Title:	Dynamics on Spatially Extended Systems
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Abstract: We present the analysis and characterization of emergent behaviour, arising from the interplay of local dynamics and the form and structure of coupling, in complex dynamical systems motivated by biological phenomena. First, the dynamics of a non-fatal infection spreading across a population is modeled, and the emergence of persistent infection in a closed region is explored. In this system, the disease progression of an individual is given by the SIRS model, with an individual becoming infected on contact with another infected individual. The persistence of contagion is qualitatively and quantitatively investigated, under increasing heterogeneity in the partitioning of the population into different disease compartments, as well as increasing heterogeneity in the phases of the disease among individuals within a compartment. It is observed that the system's asymptotic behaviour is attracted to two distinct states - an absorbent state devoid of infection and a persistent state with regular spatiotemporal oscillations - depending on the initial composition of the individual disease phases in the population, with initial heterogeneity aiding the emergence of long-term persistent infection. Next we focus on the role of synchronization in the persistence of infection in such a closed region. The following key result is observed: higher degree of synchronization in the individual states, both globally in the population and locally in the neighbourhoods, hinders persistence of infection. Importantly, it is demonstrated that early short-time asynchrony appears to be a consistent precursor to future persistence of infection, and can potentially provide valuable early warnings for sustained contagion in a population patch. In a following study, it is established that populations where the initial distribution of the disease cycle is strongly compartmentalized leads to persistent infection in the complete region. Even after transience, the patterns of disease spreading in the two communities may be completely dissimilar, even though both communities settle down to the same average infected sub-population size, displaying periodic waveforms with different amplitudes, but similar frequencies. In a final study we investigate a collection of populations modeled by the prototypical chaotic Ricker map. Such chaotic maps are widely utilized to model the population growth of species with non-overlapping generations. The feedback received by each population patch is modeled to be influenced by the local mean field of its neighbourhood. The dynamics and distribution of the local populations, as well as the total biomass, in the coupled system described above, is examined. The significant observation is the following: When the range of coupling is sufficiently large, namely when enough neighbouring populations influence the growth rate of a population, the system yields remarkably large biomass values that are very far from the mean. These extreme events are relatively rare and uncorrelated in time. It is also found that at any point in time, exceedingly large population densities emerge in a few patches, analogous to an extreme event in space. These results indicate a new mechanism in coupled chaotic systems that naturally yield extreme events in both time and space.

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