Evolution towards criticality describes the ecology of meningococci causing meningitis and septicaemia

Nico Stollenwerk [1] and Vincent A.A. Jansen[2] .

The epidemiology of meningococcal disease has turned out to be a paradigmatic system for the ecology of a microparasite and its host [1]: Different mutants of the bacteria *Neisseria menigitidis* have different probabilities to cause symptomatic disease (pathogenicity), whereas the majority of infections have no effect at all for the hosts [2]. In our model with various mutants we find the epidemiological system evolving towards criticality without outer tuning of a control parameter [3]. This is an indication for self-organized criticality (SOC) [4].

The epidemic model is a susceptible-infected-recovered hosts system (SIR) for the harmless agent infecting hosts I, acting as a background to a mutant strain Y which occasionally creates severely affected hosts X. The full system of SIRYX is described in the master equation framework, suitable for simulations with a very efficient numerical technique, the Gillespie algorithm [5]. Using simulations with this method we confirm limiting assumptions about a reduced YX-system with the SIR-system in stationarity. In this limiting case we can analytically show convergence to power law scaling typical of critical states [1]. Furthermore, in this approximation we can show analytically that the control parameter, the pathogenicity in this model, evolves to be predominantly in its critical value zero. These findings are then confirmed by simulations of the full SIRYX-system [3].

Finally, first simulations of the model along the lines of empiric data of menigococcal disease in England and Wales are shown, indicating that the structural behaviour of the system can be understood from the implications of our model.

[1] School of Biological Sciences, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK (e-mail: nks22@cam.ac.uk.).

[2] (e-mail: vincent.jansen@rhul.ac.uk).

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