

Impact of Spatial Heterogeneity in Developmental Delay on Population Dynamics

Jianhong Wu

York University, Canada
WUJH@YORKU.CA

Abstract

Developmental delay plays a crucial role in shaping population dynamics, particularly for species whose maturation processes depend strongly on environmental conditions. In heterogeneous environments, the duration of developmental stages may vary across space, leading to complex patterns in population distribution. In this talk, we present recent studies based on an integro-differential equation model incorporating spatially varying developmental delay, which introduces a nonlocal feedback mechanism into the population dynamics of individuals undergoing maturation. In this framework, the delay represents the time required for individuals to develop from one life stage to another, while its spatial variability reflects environmental heterogeneity across the habitat. Using tick populations as a case study, we demonstrate the high sensitivity of population persistence to the speed of environmental change. In particular, slow environmental changes may lead to population extinction, whereas rapid environmental changes can facilitate population survival by redistributing individuals across space. Furthermore, we show that for a prescribed spatial distribution pattern, it is always possible to construct a corresponding spatially varying developmental delay such that the resulting stable positive equilibrium exhibits the desired spatial mode.