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Principles of Virus-Microbe Dynamics: From Ecology to Evolution and Back Again

JOSHUA WEITZ, Georgia Institute of Technology

Viruses are ubiquitous in the environment and can function like microbial predators, regulating the density and diversity of microbes present in a community. However, efforts to understand the dynamics of complex virus-microbe communities remain in their infancy. In this talk, I present examples of the interplay between evolutionary and ecological dynamics arising due to virus-microbe interactions. I begin by introducing canonical models of virus-microbe population dynamics in the context of observed oscillations of E. coli and associated phage. I then present a series of examples in which novel features observed in time series data arising from phage interactions with E. coli and V. cholerae can be understood when considering both population and evolutionary dynamics together. I conclude by presenting our recent efforts to extend the results of laboratory experiments to an environmental context, with significantly higher diversity of both viruses and microbes. Despite this increase in diversity, I show how network theoretic methods can reveal common principles underlying the dynamic coexistence of complex virus and host communities. Building on these findings, I describe new efforts to infer who infects whom directly from time series of multi-strain communities.