Pre-Darwinian Thinking and Charles Darwin

http://nayagam.files.wordpress.com/2006/02/397px-Charles_Darwin_by_G._Richmond.jpg

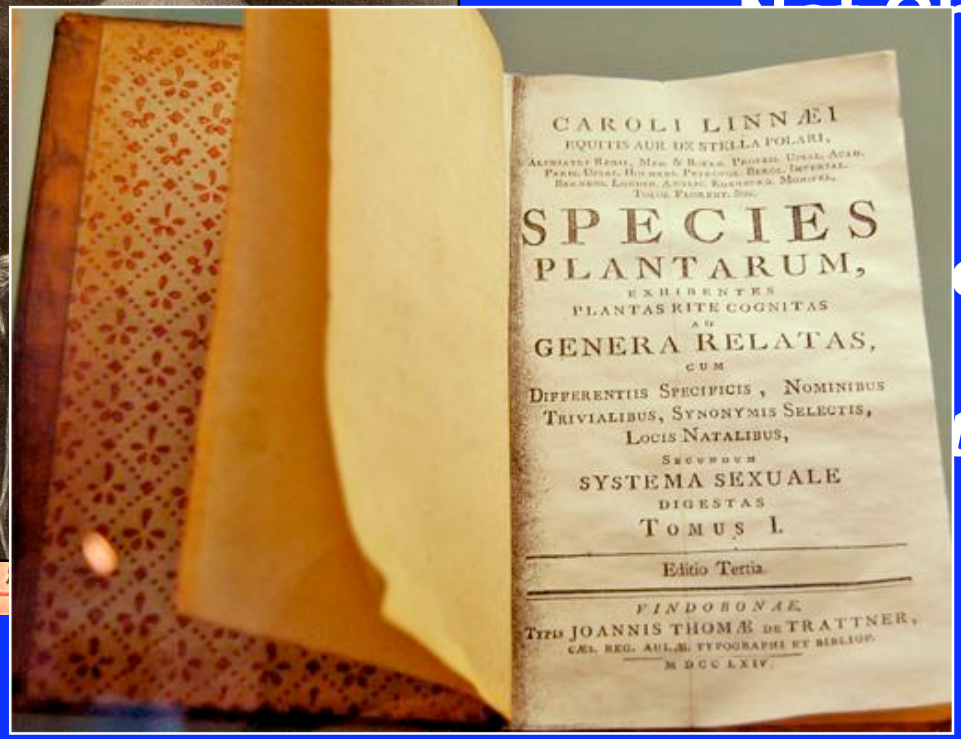
Outline

- Pre-Darwinian ideas on life
- The voyage of the Beagle
- The Origin of Species and fallout
- Post-Darwinian ideas

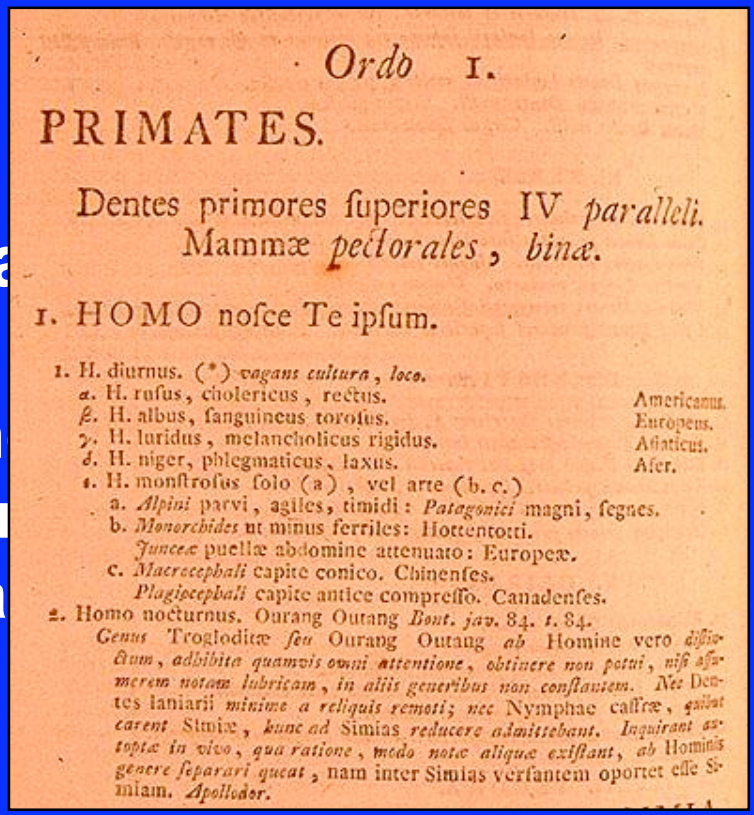
NOTE: many slides in the four evolution lectures obtained from Web sources: Ken Miller ["Hot Science, Cool Talks" at UT Austin], Elizabeth Saunders, Carl Wozniak, Caltech Bio 1

blame for humans being sified as primates?

In Linnaeus's original system, genera were grouped into orders, orders into classes, and classes into kingdoms. Thus the kingdom Animalia contained the class Vertebrata, which contained the order Primates, which contained the genus *Homo* with the species *sapiens* -- humanity.



CAROLI LINNÆI
EQUITIS AUR. DE STELLA POLARI,
SPECIES
PLANTARUM,
EXHIBENTES
PLANTAS RITE COGNITAS
AD
GENERA RELATAS,
CUM
DIFFERENTIIS SPECIFICIS, NOMINIBUS
TRIVIALIBUS, SYNONYMIS SELECTIS,
LOCIS NATALIBUS,
SECUNDUM
SYSTEMA SEXUALE
DIGESTAS
TOMUS I.
Editio Tertia.
VINDOBONAE.
TYPIS JOANNIS THOMÆ DE TRATTNER,
CÆS. REG. AUL. AC. TYPOGRAPHI ET BIBLIOP.
M DCC LXIV.



Ordo I.

PRIMATES.

Dentes primores ſuperiores IV *paralleli.*
Mammæ *pectorales*, *binæ.*

1. HOMO noſce Te ipſum.

1. H. diurnus. (*) *vagans cultura*, *loco.*
   α. H. ruſus, cholericus, rectus. Americanus.
   β. H. albus, ſanguineus toroſus. Europeus.
   γ. H. luridus, melancholicus rigidus. Aſiaticus.
   δ. H. niger, phlegmaticus, laxus. Afer.
   ε. H. monſtroſus ſolo (a), vel arte (b. c.)
   a. *Alpini* parvi, agiles, timidi: *Patagonici* magni, ſegnes.
   b. *Monorchides* ut minus ferriles: Hottentotti.
   Junceæ puellæ abdomine attenuato: Europeæ.
   c. *Macrocephali* capite conico. Chineſes.
   Plagiocephali capite antice compreſſo. Canadenſes.
2. Homo nocturnus. Ourang Outang *Bont. jav.* 84. *t.* 84.
   Genus Troglodytæ *ſeu* Ourang Outang *ab* Homine vero *diſſi-*
   cum, *adhibita quamvis omni attentione*, *obtinere non potui*, *niſi aſſu-*
   merem notam lubricam, *in aliis generibus non conſtantem.* Nec Den-
   tes laniarii *minime a reliquis remoti*; *nec* Nymphae caſſræ, *quibus*
   carent Simiæ, *hunc ad* Simias *reducere admittebant.* *Inquirant au-*
   ctoptæ in vivo, *qua ratione*, *modo notæ aliquæ exiſtant*, *ab* Hominis
   genere ſeparari queat, nam inter Simias verſantem oportet eſſe Si-
   miam. *Apollodor.*

Darwin's Beginnings

Images Source: Wikipedia

- Born 1809
- A self-described "born naturalist"
- Briefly studied medicine at Edinburgh University
- Studied theology at Christ's College, University of Cambridge

