

# Chapter 22. Evolution by Natural Selection

AP Biology

2006-

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

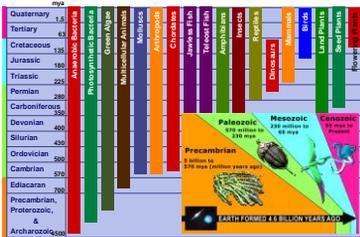
-- Theodosius Dobzhansky  
March 1973  
Geneticist, Columbia University (1900-1975)

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## Fossil record?

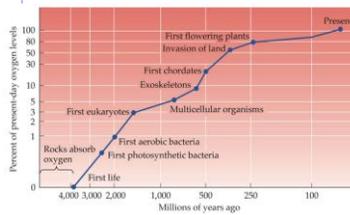


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Life's Natural History is a Record of Succession & Extinction

## Evolution of life has altered the Earth



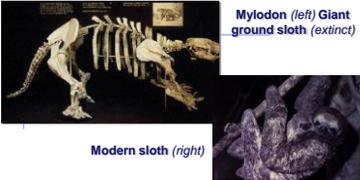
## "Succession of types"

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



Glyptodont fossils also unique to South America. Why should extinct armadillo-like species & armadillos be found on same continent?

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Mylodon (left) Giant ground sloth (extinct)

Modern sloth (right)

"This wonderful relationship in the same continent between the dead and the living will, I do not doubt, throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts."  
Chapter 8, Voyage of the Beagle

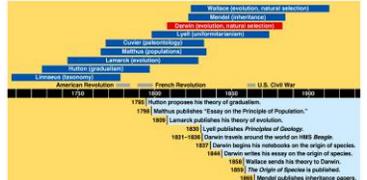
## LaMarck

- Organisms were adapted to their environments
- adaptation is a result of change caused by environmental pressures
  - 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

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## In historical context

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



## Charles Darwin

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

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## Voyage of the HMS Beagle

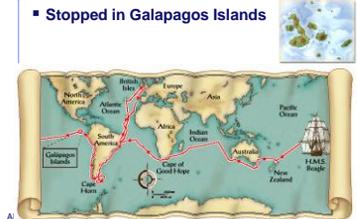
- Travels around the world
  - 1831-1836
    - makes many observations of natural world
    - main mission of the *Beagle* was to chart South American coastline

Robert Fitzroy

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## Voyage of the HMS Beagle

- Stopped in Galapagos Islands



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## Galapagos

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



800 km west of mainland

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## Unique species



## The Birds...

- Galapagos 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 note to a series of small but distinctive birds
  - some were woodpecker-like, some warbler-like, & some finch-like

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## Darwin's finches

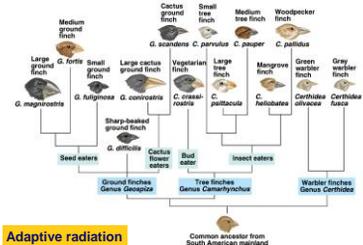
- Darwin was amazed to find out they were **all** finches
    - 14 species
    - but only one species on mainland of South America
      - 800 km away
      - all presumably originated from mainland
- Large-seed eater?      Small-seed eater?
- Warbler?      Leaf-browser?

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Warbler?

Leaf-browser?

## Correlation of species to food source



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## Darwin's finches

- Differences in beaks
  - associated with eating different foods
  - adaptations to foods available on islands

## Darwin's finches

### Darwin's conclusions

- original South American finches reached islands
  - adapted to food available in different environments
- over many generations, the finches changed anatomically & behaviorally
  - accumulation of favorable traits
  - emergence of different species

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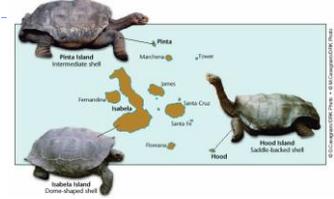
## Darwin's finches

### Finches with beak differences that allowed them to...

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

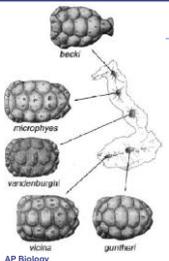
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## Correlation of species to food source



**Variation Among Tortoises** Darwin observed that the characteristics of many animals and plants varied noticeably among the different Galapagos 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 Santa I (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 Santa J (middle) has a shell that is intermediate between these two forms.

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

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

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



It is all around us today

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## Selective breeding

the raw genetic material is hidden there



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## Selective breeding

Broad variation!



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## A Reluctant Revolutionary

- Returned to England in 1836
  - wrote papers describing his collections & observations
  - 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

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## 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.



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**Darwin wrote to Lyell:**

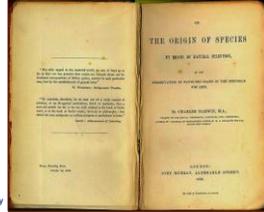
*"Your words have come true with a vengeance... I never saw a more striking coincidence... so all my originality, whatever it may amount to, will be smashed."*



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Voyage: 1831-1836

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



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**Essence of Darwin's ideas**

- His theory was simple...
  - (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**
  - (4) **Characteristics beneficial** in the struggle for existence will tend to become more common in the population, changing the characteristics of a species
  - (5) Over time, and given a steady input of new variation into a population, these processes lead to the **emergence of new species**

**LaMarckian vs. Darwinian view**

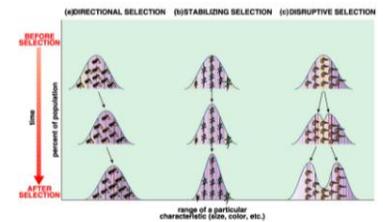
- **LaMarck**
  - ♦ in reaching higher vegetation giraffes stretch their necks & transmits the **acquired** longer neck to offspring
- **Darwin**
  - ♦ longer-necked giraffes survive better & leave more offspring who **inherit** their long necks
  - **genes**

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**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

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Natural selection can act in a number of directions

**Natural Selection can take several forms**

- **Predation Selection**
  - ♦ camouflage (mimicry)
  - ♦ speed
  - ♦ behaviors & habits
  - ♦ defenses (physical & chemical)

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**Can you find the mantis?**



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**Natural Selection can take several forms**

- **Physiological Selection**
  - ♦ fitness (food-gathering)
  - ♦ physiology efficiency (oxygen, food, water)
  - ♦ disease resistance
  - ♦ protection from injury
  - ♦ biochemical versatility

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## Natural Selection can take several forms

### Sexual Selection

- attractiveness to potential mate
- fertility of gametes
- "ultimately, differential reproductive success"

"survival" doesn't matter if you don't reproduce!  
(meaning: attract mate & breed)

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## Sexual selection

### Sexual selection acts in all sexually-reproducing species

- it influences morphology & behavior
- it acts on both males and females

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Jacanas