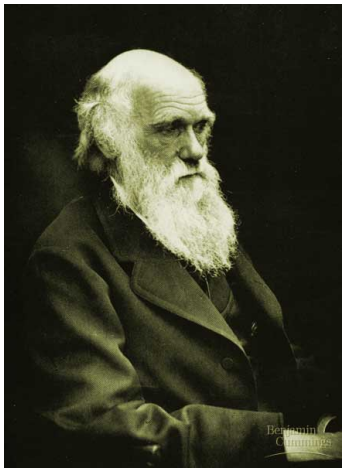
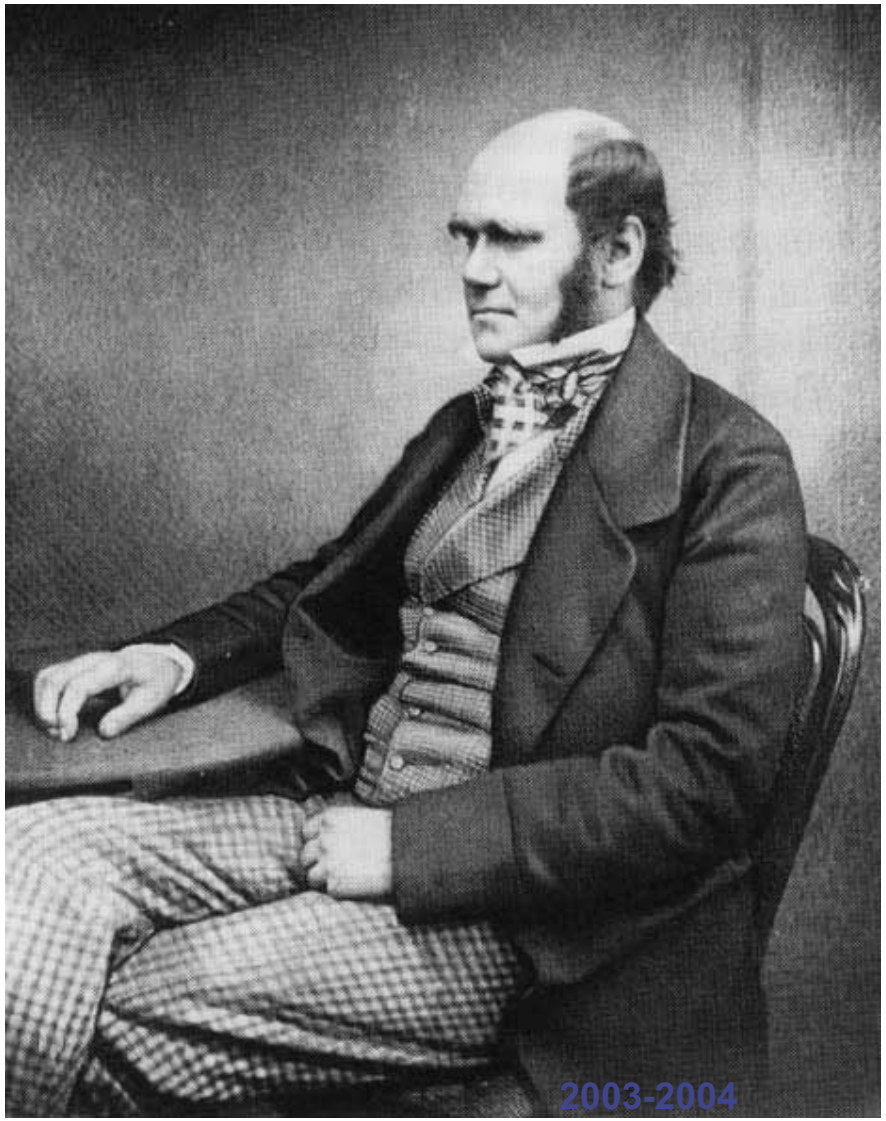