Geological Training

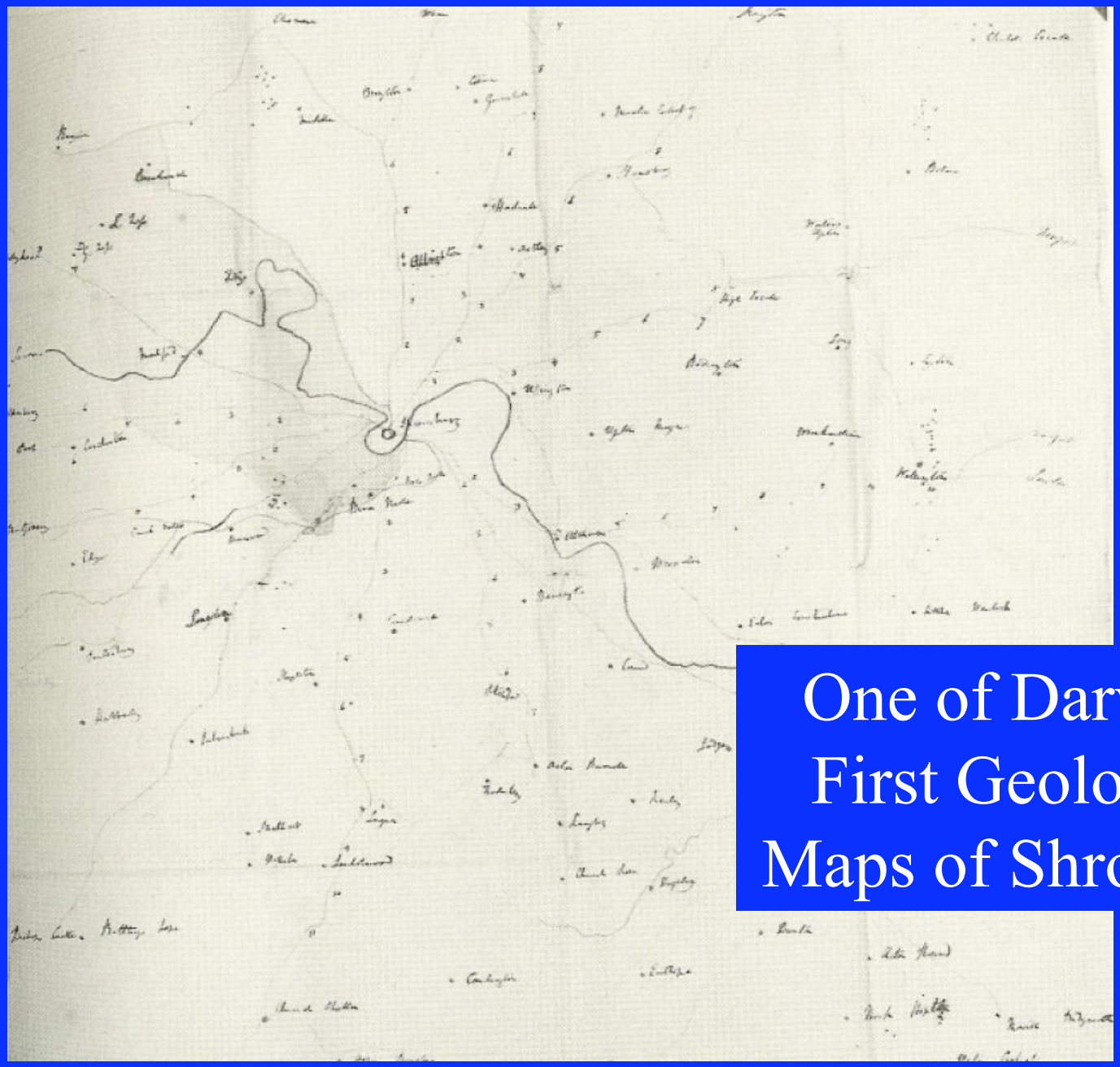
Images Source: Wikipedia

"Henslow promises to cram me in geology"

Darwin, April 1831

1831: A Year in Transition

- Mentored by John Stevens Henslow
- Completed his degree in January, 1831
- Worked for Adam Sedgwick, Summer 1831
- Introduced to Captain Robert Fitzroy, and offered a position on the *H.M.S. Beagle*
- Departed December 27th, 1831



One of Darwin's First Geological Maps of Shropshire

Image Source: Herbert 2005

Darwin's Ideas Did Not Develop in a Vacuum

Contributors to Darwin's thinking included:

Lyell – uniformitarianism

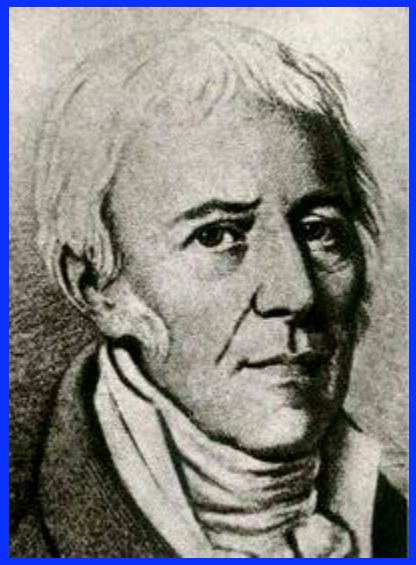
Cuvier – species extinction

Darwin's Ideas Did Not Develop in a Vacuum

Contributors to Darwin's thinking included:

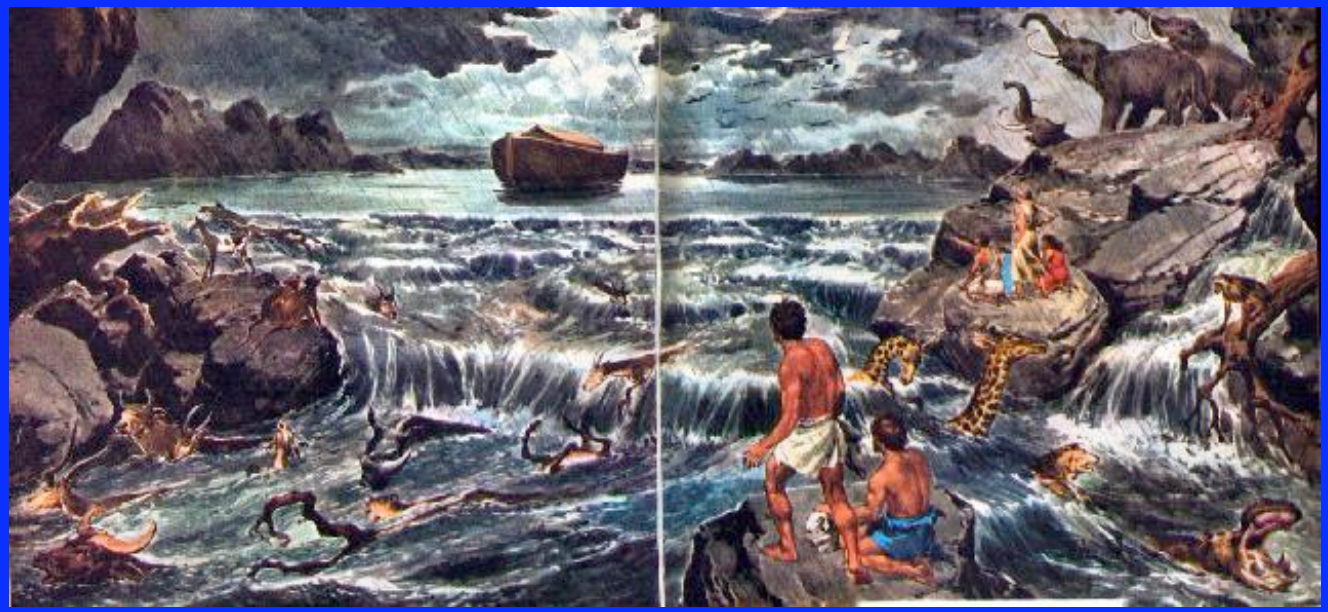
Thomas Malthus – struggle for existence.

