

Lecture 3

What Darwin saw

1. What observations did Darwin make on the Beagle and how did they influence his thinking about evolution?

2. What lead to his discovery of the mechanism of evolution – natural selection?

Key reading in Coyne – Chapter 4

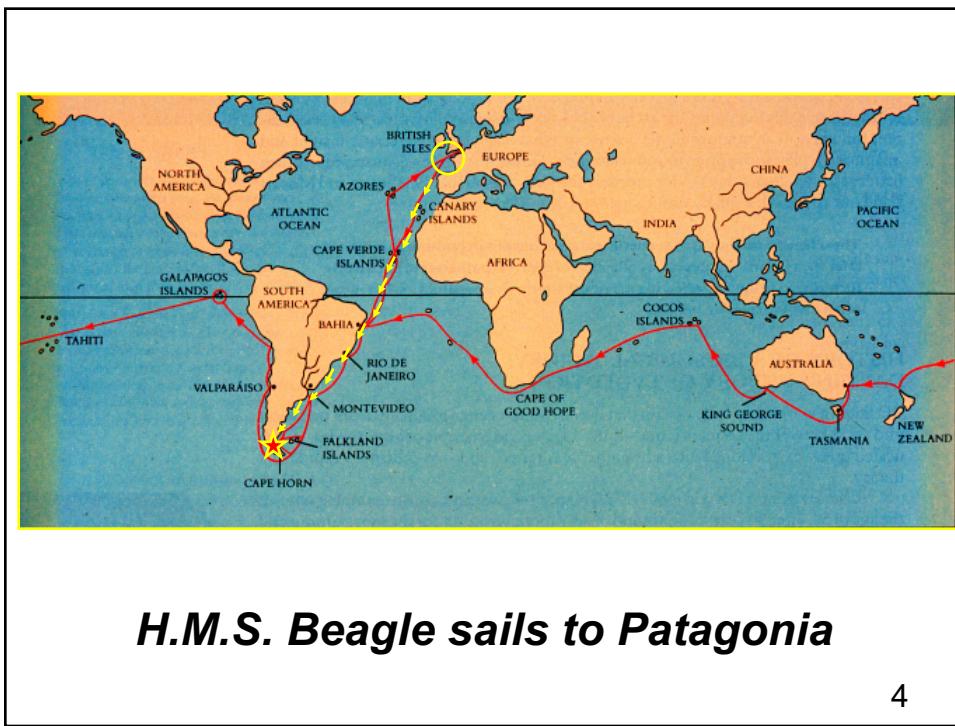
1

Charles Darwin's Voyage on H.M.S. Beagle (1831-1836)



- Age 22, ship's naturalist
- Most time spent in South America
- Observations of fossils, geographical distribution of plants and animals, and flora and fauna of oceanic islands

2



The Beagle heads south to Patagonia and Darwin discovers strikingly different environments in which abiotic factors dominate and landscapes are geologically young

Torres del Paine, Chile



Grey Glacier, Chile



El Chaltén, Argentina



Darwin finds fossils of extinct mammals in Argentina

Tolypeutes matacus

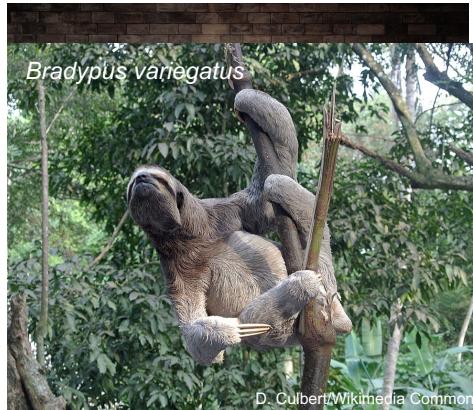


Glyptodon

giant armadillo



Darwin finds fossils of extinct mammals in Argentina



Megatherium in Punta Alta, Argentina

7

Observations in Patagonia

- Modern living (extant) species can “replace” extinct species
- These species are “allied” (belong to the same group)
- Why would species be replaced over time?

8

In his own words...

