

Applying methods of the theory of heterogeneous populations to the problem of pathogen co-existence

Eric Sarfo Amponsah, Artem Novozhilov

Department of Mathematics, North Dakota State University, Fargo, ND

`eric.sarfoamponsah@ndsu.edu`

No two species can indefinitely occupy the same ecological niche according to the competitive exclusion principle. When competing strains of the same pathogen invade a homogeneous population, the strain with the largest basic reproductive ratio R_0 will force the other strains to extinction. It is imperative to know the results for heterogeneous models since the host population may differ in susceptibility. Heterogeneous models tend to capture dynamics such as evolution, resistance to infection, etc., giving a more accurate results of the epidemics. The talk will focus on the behaviour of multi-pathogen heterogeneous models and will try to answer the question: What are the conditions that lead to pathogen coexistence?. The goal is to understand the mechanisms in heterogenous populations that mediates pathogen coexistence by studying (numerically and analytically) the existence and stability of coexistence equilibrium in heterogeneous models. We will study and analyse the model (and introduce demography to it):

$$\begin{aligned}
 \frac{\partial s}{\partial t} &= -(\nu_1 P_1 + \nu_2 P_2)s(\nu_1, \nu_2, t), \\
 \frac{dP_1}{dt} &= P_1 \int_0^\infty \int_0^\infty \nu_1 s(\nu_1, \nu_2, t) d\nu_1 d\nu_2 - \mu_1 P_1, \\
 \frac{dP_2}{dt} &= P_2 \int_0^\infty \int_0^\infty \nu_2 s(\nu_1, \nu_2, t) d\nu_1 d\nu_2 - \mu_2 P_2.
 \end{aligned} \tag{1}$$

where $s(\nu_1, \nu_2, t)$ denotes the density of the density of hosts with susceptibility between ν_1 and $\nu_1 + d\nu_1$ with respect to the pathogen strain one, P_1 and susceptibility between ν_2 and $\nu_2 + d\nu_1$ with respect to the pathogen strain two P_2 , at time t . P_1 and P_2 are the densities of the pathogen strains at a particular time. It is important to note that the initial conditions for $s(\nu_1, \nu_2, t)$ is a function of t , ν_1 and ν_2 .