Biology of the Galapagos

Wikelski reading, Web links

26 March 2009, Thurs
ECOL 182R UofA
K. E. Bonine

Alan Alda
Video?

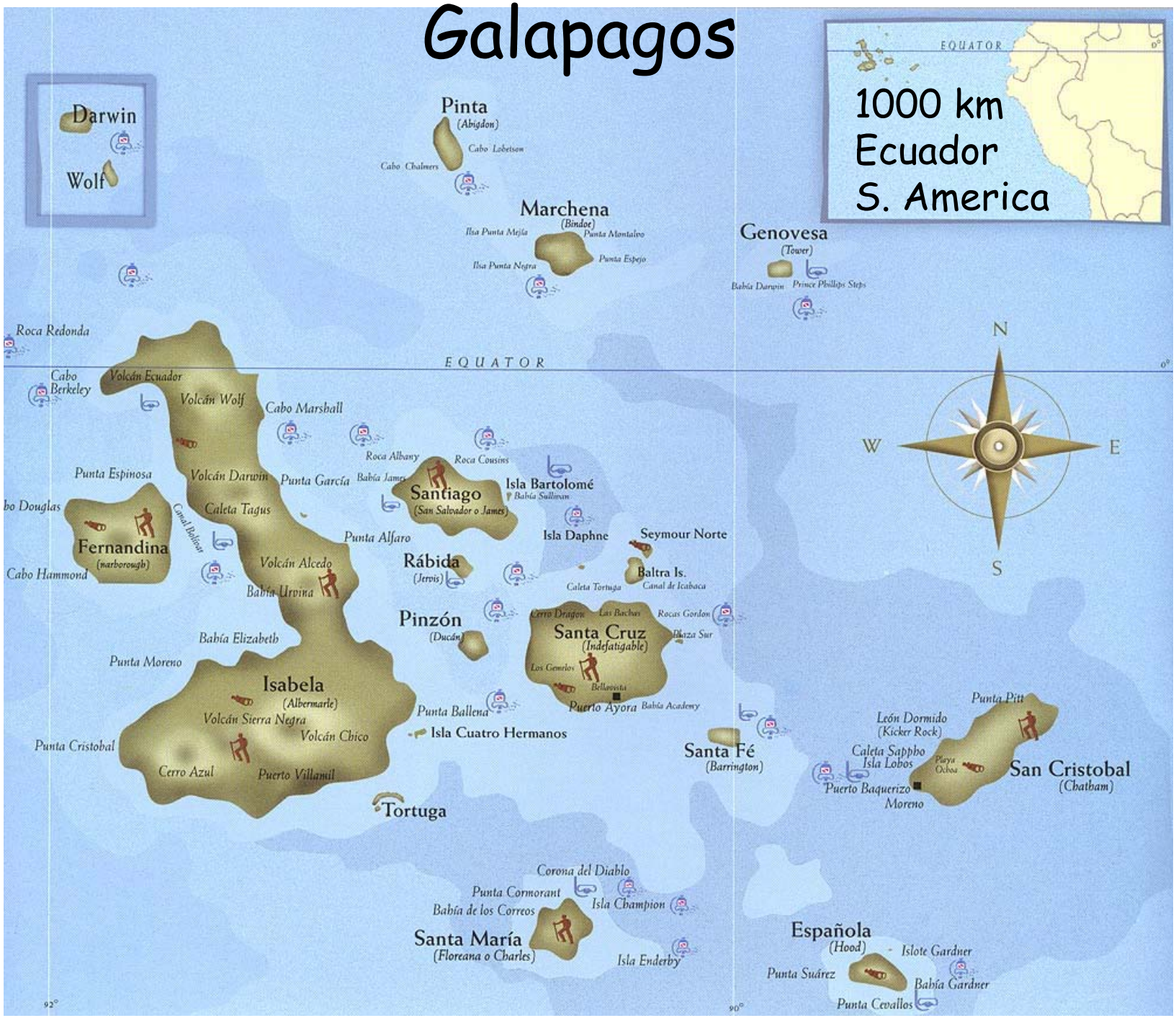
Student Chapter of the Tucson Herpetological Society

COME JOIN!!!!!

General Information…

- Herpetology: the branch of zoology having to do with the study of reptiles and amphibians.
- What We Do: Education outreach, Fun Trips, Exposure to reptiles and amphibians.
- Meeting Time and Location: Every third Thursday of every month; outside, on the North side of Biological Sciences East. Except on March 26, 2009 (b/c spring break).

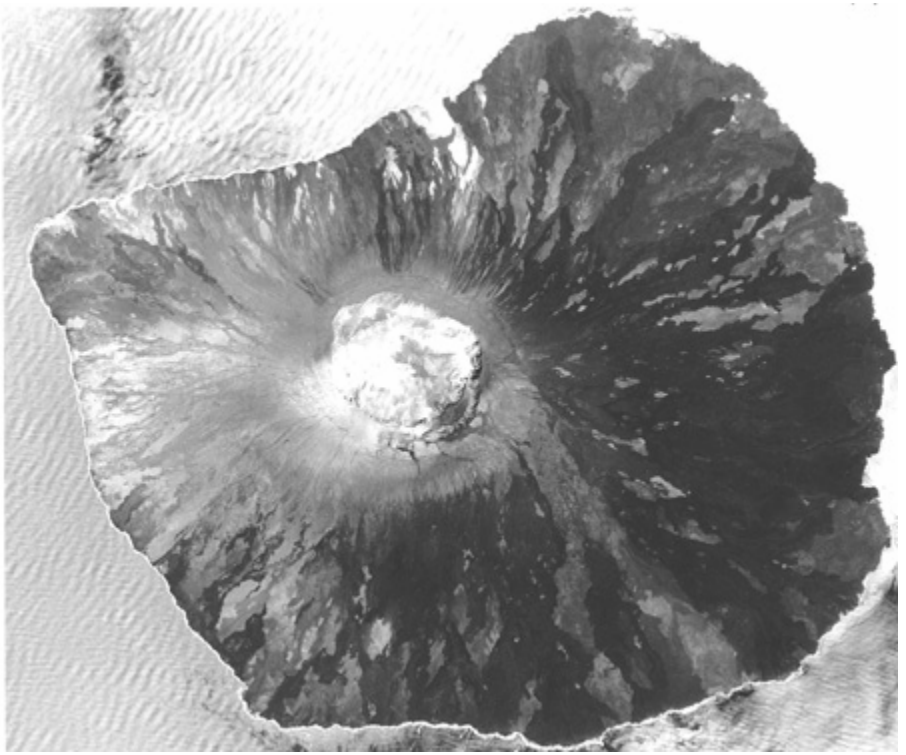
Galapagos


Darwin
Wolf
Pinta
(Abigdon)
Cabo Robetson
Cabo Chalmers
Marchena
(Bindoe)
Ilsa Punta Mejia
Punta Montalvo
Punta Espejo
Ilsa Punta Negra
Genovesa
(Tower)
Bahía Darwin
Prince Phillips Steps
1000 km
Ecuador
S. America
EQUATOR
Roca Redonda
Cabo Berkeley
Volcán Ecuador
Volcán Wolf
Cabo Marshall
Roca Albany
Roca Cousins
Punta Espinosa
Volcán Darwin
Punta García
Bahía James
Santiago
(San Salvador o James)
Isla Bartolomé
Bahía Sullivan
Caleta Tagus
Canal Bolívar
Punta Alfaro
Isla Daphne
Seymour Norte
Fernandina
(narborough)
Cabo Hammond
Volcán Alcedo
Bahía Urvina
Rábida
(Jervis)
Baltra Is.
Canal de Icabaca
Caleta Tortuga
Pinzón
(Ducán)
Cerro Dragon
Las Bachas
Rocas Gordon
Santa Cruz
(Indefatigable)
Bahía Elizabeth
Punta Moreno
Los Gemelos
Bellavista
Isabela
(Albermarle)
Puerto Ayora
Bahía Academy
Punta Ballena
Volcán Sierra Negra
Volcán Chico
Isla Cuatro Hermanos
Punta Cristobal
Cerro Azul
Puerto Villamil
Santa Fé
(Barrington)
Punta Pitt
León Dormido
(Kicker Rock)
Caleta Sappho
Isla Lobos
Playa Ochoa
San Cristobal
(Chatham)
Puerto Baquerizo
Moreno
Tortuga
Corona del Diablo
Punta Cormorant
Bahía de los Correos
Isla Champion
Santa María
(Floreana o Charles)
Isla Enderby
Española
(Hood)
Islote Gardner
Punta Suárez
Bahía Gardner
Punta Cevallos
N
W
E
S
92°
90°

