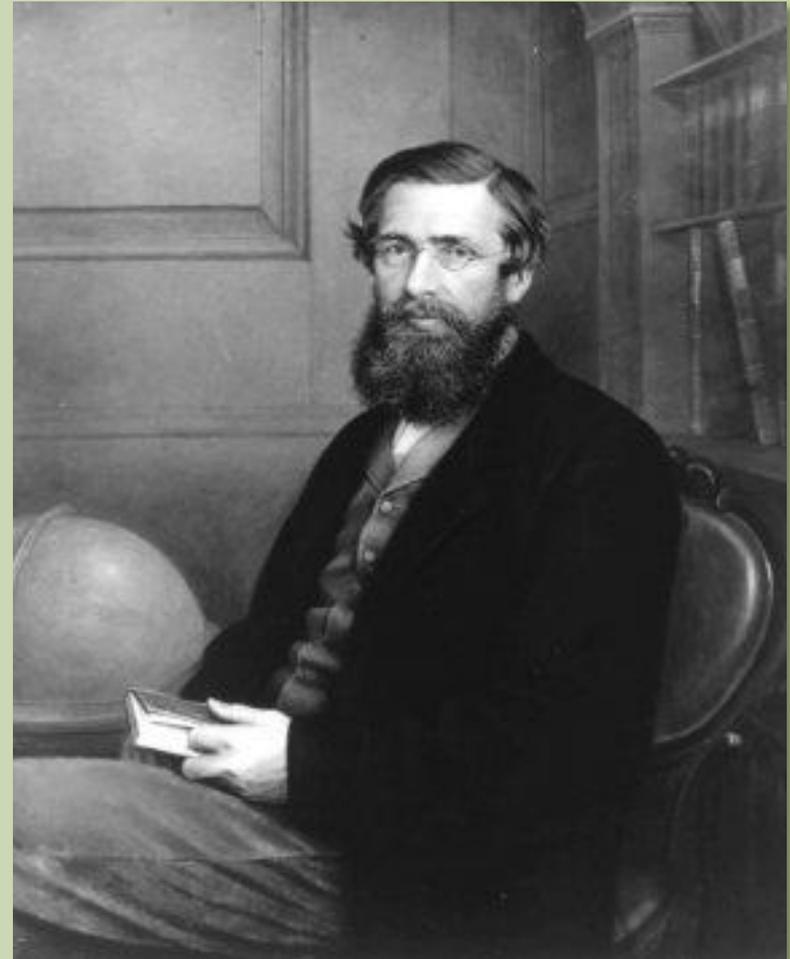
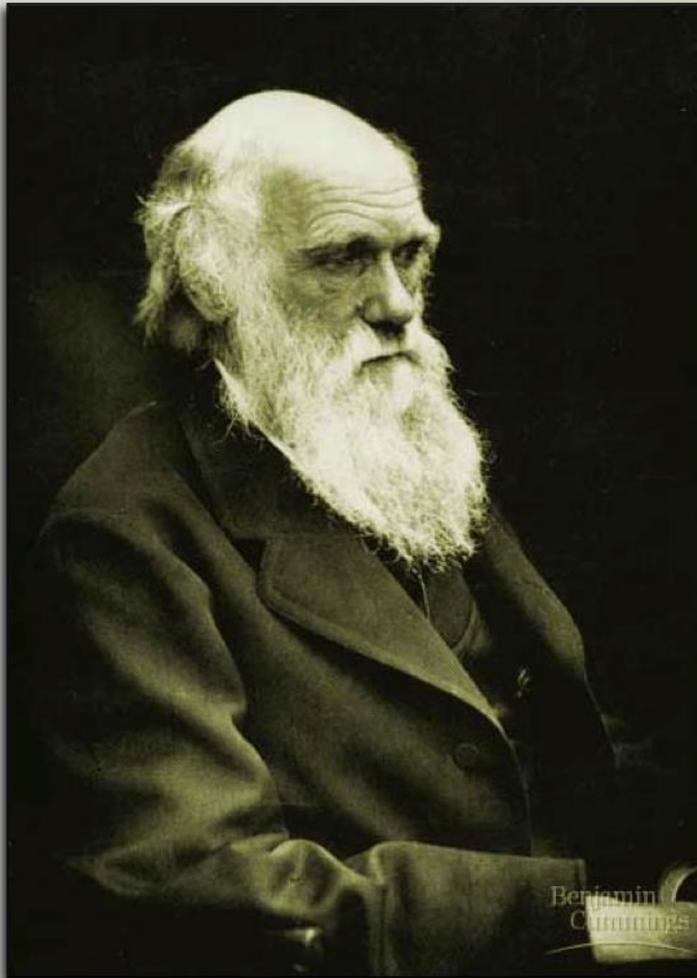


Darwin's Theory of Evolution

Chapter 16



What does “evolution” mean?

- Change that happens slowly over time
- Biological evolution is the slow change of living things over time

Scientists before 1800 thought

- The earth was only a few thousand years old
- Each living thing was always exactly the same since it was created by God
 - They will stay the same until the end of time

The Fossil record...



OBSERVATION



People started noticing problems with the idea that organisms stayed the same

- Fossil Record
 - Found fossils of organisms no longer living
- Artificial Selection
 - People selecting which organisms to breed had changed many domestic plants and animals

These domesticated vegetables have all evolved from wild mustard.



