4th International Workshop

13.04 – 15.04.2011

SIZEMIC Workshop: Changing Climate, Physiological Adaptation, Ecosystem Resilience & Body Size Constraints

Host Institution: Institute for Hydrobiology & Fisheries Science,
University of Hamburg, Grosse Elbstrasse 133, Hamburg, Germany
Organisers: Ute Jacob, Ulrich Brose & Owen Petchey

Wednesday, 13th April, 2011

WELCOME TO THE SIZEMIC FINALES!
Ute Jacob, Ulrich Brose & Owen Petchey

Theme 1:

PHYSIOLOGICAL ADAPTATION & FRAGILITY OF ECOLOGICAL NETWORKS
One of the largest uncertainties in predicting the impacts of climate change on ecological networks is the understanding of cause and effects of a species responding differently to shifting environmental conditions. With this theme we will link studies on the constraints of a species physiological performance and the effects on ecosystem structure and functioning.

CHAIR: Ute Jacob

PLENARY: Ecophysiological Specialization to Climate in Marine Ectotherms: Functional Consequences and Implications for Allometry

HANS O. PÖRTNER

Climate warming emphasizes the need for a common understanding of thermal limitation, which results from thermal specialization and the associated functional consequences. The whole organism responses to warming or cooling link to ecosystem response and build on a suite of tissue, cellular, molecular and genomic events, in a systemic to molecular hierarchy of limitation. All of these are involved in specialization on local climate, shaping a time-limited budget of tolerance beyond thermal limits. The concept of oxygen and capacity limitation of thermal tolerance (OCLT) was proposed as a matrix integrating various environmental stressors The paper will discuss how adaptation to various climate regimes involves functional consequences and implications for the setting of body size.

INVITED TALK: Warming and the stability of freshwater food webs under top-down and bottom-up perturbations

JONATHAN SHURIN, Pavel Kratina, Hamish S. Greig, Patrick L. Thompson & Ticiana C. Pereira

Higher temperatures can affect the sensitivity of ecosystems to different kinds of environmental changes. We tested the effect of 3 degrees of warming on the stability of pond food webs against trophic cascades and eutrophication. Warming magnified the effects of predators on system production, and dampened the effects of nutrient loading. The destabilizing effects of nutrients on phytoplankton variability were also diminished at higher temperatures. Our experiment indicates that a warmer climate may lead to a shift toward stronger top-down control and weaker bottom-up effects on aquatic ecosystems.

INVITED TALK: Fish being fished in waters being warmed: Can we disentangle the role of climate on the productivity of key North Sea species?

MYRON PECK, Ute Daewel, Ken Drinkwater, Marc Hufnagl, Christian Möllmann, John K. Pinnegar, Corinna Schrum & Adriaan D. Rijnsdorp

Notable, climate-driven changes have occurred world-wide in the abundance and distribution of heavily exploited populations/stocks of marine fish species. Within EU waters, the "RECLAIM" program was charged with providing future research priorities to the EU to better understand impacts of climate variability and change on fish and shellfish resources in European waters. This presentation focuses on RECLAIM results for the North Sea, a shelf sea system where the coupling of long-term, retrospective analyses and novel, physiological-based biophysical modelling shows great potential to reveal a "cause and effect" understanding of observed changes in key species. Case studies are provided for some of the most ecologically- and commercially-important pelagic and demersal species (herring, cod, plaice and sprat). Opportunities and challenges are discussed regarding the ability to use physiological-based tools to provide both practical management advice as well as projections of future changes in these important ecosystem players.

INVITED TALK: Climate Forcing of Growth Dynamics in the Bivalve *Laternula elliptica* at the West Antarctic Peninsula

THOMAS BREY

The bivalve *Laternula elliptica* is the dominant infaunal suspension feeder in many shallow soft bottom habitats around the whole Antarctic. Based on samples collected in the Maxwell Bay area of King George Island we established a 49-year shell growth chronology (1961/62 to 2009/10). This chronology indicates a doubling in growth rate and a 1/3 decrease in maximum body size over half a century. We offer models and hypotheses that link these changes in growth dynamics mechanistically to likely environmental drivers.

