Quick announcements:

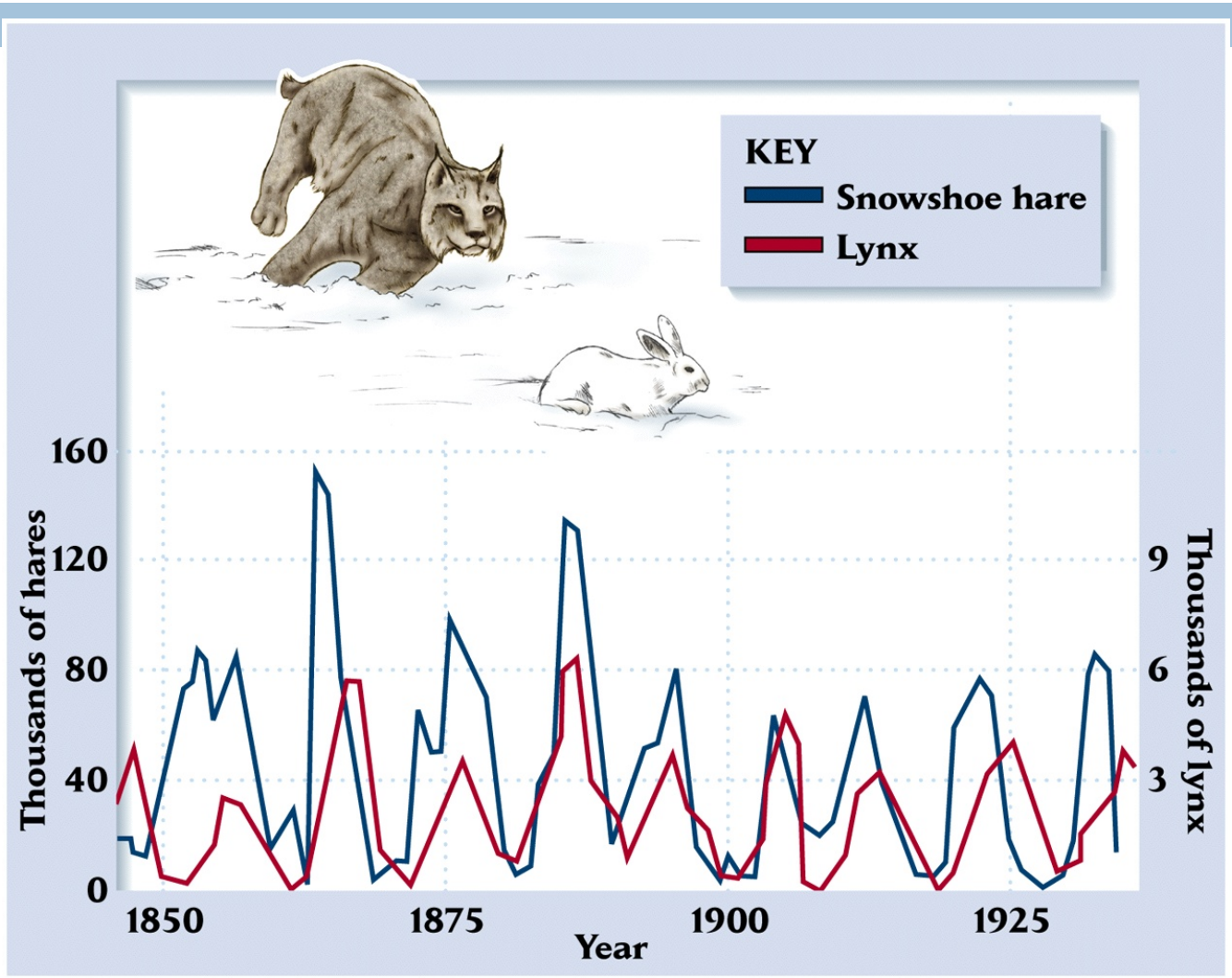
- This week: Final draft → Review paper
- Next week:
  - Tuesday: Guest lecture- Rylee Murray
  - Thursday: In-class assignment with David Green
- Exam #2: 2 weeks from today
  - Review Questions posted this weekend

*** If you have to miss an assignment...be in touch BEFORE it is due!**

In-class #3: Keystone Predators

- Load SimBio Software → laptop (desktop)
- Bring to class next Thursday!
- Work together, but each person needs to log in & complete assignment (Quiz @ end)

Predators and prey sometimes cycle



Predator-prey systems can be modeled with simple math

R is p<u>R</u>ey pop^n

P is <u>P</u>redator pop^n

$$dR/dt = rR - cRP$$

Growth of prey population

(*r* is growth rate)

Loss to predator population

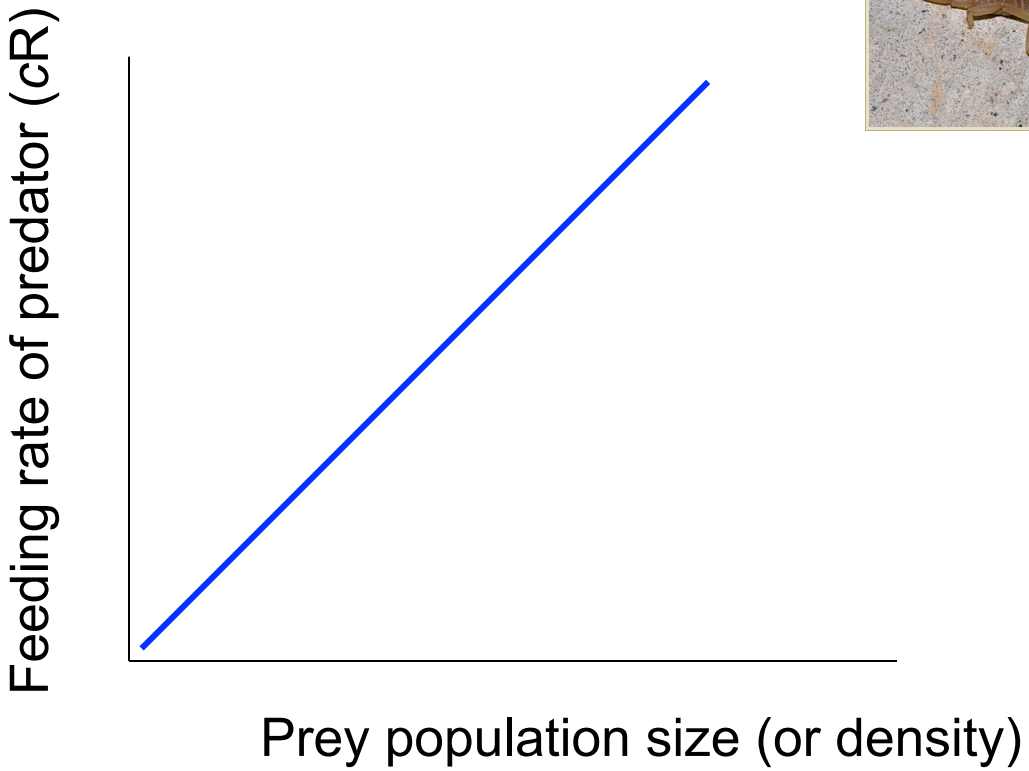
(*c* is capture efficiency)

What does it mean that *c* is a fixed number?

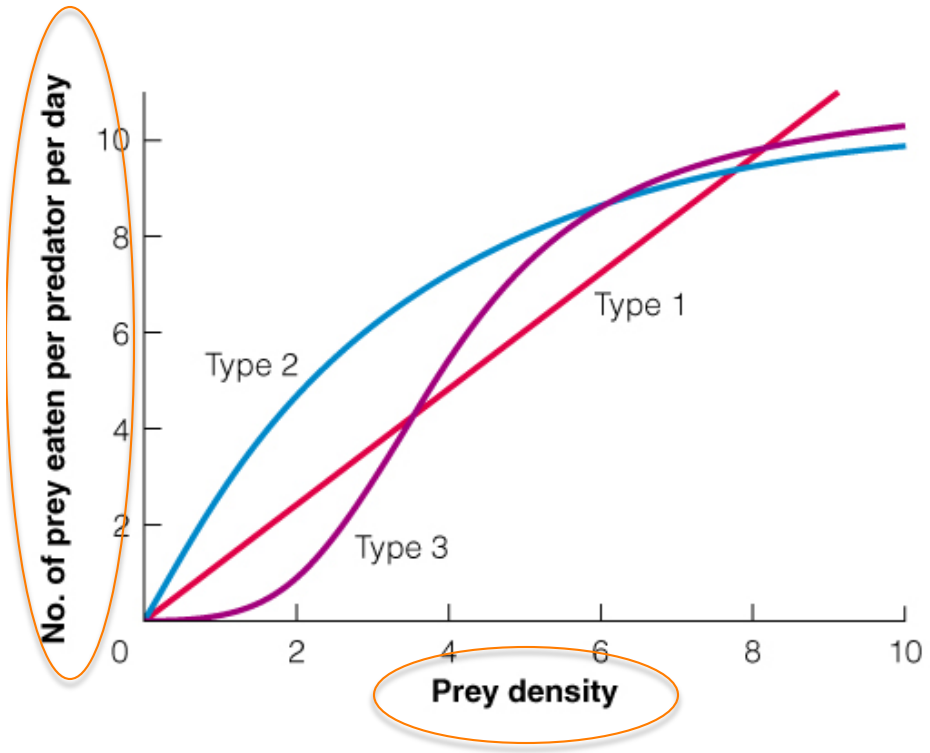
Predator functional response

Loss to predator population = *c*RP

Remember the y-axis is a RATE!



3 forms of the Predator Functional Response



Type I :

linear increase with increasing prey
assumed by Lotka-Volterra
Uncommon in nature, why?

