Interspecific Interactions

2 Species, Insight Understand Larger Communities

Species 1 & 2

Time-dependent Densities N_1 & N_2

Dynamics:

$$d N_1/dt = F_1(N_1, N_2) N_1$$

$$d N_2/dt = F_2(N_1, N_2) N_2$$

$F_i(N_1, N_2)$: Growth rate *per* individual; i = 1, 2

Suppose Both Species Self-regulate

$$\frac{\partial F_i\left(N_i, N_j\right)}{\partial N_i} < 0; \quad i = 1, 2; \quad i \neq j$$

Intra-specific Competition

Interspecific Effects:

$$\left(\frac{\partial F_1}{\partial N_2}, \quad \frac{\partial F_2}{\partial N_1} \right)$$

(0, 0) Neutralism

(< 0, 0) Amensalism (Sp 2 “polluter’)

(> 0, 0) Commensalism,

(Sp 1 commensal, Sp 2 host)

(< 0, < 0) Interspecific Competition

(> 0, > 0) Mutualism

(> 0, < 0) Consumer-resource, Exploiter-victim

Sp1 predator, Sp 2 prey

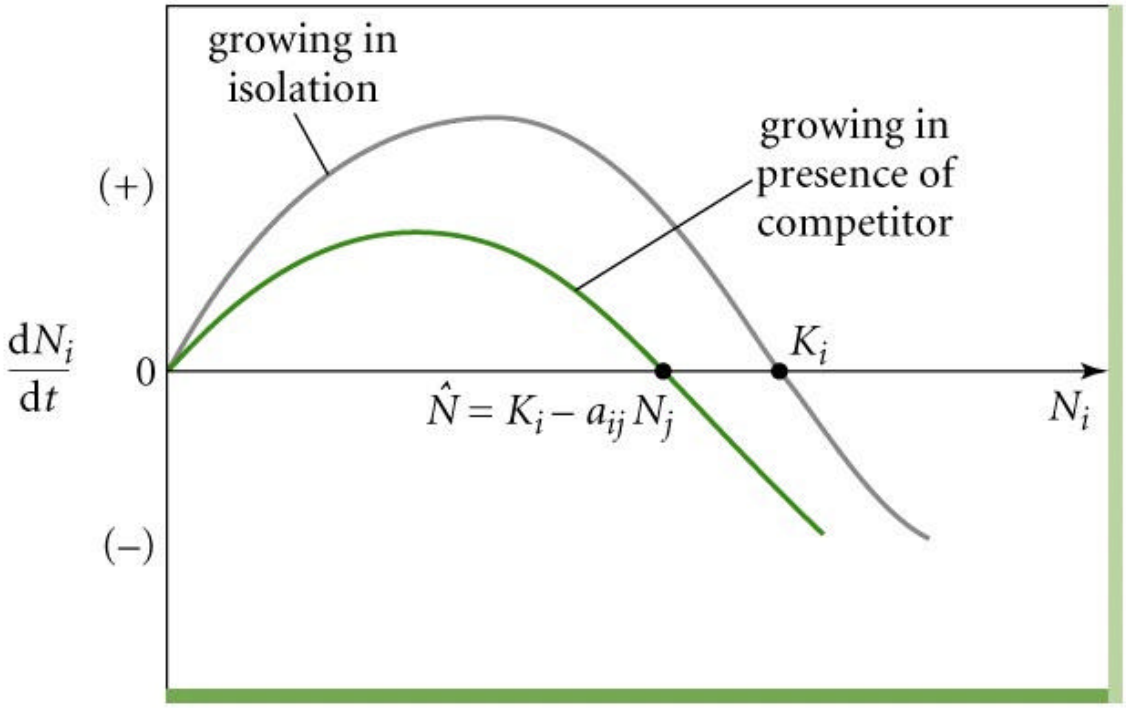
Sp 1 parasite, Sp 2 host

Sp 1 herbivore, Sp 2 plant

Interspecific Competition

Competitive Exclusion or Coexistence?

