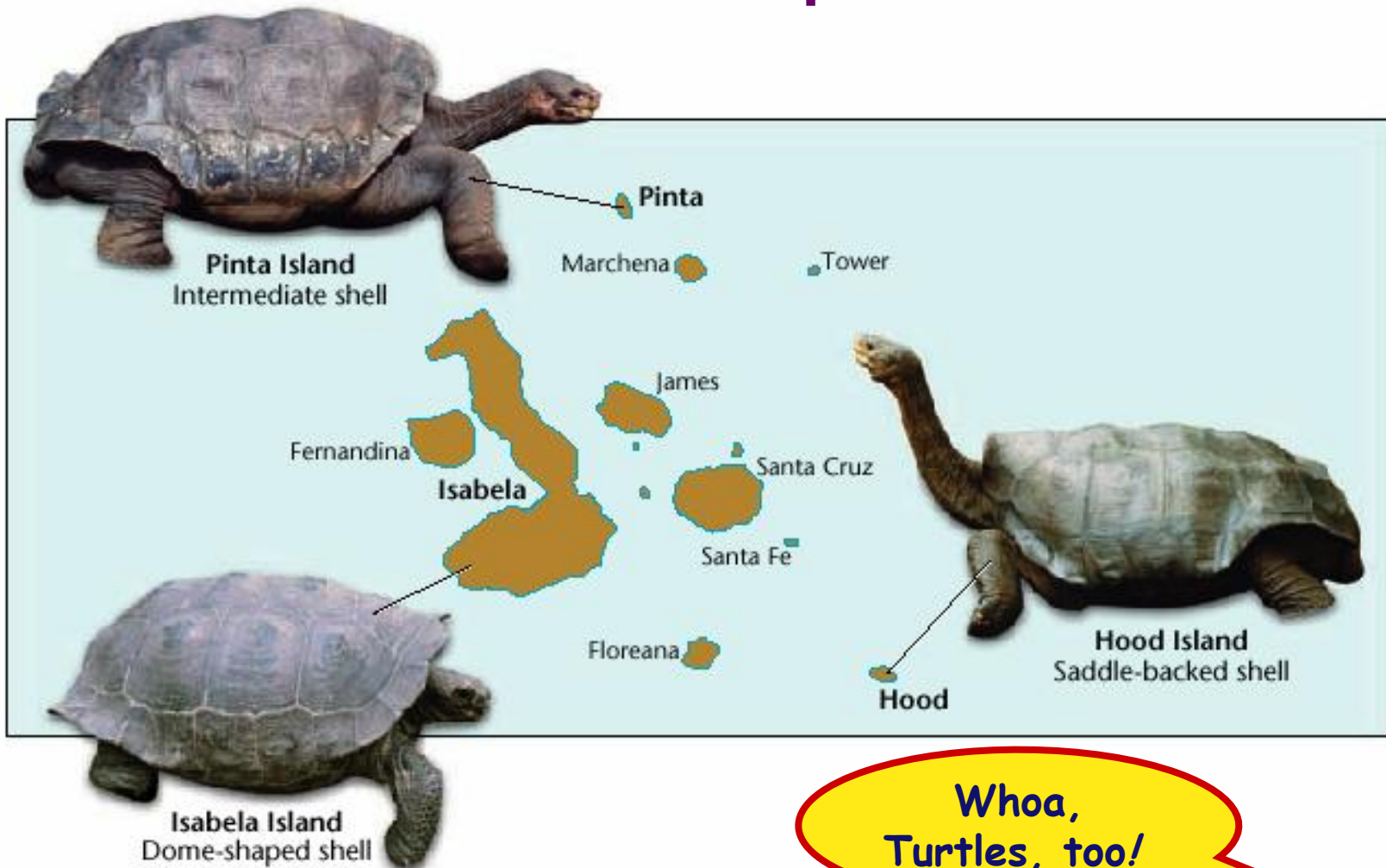
Darwin's finches

Finches with beak differences that allowed them to...