Figure 13.4A



German shepherd



Yorkshire terrier



English springer spaniel



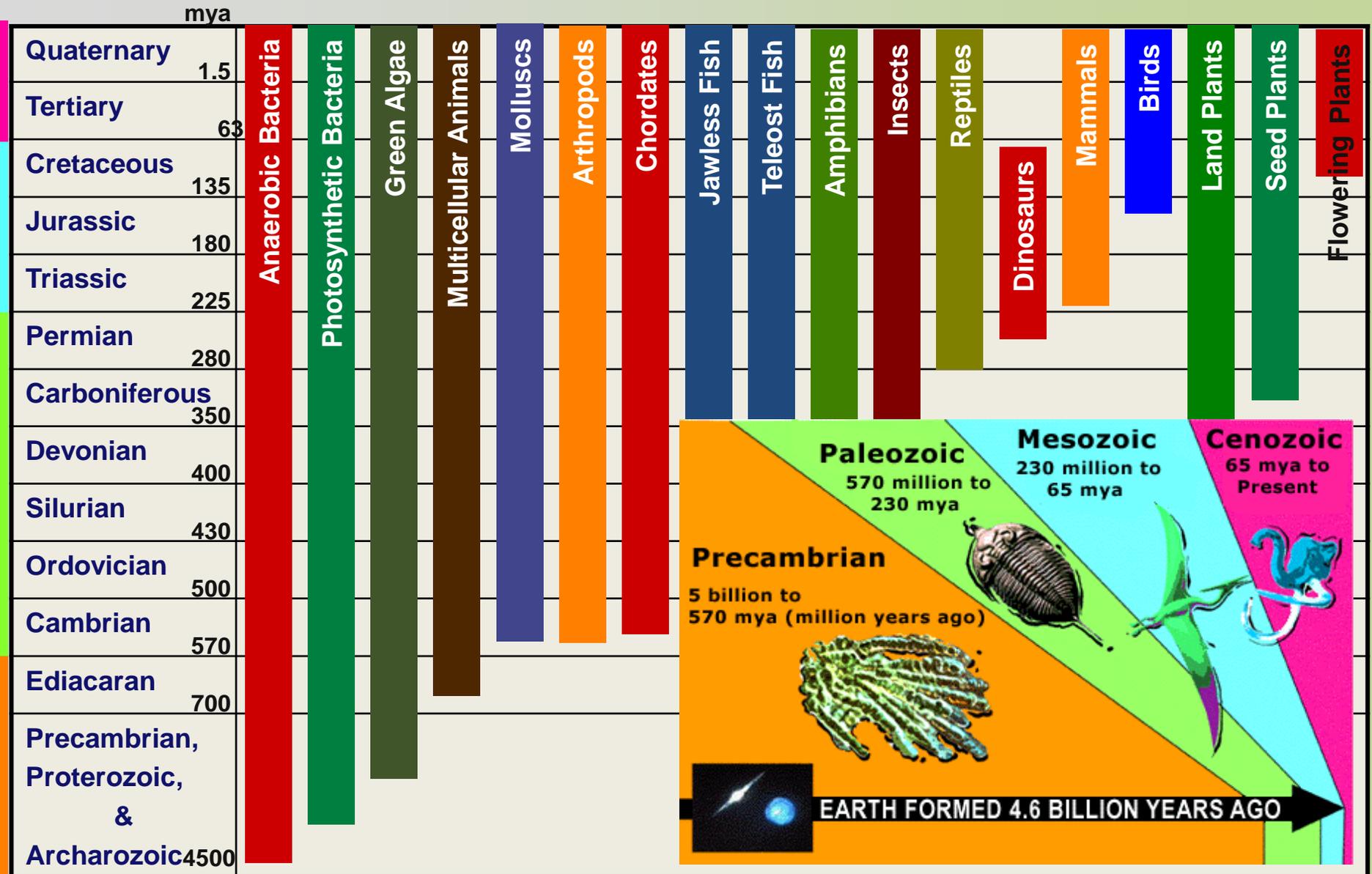
Mini-dachshund



Golden retriever

**Hundreds to
thousands of years
of breeding
(artificial selection)**

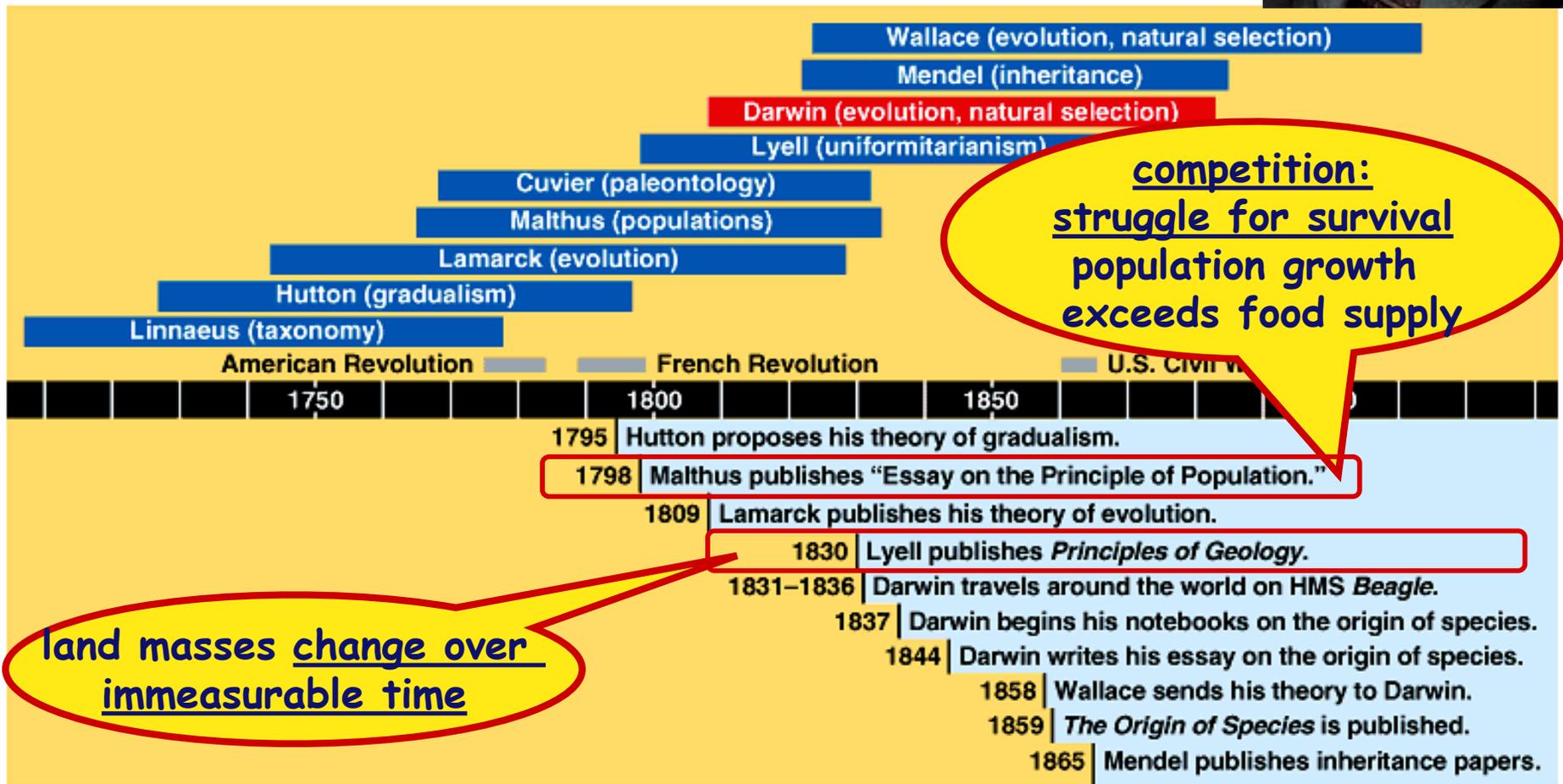
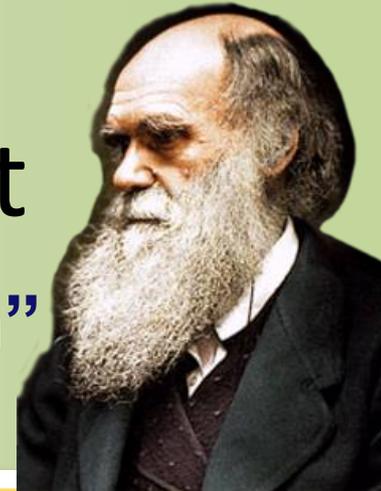
Ancestral dog



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

Darwin In historical context

“Science Does Not Happen In A Vacuum”



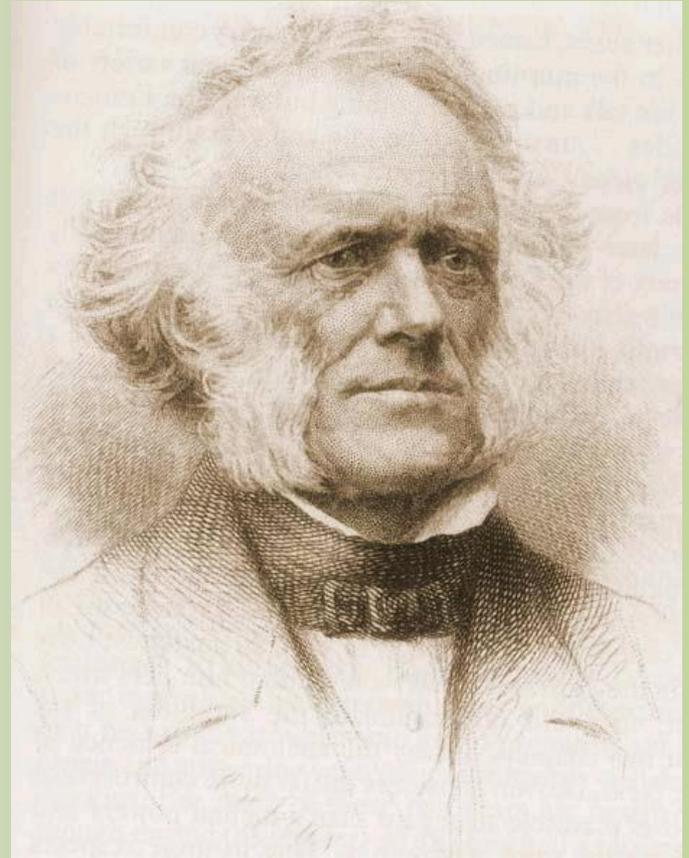
Thomas Malthus



"The power of population is indefinitely greater than the power in the earth to produce subsistence for man."

Economist -
Humans reproducing faster than our ability to grow food
Predicted famine, war, disease, etc.

Georges Cuvier and Charles Lyell



Cuvier, and Catastrophism

- Fossils are remains or traces of organisms from the past
 - Usually found in sedimentary rock, which appears in layers or strata
- Organisms changed due to Catastrophes like floods and volcanos

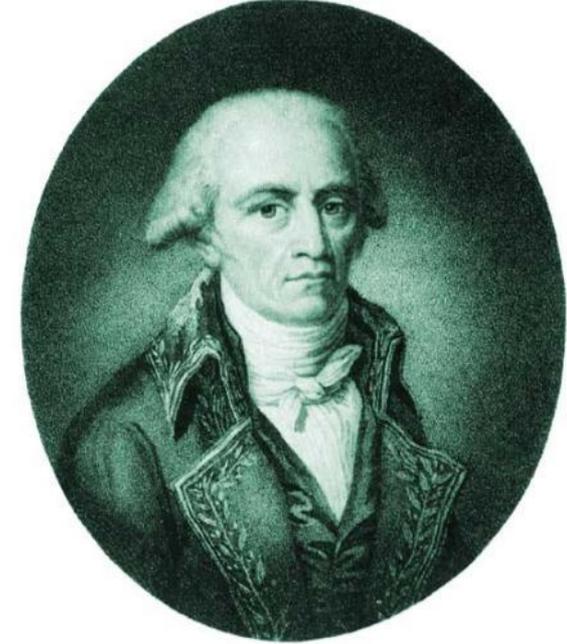


Figure 22.3

Lyell and Gradualism

- Geologist
- Said Erosion and deposition could change land slowly over time
- Not just quickly in catastrophes
- Concluded Earth was very old

Jean-Baptiste LaMarck

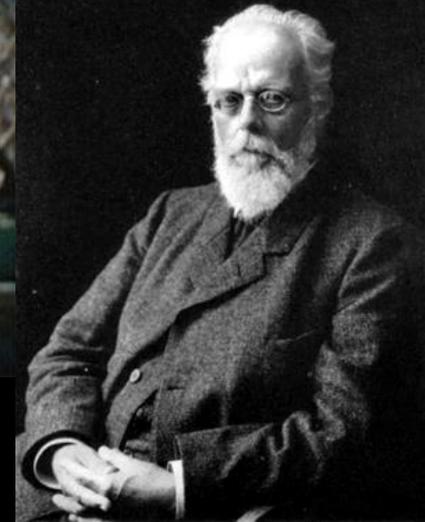


- Organisms adapted to their environments by acquiring traits
 - **Use & Disuse**
organisms lose parts because they don't use them.
 - **Perfection with Use & Need**
the constant use of an organ leads that organ to increase in utility.
- transmit acquired characteristics to offspring

Acquired traits cannot be inherited

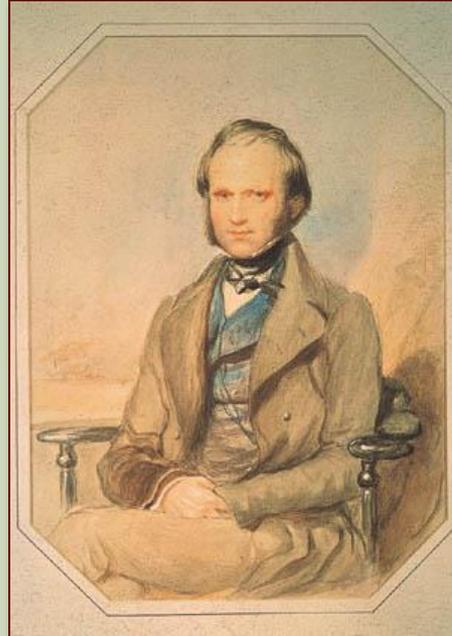
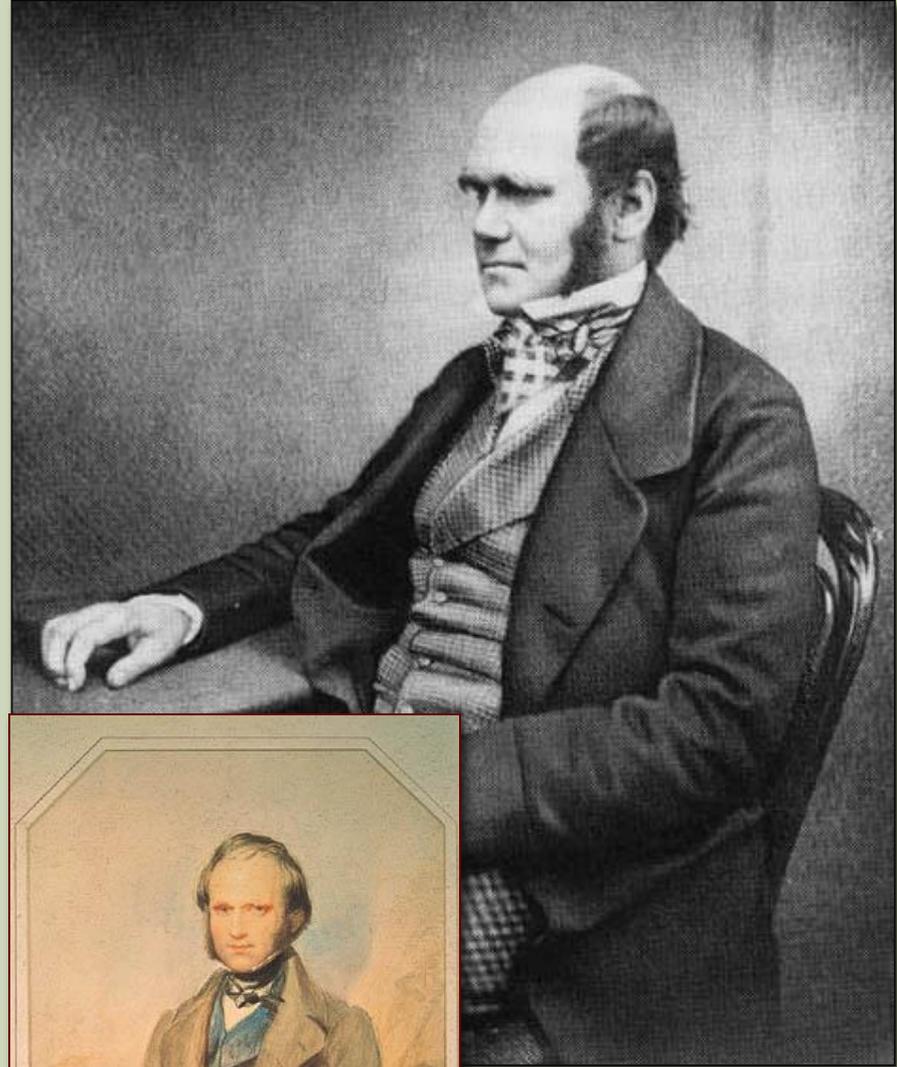


