### Galápagos Archipelago Geography

Islands straddle equator at 90°W
Nearest land: Mainland Ecuador 600 mi

Charles Darwin visited the Galápagos @ age 26 in 1835

His observations were crucial to his theory of evolution via natural selection

### Darwin's Key Observations about the Galápagos

1. Their isolation
2. "Sieve" of ocean
3. Lack of competitors
4. Lack of predators
5. Difficulty of establishment

**Consequence:**
A high degree of *endemism* & an unusual degree of *speciation* as organisms move into new adaptive zones

### 1. Isolation

Isolation allows genetic differences to develop without swamping by mainland populations (Limited gene flow)

Isolation in an archipelago is multiple:
1. Isolation of all islands from mainland
2. Isolation of individual islands from each other

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*All photos by W.G. Abrahamson unless otherwise noted*
1. Isolation

* e.g., Marine Iguanas: Darwin’s “Imps of Darkness”

Marine Iguana vs. Mainland Iguana
- Only iguana that feeds on algae in ocean
- Snout flattened, blunt-serrated rasp teeth
- Flattened tail for swimming
- Drinks sea water; salt glands to concentrate & expel salt through nostrils

Galápagos marine iguana

Mainland iguana

2. Ocean “Sieve”

Volcanic islands are initially devoid of life (like a “sterile petri dish”)

Variation among islands in:
- **Size:**
  - Largest on Fernandina & Isabela
  - Smallest on Genovesa
- **Color:**
  - Bright on Española
  - Dark on Genovesa

Española race

Genovesa race

Mainland iguana
2. Ocean "Sieve"

Volcanic islands are initially devoid of life (like a "sterile petri dish")

How do organisms colonize?
1. Rafting or free floating
   - Rafts from mainland
   - Humboldt Current
   - El Niño Current
2. Air dispersal
   - Birds, bats, some insects, spores
   - Parachute-like plant seeds
   - Typhoons may help
3. Organisms carried on or in the body of another organism
   - Seeds
   - Snails
   - Parts of plants
   - Fleas & other ectoparasites

First Colonizing Animals

Sea birds - Why?
- Highly vagile (freely move about)
- No predators were on islands

First plants & plant relatives:
- Lichens & mosses first
- Ferns with spores

Reduced predation and absence of humans accounts for tameness of Galápagos animals.
2. Ocean “Sieve”

Ocean “sieve” hard on high-metabolism mammals
Native mammals poorly represented
2 species of bats (one endemic)
Several species of rice rats (arrived via rafts)

3. Lack of Competition
Expressed as “Adaptive Radiation”

Mockingbirds - radiated into 4 species
Behave like jays
Longer legs & beaks
Kill/eat young finches & lizards
Española population eats eggs, feeds on wounds on birds

Darwin’s finches - 13 species
Species fall into 3 genera:
Geospiza – ground finches (4 spp.)
Camarhynchus – vegetarian finch, tree finches (3 spp.), woodpecker finch, & mangrove finch
Certhidea – warbler finch

3. Lack of Competition
Expressed as “Adaptive Radiation”

Similar mockingbird species on different Galápagos islands

Darwin’s finches - 13 species

Large Ground Finch

Galápagos sea lion (endemic subspecies, from north)
Fur seal (endemic species, from south)
3. Lack of Competition
Expressed as “Adaptive Radiation”

Mangrove Finch
Small Tree Finch
Woodpecker Finch

Warbler Finch

Adaptive Radiation Darwin Finches

4. Lack of Predation

e.g., Green sea turtles endangered everywhere - but abundant in Galápagos

4. Lack of Predation

e.g., Existence of giant tortoises
4. Lack of Predation

- Breeding birds: Waved Albatross, Yellow-crowned Night-heron, Red-billed Tropicbird

5. Difficulty of Establishment

- Lack of soil problem for higher plants
  - Brachycereus cacti one of the first colonizers of new lava flows

- Many plants need insects or other animals to ensure fertilization - without pollinators, there's no colonization
  - Carpenter bee

- Few colonizers = initial low genetic diversity
  - Referred to as: Founder Effect

- ~30 successful invasions over the millions of yrs account for all native land vertebrates
  - Land iguana: Two endemic species
5. Difficulty of Establishment

~30 successful invasions over the millions of yrs account for all native land vertebrates

~100 successful invasions over the millions of yrs account for ~250 endemic vascular plants

Consequence: Biotic Disharmony

Families that are over-represented relative to mainland:
- Ferns
- Grasses
- Sunflowers
- Pigweeds
- Legumes (beans)
- Sedges
- Also, lichens
- Mosses & liverworts

Consequence: Biotic Disharmony

Families that are under-represented relative to mainland:
- Palms
- Cashews
- Mahogany
- Mints
- Figworts
- Orchids
- Acanthus
- Melastomas
- Pineapples

Consequence: Biotic Disharmony

Preponderance of Reptiles; NO Amphibians
- Many Birds; FEW Mammals

Trends in Islands

1. Gigantism in animals
2. Perennial (woody) plants
3. Inconspicuous flowers
4. Loss of dispersal

1. Gigantism in Animals

Vegetarian animals from Spanish word “galápagos” meaning “saddle” after saddle-backed tortoises
1. Gigantism in Animals

Carapace shapes vary island to island
Larger, dome-backed on Santa Cruz & Isabela
Smaller, saddle-backed on Española & Pinta

Dome useful in more moist environments
Can't reach as high but can push way through dense vegetation

Saddle useful in more arid environments
Reach higher for food

Trends in Islands

1. Gigantism in animals
2. Perennial (woody) plants
3. Inconspicuous flowers
4. Loss of dispersal

2. Perennial Habit in Plants

Tree sunflowers (Scalesia) to 45' tall
15 species & 6 subspecies & varieties

3. Inconspicuous Flowers

Few pollinators,
Most Galápagos flowers are small
Many are wind pollinated
Trends in Islands

1. Gigantism in animals
2. Perennial (woody) plants
3. Inconspicuous flowers
4. Loss of dispersal

4. Loss of Dispersal

Many Galápagos plants show reduced dispersal, e.g., Scalesia.

Consequence: Endemism

Endemic Species Are Not Naturally Found Elsewhere

40% of 500 vascular plants are endemics!!

Scalesia has radiated to 17 endemic species

Endemism

Endemic Species Are Not Naturally Found Elsewhere

3 genera of cacti – Brachycerus & Jasminocerus are endemic to islands
Opuntia includes 14 endemic species, even tree-sized
Consider Traveling with Bucknellians

Great Memories of Time Together
Daughter Jill Abrahamson
Associate Director
Alumni Relations

Great Memories of Time Together
abe & Kristin Coffey '98
Former Abrahamson Students
Galápagos Trip 2008

Bucknell Galápagos 2008
33 Participants
Ranging in age from 14 to 80

Great Memories of Time Together
Former Abrahamson Students
Galápagos Trip 2008

Continue EvolutionLab Simulation Model
Assignments #2 (Selection), #3 (Variance), #7 (Heritability - group project), & #3 (Clutch Size)

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