

Community Ecology: Interactions

THE REALM OF ECOLOGY

• **Community Ecology:** Interactions among members of all of the species in a given habitat.

Community Ecology

Community: All the populations of organisms living together in a given place

Characteristics:

- **Biodiversity** —
 - Species richness
 - Relative abundance
- **Dominant vegetation**
- **Stability/disturbance**

Redwood forest community

The Niche Concept

- A population's **Habitat** is the area in which it lives - "address"
- **Niche** is a population's total use of biotic and abiotic resources - "profession"
- Multiple species within a community share habitat, but have different niches
 - The **competitive exclusion principle** states that two species competing for the same limiting resources cannot coexist in the same place

Why do species Y & Z coexist?

- **Individualistic Hypothesis**
 - Y & Z need similar physical environment
- **Interactive Hypothesis**
 - Y needs Z

Interspecific Interactions

Y	Z	
–	–	competition
+	–	trophic — parasites / predators
+	o	commensalism / facilitation
+	+	mutualism
o	–	amensalism

Community Ecology

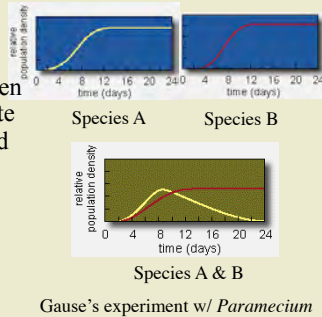
Interactions among members of all of the species in a given habitat.

A. Competitive Interactions	} Direct interactions
B. Trophic Interactions	
C. Symbiotic Interactions	
D. Amensal Interactions	} Indirect interactions
E. Facilitative Interactions	

Community Ecology: Interactions

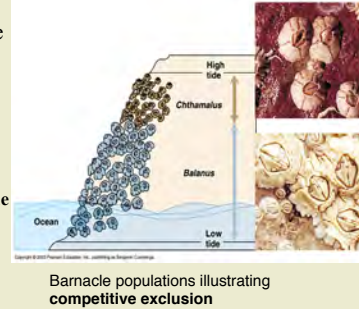
A. Competition

- **Interspecific Competition** = when two species compete for the same limited resource
- **Competitive Exclusion** = the elimination of a population due to competition



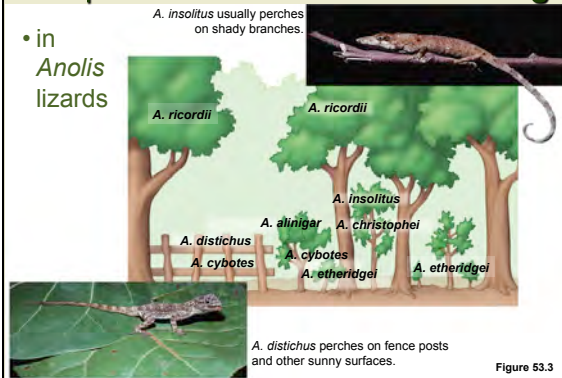
Example of Competitive Exclusion

- Two barnacle populations require the same resource: **space**
- When *Balanus* is removed *Chthamalus* spreads lower
 - **Fundamental niche**
- When both species compete *Balanus* displaces *Chthamalus*
 - **Realized niche**