A. Weismann



Charles Darwin

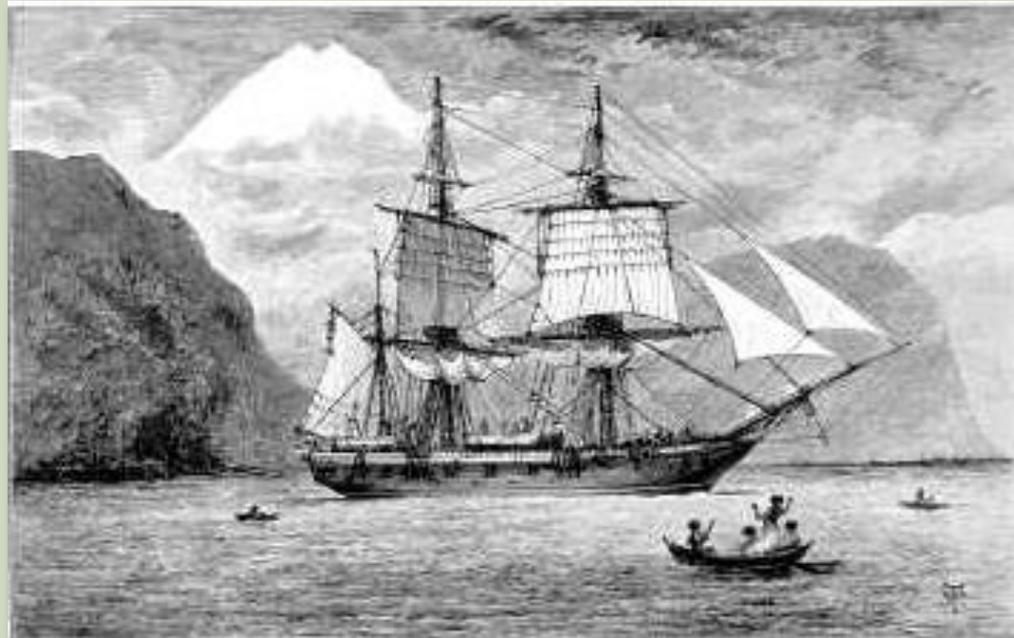
- 1809-1882
- British naturalist
- Evolution by natural selection
- Supported the theory with evidence.



Voyage of the HMS Beagle

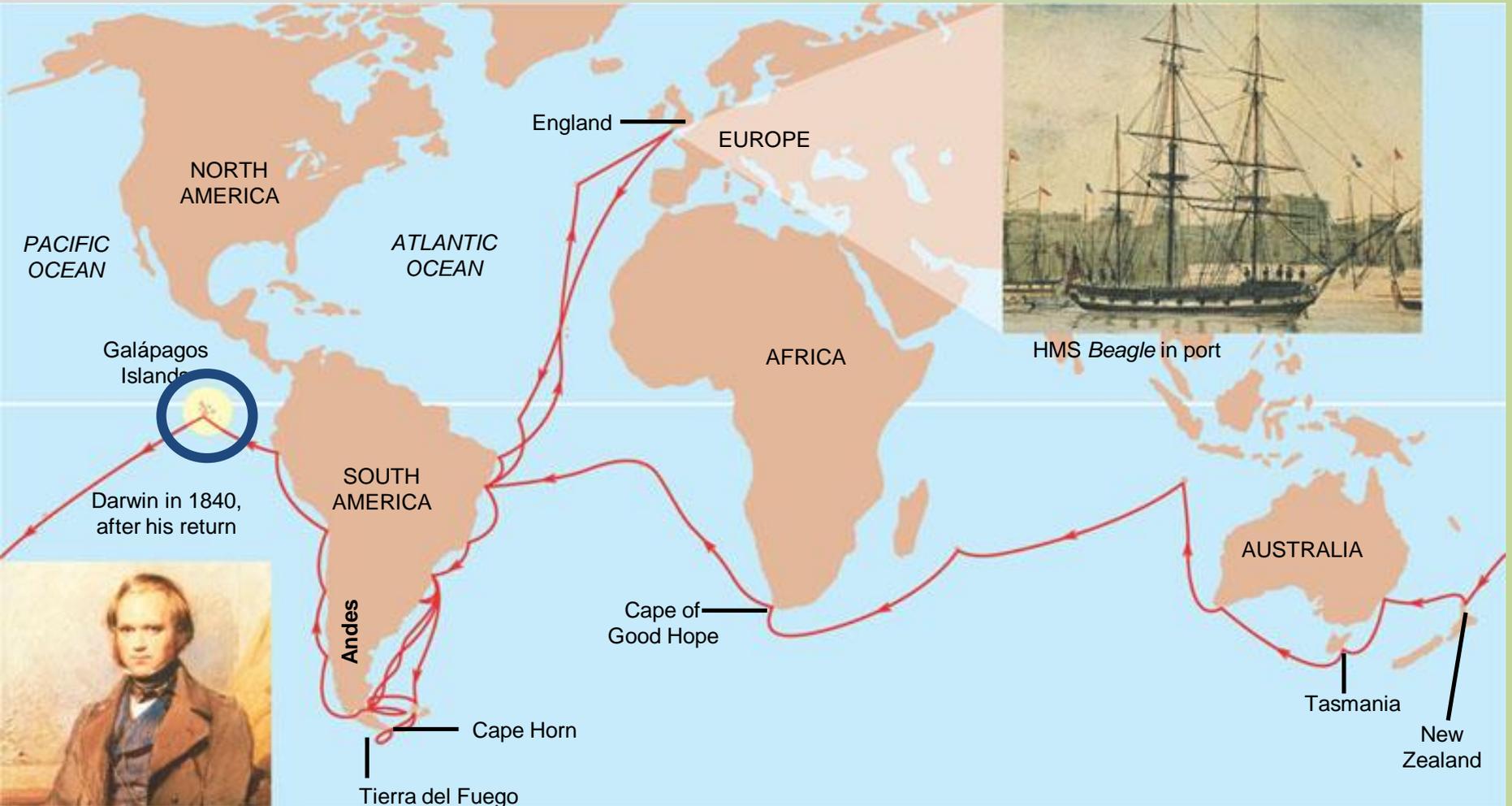
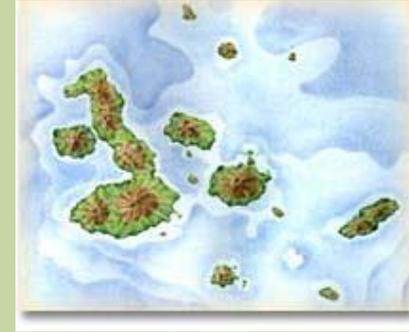
- Traveled around the world
 - 1831-1836 (22 years old!)
 - makes many observations of nature

Robert Fitzroy

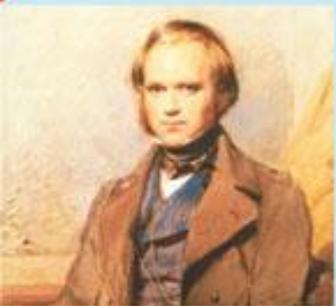


Voyage of the HMS Beagle

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



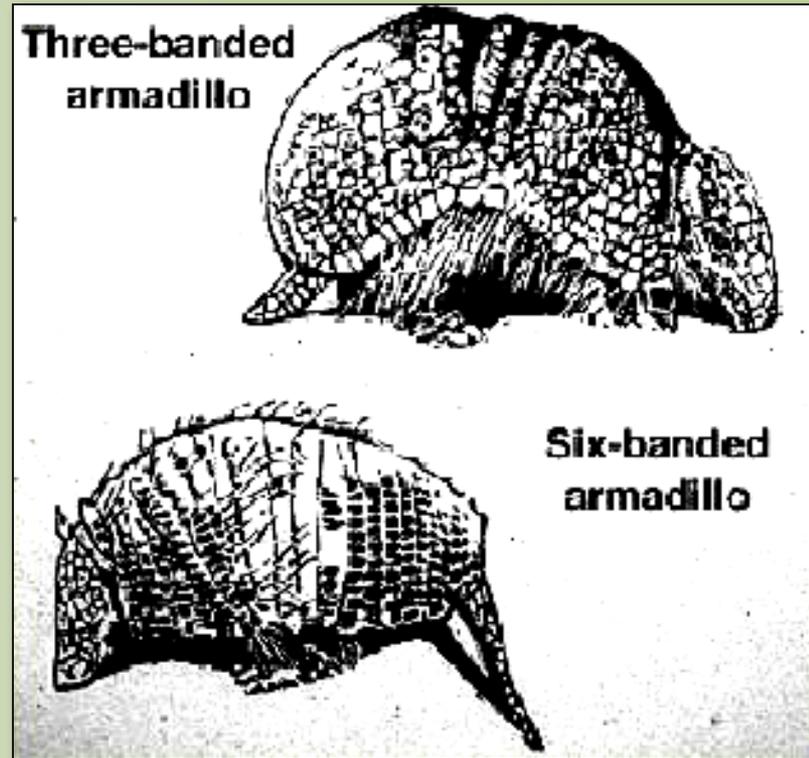
HMS *Beagle* in port



Darwin in 1840,
after his return

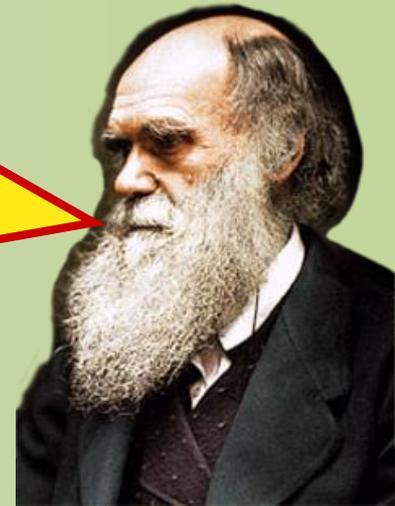
Succession of types

Armadillos are native to the Americas. Most species found in South America.

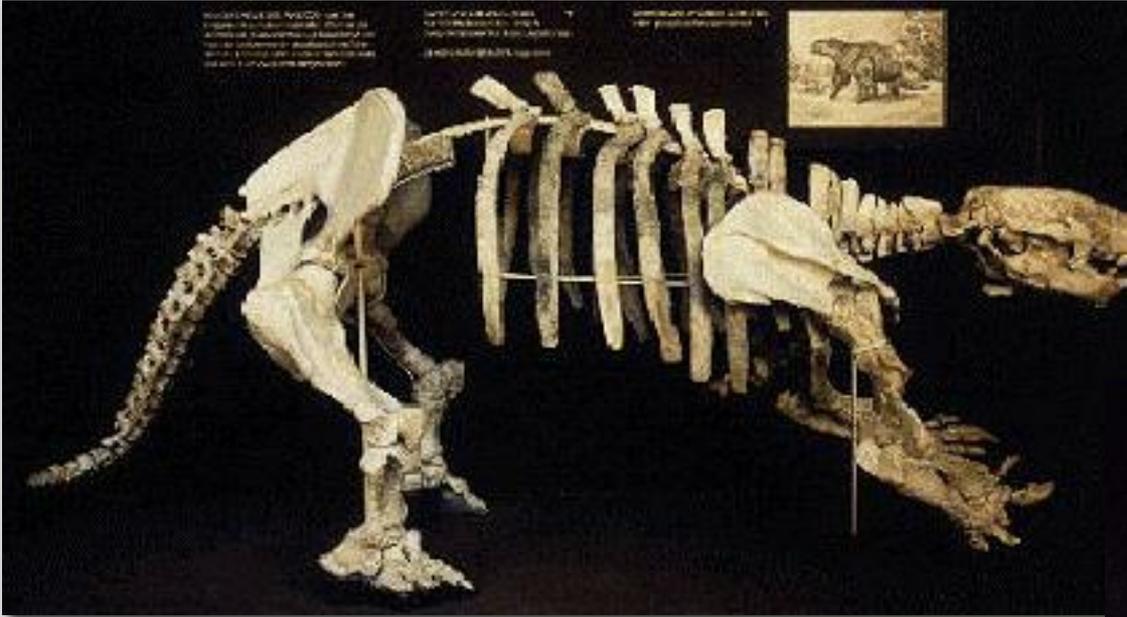


Glyptodont fossils also unique to South America.