- ◆ successfully compete
- ◆ successfully feed
- ◆ successfully reproduce
 - pass successful traits onto their offspring



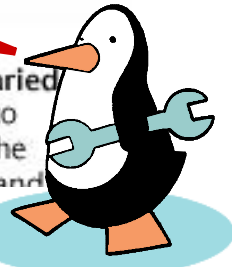
Correlation of species to food source

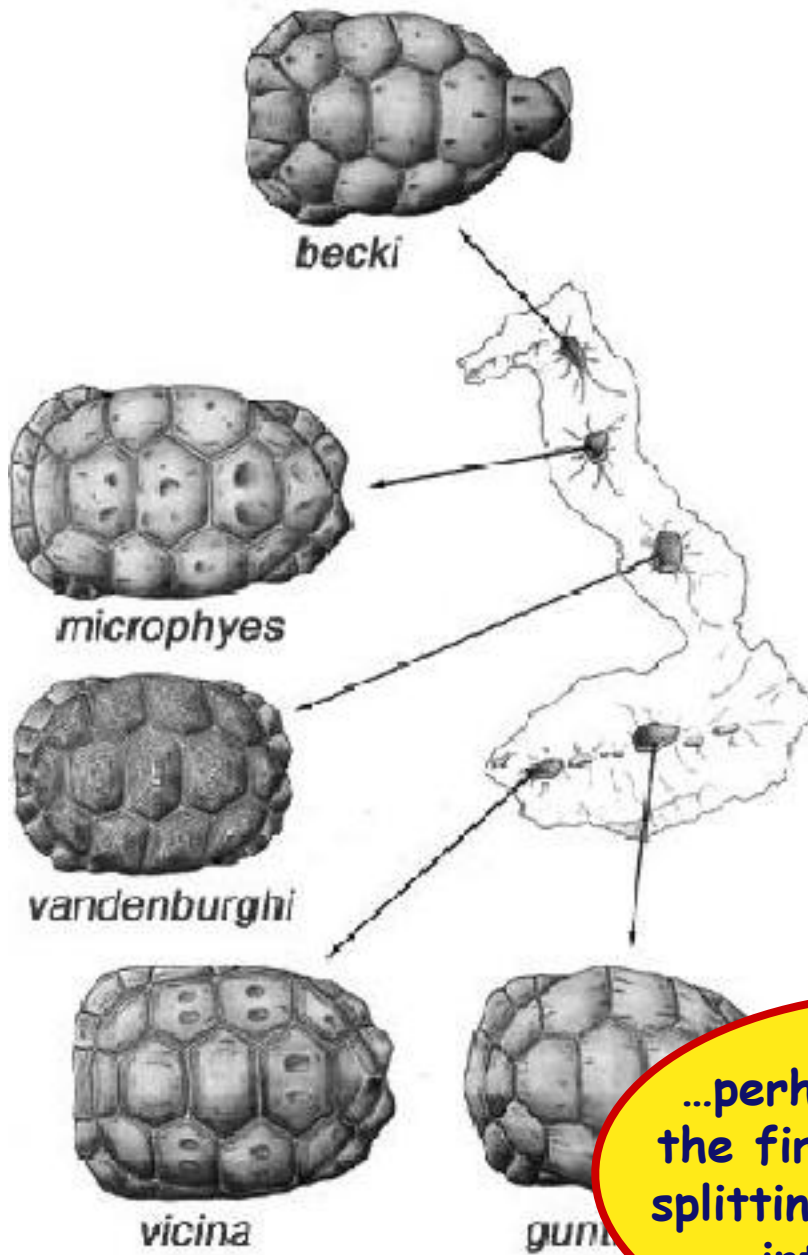


© D.Cavagnaro/DRK Photo • © M.Cavagnaro/DRK Photo

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 to the ground. The tortoise from Pinta Island has a shell that is intermediate between these two forms.