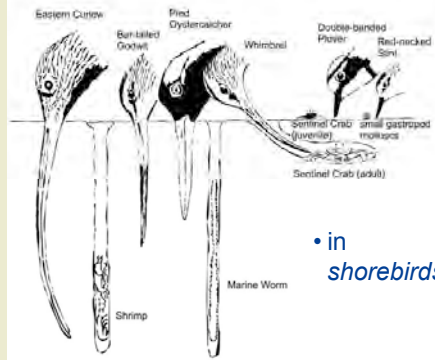
Competition & Resource Partitioning

- in *Anolis* lizards



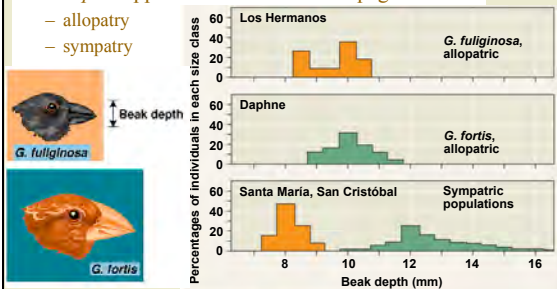
Competition & Resource Partitioning

- in shorebirds



Competition & Character Displacement

- *Geospiza* spp. on islands of the Galapagos
 - allopatry
 - sympatry



B. Trophic (Feeding) Interactions

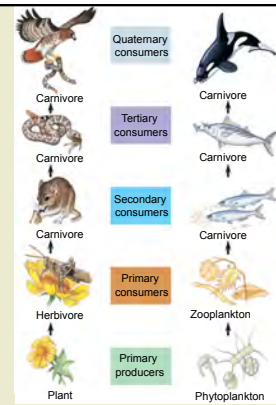


Figure 54.11

B. Trophic (Feeding) Interactions



• A very localized food chain:
Tomato plant → hornworm caterpillar → parasitoid wasp

Primary producers

- **Autotrophs** (“self feeder”)
 - Photosynthetic plants, protists, bacteria
 - Chemoautotrophic bacteria
- Obtain nutrients from nonliving materials
 - Inorganic compounds, minerals
 - CO₂ to make organic backbones
 - **Carbon fixation**

Consumers

- **Heterotrophs** (“feed on others”)
 - **Herbivores** (“plant eater”)
 - **Primary consumers:** eat producers
 - **Carnivores** (“meat eater”)
 - **Secondary consumers:** eat other consumers

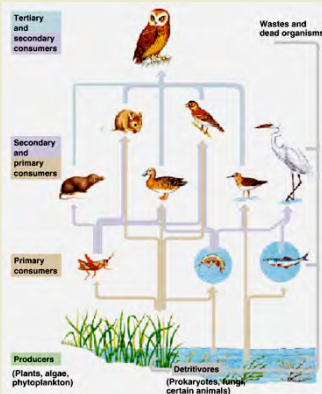
Decomposition is an important part of an ecosystem

- **Detritivores** (*detritus* = decaying matter)
 - ❖ Another level of consumer
 - ❖ Recycle matter back into the abiotic world

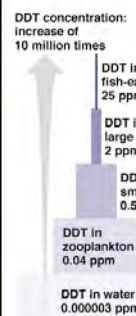


A food web

- Trophic patterns are rarely linear
- Typically ~10% [5–20%] efficiency of transfer between levels
- I.e., to grow or reproduce, 10x the added energy & mass must be consumed.
- Thus there must be a lot of primary production to support long food chains.



Biomagnification



- Efficiency of transfer creates a food pyramid.
- Pyramid effect may result in biomagnification of environmental contaminants.
 - Esp., compounds sequestered in fat or skeleton.



Predation and Adaptations

- Mechanisms of defense have evolved in every species (size, flee, hide, venom)
- **Coevolution** = a series of reciprocal adaptations in two species (a type of “arms race”)

Coevolution: caterpillar and passionflower vine

Consumers

- **Herbivory**
 - One species (herbivore) eats part of a producer (prey)

+ -
Herbivory

Coevolution

1. Plants develop physical and chemical feeding deterrents.
2. Specialized grazers develop mechanisms and strategies to get past the plant defenses.
 - Now they have that resource to themselves.
3. Back to step 1.

Herbivory

- Specialist herbivores acquire resistance to chemical defense of specific prey

Consumers

- **Predation**
 - One species (predator) kills & consumes another species (prey)