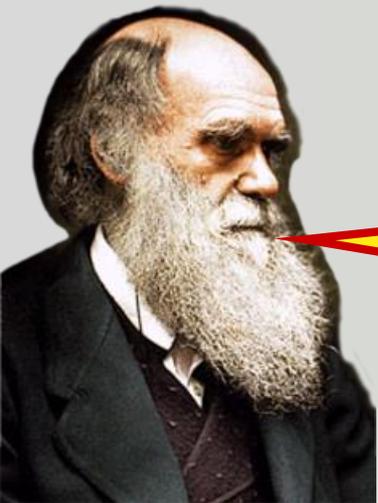
Why should extinct armadillo-like species & living armadillos be found on the same continent?



Mylodon (left) Giant ground sloth (extinct)



Modern sloth (right)

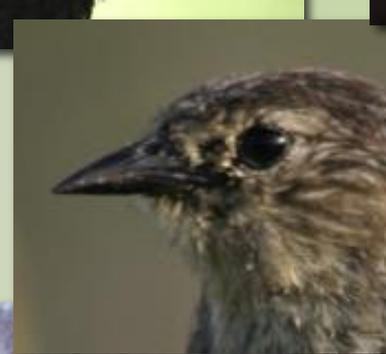
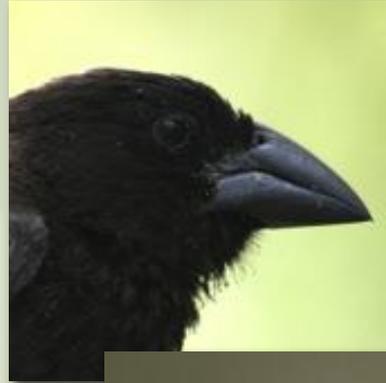


"This wonderful relationship in the same continent between the dead and the living will...throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts."



The Galapagos Islands

Unique species



A marine iguana, well-suited to its rocky habitat in the Galápagos Islands









Galapagos Sea Lion







Darwin found... birds

Collected many different birds on the Galapagos Islands.

Thought he found very different kinds...



Finch?



Sparrow?



Woodpecker?



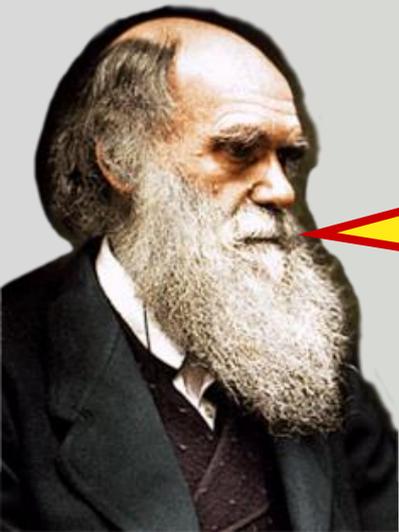
Warbler?

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!



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



Large Ground Finch



Small Ground Finch



Warbler Finch



Veg. Tree Finch

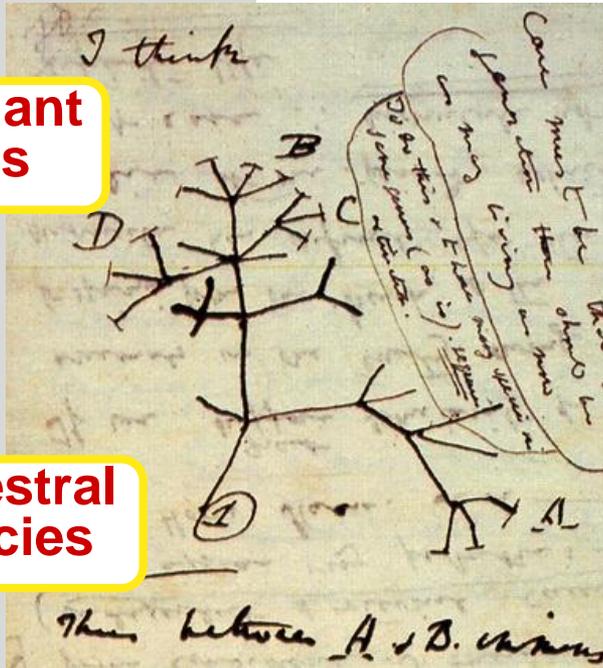




“Tree Thinking”

Descendant species

Ancestral species



Large Ground Finch



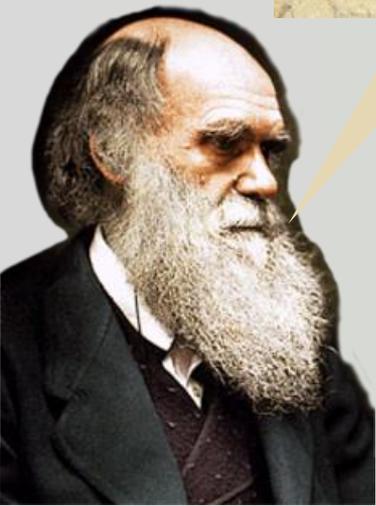
Small Ground Finch



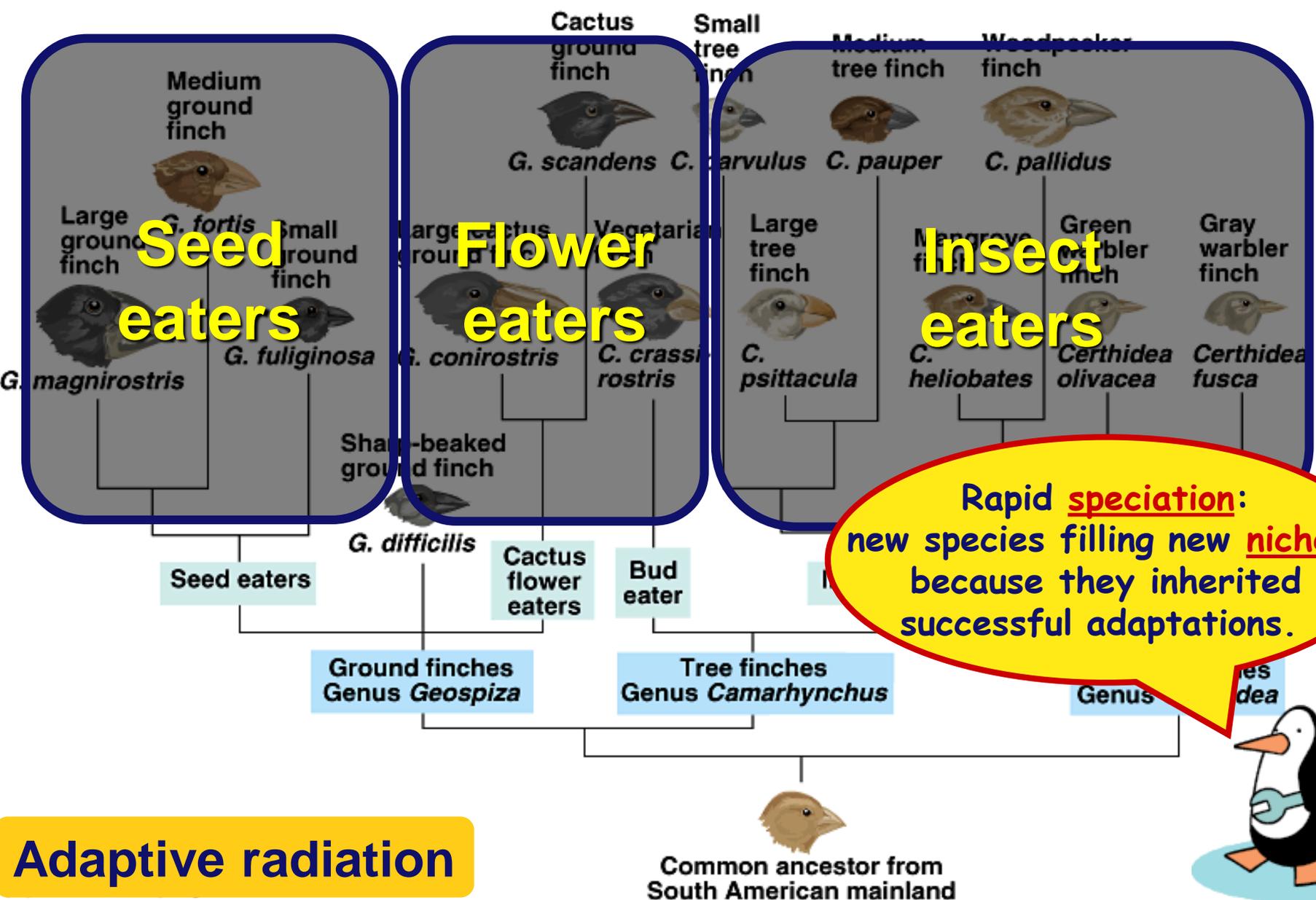
Warbler Finch



Veg. Tree Finch



Correlation of species to food source



Beak variation in Galápagos finches



(a) **Cactus eater.** The long, sharp beak of the cactus ground finch (*Geospiza scandens*) helps it tear and eat cactus flowers and pulp.



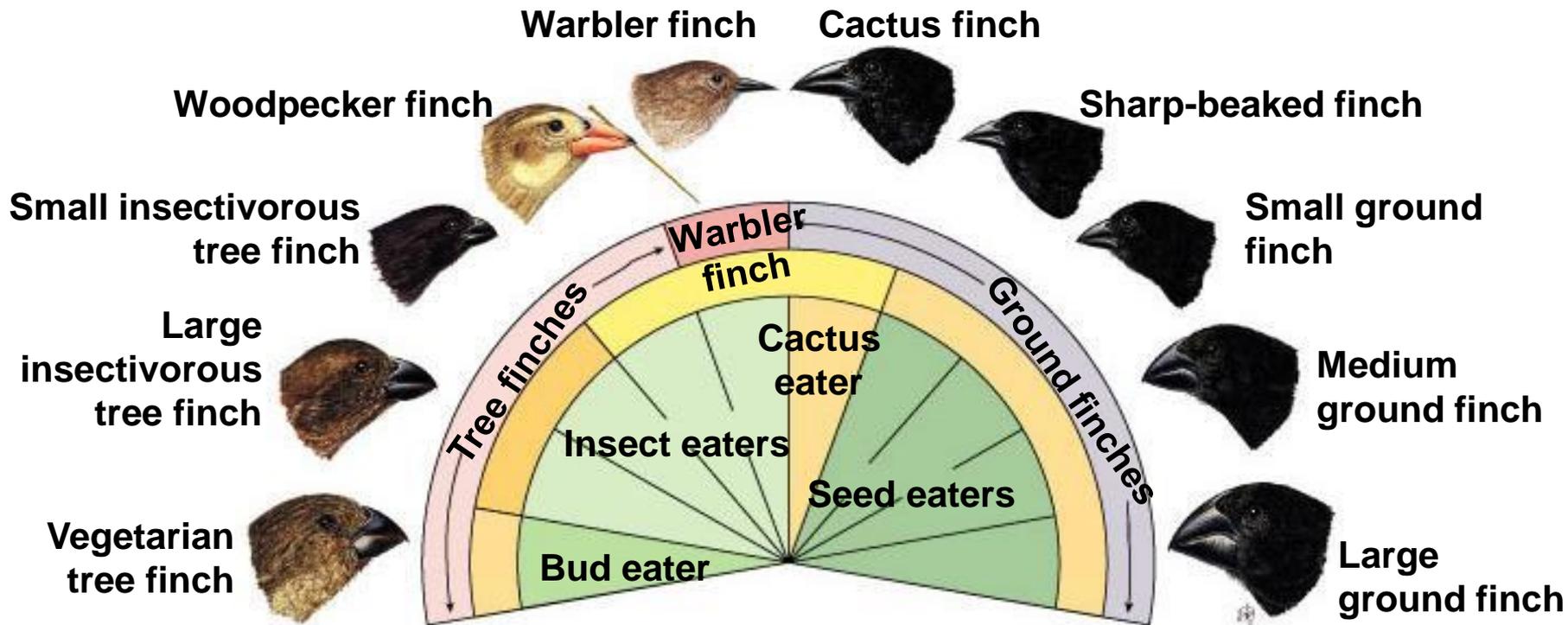
(c) **Seed eater.** The large ground finch (*Geospiza magnirostris*) has a large beak adapted for cracking seeds that fall from plants to the ground.