Evolution by Natural Selection

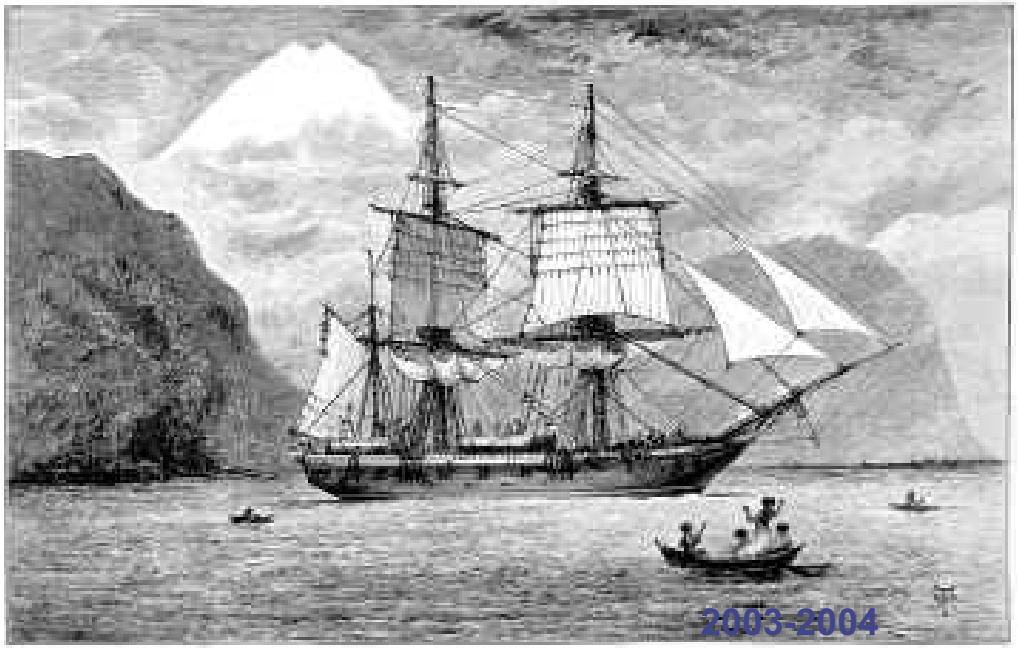
Charles Darwin

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



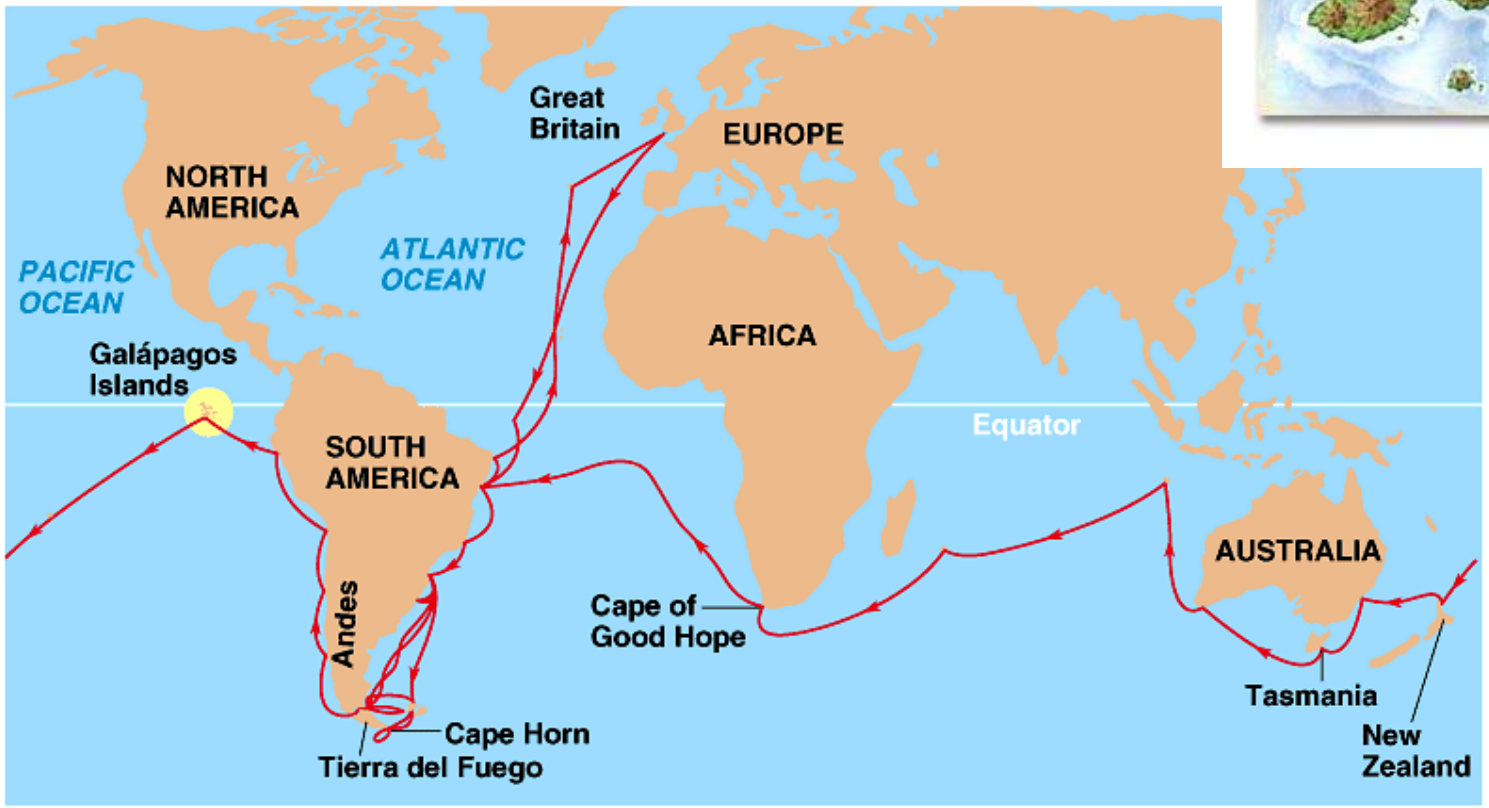
Voyage of the HMS Beagle

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



Voyage of the HMS Beagle

- Stopped in Galapagos Islands

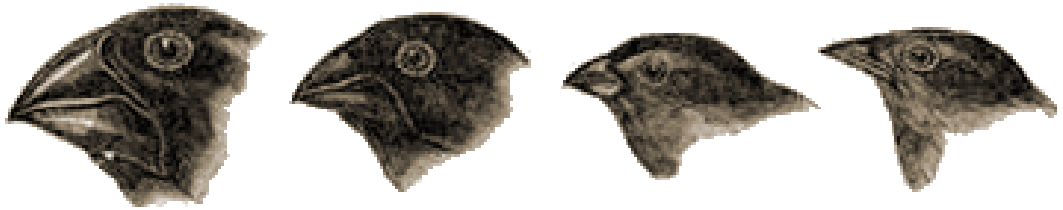


Darwin's finches

- 13 species of finches in the Galápagos Islands
- Was puzzling since only 1 species of this bird on the mainland of South America, 600 miles to the east, where they had all presumably originated

