Mutualism and Competition between two kinds of scale eaters

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So far, it is thought that competition and mutualism are entirely different. In the present paper, however, we deal with a virtual ecosystem composed of two species scale eaters, and find that the relationship between both species is represented by competition in certain cases and by mutualism in other cases. Spatial distribution of species is self-organized into a specific pattern of either competition or mutualism.

Consider a square lattice consisting of two species R and L. Each lattice site is labeled by R, L, or O, where R (or L) is the site occupied by scale-eater of R (or L) type. And O represents the vacant site. The site of R (or L) may become O by death process, where D_R and D_L are the death rates of species R and L, respectively. These values are assumed to be constants, and they never change throughout the simulation. On the other hand, the birth process is defined by

$$\mathrm{O} \xrightarrow{B_R} 2\mathrm{R}, \quad \mathrm{O} \xrightarrow{B_L} 2\mathrm{L} \tag{1}$$

where B_R (B_L) is the birth rate of species R (L).The birth rates should be determined by local densities of R and L. We assume that B_j increases with the increase of both N_R and N_L where j =R, L, and N_j is a local density of specie j . If a single species R or L goes extinct, then our model becomes the contact process (CP) which has been extensively studied from mathematical and physical aspects. We apply a lattice Lotka-Volterra model which is an extension of CP.

We carry out birth and death processes by computer simulation. It is found that the densities of both species reach stationary values. In Fig.1, a typical example of steady-state densities are plotted against the death rate of R. This figure shows both competition (small values of D_R) and mutualism (large values of D_R). Moreover, we find that spatial distribution of species is self-organized into a specific pattern of either competition or mutualism.

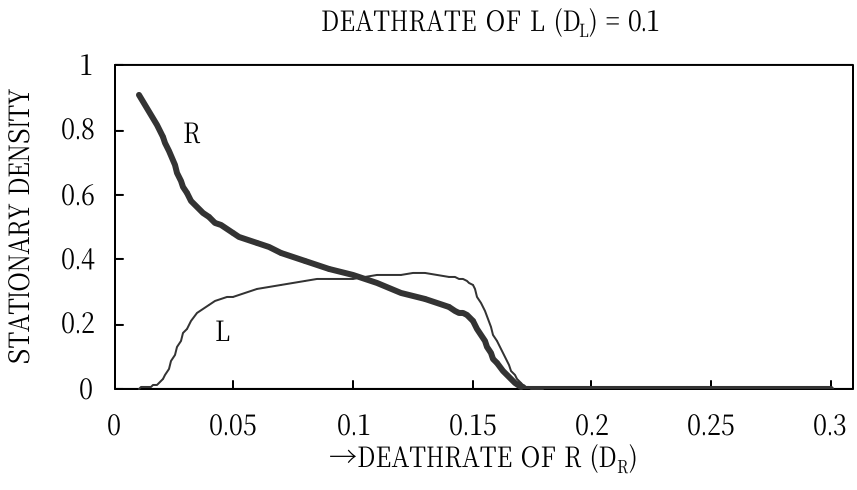

Fig1: The steady-state densities are plotted against the death rate (D_R) of species R, where we put D_L =0.05.