INVITED TALK: Temperature and body size effects on metabolic and consumption rates of marine species

MARION TWOMEY, Ute Jacob, Eva Brodte, Ulrich Brose, Tasman Crowe & Mark Emmerson

Understanding and predicting the consequences of warming for complex ecosystems and indeed, individual species, remains a major ecological challenge. Here, we investigated the effect of increased seawater temperatures on the metabolic and consumption rates of five diverse marine species. The experimental species were chosen for their feeding, locomotion and anatomical differences, and include an herbivorous gastropod, a scavenging decapod, a predatory echinoderm and decapod, and a vertebrate fish. Using the metabolic theory framework we determined the mass- and temperature-dependant scaling of metabolism and consumption for each species, and assessed changes in their consumption efficiencies with increasing temperature.

INVITED TALK: The role of temperature in structuring marine fish ecosystems and the possible impact of climate change: Insights to be gained from size based models.

JOHN G. POPE, Henrik Gislason, Jake C. Rice and Nils Daan

Marine fish ecosystems are assemblages of species with different life-history strategies. The physiological processes that drive them are strongly determined by temperature and body size. However, to study how these processes favor particular life-history strategies requires size based multispecies models. To gain useful insights requires models that are sufficiently detailed to capture the main interactions but sufficiently simple to understand the results. Here we present results both from historical and new size based multispecies models. These provide insights as to how systems evolve at different temperatures and how these systems might be modified by climate change and fisheries.

Theme 2:

CHANGING CLIMATE & COMPLEX FOOD WEBS

Declining trends in biodiversity may disrupt the structure and function of complex food web. Loss of species within these complex food webs will most likely result in the disappearance of functional roles and lead to loss of ecosystem services. With this theme we will bring together scientists working on network structure and stability of complex "real world" food webs, which has increasing relevance for understanding the effects of a changing climate on structure & functioning of food webs and the provision of ecosystem services.

Chair: Guy Woodward

PLENARY: How robust is the structure and functioning of ecosystems to environmental warming?

JOSE M. MONTOYA

There is ample evidence that ecological responses to climatic warming are already occurring at the individual species (population) level. The challenge now is to investigate the effects of warming on biotic interactions and ecosystem services supply. I will present some ideas on how to predict novel emergent ecosystems composed of new species assemblages resulting from differential rates of range shifts of species. Also, I will provide examples on how resilient ecosystem functioning and key aspects of network structure will be in a warmer world.

INVITED TALK: Design of a Modelling Approach for the Bering Sea Benthic Food Web

JAMES R. LOVVORN

In the Arctic North Pacific, expansion of bottom trawling and drilling for oil and gas will be superimposed on climate-driven changes in ecosystem processes. Identifying and predicting the multiple and often indirect effects of these factors requires comprehensive food web models. The modeling framework should include network models with detrital cycling and microbial-invertebrate coupling that are nested within interacting patch types driven by periodic disturbances. Disturbances will depend partly on the abundance of food web components that allow profitable foraging by walruses. Understanding the food web implications of disturbance at different frequencies and scales will be key to assessing a range of human impacts.

INVITED TALK: Non linear Interaction Strength in a Changing World

BJÖRN C. RALL

Feeding interactions are the energetic backbone of every ecosystem controlling energy fluxes from smallest to largest organisms, which determines ecosystem stability and ecosystem resilience. Changing climate (e.g. global warming) alters the strength of these feeding interactions (i.e. functional responses) leading to tremendous changes in population stability. Recent studies showed that temperature increases have stronger effect on metabolism than on feeding. This unbalance of energy intake and energy consumption dampens population oscillations, but may eventually lead to extinction due to starvation of the largest predatory species.

