Mechanism of species coexistence with space-limited demographic process.

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In coral communities, we can find the distinct differences in the composition of morphological types. For example, branching corals dominated the protected site, whilst tabular corals were abundant at the exposed site. We formulate a simple model for the dynamics of coverage of the two morphotypes in order to understand the demographic processes, larval settlement, growth, and death, which form and maintain the observed patterns.

The model incorporates the space-limited recruitment and the space-limited growth. The larval settlement rate is proportional to the amount of vacant space in the local habitat and to the abundance of larvae in the water column. The growth rate of colony size (coverage area) increases with the size and with the fraction of vacant space. The coverage X_i of type *i* in a local habitat are

$$\frac{dX_i}{dt} = x_i^0 s_i L_i F + g_i \frac{F}{A} X_i - u_i X_i, \qquad (i = 1, 2),$$

where x_i^0 is the size of newly settled adult; L_i, the abundance of larvae; s_i, the efficiency of larval settlement; g_i, the maximum growth rate; and u_i, the mortality. F, is the amount of free space: $F = A - X_1 - X_2$. The initial condition is assumed to be zero ($F = A$).

The result of the model show that the trajectory of coverage has three phases if mortality is low. [1] In the beginning, the relative abundance of the two types is controlled by the ratio of the larval settlement. [2] When the vacant space becomes occupied, both settlement of larvae and growth of settled colonies affect the dynamics of coverage. [3] After free space is depleted, both larval settlement and growth become very small. Now the slow process of colony death comes to have an influence and causes the final convergence to the equilibrium composition. We also analyzed other cases in which one of the three demographic process was rather smaller than the others.