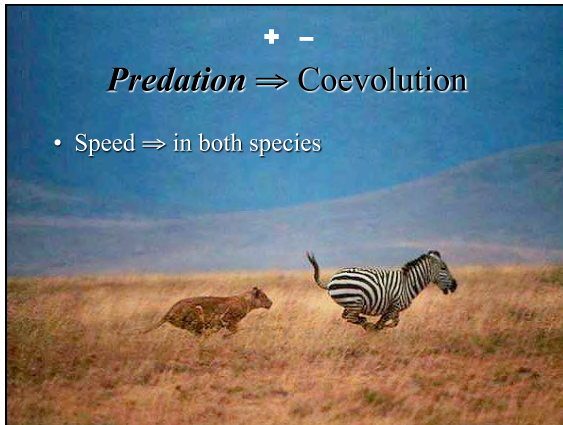
Predation

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+ -

Predation ⇒ Coevolution

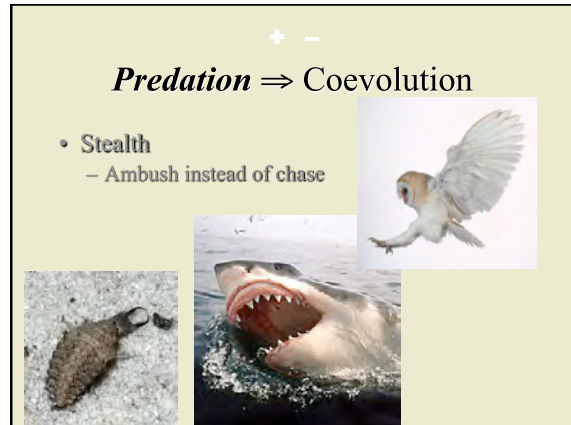
- Speed ⇒ in both species




+ -

Predation ⇒ Coevolution


- **Stealth**
 - Ambush instead of chase




Cryptic Coloration (Camouflage)




scorpionfish



praying mantid



yellow crab spider




polar bear

- ◆ Works for both predator and prey

Physical (Mechanical) defenses


- Spines, bristles, shells
- Repels predator
- Makes hard to swallow/digest
- Makes it too energetically expensive
 - Cost > benefit for the predator



porcupine


Chemical defenses

- Chemical warfare
 - Predator learns to avoid species
 - Examples
 - Eucalyptus oil, oleander shrubs, stinkbugs, skunks, cane toads



Stink beetle

Sometimes defenses don't work!





- Grasshopper mouse sticks stinky end into ground to munch head



Mimicry

- Color and patterns of warning coloration are copied








(a) Cuckoo bee Figure 53.8
(b) Yellow jacket

- In **Müllerian mimicry**, multiple noxious or unpalatable species resemble each other.

Mimicry

- Color and patterns of warning coloration are copied






- In **Batesian mimicry**, harmless species mimic dangerous or toxic species.

Mimicry

- Color and patterns of warning coloration are copied






anterior end of a green parrot snake posterior end of a hawkmoth caterpillar

- In **Batesian mimicry**, harmless species mimic dangerous or toxic species.

Mimicry

- Color and patterns of warning coloration are copied

venomous coral snake non-venomous king snake

- In **Batesian mimicry**, harmless species mimic dangerous or toxic species.

Mimicry

- In **Batesian mimicry**, harmless species mimic dangerous or toxic species.
- **Only works if predators learn to avoid real danger!**

Scarlet king snake (nonpoisonous)
Range of scarlet king snake only
Overlapping ranges of scarlet king snake and eastern coral snake

Eastern coral snake (poisonous)
Scarlet king snake (nonpoisonous)

RESULTS

Area	Artificial King snakes	Brown artificial snakes
Coral snakes absent	83%	17%
Coral snakes present	16%	84%

Figs. 1.25–1.27

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Figure 54.6

Mimic Octopus master of Batesian mimicry

- Rapidly changes coloration, morphology & behavior

(a) Mimicking a venomous sea snake
(b) Mimicking a poisonous flounder
(c) Mimicking a stingray

<https://www.youtube.com/watch?v=L1TWFnGmeg>

Avoiding Predation

- Startle Coloration

Predation and Diversity

- Keystone Predator** = a species that reduces the population density of the strongest competitors
- Predation can help maintain species diversity

Pisaster sea star eating a mussel

Year	With <i>Pisaster</i> (control)	Without <i>Pisaster</i> (experimental)
1963	18	18
1964	18	18
1965	18	18
1966	18	18
1967	18	18
1968	18	18
1969	18	18
1970	18	18
1971	18	18
1972	18	18
1973	18	18

Predation and Diversity

- Keystone Predator** = a species that reduces the population density of the strongest competitors
- Predation can help maintain species diversity

