BIOL 3340 Ecology Study Guide for Exam 2: Lecture 11: Predation and Herbivory

Source: the lecture slides (text, figures and slide notes). No textbook.

Each heading is one Study Lab objective. [L13 s08] = Lecture 13, slide 8.

(teal italics) = plain meaning of the word before it. ⚠ **Do not mix up = a look-alike pair to keep apart.** **Amber dotted words** = names printed on the figure beside them.

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Click a line to jump to it. The PDF side panel (bookmarks) has the same parts.

L11.1 Predators and other natural enemies

⚠ **Do not mix up: Predation is NOT +/+ or +/0: it is +/- because the prey is killed and eaten.** [L11 s06]

Predation *(one species kills and eats another)* is a +/- interaction between species. [L11 s06]

The **predator** *(the killer and eater)* gains (+); the **prey** *(the one eaten)* loses (-). [L11 s06]

Predation is an **interspecific** *(between different species)* interaction. [L11 s06]

Continuum *(a smooth range)*: runs microparasite, macroparasite, parasitoid, predator; body size rises along it. [L11 s07]

Parasitoid *(a parasite that eventually kills its host)*: similar in size to host, such as wasp and moth. [L11 s07]

Macroparasite *(parasite smaller than its host)*: smaller than host, usually mild effect, low ability to regulate host population. [L11 s07]

Regulation: predation has a high potential to regulate prey populations. [L11 s08]

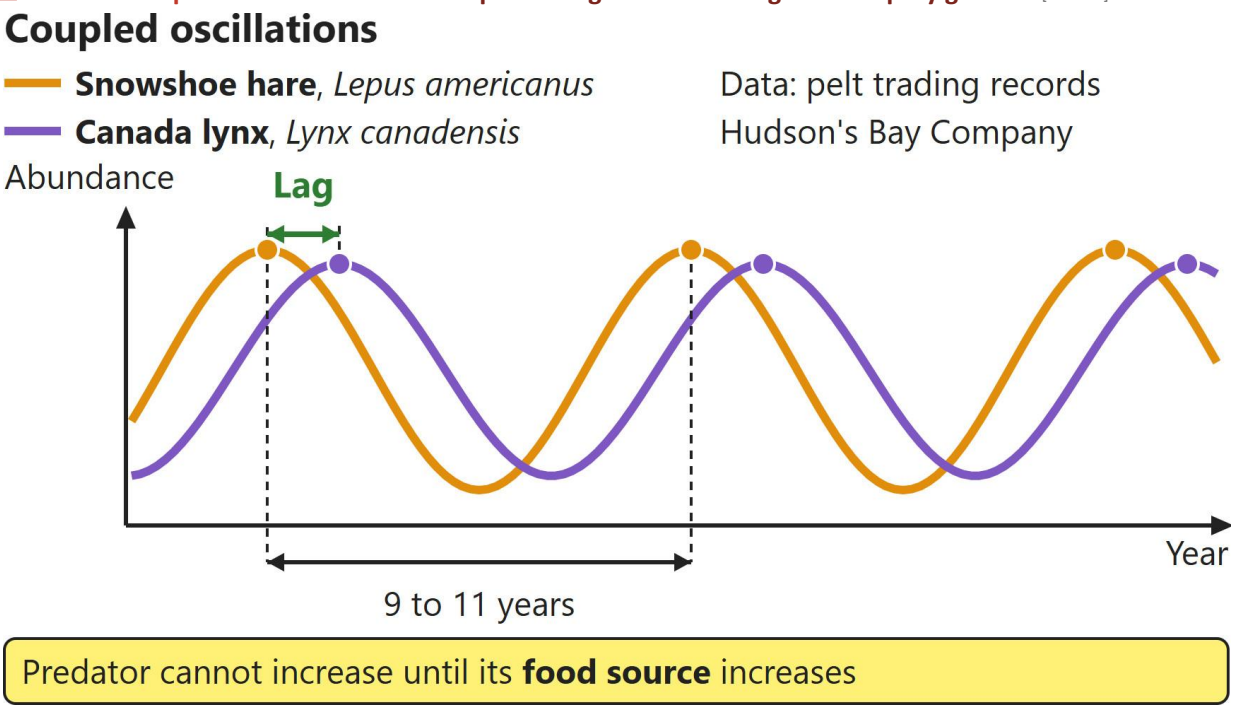
Microparasite to predator: life history traits

