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Intraguild Predation in a Source–Sink Metacommunity

Dispersal of organisms in a heterogeneous landscape strongly influences the persistence of indirectly interacting populations. The source–sink habitat structure is one of the major mechanisms to promote coexistence of locally exclusive competitors. It is known that two populations that interfere with each other (Takeuchi 1989) or compete exploitatively (Namba and Hashimoto, 2004; Abrams and Wilson, 2004) or apparently (Namba, 2007) in spatially heterogeneous metacommunities can coexist regionally even if one of them is locally inferior in both patches.

Here, I consider a Lotka-Volterra model of intraguild predation in two patches that have different environmental conditions and are connected by dispersal:

$$\begin{aligned}
\frac{dR^i}{dt} &= \left\{r^i - a_{RR}R^i - a_{RC}C^i - a_{RP}P^i\right\}R^i, \\
\frac{dC^i}{dt} &= (-m_C + e_{RC}a_{RC}R^i - a_{CP}P^i)C^i - d_C(C^i - C^j), \\
\frac{dP^i}{dt} &= (-m_P + e_{RP}a_{RP}R^i + e_{CP}a_{CP}C^i)P^i - d_P(P^i - P^j),
\end{aligned}$$

$(i, j) = (1.2)$ or $(2, 1)$. r's are intrinsic growth rates, m's are mortalities, a's are interaction coefficients, e's are conversion efficiencies, and m's are diffusion rates. The subscripts express species identity and the superscripts denote patch number.

I study conditions for coexistence and competitive exclusion in the following four cases; (1) when the intraguild prey is inferior in both patches, (2) when the intraguild predator is inferior in both patches, and (3) when the local interactions are bistable and either of the intraguild prey and predator can dominate each patch if it is initially abundant, (4) when the intraguild prey is inferior in one patch (a sink) and superior in another patch (a source). I will show that the intraguild prey and predator can coexist regionally in a habitat with a source–sink structure even if one of them becomes competitively excluded in isolated patches in the absence of dispersal. When the habitat is in a true source–sink structure and each species dominates one of the two patches, both patches may become sinks for the intratuild prey when the dispersal rate of the intraguild predator is intermediate. I will also show the stabilizing role of diffusion when the local dynamics are oscillatory. In summary, dispersal between patches in different environmental conditions may either promote or demote coexistence depending on the precise habitat conditions and interaction strengths.

References

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