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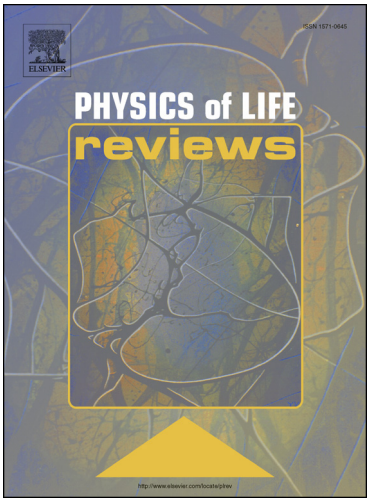

Understanding spatial spread of emerging infectious diseases in contemporary populations

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Comment on "Pattern transitions in spatial epidemics: Mechanisms and emergent properties" by Gui-Quan Sun et al.

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The increased prevalence of emerging and re-emerging infectious diseases (EIDs) in recent decades has incurred substantial health and economic burdens [1,2]. Contemporary human society shaped under urbanization and globalization processes facilitates the emergence of novel pathogens and amplifies their pace of global spread [3,4]. Empirical evidence is widespread, such as the multi-national transmission of SARS in 2003 [5] and MERS in 2012 and 2015 [6,7], global spread of A/H1N1 pandemic influenza in 2009 [8,9], avian influenza dissemination in Southeast Asia [10,11], the west African Ebola outbreak in 2014-2015 [12], recent emergency of Yellow Fever [13] and global spreading of Zika virus [14]. Understanding the dynamics and pattern transitions for spatial spread of EIDs has been a major focus of health-related research.

Sun et al. [15] reviews the emergent properties and mechanisms of spatial epidemic pattern transitions. They addressed two types of spatial patterns for sustained diseases (SDs), i.e. time-invariant stationary patterns and dynamic spatiotemporal patterns, which can be modeled via stylized mathematical tools, including reaction-diffusion processes in continuous space and cellular automata for interactive agents in regular networks. In particular, they identified three mechanistic factors mediating pattern formations for SDs. The first concerns spatial heterogeneity, in which the assumption of homogeneous mixing can be released for individuals in conventional compartmental models. Community structures resulting from heterogeneous connectivity can significantly impact the efficiency of disease spread. The second refers to seasonality and noise in contacts rates, environment, and demographics, which often contain rich dynamic information for studying real-world SDs. The last is on disease-behavior feedback induced by human behavior, which may provide insights in understanding vaccine hesitancy.

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