Origins of the Galapagos

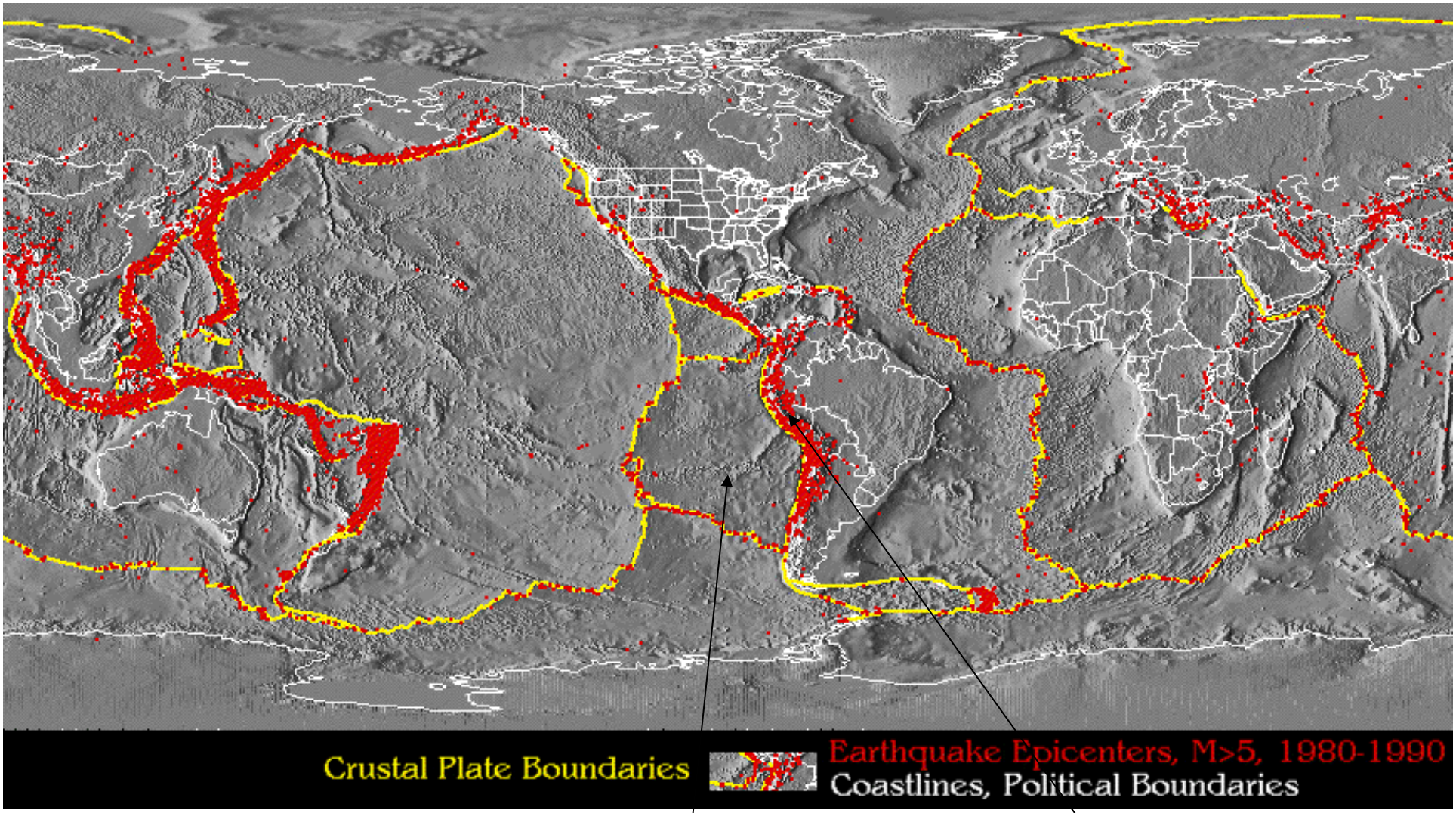
(first islands about 10mya,
oldest current islands _____)
What happened to the older ones???

Oceanic or Continental Islands?



Stationary _____ creates islands, then tectonic plate "rafts" east

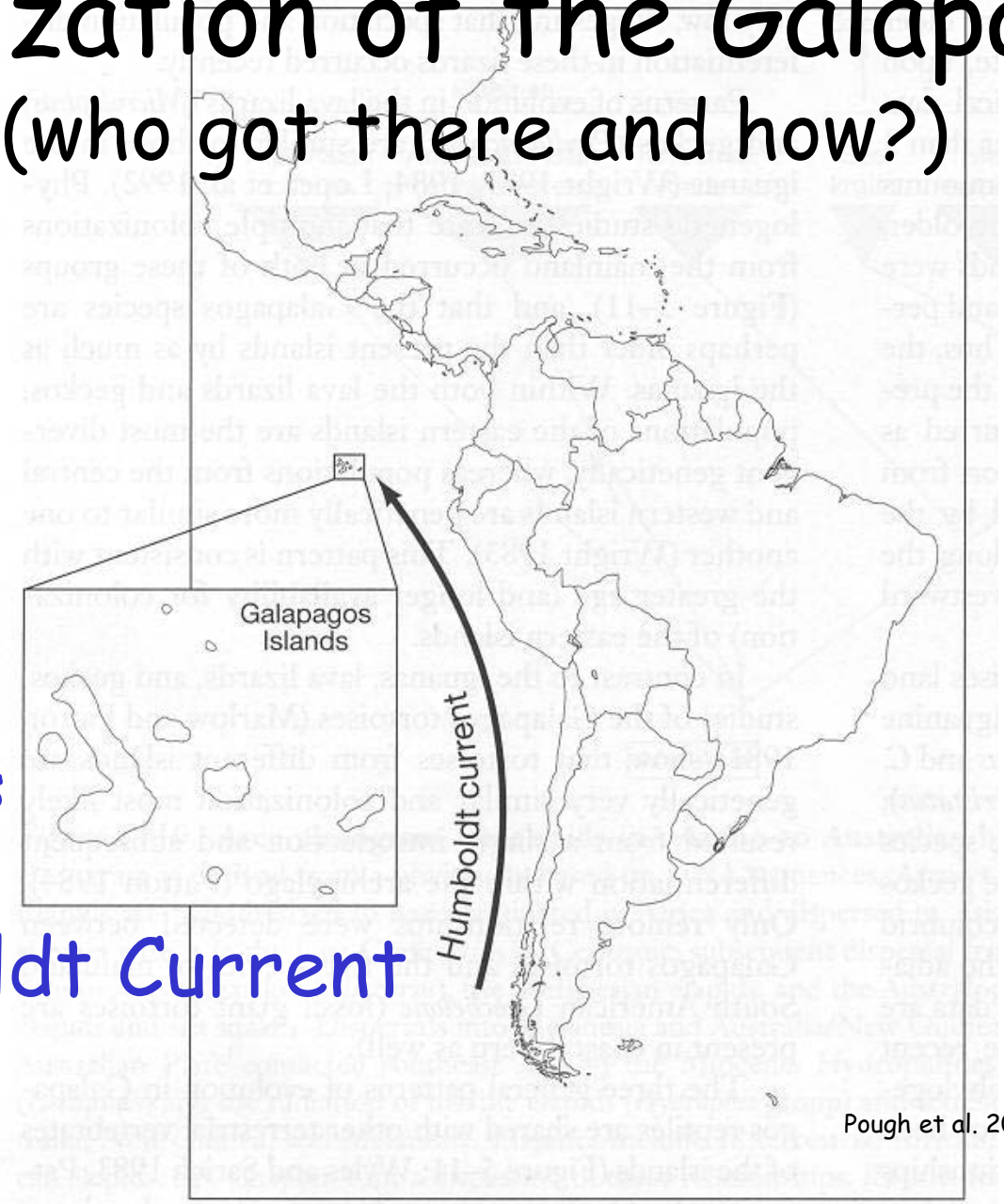
Plate Tectonics



Nazca Plate

Andes

Colonization of the Galapagos
(who got there and how?)

