Ecological Interactions

Leaf-cutter Ants (*Atta sp.*)

Temperate vs. Tropical

Ecological interactions:

Do they play a greater role in structuring communities and ecosystems in the tropics than in the temperate zone?

- Greater species diversity & density
- Relatively favorable climate

Temperate Willow (*Salix sp.*) is wind-pollinated

Tropical Cannonball tree (*Couroupita guianensis)* is bat-pollinated.

Types of Ecological Interactions

Interspecific vs. intraspecific

	Affect on Sp.1	Sp.2
Mutualism	+	+
Antagonism	+	-
Commensalism	+	0
Amensalism	-	0
Competition	-	-

Symbiosis = "living together". Not synonymous with mutualism.

Mutualism Examples (+,+)

- Pollination
- Seed-dispersal
- Mycorrhizae
- Reef-building
- Human digestion

Pollination

~95% of tropical tree species are animal-pollinated
80% of temperate trees are wind-pollinated

Pollination - Insects

Entomophily

Bees
yellow
nectar guides
sweet smell
day

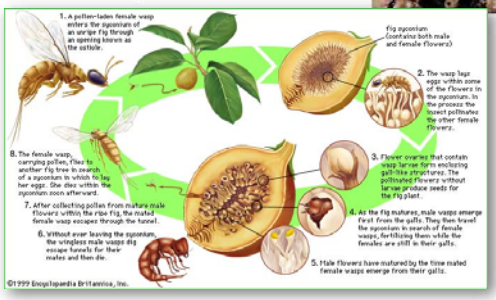
Butterflies
red
tubular
odorless
day

Moths
light color
nectar tube
open @ night

Flies
reddish
rotten smell

Fig Pollination by Fig Wasps

- A highly specialized **obligate mutualism**
  - neither can reproduce without the other



Pollination - Bats

Chiropterophily

Pollination - Birds

Ornithophily

- red, orange, pink
- tubular
- odorless
- abundant sugary nectar

Hummingbirds: New World only

Honey-eaters and Sunbirds: Old world only

Floral Rewards

Nutritive rewards
- Nectar
- Pollen
- Food bodies

Non-nutritive rewards
- Nesting materials (waxes, hairs)
- Brood places
- Heat
- Sleeping places
- Sex
  - pheromones
  - pseudocopulation

Eonycteris on *Parkia*

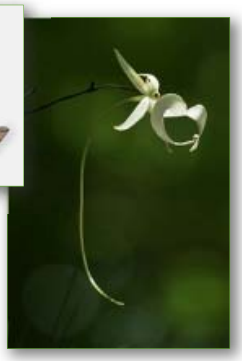
Animal pollinator provides non-random deposition of gametes

Beetle pollination of thermogenic flowers

How do Mutualisms Come About?

Reproductive Assurance = Evolution always favors traits that assure reproduction.

An interaction that increases the likelihood of reproduction (fitness) of those involved is **self-reinforcing**.



Agraecum orchids are pollinated by long-tongued Hawkmoths.

Frugivory & Seed Dispersal

Why is this feeding guild much more prominent in the tropics?

- year-round fruit availability
- high plant diversity
- limited wind

Endozoochory vs. Ectozoochory

Figs (*Ficus*) – 800 spp.

Fruit production is costly!

Read Kricher p. 158

1274 bird and mammal spp. are known to eat figs! (Shanahan 2001)

Benefits of Zoochory

Making fruit is **expensive!**

But 50 - 90% of tropical plants are animal dispersed!

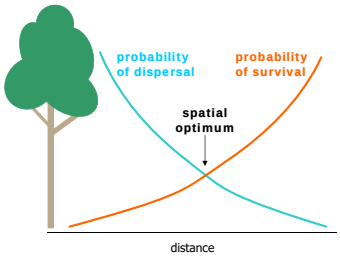
Selective advantages:

- long-distance dispersal
- non-random
- fruits deposited with fertilizer
- scarification
- genetic mixing
- expansion of range

Where is wind or water dispersal more common?

Evolutionary Consequences of Zoochory

Long-distance dispersal: rare but important!



Frugivores (and seed predators) influence the survival and spacing of trees, and thus forest structure & diversity!

Evolutionary Consequences of Frugivory

Frugivory: Diet >50% fruit

- Abundant, easy to "catch"
  - "free time" for courtship
  - high frugivore biomass
  - less competition
- Patchy
  - High mobility
  - Sociality – mixed-species flocks
- Low protein & fat content

Read Kricher pp.157-168
Figs, Fruitcrows, Peccaries & Manakins

Wire-tailed manakins may spend 90% of their day courting females

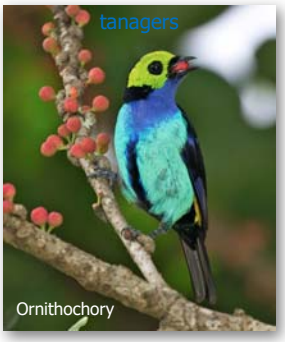
Lipid-rich fruits

Arils on nutmeg *(Virola:* Myristicaceae*)*

Avocado family: **Lauraceae**

Elaiosomes on ant-dispersed plants

Important Frugivores



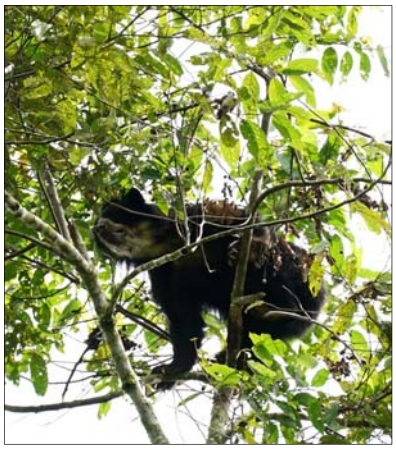
Spider monkeys eat 250 species, disperse 200,000 fruits/year.
Ave. distance ~250m, max. 500m (Dew 2011)

Scatter-hoarding by Agoutis

Cauliflory & Mammal Dispersal

A holdover from extinct large ground mammals?

