**First International Sizemic Workshop**

**Trophic dynamics in ecosystems: feeding interactions, species identity, and body size**

Friday-Monday, 4th-7th April 2008
Clare College, Cambridge

**Programme for Saturday, 5th April 2008**
(plenary all day)

9:00 am Start

9:00 am 30 minutes
*"Welcome and Introduction"*
Richard Law, University of York

9:30 am 50 minutes
*"Does one size fit all?"*
Joel Cohen, Rockefeller and Columbia Universities

Understanding ecosystem dynamics will require data structures that integrate diverse approaches to describing ecosystems. The food web directed graph has been used since 1880; it has a node for each group of organisms and an arrow for each feeding link from resource to consumer. In recent decades, this data structure has been extended by adding to each node the average individual body mass and numerical abundance of the associated organisms; and by adding to each edge estimates of the fluxes of energy and materials. Further extensions to individuals and to the environment are desirable and feasible. I give two examples here, and others in the talk. The average body mass could be replaced by the frequency distribution of body mass or other physiological stage, and bivariate frequency distributions could report the frequency of eating by the body size or physiological stage of both the resource individual and the consumer individual. If chemical compositions (or at least measurements of C, N and P) were added to the vector of each node's attributes and if a nodal population growth model took explicit account of chemical concentrations of nutrients and toxins, then population biology and food web dynamic ecology could integrate with biogeochemistry (ecological stoichiometry). But it is easier to imagine a data structure (a skeleton of thought) than it is to flesh it out with reliable data (the muscles on the bones). This meeting can help bridge the gap between what can be studied theoretically and what can be achieved empirically.

*10.20 am Refreshments* *30 minutes*

10:50 am 50 minutes
*"Size and species-based analyses of food webs"*
Simon Jennings, Centre for Environment, Fisheries and Aquaculture Science

Size-based analyses of food webs, where body size rather than species identity is the principle descriptor of an individual's role in the food web, provide insights into food web structure and function that complement and extend those from species based analyses. This talk describes the application of cross-species and phylogenetic comparative analysis to study relationships between species' body size and trophic level in aquatic food webs, and how these relationships compare with those that classify all individuals by body size irrespective of species identity. The results show that weak cross-species relationships between species' body size and trophic level can belie powerful size-based structuring, and that size-based analyses can be used to estimate food web properties such as predator-prey size ratios, transfer efficiency, maximum food chain length and relationships between

predator and prey species diversity. These estimates can contribute to the development, parameterisation and validation of food web models.

11:40 am 50 minutes
*"Should interaction strengths be at the individual or species level?"*
Peter de Ruiter, Wageningen University Research Centre

*…or at the functional group level?* In my talk I will approach interaction strength from a conceptual and an empirical perspective. First, interactions are obviously dealing with a 'set of two' (individuals/populations/species/functional groups), but the strengths of the interactions, and especially how interaction strengths influence community structure and stability depends on the organisation of interaction strengths in the community as a whole. From there I will present examples of interactions strengths in real food webs in order to show patterns that are important to stability; herewith I will also introduce the concept of maximum loop weight as a way to understand and 'quantify' food web stability. Finally I will discuss how these findings may relate to *the ecological implications of body-size*.

*12:30 pm Lunch 1 hour*

1:30 pm 50 minutes
*"Size-dependent foraging affects predator-prey interaction strengths and food-web stability"*
Ulrich Brose, Darmstadt University of Technology

Metabolic theory predicts that *per capita* metabolism and consumption rates follow three-quarter power-laws with individual body mass. Foraging theory predicts that these overall consumption rates are unevenly distributed amongst the multiple feeding links of predators, and attack rates follow a hump-shaped relationship with the predator-prey body-mass ratios. These theories are illustrated by experimental data on the rates of metabolism, consumption and attack of ground-dwelling beetles and spiders at the *per capita* (metabolic theory) and *per link* (foraging theory) levels. A combination of both theories suggests that (i) *per capita* biomass fluxes first increase and then decrease with predator mass, (ii) small predators have higher *per capita* biomass fluxes when attacking small prey, whereas large predators have higher biomass fluxes while consuming large prey, and (iii) total biomass fluxes decrease with predator mass. Interestingly, these relationships indicate variation in predator-prey interaction strengths in natural food webs may be highly constrained by the species' body masses (i.e., size-dependent foraging). Prior models used interaction strength as an unconstrained variable affecting population stability and documented that *anything is possible*. In contrast, model analyses based on size-dependent foraging yield body-mass dependent interaction strengths and suggest that *what is probable is only a restricted subset of what is possible*. In particular, they demonstrate that omnivory stabilizes population dynamics, which has profound implications for our understanding of complex food-webs.

2:20 pm 50 minutes
*"Time for a paradigm shift in biodiversity? The role of size-structure in ecosystem function"*
Pablo Marquet Centre for Advanced Studies in Ecology and Biodiversity (CASEB), Departamento de Ecologia Pontificia Universidad Católica de Chile and Institute of Ecology and Biodiversity (IEB)

In ecology, unlike physical science, most problems are not usually resolved but go out of fashion. Paradigms in ecology bounce back, linger and are usually reborn in disguise to coexist. This in part reflects the complex nature of our study systems but also the difficulty in anchoring ecological enquiry to simple and fundamental principles and state variables. The emphasis in abundance and diversity is giving way to an emphasis in energy, size and biomass as potential state variables for understanding ecological systems. In this talk I will present a framework that emphasize the importance of size for ecosystem structure and functioning and will outline some vexing questions that need to be addressed if we are to

think of a paradigm shift in biodiversity. This shift I propose, entails ways of finding the unity underlying diversity.

*3:10 pm* *Refreshments* *30 minutes*

3:40 pm 50 minutes
*“Growing predators and growing prey – Effects on dynamics and community structure”*
Lennart Persson, Umeå University

Theoretical and empirical evidence suggests that the fact that individuals grow substantially in size over their life time has strong impact on both the dynamics and structure of ecological systems. Food-dependent growth of predators may induce cycles that cascades through the food web via overcompensatory increase in predator per capita fecundity. Food dependent growth of predators may also demote coexistence in intraguild predation systems. In consumer-resource resource systems, ontogenetic size dependent differences in different process rates may induce cycles. Food-dependent development in consumers will also induce alternative stable states in communities including a high sensitivity to catastrophic collapses in predators. In my talk I will review the theoretical basis for these strong effects of ontogenetic development on community dynamics and structure and the growing empirical evidence.

4:30 pm 50 minutes
*"Modelling size spectra: beginnings, present state and future prospects"*
Ken Andersen, Danish Fisheries Research, Technical University of Denmark

An overview of the state-of-art of current efforts in mathematical modelling of size spectra, focussing on marine systems, which are strongly structured by predator-prey interactions governed by the rule "smaller fish are eaten by larger fish". Currently there is an outburst of different size-based models which can roughly be classified as either trophic models or continuum ecosystem models. The basic principles of the models are essentially the same, namely descriptions of individual encounter with predators and prey and individual bioenergetics. The models predicts size spectrum slope, total abundance productivity rates etc. The next logical step from the pure size-based models is to add a food web structure or to add an extra trait. I will show an example of how this can be done, but also of which new problems it raises.

5:20 pm Plenary discussion 30 minutes

5:50 pm End