Exploitation and competition interact (Park 1948)

In the absence of *Adelina*, *T. castaneum* outcompetes *T. confusum* most of the time. However, in the presence of *Adelina*, *T. confusum* is usually the better competitor.
Predator - prey cycles: lynx and hare

Our old friends

Alfred Lotka

Vito Volterra

Modelling predator - prey cycles

The Lotka-Volterra predator-prey model produces reciprocal oscillations in predator and prey populations.

Rate of prey or host population change... = \frac{dN}{dt} = rN - aNP

Eliminating the time axis reveals an elliptical oscillation in predator and prey numbers.

Host to predator conversion rate Prey or Host Population Growth

Rate of predator or parasite population change... = \frac{dN}{dt} = cPN - dN

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Refuges and the importance of environmental structure
Huffaker (1958)

Huffaker’s results

Simple universe

More complex
Huffaker’s results continued - complex universe

Tray design - barriers

Rosenzweig - MacArthur predator-prey model
Rosenzweig - MacArthur predator-prey model

Prey ZNGI peaks outside Pred ZNGI

Prey ZNGI peaks inside Pred ZNGI

Population of prey \((N_h)\)

Population of predators \((N_p)\)

Stable\(\smiley\)\(\smiley\)

Paradox of enrichment....
Mycorrhizal fungi – one of THE mutualisms
Present in all but a few plant families (92%)
>80% of plant species estimated to house mycorrhizae

AM associations may have originated with the colonization of land. >400 Mya

Arbuscular mycorrhizae  Ectomycorrhizae

Interaction Continuum
Example: Mycorrizae work by Johnson et al. (1993, 1997)
Tripartite Mutualism

Leaf-cutter Ants
Fungus
Streptomyces

Combats Escovopsis

Figure 1: Photograph showing the presence of the third mutualist, Streptomyces, on the outside of Escovopsis.

Figure 3: Research challenge between Streptomyces and Escovopsis, the specialized parasites of entire fungal gardens, associated with Aborinella ochrophanes, illustrating the substantial zone of inhibition of fungal growth.

Animal Pollination – Another one of THE mutualisms
Senita cactus - senita moth
*A pollination-seed predator mutualism*…

Holland and DeAngelis (2002) model of the *Lophocereus-Upiga* mutualism

![Graph showing the model](image)