Couroupita guineensis – Cannonball tree



Spectacled Bear

feeding on fat-rich Lauraceae fruits

Frugivorous Fish

Ichthyochory by Tambaqui (*Colossoma macropomum)* in flooded forest

Kricher p. 169

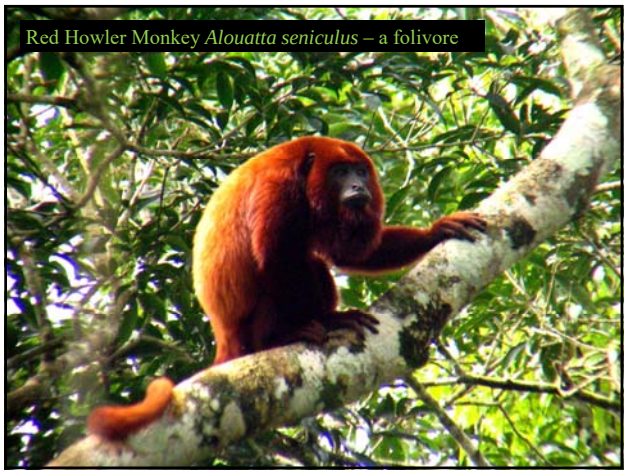
Seed Predation Trade-off

Herbivory (+,-)

- ~30% of plant biomass removed
- ¾ by phytophagous insects
  - Caterpillars (Lepidoptera)
  - Beetles (Coleoptera)
- Plants defend themselves!

Leaf-cutter Ants (*Atta* spp.)

Kricher pp. 174-177

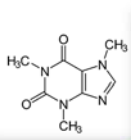


Plant Chemical Defenses

"Secondary compounds"

Alkaloids (15% of all plants)

- **N-containing bases**
  - nicotine, caffeine, cocaine, morphine, theobromine, strychnine
- disrupt liver & membrane function, acetylcholine transmission
- 4,000: many toxic, many medicines!



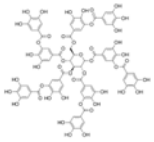
Coffee beans, and periwinkle, source of Vincristine leukemia medicine

Read Kricher 187-192

Plant Chemical Defenses

- **Phenolics (incl. tannins)**
  - hydroxyl group on aromatic hydrocarbon; water soluble
    - spices, capsaicin (hot chilis), menthol, aspirin
  - bind with proteins, reduce digestibility
  - antimicrobial
  - affected by leaf age, light

Tannic acid
$C_{76}H_{52}O_{46}$



Plant Chemical Defenses

- **Terpenoids**
  - 22,000 compounds
  - mimic insect growth hormones
  - antifungal
    - leaf-cutters avoid
- **Cyanogenic glycosides**
  - *Passiflora*, manioc (prussic acid)
  - blocks Na+ channels
  - muscle paralysis

Passionflowers contain cyanogenic glycosides. *Heliconius* butterflies specialize on them.

squeezing toxins out of manioc

Mechanical Plant Defenses

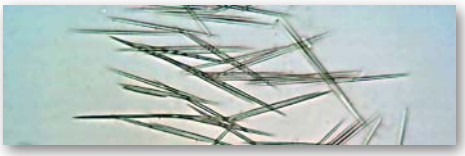
thorns, spines, hairs, sticky latex, toughness, delayed greening

Patterns of Plant Defenses

- Tropics > Temperate
- Younger tissues > Older tissues
- High sunlight > low sunlight
- Soil fertility
  - Very low fertility → "cheap" 2° compounds (tannins)
  - Low fertility → high diversity of 2° compounds
  - High fertility → few 2° compounds
- Seasonality → dry climates = more mechanical defenses

Defenses are expensive to produce
Trade-off between defense and growth

"Raphides"
Calcium oxylate
crystals in Araceae



Ant-Plant Mutualisms

Protectionist theory

Myrmecophytes provide reward for ants in exchange for protection

- extrafloral nectaries
- food bodies
- domatia

Many Examples!

Cecropia and *Azteca*

Inga and various ant spp.

Read Kricher pp 192-194

https://www.youtube.com/watch?v=KiAEzfF2y0M

Predation and Herbivory as Selective Forces

Natural selection works to **reduce the NEGATIVES (-)**

Leads to evolution of:

- crypsis and mimicry
- escape tactics
- defensive armor & toxins
- aposematic coloration
- infochemicals?

Warning Coloration & Mimicry

Müllerian mimicry

convergent colors among toxic species

- Heliconius butterflies (below)
  - bees and wasps
  - coral snake species

Batesian mimicry

non-toxic spp. mimic toxic ones

- non-toxic sp. must be less abundant
  - Coral snake vs. king snake
    - Viceroy vs. monarch

Parasitism

One organism living within or on a host, from which it obtains some benefit, to the detriment of the host

Cordyceps parasitism on insects

Parasitoids

Commensalisms - Some Examples

Epiphytes (above) cling to a tree trunk; sea turtle shell provides a home for algae

"Hitch-hiking" seeds stick to fur or skin for transportation; a bird louse (left) hitches a ride on a fly's legs.

Coevolution – a two-way street

Ecological interactions exert powerful **selective pressures** on both species.

Coevolution = the evolution of one species in response to the evolution of another.

- e.g., long proboscis in butterflies and long tubular flowers
- e.g., toxic plant and catepillar that eats it

Selection works to reduce the negatives (minuses) in the interaction.