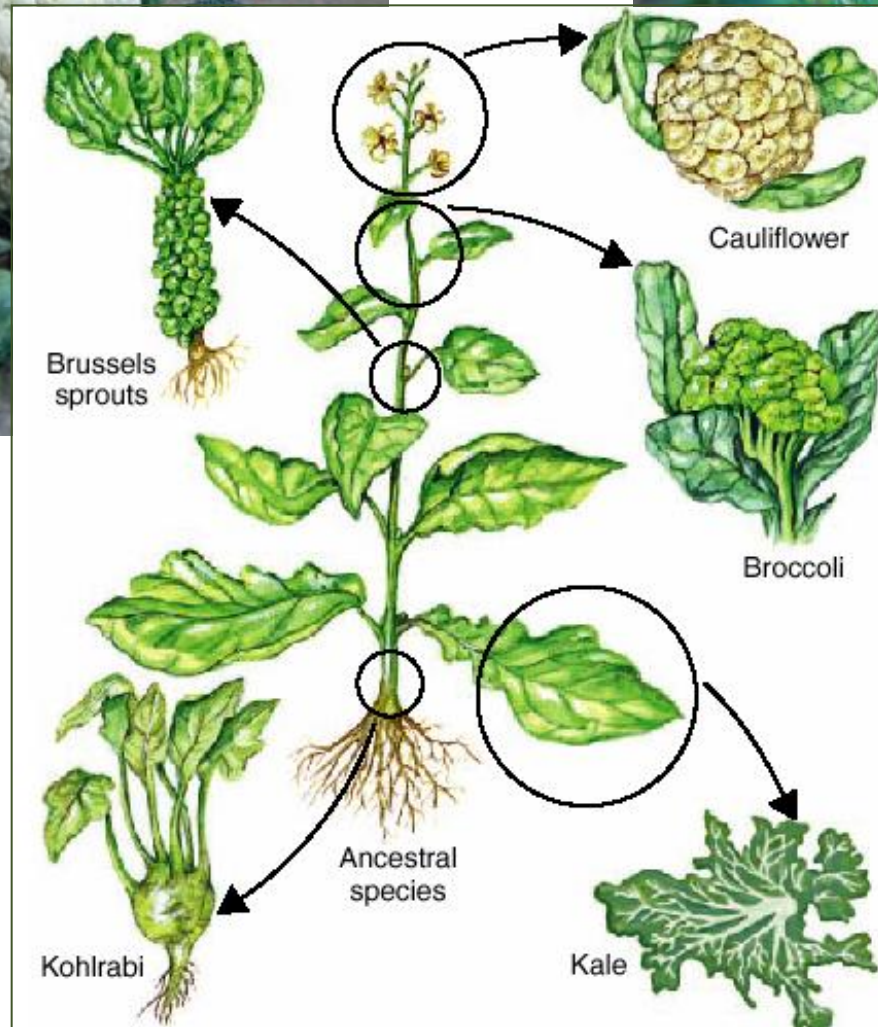
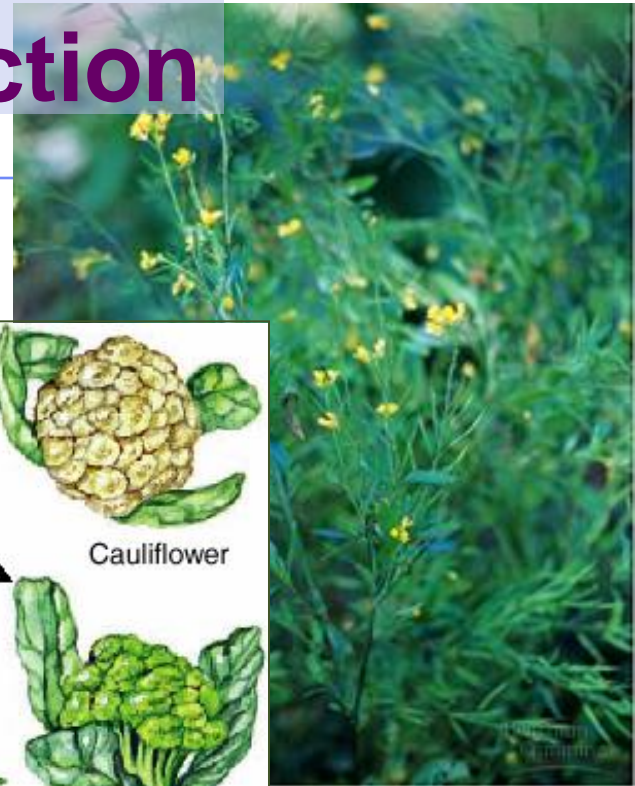


Many islands also show distinct *local* variations in tortoise morphology..