Jean Baptiste de Lamarck – evolution by acquired characteristics.



Context: Catastrophism

- In 1700s and earlier, standard model
- Idea: Earth's features arose suddenly in past by means that no longer occur
- Example: Great Flood (in many cultures)
- Does catastrophism really play any role?



http://astrobeccah.tripod.com/ark.jpg

Context: Uniformitarianism

- Processes are operating now, not just in past
- "The present is the key to the past"
- Avicenna (1027 AD!), Hutton (late 1700s)
- Can lead to catastrophic effects, e.g., flooding
- Requires huge amount of time

Grand Canyon
Would require millions of years

http://io.uwinnipeg.ca/~simmons/16cm05/1116/22-04-GrandCanyon.jpg

Context: Species Extinction

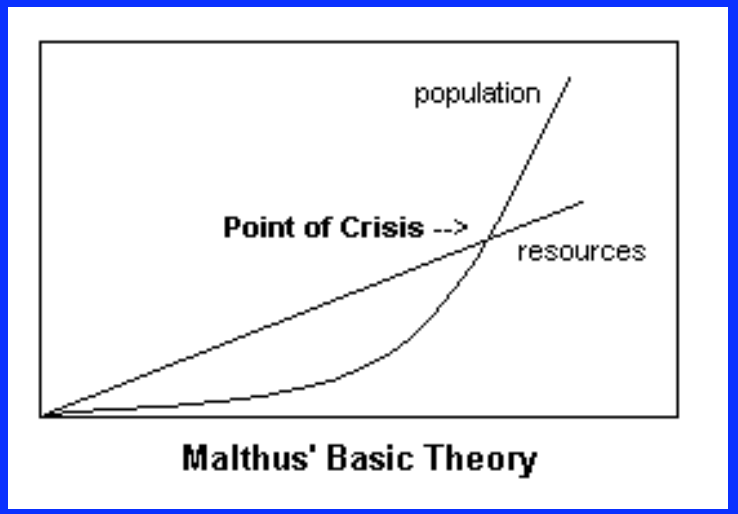
http://upload.wikimedia.org/wikipedia/commons/2/28/Georges_Cuvier.jpg

http://www.blackwellpublishing.com/ridley/images/dodo.jpg

- Until 1796, widely thought that no species had ever gone extinct (perfect creation)
  Mammoths etc.: tropical species moved out of more polar regions
- Then Georges Cuvier showed this was false
  New question: was any species permanent?

Struggle for Existence

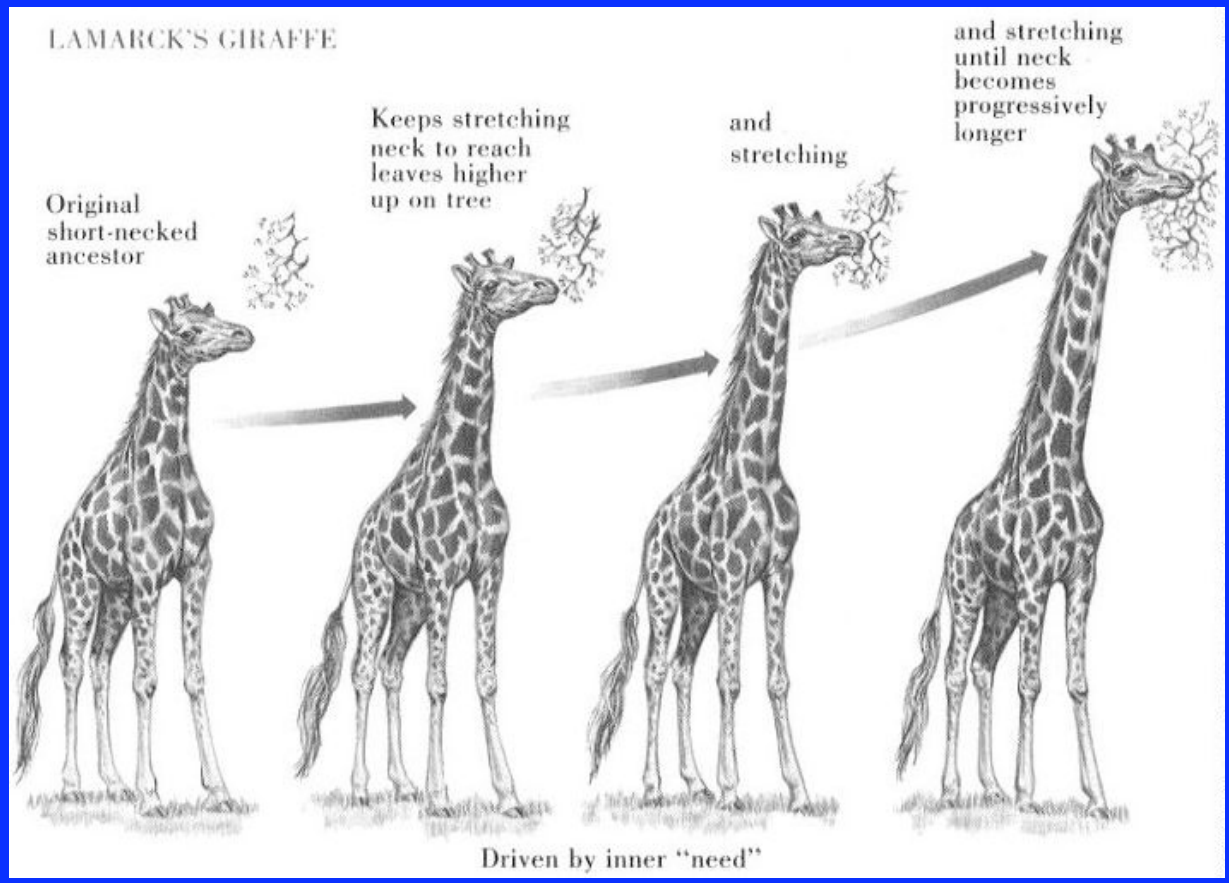
- "An Essay on the Principle of Population": Malthus
- Idea: unchecked population grows geometrically (1,2,4,8,...) but resources grow arithmetically
- Either self-restraint or external factors restrict this
- If external, might subset of population do best?



http://www.fordham.edu/halsall/mod/lect/malthus.gif

Acquired Characteristics?

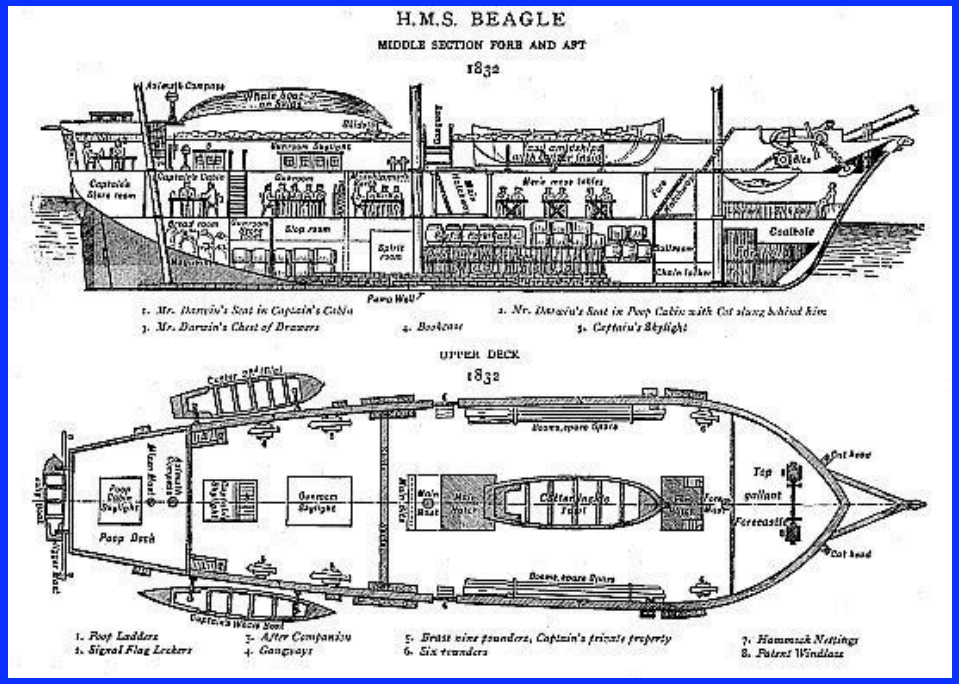
- If species change, how does it happen?
- One possibility: use of ability improves ability and this can be passed on; Lamarck 1803