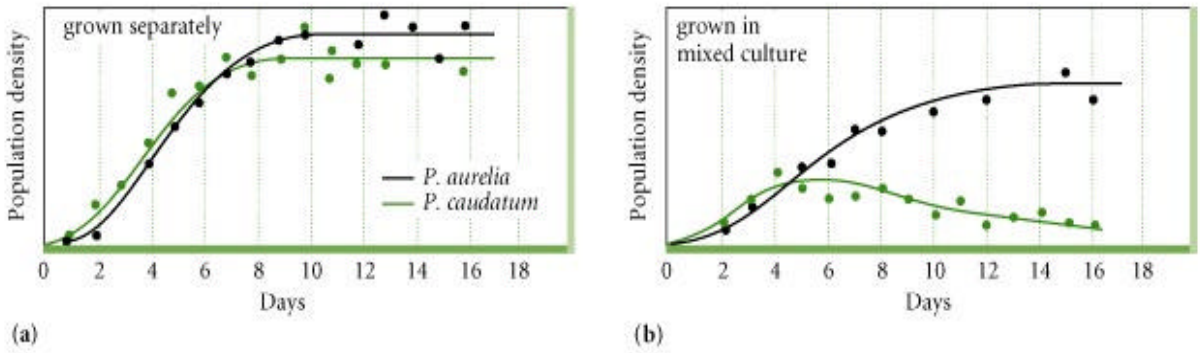
Ricklefs & Miller, 1999



Self-regulation: alone

Self-regulation plus competition together

Gause, 1934 (from Ricklefs & Miller)



Paramecia aurelia (superior competitor)

Paramecia caudatum (inferior competitor)

Predict Outcome of Interspecific Competition:

Competitive Exclusion *vs* Coexistence

Invasibility Analysis:

Invasion – Positive Growth When Rare

Competition: Invasion Analysis

1. Set Sp 1 at Its Carrying Capacity (Alone, Self-regulated)
2. Introduce Small Density of Sp 2
3. Ask If Sp 2 Increases When Rare (Sp 2 *Invades* Sp 1)

   or Declines to Extinction (Sp 1 *Repels* Sp 2)
4. Set Sp 2 at Its Carrying Capacity (Alone, Self-regulated)
5. Introduce Small Density of Sp 1
6. Ask If Sp1 Increases When Rare = Invades Sp 2,

   or Declines to Extinction = Repelled by Sp 2

Invasion Analysis:

Is Equilibrium Where One Sp at its K,

Other Sp Extinct Stable?

Results Discriminate Competitive Exclusion

from Competitive Coexistence

Interspecific Competition and Invasion Analyses

Cases 1 & 2. One species always excludes the other.

Superior Efficiency in Use of Limiting Resource

Case 3. Neither species invades the other.

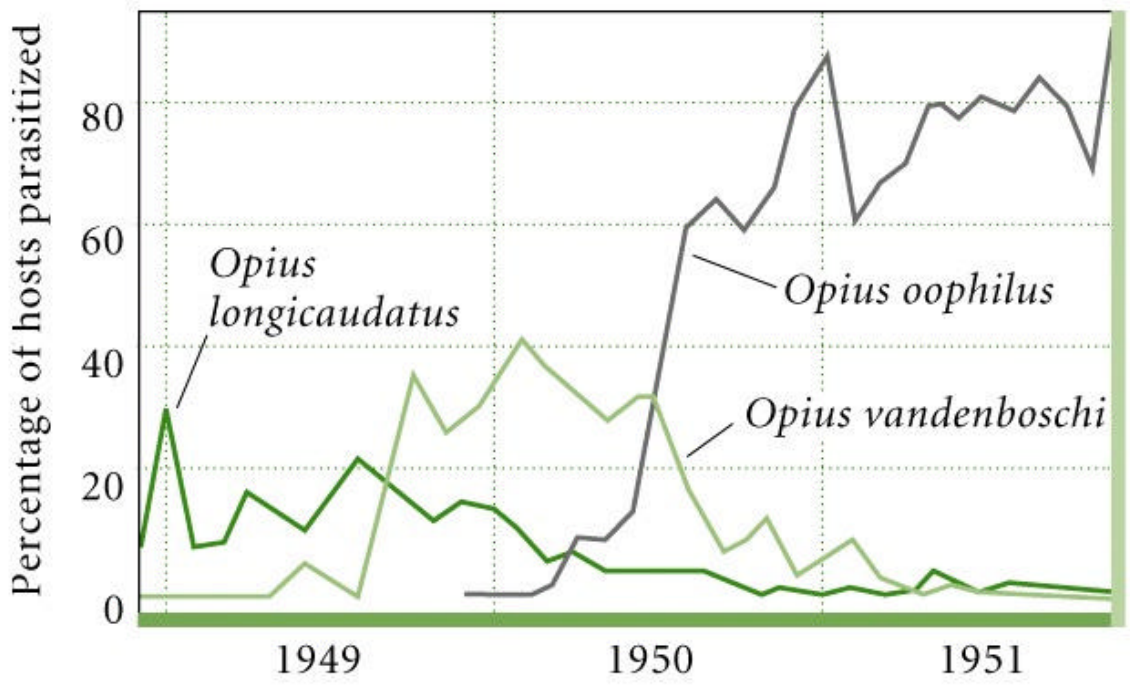
Each species' growth regulated more strongly by interspecific competition than by self-regulation.