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



Artificial selection

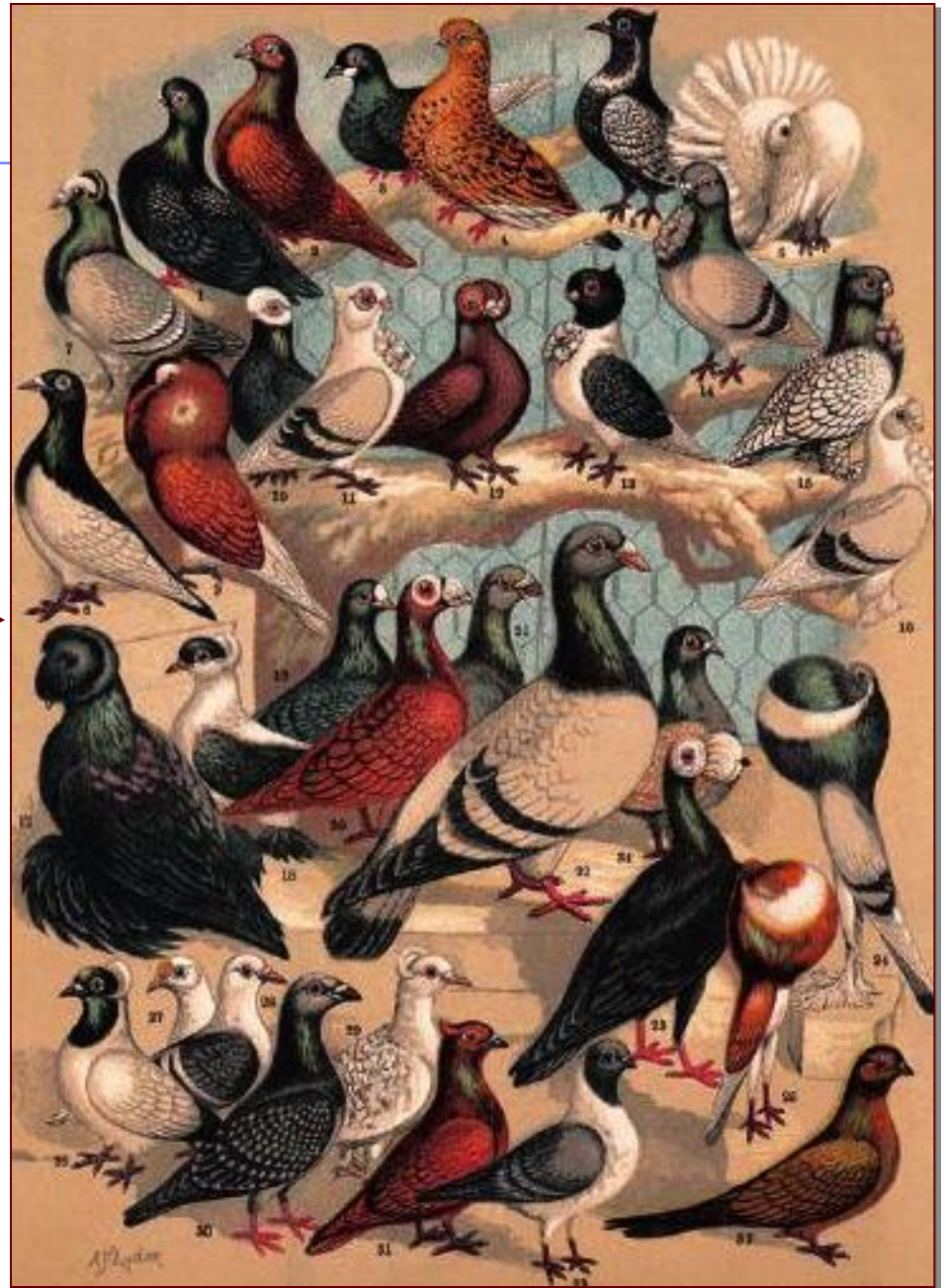


This is not just a process of the past...