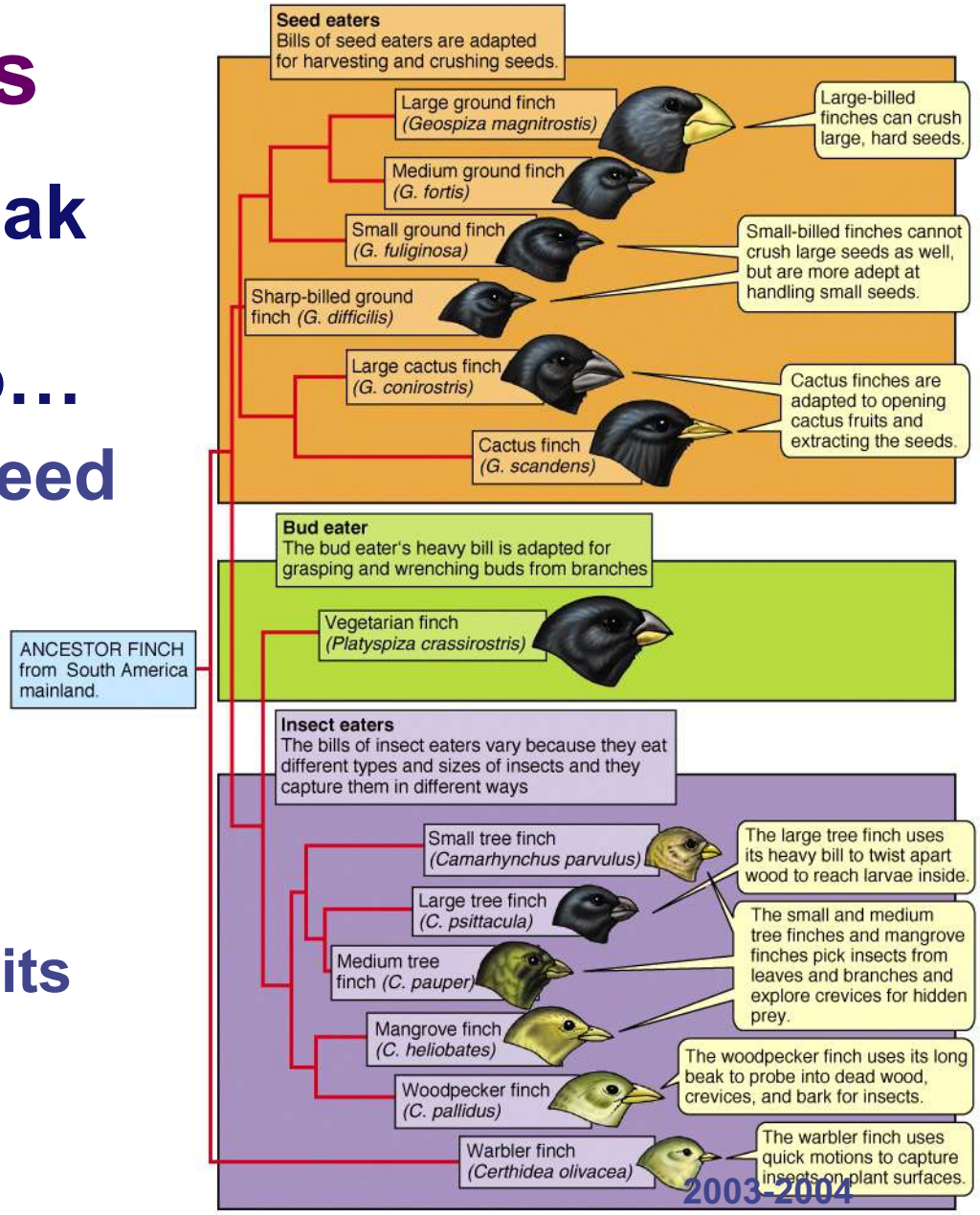
Darwin's finches

- **Differences in beaks**
  - associated with eating different foods
  - **adaptations to the foods available on their home islands**
- **Darwin concluded that when the original South American finches reached the islands, they adapted to available food in different environments**



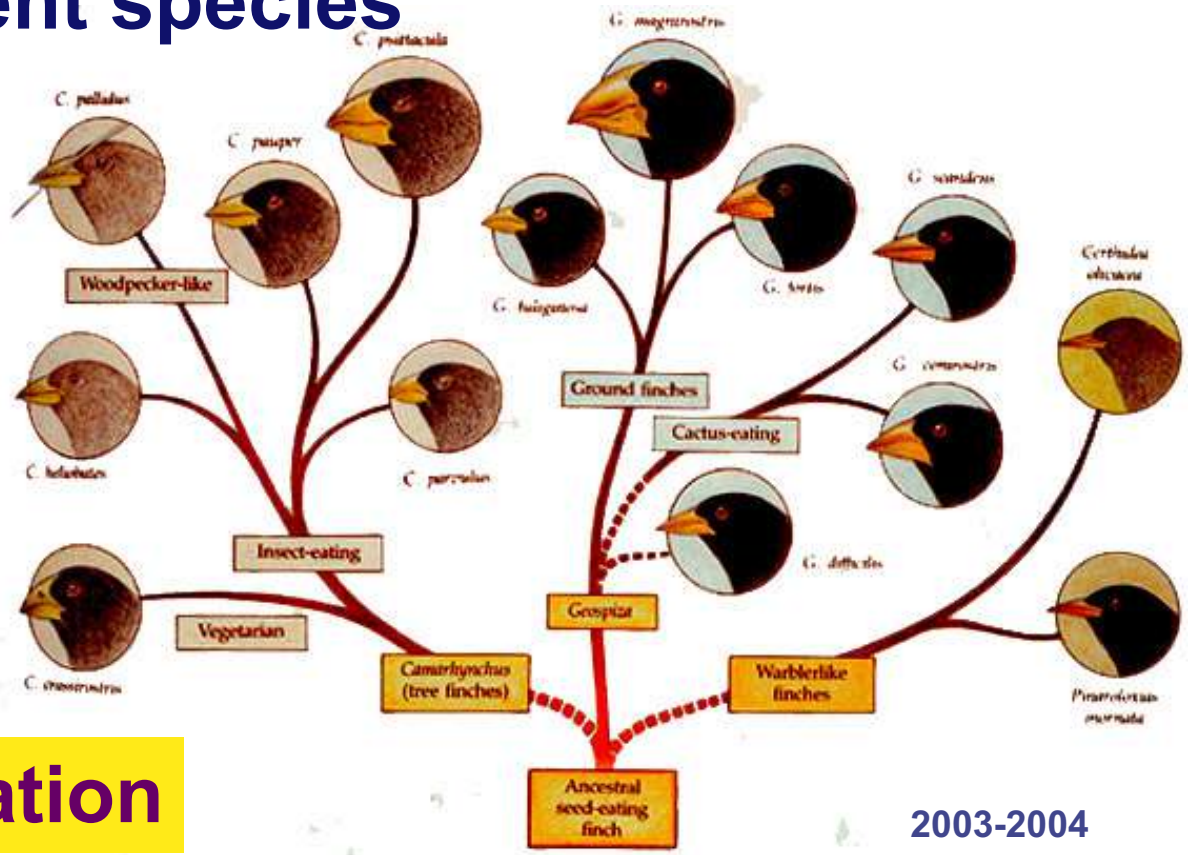
Darwin's finches

- Finches with beak differences that allowed them to…
  - ◆successfully feed
  - ◆successfully compete
  - ◆successfully reproduce
    - pass the successful traits onto their offspring