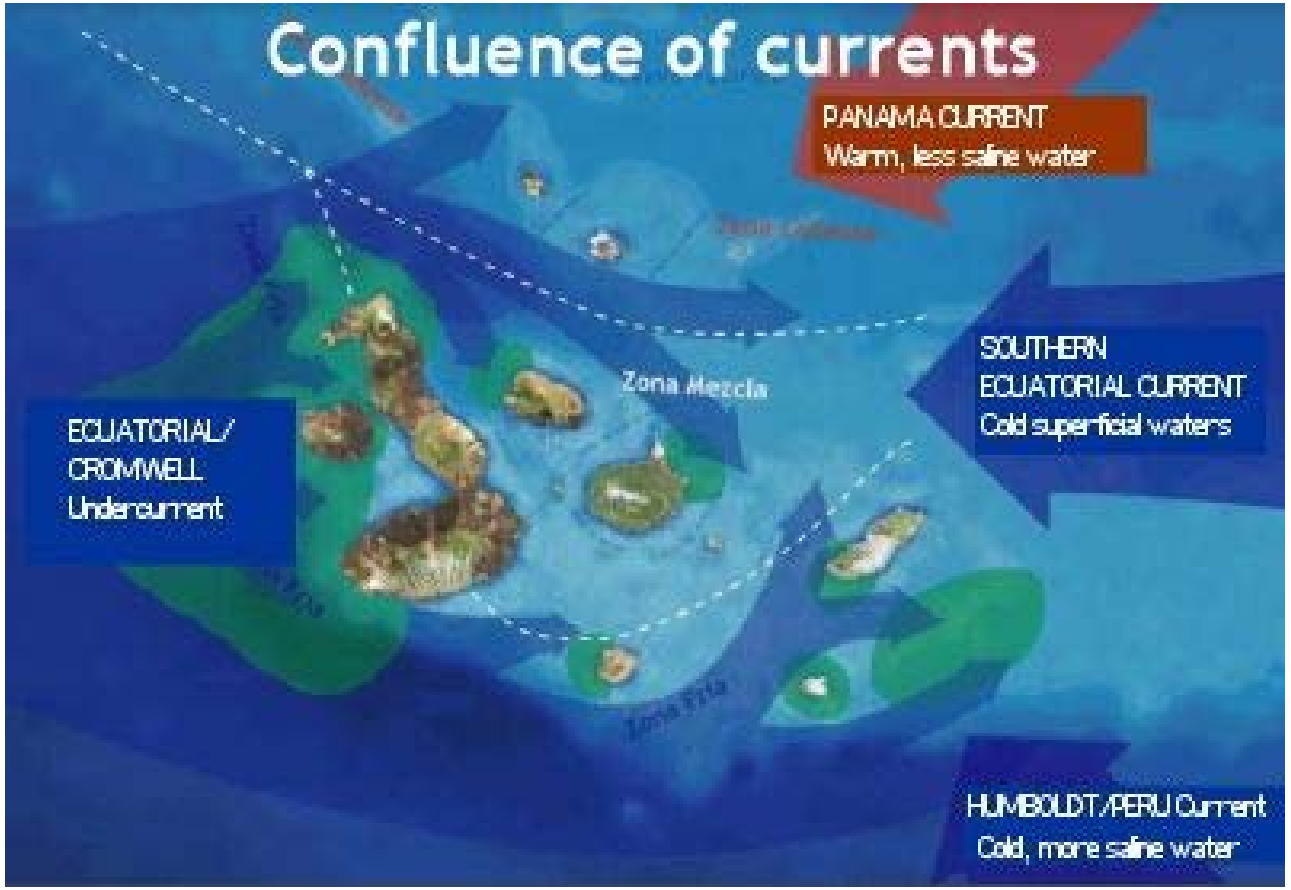


Galapagos

Humboldt Current

Pough et al. 2004

Colonization of the Galapagos
(who got there and how?)



HOW MANY?

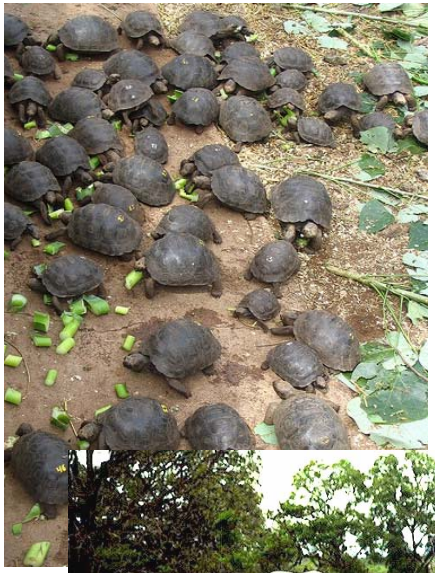
-Birds
-Frogs
-Lizards & Snakes
-Mammals
    Marine or Terrestrial?
-Plants

Galapagos difficult to colonize.
Some taxa make the journey better than others.

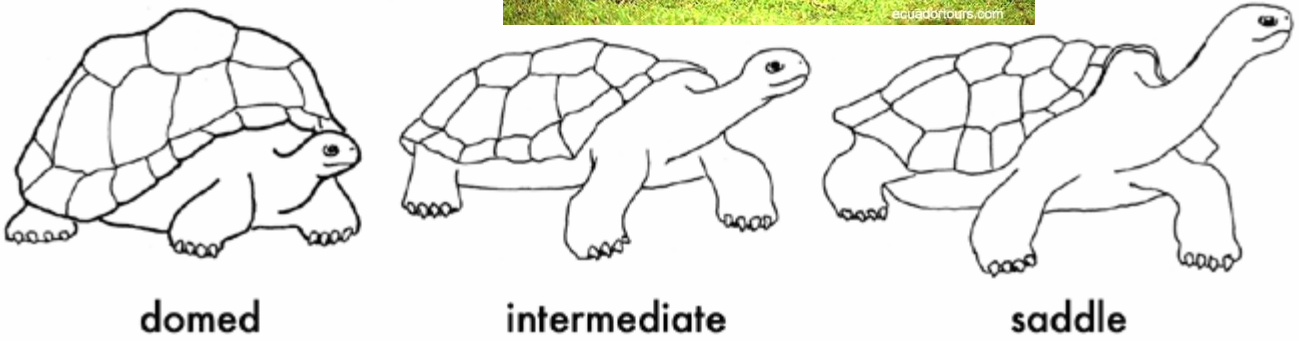
Many _____ species than _____ .

... is the diversification of a single or small groups of species into a large number of descendant species that occupy various ecological niches.

This is an evolutionary process driven by natural selection.




equadortours.com

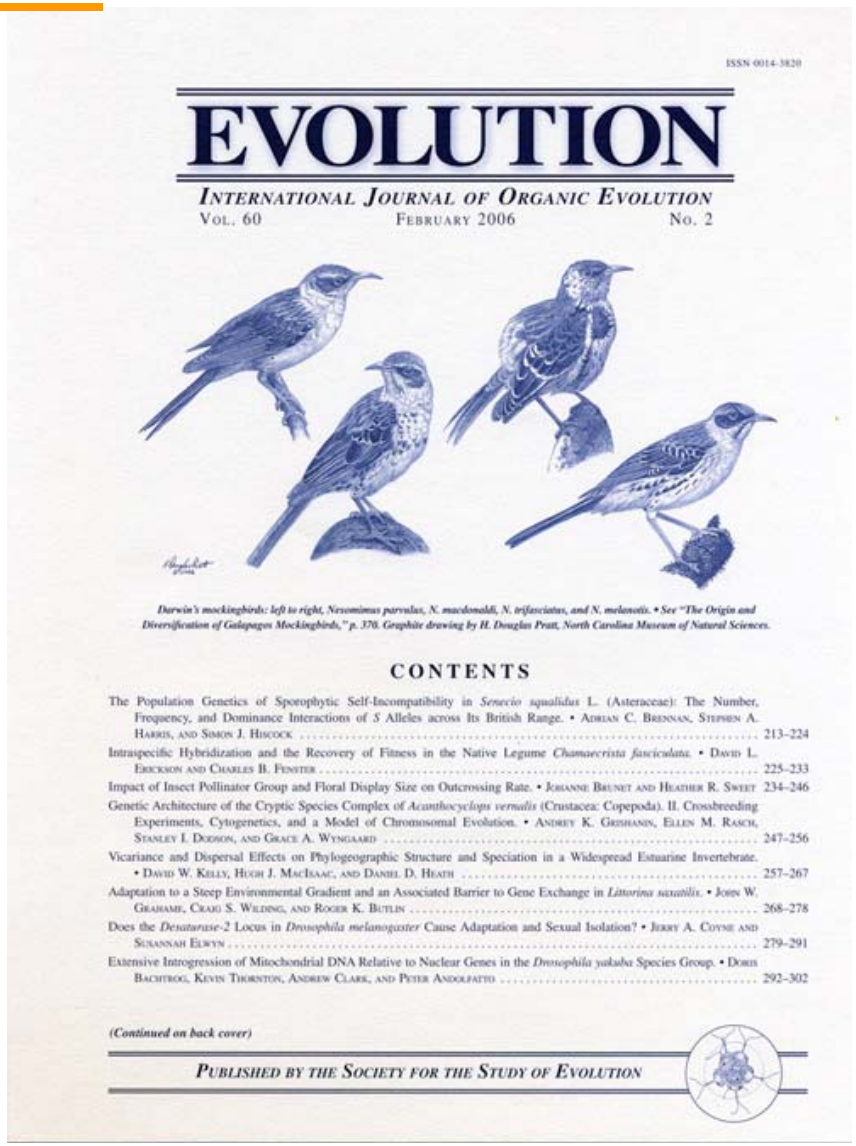

domed
intermediate
saddle

Scalesia spp.

There are 15 currently recognised species plus five subspecies of *Scalesia*; species are shrubs but four commonly grow into trees. All are endemic to Galapagos. They are an excellent example of adaptive radiation, the development of new species to fit different vegetation zones and islands. There is great diversity between species:

- Species vary in size, from less than one meter to over 10 meters in height.
- Leaves vary in size and shape between species and are usually hairy. Leaves cluster at ends of twigs.
- The flowers are carried in white, daisy-like heads of 15 (*Scalesia cordata*) to 300 (*S. villosa*) small flowers.
- Some species grow mainly in the arid zone while others, especially the larger trees, are adapted to the humid zone.

