Biology 44

Section 4

Professor Donald McFarlane

Lecture 20 Ecology 3: Species Interactions.

Craniates

- 2 defining characteristics compared to invertebrate chordates

1. Cranium - protective bony or cartilaginous housing for brain
2. Neural crest - embryonic cells that will disperse throughout the embryo contributing to the development of the skeleton, jaws, and teeth

- Also, at least 2 Hox clusters

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Table 57.1 Summary of the Types of Species Interactions

Nature of interaction	Species 1*	Species 2*
Competition	–	–
Amensalism	–	0
Predation, herbivory, parasitism	+	–
Mutualism	+	+
Commensalism	+	0
Neutralism	0	0

*+ = positive effect; – = negative effect; 0 = no effect.

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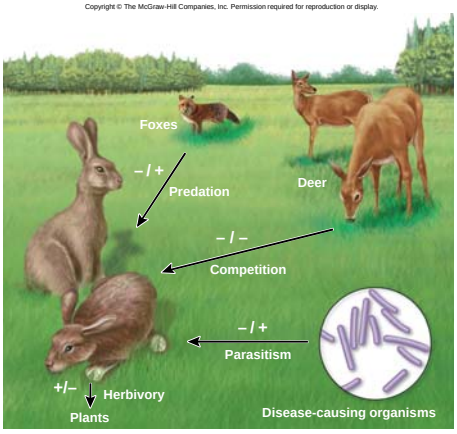

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Competition

- Intraspecific – between individuals of the same species
- Interspecific – between individuals of different species
- Exploitation competition – organisms compete indirectly through the consumption of a limited resource
- Interference competition – individuals interact directly with one another by physical force or intimidation

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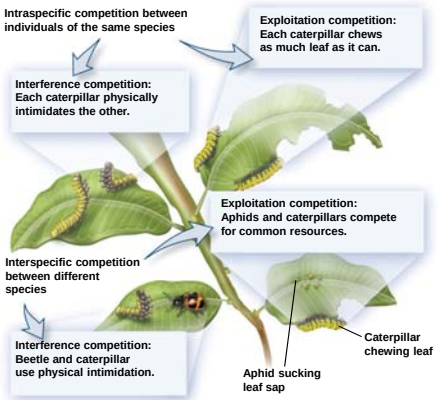

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- Field studies
  - 1983 review found competition in 55% of 215 species surveyed, demonstrating that it is indeed frequent in nature
  - Generally in studies of single pairs of species utilizing the same resource, competition is almost always reported (90%)
    - Percent competition varies with the number of species involved
  - Plants showed a high degree of competition
  - Marine organisms tended to compete more than terrestrial ones

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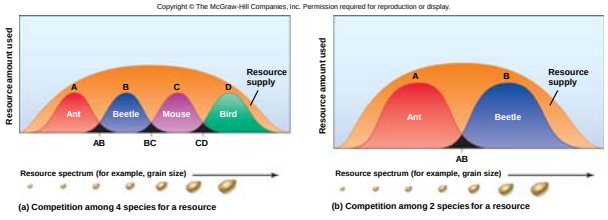

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- Competitive exclusion principle
  - Gause worked with 3 protists – *Paramecium aurelia*, *Paramecium bursaria*, and *Paramecium caudatum*
  - Grown separately all 3 grew logistically
  - When *P. caudatum* and *P. aurelia* grown together, *P. caudatum* went extinct
  - When *P. caudatum* and *P. bursaria* grown together, neither went extinct
  - Concluded that 2 species with exactly the same requirements cannot live together in the same place and use the same resources, that is, occupy the same niche
  - Competitive exclusion principle – complete competitors cannot coexist

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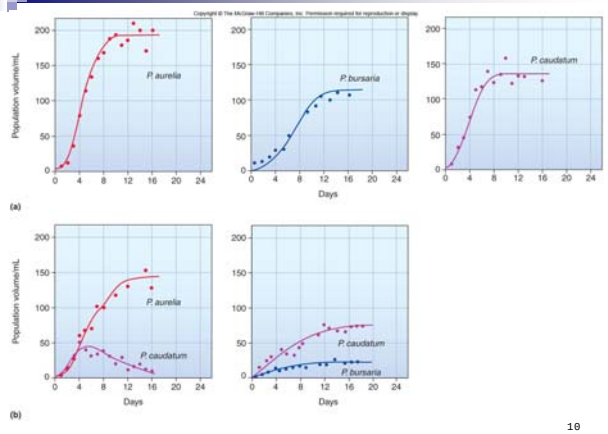