Darwin's finches

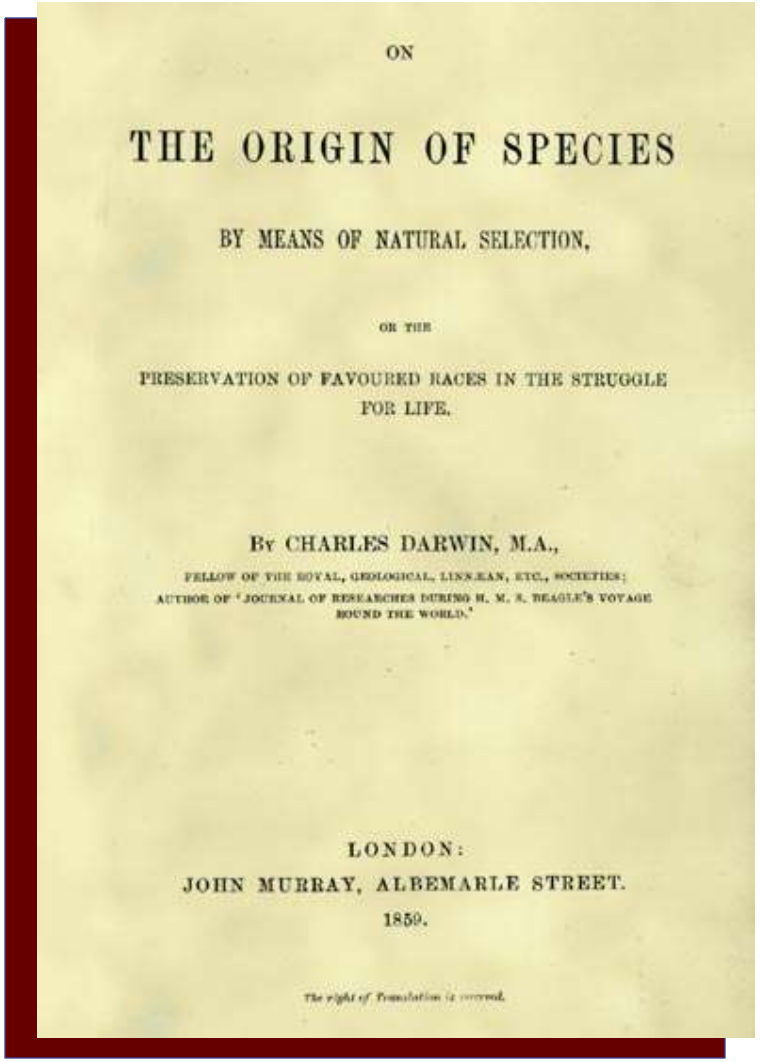
- Over many generations, the finches changed anatomically and separated into different species



adaptive radiation

Origin of Species

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



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

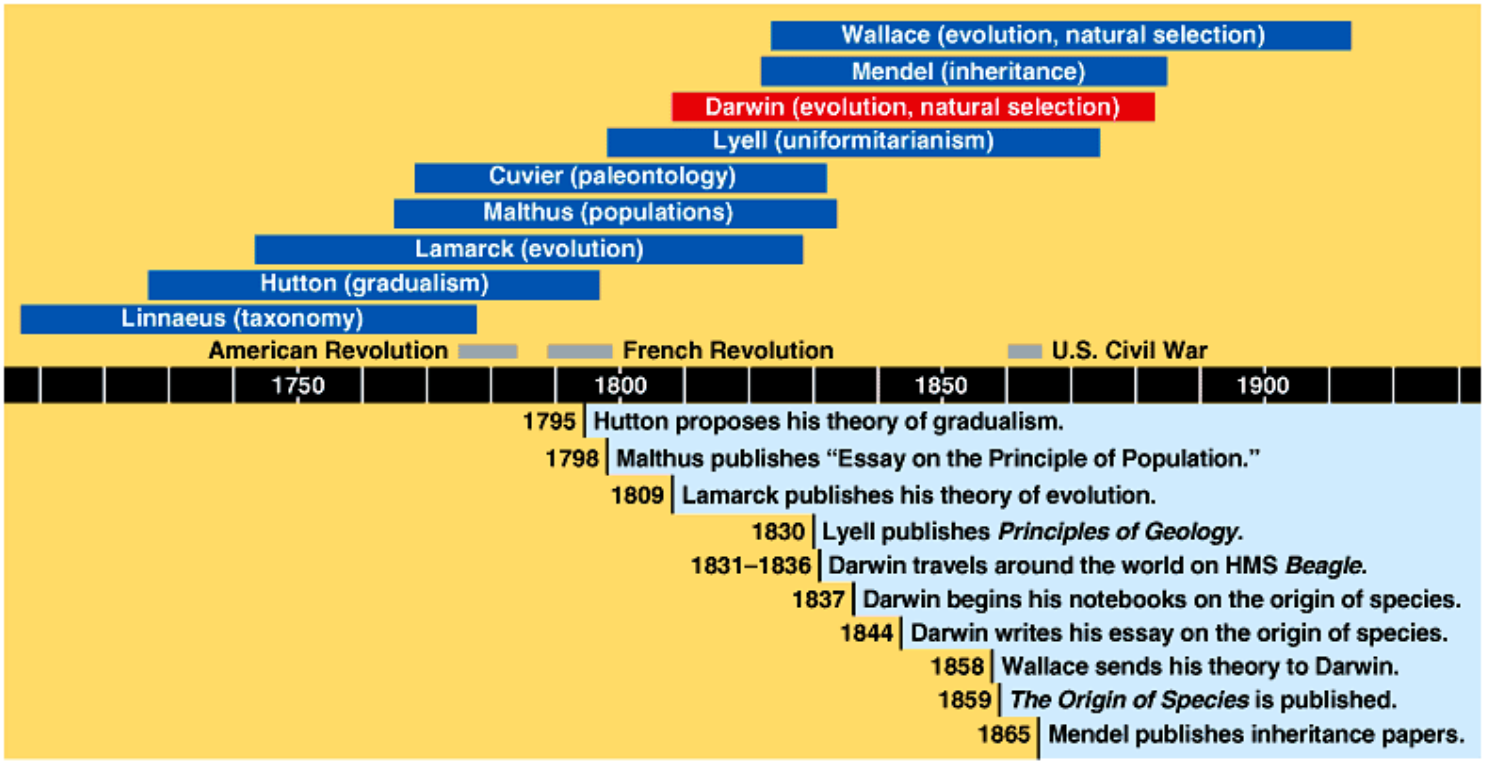
PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