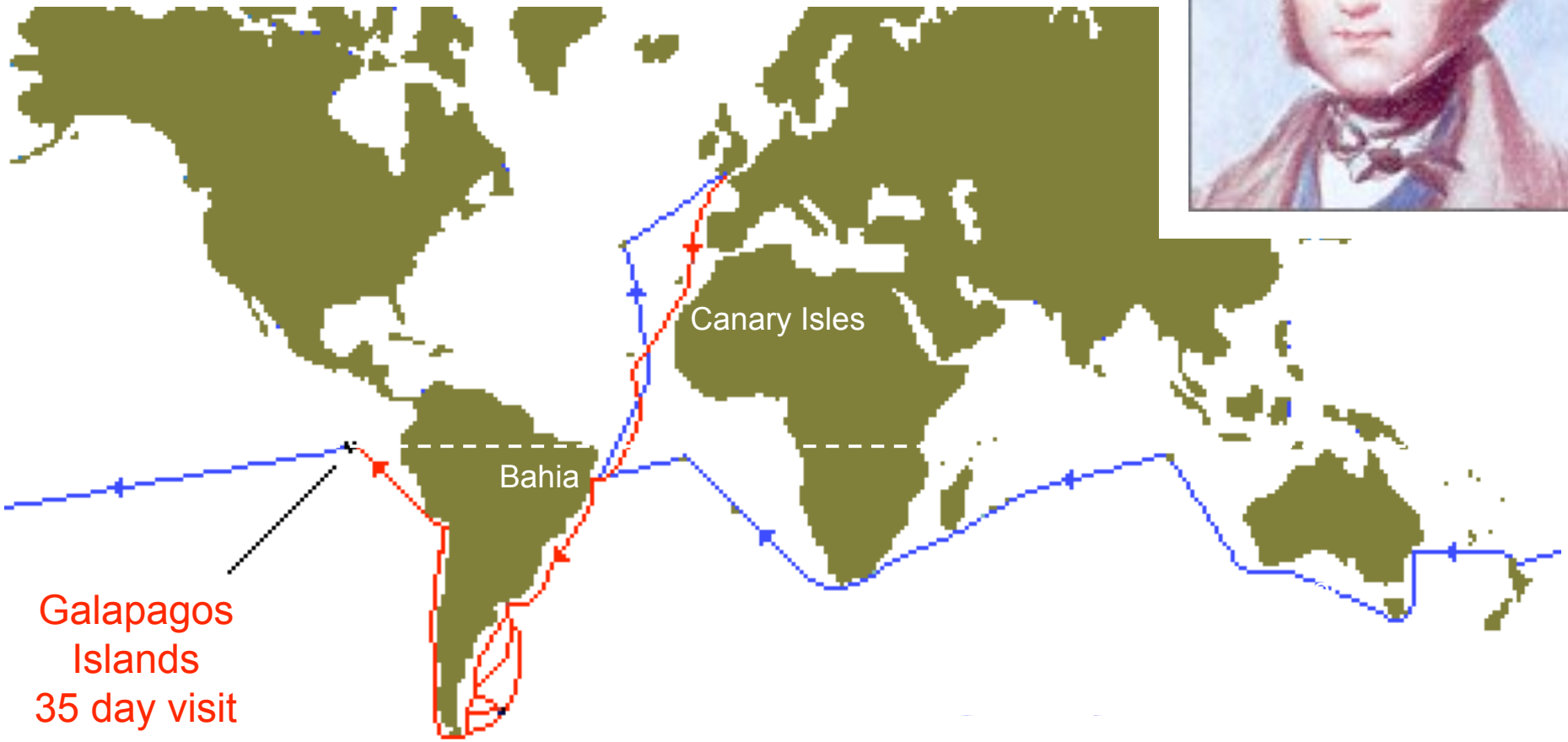
http://www.princessleia.com/images/MyImages/essays/giraffe_lamark.jpg

H.M.S. Beagle

- Five year journey to South America
- Darwin's position onboard



Source: Charles Darwin, Journal of Researches into the Natural History and Geology of the Countries Visited during the Voyage round the World of *H.M.S. Beagle*, under the Command of Capt. Fitz Roy, R.N.


Canary Isles
Bahia
Galapagos
Islands
35 day visit
journey out
journey home

Further Training

Images Source: Wikipedia

- While onboard, Darwin read extensively
  - Charles Lyell, Principles of Geology
  - John Playfair, Illustrations of the Huttonian Theory of the Earth