Case 4. Each species can invade the other.

Each species' growth more strongly regulated by self-regulation than by interspecific competition.

Stable Coexistence: Strong self-regulation,

Interaction between species not too strong



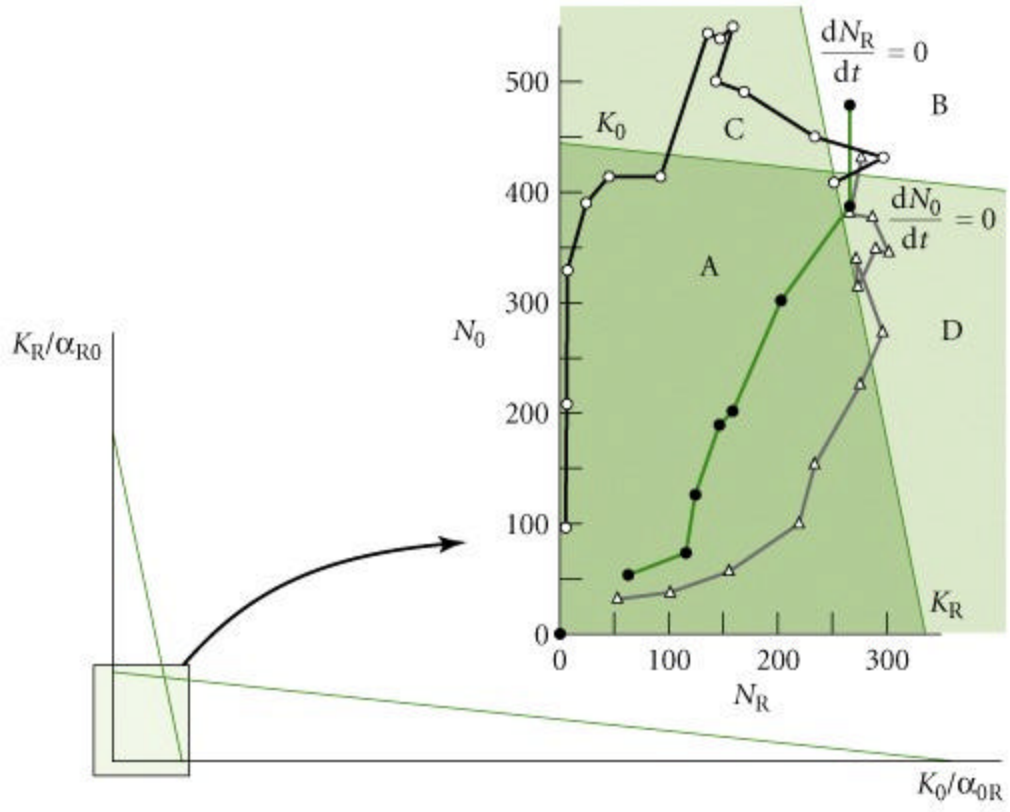
Parasitoids, Attack Fruit Fly Pests (from Rciklefs & Miller)