INVITED TALK: Taxonomic Rank and its Relevance for the Structure of Ecological Networks

ANNA EKLÖF

Explaining food web structure is one of the great challenges in ecology. To find in what way species share common interaction patterns is one way to identify, and possibly explain, the basic structures. Species sharing similar interactions are likely to have some traits in common. Closely related species share traits they have from common ancestors and should thereby possibly share similar sets of preys and/or predators. Species phylogenies are a natural first step in testing which traits those are. However, closely related species should also differentiate from each other due to competition. Here we use a probabilistic model to address the question if the phylogenies of species are a relevant way to divide species into functional groups. We also use model selection to answer what taxonomic level best captures the basic feeding patterns. Finally we extend the analysis to include other species-specific traits.

Thursday, 14th April, 2011

Theme 3:

SIZE-STRUCTURE & BIODIVERSITY ACROSS ECOSYSTEMS IN A CHANGING CLIMATE

With this theme we will bring together scientists working on the importance of size structure in terrestrial, freshwater and marine systems. Each of the speakers will introduce a variety of methods that can be applied to gain an integrated perspective of climate effects on the size structure of ecological communities with the subsequent implications for ecosystem function.

CHAIR: Jonathan Shurin

PLENARY: Biodiversity controls Production and Stability for Plants and Consumers

ELISABETH BORER

Species diversity, biomass productivity, and temporal stability represent a tightly-linked triad in ecological communities. Most research in this area has focused on primary producers, generating little understanding about this triad for consumers. Using a decade-long study of insects from experimental plant communities of differing diversity, we test concordance of plant and insect triads and whether feeding niches, environmental heterogeneity, or consumer metabolic constraints control the insect community. Structural equation analysis demonstrates that insect diversity-biomass-stability relationships are similar in strength and direction to plants and that total plot productivity, determined by plant diversity, sets a limit on aggregate insect biomass and a baseline to divide resources among species. Thus, our analyses support consumer metabolic constraints as the primary pathway between plant and insect diversity in this system.

INVITED TALK: Diversity spectra: empirical patterns, mechanistic models and applications

DAN REUMANN

Biodiversity depends on body mass. This relationship has been studied for broad taxonomic groups (e.g., mammals) for decades. Instead, taking a whole-community perspective not limited to any taxonomic group, we used the "diversity spectrum" to describe how diversity in an ecosystem is distributed across the range of body masses. Empirical diversity spectra for soil, freshwater, estuarine, and marine systems were found generally to be linear, with slope in a range. A mechanistic model explaining these results for marine systems is discussed, as well as applications of diversity spectra and the potential for a generalized theory explaining non-marine systems.

INVITED TALK: The Susceptibility of Species to Primary Extinctions across Ecosystems

AMREI BINZER

Using a dynamic food web model we explored factors determining the susceptibility of species to primary extinction. We found that large species with high trophic level and similarly sized predators run the greatest risk of primary extinction while network factors and community characteristics can be neglected. At the same time body-size plays a crucial role in determining the time to extinction with larger species taking longer to die out than smaller species. These model analyses provide a conceptual foundation for predicting extinction risk across ecosystems.

INVITED TALK: Large-scale Reorganizations in North Atlantic Marine Ecosystems

CHRISTIAN MÖLLMANN

Ecosystem reorganizations, commonly termed „Ecosystem Regime shifts“ are changes between contrasting persisting states of ecosystem structure and function. These reorganizations usually have significant ecological but as well social and economic impacts. Here I report on a meta-analysis of regime shifts based on multitrophic level information across 24 North Atlantic marine ecoregions. These include ecosystems from the Western North Atlantic, Eastern Atlantic Shelf Seas, the Barents Sea, the North Sea, the Black Sea, the Baltic Sea and the Mediterranean Sea. Based on this dataset I address questions of (i) synchronicity in ecosystem changes, (ii) the importance of large-scale versus local drivers, and (iii) potential irreversibility in ecosystem reorganizations.