Type II:

predator consumption saturates
Limited by handling time and digestion (satiation)

Type III:

accelerating phase at low densities
saturation at high densities
Prey switching/hiding places at low densities & satiation at high densities

Predation components

1) **searching** for prey
2) **attacking** prey
3) **handling and digesting** prey

1. The more prey, the less time required to (search) find one to attack

2. Most predators very well adapted for attacking their prey. Often a small part of the predation process

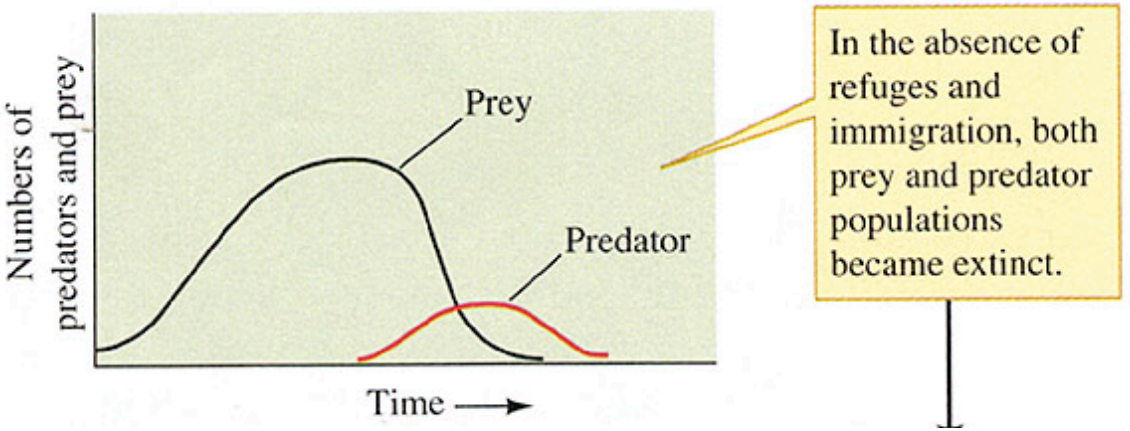
3. Handling time determines how many prey a predator can actually consume at any given prey density

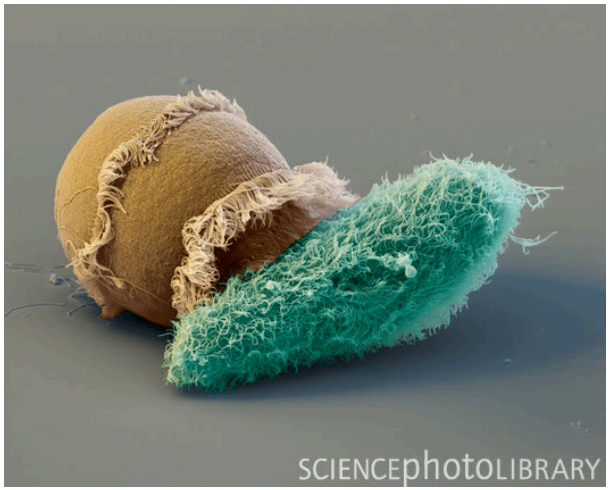
Numerical response

change in predator population size in response to predation

- **Immigration/aggregation**
  - Highly mobile predators (faster response)
- **Reproduction/population growth**
  - Lags behind changes in prey abundance (slower response)

Lab-based Experiments





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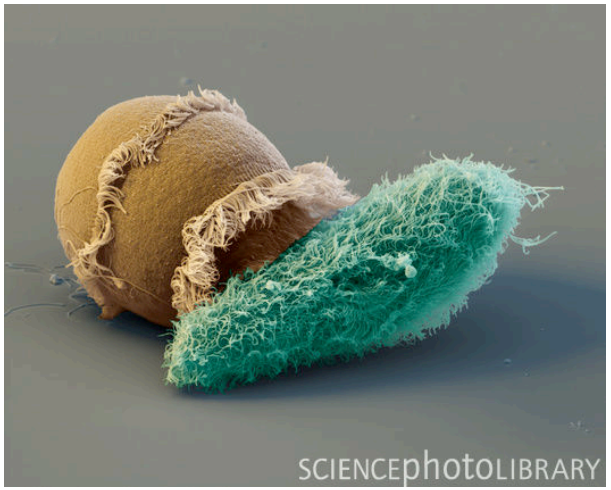

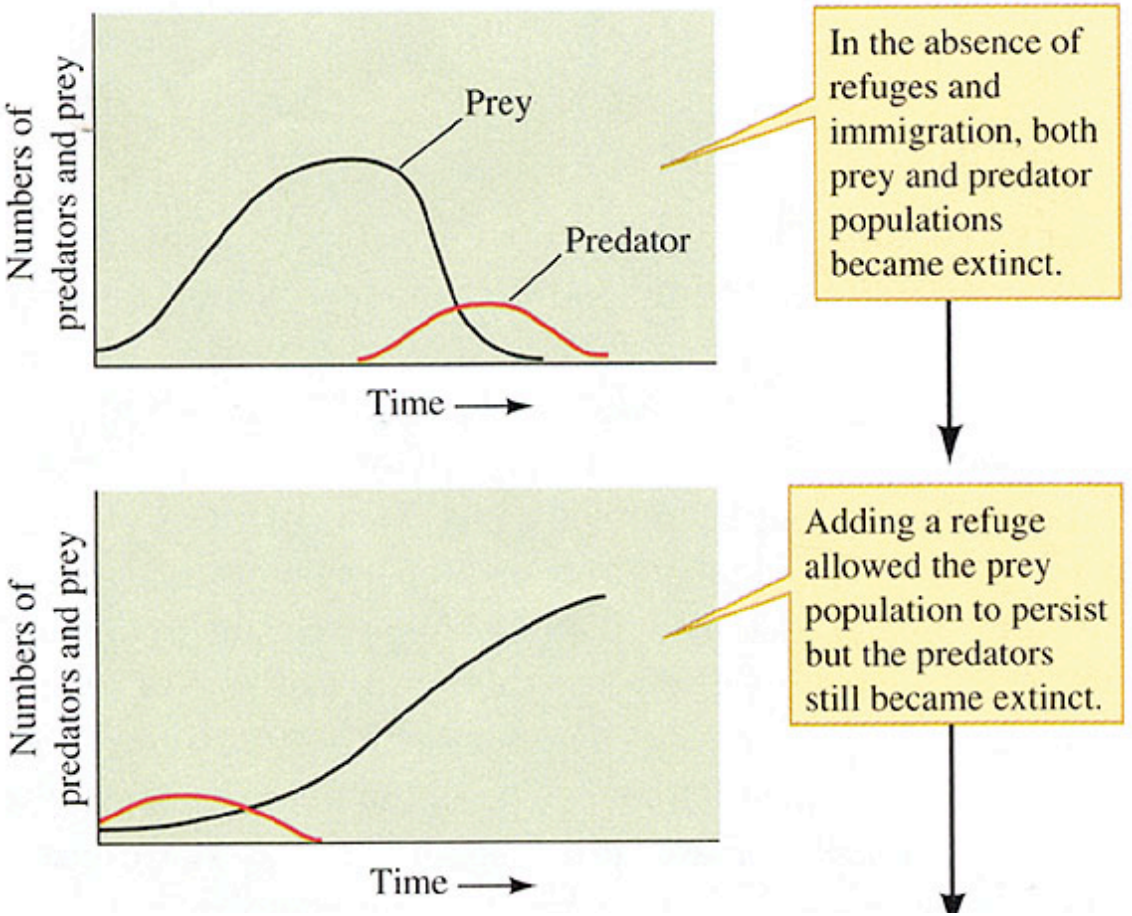

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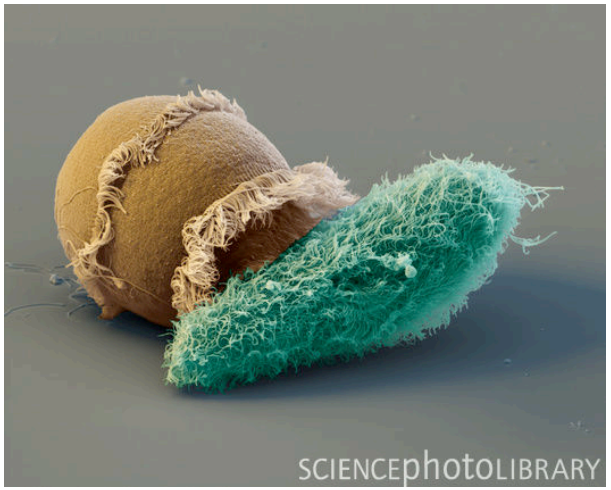
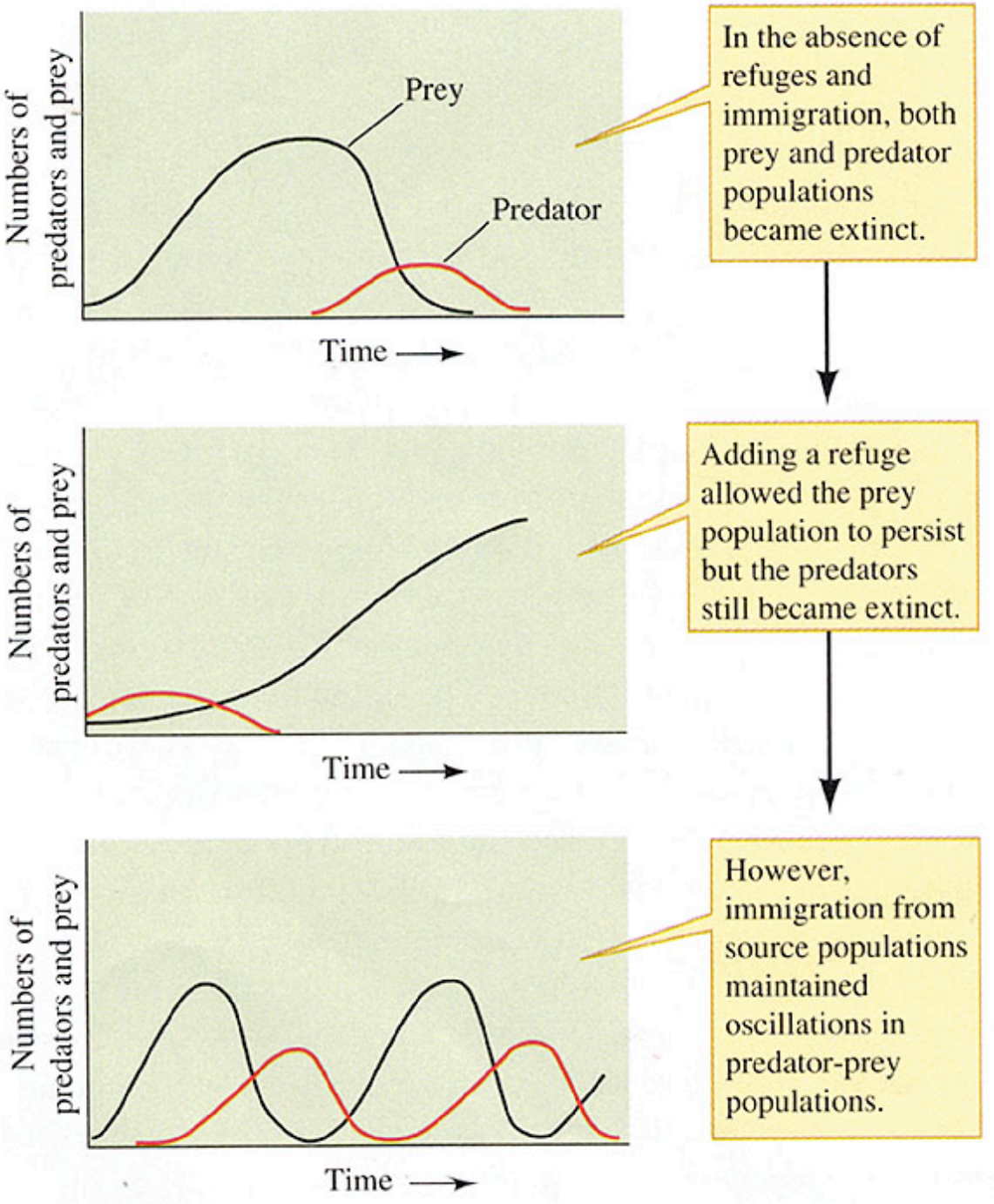
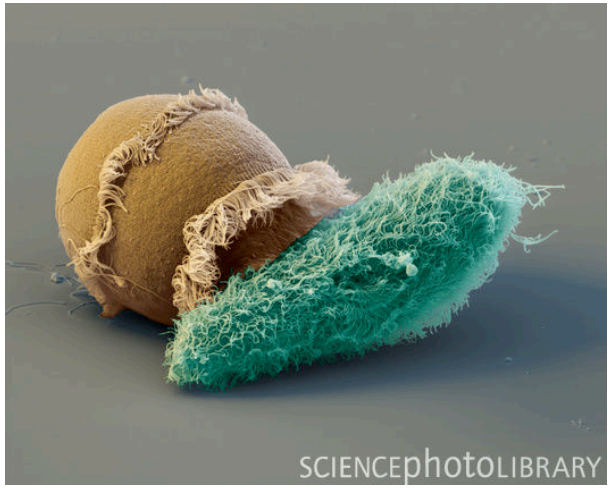
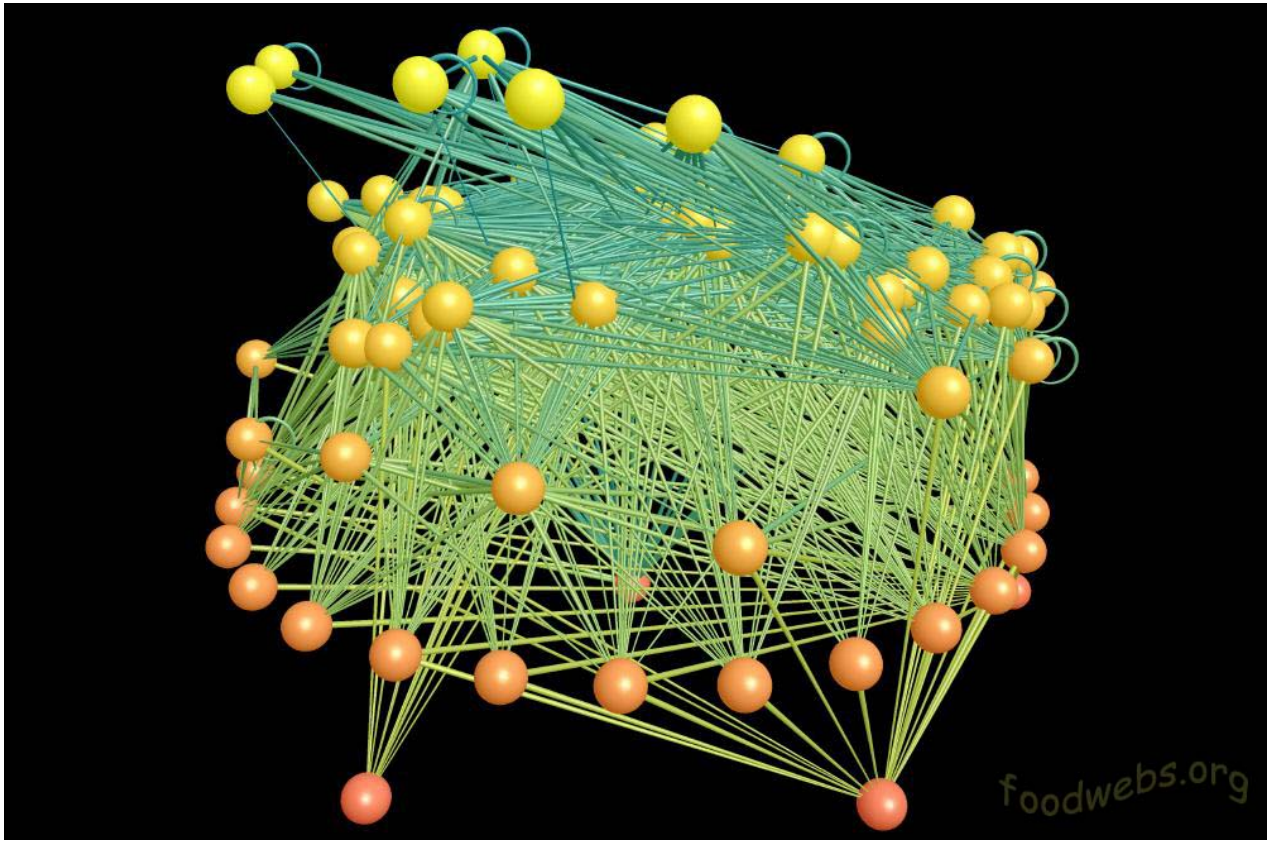