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.

In historical context



What did Darwin say?

- Every population of organisms includes variation
  - differences between individuals

What did Darwin say?

- Organisms reproduce more than the environment can support
  - some offspring survive
  - some offspring don't survive
    - competition
      - for food
      - for mates
      - for nesting spots
      - to get away from predators

Natural selection

- Put together variation and competition and you get natural selection
  - survival of the fittest
    - fittest are the ones that survive to reproduce

Dodo bird

Survival of the fittest

- Who is the fittest?
  - traits fit the environment
  - the environment can change, so who is fit can change

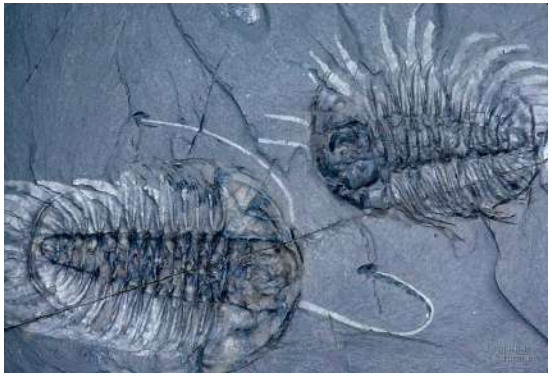
Peppered moth

Peppered moth

Year	% dark	% light
1848	5	95
1895	98	2
1995	19	81

Support for Darwin's ideas

- **Fossil record**
  - layers of sedimentary rock contain fossils
  - new layers cover older ones, creating a record over time
  - fossils within layers show that a succession of organisms have populated Earth throughout a long period of time