It is all around us today

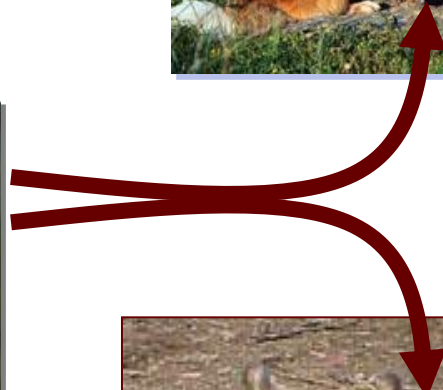
Selective breeding

the raw genetic material is hidden there



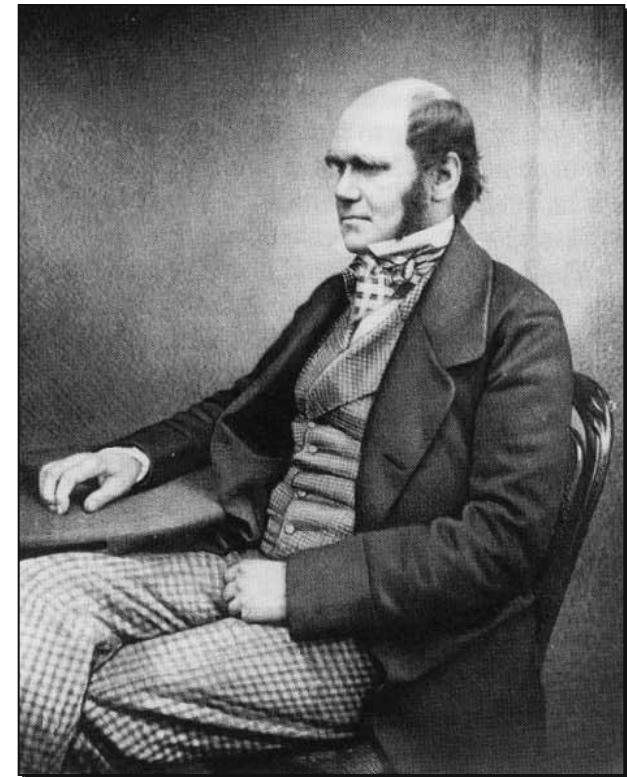
Selective breeding

Lots of hidden variation comes out!