How common are predator prey cycles in nature?





*Mostly in arctic ecosystems

Why don't most predator-prey populations cycle?

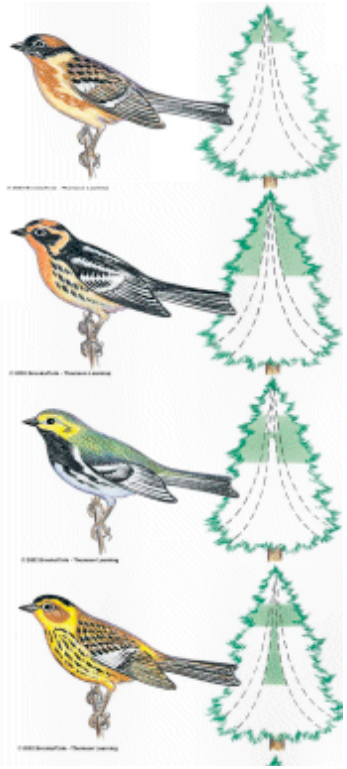


Factors that stabilize predator-prey systems

- Predator inefficiency
- Density-dependence of predators or prey
- Alternative food sources for predator
- Refuges for prey
- Reduced time delays in predator response to prey dynamics

Competition

Competition *is the use of a resource by one individual that reduces its availability to other individuals*



Interspecific competition

-between species

Intraspecific competition

-within species

**(e.g. logistic growth)

Competition

- Can also classify by the nature of the interaction

Resource (exploitative) competition

- When organisms use common resources that are in short supply

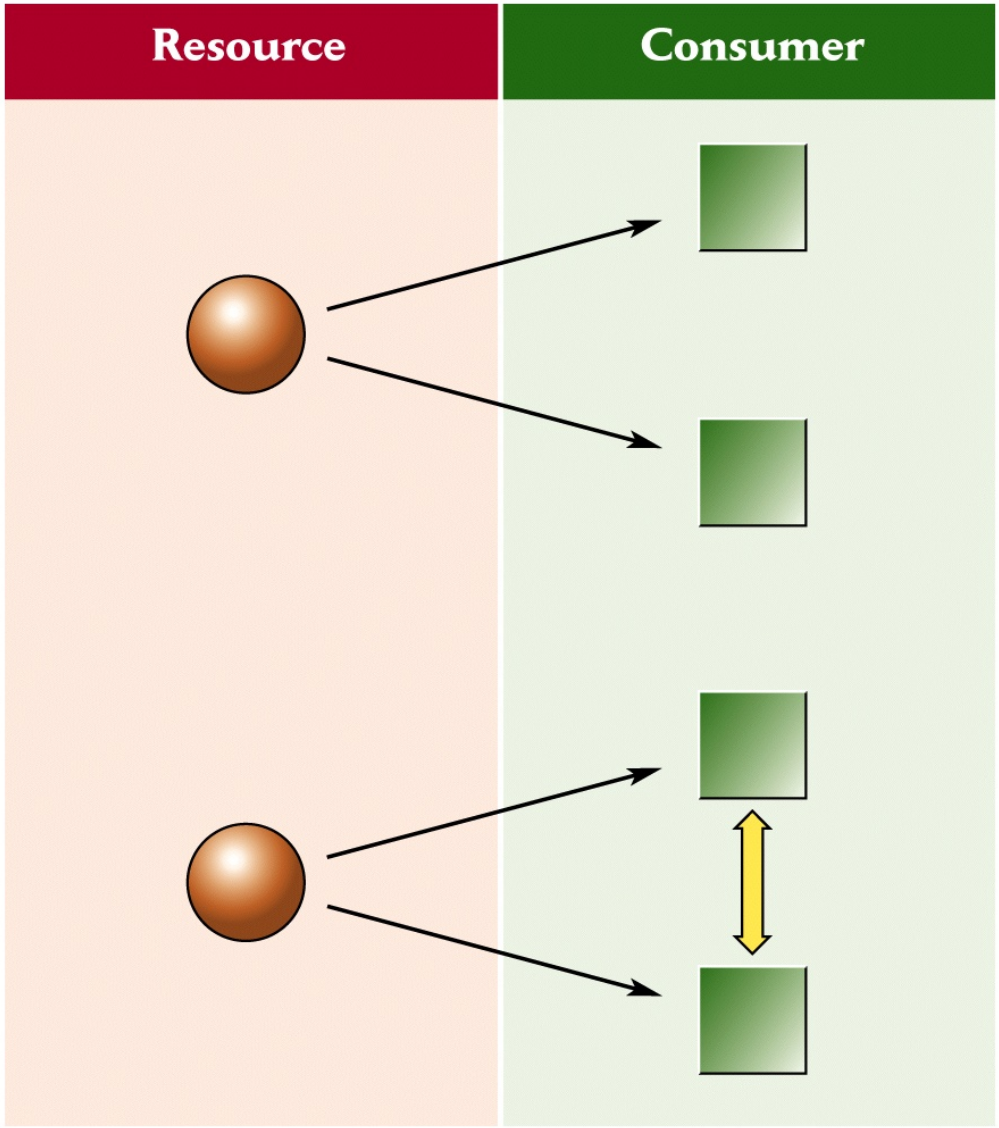
Desert rodents & ants (book)

Interference competition

- Organisms seeking a resource harm one another in the process

Competing ants (book), allelopathy

Resource & Interference competition



Resource (Exploitative)

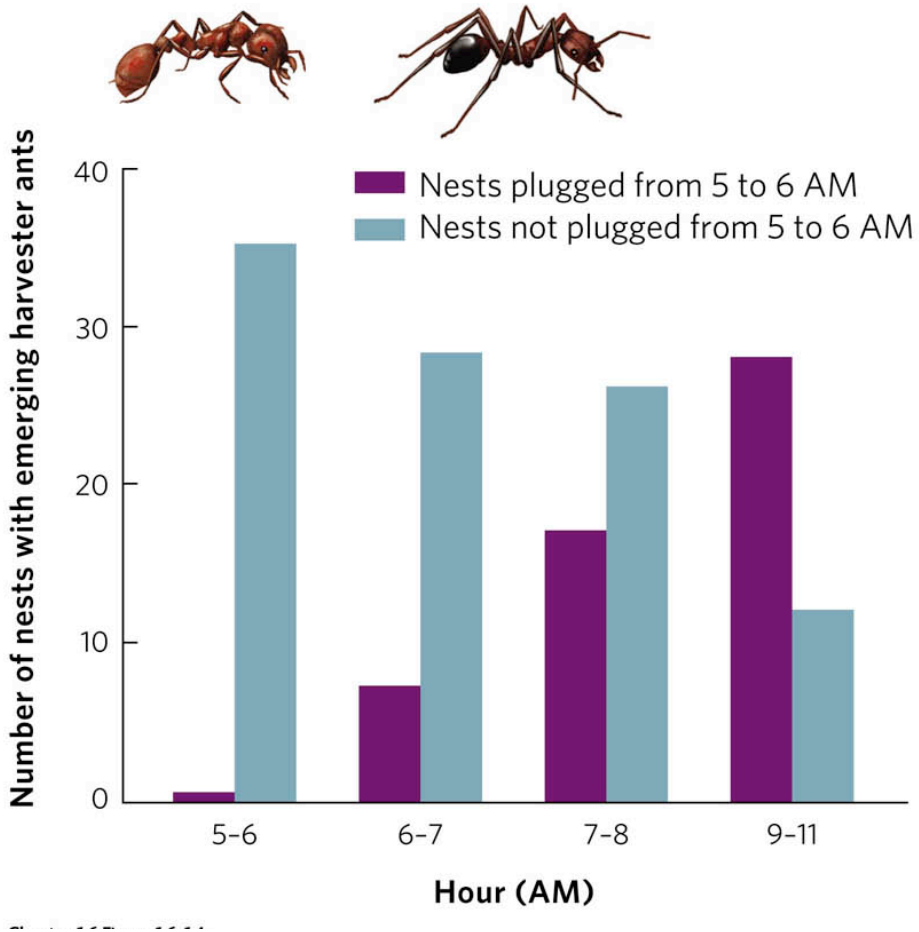
This is what we have talked about so far...