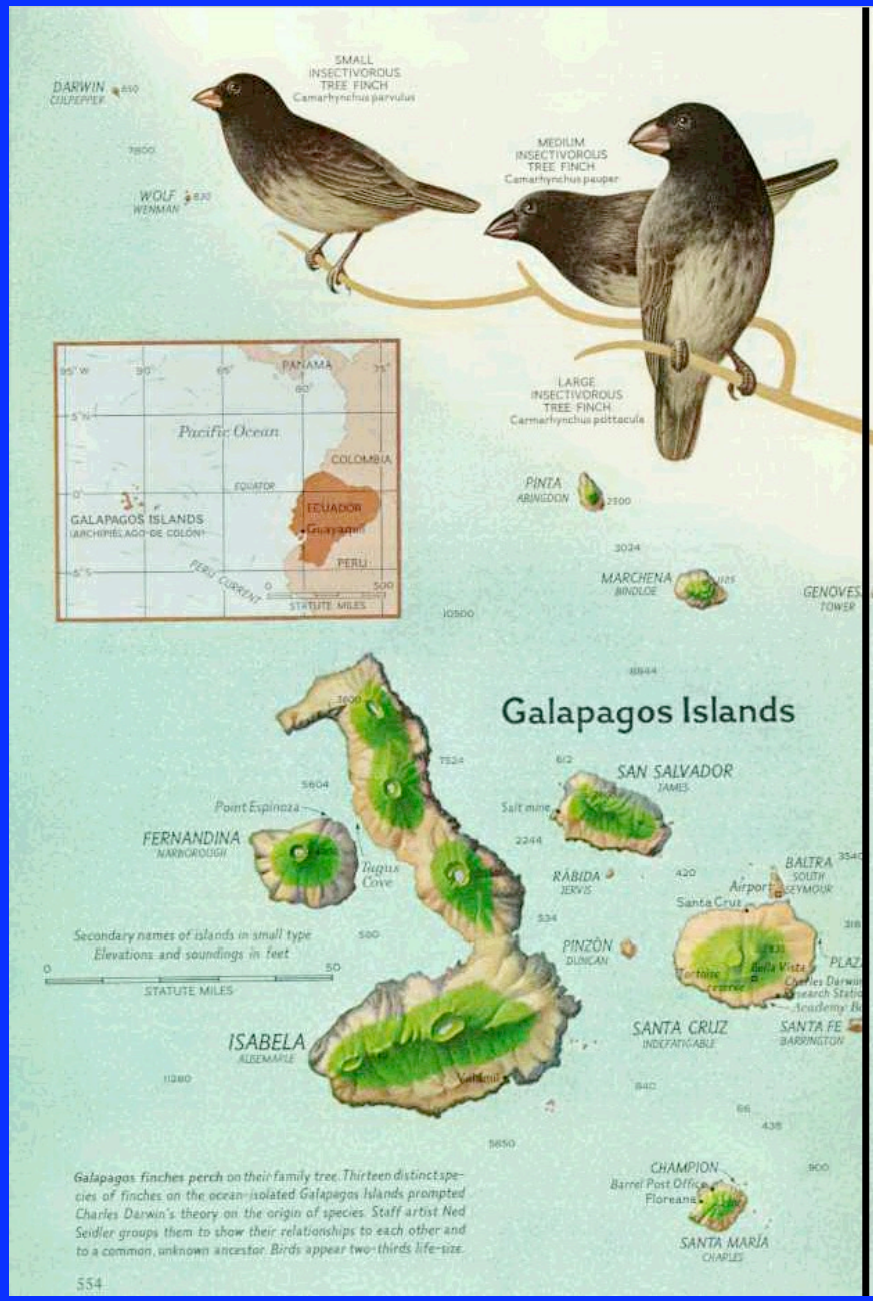
Geological Observations

- Coral Reefs
- Andes Mountains
- Volcanic Islands

Images Source: Herbert 2005

Acceptance in the Geological Community

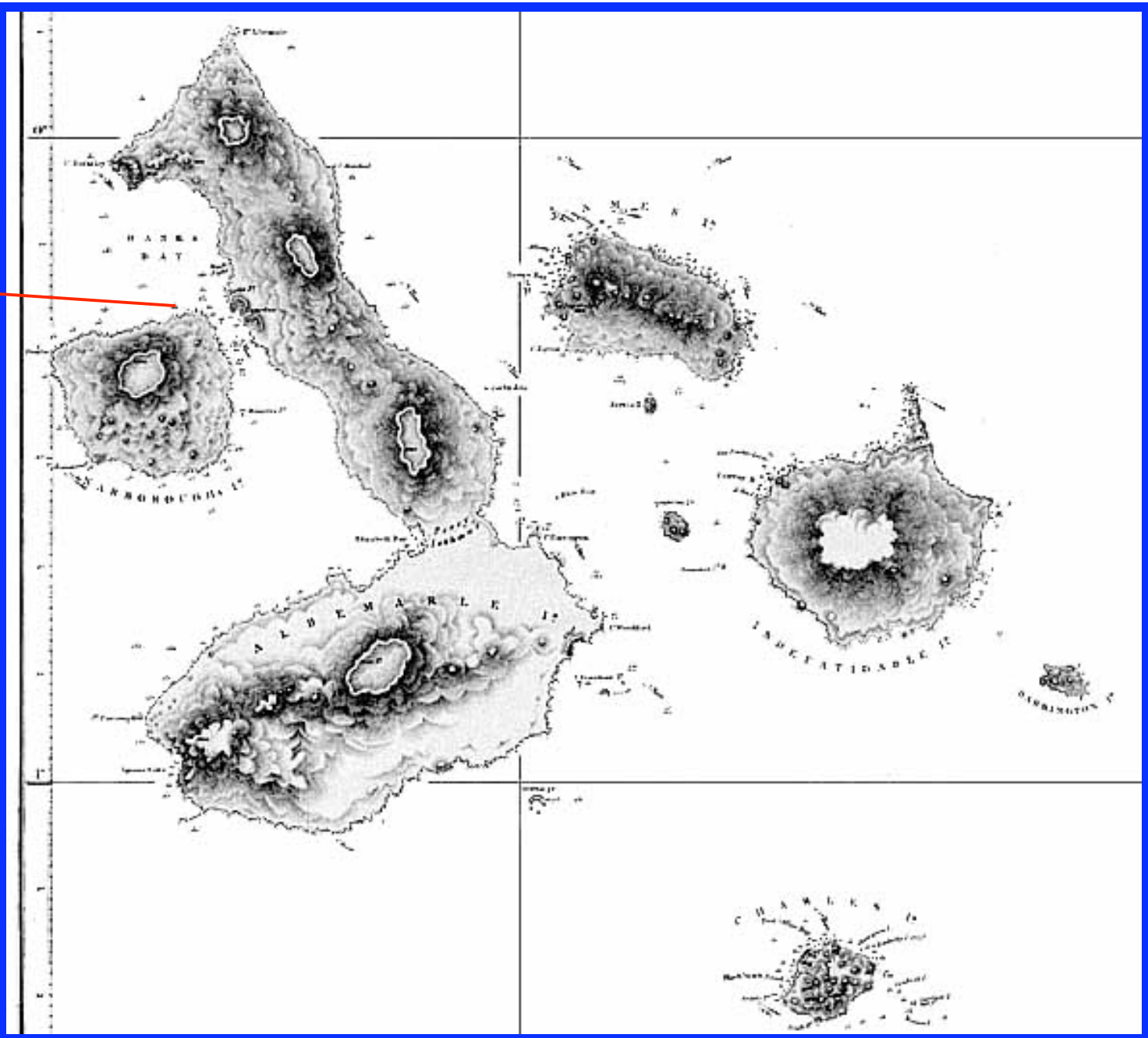
- Gained scientific and public acceptance with the publication of his observations from the voyage of the *Beagle*
- Awarded the highest honor by the Geological Society, the Wollaston Medal in February, 1859


SMALL INSECTIVOROUS TREE FINCH
Camarhynchus parvulus
MEDIUM INSECTIVOROLIS TREE FINCH
Camarhynchus pauper
LARGE INSECTIVOROUS TREE FINCH
Camarhynchus pöttacula
DARWIN
CULPEPPER
WOLF
WENMAN
PINTA
ABINGDON
MARCHENA
BINDLOE
GENOVESA
TOWER
Pacific Ocean
PANAMA
COLOMBIA
EQUATOR
ECUADOR
PERU
GALAPAGOS ISLANDS
(ARCHIPIÉLAGO DE COLON)
PERU CURRENT
STATUTE MILES
Galapagos Islands
SAN SALVADOR
JAMES
Salt mine
Point Espinoza
FERNANDINA
NARBOROUGH
Tagus Cove
RÁBIDA
JERVIS
BALTRA
SOUTH SEYMOUR
Airport
Santa Cruz
PINZÓN
DUNCAN
Bella Vista
Charles Darwin Research Station
Academy Bay
SANTA CRUZ
INDEFATIGABLE
SANTA FE
BARRINGTON
ISABELA
ALBEMARLE
Volcano
CHAMPION
Barrel Post Office
Floreana
SANTA MARÍA
CHARLES
Secondary names of islands in small type
Elevations and soundings in feet
STATUTE MILES
Galapagos finches perch on their family tree. Thirteen distinct species of finches on the ocean-isolated Galapagos Islands prompted Charles Darwin's theory on the origin of species. Staff artist Ned Seidler groups them to show their relationships to each other and to a common, unknown ancestor. Birds appear two-thirds life-size.
554


MANGROVE FINCH
Camarhynchus heliobates
WOODPECKER FINCH
Camarhynchus pallidus
CHARLES DARWIN (1809-1882)
LARGE GROUND FINCH
Geospiza magnirostris
MEDIUM GROUND FINCH
Geospiza fortis
SMALL GROUND FINCH
Geospiza fuliginosa
LARGE CACTUS GROUND FINCH
Geospiza conirostris
CACTUS GROUND FINCH
Geospiza scandens
VEGETARIAN TREE FINCH
Camarhynchus crassirostris
SAN CRISTÓBAL
CHATHAM
SHARP-BEAKED GROUND FINCH
Geospiza difficilis
ESPAÑOLA
HOOD
WARBLER FINCH
Certhidea olivacea
NATIONAL GEOGRAPHIC SOCIETY

