


Galápagos: Islands in Time Outline

- I. The Setting
Geography
- II. Colonization
 - Isolation
 - "Sieve" of ocean
 - Reduced competition
 - Reduced predation
 - Difficulty of establishment
- III. "Biotic Disharmony"
- IV. Trends in Islands
 - Gigantism in animals
 - Perennial (woody) plants
 - Inconspicuous flowers
 - Loss of dispersal
- V. Endemism




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



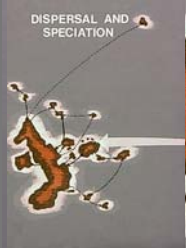
Charles Darwin

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








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 cool it





Galápagos marine iguana



Mainland iguana

1. Isolation


e.g., Marine Iguanas: Darwin's "Imps of Darkness"


Variation among islands in:

Size:


- Largest on Fernandina & Isabela
- Smallest on Genovesa

Color:





Genovesa race



Española race

2. Ocean "Sieve"

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





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. Ocean "Sieve"

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

How do organisms colonize?

1. Rafting or free floating

- Birds, bats, some insects, spores
- Parachute-like plant seeds
- Typhoons may help



2. Ocean "Sieve"

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

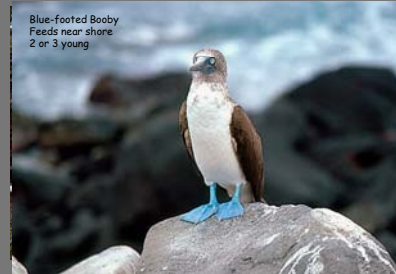
How do organisms colonize?

1. Rafting or free floating
2. Air dispersal
3. Organisms carried on or in the body of another organism
 - Seeds
 - Snails
 - Parts of plants
 - Fleas & other ectoparasites



2. Ocean "Sieve" First Colonizing Animals

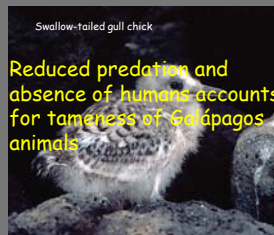
Sea birds - Why? Highly vagile (freely move about)
No predators were on islands



2. Ocean "Sieve" First Colonizing Animals

Sea birds - Why?

Highly vagile
No predators were on islands



2. Ocean "Sieve"

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



Lichens

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)



Red bat, endemic subspecies
Bat Conservation International



Santiago rice rat, rediscovered in 1997

2. Ocean "Sieve"

Ocean "sieve" hard on high-metabolism mammals

Galapagos marine lion (endemic subspecies, from north)

Fur seal (endemic species, from south)



3. Lack of Competition Expressed as "Adaptive Radiation"

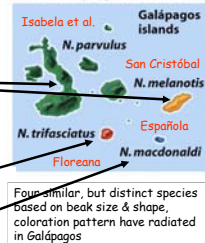
Mockingbirds - radiated into 4 species



Behave like jays
Longer legs & beaks
than on mainland
Kill/eat young finches & lizards
Española population eats eggs,
feeds at wounds on birds

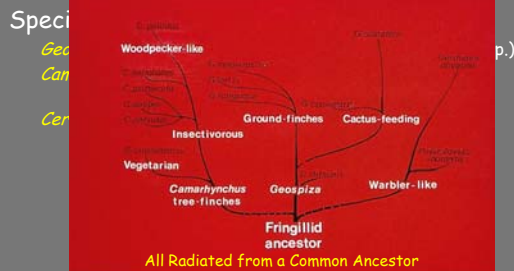
3. Lack of Competition Expressed as "Adaptive Radiation"

Similar mockingbird species on different Galápagos islands



3. Lack of Competition Expressed as "Adaptive Radiation"

Darwin's finches - 13 species



3. Lack of Competition Expressed as "Adaptive Radiation"

Large Ground Finch



3. Lack of Competition Expressed as "Adaptive Radiation"

Woodpecker finch

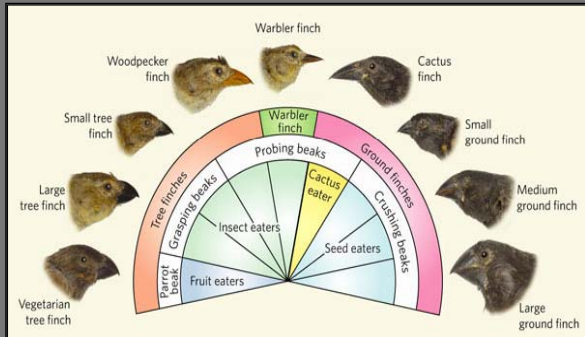


3. Lack of Competition Expressed as "Adaptive Radiation"

Warbler finch



Adaptive Radiation Darwin Finches



4. Lack of Predation

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



Tui De Roy/Minden Pictures

4. Lack of Predation

e.g., Existence of giant tortoises



4. Lack of Predation

e.g., Breeding birds



4. Lack of Predation

e.g., Breeding birds



5. Difficulty of Establishment

Lack of soil problem for higher plants

Brachycereus cacti one of first colonizers of new lava flows



5. Difficulty of Establishment

Many plant need insects or other animals to ensure their fertilization - without pollinators, there's no colonization



5. Difficulty of Establishment

Few Colonizers = Initial Low Genetic Diversity



5. Difficulty of Establishment

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



Adult male iguanas from Isabela Island:
Yellow form (A, Sierra Negra; D, Volcan Wolf)
Rosada (pink) form (B & C, Volcan Wolf)
(Left photographs: Gabriele Gentile) [PNAS Jan 13, 2009](#)

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

Vegetation that is from Spanish word "galápagos"
On meaning "saddle" after saddle-shaped volcanic main





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

Endemic genus *Scalesia*



Trends in Islands

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



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

Endemic Flightless cormorant



4. Loss of Dispersal

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



4. Loss of Dispersal

Normal flight

Flightless



Double-crested cormorant
The Wilderness Classroom Organization



Endemic Flightless cormorant - Vulnerable
John Merck

Consequence: Endemism

Endemic Species Are Not Naturally Found Elsewhere

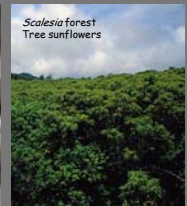
40% of 500 vascular plants are endemics!!
Scalesia has radiated to 17 endemic species



Endemic Galápagos cotton



Hairy morning glory
Liz Leydon



Scalesia forest
Tree sunflowers

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



Opuntia

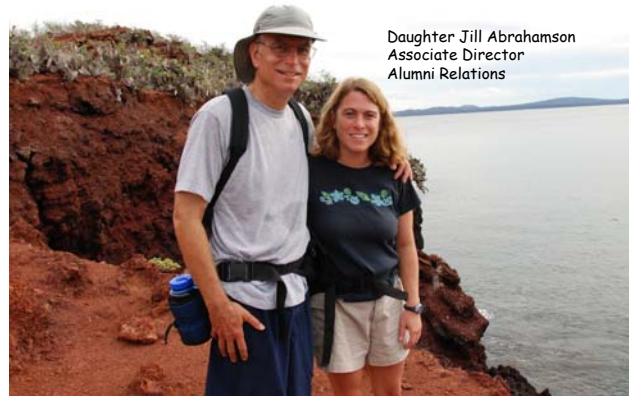
Jasminocerus

Bucknell in the Galapagos Islands 2008
Great Memories of Time Together
John & Rita McKee





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