Interference

Resource & Interference competition

Interference competition

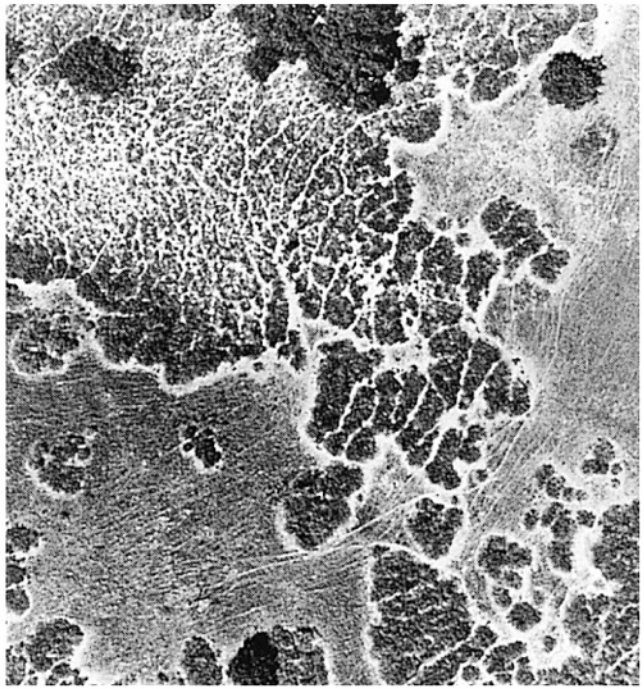
Long-legged ants directly impede Red harvester ants



Sage brush exude toxins – **allelopathy**

Plant chemical competition

How could you test competition experimentally?



Eucalyptus trees promote hot fires

-Oil promotes hot fires

-Fire kills seedlings and young trees of potential competitors

-Leaves eucalyptus relatively unharmed

-Thrives post-fire in lower competition

-Similar to allelopathy

Competition between two species of plants (Tansley 1917)

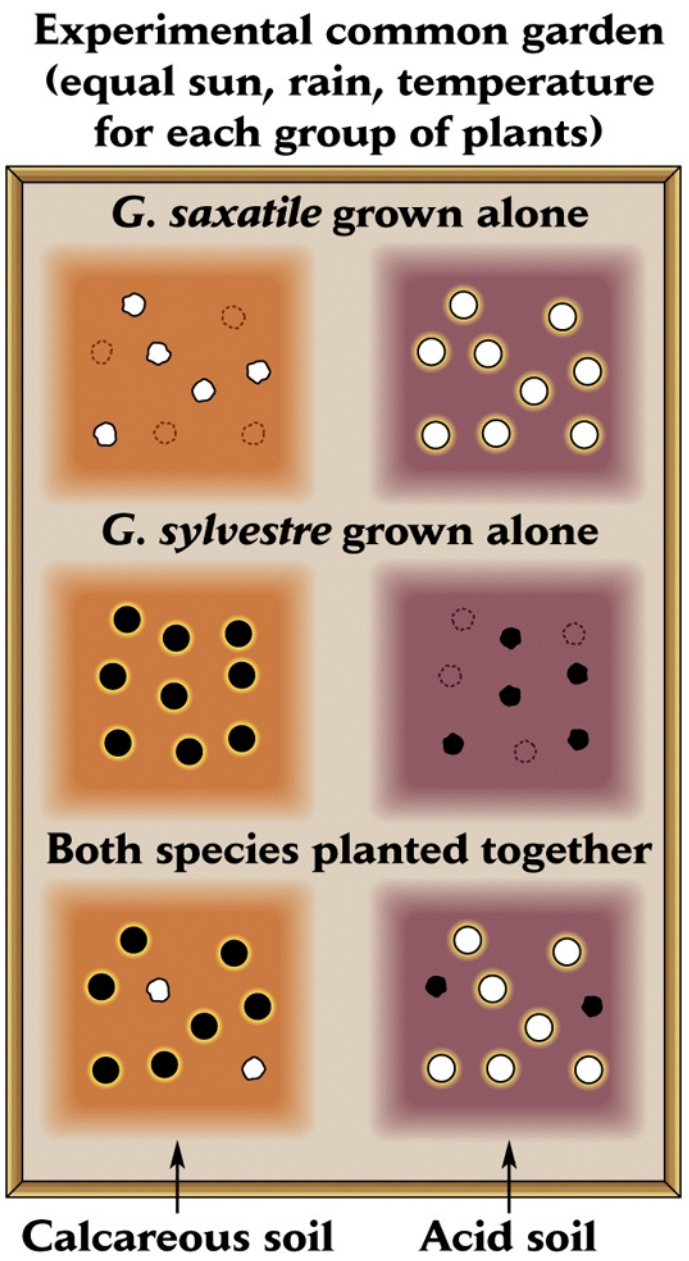
'Common garden' experiment

Observation: Conspicuous non-overlapping pattern in species occurrence

Is this different environmental tolerance?

Competition?

Or both?



Soil treatments

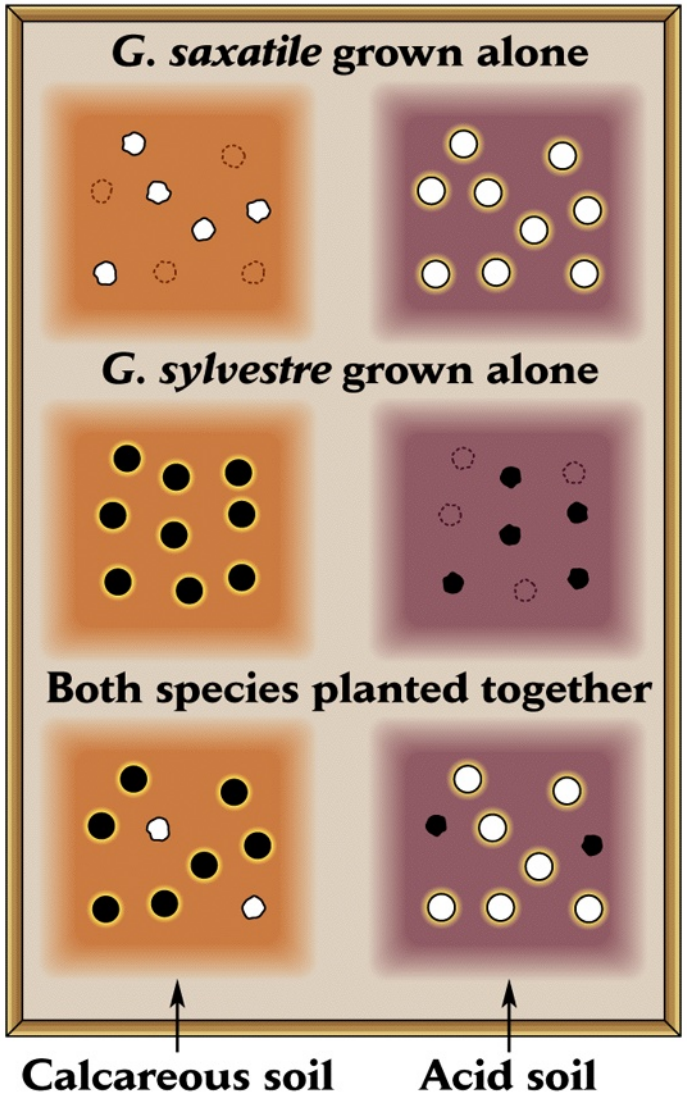
neutral pH **low pH**

Species treatments

Species A

Species B

Species A & B



Tansley's conclusions:

1. Species presence/absence could be due to competition

2. Environmental conditions can affect competition

3. Present species distributions could indicate competition from the past

4. Closely related species often experience intense competition

Categories of Resources

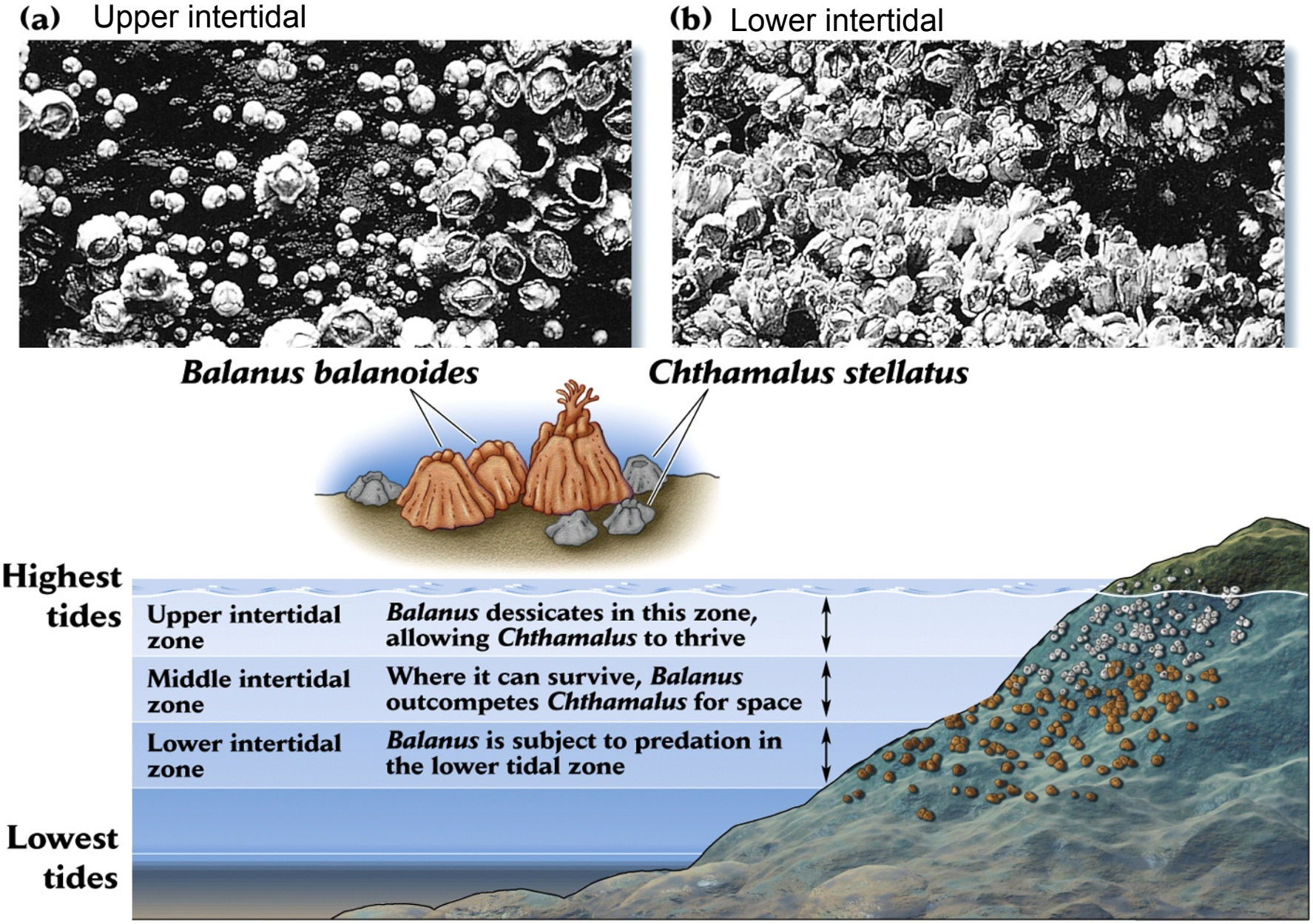
Nonrenewable – e.g., space

once occupied, it is not replenished until the organism leaves

Renewable – e.g, nutrients, food, etc.

continuously replenished (but at varying rates!)