Mockingbirds



ISSN 0014-3820

EVOLUTION

INTERNATIONAL JOURNAL OF ORGANIC EVOLUTION

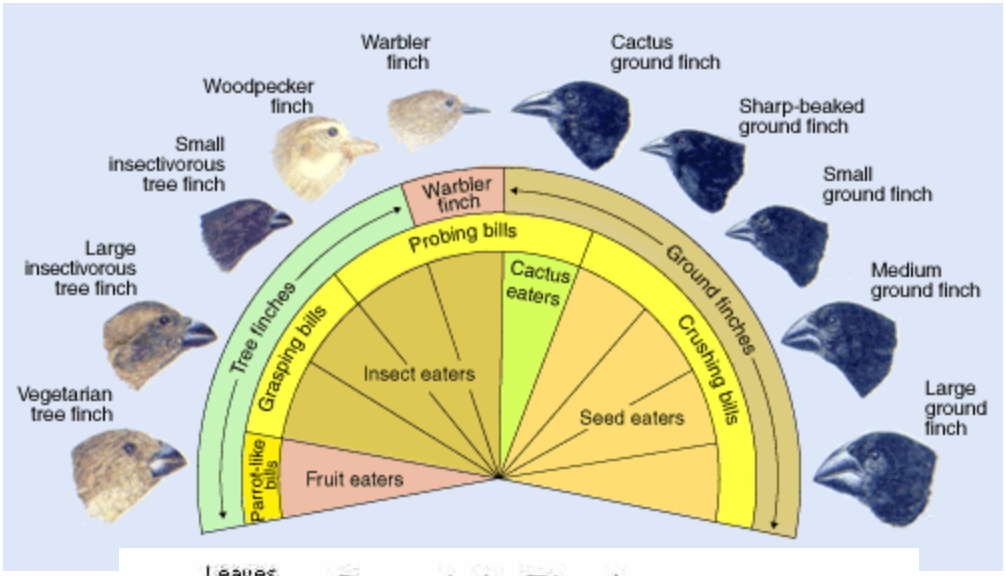
VOL. 60 FEBRUARY 2006 NO. 2

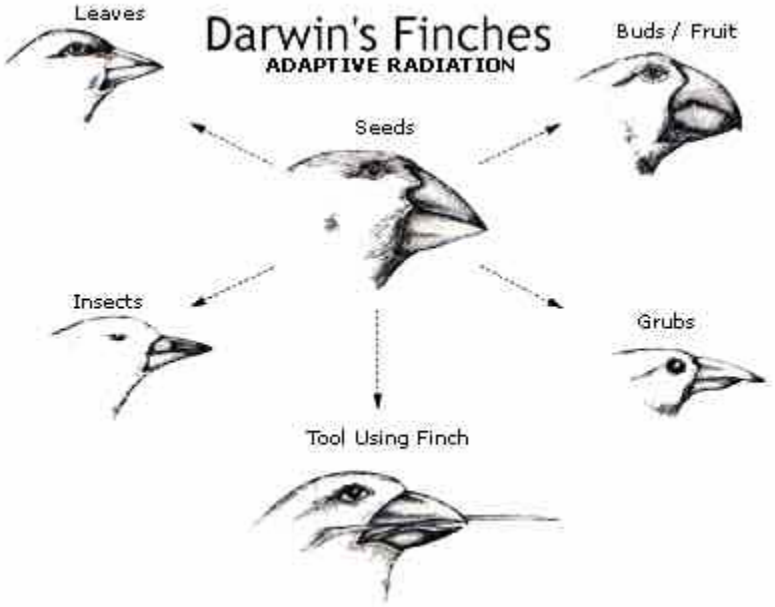
Darwin's mockingbirds: left to right, Nesomimus parvulus, N. macdonaldi, N. trifasciatus, and N. melanotis. • See "The Origin and Diversification of Galapagos Mockingbirds," p. 370. Graphite drawing by H. Douglas Pratt, North Carolina Museum of Natural Sciences.

CONTENTS

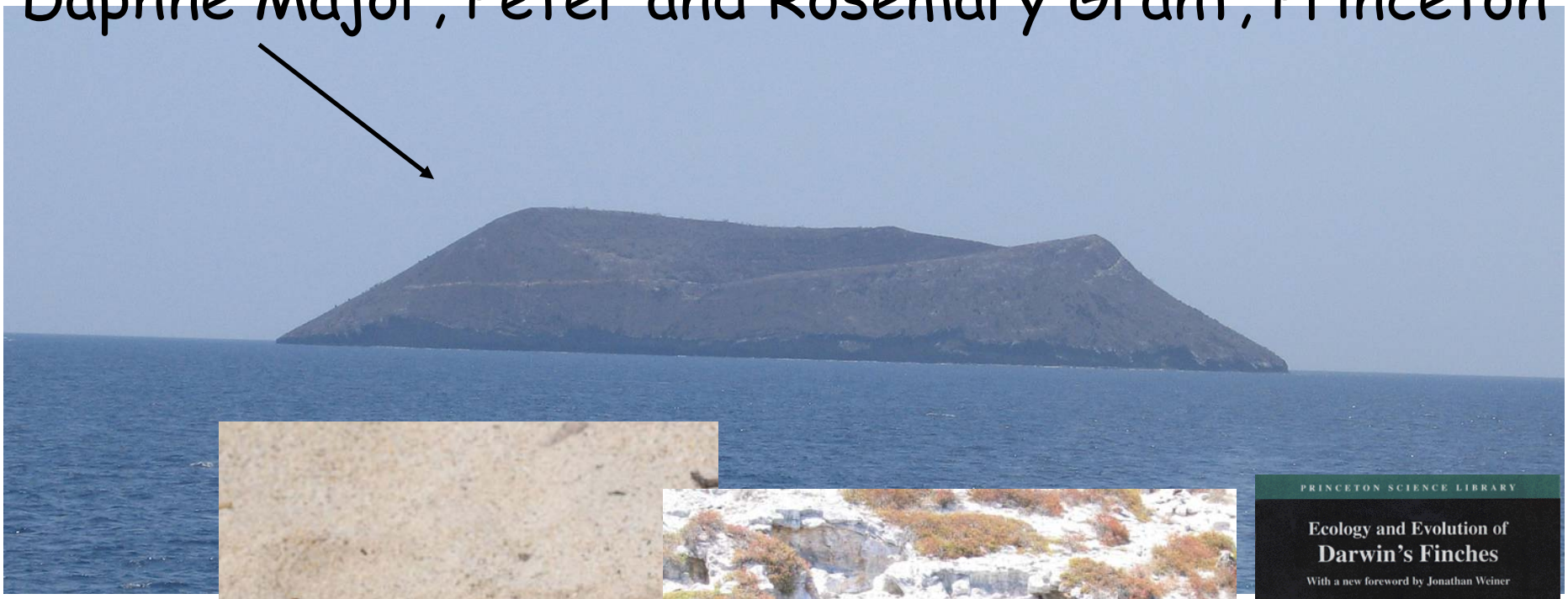
(Continued on back cover)

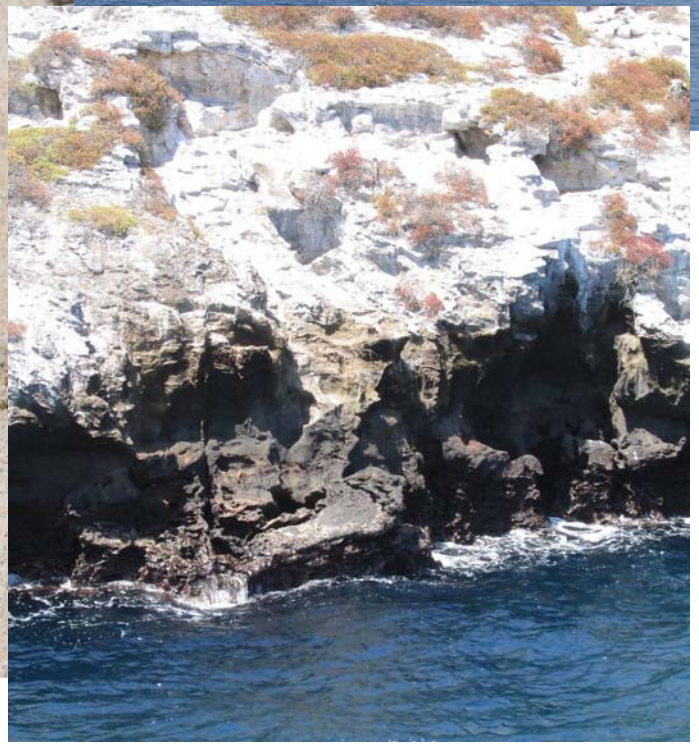
PUBLISHED BY THE SOCIETY FOR THE STUDY OF EVOLUTION

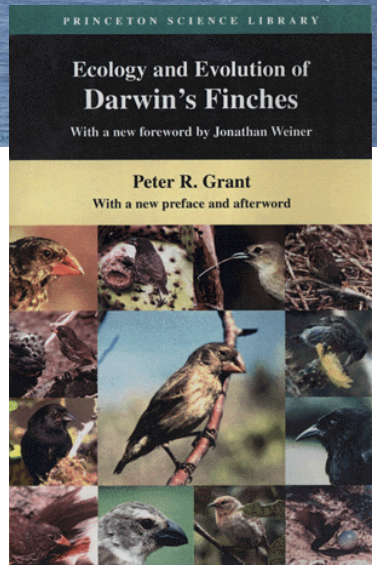

Warbler finch
Cactus ground finch
Woodpecker finch
Sharp-beaked ground finch
Small insectivorous tree finch
Small ground finch
Large insectivorous tree finch
Medium ground finch
Vegetarian tree finch
Large ground finch
Warbler finch
Probing bills
Cactus eaters
Tree finches
Grasping bills
Insect eaters
Ground finches
Crushing bills
Seed eaters
Parrot-like bills
Fruit eaters