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- Robert MacArthur examined coexistence between five species of warblers feeding within spruce trees in New England
- Found that the species occupied different heights and portions in the tree and thus each probably fed on a different range of insects
- Resource partitioning – differentiation of niches, both in space and time, that enables similar species to coexist in a community

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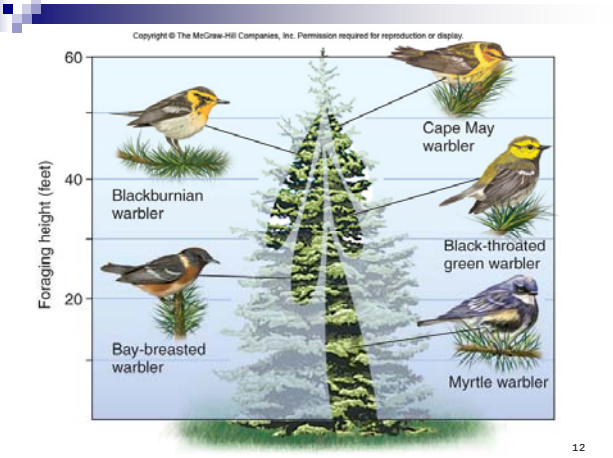

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- Morphological differences allow coexistence
  - Some partial level of competition between complete competitors can exist if it is not severe enough to drive one competitor extinct
  - G. Evelyn Hutchinson compared size differences in feeding apparatus between sympatric (same geographic area) and allopatric (different geographic areas) species
  - When species were sympatric, feeding apparatus size changed to specialize on different food
  - Size differences did not occur in allopatric species
  - Character displacement – tendency for 2 species to diverge in morphology and resource use due to competition
  - Galapagos finch example

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Table 57.2 Comparison of Feeding Characters of Sympatric and Allopatric Species

		Measurement (mm) when		Ratio* when	
Animal (character)	Species	Sympatric	Allopatric	Sympatric	Allopatric
Weasels (skull)	*Mustela erminea*	50.4	46.0	1.28	1.07
	Mustela loulis	39.3	42.9		
Mice (skull)	*Apodemus flavicollis*	27.0	26.7	1.09	1.04
	Apodemus sylvaticus	24.8	25.6		
Nuthatches (beak)	*Sitta tephronota*	29.0	25.5	1.23	1.02
	Sitta neumayer	23.5	26.0		
Galápagos finches (beak)	*Geospiza fortis*	12.0	10.5	1.43	1.13
	Geospiza fuliginosa	8.4	9.3		

*Ratio of the larger to smaller character.

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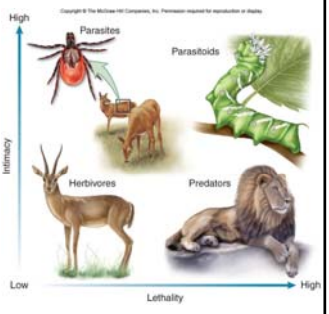
Predation

- Categories of predation can be classified according to how lethal they are for the prey and the length of association between consumer and prey



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- Antipredator strategies
  - Chemical defense
    - Bombardier beetle ejects hot spray
    - Aposematic coloration, or warning coloration, which advertises an organism's unpalatable taste
    - Many tropical frogs have bright coloration to advertise their skin's lethality
  - Cryptic coloration
    - Camouflage
    - Stick insects mimic branches
    - Sea horses adopt body coloration to mimic habitat

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(a) As it is held by a tether attached to its back, this bombardier beetle (*Stenaptinus insignis*) directs its hot, stinging spray at a forceps "attacker."

(b) Aposematic coloration advertises the poisonous nature of this blue poison arrow frog (*Dendrobates azureus*) from South America.

(c) Cryptic coloration allows this Pygmy sea horse (*Hippocampus bargibanti*) from Bali, to blend in with its background.

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- Mimicry
  - Resemblance of mimic to another organism (model)
  - Müllerian mimicry – noxious species converge to reinforce warning, black and yellow stripes of bees and wasps
  - Batesian mimicry – palatable mimic resembles unpalatable model, scarlet king snake and coral snake
- Displays of intimidation
  - Porcupine fish inflates itself
  - Deceive predator about ease of eating prey
- Fighting
  - Horns and antlers can be used in defense

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(d) In this example of Batesian mimicry, an innocuous scarlet king snake (*Lampropeltis triangulum*) (*left*) mimics the poisonous coral snake (*Micrurus nigrocinctus*) (*right*).

