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EEB 200B

Predator-prey interactions — Assignment 1

1. Consider the following version of the Lotka-Volterra predator-prey model with self-limitation in the prey:

$$\begin{aligned} \frac{dR}{dt} &= rR(1-\alpha_R R) - aRC \\ \frac{dC}{dt} &= eaRC - dC \end{aligned} \tag{1}$$

where α_R is the intra-specific competition coefficient of the prey species.

(i) Solve for all equilibria of the model.

(ii) Construct the Jacobian matrix and evaluate it at the coexistence equilibrium. Use Routh-Hurwitz criteria to evaluate the stability of the coexistence equilibrium. Under what conditions is the coexistence equilibrium stable?

(iii) Based on your analysis, what can you say about the effect(s) of a prey self-limitation on predator-prey oscillations?

2. Consider the following version of the Lotka-Volterra predator-prey model that contains a Type II functional response for the predator:

$$\begin{aligned} \frac{dR}{dt} &= rR - \frac{aRC}{1+ahR} \\ \frac{dC}{dt} &= \frac{eaRC}{1+ahR} - dC \end{aligned} \tag{2}$$

where h is the handling time of the predator.

(i) Solve for all equilibria of the model.

(ii) Construct the Jacobian matrix and evaluate it at the coexistence equilibrium. Show algebraically that $J_{22} = 0$. What does $J_{22} = 0$ signify biologically?

(iii) Use Routh-Hurwitz criteria to evaluate the stability of the coexistence equilibrium. Under what conditions is the coexistence equilibrium stable?

(iv) Based on your analysis, what can you say about the effect(s) of a Type II functional response on predator-prey oscillations?

3. Consider the paradox of enrichment model:

$$\begin{aligned}\frac{dR}{dt} &= rR(1-\alpha_R R) - \frac{aRC}{1+ahR} \\ \frac{dC}{dt} &= \frac{eaRC}{1+ahR} - dC.\end{aligned} \tag{3}$$

(i) Solve for all equilibria of the model.

(ii) Use the expression for the resource species' per capita growth rate to illustrate how the balance between negative and positive feedback dampens or amplifies consumer-resource oscillations.