Competition for space in barnacles (Connell)



3 types of **renewable** resources:

1) Externally supplied (rainfall, sunlight)

-weak or no feedbacks to consumers

2) Regenerated directly within the ecosystem

-affected by consumer

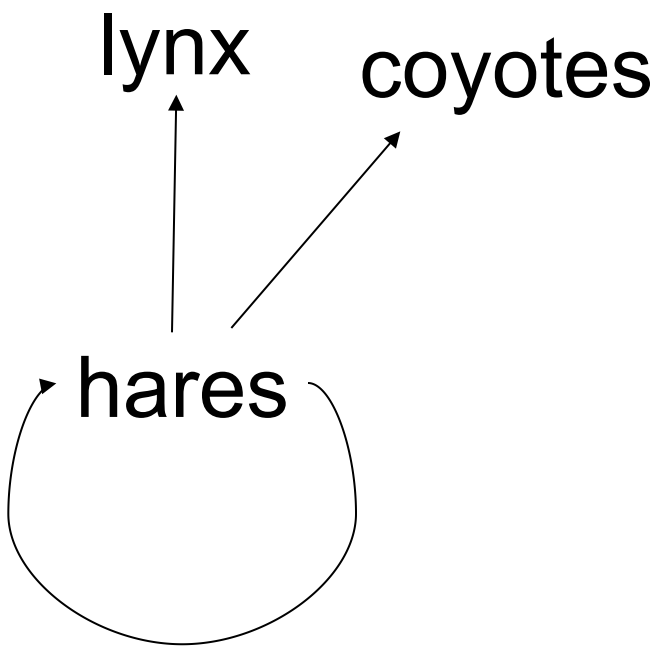
(e.g., most predator-prey, plant-herbivore)

3) Regenerated indirectly within ecosystem

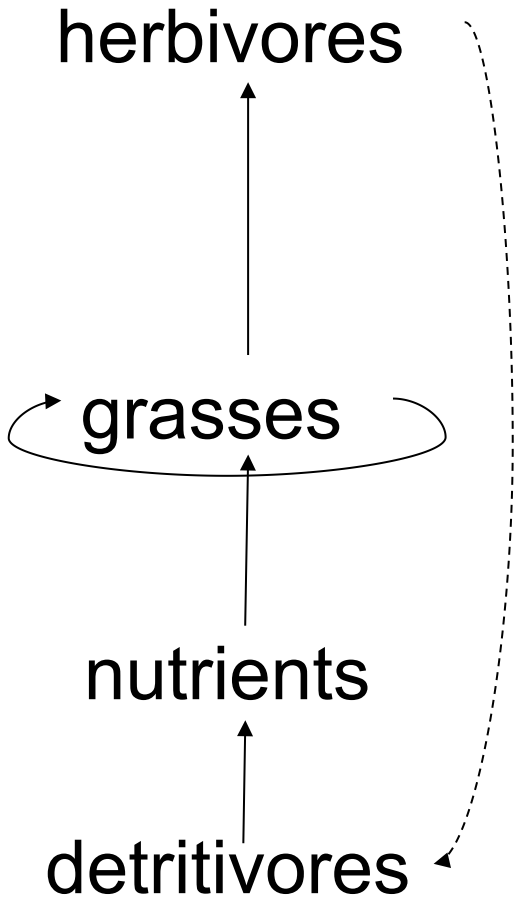
-weak but important feedbacks

(e.g., nutrient recycling by herbivores)

Renewable: Direct regeneration



Renewable: Indirect regeneration

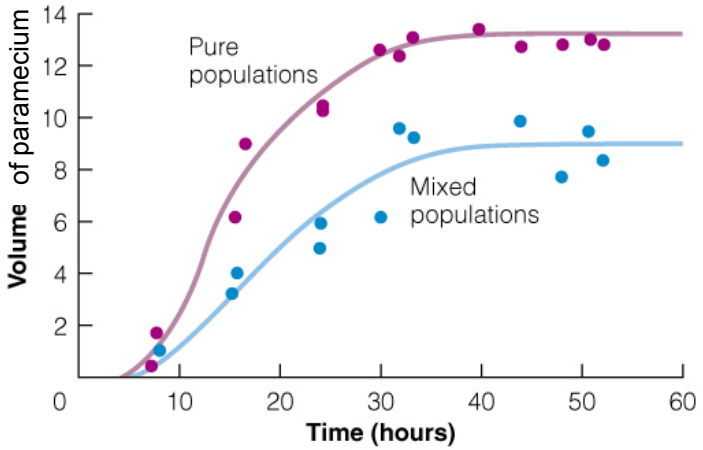


*Michael Pollan's Omnivore's Dilemma

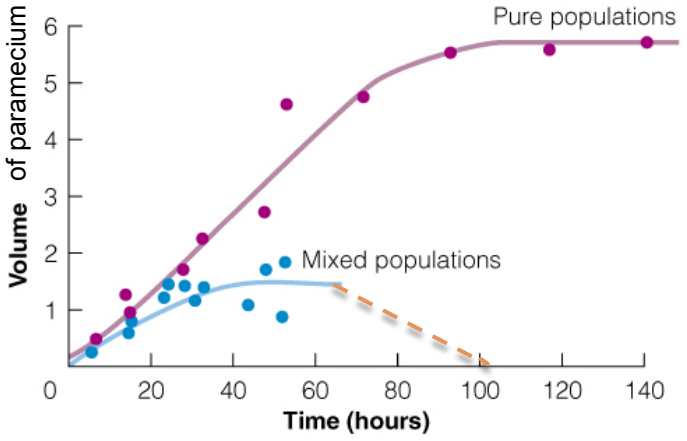
‘Competitive exclusion principle’ from Gause’s (1932) famous experiments with protozoans

Protists in genus *Paramecium*

Species 1



Species 2



Grown in test-tubes
Fixed amount of food (bacteria)

Gause's (1932)

"As a result of competition two similar species scarcely ever occupy similar **niches**, but displace each other in such a manner that each takes possession of certain peculiar kinds of food and modes of life in which it has an advantage over its competitor."

The competitive exclusion hypothesis
Said more simply :

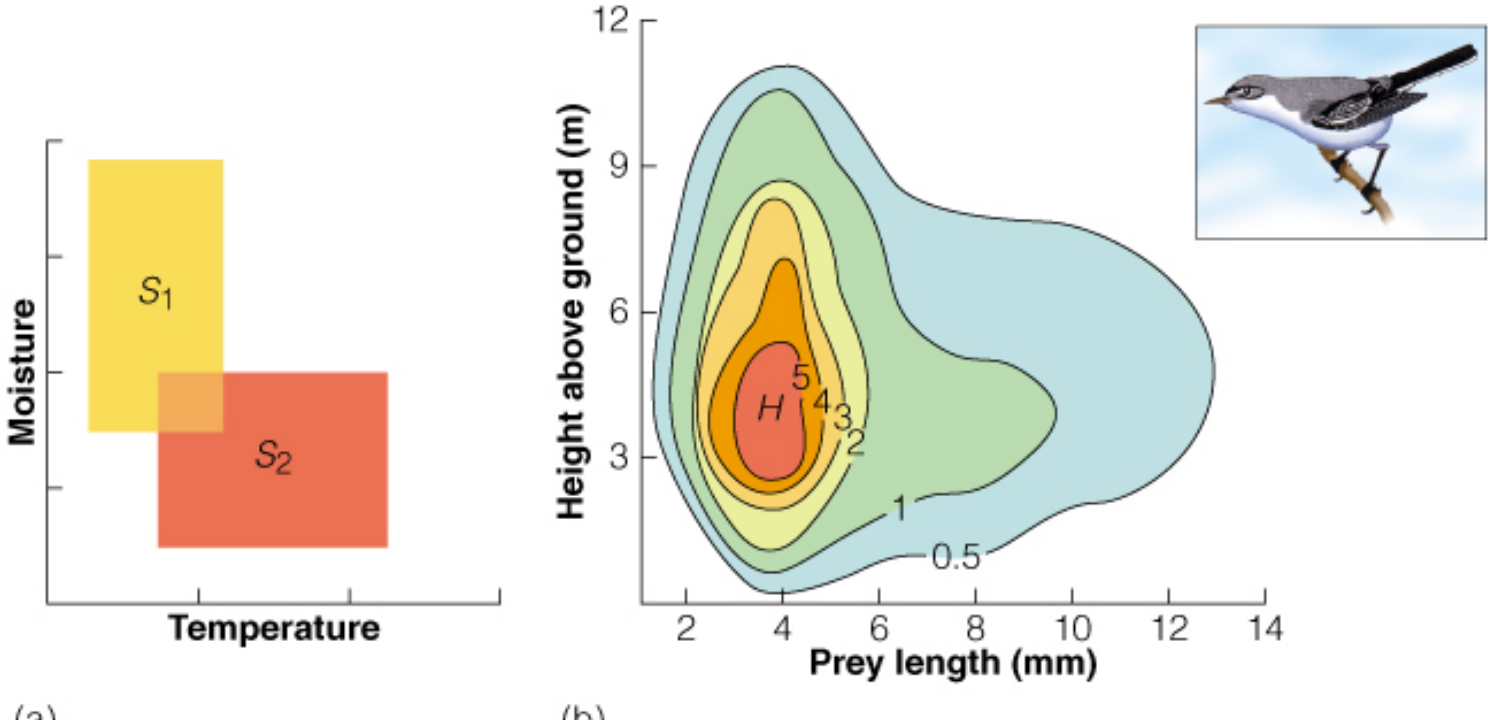
-2 species can not co-exist indefinitely on the same **limiting** resource

-or co-exist in the same **niche**

Niche concepts

Fundamental niche:

- a species 'role' in the community **Elton (1927)**
- overlap of all the tolerable conditions (n-dimensions) for that species **Hutchinson (1958)**



Niche concepts

Fundamental niche:

-infinite number of possible variables

-impossible to measure

-would need to measure species in the absence of competition/predation/etc.