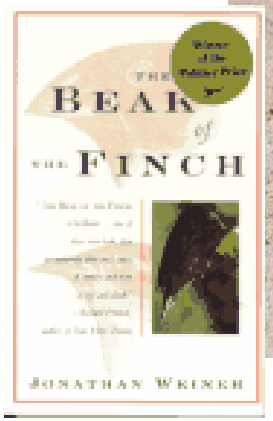

Darwin's Finches
ADAPTIVE RADIATION
Leaves
Buds / Fruit
Seeds
Insects
Grubs
Tool Using Finch

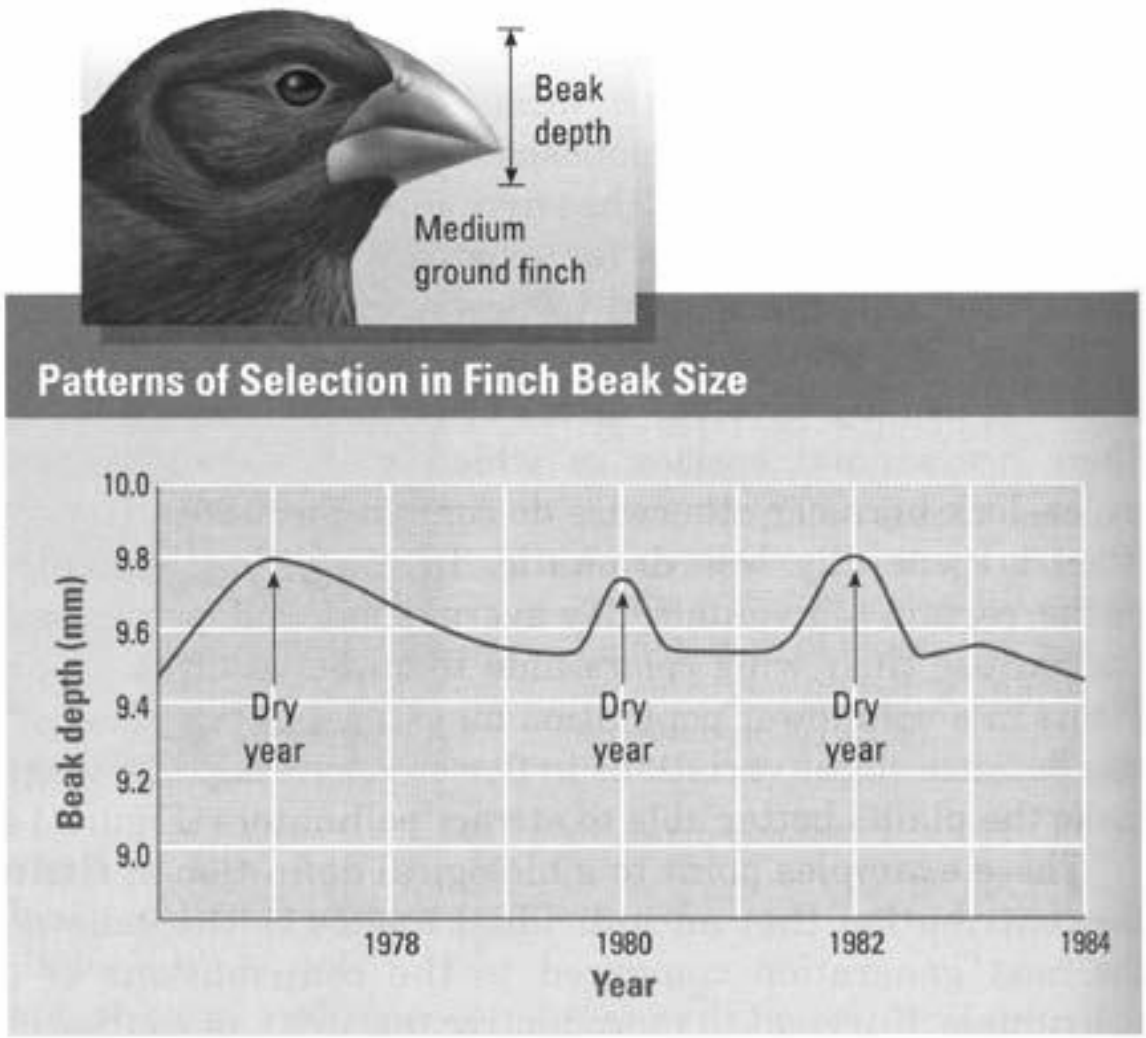
Daphne Major, Peter and Rosemary Grant, Princeton





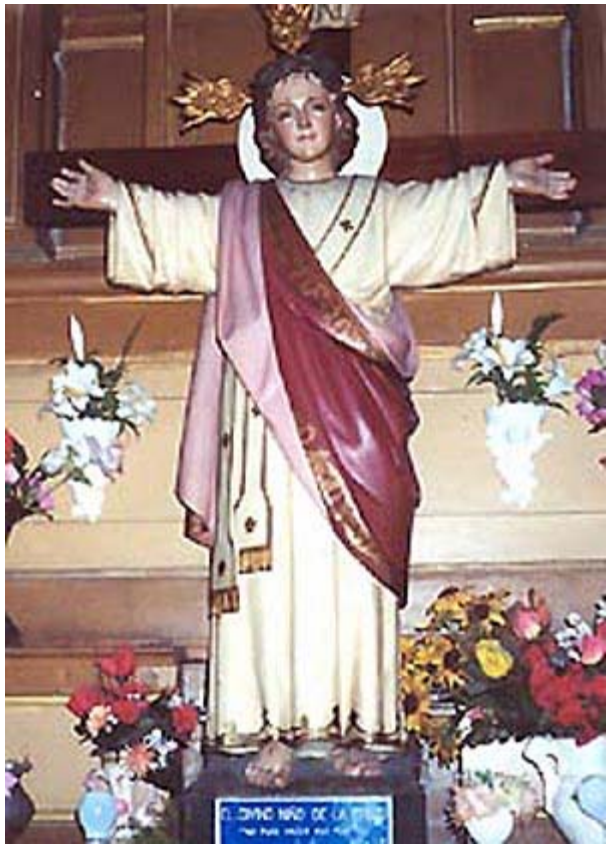


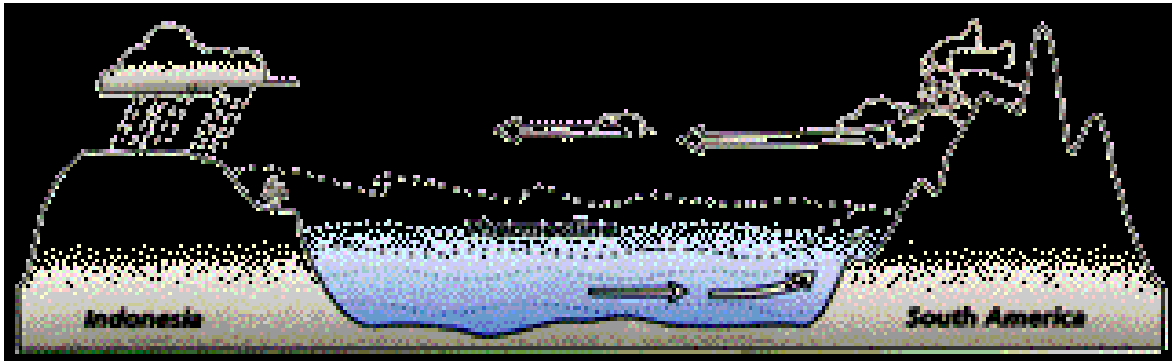




▲ **Figure 14-31** The Grants documented changes in beak size among medium ground finches over many years.