(a) Sea otter abundance
(b) Sea urchin biomass
(c) Total kelp density

Food chain

Consumers

- Partivory**
 - One species (partivore) consumes part of another species (host) without killing or consuming all of it

Aedes aegypti feeding on human


c. Symbiosis

- Sym- : "together"; -bios: "living"
- One species living in, or on, or in tight association with another species
- Symbiont and Host**
- Three types of symbiosis
 - Parasitism + -
 - Commensalism + o
 - Mutualism + +


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+ -
Parasitism


- Symbiont benefits at the expense of the host
- Trophic parasite feeds off tissues of host (partivore)
 - Ectoparasites & Endoparasites
 - Not all partivores are parasites (symbionts)!



tapeworm




leech




tick

Parasitism

- Symbiont benefits at the expense of the host
- Other kinds of parasite cost their host something else
- E.g., “brood parasite”: Cuckoo “foster” their young in other species nests




young cuckoo



juvenile cuckoo and "parent"

Parasitoid

- Parasite or slow predator?
 - A “good” parasite does **not** kill its host
- Parasitoid wasp stings & paralyzes spider — but does not kill it
- Lays eggs inside spider
- Wasp larvae hatch & consume living spider
- Spider killed when larva metamorphose & emerge




+ 0
Commensalism



Eagles nesting in conifers

- Symbiont has no significant effect on host


+ 0?
Commensalism or Parasitism?



- Manta & remoras
- Is the effect of the symbiont on the host *really* insignificant?

+ +
Mutualism

Both symbiont & host benefit from the relationship



Acacias & ants


S. Am. Acacias provide shelter, nectar & antfood to harbor *Pseudomyrmex* ants

Ants defend the acacias from herbivores, pathogenic fungi, & competing vegetation


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Endosymbiotic Mutualism



Termites & *Trichonympha*



Corals & *Symbiodinium* [Zooxanthellae]







Amensalism:

A species is neither benefited nor harmed by another species, but the activity, metabolism or defenses of the first species inhibits or eliminates the second species

Harmful algal blooms (HAB)

- Overgrowth of photosynthetic cyanobacteria or protists
- Consumption of dO_2 , decreased light penetration, and/or production of toxic metabolites impacts other aquatic spp.






Amensalism:

A species is neither benefited nor harmed by another species, but the activity, metabolism or defenses of the first species inhibits or eliminates the second species

Human amensalism

- Agricultural & urban development, and waste production
- Negatively impact many species

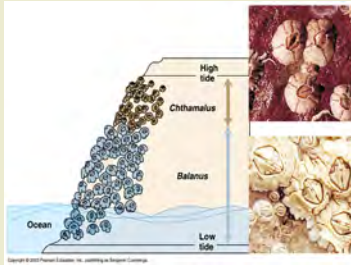


Burrowing owls

- Inhabit old tunnels of prairie dogs or ground squirrels in dry grasslands
- Populations nation-wide threatened by habitat loss
- Listed as endangered & CA Species of Special Interest

Competition or Amensalism?

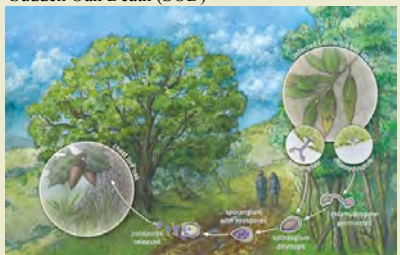
- If *Balanus* distribution is the same whether or not *Chthamalus* is present, should it be called a competitive or amensal interaction?



Barnacle populations illustrating **competitive exclusion**

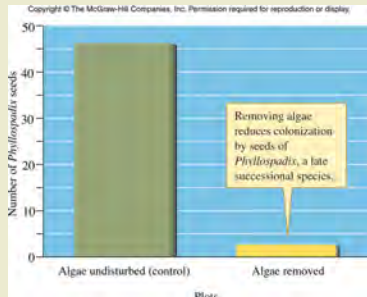
Pathogens

- Microorganisms that cause disease
- May be trophic or amensal
- Sudden Oak Death (SOD)



Facilitation

- Growth of turf algae → slows water flow rate → enhanced recruitment by seagrass seeds



Removing algae reduces colonization by seeds of *Phyllospadix*, a late successional species.