Biomathematics Seminar Series

Department of Mathematics and Statistics

Nutrient-mediated pathogen transmission and host immunity in a stoichiometric disease model

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Hosts rely on the availability of nutrients for growth, and for defense against pathogens. At the same time, changes in host nutrition can alter the dynamics of pathogens that rely on their host for reproduction. For primary producer hosts, enhanced nutrient loads may increase host biomass or pathogen reproduction, promoting faster density-dependent pathogen transmission. However, the effect of elevated nutrients may be reduced if hosts allocate a growth-limiting nutrient to pathogen defense. While there are well established modeling frameworks in both disease and ecosystem ecology, these processes are often decoupled in models. Here, we explore the implications of nutrient-mediated pathogen infectivity and host immunity on infection outcomes. We developed a stoichiometric disease model that explicitly integrates the contrasting dependencies of pathogen infectivity and host immunity on nitrogen (N) and parameterized it for an algal-host system. Our findings reveal dynamic shifts in host biomass build-up, pathogen prevalence, and force of infection, along N supply gradients with N-mediated host infectivity and immunity, compared to a model where the transmission rate was fixed. We show contrasting responses in pathogen performance with increasing N supply between N-mediated infectivity and N-mediated immunity, revealing an optimum for pathogen transmission at intermediate N supply. By integrating both nutrient-mediated pathogen infectivity and host immunity into a stoichiometric model, we provide a theoretical framework that is a first step in reconciling the contrasting role nutrients can have on host-pathogen dynamics.

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