Successive Invasion by More Efficient Species

Exclusion of Inferior Competitors

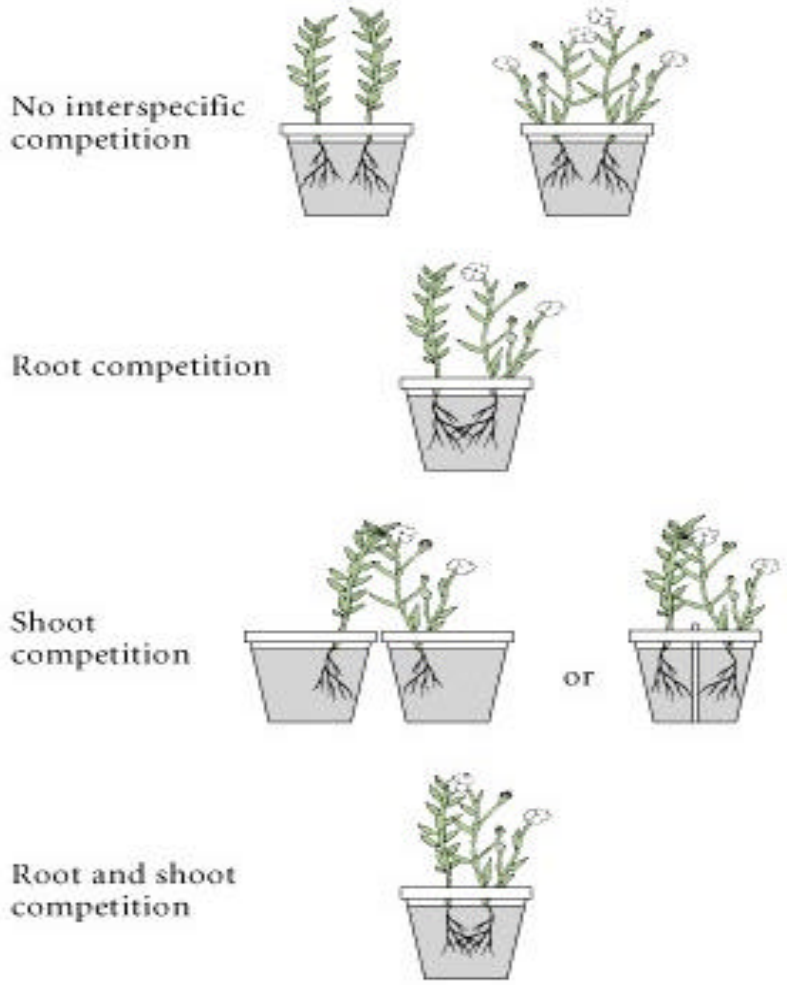
Coexisting Flour Beetles

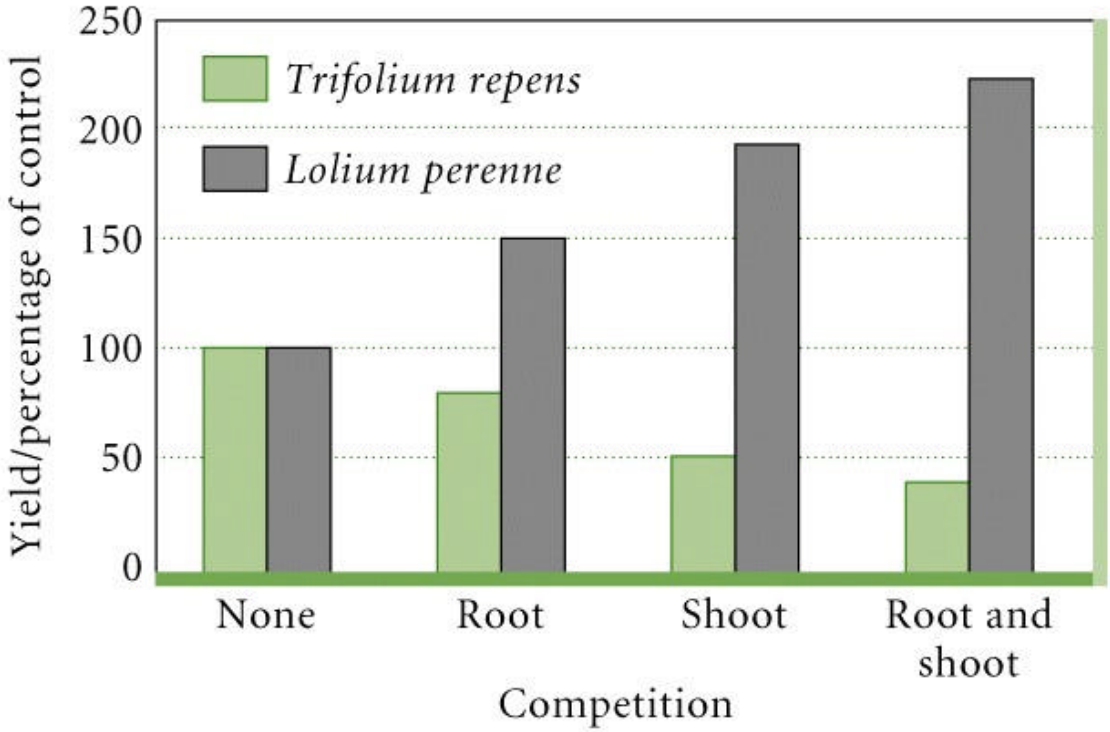
Interior Equilibrium



(from Ricklefs & Miller)

Competition for > 1 Resource





(from Ricklefs & Miler)