“...in the same formation I found a large surface of the osseous polygonal plates....Immediately I saw them and thought they must belong to an enormous Armadillo, living species of which genus are so abundant here”

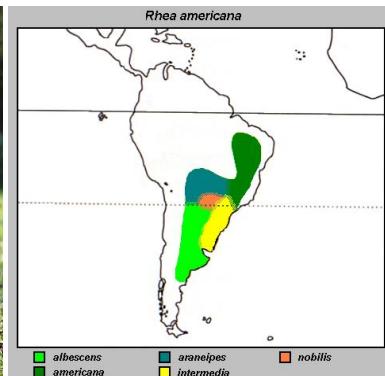
Charles Darwin (1832)
Letter to John Henslow

9

Rheas of South America



Greater Rhea
Rhea americana



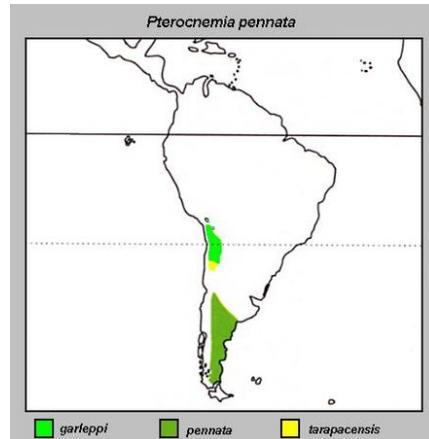
All images: Wikimedia Commons

10

Rheas of South America



Lesser Rhea
Rhea pennata



11

Observations about Rheas of South America

- Lesser rhea “replaces” greater rhea in southern South America
- birds are similar in appearance and habits
- closely “allied” – congeneric relatives
- Why would one species replace another in space?

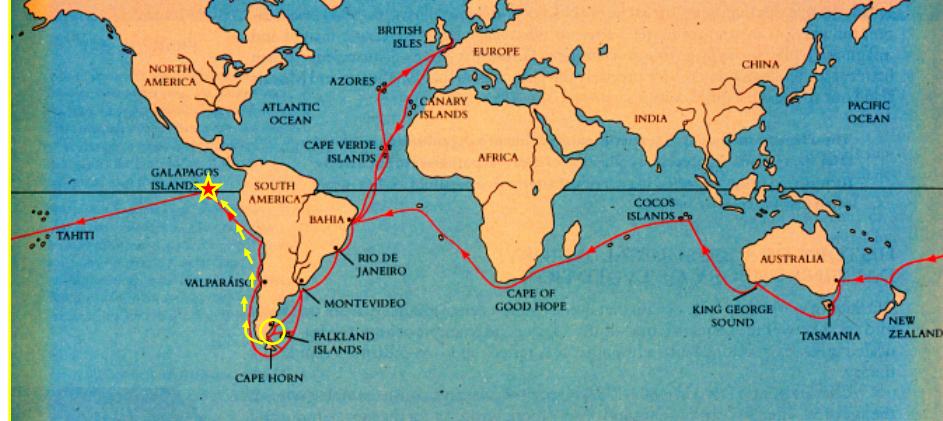
12

In his own words...

“When at the Rio Negro in Northern Patagonia, I repeatedly heard the Gauchos talking of a very rare bird which they called Avestruz Petise. They described it as being less than the common ostrich (which is there abundant), but with a very close general resemblance... This species occurs most rarely on the plains bordering the Rio Negro; but about a degree and a half further south they are tolerably abundant.”

Charles Darwin (1839)
Voyage of the Beagle

13



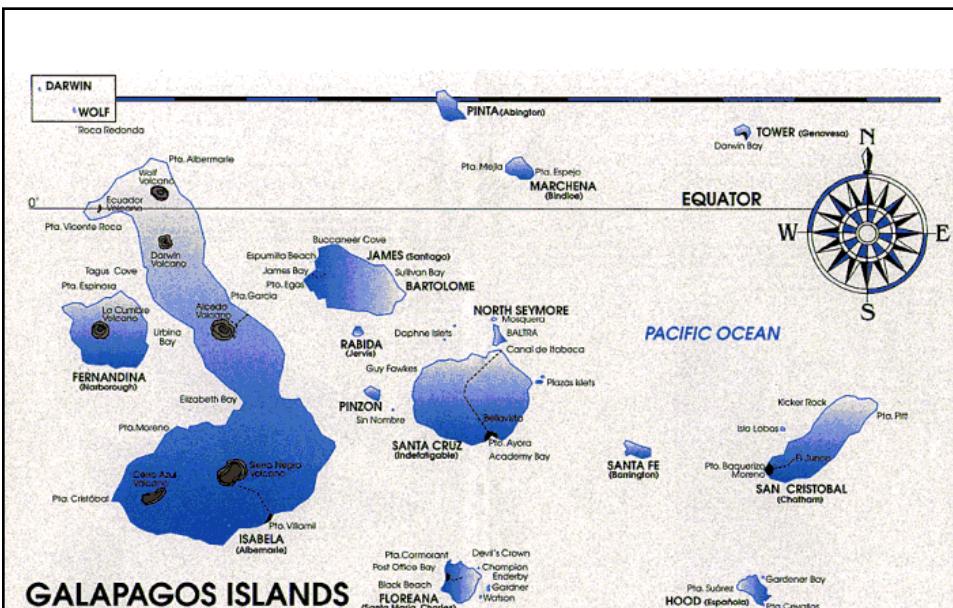
H.M.S. Beagle sails to Galápagos Islands