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

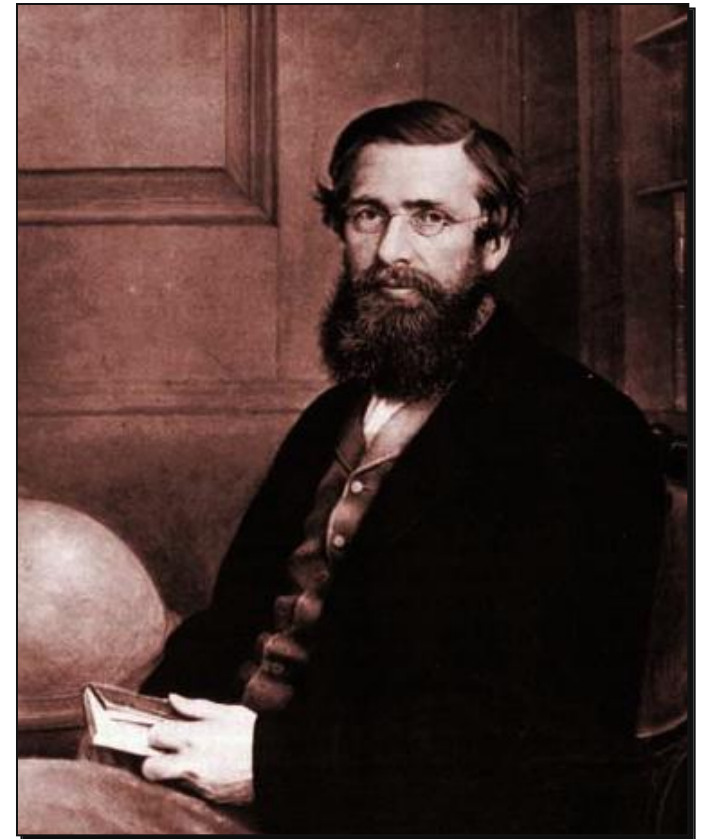


And then came the letter....

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 theory. He asked Darwin to evaluate his theory 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 provision for the preservation of originally created distinct species.

In the absence of scarcity of facts and observations, the argument has had great weight with naturalists, and has led to a prejudiced belief in the stability of species. "permanent or true varieties," - races of which differ so slightly (although constantly) from the original form of the other. Which is the variety and which the original form, is determining, except in those rare cases where a variety is unlike itself and resembling the original form. "permanent invariability of species" - varieties have strict limits, and can never be proved to have it, which, from the analogy of the original form, is certainly proved.

It will be observed that this argument, as applied to the state of nature are in all respects analogous to those which are governed by the same laws as regards the present paper to show that this assumption of a state of nature which will cause many varieties to be produced, and variations departing further and further from the original form, as in domesticated animals, the tendency of varieties to return to the original form.

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.

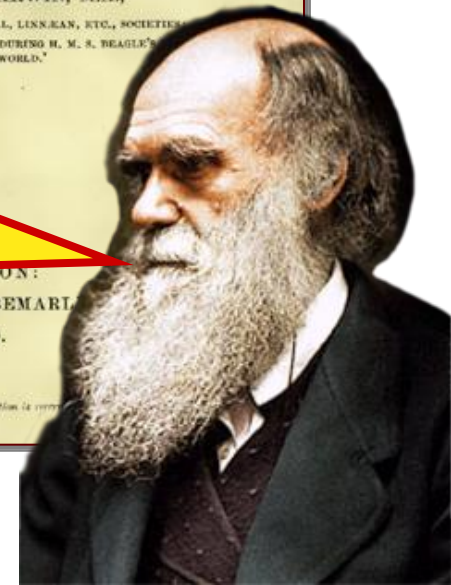
By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES
AND OF THE LONDON AND EDINBURGH SOCIETIES OF NATURALISTS
A JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE
ROUND THE WORLD.

LONDON:
JOHN MURRAY, ALBEMARLE STREET,
1859.