(b) **Insect eater.** The green warbler finch (*Certhidea olivacea*) uses its narrow, pointed beak to grasp insects.

Darwin's finches

- Differences in beaks
 - associated with food type
 - Adaptations to available food on islands led to differential survival and reproduction

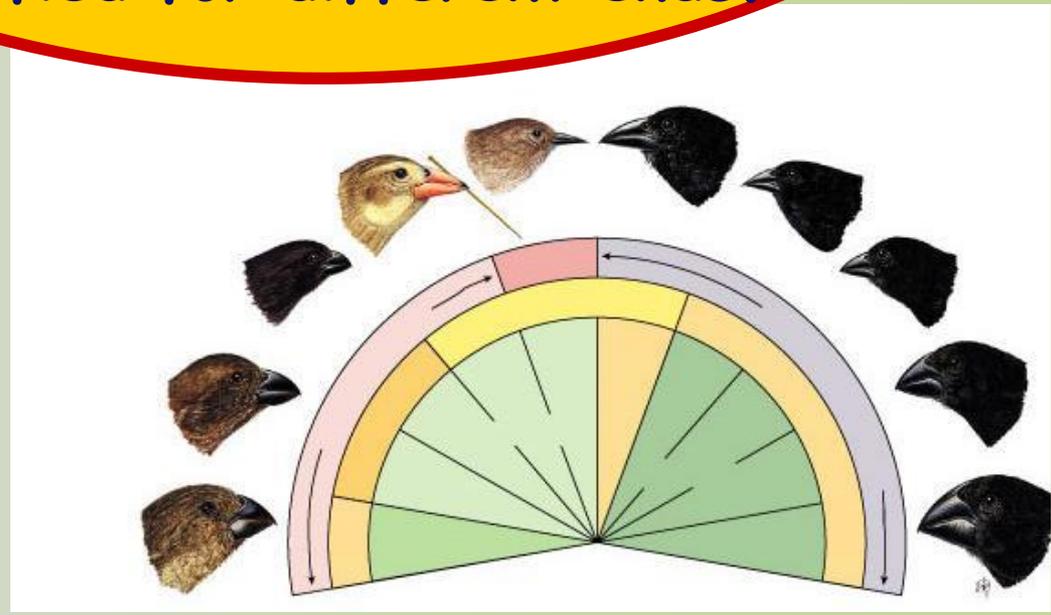
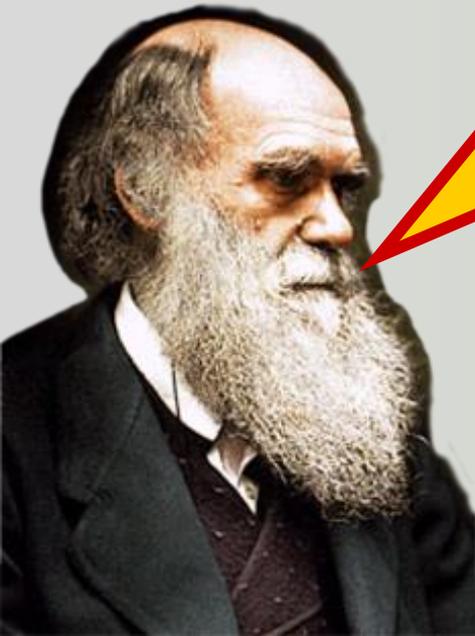


Darwin's finches

- 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

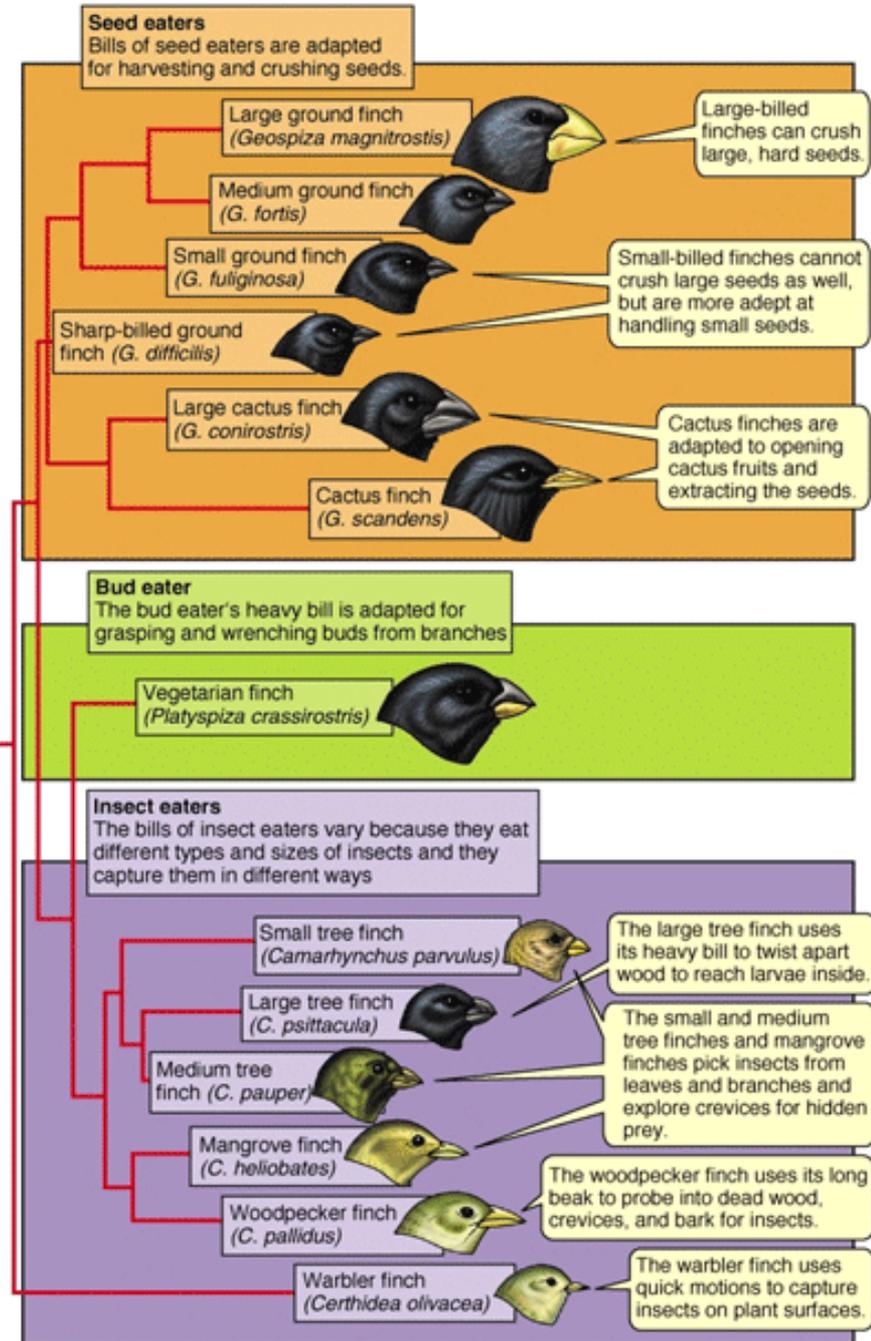


"Seeing this gradation & diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species has been taken & modified for different ends."

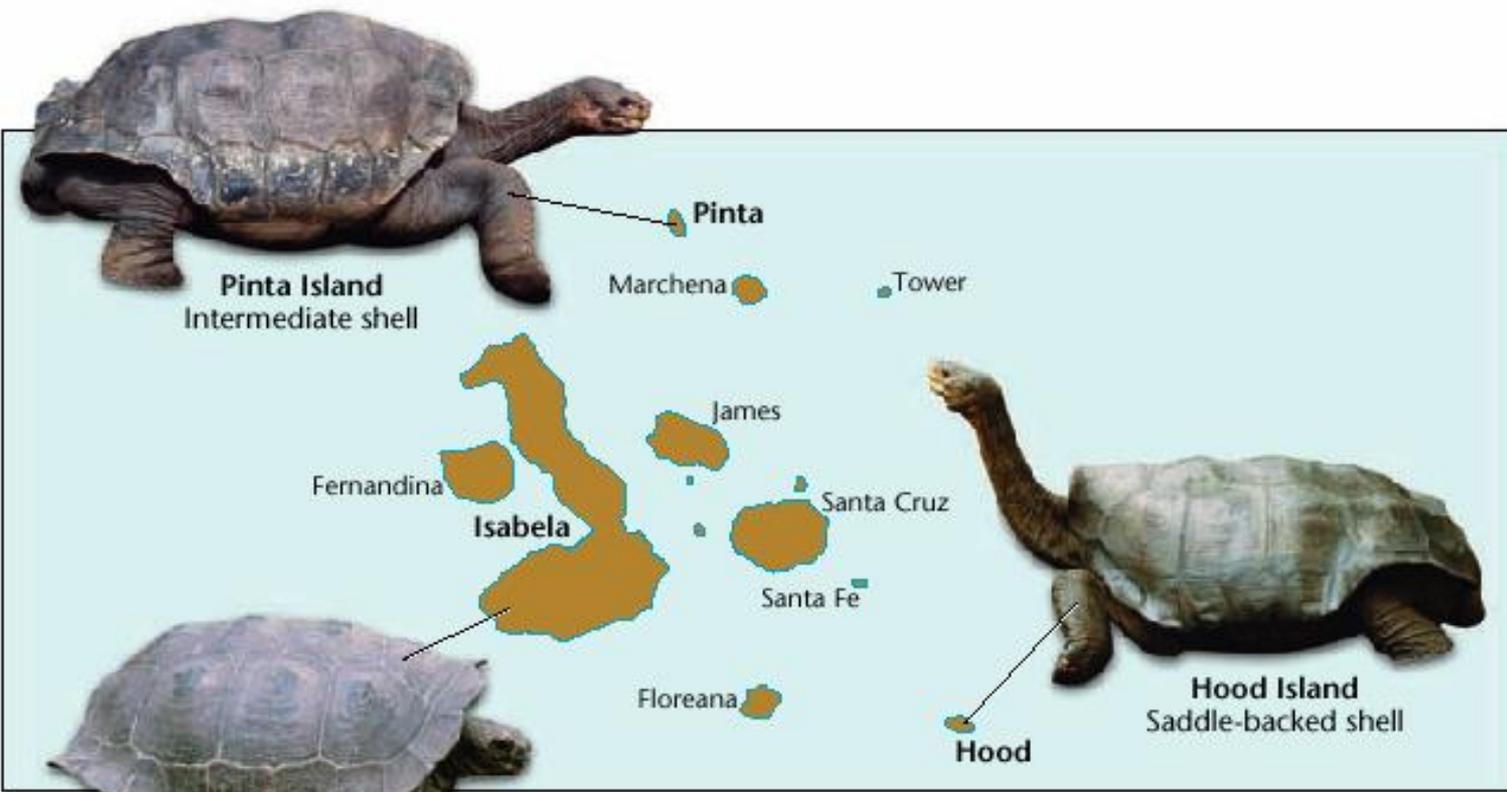


Darwin's finches

- Differences in beaks allowed some finches to...
 - compete
 - Feed
 - reproduce
 - pass successful traits onto their offspring



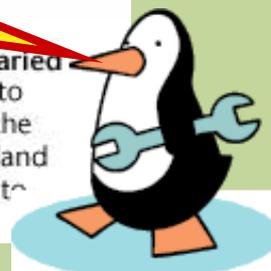
More observations... Correlation of species to food source



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

Whoa,
Turtles, too!