Trait	Microparasite	Macroparasite	Parasitoid	Predator
Body size	Microscopic	Smaller than host	Similar in size (wasp and moth)	Often larger than prey unless social hunter
Intrinsic rate of population growth	Rapid	Faster than hosts	Comparable to host	Comparable to but often slightly slower than prey
Number per host	One host usually supports populations of several different species	One host supports a few to many individuals of different species	One host usually supports one, but can support many individuals	Each predator eats many prey individuals
Fatality to host	Mild to severe	Usually mild	Eventually fatal	Immediately fatal
Stability of the interaction with the host	Intermediate	High	Intermediate	Usually low
Ability to regulate host population	Moderate to high	Low	Moderate to high	High

Table source: [L11 s07, L11 s08]

L11.2 Predation and population growth

⚠ **Do not mix up: Predators do NOT lead: predator growth often lags behind prey growth.** [L11 s10]



Hare and lynx waves: the lynx peak trails the hare peak by a lag [L11 s10]

On the figure: Coupled oscillations · Snowshoe hare · Canada lynx · Lag · 9 to 11 years

Coupled oscillations *(linked ups and downs)*: predator and prey abundances cycle in linked waves. [L11 s10]

Snowshoe hare and Canada lynx: coupled oscillations of **9 to 11 years**. [L11 s10]

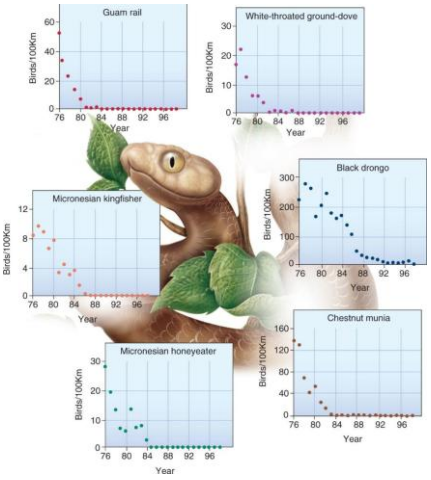
Lag *(delay)*: predator growth often trails prey growth. [L11 s10]

The predator cannot begin to **increase** until its food source begins to **increase**. [L11 s10]

Lynx peaks come just after hare peaks. [L11 s10]

Non-native predators can cause extinction because the prey are not adapted to the predator. [L11 s11]

Brown tree snake, introduced to **Guam**: native bird species fell to zero or near zero. [L11 s11]



Six Guam bird species fall to near zero after the snake arrives [L11 s11]

On the figure: Guam

L11.3 Lotka-Volterra predator-prey model

⚠ **Do not mix up: NOT swapped: prey isocline is horizontal at r/s; predator isocline is vertical at m/es.** [L11 s17]

Start with **geometric increase** *(growth by a fixed multiple each step)* of prey: N(t+1) = R0 x N(t). [L11 s13]

Searching efficiency *(how well predators find and attack prey)*, or attack rate, is called **s**. [L11 s14]

Prey attacked also depends on number of prey (N) and number of predators (P). [L11 s14]

Consumption of prey combines these three features: **sPN**. [L11 s14]

Prey equation: N(t+1) = R0 N(t) - s P(t) N(t). [L11 s14]

In the prey equation, the **sPN** term is prey removed by predators. [L11 s14]

The term for number of prey (N) is on both the positive and negative parts. [L11 s14]

If s is very high, like an introduced predator, extinction of prey could occur. [L11 s14]