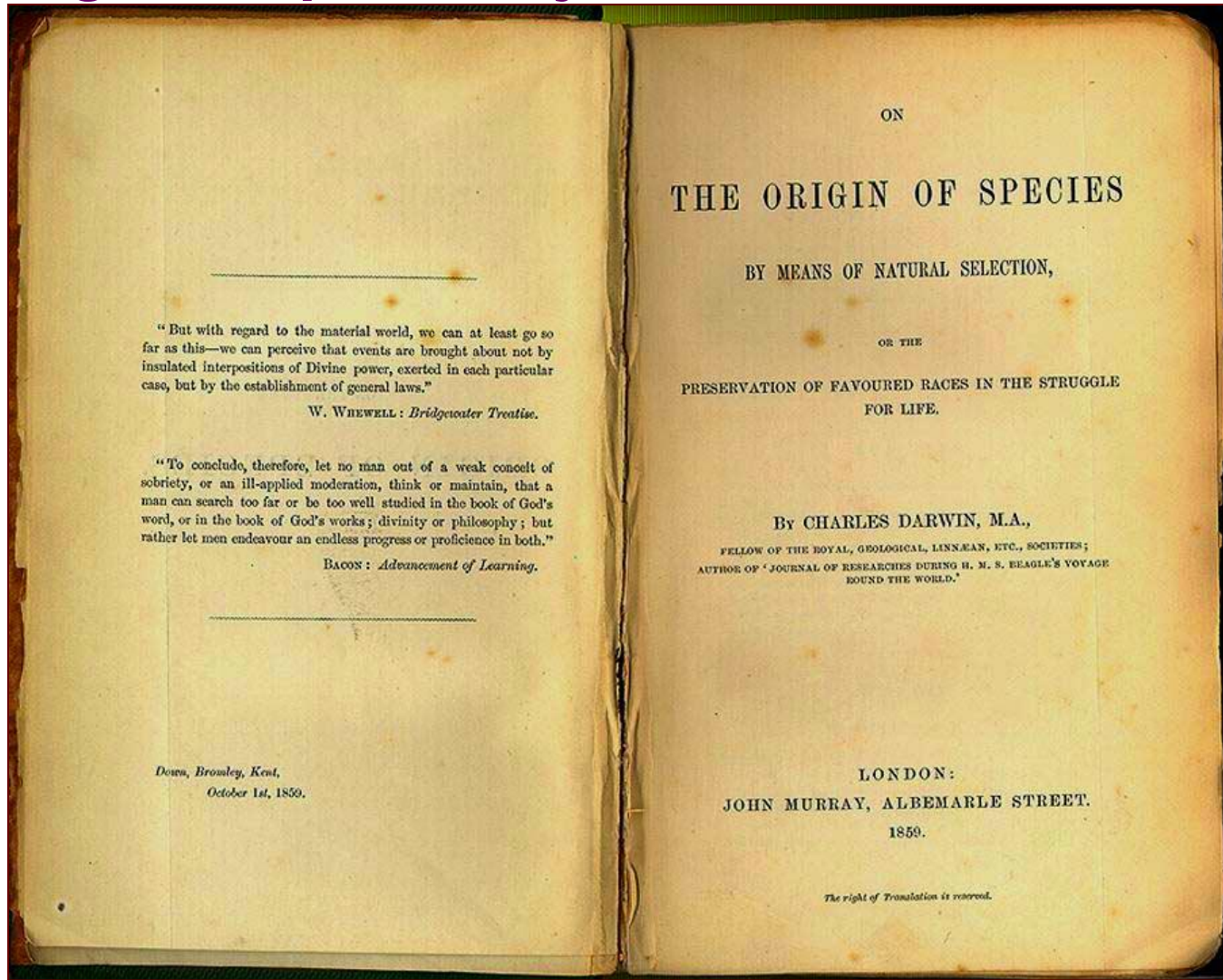
The right of Translation is reserved.

To 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.

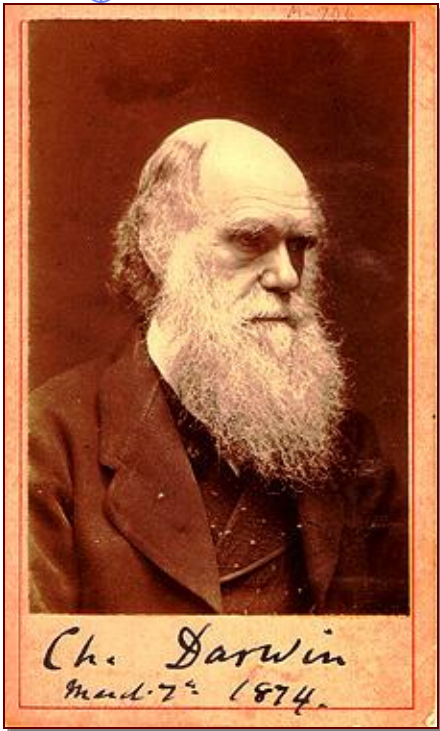


Voyage: 1831-1836

November 24, 1859, Darwin published
“*On the Origin of Species by Means of Natural Selection*”



