**Parameters used in our model:**

|  |  |
| --- | --- |
| Term | Parameter value |
| Chemostat dilution rate |  |
| Constant growth coefficient |  |
| Siderophore-iron association constant |  |
| Siderophore-iron disassociation constant |  |
| Supplied iron concentration |  |
| Number of species |  |
| Number of siderophores |  |
| Resource budget (local community) |  |
| Resource budget (invader) |  |

**Resource competition model on iron competition:**

Each microbe can produce siderophores of type with resource budget , and obtain iron by absorbing siderophore-iron complexes through corresponding receptors (fraction of receptors denoted as ). Growth rate is proportional to the total amount of absorbed iron-siderophore complex () and the fraction of resources allocated to primary metabolism, ,

where d is the dilution rate of the chemostat. The production of siderophore of type j () and uptake of siderophore-iron complex of type j () are characterized as follows. The transformation process between the siderophore and its associated siderophore-iron complex is elucidated in accordance with the law of mass action,

where and represent the binding and dissociation rate constants for the formation of the iron-siderophore complex, respectively, and is the coefficient representing siderophore production. And the concentration of iron in the chemostat is shown as following,

where represents the concentration of iron in the fresh medium flowing into the chemostat. Various species with distinct strategies are considered, including single-receptor producers, multi-receptor producers, and non-producers, differing in their and values. The resource budget parameters take random values between 0 and 1. For single-receptor producers, the fraction of receptors for self-receptors (the receptor intaking the siderophore produced by the species itself) is 1. For multi-receptor producers, we assign the for self-receptors a constant value 0.2 and remaining receptors (the receptors for other siderophores produced by other strains) take random values that sum to 0.8. For non-producers, take random value that sum to 1.

Species assemble into communities, with diverse initial inoculation densities (random values between 0 and 1). They then compete in a chemostat-like model until reaching a steady state.

**Simulation of a Community Composed Exclusively of a Single Strategic Type:**

Communities comprising 20 species and producing 10 types of siderophores, each characterized by a singular strategic approach—namely, single-receptor producers, multi-receptor producers, and non-producers—are systematically simulated until a steady state is reached. Upon achieving this equilibrium, the number of species that persist is recorded and analyzed. This process facilitates a comprehensive examination of the community's diversity, highlighting the impact of different siderophore strategies on species composition and stability.

**Simulation of an invasion event within a community:**

Local communities, each comprising 19 species that embody various strategies (including single-receptor producers, multi-receptor producers, and mixtures of both), are subjected to simulations until a steady state is achieved. These simulations incorporate randomized values for , , and initial mass as previously described, ensuring a diverse range of interactions. The local communities that do not go extinct in the steady state are used for the subsequent invasion event simulation. Subsequently, a species, representing a pathogen (invader), is introduced into the local community in minimal quantities to simulate an invasion scenario. The ecological repercussions of the invasion are explored, including the probability of successful invasion, the likelihood of wiping out the local community, and the loss of diversity post-invasion. Moreover, to evaluate the impact of the relationship between the local community and the invader on the invasion success rate, we evaluate the probability of a single-receptor producer successfully invading a local community composed of multi-receptor producers. This evaluation is conducted across the four distinct iron-interaction relationships presented in Figure 5i.