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Colpidium striatum

Paramecium aurelia

Abstract

- Single species experiments with two species from genera *Colpidium* and *Paramecium*, and analysis of data were completed to estimate growth rates and carrying capacities. The underlying model for each species is a differential equation with logistic growth. Experimental data was used to estimate carrying capacity (K) and growth rate (r) of the two species. Next, the two species were grown in competition; that data was used to determine competition coefficients for the two species. This data will be used in the next phase of the experiment, which is to include a spatial component. We are currently in the process of determining migration rates of the two species; once the rates have been determined experimentally we will begin the next phase. We hope to prove that propagule pressure will affect invasibility of a system that includes migration.

Methods

Experiment 1:

- Monocultures of *Paramecium aurelia* and *Colpidium striatum* Were Grown at Different Initial Densities using a 3 Replicate System.
    - 1 individuals/mL
    - 5 individuals/mL
    - 10 individuals/mL

- Samples of 0.2 mL Were Taken and Organisms Were Counted to Assess Microcosm Density.
- Nutrients Were Then Replenished After Sampling.

Experiment 2:

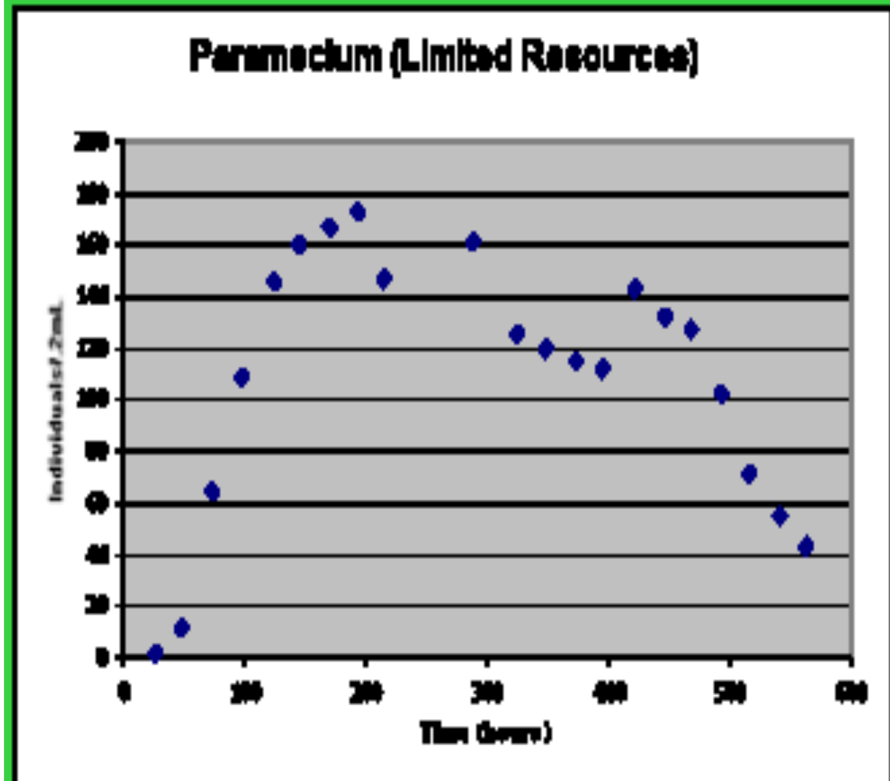
- Cultures of *Paramecium aurelia* and *Colpidium striatum* Were Grown in Competition and in Monoculture Using a Four Replicate System.
    - Initial Concentrations (*Paramecium/Colpidium*)
        - 9/1 individuals per mL
        - 5/5 individuals per mL
        - 1/9 individuals per mL
        - 10/0 individuals per mL
        - 0/10 individuals per mL
- Samples of 0.2 mL Were Taken and Organisms Were Counted to Assess Microcosm Density.
- Nutrients Were Then Replenished After Sampling.

