パッチ状環境における食物連鎖
Food Chains in a Patchy Environment

難波　利幸・山下　典子（大阪女子大・理・環境理）

Toshiyuki Namba* and Noriko Yamashita
Osaka Women's University, Department of Environmental Sciences
*email: tnamba@center.osaka-wu.ac.jp

We assume a patchy environment with two different patches and consider the following three–trophic–level food chain model with interactions of the Lotka–Volterra type:

$$\frac{dP_i}{dt} = \left\{ r_i \left(1 - \frac{P_i}{K_i} \right) - a_h H_i \right\} P_i - d_p (P_i - P_j), \tag{1}$$

$$\frac{dH_i}{dt} = (-m_{hi} + b_h a_h P_i - a_c C_i) H_i - d_h (H_i - H_j), \tag{2}$$

$$\frac{dC_i}{dt} = (-m_{ci} + b_c a_c H_i) C_i - d_c (C_i - C_j). \tag{3}$$

where P_i, H_i, and C_i are the population densities of plant, herbivore and carnivore in the $i-$th patch ($i, j = 1, 2$, and $i \neq j$). r_i and K_i are the patch–specific intrinsic growth rate and carrying capacity of the plant. m_{hi} amd m_{ci} are the patch–specific mortality rates of the herbivore and carnivore. a_h and a_c are the predation rates by the herbivore and carnivore, and b_h and b_c are the conversion efficiencies of the herbivore and carnivore. d_p, d_h and d_c are the dispersal rates and we have assumed the diffusive dispersal of the plant, herbivore and carnivore.

We will show, by numerically solving equilibria and calculating eigenvalues of the Jacobian matrix, that the system may be persistent even if the local patches can only sustain chains with one or two trophic levels in the absense of dispersal. We also discuss the effects of magnitudes of the dispersal rates.

Our results suggest that the food chain length in a community may be highly dependent on spatial structure of the habitat, and that several poor patches can support a long food chain if the rates of dispersal among patches satisfy some appropriate relations.