10-28-10

- Interspecific competition shows (-/-) interaction with two species at a time.
  - There is a classic old experiment by Gause.
    - In 1934, he experimented with Paramecium.
    - In 1928, he experimented with yeast, specifically two species saccharomyces(1) and schitosaccharomyces (2). The experimental design allowed both to grow alone (allopatry), and grow both together (sympatry). The results were then compared and contrasted. How are they similar? How are they different? *Reference Figure 1* for further illustration of this.
- When comparing similarities, intraspecies comparison showed both species follow logistic population growth, alone and together.
- When contrasting similarities, interspecific competition showed Saccharomyces had a higher k than schitosaccharomyces. Each species has a lower K in sympatry than in allopatry.
  - Each species has a lower dN/dt, slope of N vs. t curve, in sympatry than allopatry.
- So when building the logistic model, and on Gause's data, Lotka and Volterra came up with competition equations for each species.
  - Species 1:

$$\frac{dN}{dt} = r_1 N_1 \left[\frac{K_1 - N_2 - \alpha_{1,2} N_2}{K_1}\right]$$

  - Species 2:

$$\frac{dN_2}{dt} = r_2 N_2 \left[\frac{K_1 - N_2 - \alpha_{2,1} N_1}{K_2}\right]$$

- Alpha refers to the interspecific competition coefficient, which measures the effect of species j on species i.
- dN/dt refers to the instantaneous slope, N versus t curve, where N is the population density, K is the carry capacity, r is the population growth rate without density dependence. Refer to *Figure 2* for further illustration.
  - On the graph, as $N_2$ increases, effective $K_1$ decreases, where effective $K_1 = K_1 - \alpha_{1,2}N_2$

- Species 1 has a similar effect on species 2, at the same time.
- What are the possible outcomes of the L-V model?
  - We would see stable coexistence.
  - One species, a superior competitor, always wins. The most common result in lab studies of interspecies competition.
  - Unstable coexistence, where the species that wins is random.
- Two species of Paramecium are P. Aurelia(1) and P. caudatum(2). Refer to *Figure 3* for further illustration.
  - Looking at the graphs, you will see that P. Aurelia wins, eventually goes to $K_1$, but doesn't get there until P. caudatum is extinct.
  - When alone, each species has logistic population growth.
  - When together, each depresses the others dN/dt.

- Species 1 achieves $N_1=K_1$.
- Species 2 achieves $N_2=0$.

- How do we track both species dynamics simultaneously, and figure out whether we get stable coexistence, one species always winning, or whatever?
  - Solve experiment one data for model parameters; use a graphical approach. Refer to *Figure 4* for further illustration.

11-2-10

- Looking at the Lotka Volterra Competition model, you may wonder how you look for stability. Coexistence, or one species winning, and the other going extinct represent this.
- We make use of the fact that in the logistic model, at K, dN/dt is equal to zero.
  - Looking at *Figure 5* , you will see a graph indicating the portion that is equal to zero. Under the graph, Sargent shows the derivation of the equation for the effective K when the slope is equal to zero.
  - The final equation $N_1 = K_1 - \alpha_{1,2}N_2$ is a straight line with the $N_1$ intercept equal to K and the slope $-\alpha_{1,2.}$ *Figure 6* illustrates this for species one and species 2.
  - To see what the two species do together, plot both isoclines on the same graph, do the vector addition of $N_1$ and $N_2$, and then see what happens. The two possibilities will be that the isoclines doesn't cross or that it does cross.

- *Figure 7* illustrates two graphs where the isoclines do not cross. If isoclines don't cross, whichever species isoclines is furthest from the origin (0,0) will go to its K, and the other goes locally extinct.
- However, if isoclines do cross, there is coexistence, which may be stable or unstable. *Figure 8* shows two graphs. One to illustrate stable coexistence and the other represent unstable coexistence. An example in nature of species coexistence could refer to two species of grain beetle larvae. One eats a bean from the outside in, while the other eats it from the inside out. This resulted in stable coexistence. Sargent mentioned no examples in nature of unstable coexistence.

- How do I know from looking at crossing isoclines if coexistence is stable or not?
  - Do the vector additions and see. Remember the relative sizes of intercepts on the two axes.
    - If $K_1 < \frac{K_2}{\alpha_{2,1}}$ and $K_2 < \frac{K_1}{\alpha_{1,2}}$ then it is stable.
- Interspecific competition is less than intraspecific competition. Each species is more limited by itself than by other species. Thus, they don't share too many resources.
  - If $\alpha_{1,2}\alpha_{2,1} > 1$ then coexistence is unstable. The reverse is true as well.

# FIGURES STILL TO COME