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Editorial

Progress in Mathematical Ecology

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Mathematical modelling plays a special role in ecology. Although traditional ecology is a largely empirical science, replicated experiments are not often possible because of the high complexity of ecological interactions and the impossibility to reproduce the weather conditions. Moreover, large-scale field experiments (where the consequences are usually not fully known) can be damaging for the ecological communities and costly or even dangerous for humans. Mathematical modelling provides an efficient supplement and sometimes even a substitute to an empirical study; it creates a virtual laboratory where different hypotheses can be tested safely, and at relatively low cost.

Application of mathematics to problems arising in ecology and population dynamics—to which we broadly refer as mathematical ecology—has a long and glorious history. It was mutually beneficial for both of the disciplines involved and there are many examples of that. Prey–predator population cycles are one of the core concepts of contemporary ecological theory, but the route of this idea goes back to the works of Vito Volterra. Food web analysis is a fruitful and fast developing area of ecology, but its progress would hardly be the same without the insights and tools from the mathematical theory of networks. Ecological research on the spatial spread of traits and species was the starting point for the mathematical theory of diffusion-reaction waves, and Alan Turing's study on morphogenesis led to the development of the theory of self-organized pattern formation.

New times have brought new challenges and stimulated further developments in mathematical ecology. This volume of Mathematics presents a carefully selected collection of papers that, taken together, provide a rather comprehensive account of the state of the art in this science. A broad range of problems is addressed. The first two papers [1,2] consider some new aspects of the classical problem of pattern formation. The dynamics of infectious diseases is another old problem where many aspects are still poorly understood; this is addressed [3,4]. Comparisons between different patterns of animal movement are made, [5] and the effect of dispersal and migration on the population dynamics in fragmented habitats are considered [6,7]. Biological invasion of an alien population of "ecosystem engineers" is considered [8], where it is shown how nonlinear feedbacks may lead to a self-organized regime shift resulting in the collapse of the invading population. The structural complexity of ecosystems is revisited in a review paper [9], where the meaning and value of various biodiversity indices is reassessed. The final paper [10] provides a new mathematical insight into a classical problem of genealogy.

We hope that, along with, obviously, shedding new light on several important problems, this volume also brings new questions and hence will stimulate future advances in mathematical ecology.

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