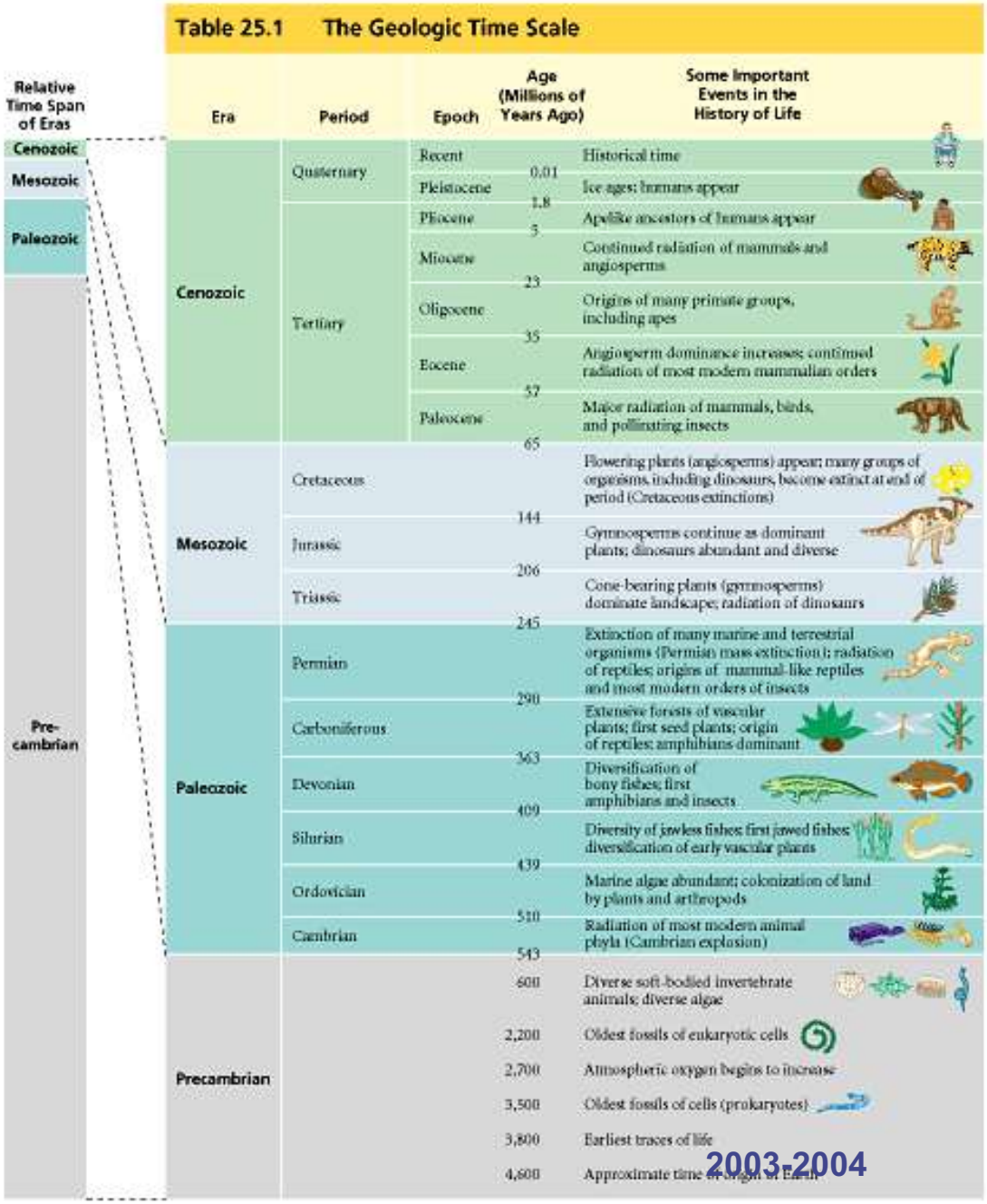


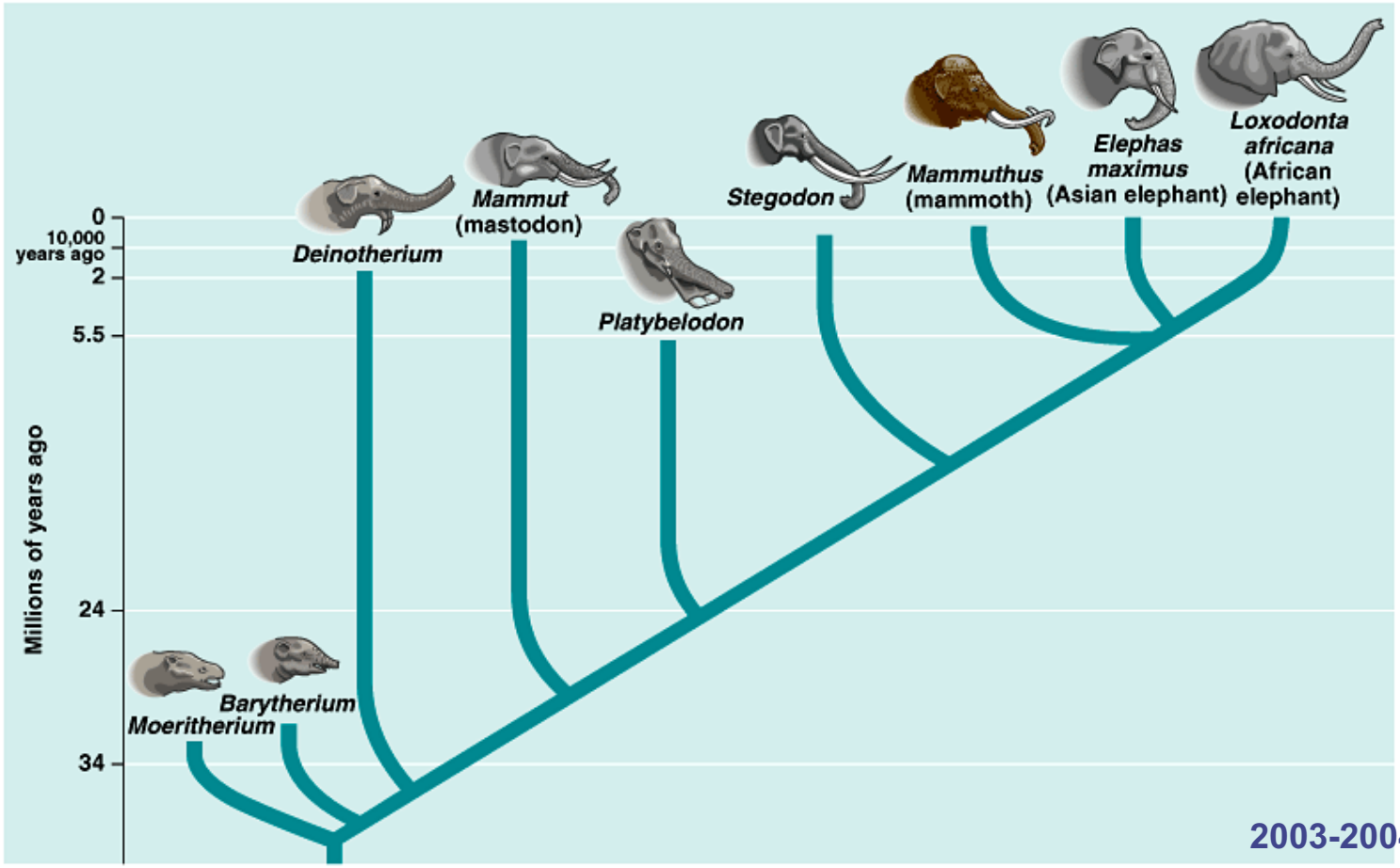
Table 25.1 The Geologic Time Scale
Relative Time Span of Eras
Cenozoic
Mesozoic
Paleozoic
Pre-cambrian
Era
Period
Epoch
Age (Millions of Years Ago)
Some Important Events in the History of Life
Cenozoic
Quaternary
Recent
0.01
Historical time
Pleistocene
1.8
Ice ages; humans appear
Tertiary
Pliocene
5
Apelike ancestors of humans appear
Miocene
23
Continued radiation of mammals and angiosperms
Oligocene
35
Origins of many primate groups, including apes
Eocene
57
Angiosperm dominance increases; continued radiation of most modern mammalian orders
Paleocene
65
Major radiation of mammals, birds, and pollinating insects
Mesozoic
Cretaceous
144
Flowering plants (angiosperms) appear; many groups of organisms, including dinosaurs, become extinct at end of period (Cretaceous extinctions)
Jurassic
206
Gymnosperms continue as dominant plants; dinosaurs abundant and diverse
Triassic
245
Cone-bearing plants (gymnosperms) dominate landscape; radiation of dinosaurs
Paleozoic
Permian
290
Extinction of many marine and terrestrial organisms (Permian mass extinction); radiation of reptiles; origins of mammal-like reptiles and most modern orders of insects
Carboniferous
363
Extensive forests of vascular plants; first seed plants; origin of reptiles; amphibians dominant
Devonian
409
Diversification of bony fishes; first amphibians and insects
Silurian
439
Diversity of jawless fishes; first jawed fishes; diversification of early vascular plants
Ordovician
510
Marine algae abundant; colonization of land by plants and arthropods
Cambrian
543
Radiation of most modern animal phyla (Cambrian explosion)
Precambrian
600
Diverse soft-bodied invertebrate animals; diverse algae
2,200
Oldest fossils of eukaryotic cells
2,700
Atmospheric oxygen begins to increase
3,500
Oldest fossils of cells (prokaryotes)
3,800
Earliest traces of life
4,600
Approximate time of origin of Earth