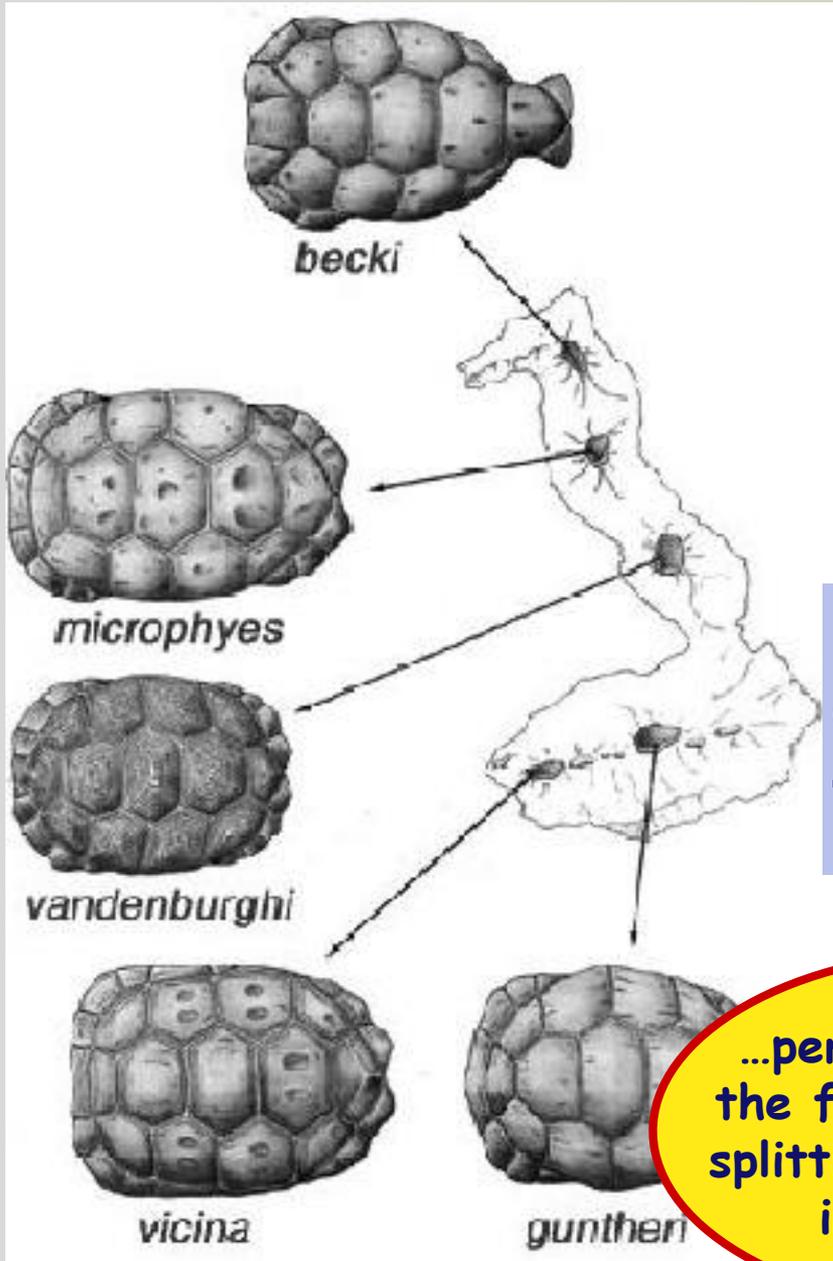
Variation Among Tortoises Darwin observed that the characteristics of many animals and plants varied noticeably among the different Galápagos Islands. Among the tortoises, the shape of the shell corresponds to different habitats. The Hood Island tortoise (right) has a long neck and a shell that is curved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



Giant Tortoise

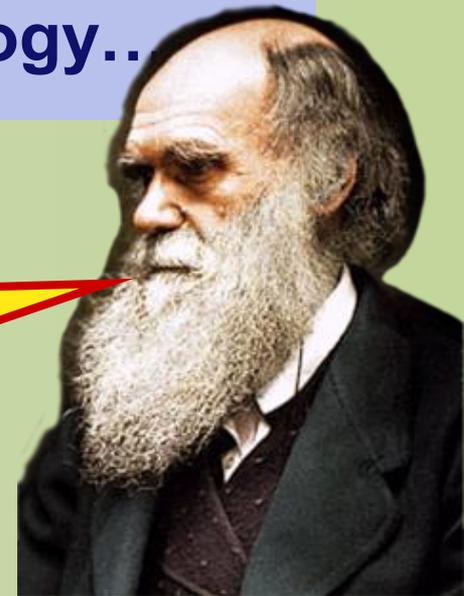




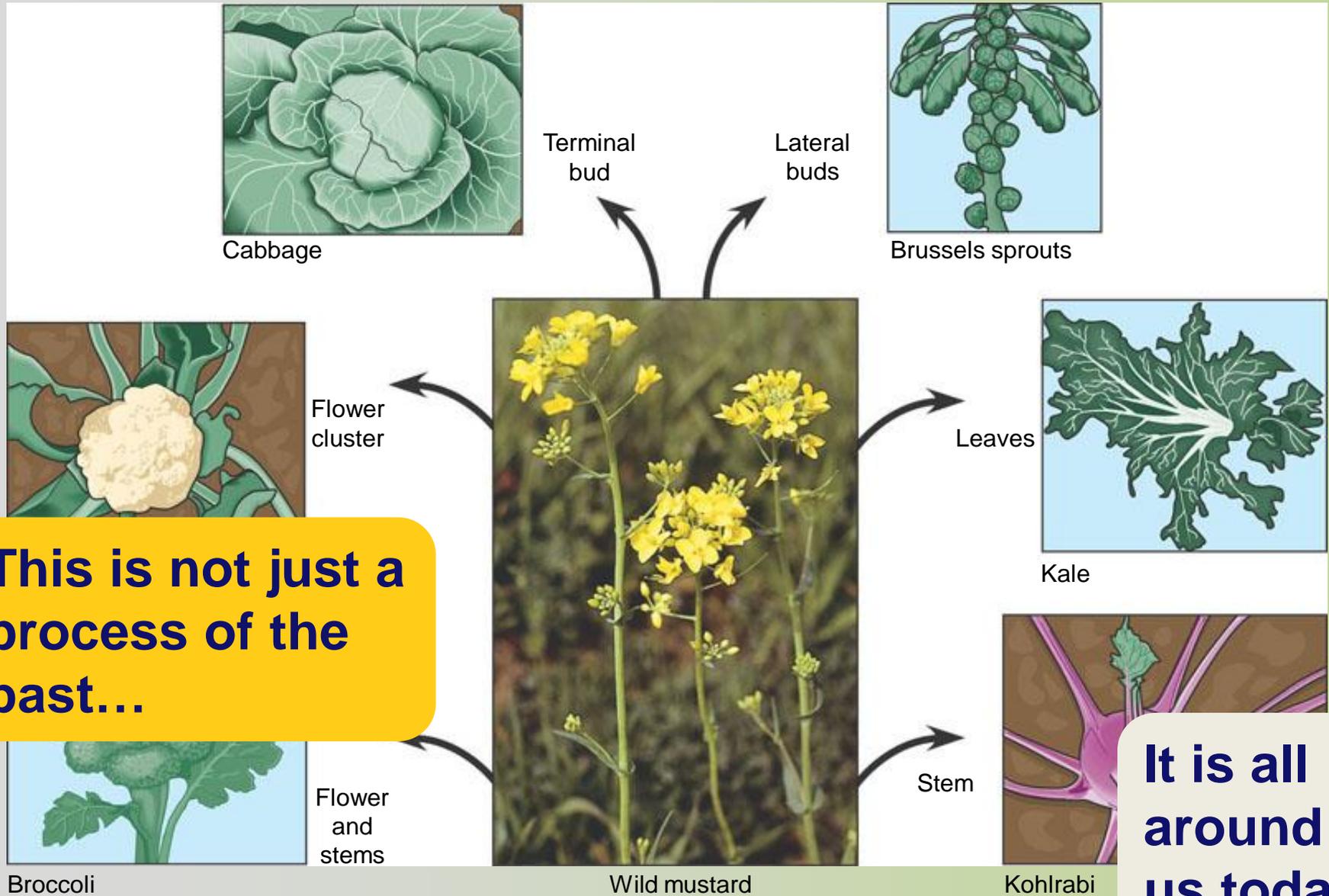


Many islands also show distinct *local* variations in tortoise morphology..

...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...