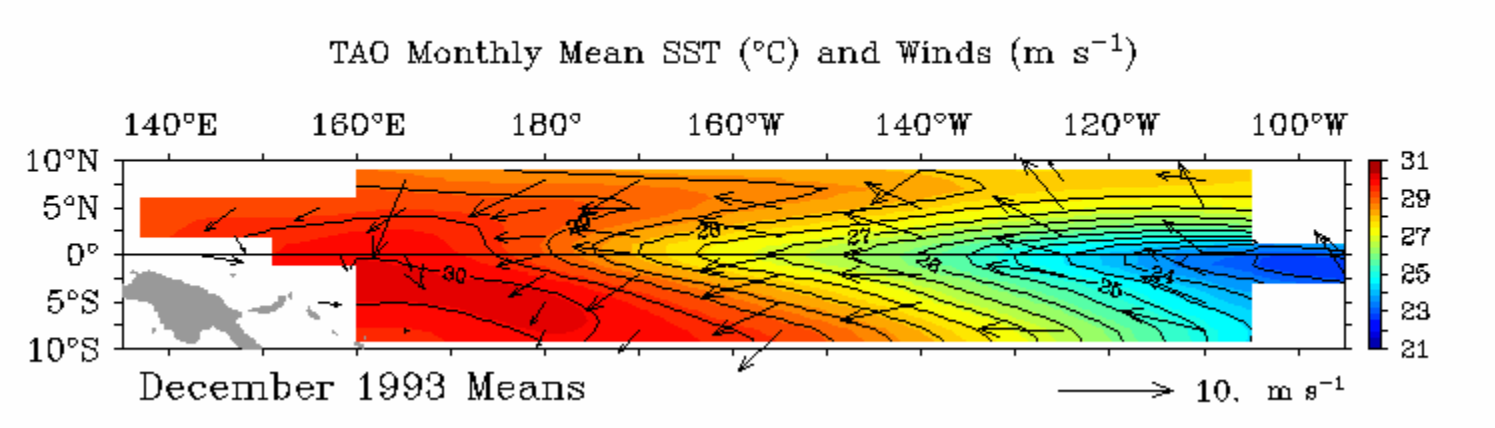
El Niño
is an oscillation of the ocean-atmosphere system in the tropical Pacific



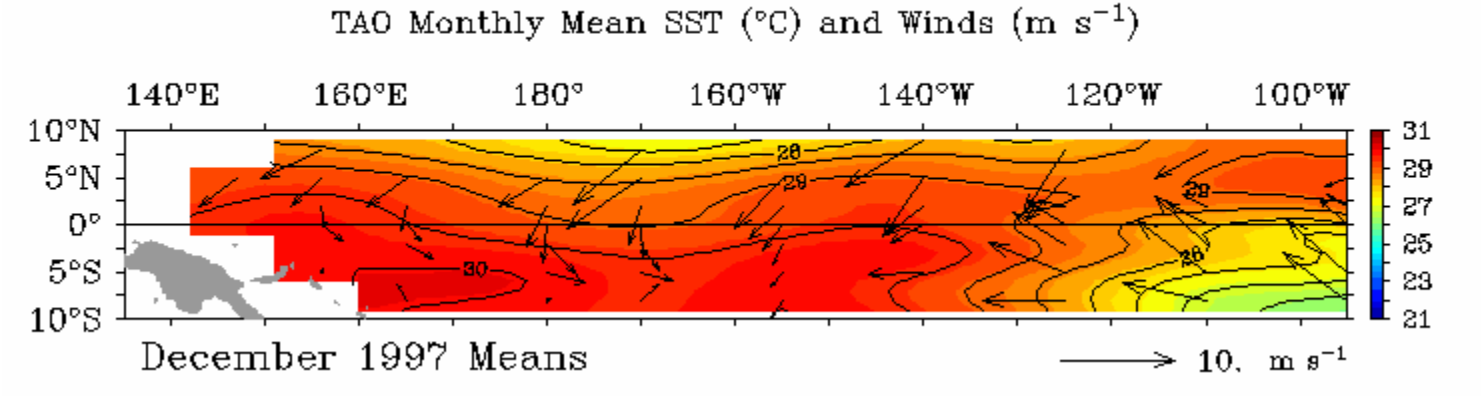


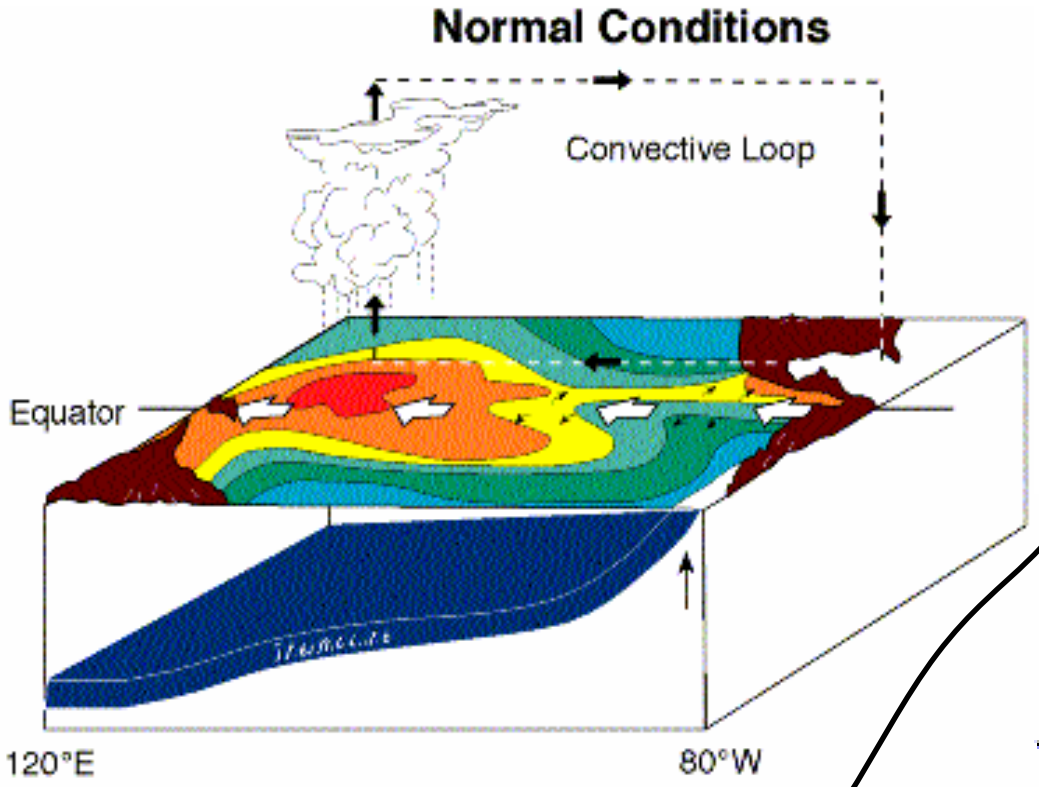
http://kids.earth.nasa.gov/archive/nino/intro.html

Normal Conditions:



El Nino Conditions:

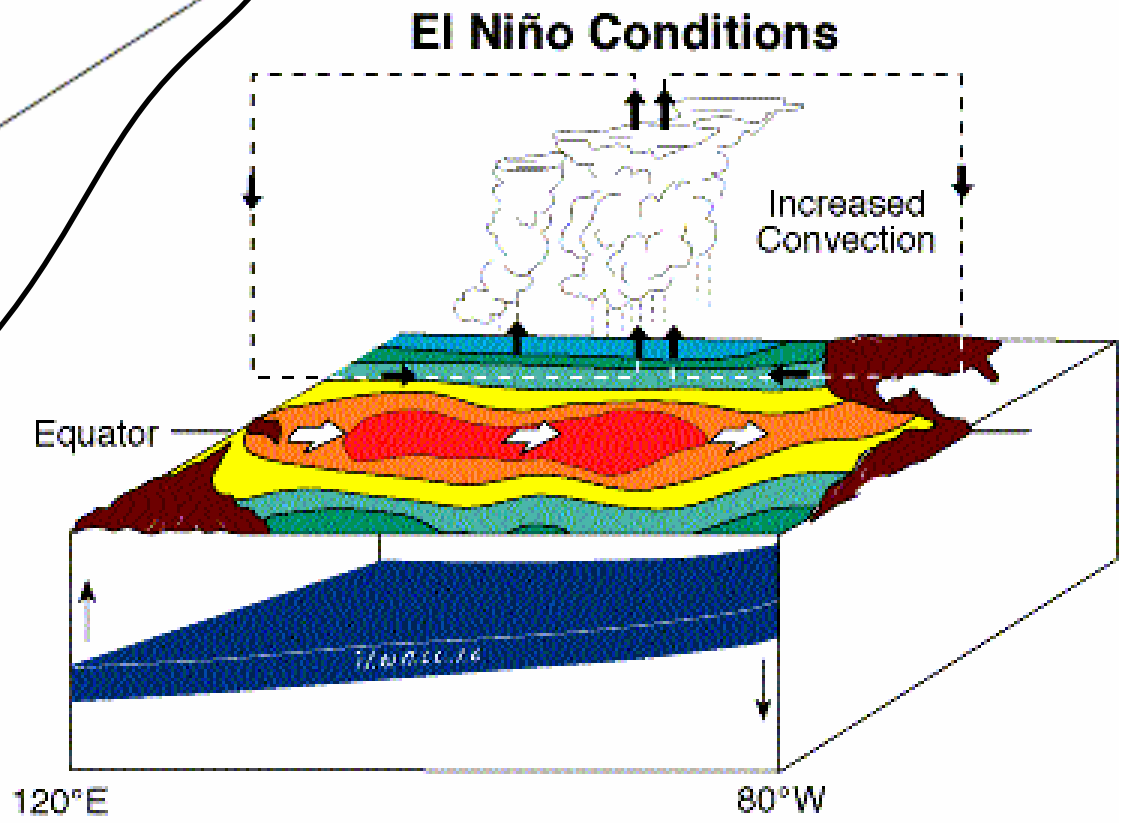




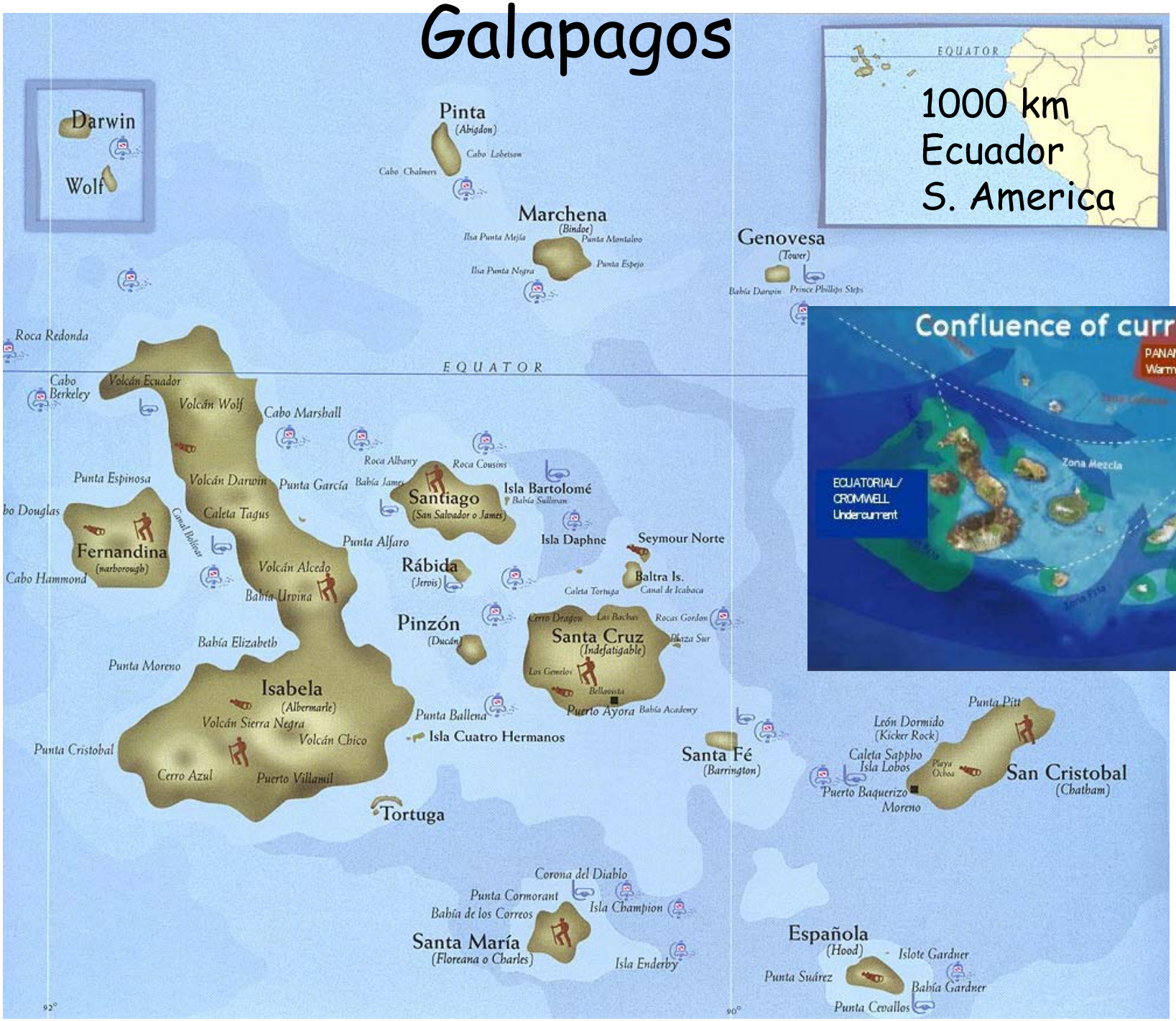
Wind
to East from West

Flooding
in Peru and SW US,

Drought
in Australia and
Indonesia



Galapagos

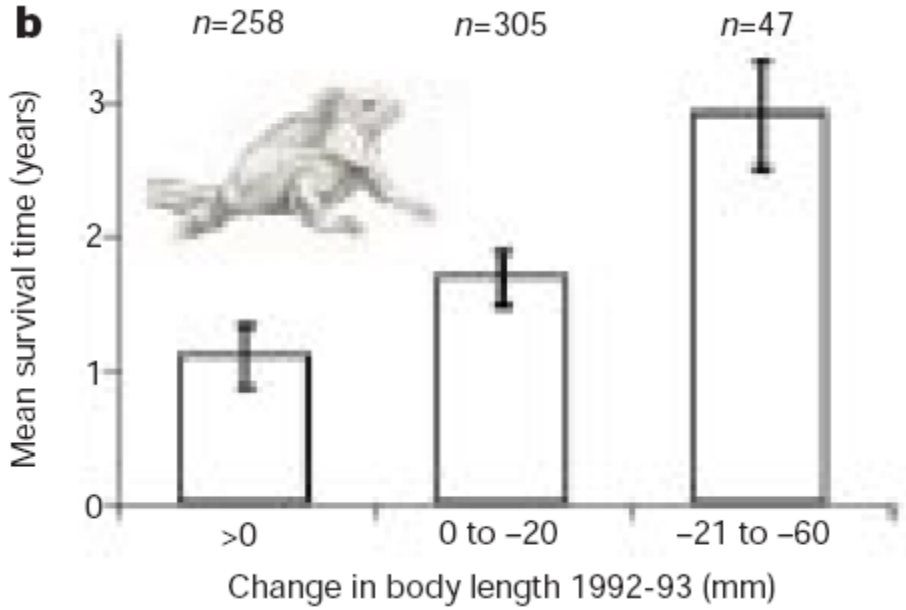


1000 km
Ecuador
S. America

Marine iguanas shrink to survive El Niño

Changes in bone metabolism enable these adult lizards to reversibly alter their length.

Wikelski and Thom, 2000



Why?

Cold up-welling of Cromwell current brings _____ to western Galapagos.

Without it, much of the marine food web is lost…

Galapagos Marine Iguana

Fernandina/Isabela (W)
- males to 10+ kg
- females to almost 3 kg

Genovesa (NE)
- males only to 1 kg
- females to < 1kg

Amblyrhynchus cristatus

Why?

Iguanas bigger on some islands:

1. Water _____
2. Current strength
3. Food Availability

Males bigger than females:

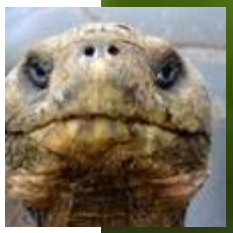
_____ selection

What are sneaker males?

Video clip about Galapagos and Marine Iguanas
Martin Wikelski with Alan Alda, etc.
Borrowed video from Angela

0-10 min	intro and general biogeography
10-18 min	~finches and beak evolution on Daphne Major
18-30 min	marine iguanas
30-39 min	nazca boobies and siblicide
39-52:40	conservation etc.

Galapagos Conservation



Discovered 1530s

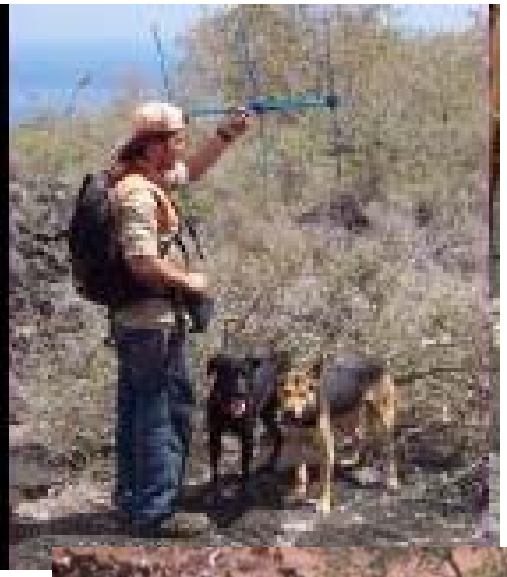
People Bring Problems

Invasive Herbivores

Goats

No Goats

http://www.darwinfoundation.org/en/our-work/featured-projects/project-isabela



Judas Goats on Isabela, Galapagos

Galapagos Islands

http://www.darwinfoundation.org/en/our-work/featured-projects/project-isabela

Invasive Species Threaten Galapagos's Diversity, By Juliet Eilperin
Washington Post Staff Writer, Monday, February 27, 2006; A06

The eight-year battle to remove wild goats, donkeys and pigs from Santiago, Pinta and northern Isabela islands has cost at least $5.2 million and is still just shy of completion. The United Nations covered three-quarters of the cost.

The assault against feral goats -- along with an ongoing campaign against wild dogs, cats, pigs, donkeys and an array of invasive plants and insects -- demonstrates the challenge conservationists face in preserving this hotbed of genetic diversity. Alan Tye, interim director of sciences at the Charles Darwin Research Station on the island of Santa Cruz, said his institute focuses on just two things: "threats and threatened things."
Although 95 percent of the species that were here when humans first arrived still exist in the Galapagos, the International Union for Conservation of Nature and Natural Resources lists dozens on its "red list" of threatened species. These include the Galapagos hawk and the Galapagos fur seal, along with 57 species of Bulimulus snails.

Other species, including plants and insects, are harder to eradicate. At this point, the 720 introduced plants growing in the Galapagos outnumber the islands' 500 original plant species. Blackberry bushes, planted by farmers, have spread widely, along with quinine trees. Newer residents are bringing in ornamental shrubs such as lantana, nicknamed "the curse of India" because it drives out other plants, and other garden plants to the Galapagos.