Predator birth rate depends on sPN and **e**, how efficiently predators turn food into new predators. [L11 s15]

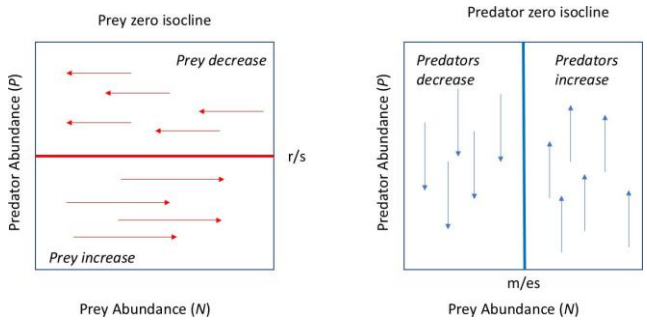
Predator growth: P(t+1) = e s P(t) N(t). [L11 s15]

Predator mortality depends on a mortality rate (m) and the number of predators (P). [L11 s16]

Predator equation: P(t+1) = e s P(t) N(t) - m P(t). [L11 s16]

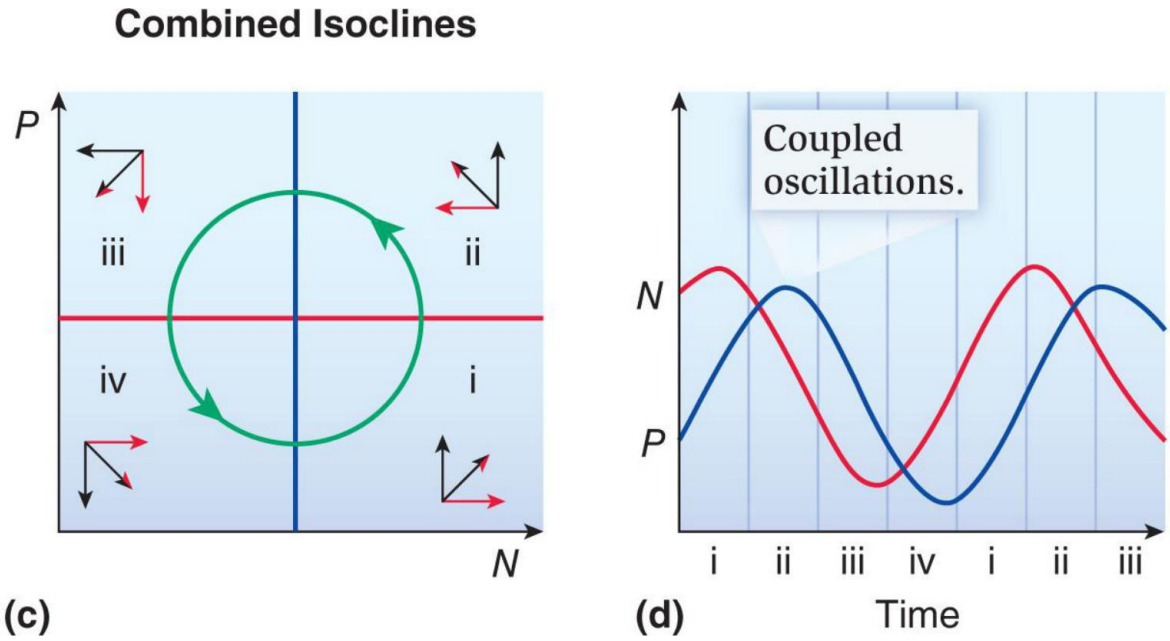
In the predator equation, esPN is predator growth and mP is predator death. [L11 s16]

Zero isocline *(line where a population stops changing)*: one for prey and one for predators. [L11 s17]



Prey isocline is horizontal at r/s; predator isocline is vertical at m/es [L11 s17]

On the figure: zero isocline · r/s · m/es



Combined isoclines make a cycle, giving coupled oscillations of prey and predators [L11 s18]