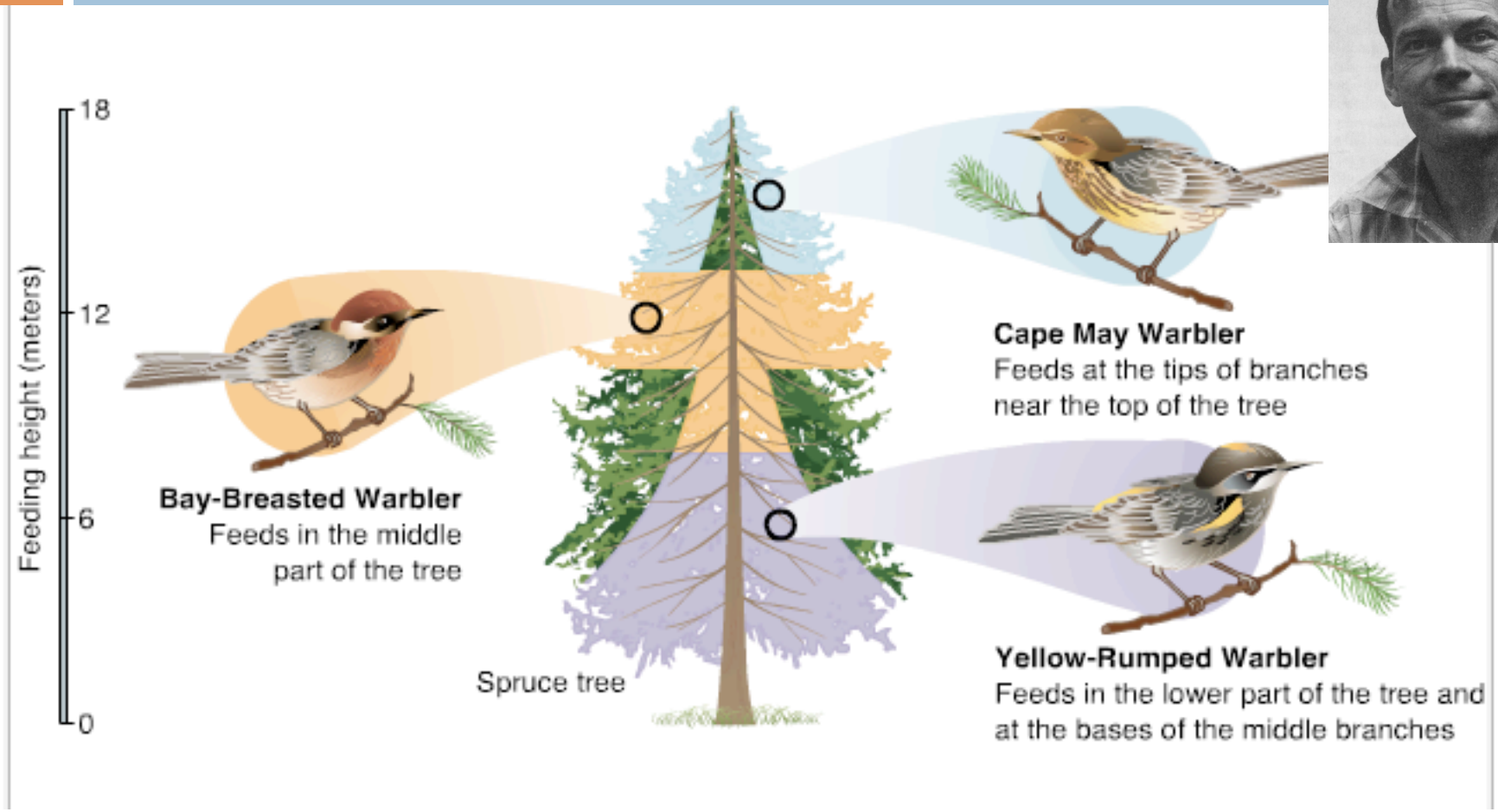
Niche concepts

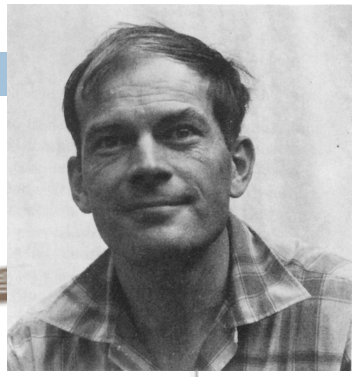
Realized niche:

- the observed resource use of a species in the presence of competition (predation, parasites, etc.)

- can be a tiny fraction of the ***fundamental niche***

Competitive exclusion in nature

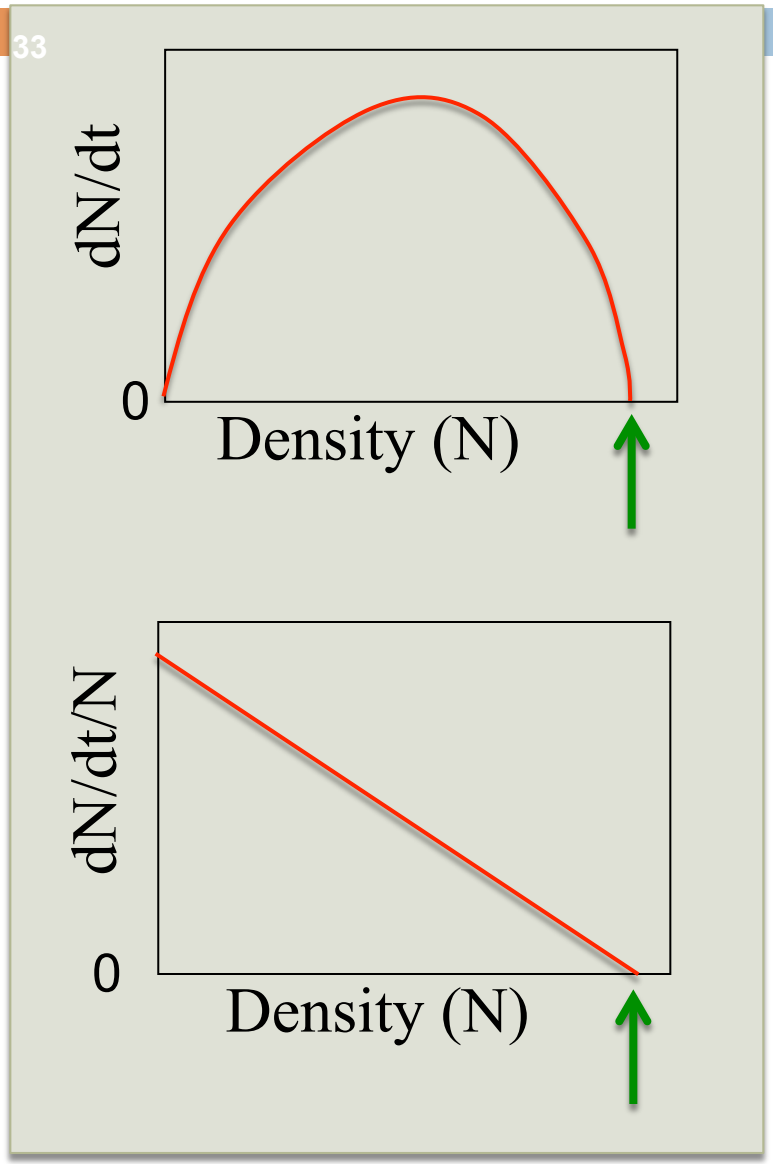


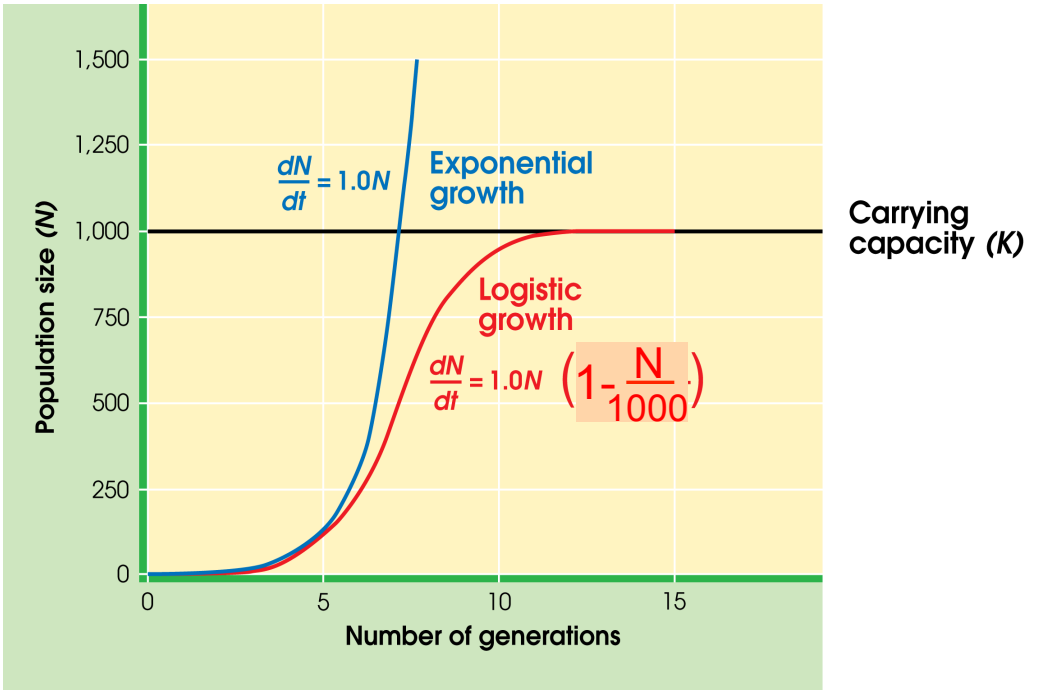


Robert MacArthur

How can we quantify competition?