Invasive Insects

Charles Darwin Research Station Fact Sheet

Eradication of fire ants

The little fire ant, *Wasmannia auropunctata*, is one of the most aggressive invertebrate species ever introduced to Galapagos. Together with the tropical fire ant, *Solenopsis geminata*, fire ants greatly affect native invertebrates and vertebrates, presenting a serious threat to fragile Galapagos ecosystems. Their control is a priority project for the Charles Darwin Foundation (CDF).

Arrival in Galapagos

W. auropunctata is native to Central and South America, but was introduced to Galapagos during 1910-1920. It first colonized Santa Cruz, but is now widely distributed on eight islands: Floreana, Isabela, Marchena, Pinzón, San Cristóbal, Santa Cruz, Santa Fé, and Santiago, and five islets.

Historically, *W. auropunctata* was probably transported between large islands on plants or in soil, and to small islands on equipment carried by people.

S. geminata is native to regions of the Americas. It was first reported in San Cristóbal in 1891. It has been recorded on six islands: Floreana, Isabela, San Cristóbal, Santa Cruz, Santa Fe, and Santiago, and five islets.

S. geminata is harder to control than *W. auropunctata* as new colonies are founded by winged females that can fly over long distances. *W. auropunctata*, on the other hand, radiates outwards from the original colony on foot to occupy extensive areas. This process is called budding.

Impact on Galapagos

W. auropunctata reduces ground and tree-dwelling invertebrate species diversity in areas where it is dominant, causing a marked reduction of native scorpions, spiders and ant species. *S. geminata* is also a voracious feeder of invertebrates but its effects are patchier because of the way it colonizes new areas.

W. auropunctata attacks tortoise hatchlings and adult tortoises. *S. geminata* affects the nesting behavior of land iguanas and tortoises, and threatens hatchling success of endemic reptiles as well as birds.

W. auropunctata can form an extensive colony over an entire small island putting at risk endemic species that are restricted to only one island (single island endemics).

CDRS Research Activities

CDF FOCUS: RESTORATION

Key Facts

Species: *Wasmannia auropunctata*

Common name: Little fire ant

Origin: Central and South America

Class: Invasive

Impact: Affects native invertebrate populations and reptile and bird breeding

Range: Extensive, spread to eight islands and five islets

Action: Control and eradication

Species: *Solenopsis geminata*

Common name: Tropical fire ant

Origin: New World

Class: Invasive

Impact: similar to *W. auropunctata*

Range: Extensive, spread to six islands and five islets

Action: Control and eradication

Invasive Plants

Charles Darwin Research Station Fact Sheet

Blackberry invasion

The five species of blackberry (local name: mora) are aggressive, invasive species that have had a negative impact on several Galapagos Islands. They compete with native and endemic species for light, water, and nutrients, and affect local agriculture. Eradication of blackberry is a major focus for the Charles Darwin Foundation (CDF) and the Galapagos National Park Service (GNPS).

Arrival in Galapagos

Five species of Blackberry have been introduced to Galapagos over the last 40 years:

- *Rubus niveus*
- *Rubus glaucus*
- *Rubus ulmifolius*
- *Rubus adenotrichos*
- *Rubus megalococcus*

Hill Blackberry (*R. niveus*) was introduced for agricultural purposes to San Cristóbal in the 1970's and has spread to Santiago, Santa Cruz, and Isabela Islands.

Many bird species feed on the fruit and are responsible for localized spread. Most cases of dispersal between islands are thought to be due to deliberate introductions by people.

The other blackberry species have been introduced more recently and are restricted to relatively small areas at present.

Impact on Galapagos

R. niveus is one of the worst weeds threatening the Galapagos National Park. It has invaded open vegetation, shrubland and forest alike. It forms dense thickets up to 4 meters high, replacing native vegetation, and threatening many rare endemic plants.

On farmland, *R. niveus* renders farmland useless and is difficult and expensive to control.

Although only found over localised areas at present, there is concern that the other four species of blackberry could become a significant problem too if they are not controlled.

CDF FOCUS: RESTORATION

Key Facts

Family: Rosaceae

Species: *Rubus niveus*, *R. glaucus*, *R. ulmifolius*, *R. adenotrichos*, *R. megalococcus*

Common name: Blackberry, Mora

Class: Invasive

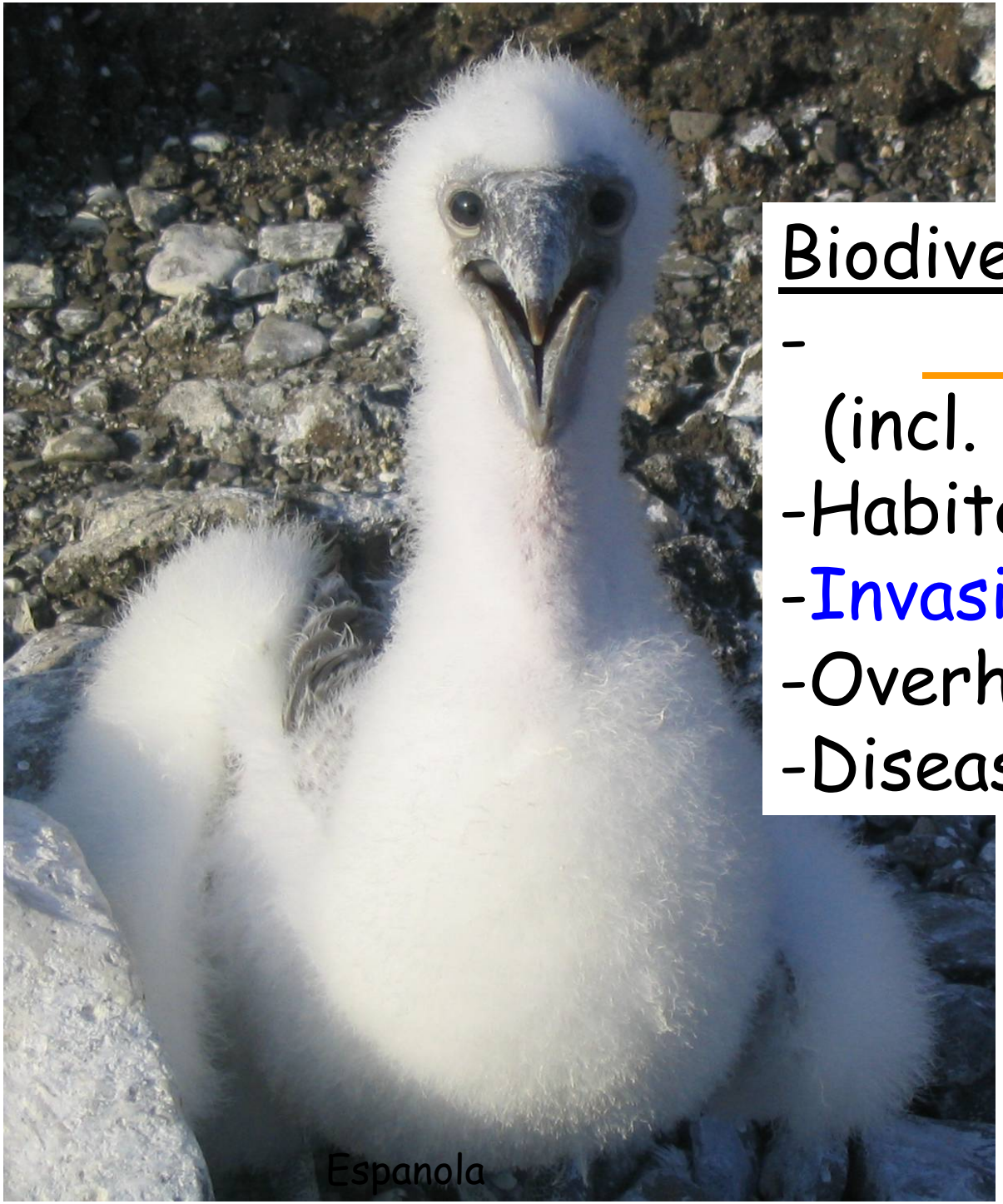
Impact: Replacing native and endemic vegetation, invading farmland

Origin: Asia (*R. Niveus*), Central to South America (*R. glaucus, R. adenotrichos, R. megalococcus*), Africa & Europe (*R. ulmifolius*)

Description: dense thickets up to 4m high

Range: San Cristóbal, Santiago, Santa Cruz, Isabela

Action: Eradication



Biodiversity Threats

-
(incl. climate change)

-Habitat Fragmentation

-Invasive Species

-Overharvesting

-Disease

Galapagos Marine Ecology (ECOL 496O/596O)

Summer Session II: July 7-Aug 1, 2009

- Spend one month this summer in the Galapagos Islands, Ecuador!
- Visit seven of the most spectacular islands in the archipelago
- Do a service project with children at a local school and the Galapagos National Park
- Do a field ecology project and learn about Galapagos ecology and evolution
- Earn 3-6 units of graduate or undergraduate credit

For more information: www.eebweb.arizona.edu/courses/galapagos/
Katrina Mangin, mangin@email.arizona.edu, 520-626-5076

Thanks for a Great 1/3 Semester