INVITED TALK: Positive Interactions and their Role in Complex Ecological Networks

SONIA KEFI

Understanding the environmental changes of the coming decades requires an improved scientific understanding of the role of ecological interactions in stabilizing or destabilizing communities. Simple systems including positive interactions among their component parts are well-known to potentially exhibit shift behavior under

external changes. Such shifts can have dramatic ecological and economic consequences. Despite the potential importance of positive interactions for community resilience, little is known about their role in stabilizing or destabilizing complex ecological communities composed of many species. I will present some results about how positive interactions may affect the functioning and the stability of complex ecological communities.

Theme 4:
SIZEMIC: WHAT WE KNOW & WHERE TO GO – SYNERGIES & GAPS

CHAIR: Ulrich Brose

With this theme we will provide (i) a summary of what has been achieved within the SIZEMIC network, (ii) an opportunity for the working groups funded by SIZEMIC to introduce their final projects and results as well as (iii) provide a springboard for future perspectives on how the grown SIZEMIC community can continue their interdisciplinary research attempts in aquatic and terrestrial ecology to support an ecosystem approach.

PLENARY: Community feedback about the SIZEMIC Research Network and future research directions.

OWEN PETCHEY

I will be distributing a questionnaire to SIZEMIC participants and the broader scientific community in order to gauge opinions about the research carried out in the SIZEMIC Research Network, what worked particularly well, and what could be improved for the future. I will also be asking for opinions on what challenges should be the scientific focus of future large scale collaborative research efforts.

INVITED TALK: Predicting effects of climate change on global fisheries from food web and biogeography perspectives

JULIA BLANCHARD, William Cheung, Simon Jennings & Manuel Barange

Different approaches are currently being used to understand and predict the potential effects of climate change on marine ecosystems and their services. Recent multidisciplinary systems modeling has focused on how effects propagate from physics all the way up to potential global fisheries and society, taking into account individual level processes (such as physiology and foraging behavior). Simple size-based food web models predict changes in fisheries potential that mirror global changes in primary productivity. Global scale models of species biogeography have suggested drastic consequences for fisheries potential in the tropics. More complex spatial food web models have also been used but require substantial data. What can we learn from different types of models, their predictions and uncertainty? What are their strengths and weaknesses in predicting changes in ecosystems? We will address these and other questions in the context of recent findings, gaps in knowledge, future challenges and opportunities.

INVITED TALK: Structure and stability in species-based and size-based ecological communities

RICHARD LAW, Michael Plank, Julia Blanchard

Recent progress in the dynamics of size-structured ecosystems makes it possible to carry out stability analyses on their steady states. This talk describes some results of this research, and compares them with the well-known results about stability of species-based ecosystems. In both approaches, the structure imposed on the Jacobian matrix by ecological interactions is a key to understanding their stability. However, effects of some ecological factors are different in the size-based and species-based contexts. This includes, for instance, the greater connectance caused by broader diets, which stabilizes size-structured ecosystems.

INVITED TALK: Evolutionary constraints, size-selective foraging, and the structure of insect communities

FRANK van VEEN

I will explore the role that body size and evolutionary constraints play in structuring plant-herbivore-parasitoid-hyperparasitoid food webs. I show that the potential for indirect interactions among species at the same trophic level, either via shared resources or shared natural enemies, is constrained by phylogeny. I also show that the realised host range, at a particular point in time, of some species, and the sex ratio of their offspring, is dependent on the body size distribution of the host community. The relative importance of the evolutionary constraints and the size-based foraging depends on the characteristics of the species involved.

FRIDAY, 15th April, 2011

Presentation of Results & Discussions of the SIZEMIC Summer School: "A Practical Course in Size- Structured Modeling of Population and Community Dynamics in a Changing Climate"

Chair: Andre de Roos & Ken Andersen

Open Discussion Forum for SIZEMIC Delegates on " SIZEMIC: What next?"

Chair: Julia Blanchard

End of SIZEMIC Meeting