Punta Espinoza

Age of the archipelago: ~ 1 million yr



British Admiralty chart of the Galapagos Islands, based on the *Beagle's* observations

Darwin's Finches
(5 genera,
including *Geospizia)*

- 13 Species, each endemic to the islands
- El Nino poses a survival challenge
- Highly specialized beaks
- Observable evolution in beak size
- Distinctive feeding habits

ground finch

tree finch

cactus finch

The voyage of the *Beagle* convinced Darwin that

1. Members of the same species often change slightly in appearance after becoming geographically isolated from each other

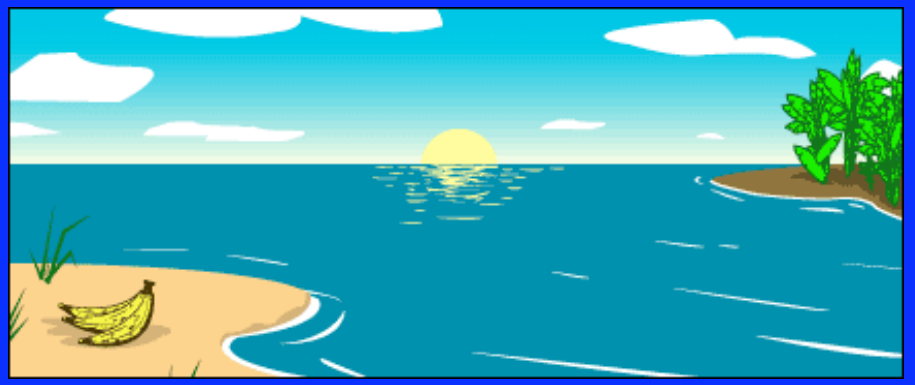
2. Organisms living on oceanic islands often resemble organisms found living on a close mainland

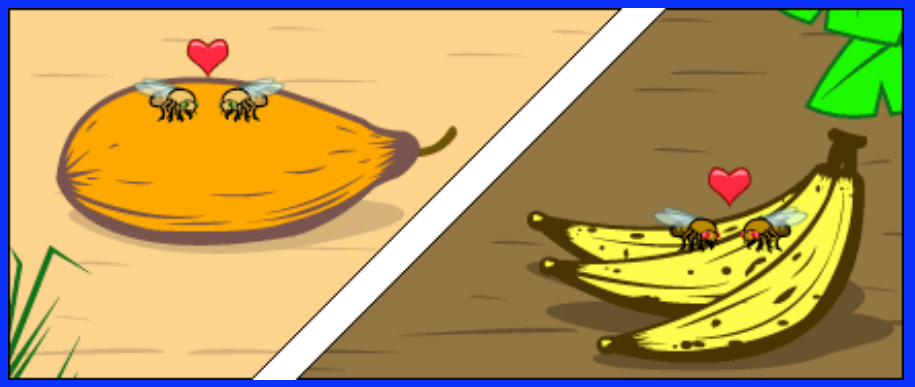
3. Factors other than or in addition to climate play a role in the development of plant and animal diversity

4. Organisms of the past and present are related to one another (but there are no fossils in the Galapagos)

Geographical Isolation

- Suppose subpopulations become isolated
  Ocean, mountain, ...
- Different selection pressures operate
- Can lead to different species