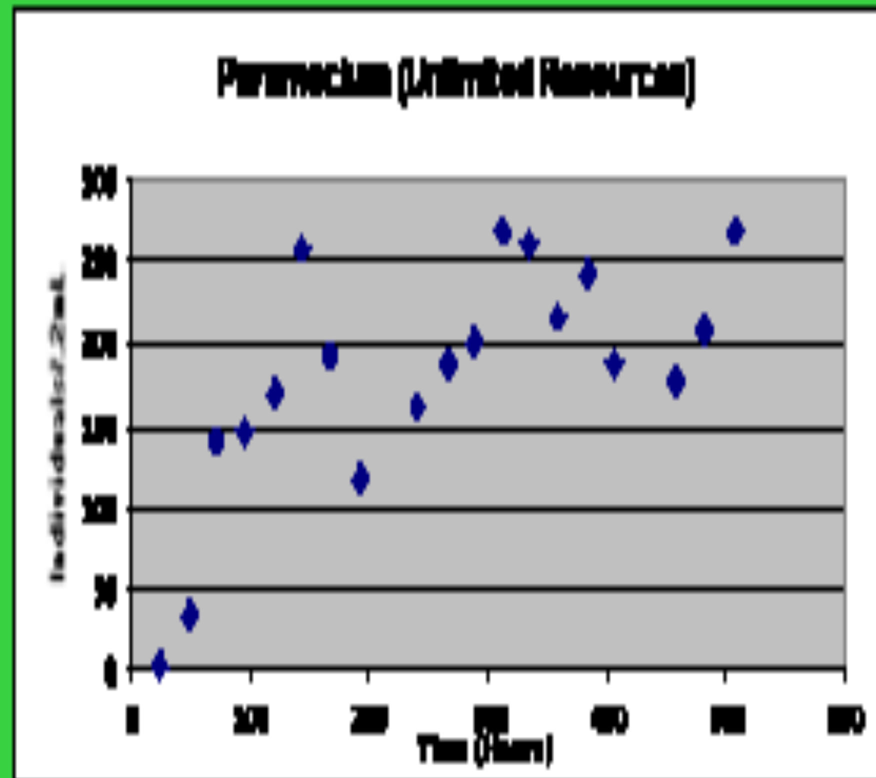
Initial Single Species Experiment

-Instead of following the logistic growth model, the initial paramecium cultures approached extinction after they reached their carrying capacities.

-The bacteria on which these paramecia feed had no replenishing carbon source and in effect became a limited resource. This violates the assumption of unlimited resources which is necessary for logistic growth.

-In later experiments we corrected this problem by introducing a carbon source (wheat seed) to the system. This resulted in a population which follows logistic growth.





-The initial culture has limited resources and approaches extinction after reaching its carrying capacity.

