International Workshop on Differential Equations in Mathematical Biology

Reaction, Diffusion and Noise in Models of Plankton Dynamics

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ABSTRACT

The dynamics of spatial and spatiotemporal pattern formation in nonlinear biosystems far from equilibrium are of continuous interest and many mechanisms of structure generation are not known yet. In this paper, the fascinating variety of spatiotemporal patterns in such systems and the governing mechanisms of their generation and further dynamics are decribed and related to plankton communities.

Under conditions of relative physical uniformity, the temporal and spatiotemporal variability can be a consequence of the coupled nonlinear biological and chemical dynamics. For illustration, the formation and spread of spatiotemporal structures in a conceptual prey-predator diffusion model of phytoplankton-zooplankton dynamics with viral infection of phytoplankton is demonstrated. There is not much known about the mechanisms of viral infection and spread of disease in and between plankton populations as well as along plankton-fish food chains. Here, the phytoplankton population is split into a susceptible (S) and an infected (I) part [1]. Lysogenic and lytic infections are considered. Zooplankton (Z) is grazing on susceptibles and infected. The analysis of the local S-I-Z system yields a number of stationary and/or oscillatory regimes. Correspondingly interesting is the spatiotemporal behaviour, modelled by reaction-diffusion equations. Spatial spread or suppression of infection will be presented just as well as competition of concentric and/or spiral population waves with non-oscillatory sub-populations for space, and long transients to spatially homogeneous population distributions. The impact of external multiplicative white noise, modelling the environmental variability, on survival and spread of populations as well as on spatiotemporal pattern formation and transitions is shown.

Key Words: Plankton, viral infections, stochastic reaction-diffusion system, noise-enhanced spatial spread and survival, spatiotemporal structures

AMS Classification: 60H15, 60H35, 68U20, 92B05, 92D25, 92D30, 92D40

References

[1] Malchow, H., Hilker, F.M., Petrovskii, S.V. and K. Brauer (2004). Oscillations and waves in a virally infected plankton system. Part I: The lysogenic stage. *Ecological Complexity* **1**(3), 211-223.