Contact processes, spreading of populations in space, and the boundaries of species distributions

Beáta Oborny[1], Jeromos Vukov[1], Michael Gastner[2], György Szabó[3], Gunnar Pruessner[4], Ole Peters[2], Nicholas Moloney[1] and Géza Meszéna[1]

[1] Loránd Eötvös University, Budapest.

[2] Santa Fe Institute.

[3] Research Institute for Technical Physics and Material Science, Budapest.

[4] Imperial College, London.

The Contact Process (CP) is a basic model for colonization-extinction processes in space. It was originally introduced in epidemiology, and entered into ecology for modeling population dynamics and metapopulation dynamics in dispersal-limited species. The CP shows some interesting scaling properties. In our earlier studies (Oborny, Szabó, and Meszéna), we reviewed these scaling laws, and suggested some implications for the protection of endangered species and the eradication of pests. There is a characteristic phase transition in the CP: as we decrease the rate of colonization *c* relative to the rate of extinction *e*, we reach a sharply defined *c/e* ratio below which the species always dies out in the long term. Approaching this threshold, the equilibrium population size declines and the correlation length and correlation time diverge by scaling laws. The scaling exponents are independent of many kinds of local details of the model, which suggests that the CP could be generalized, and its application could be broadened to a suite of population dynamic processes. As a first step, we examined the CP in a diluted lattice with random fluctuations, which represented a fine-grained, heterogeneous environment, in which the habitat patches for the species could change over time. The results confirmed that the scaling laws are applicable: the system belongs to the same universality class as the classical CP. As a next step, we wish to examine the behavior of populations across environmental gradients, where *c* and/or *e* would change in space. We expect a rather sharp borderline relative to the gradual change of environmental conditions, i.e. the occurrence of a phase transition in space. I wish to propose some hypotheses regarding the emergence, geometry and fluctuations of the borderline, and introduce our Borderline Project.