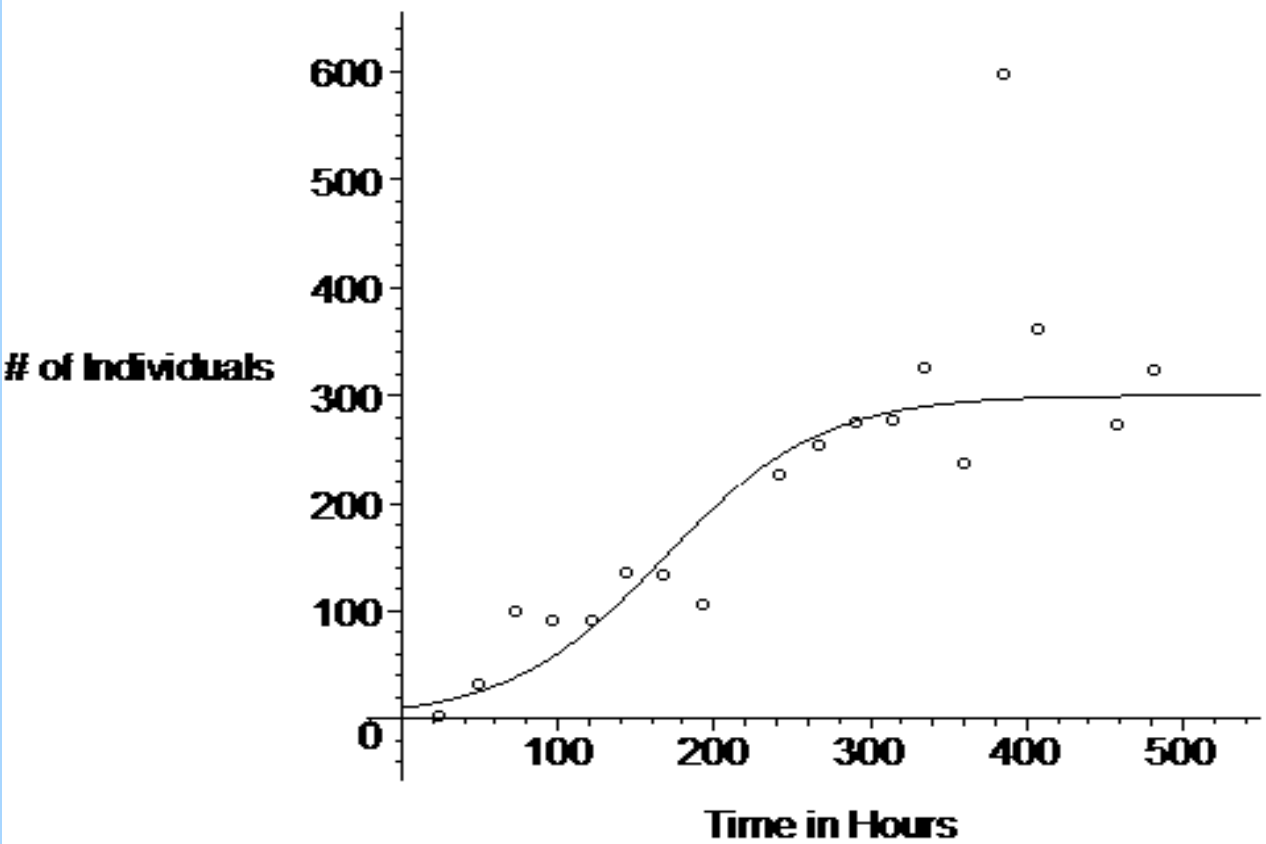
-The culture with the wheat seed has unlimited resources and follows logistic growth. [$dN/dt = rN(1-N/K)$]

Experiment 2: Competition

- *Colpidium striatum* and *Paramecium aurelia* were the two species used throughout the experiments
- Each experiment assumed logistic growth, and used a multiple replicate system to reduce error
- Individual populations of both species were grown to determine Growth Rate (r) and Carrying Capacity (K)
- A competition experiment was designed and the data used to create Ordinary Differential Equation (ODE) models of growth
- The ODEs were then used to estimate the competition coefficients (alpha and beta) between the two species