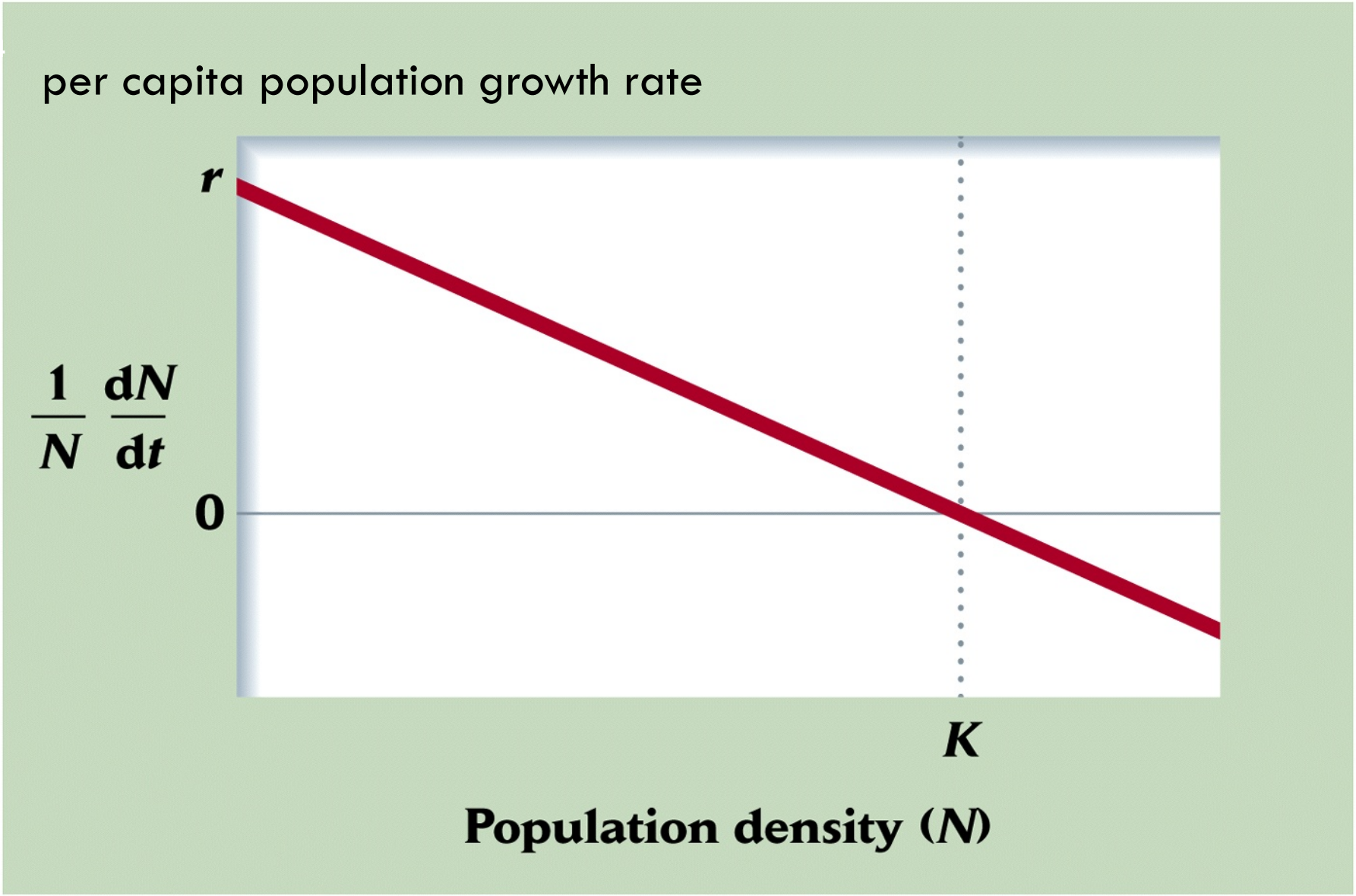
Recall the logistic model of population growth..





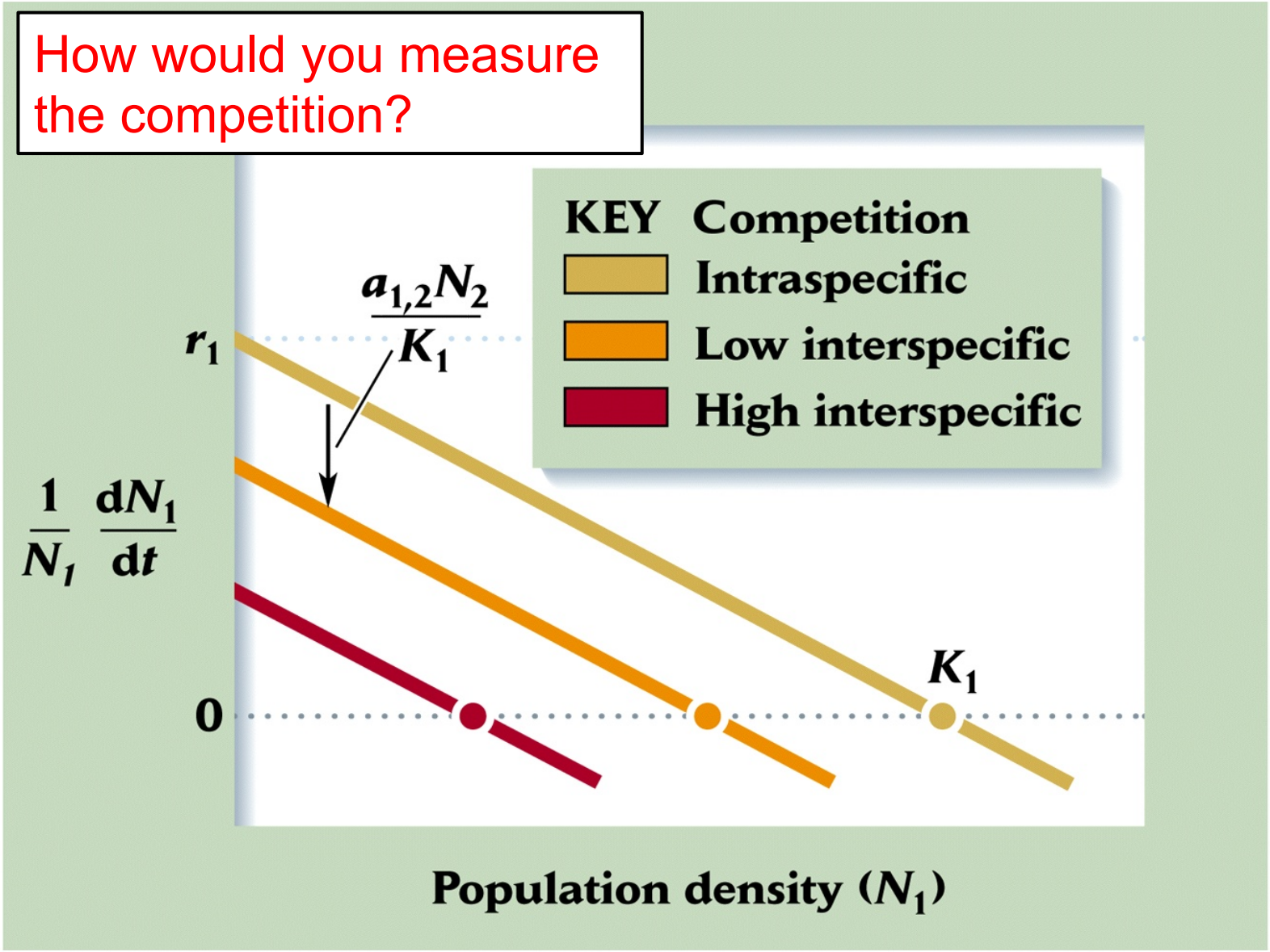
What kind of competition does this model represent?

Recall the logistic model of population growth..

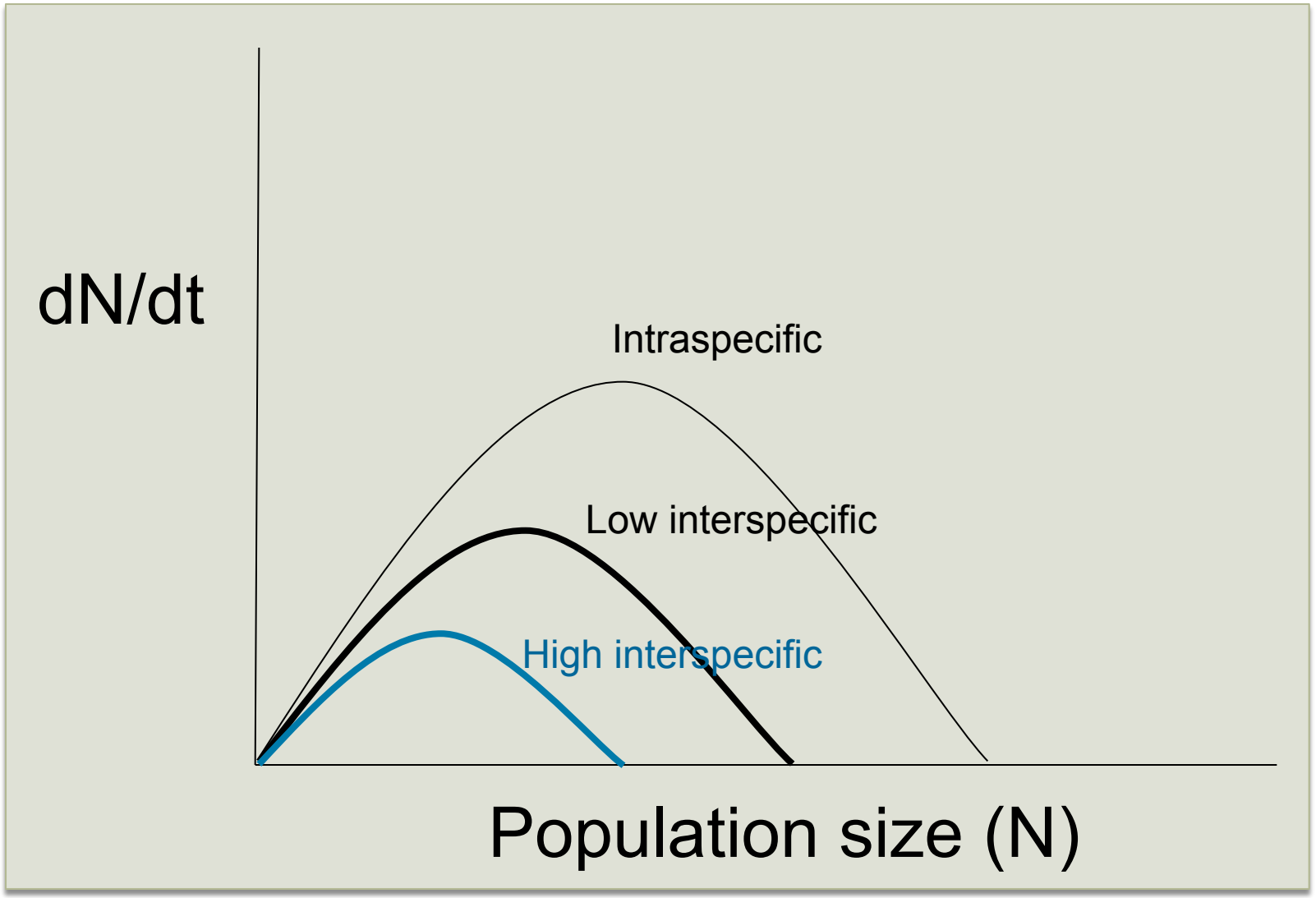


Adding Interspecific competition

How would you measure the competition?