Archaeopteryx

A fossil of *Archaeopteryx* (Smithsonian Museum, Washington, DC), **a reptilian bird ancestor that lived about 150 million years ago.**

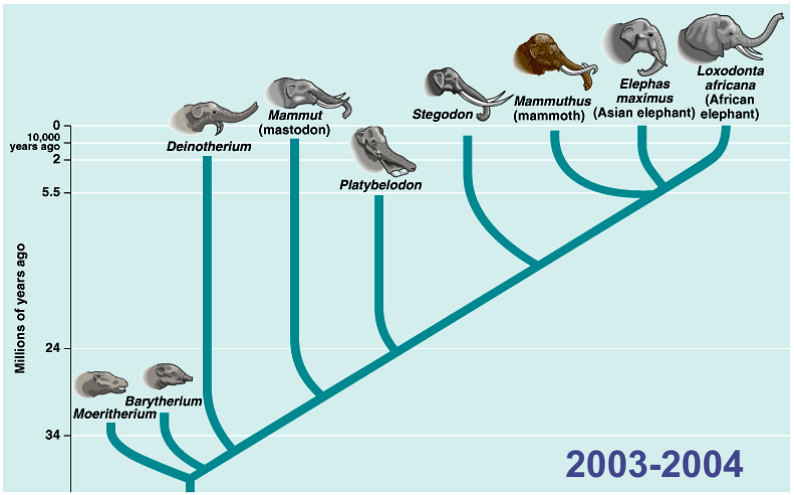
Fossil record

- Today's organisms descended from ancestral species



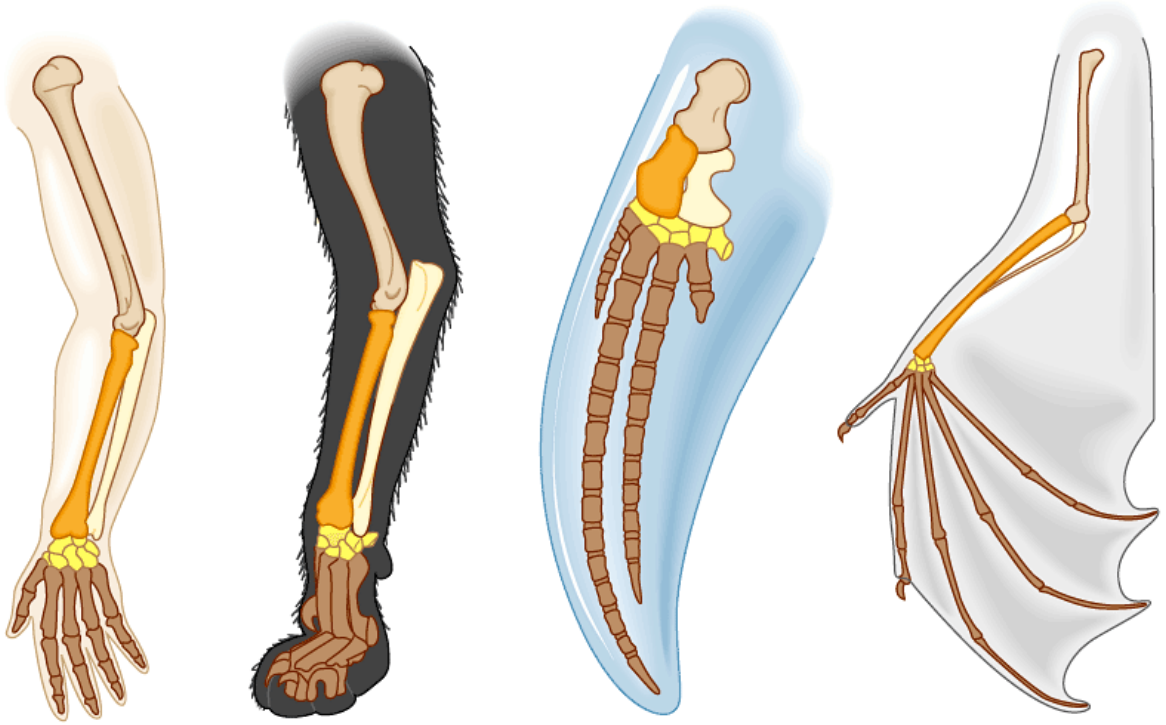
Descent with modification

- The history of life is like a tree with multiple branches from a common trunk
- Closely related species — the twigs of the tree — shared the same line of descent until they branched off from a common ancestor