Competition Experiment

Colpidium Monoculture



Estimated r = 0.02

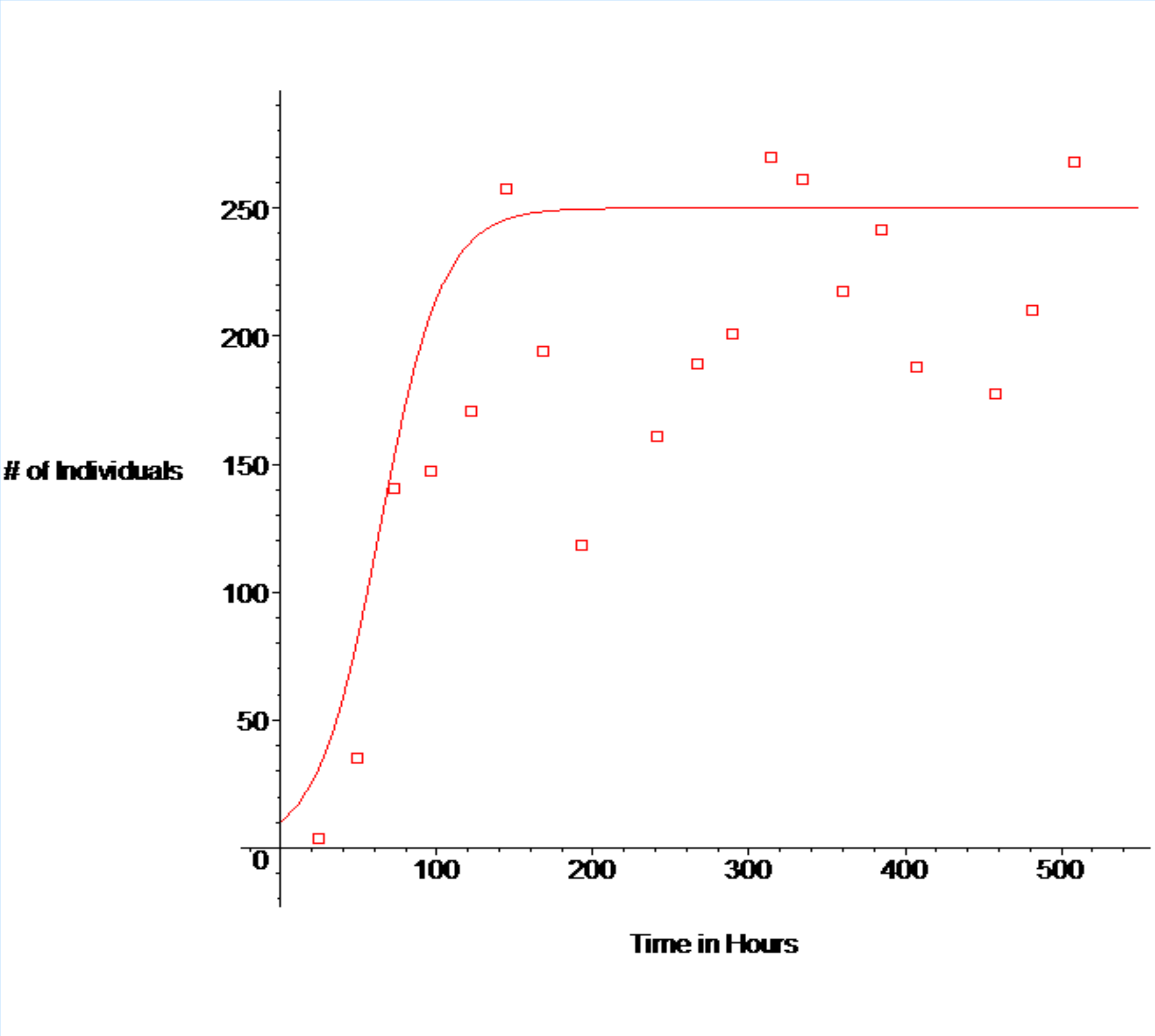
Estimated K = 300

# of Individuals =

$$\frac{300}{1+\ 29\,\tilde{a}^{-0.02t}}$$

Competition Experiment

