

# Abstract

## Biotic interactions and species abundances in ecological communities

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Lotka-Volterra models have long been used as a mathematical tool to model relatively simple biotic interactions, especially where interspecific competition occurs. As such, Lotka-Volterra models have been utilised extensively in the study of microbial environments, where the assumptions of the model are more easily shown to be met [1]. However, recent evidence points to the viability of Lotka-Volterra models as qualitative predictors of ecosystem patterns in more varied, larger scale ecosystems [2].

As many species are facing extinction due to global change, this work assesses the contribution of biotic interactions in the abundance of species in ecological communities. More specifically, a generalized Lotka-Volterra model with many species is considered. The model assumes that the species are governed by the logistic equation in the absence of others, and the interspecific interactions affect the populations growth linearly. The pairwise interactions (between two species) can be competitive, antagonistic, or mutualistic. Various criteria for the stability of this generalised Lotka-Volterra model are developed through – *inter alia* – Lyapunov functions. The interpretations of these stability criteria in terms of the inter-specific interactions within the community are presented. Finally, explorations of results for various community structures are conducted through numerical simulations.

*Keywords: Lotka-Volterra Models, Stability, Trait-Mediated Interactions*  
*MSC2020: 92-10, 92D25, 92D40*

## References

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- [2] Bryan Shorrocks, *Competition, interspecific*, Encyclopedia of biodiversity, 2024, pp. 22–40.