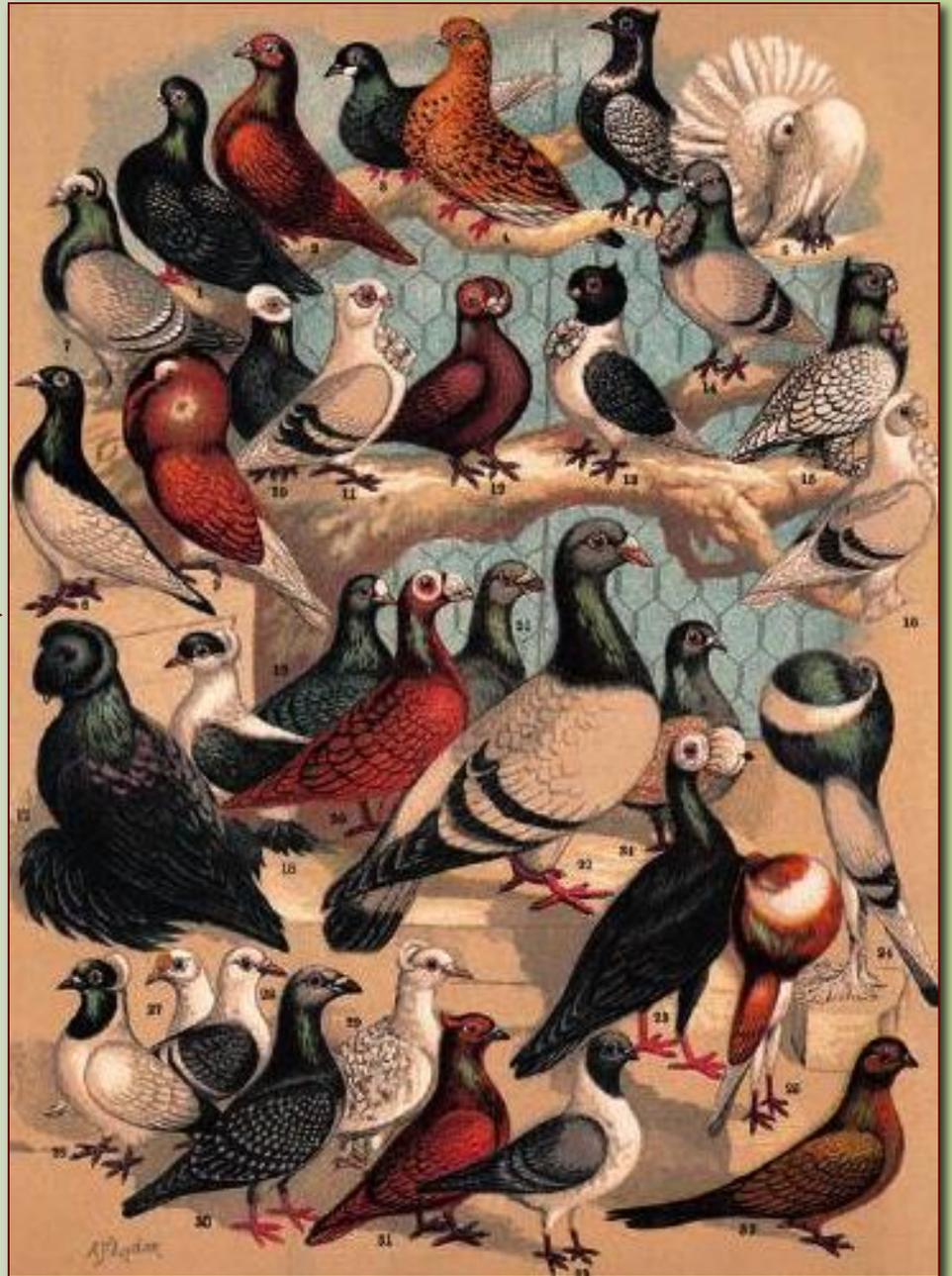
It is all around us today

Maize: a product of artificial selection



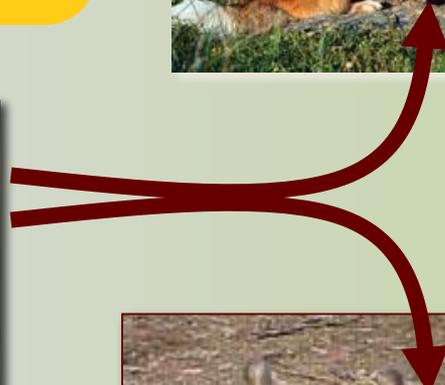
Selective breeding

the raw genetic material (variation) is hidden there



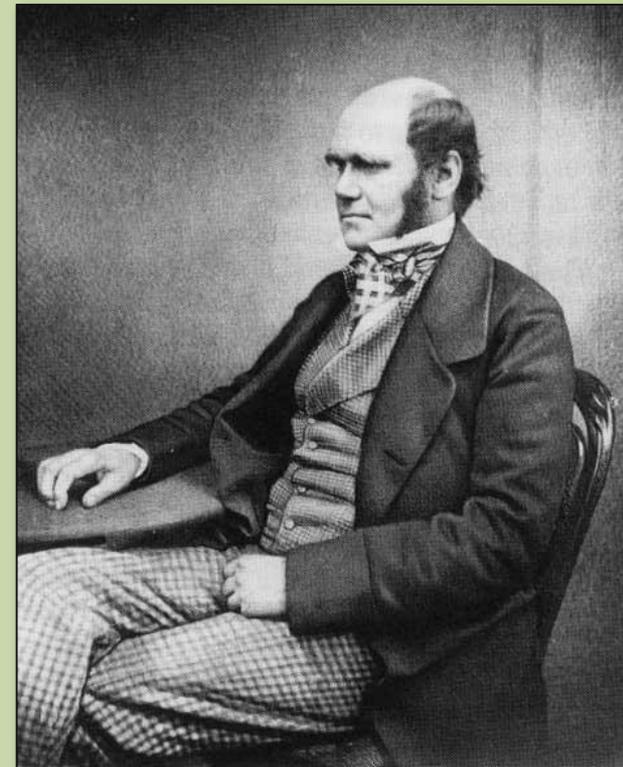
Selective breeding

Hidden variation can be exposed through selection!



A Reluctant Revolutionary

- Returned to England in 1836
 - wrote papers describing his collections & observations
 - long treatise on barnacles
 - drafts of his theory of species formation in 1844
 - To be published upon his death

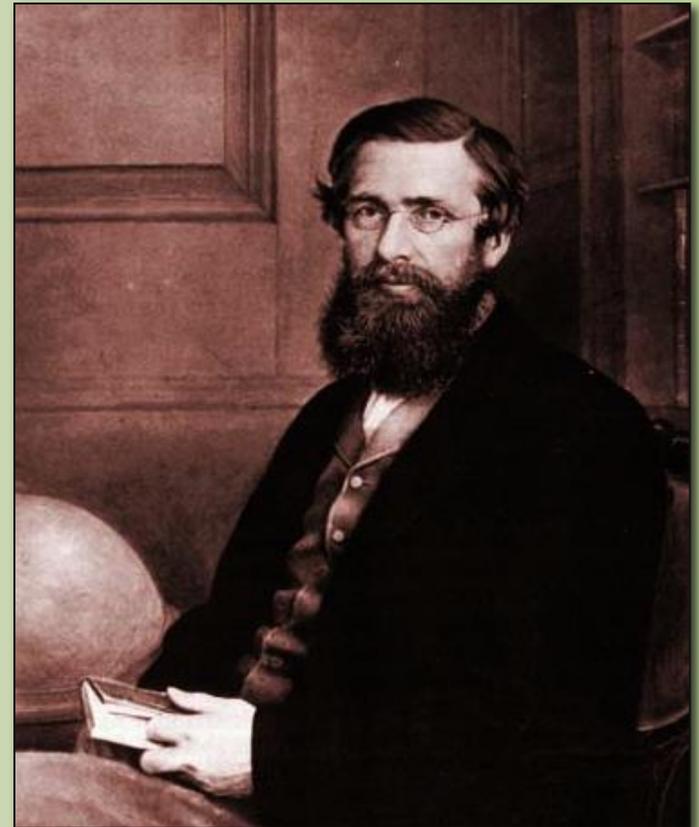


And then came a letter....

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 proof of the originality of the 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 which differ so slightly (although constantly) from the original form of the other. Which is the variety determining, except in those rare cases where the variety is unlike itself and resembling the parent? "permanent invariability of species" - races which have strict limits, and can never be proved to have departed from it, which, from the analogy of domesticated animals, the tendency of varieties to

It will be observed that this argument, which is in all respects analogous to that of the present paper to show that this assumption is not true, and that nature which will cause many varieties to depart further and further from the original form of domesticated animals, the tendency of varieties to

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.

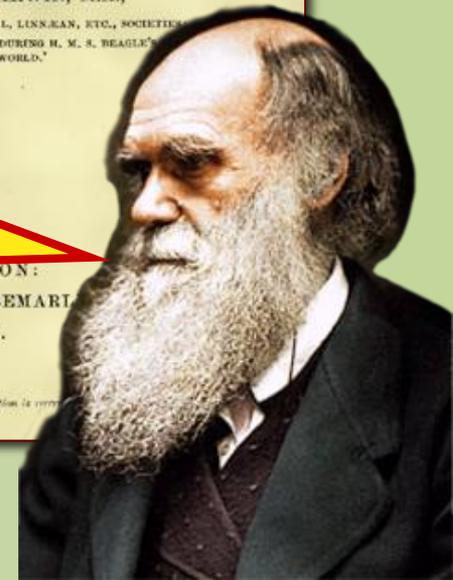
By CHARLES DARWIN, M.A.,

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

LONDON:
JOHN MURRAY, ALBEMARLE STREET,
1859.

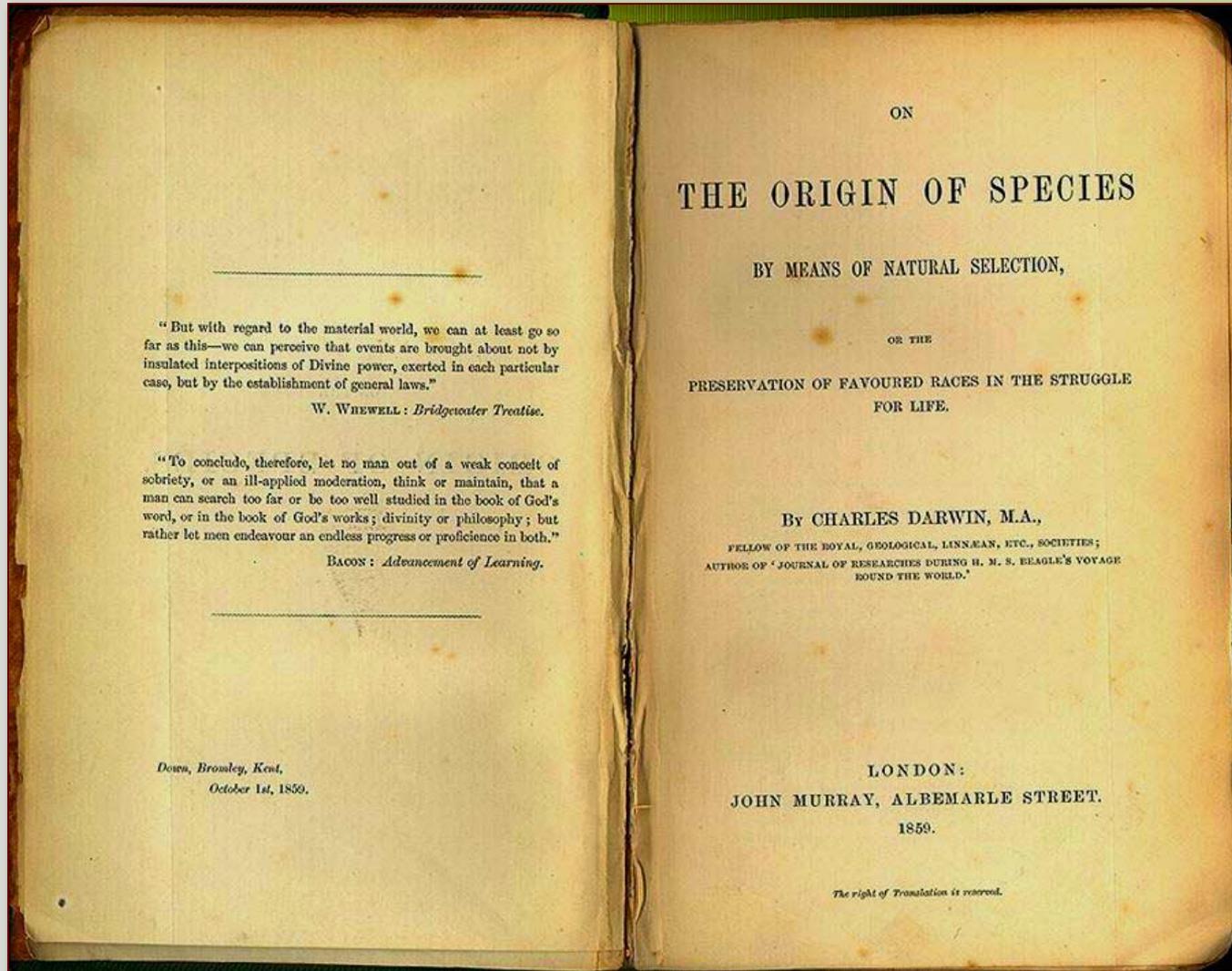
The right of Translation is reserved.