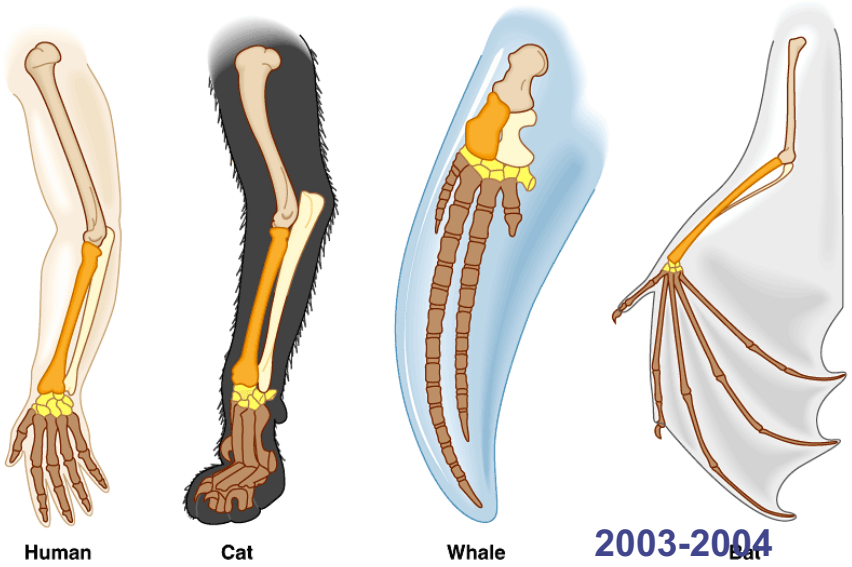
Support for Darwin's ideas

- Homology
  - similarities in characteristics resulting from common ancestry



Homologous structures

- The forelimbs of human, cats, whales, and bats share the same skeletal structures
  - but different functions
  - branched off from common 4-limbed ancestor
    - **homologous structures**



Support for Darwin's ideas

- **Artificial selection**
  - ⑩ **Artificial breeding can take advantage of differences between individuals**

"descendants" of the wolf

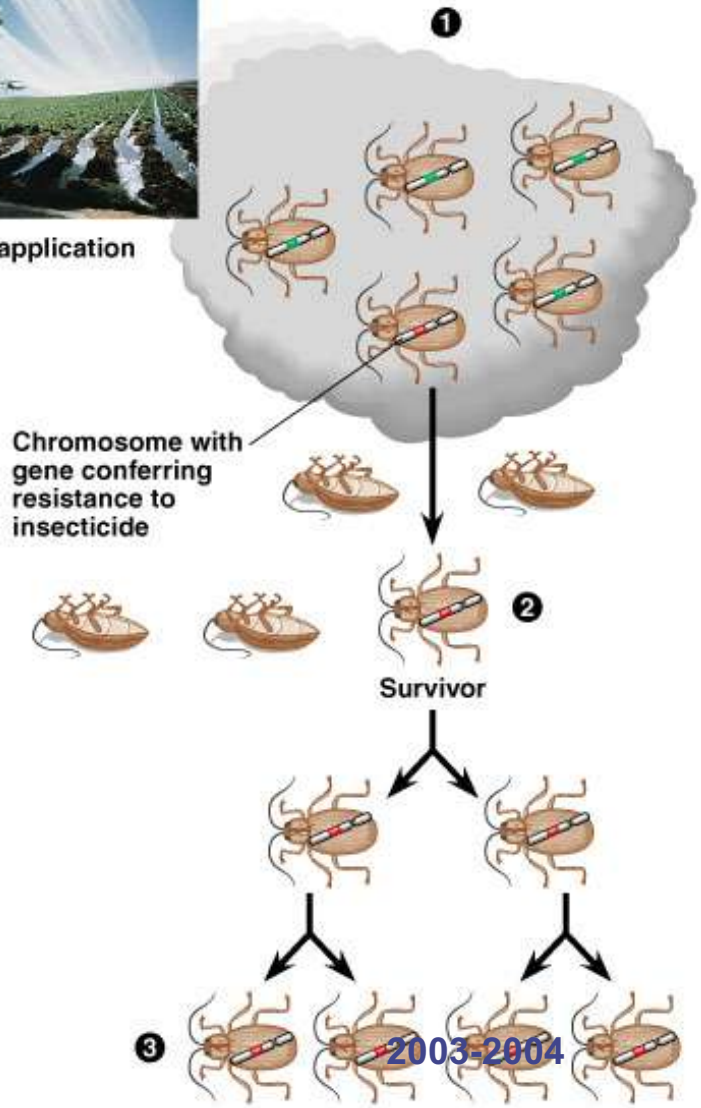
Support for Darwin's ideas

- **Artificial selection**
  - ⑩ **Artificial breeding can take advantage of differences between individuals**

"descendants" of the wild mustard

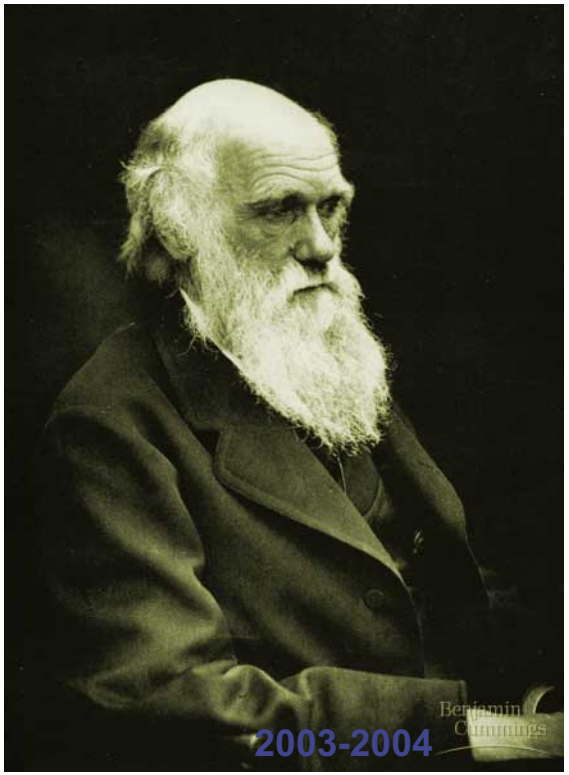
Support for Darwin's ideas

- Natural selection in action
- Insecticide & drug resistance
  - insecticide didn't kill all individuals
  - resistant survivors reproduce
  - resistance is inherited
  - insecticide becomes less & less effective



Theory of Evolution

- **Theory of evolution by natural selection**
  - well-supported idea
  - **not** "just a theory"!
- **Natural selection is widely accepted in science because its predictions have withstood thorough, continual testing by experiments & observations**



Unity & diversity

- Only evolution explains both the unity & diversity of life
- By attributing the diversity of life to natural causes rather than to supernatural creation, Darwin gave biology a strong, scientific, testable foundation