On the figure: coupled oscillations · isoclines

Combining both **isoclines** gives **coupled oscillations** *(linked ups and downs)* of prey and predators. [L11 s18]

Lotka-Volterra can also model parasitoid and host, or herbivore and plant, if attack **increases** death. [L11 s18]

Lotka-Volterra symbols

Symbol	Meaning
R0	Prey geometric **increase**: N(t+1) = R0 x N(t)
r	Prey growth term that sets the prey isocline position r/s (the equations write the prey multiplier as R0)
s	Searching efficiency, or attack rate, of predators
N	Number of prey
P	Number of predators
sPN	Consumption of prey (prey removal)
e	Efficiency of turning food into new predators
m	Predator mortality rate

Table source: [L11 s13, L11 s14, L11 s15, L11 s16, L11 s17]

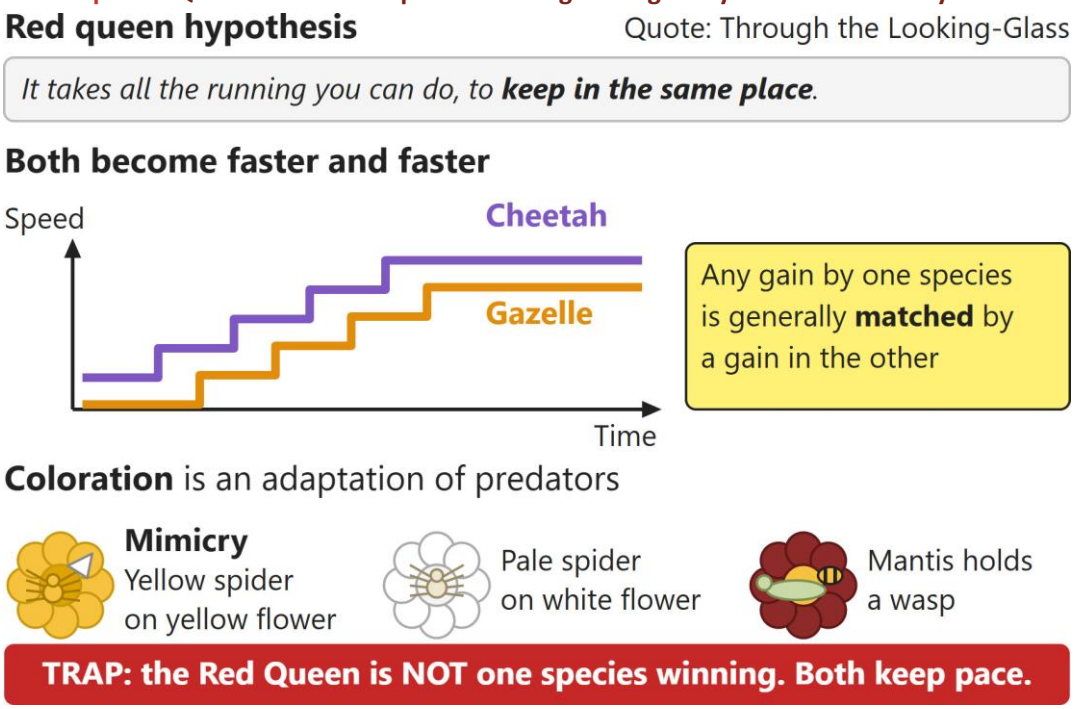
The two isoclines

Isocline	Shape	Position	What happens either side
Prey zero isocline	Horizontal line	r/s on the predator axis	Below: prey **increase**. Above: prey **decrease**
Predator zero isocline	Vertical line	m/es on the prey axis	Left: predators **decrease**. Right: predators **increase**

Table source: [L11 s17]

L11.4 Red Queen and predator adaptations

⚠ **Do not mix up: Red Queen is NOT one species winning: each gain by one is matched by the other.** [L11 s21]



Cheetah and gazelle speeds rise in matched steps; predators use coloration and mimicry [L11 s21]