Paramecium Monoculture



Estimated r = 0.05

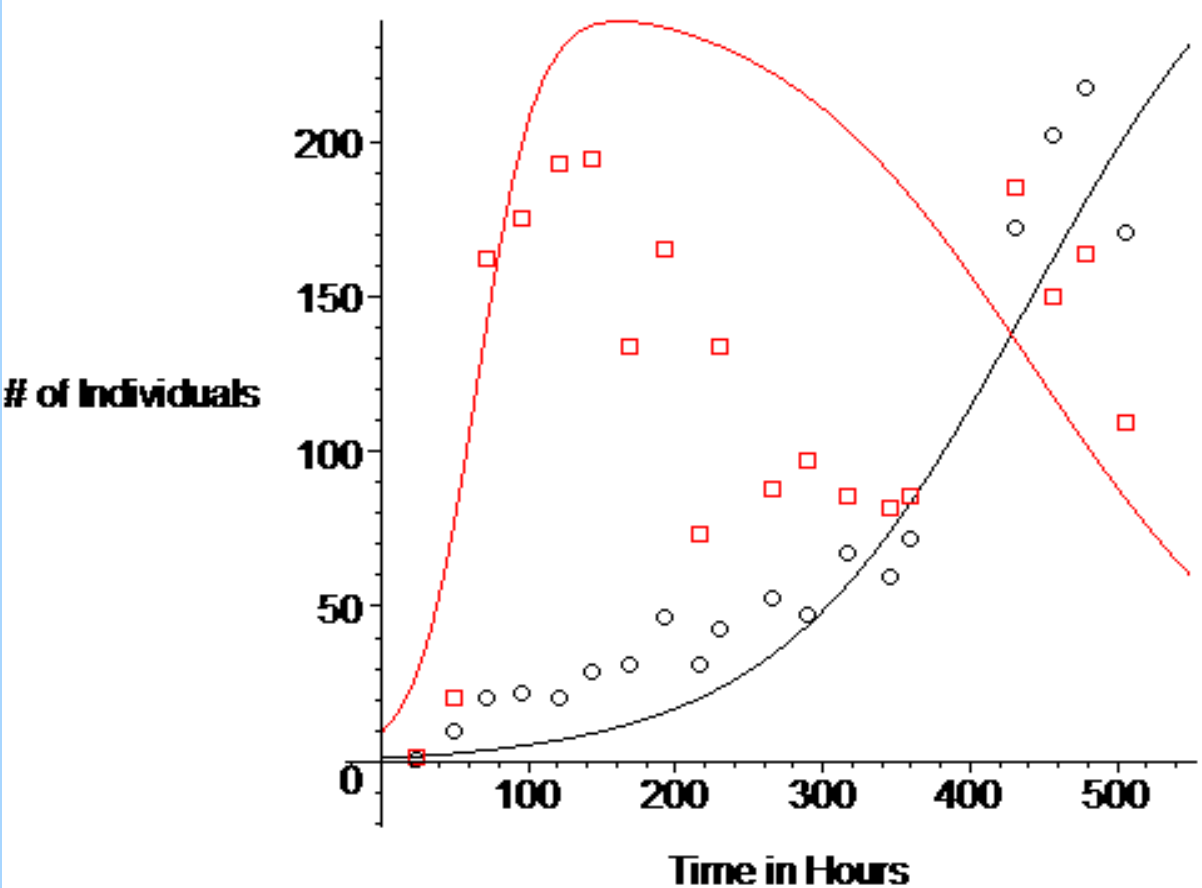
Estimated K = 250

# of Individuals =

$$\frac{250}{1 + 24\,\tilde{a}^{-0.05t}}$$

Competition Experiment

Colpidium (1) – Paramecium (9)



