Does toxicity promote coexistence?

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In this talk I will introduce a two-prey one-predator system in which one of the prey has on the predator a toxic effect that inhibits its growths. After discussing the biological motivations for this work, I will present the following Lotka-Volterra system with diffusion:

$$\begin{aligned}
\frac{dN_1}{dT} &= D_1\Delta N_1 + N_1(\rho_1 - \alpha_{11}N_1 - \alpha_{12}N_2 - \alpha_{13}N_3) \\
\frac{dN_2}{dT} &= D_1\Delta N_2 + N_2(\rho_2 - \alpha_{21}N_1 - \alpha_{22}N_2 - \alpha_{23}N_3) \\
\frac{dN_3}{dT} &= D_1\Delta N_3 + N_3(\alpha_{31}N_1 - \alpha_{32}N_2 - \rho_3)
\end{aligned} \tag{1}$$

In this talk, I will address the following questions:

1. Can the toxicity of prey promote the coexistence of different species?
2. Can a predator survive despite eating a toxic prey?

At first, I will focus on the ODE system discussing linear stability and some results obtained through bifurcation analysis. Focusing on α_{32} and α_{23} we'll see that a "weak toxicity" (small α_{32}) leads to the monopoly of the toxic species while increasing α_{32} might promote species diversity. After this, I will add the diffusion terms to the system. The existence of a traveling wave solution and the relation of its velocity with the parameter α_{32} will be discussed. Finally, I will show some numerical simulations in a 2-dimensional domain and the emergence of spatial patterns due to diffusion-driven instability.

[1] Robbins T.R., Freidenfelds N. A., Langkilde T.: *Native Predator Eats Invasive Toxic Prey: Evidence for Increased Incidence of Consumption Rather Than Aversion-Learning*, Biol. Invasions Vol. 15, Issue 2, pp. 407-415, 2013;
[2] Roy S., Alamb S., Chattopadhyay J.: *Competing Effects of Toxin-Producing Phytoplankton on Overall Plankton Populations in the Bay of Bengal*, Bulletin of Math. Biol., 68, pp. 2303-2320, 2006.