On the figure: Red queen hypothesis · Cheetah · gazelle · Coloration · Mantis · wasp · keep in the same place

Red queen hypothesis *(both sides keep evolving just to stay level)*: predator and prey keep pace. [L11 s20]

Quote: it takes all the running you can do, to **keep in the same place**. [L11 s20]

Cheetah and gazelle are the classic example supporting the red queen hypothesis. [L11 s21]

Both became faster and faster. [L11 s21]

Any gain in speed by one was generally matched by gains in speed of the other. [L11 s21]

Coloration is an adaptation of predators. [L11 s22]

Predators use coloration to hide while hunting; prey use **cryptic coloration** *(blending in)* to avoid being detected. [L11 s22, L11 s27]

Predator examples: a lizard (beside a grasshopper), crab spiders on flowers, a **mantis** with a **wasp**. [L11 s22, L11 s23, L11 s24, L11 s25, L11 s26]

The spiders match their flowers: yellow spider on yellow petals, pale spider on white flowers. [L11 s23, L11 s25]

L11.5 Antipredator adaptations

⚠ **Do not mix up: Batesian mimic is NOT toxic: it is palatable. Müllerian species are all noxious.** [L11 s27]

Antipredator adaptations *(prey defenses against being eaten)*: cryptic coloration, mimicry, physical defenses, predation satiation. [L11 s27]

Intimidation *(looking threatening)* is shown together with armor under physical defenses. [L11 s27]

Cryptic coloration *(blending in)* is the blending of an organism with its habitat background. [L11 s27]

Cryptic coloration is an aspect of **camouflage**. [L11 s27]

It is a common method of avoiding detection by predators. [L11 s27]

Cryptic coloration is prevalent in the vertebrate *(backboned animal)* world. [L11 s27]

Indian leaf butterfly mimics the leaves on which it rests. [L11 s28]

Pygmy seahorse blends in with its background. [L11 s28]

Mimicry *(looking like another species)*: the mimic resembles the model, which secures protection from predators. [L11 s27]

Batesian mimicry: a palatable *(tasty)* mimic copies an unpalatable *(bad tasting)* model. [L11 s27]

Batesian example: the innocuous *(harmless)* scarlet king snake mimics the poisonous coral snake. [L11 s29]

Müllerian mimicry: many noxious *(harmful or foul tasting)* species converge to look the same, reinforcing the distasteful design. [L11 s27]

Müllerian example: viceroy, queen, and monarch butterflies share warning coloration and are all toxic to birds. [L11 s29]

Physical defenses: armor, claws, stingers, horns. [L11 s27]

Armor: the strong shell of a juvenile ornate box turtle can deter much larger predators. [L11 s30]

Intimidation *(looking threatening)*: the porcupine fish puffs itself up to look threatening to predators. [L11 s30]

Predator satiation *(filling predators up)*, also called predation satiation: synchronous *(at the same time)* production of many progeny. [L11 s31]

All individuals in the population do it, so predators fill up and some survive. [L11 s31]

Periodical cicadas: **13**- and **17**-year cicadas are the example. [L11 s31]

Predators cannot **increase** their population quickly enough to eat a large percentage of cicadas. [L11 s31]

This holds until cicadas finish their life cycle and the grubs burrow back into the ground. [L11 s31]

Antipredator adaptations

Adaptation	Description	Example
Cryptic coloration	Blending of an organism with the background of its habitat	Indian leaf butterfly, pygmy seahorse
Mimicry	A mimic resembles a model; two major types	Two types: Batesian and Müllerian
Batesian mimicry	Palatable mimic copies an unpalatable model	Scarlet king snake copies coral snake
Müllerian mimicry	Many noxious species converge to look the same	Viceroy, queen, monarch butterflies
Physical defenses	Armor, claws, stingers, horns	Ornate box turtle shell
Intimidation	Looking threatening to predators	Porcupine fish puffs up
Predation satiation	Synchronous production of many progeny to satiate predators	**13**- and **17**-year cicadas

