Mathematical Ecology: Theory and Applications (META)

Joint Research Group in the UK - LMS Scheme 3

META WORKSHOP

`Analytical and computational methods for multi-scale ecology'

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ABSTRACTS

Sergei Fedotov
University of Manchester

Non-Markovian random walks and anomalous transport: applications in biology and spatial ecology

The talk will be concerned with the extension of the linear fractional PDE's for the non-linear case involving interactions of subdiffusive particles and Lévy walkers. Applications of the new non-linear fractional PDE's in biology and spatial ecology will be discussed.

Thilo Gross
University of Bristol

Networks, spatial structure and patterns in ecology.

In ecology we find spatial patterns on almost every scale. Two key questions are where do these patterns come from and what are there implications for ecology. In this talk I will address these questions from a networks perspective. Suppose we have a structured environment described by a network. Using analyticalmethods I will explain the impact of this structure on population dynamics, and in particular on the formation of another layer of structure in the populations occupying the network. Understanding the dynamics of spatial networks will also shed insights on the dynamics of food webs and food web motifs.

Eleni Matechou and François Caron
University of Kent

Modelling individual migration patterns using a Bayesian nonparametric approach for capture-recapture data

We present a Bayesian nonparametric approach for modelling wildlife migration patterns using capture-recapture (CR) data. Arrival times of individuals are modelled in continuous time and assumed to be drawn from a Poisson process with unknown intensity function, which is modelled via a flexible nonparametric mixture model. The proposed CR framework allows us to estimate: i) the total number of individuals that arrived at the site, ii) their times of arrival and departure and hence their stopover duration, and, iii) the density of arrival times, providing a smooth representation of the arrival pattern of the individuals at the site. We apply the model to data on breeding great crested newts (Triturus cristatus) and on migrating reed warblers (Acrocephalus scirpaceus). For the former, the results demonstrate the staggered arrival of individuals at the breeding ponds and suggest that males tend to arrive earlier than females. For the latter, they demonstrate the arrival of migrating flocks at the stopover site and highlight the considerable difference in stopover duration between caught and not-caught individuals.

Natalia Petrovskaya
University of Birmingham

Modelling patchy invasion of alien species with long-distance dispersal

Biological invasion of alien species is regarded as one of the major threats to ecosystems all around the world and understanding of spatiotemporal patterns arising in invasive species spread is necessary for successful management and control of harmful species. Patchy invasion presents a scenario of biological invasion alternative to a continuous population travelling front and patchy spread of alien species has recently been confirmed by both empirical and theoretical results. While study of patchy invasion has been restricted so far to the case where the invasive species spreads by predominantly short-distance dispersal, there is raising evidence that the long-distance dispersal is a strategy that is used by many species. It will be discussed in the talk how the patchy invasion can be modified by the effect of the long-distance dispersal. Among the other aspects of the problem validation of numerical solution is of primary interest. It will be demonstrated that fat tails of the dispersal kernels have significant impact on the accuracy of computation when patchy invasion is modelled numerically.

Jonathan Potts
University of Sheffield

Animal movement modelling as a technique for understanding population abundance distributions

Analysing population abundance distributions of animals is fundamental for a wide range of ecological applications, from designing conservation strategies to predicting biological invasions. Many models that link environmental factors to population patterns are purely statistical in nature, inferring that the abundance of a species at position X is a function of the bio-geographical covariates at X. In other words, they work on a single scale - the population level. However, complex animals (such as mammals, birds, reptiles etc.) make their decisions about where to be based on both knowledge of their surrounding area and their ability to move.

Here, we show that such behavioural decisions can cause spatial patterns to emerge that cannot be explained purely in terms of the local environmental covariates. Our analysis reveals that observed effects on abundance patterns of (i) patch size, (ii) patch isolation, and (iii) habitat edges, can be understood by incorporating movement into our understanding of population abundance. This work represents the idea that a shift from a single-scale statistical approach to a multi-scale mechanistic approach can aid in our understanding of population abundance patterns.

Axel Rossberg
Queen Mary University of London

The theory of competition in food webs

Yes, a quantitative theory of community structure is possible, and it works. A powerful mechanism determining local species richness is structural instability, i.e. a sensitivity of communities to pressures so large that species easily get lost. It naturally results from and constrains community assembly. In food webs, for example, structural instability sets in when predators are about 1/3 as rich their prey (Rossberg, 2013, ISBN 9-780470973-55-4), the ratio observed in nature. Structural instability has wide-ranging implications for community dynamics, invasibility, and management. A full understanding of the explanatory power of the theory, however, will have to take spatial ecology into account.