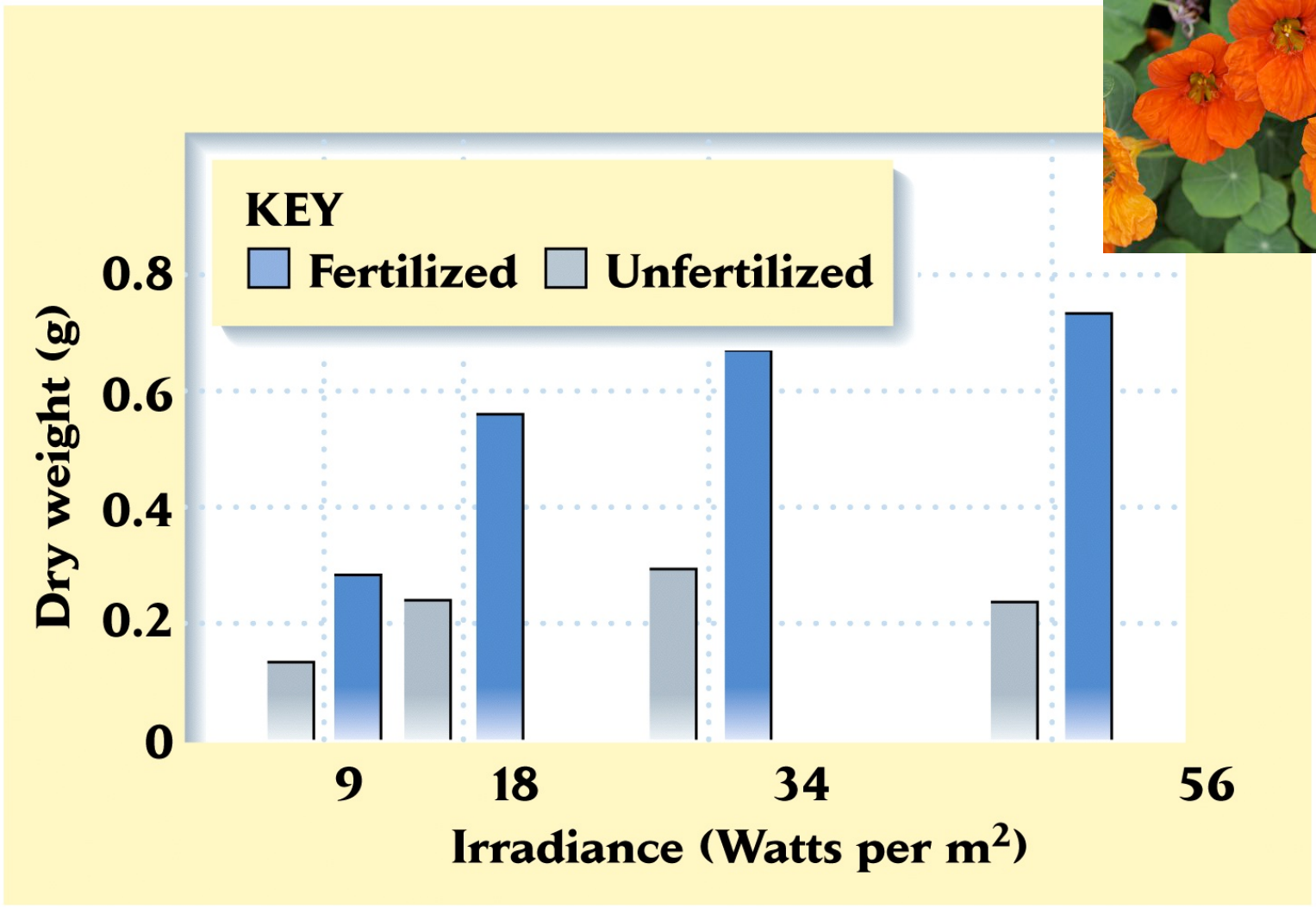
Logistic population growth



What is the difference between a **resource** and a **limiting resource**?

Could you design an experiment to determine the limiting resource for a species?

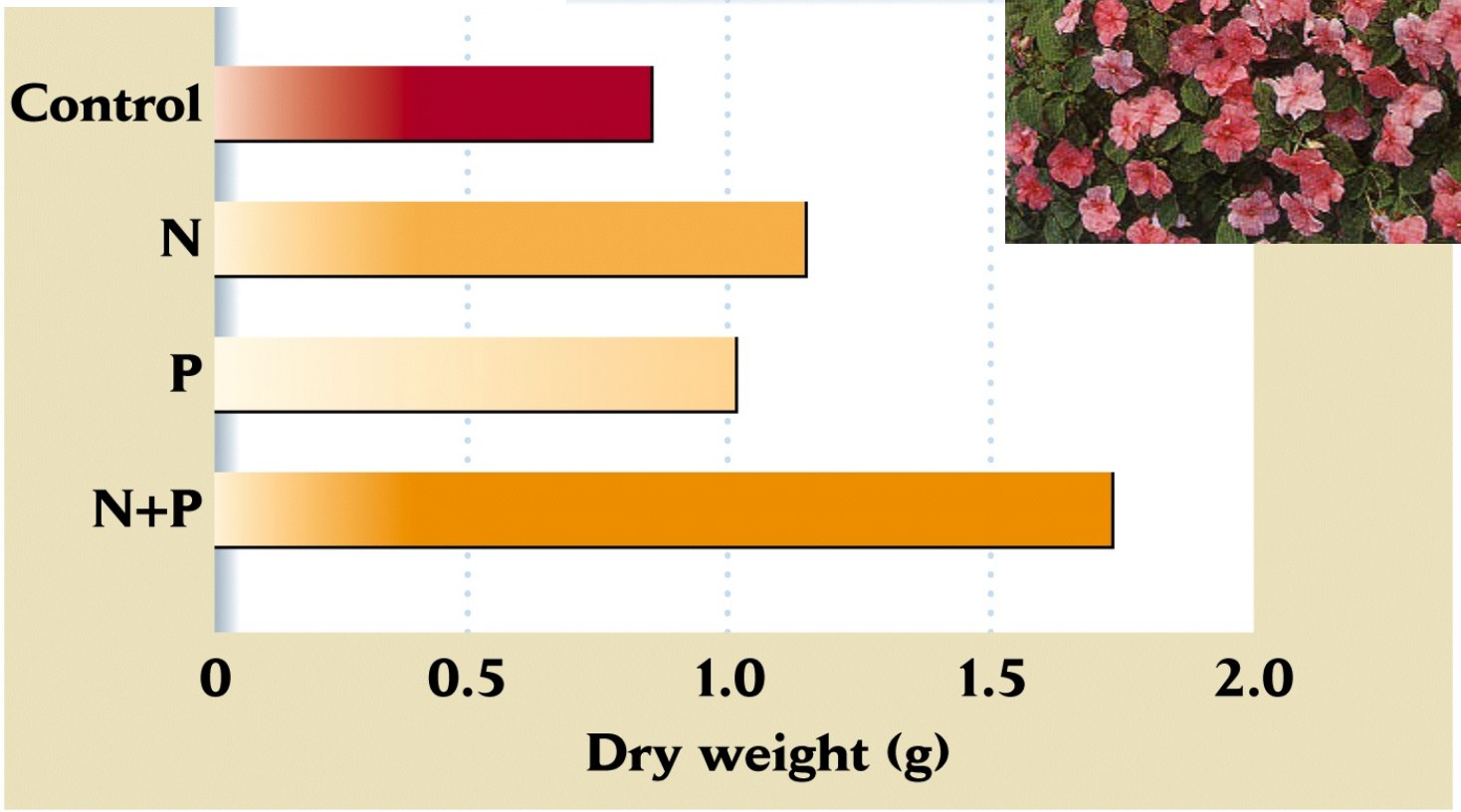
Resources may be limiting



Resources may interact to affect growth (co-limitation)

What kind of experimental design is this?

Impatiens



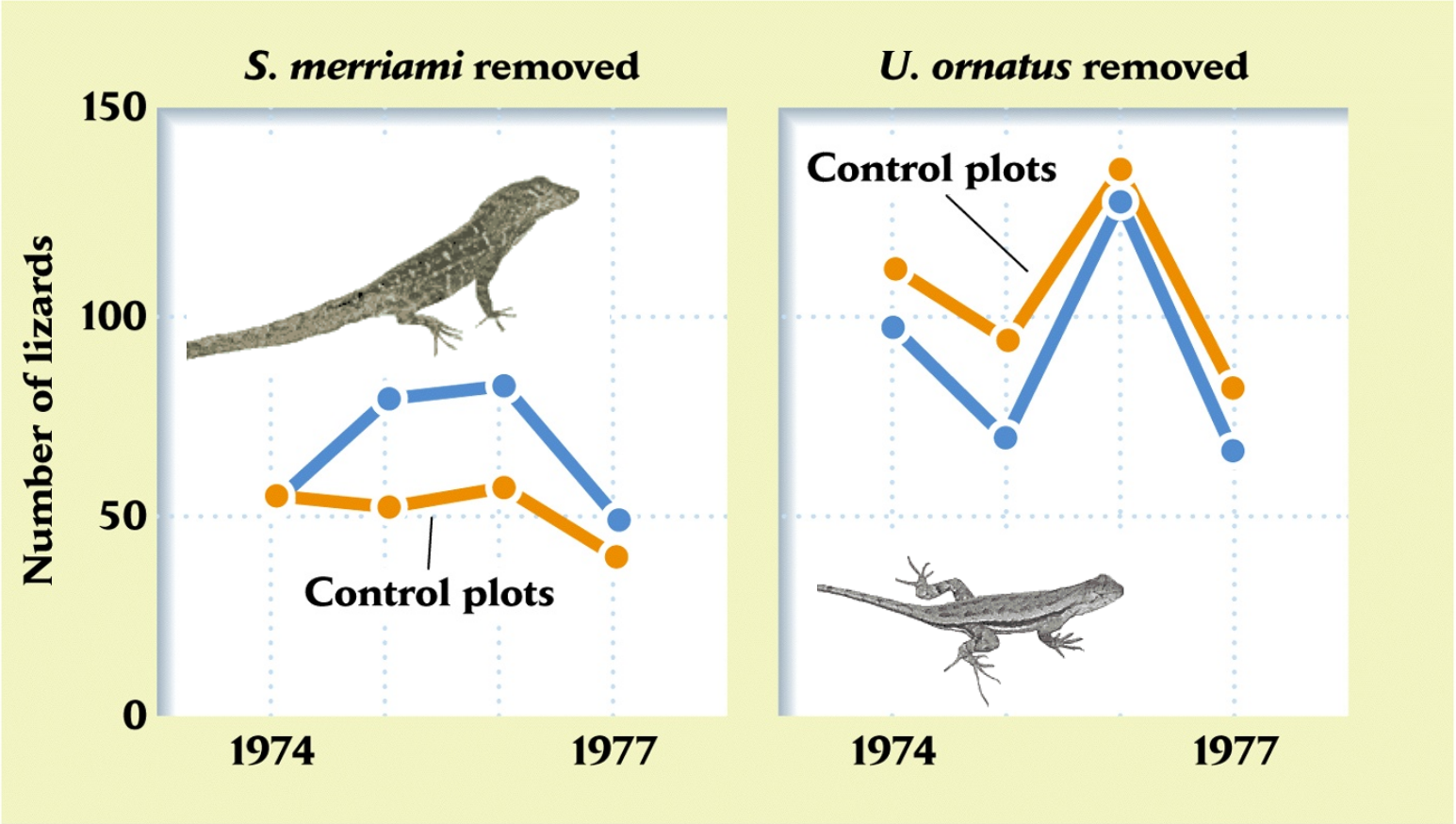
Can competition be un-equal?

Asymmetric competition

U. ornatus

S. merriami

Two lizard species overlap in nature (control), do they compete equally?



Predators and their effects on competition

(a)

(b)

(c)

In-class #3 Next Thursday!

How would you design an experiment to determine:

1) Whether two species were competing with each other?

2) Measure the strength of the competitive effects of each species on the other?

Diet composition of two ant species

Do they compete?

How would you quantify it?

Ant species	% seeds	% insects	% detritus	total
A	50	30	20	100
B	20	30	50	100