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**

Natural Selection

- Darwin referred to all of these factors together as **natural selection**
 - ◆ variation
 - ◆ production of more offspring than can survive
 - ◆ competition
 - for food, for mates & nesting spots, to escape predators
 - ◆ differential survival based on traits
 - successful traits = adaptations



LaMarckian vs. Darwinian view

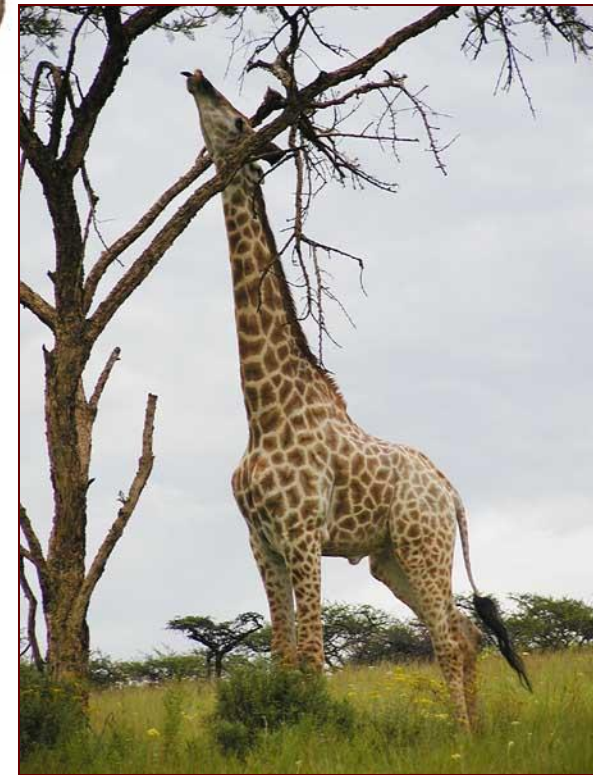
■ LaMarckian

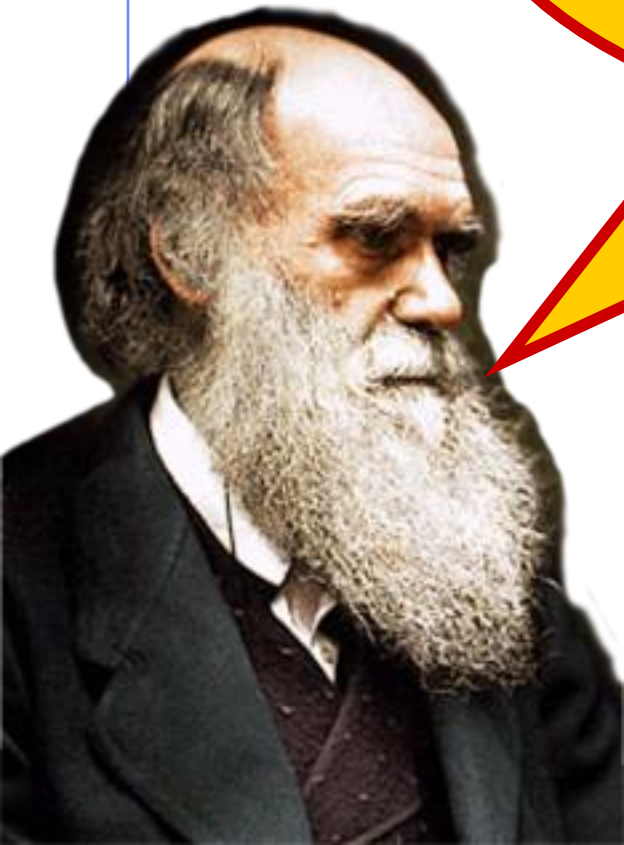
- ◆ in reaching higher for vegetation giraffes stretch their necks & transmit the acquired longer neck to offspring



■ Darwinian

- ◆ longer-necked giraffes survive better & leave more offspring who inherit their long necks
 - genes





Any Questions??