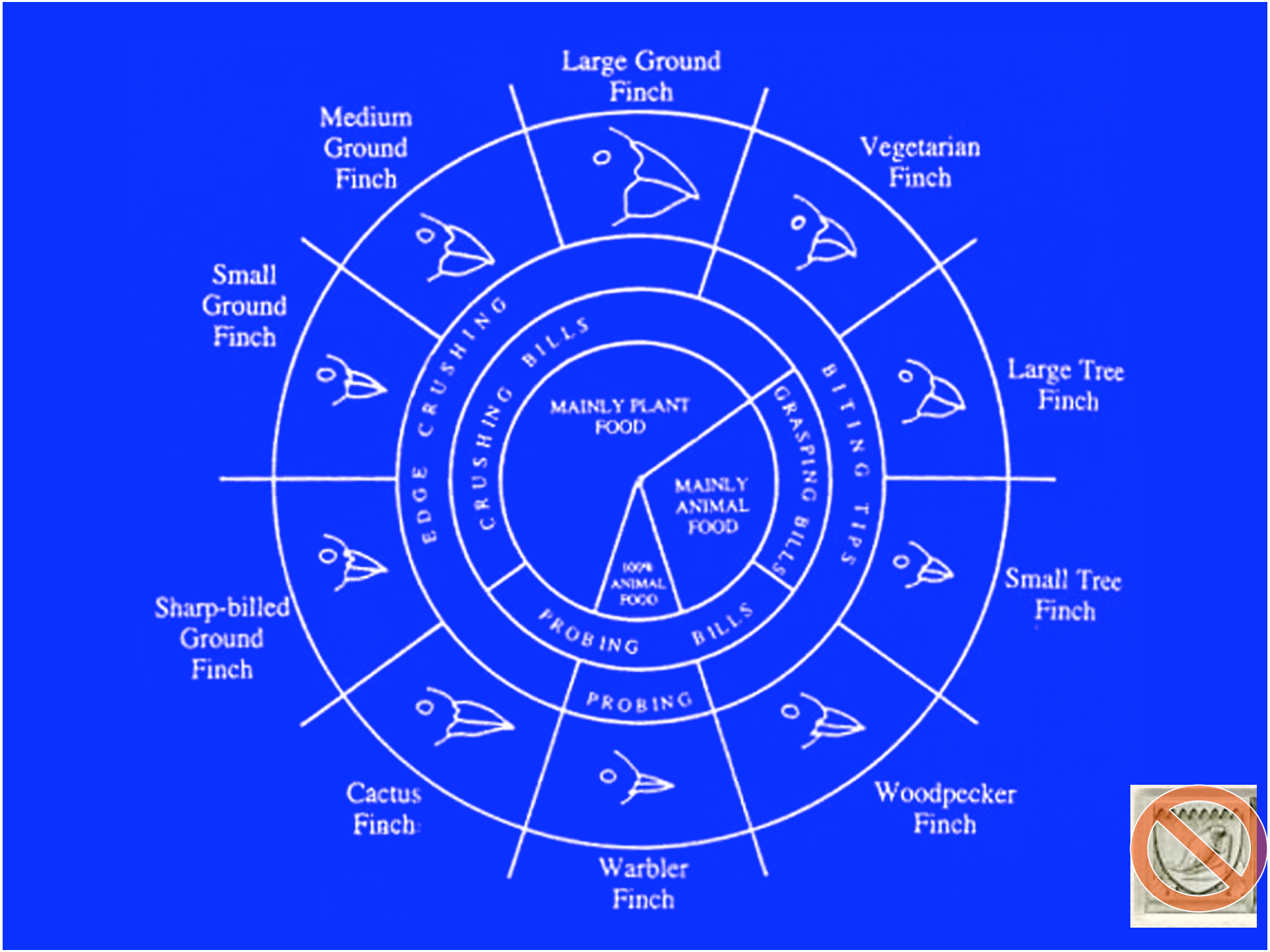


Both from evolution.berkeley.edu

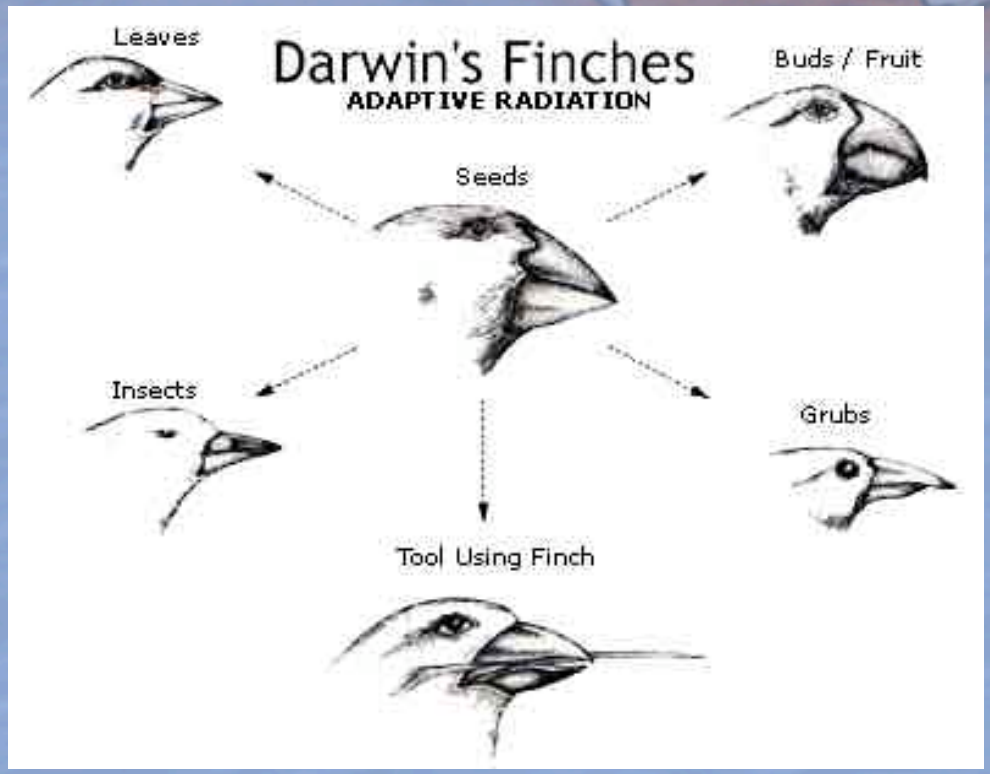
Island vs. Mainland

- Maybe was land bridge? Or drifted?
- Islands are smaller, so unique niches
- Risk: easier to go extinct

http://www.escapeartist.com/efam/73/roomap.gif


Large Ground Finch
Medium Ground Finch
Vegetarian Finch
Small Ground Finch
Large Tree Finch
Small Tree Finch
Sharp-billed Ground Finch
Cactus Finch
Warbler Finch
Woodpecker Finch
EDGE CRUSHING BILLS
CRUSHING BILLS
BITING TIPS
GRASPING BILLS
PROBING BILLS
PROBING
MAINLY PLANT FOOD
MAINLY ANIMAL FOOD
100% ANIMAL FOOD

Adaptive Radiation



- **Adaptive radiation** – the rapid speciation of a species to fill many ecological niches.
- This is an evolutionary process driven by mutation (heritable/genetic variation) and natural selection.

Causes of Adaptive Radiation

Opportunity

- Isolated ecosystems colonized by a species which undergoes rapid divergent evolution.
- Occurs in situations in which the environment is relatively empty of potentially competing species
- Monotremes (egg-laying mammals) and marsupials are examples of geographic isolation in Australia.

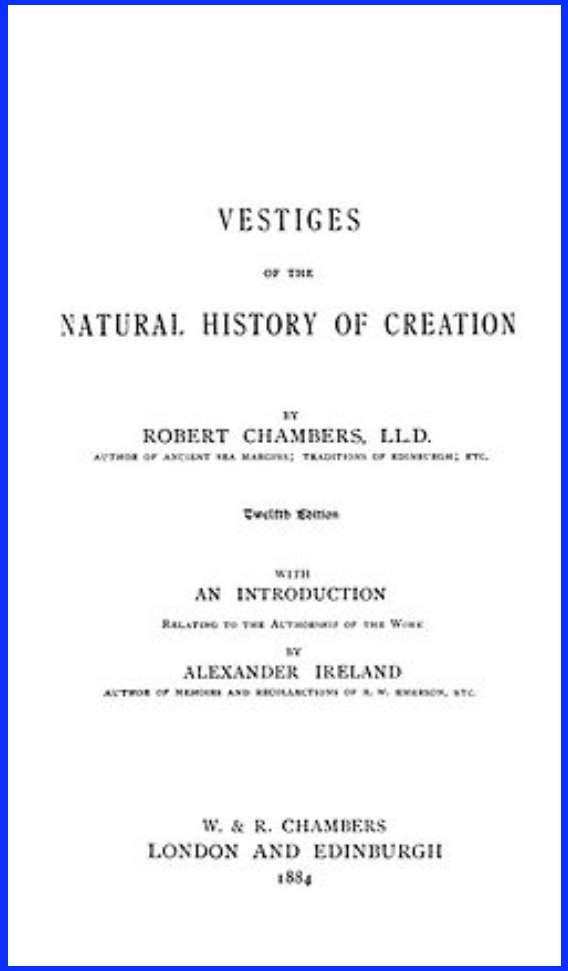
Causes of Adaptive Radiation

Extinction

- Adaptive radiation can also occur after mass extinctions.
- Species have undergone rapid speciation as newly formed species adapted to different aspects of the new environment

Why Did Darwin Wait?

- Darwin had his theory for decades before he published
- Why? He knew public reaction would be intense
- "Vestiges", anonymous work published in 1844
- Ultimately, very negative reaction
- Darwin would wait more...


VESTIGES

OF THE

NATURAL HISTORY OF CREATION

BY

ROBERT CHAMBERS, LL.D.

AUTHOR OF ANCIENT SEA MARGINS; TRADITIONS OF EDINBURGH; ETC.

Twelfth Edition

WITH

AN INTRODUCTION

RELATING TO THE AUTHORSHIP OF THE WORK

BY

ALEXANDER IRELAND

AUTHOR OF MEMORIES AND RECOLLECTIONS OF R. W. EMERSON, ETC.

W. & R. CHAMBERS

LONDON AND EDINBURGH

1884

http://upload.wikimedia.org/wikipedia/commons/thumb/5/51/Vestiges1884.jpg/250px-Vest

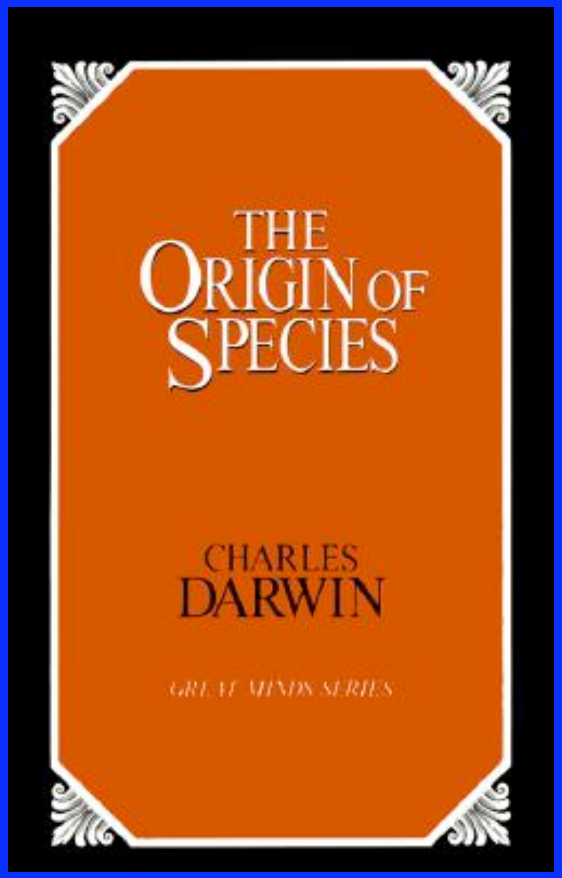
Alfred Russel Wallace Independently Drew the Same Conclusions as Darwin

Papers from Wallace and Darwin were jointly presented (with little impact) to the Linnaean Society in 1858.