14

Galápagos Islands

- 15 main islands of volcanic origin; oldest 5-10 million years old; youngest more recent
 - Flora and fauna colonized by species capable of long-distance dispersal from South American mainland
 - Distinct races and species on different islands provide evidence of early stages of speciation
 - Darwin spent only 5 weeks on the islands but his observations formed the foundation for his theory of evolution

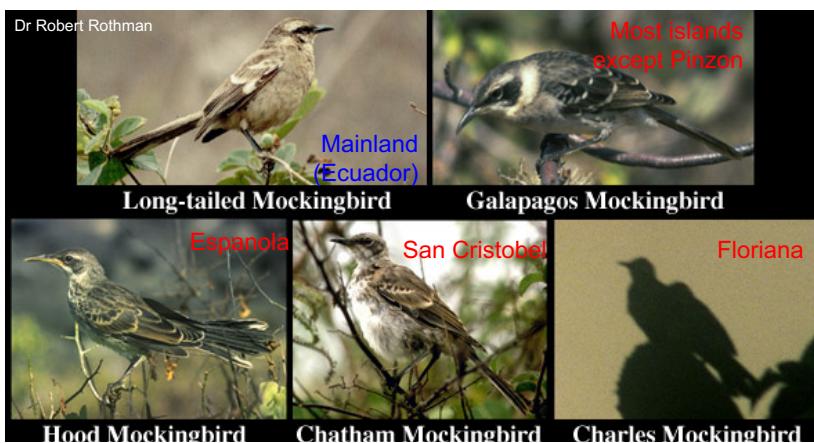
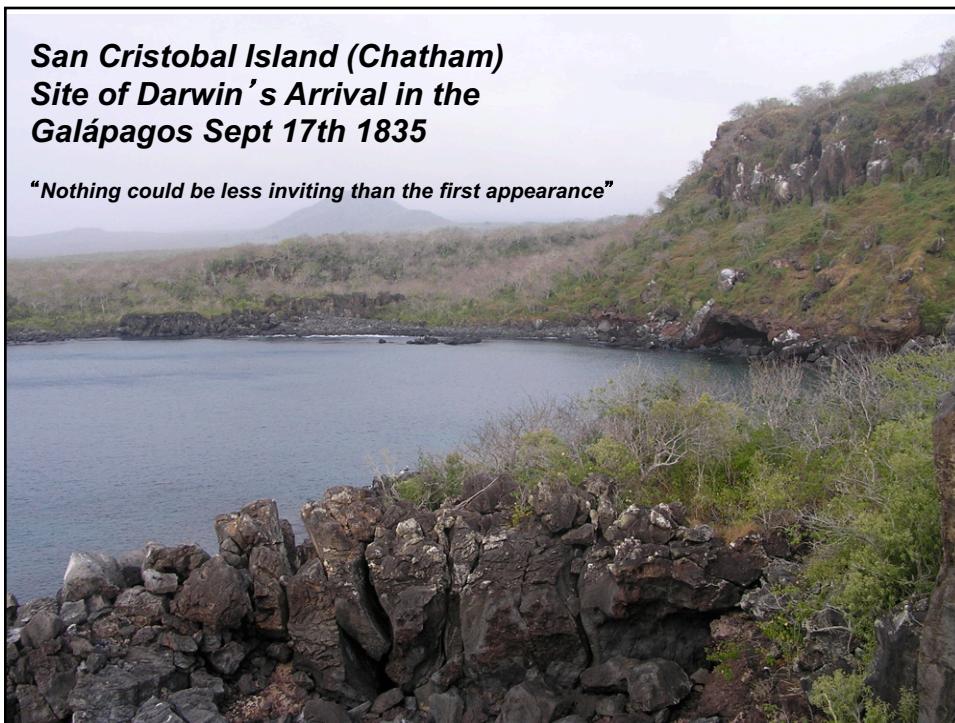
15



16

San Cristobal Island (Chatham)
Site of Darwin's Arrival in the
Galápagos Sept 17th 1835

"Nothing could be less inviting than the first appearance"



- 4 species of mockingbird found on Galapagos Islands
- Darwin collected 1 specimen from 4 islands



Pinta
(Abingdon)

Isabela
(Albemarle)

Santa Cruz
(Indefatigable)

Tortoises on different islands have different shell patterns – 10 subspecies of a single species - *Geochelone nigra* - are today recognized and many are highly endangered

Pinta

Santa Cruz

Isabela

20

Observations from Galapagos Island

- Mockingbirds and tortoises from each island differed more in appearance from each other than they did across all of South America
- Could these island species have “replaced” mainland species?
- Did the island species descend from mainland species?

