ミュラー擬態によって競争種の死亡率が相互減少する。

Mutual reduction of mortality in competing species by Müllerian mimicry

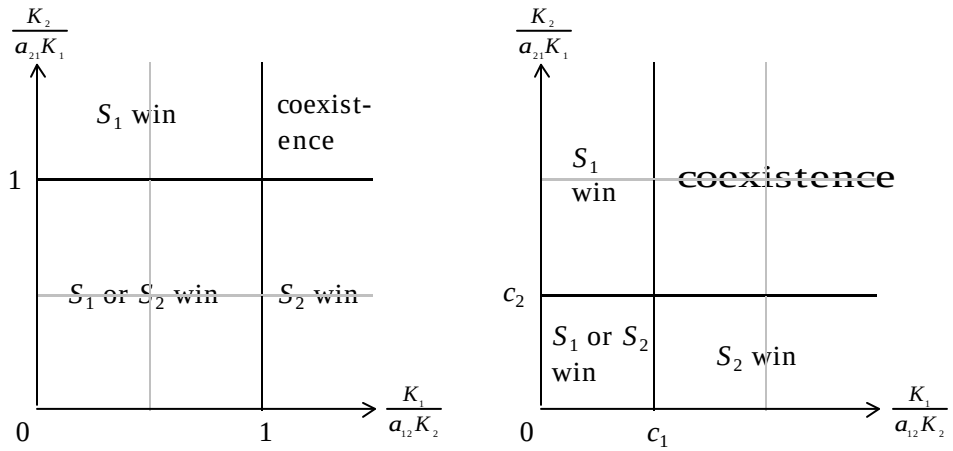
Yamamoto T., Kashima Y. and Yoshimura J.

Department of Systems Engineering, Shizuoka University.

Heliconius butterflies in Central to South America is well-known for their Müllerian mimicry. Recently spatial patterns of Müllerian mimicry are analyzed using spatial population models. However, a simple population dynamics of such mimicry in a single location is not explored yet. Here we develop a general population dynamics model of two competing species S_1, S_2 (populations N_1, N_2):

$$\frac{dN_i}{dt} = (b_i - m_i h_i)N_i \qquad \begin{cases} b_i = b_{i0} - (b_{i0} - b_{ik})(N_i + a_{ij}N_j)/K_i \\ m_i = m_{i0} + (m_{ik} - m_{i0})(N_i + a_{ij}N_j)/K_i \\ h_i = N_i/(N_i + s \cdot N_j) \end{cases}$$

where b_i, m_i represent birth and mortality rates of species S_i without mimicry, respecitively. (b_{i0}, m_{i0} are intrinsic, and b_{ik}, m_{ik} are at the carrying capacity K_i). Note that $b_{i0} \geqq b_{ik} = m_{ik} \geqq m_{i0}$. Let h_i denote the reduction factor in S_i -mortality rate, and s the degree of similarity of two species by Müllerian mimicry ($0 \leqq s \leqq 1$). And α_{ij} is the resource-competition coefficient ($i,j \in \{1,2\}$, $i \neq j$). The current model is compared with the traditional Lotka-Volterra model of pure resource competition by changing s. Interestingly, the analytical solution of phase planes indicates nonlinearity in their zero-growth isoclines, unlike those of Lotka-Volterra competition equations (s=0). The results show the increase of coexistence in the parameter space (Fig. 1). In the two measures of parameter space, the coexistence area increases by shifting their boundaries from 1 (Fig. 1a) to c_i (Fig. 1b), where c_i is a constant calculated from the birthrate parameters, $0 < c_i = (b_{i0} - b_{ik})/b_{i0} < 1$. Here the parameter s is independent from the boundaries constants c_i. Thus the coexsitence is promoted as is expected.



(a) s=0 (b) 0<s≦1

Fig. 1