Table source: [L11 s27, L11 s28, L11 s29, L11 s30, L11 s31]

Batesian vs Müllerian mimicry

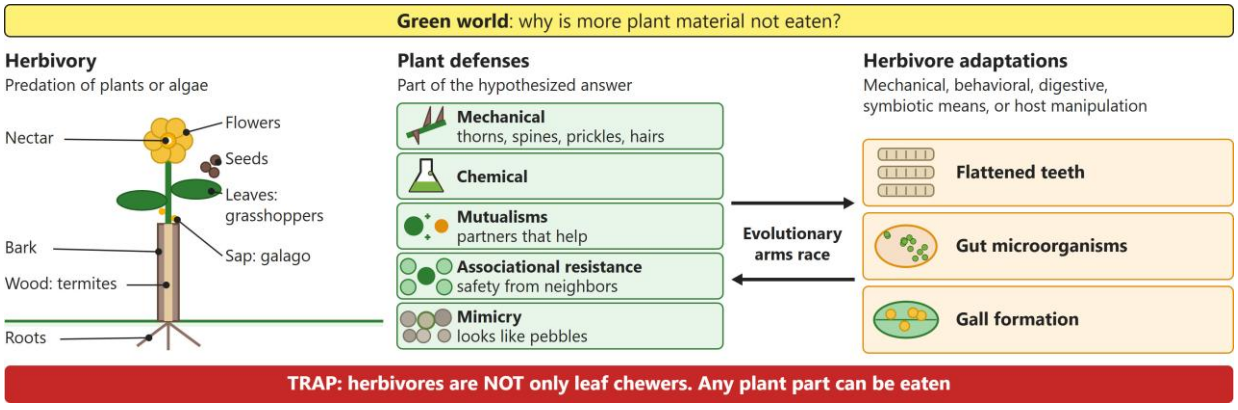
	Batesian mimicry	Müllerian mimicry
Who is involved	Unpalatable model, palatable mimic	Many noxious species that converge
Effect	Mimic gains protection	Reinforces the distasteful design
Example	Scarlet king snake and coral snake	Viceroy, queen, monarch butterflies

Table source: [L11 s27, L11 s29]

L11.6 Herbivory and plant defenses

⚠ **Do not mix up: Herbivores are NOT only leaf chewers: they also eat seeds, nectar, roots, wood, bark, and sap.** [L11 s33]

Herbivory *(eating plants)* is predation of plants or algae. [L11 s33]



Parts of a plant that are eaten, plant defenses and herbivore counters in an arms race [L11 s33]

On the figure: Nectar · Seeds · Bark · Sap · plant defenses · Evolutionary arms race · Flattened teeth · Gall formation

Herbivores feed on flowers, **seeds**, leaves, **nectar**, roots, wood, **bark**, and **sap**. [L11 s33]

Green world question: why is more plant material not eaten? [L11 s34]

Part of the hypothesized answer is **plant defenses**. [L11 s34]

Defenses: mechanical, chemical, **mutualisms** *(partners that help)*, **associational resistance** *(safety from neighbors)*, mimicry (pebble-like plants that blend with gravel). [L11 s34]

Mechanical defenses: thorn, cactus spines, stem prickles, a tiny hair, spiny holly leaves. [L11 s35]

Evolutionary arms race: plants and herbivores are often in one, like the Red-queen hypothesis. [L11 s36]

Herbivores adapt via mechanical, behavioral, digestive, or symbiotic means, or host manipulation. [L11 s36]

Examples: **flattened teeth** (mechanical), **gut microorganisms** (symbiotic), **gall formation** *(lump grown on a plant)* (host manipulation). [L11 s36]

The **goldenrod gall fly** makes a gall: host manipulation. [L11 s36]

Herbivore examples

Herbivore	What it eats
Leaf chewers like grasshoppers	Leaves
Termites	Wood
Galago	Sap

Table source: [L11 s33]