21

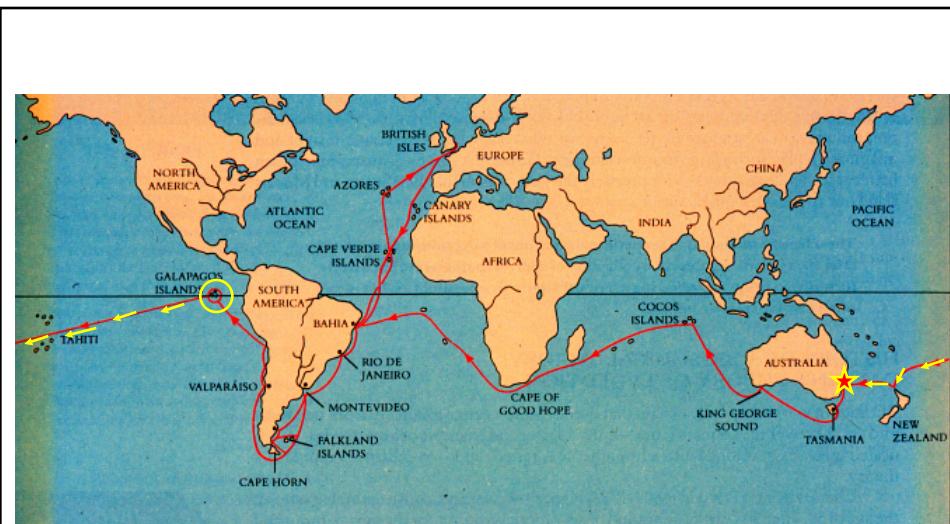
In his own words...

“Animals on separate islands ought to become different if kept long enough apart with slightly differing circumstances”

Charles Darwin (1837-1838)

Notebook B

22



**H.M.S. Beagle sails to Australia
spends two months there**

23

Australia

- Distinct flora and fauna with high levels of endemism* and many unique adaptations
- Biological uniqueness due to long history of isolation from other land masses
- Although a continent Australia is also an island and shows many island characteristics e.g. endemism, radiations & unique adaptations

*Endemic species are restricted to a particular geographical region or habitat

24

Dry Forests composed of Eucalyptus (Gum Tree)

The dominant tree group in Australia with 700 spp., only 15 of which occur outside the continent

Blue Mtns, New South Wales

Endemic species of Australia



26

Observations from Australia

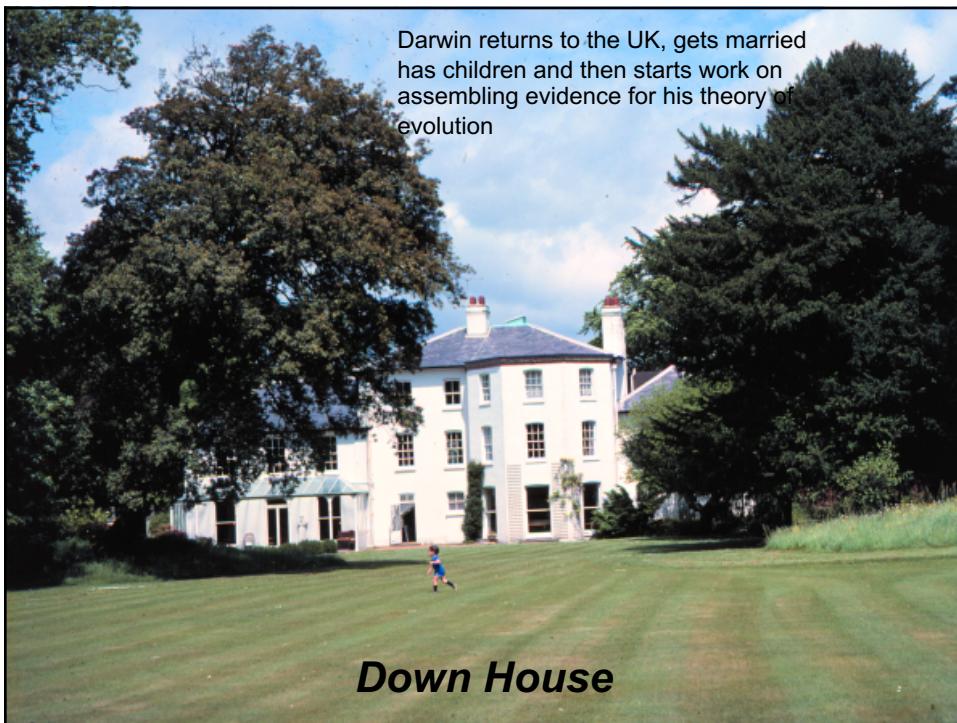
- Potoroos and platypi in Australia occupy the same ecological niches as rabbits and water rats in England, but look very different