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.



November 24, 1859, Darwin published

“*On the Origin of Species by Means of Natural Selection*”



Essence of Darwin's ideas



- Natural selection

- variation exists in populations

- over-production of offspring

- more offspring than the environment can support (Malthus)

- competition

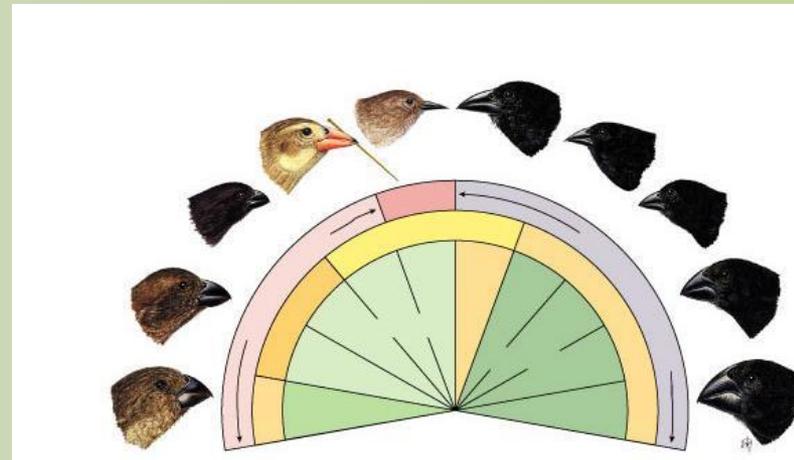
- for food, mates, nesting sites, escape predators

- differential survival

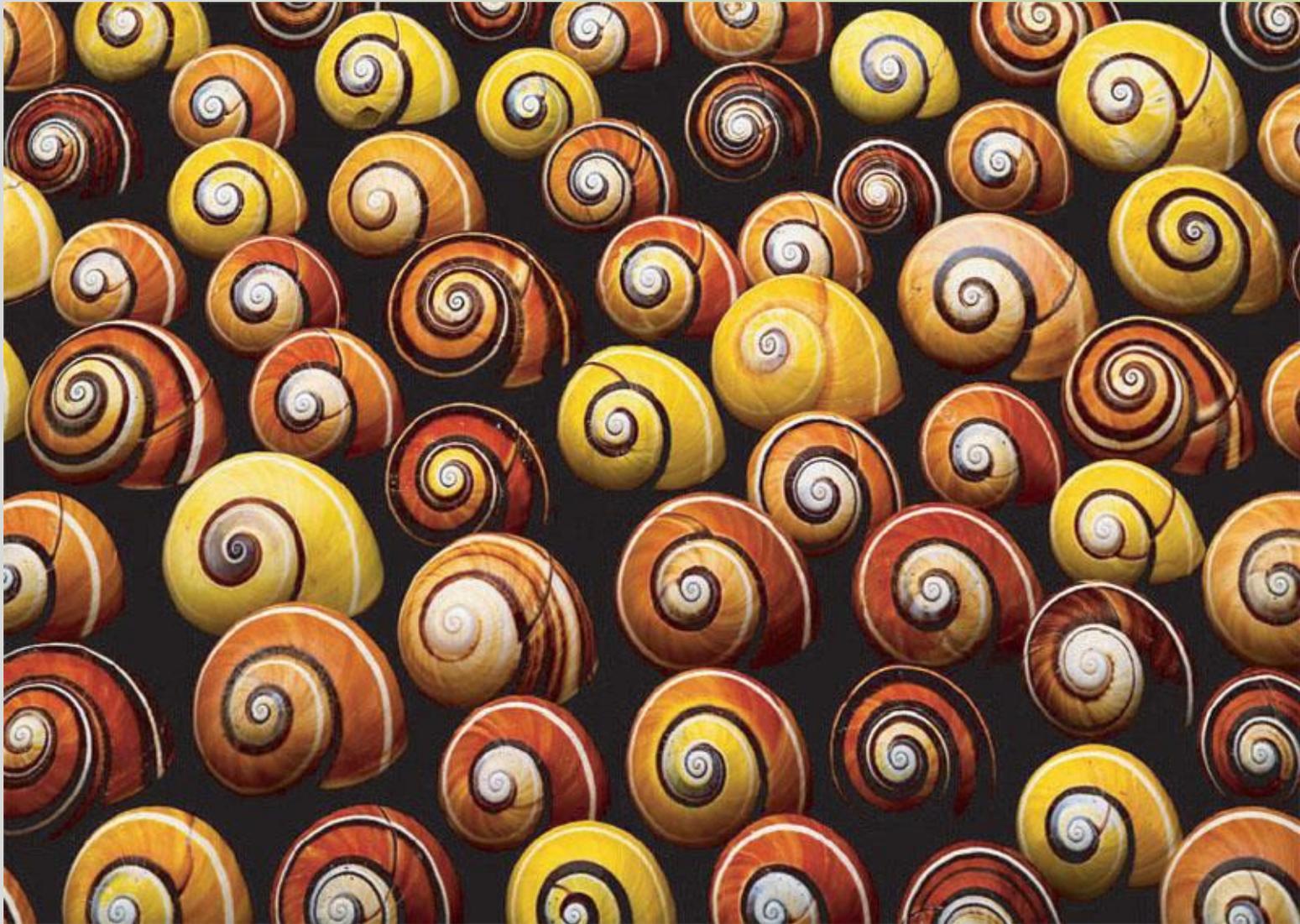
- successful traits = adaptations

- differential reproduction

- adaptations become more common in population



Variation in a natural population



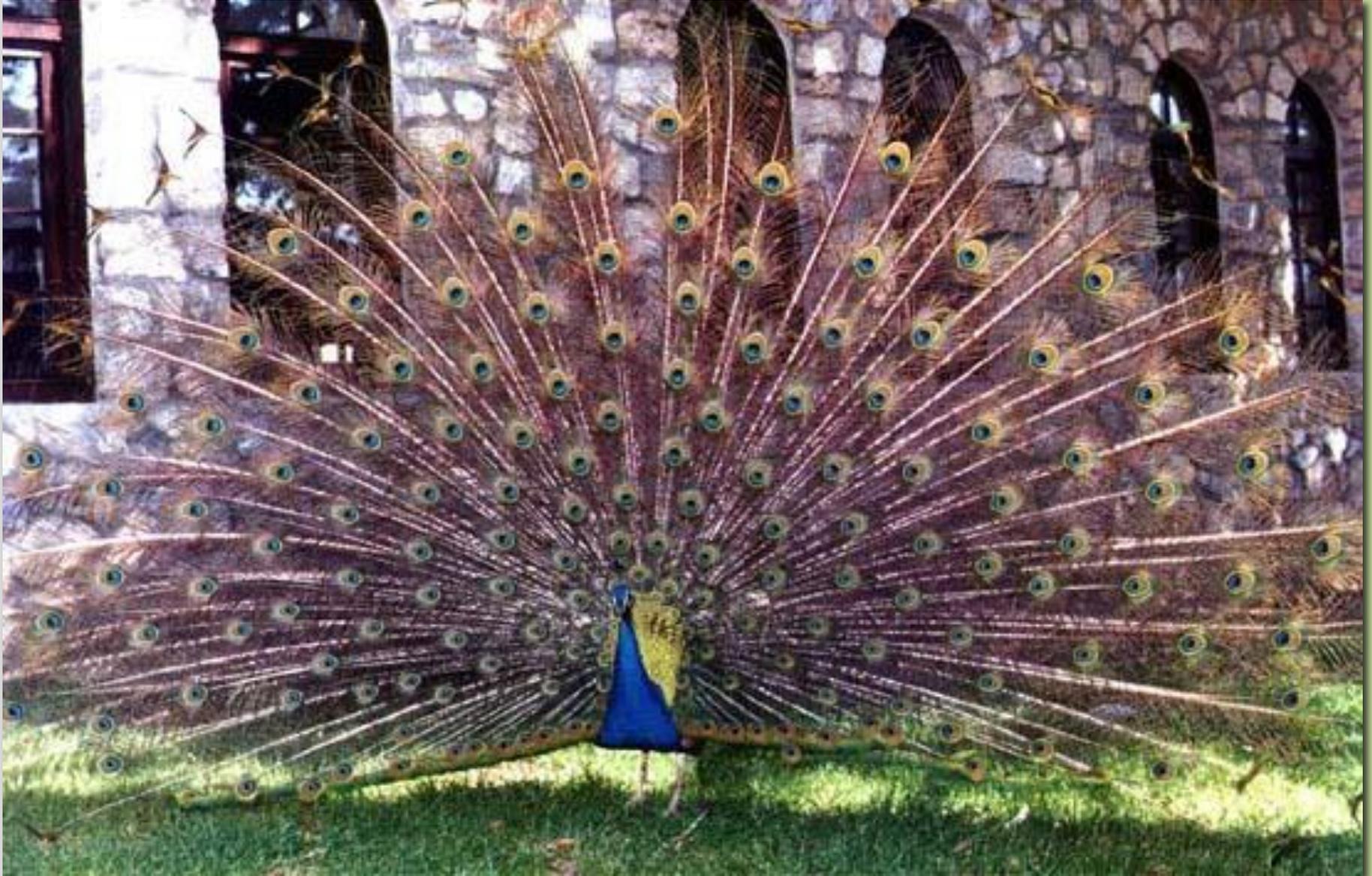
Overproduction of offspring



Competition



Differential Reproduction



Camouflage as an example of evolutionary adaptation

(a) A flower mantid in Malaysia



(b) A stick mantid in Africa



LaMarckian vs. Darwinian view

- LaMarckian
 - in reaching higher vegetation giraffes stretch their necks transmits the acquired longer neck to offspring



- Darwinian
 - giraffes born with longer necks survive better & leave more offspring who inherit their long necks



To assess public opinion on creationism, **Gallup** asked:

Which of the following statements comes closest to your views on the origin and development of human beings?

1) Human beings have developed over millions of years from less advanced forms of life, but God guided this process,

2) Human beings have developed over millions of years from less advanced forms of life, but God had no part in this process,

3) God created human beings pretty much in their present form at one time within the last 10,000 years or so?

Polled in November **2004**, 38% of respondents chose (1), 13% chose (2), 45% chose (3), and 4% offered a different or no opinion. These results are also similar to those from previous **Gallup** polls, which extend back to 1982.

(National Center for Science Education, 2004)

**Stick your neck out...
Ask Questions!**



Review Questions

1. Increased UV irradiation causes the skin of humans to become more darkly pigmented over a period of days. The notion that the offspring of such tanned individuals should consequently inherit darkened skin from their parents is consistent with the ideas of
 - A. Charles Darwin.
 - B. Carolus Linnaeus.
 - C. Alfred Wallace.
 - D. Jean Baptiste Lamarck.
 - E. Charles Lyell.

2. Acquired Characteristics

- A. Are passed on to offspring, regardless of the parent who possesses them.
- B. Are the basis for all variation in a population
- C. Can not be inherited
- D. Are the raw material for natural selection
- E. Are passed on to offspring only if the mother acquires them