Estimated r (Paramecium): 0.05

Estimated K (Paramecium): 250

Estimated r (Colpidium): 0.02

Estimated K (Colpidium): 300

Red = Paramecium

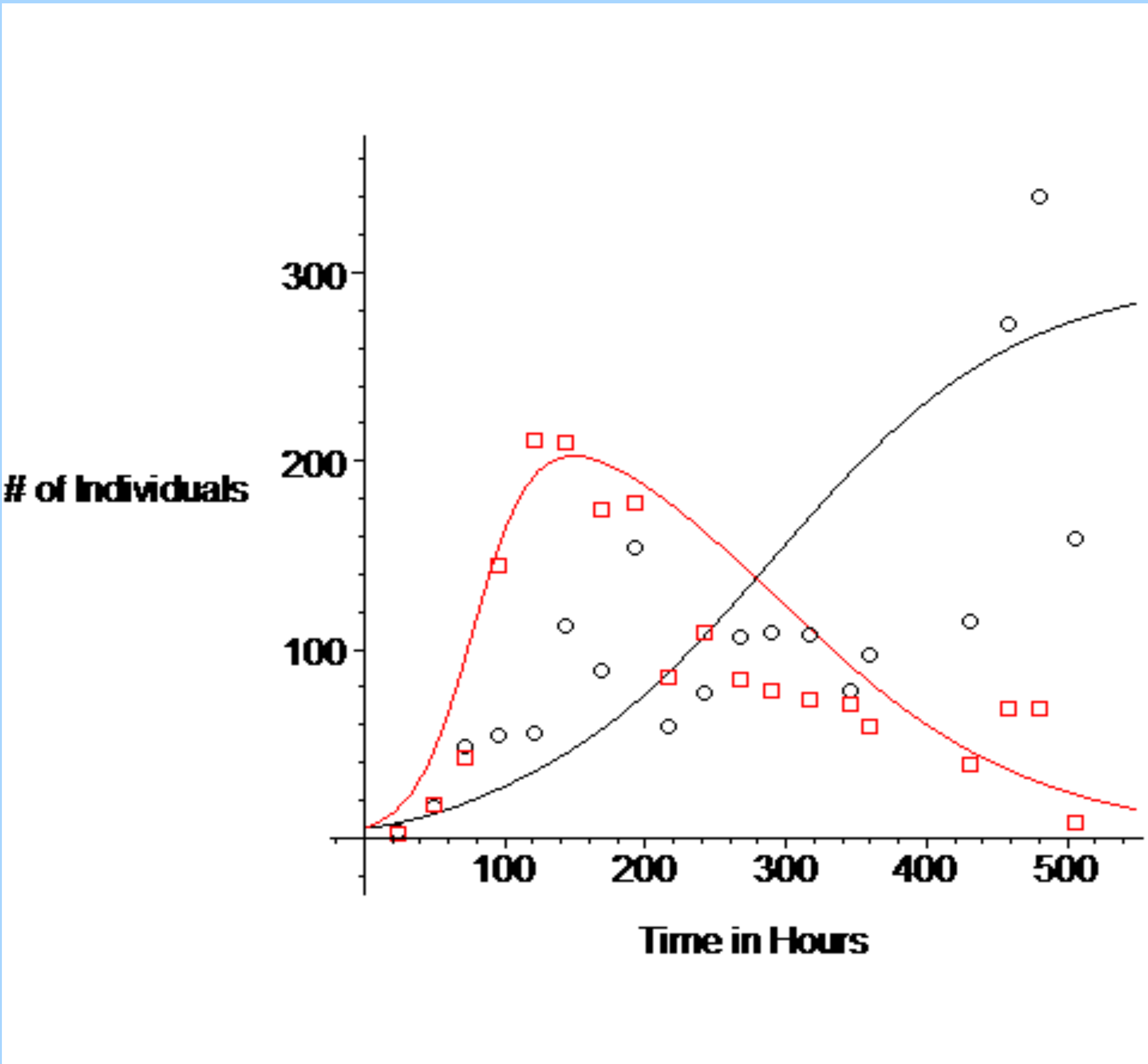
Black = Colpidium

$$\frac{dP}{dt} = 0.05\,P\;t\;\;1 - \frac{P\;t - C\;t}{250}$$

$$\frac{dC}{dt} = 0.02\,C\;t\;\;1 - \frac{300C\;t - 0.5P\;t}{300}$$

Competition Experiment

Colpidium (5) – Paramecium (5)