27

In his own words...

“A Disbeliever in everything beyond his own reason, might exclaim, ‘Surely two distinct creators must have been (at) work; their object however has been the same and certainly in each case the end is complete’...would any two workmen ever hit on so beautiful, so simple and yet so artificial a contrivance?””

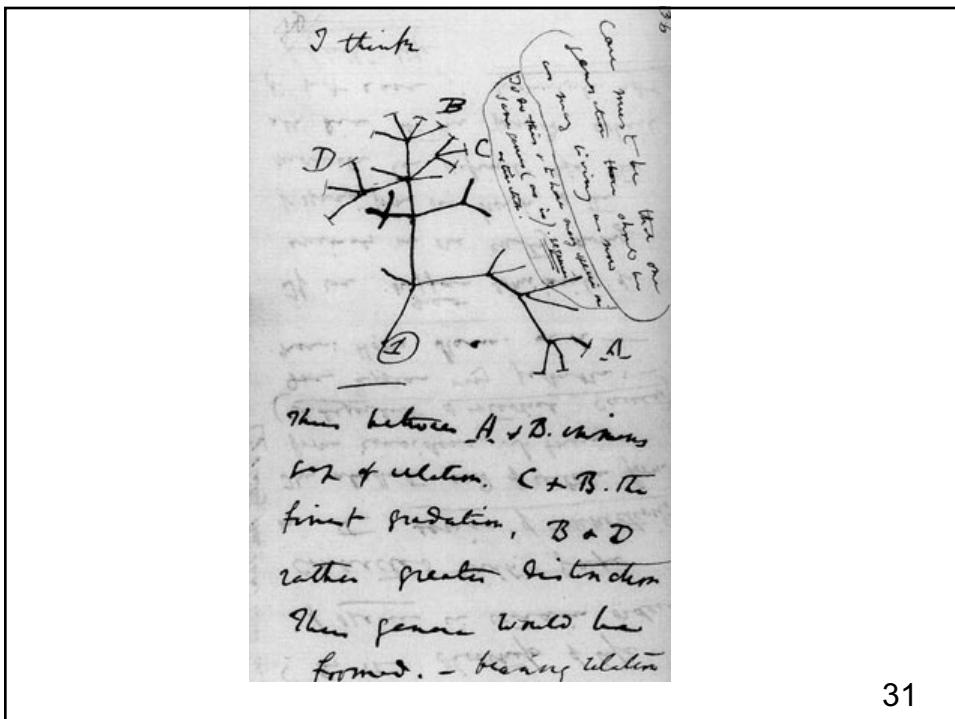
28



“During the voyage of the *Beagle* I had been deeply impressed by discovering...great fossil animals covered with armour like that on existing armadillos; secondly, by the manner in which closely allied animals replace one another in proceeding southwards over the Continent; and thirdly, by the South American character of most of the productions of the Galapagos archipelago, and more especially by the manner in which they differ slightly on each island of the group...It was evident that such facts as these...could only be explained on the supposition that species gradually become modified...”

Charles Darwin (1859)
On the origin of species

30



The Origin of Species

Two key components

- All organisms have descended with modification from common ancestors
- The major agent of modification is natural selection operating on variation among individuals

32

How did Darwin come up with natural selection?

- 1837-1839 “Transmutation Notebooks”
- reads breeders’ manuals – breeders select for favorable traits – but what plays the role of breeder in nature?
- reads Malthus – nature favours (or selects) variations that help an individual survive and/or reproduce

33

Three principles will account for all:

- (1) Grandchildren like grandfathers
- (2) Tendency to small change, especially with physical change
- (3) Great fertility in proportion to support of parents

Charles Darwin (1839)
Notebook E

34

Requirements for Darwin's theory to work

- **Variation** – variation among individuals in a population
- **Heredity** – progeny resemble their parents more than unrelated individuals
- **Selection** – some forms better at surviving and breeding than others in a given environment

35