(e) In a display of intimidation, this porcupine fish (*Diodon hystrix*) puffs itself up to look threatening to its predators.

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- Predators still affect prey densities
  - Importance of predation depends on if it is
    - Donor-controlled system, prey supply is determined by factors other than predation, such as food supply, so that removal of predators has no effect on prey density
    - Predator-controlled system, action of predator feeding reduces supply of prey, so removal of predator results in increase in prey

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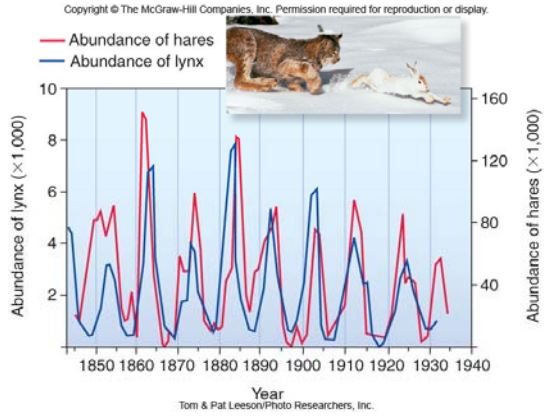

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- Invasive species do not have their natural predators
  - Brown tree snake introduced to Guam
  - By 1980's 8 of 11 of island's forest birds extinct
  - Birds had no defense against snake they didn't evolve with
- Systematic decline in whales of various species in response to human whaling industry

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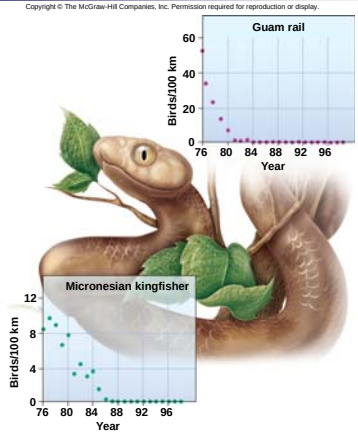

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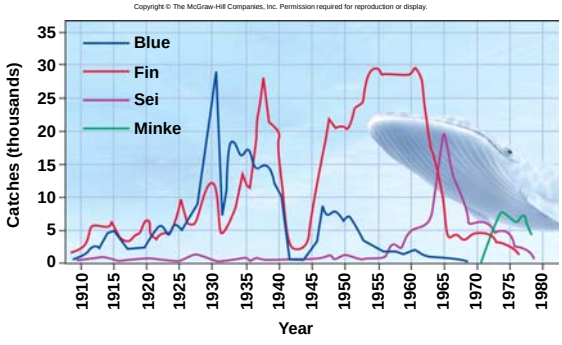

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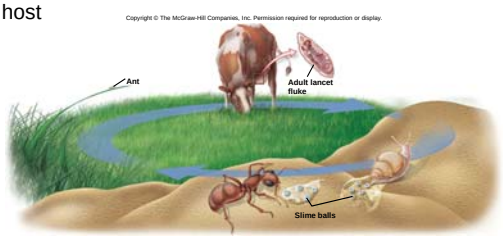
Parasitism

- One organism feeds off another, but does not normally kill it outright
- Predatory organism is termed a parasite and the prey a host



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- Parasitic flowering plants
  - Holoparasites lack chlorophyll and are totally dependent on the host plant for their water and nutrients
    - *Rafflesia arnoldii*, which lives most of its life within the body of its host with only the flower developing externally (largest known flower in the world)
  - Hemiparasites generally do photosynthesize, but they lack a root system to draw water and thus depend on their hosts for that function
    - Mistletoe (*Viscum album*)

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- Ectoparasites – live on the outside of the host body (fleas and ticks)
- Endoparasites – live inside the host body (bacteria and tapeworms)

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- Parasites may outnumber free-living species by four to one
- Most plant and animal species harbor many parasites
- Few cases of experimental removal of parasites confirm that parasites can reduce host population densities

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Mutualism

- Close associations between species in which both species benefit
- Leaf-cutting ants and fungus
  - Ants chew up leaves to feed to fungus they care for
  - Fungus produces gongylidia as ant food
  - Both species entirely dependent on each other

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Commensalism

- One member derives a benefit while the other neither benefits nor is harmed
- Epiphytes growing in trees do not harm the trees
- Cattle egrets benefit from cattle stirring up insects
- Phoresy – one organism uses another for transportation
  - Flower-inhabiting mites use hummingbird nostrils

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