Estimated r (Paramecium): 0.05

Estimated K (Paramecium): 250

Estimated r (Colpidium): 0.02

Estimated K (Colpidium): 300

Red = Paramecium

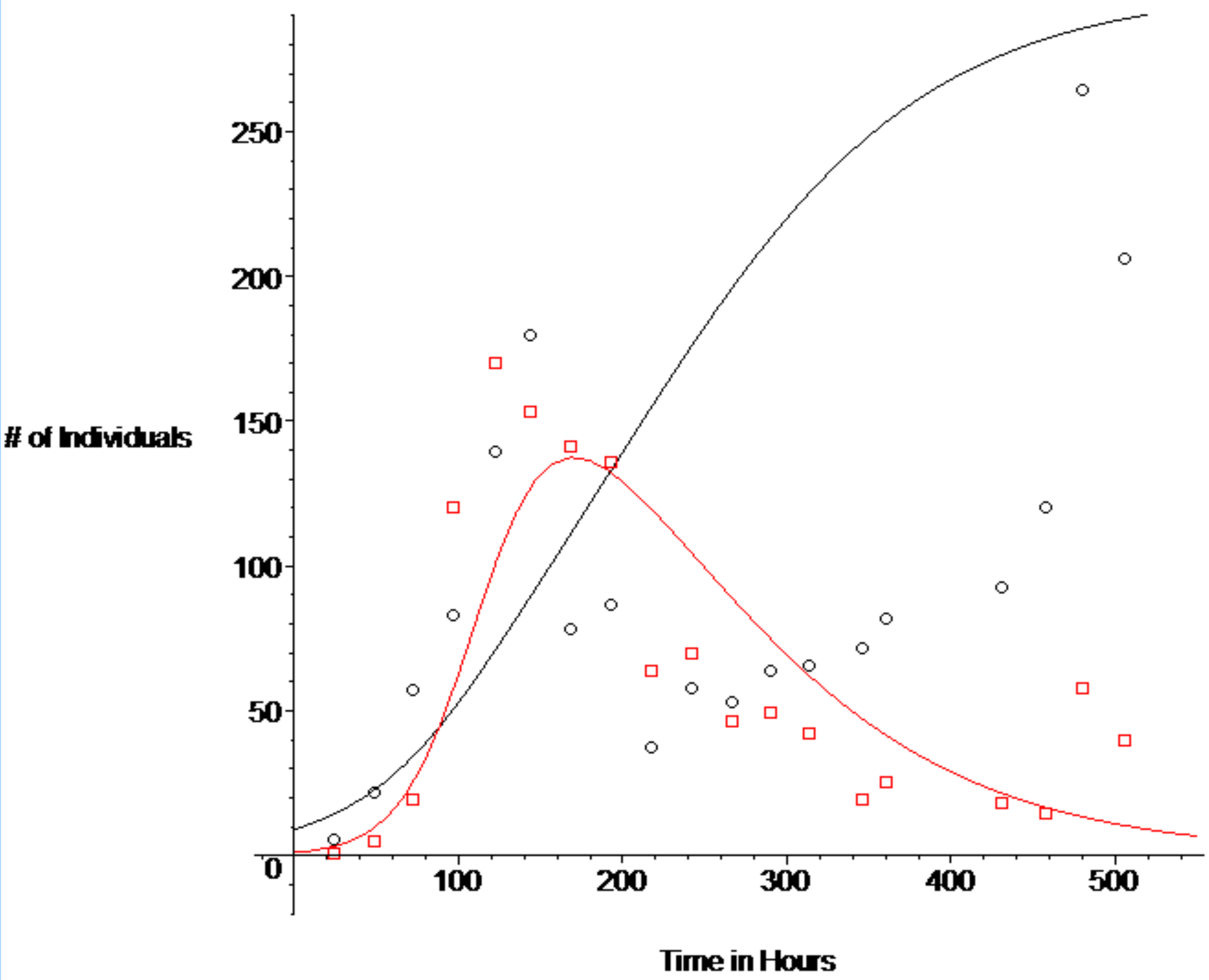
Black = Colpidium

$$\frac{dP}{dt} = 0.05\,P\,t \quad 1 - \frac{P\ t\ -\ C\ t}{250}$$

$$\frac{dC}{dt} = 0.02\,C\,t \quad 1 - \frac{300C\ t\ -\ 0.5P\ t}{300}$$

Competition Experiment

Colpidium (9) – Paramecium (1)



Estimated r (Paramecium): 0.05

Estimated K (Paramecium): 250

Estimated r (Colpidium): 0.02

Estimated K (Colpidium): 300

Red = Paramecium

Black = Colpidium

$$\frac{dP}{dt} = 0.05\,P\,t \quad 1 - \frac{P\ t - C\ t}{250}$$

$$\frac{dC}{dt} = 0.02\,C\,t \quad 1 - \frac{300C\ t - 0.5P\ t}{300}$$

Results / Conclusions

- It appears that *Colpidium* use resources more efficiently than *Paramecium*.
- The two earlier graphs (in green) show that when resources are not held relatively constant, the *Paramecium* tend to die out, whereas they do not under the constant resource condition.
- This effect was not observed under the same time scale for *Colpidium*.

- Initial populations of *Colpidium* and *Paramecium* showed *Paramecium* with the higher growth rate (r), and *Colpidium* with the higher carrying capacity (K).
- Based on those parameters, and assuming logistic growth, a model was created using competition coefficients of 1.0 for *Colpidium* and 0.5 for *Paramecium*.
- The model and experiments confirm that *Colpidium* should always out-compete *Paramecium*, regardless of starting densities.
- Biological data showed that initial densities could create a delay in the rise of *Colpidium,* but could not prevent the eventual decline of *Paramecium*.
- This work builds the basis for our invasibility model.