"All that was new in them was false,
and what was true, was old"

Review of presentation by
Professor Haughton of Dublin

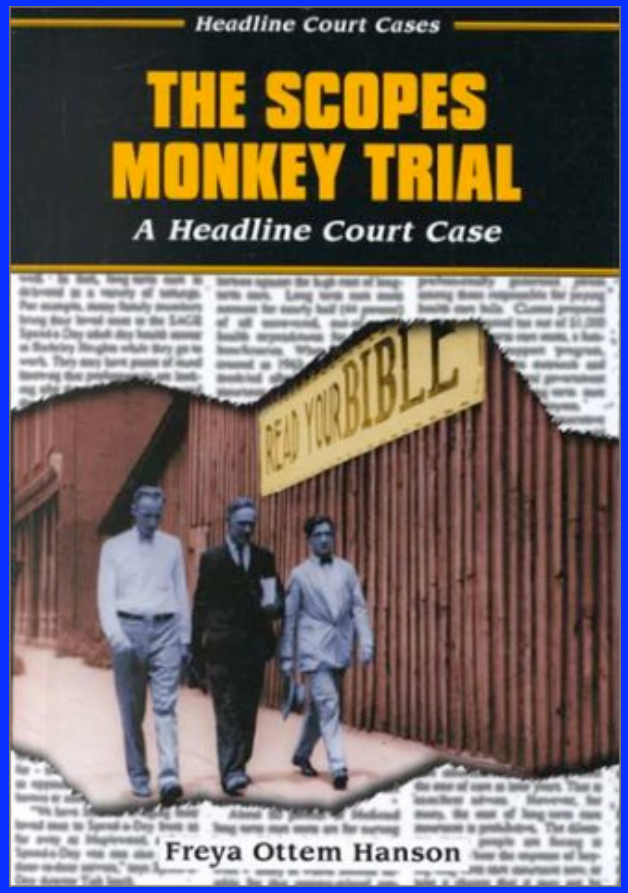
The Origin of Species

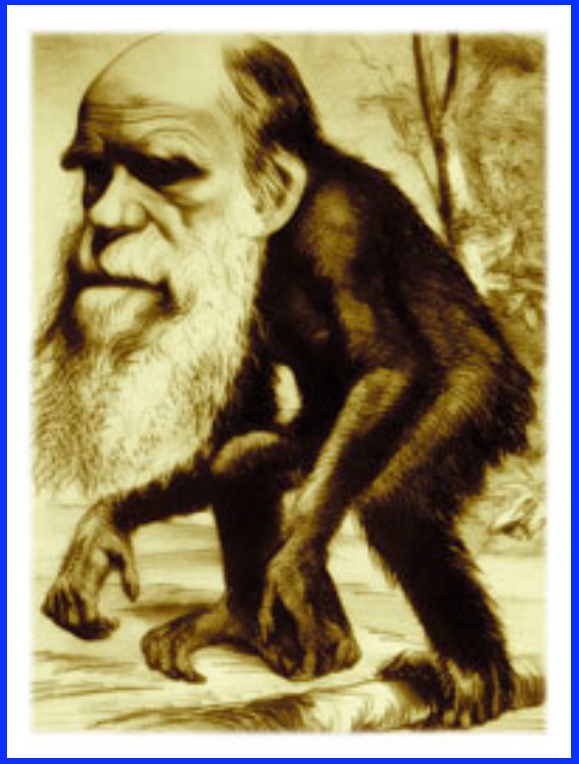


Images Source: Wikipedia

- Eight months later, in November 1859, The Origin of Species was published
- Darwin's theory of evolution overshadowed his geological acheivements

The upheaval surrounding evolution began with publication of *On the Origin of Species* and continues nearly 150 years later.





"Are you descended from monkeys on your grandmother's side or your grandfather's?" -- "Soapy Sam" Wilberforce to Thomas Huxley

The Scopes Monkey Trial

- 1925, Dayton, Tennessee
- John Scopes was recruited to teach evolution as a way of challenging its ban
- Was found guilty, but national publicity resulted
- It was not until 1968 (Epperson v. Arkansas) that such bans were found unconstitutional
- Anti-evolution movement has tried many strategies subsequently

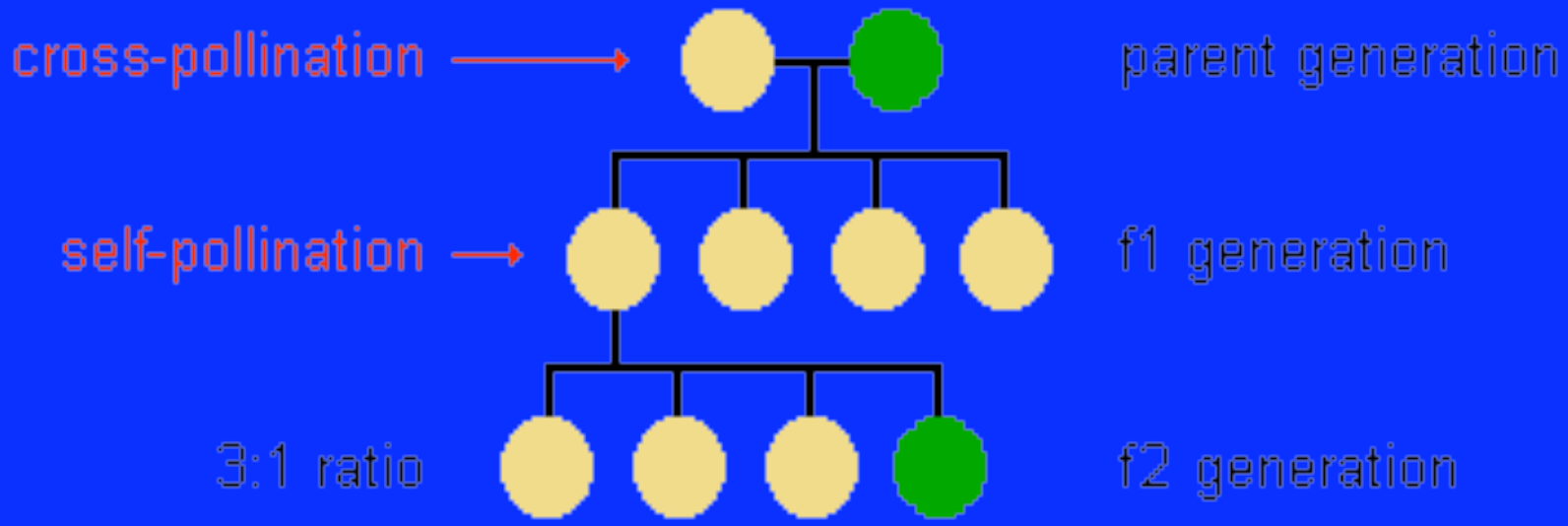
The Weak Link of Genetics and the Modern Synthesis

A major problem in Darwin's theory was the lack of a mechanism to explain natural selection.

How could favorable variations be transmitted to later generations?

The Monk and the Pea Pods

- Gregor Mendel: Austrian monk
- Pea pods have distinct characteristics
  E.g., yellow or green
- Cross-breeding showed laws of inheritance
- Dominant vs. recessive alleles



http://anthro.palomar.edu/mendel/mendel_1.htm

Mendel vs. Darwin?

- Clash for first couple of decades of 20th century
- Why? Darwin emphasized gradual change, but genetics indicated abrupt change possible between generations
  Yellow pea can produce green pea

The Modern Synthesis

- Developed by many researchers
  Morgan, fruit flies
- Single mutations don't create new species
- They do affect genes
- Enough such changes, and a new species can emerge

T.H. Morgan and friend

Summary

- Many influences of evolutionary theory
- Darwin put it all together
- But, this is an evolving subject; Darwin could not have known it all!
- Next: what are common misconceptions about evolution?