

ÜBERSICHT DER ABSTRACTS – BERUFUNG “AQUATISCHE EVOLUTIONSÖKOLOGIE”

Traits and parasites: the ecology of adaptation in freshwater fish

Dr. Jasminca Behrmann-Godel, University of Konstanz

The adaptation of organisms to their environment is in the major focus of my work. We investigate ecologically driven adaptations focusing on regional freshwater fish species as model organisms. Field and laboratory studies are conducted and we combine various analytical techniques such as genetics, geometric morphometrics and stable isotope analysis. First I will focus on whitefish *Coregonus lavaretus* diversification in Lake Konstanz where we found adaptation by trophic trait evolution to a change in the lake's trophic status. Further I will present results of a very recent project: adaptation by phenotypic plastic response to environmental changes in juvenile perch *Perca fluviatilis*. We found that perch can (1) develop a phenotype-environment match allowing for optimal resource exploitation and (2) match their phenotype with congeners in the social context of shoaling. Finally I will concentrate on the adaptive role of major histocompatibility complex (MHC) genes in perch/host-parasite interactions and coevolution. We deciphered the architecture, function and molecular evolution of MHC genes and found that MHC genes are traits under selection in parasite-host arms race and may be important in host adaptation to local parasites. We further found that climate warming (long term increase in water temperature) affected parasite-host coevolution by increasing allelic turnover and decreasing allelic richness of MHC genes in a perch population that was enclosed in a heated biotest basin.

Human-induced responses of aquatic systems under global change

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Human-induced environmental changes in aquatic systems are unprecedented in their rate, intensity, magnitude, and temporal and spatial scale. In many cases such changes in environmental conditions have resulted in the creation of novel ecosystems that exhibit unique species compositions and ecosystem processes that may have little similarity to historic or existing ecosystems. Although these changes can have a profound effect on both ecological and evolutionary processes, the interaction between ecology and evolution still remains comparatively neglected. However, the boundaries between disciplines like ecology, evolution, behaviour, physiology, and modelling are to some extent arbitrary and require cross-sections in order to cope with specific scientific problems and applications. For example, physiological ecology encompasses the diversity not only of organisms, but also of solutions to challenges posed by the environment. A major challenge of my own work is thus linking processes at the level of individual organisms, mainly behaviour, physiology and life

history, with processes acting at higher orders of ecological organisation (e.g. behavioural patterns, population dynamics, food web interactions, and evolutionary adaptations) by employing different experimental, modelling, and citizen science approaches. One major focus of my current research is the investigation of short-term and long-term consequences of a so far little-noticed environmental stressor: the transformation of nocturnal landscapes (nightsapes) due to the widespread use of artificial light at night, which may have serious ecological and evolutionary implications for many organisms, from bacteria to fish, and may reshape entire aquatic ecosystems. Future research should consider response mechanisms in aquatic systems such as acclimation and adaptation, including the physiological, behavioural and evolutionary compensatory mechanisms that can be linked to environmental context and seasonal timing. This allows to map out the potential breadth of biological impacts of human-induced changes and to identify ways in which practical steps can be taken to reduce environmental concerns.

Mikolajewski Dirk

The Evolution of Biodiversity

-causes and pathways-

Biodiversity is paramount to healthy ecosystems and contributes to sustainable ecosystem services and directly to human well-being. Biodiversity is the result of evolutionary processes constantly shaping organisms, their interactions, and the environment. Surprisingly, we have only limited knowledge on how environmental change and organismic interactions shape the evolution of phenotypes and their interactions.

Environmental gradients, e.g. freshwater habitat gradients, which typically differ in environmental constraints along a spatial and/or temporal axis, offer a fruitful opportunity to study phenotypic evolution and to understand features of diversification and adaptation. Here, I will discuss how changes in top-predator regimes as well as seasonal time constraints cause simultaneous selection on multiple traits. The strength of selection determines phenotypic divergence in networks of multiple traits and hence species diversification. I will also discuss factors that promote or decelerate intra- and interspecific differentiation highlighting future

directions to investigate the nature of phenotypic evolution. Only when we obtain fundamental insight into environmentally driven phenotypic evolution, will we be able to predict how human-induced changes affect long-term consequences for biodiversity.

Raeymaekers Joost

Mapping population connectivity, adaptation and ecological resilience to riverscapes

Ecological resilience, the persistence of species across ecological gradients or changing environments, is an important factor underlying ecosystem functioning and stability. Species may vary in ecological resilience because of a different capacity to adapt to environmental change. This capacity depends on species-specific properties such as dispersal capacity, life history, trophic position and genomic architecture. I will show how we can gain insight in this capacity among members of a riverine fish community. By mapping genomic variation across riverscapes, we can quantify the relative contribution of spatial factors (which determine population connectivity) and environmental factors (which influence adaptive processes) shaping population divergence. From this we can deduce how populations persist or adapt, and which species may benefit most from specific management decisions.

The Enigmatic Migrations of Catadromous Eels to their Spawning Areas

Robert Schabetsberger, University of Salzburg, Department of Cell Biology

Our biodiversity surveys of lakes in Oceania and the telemetric studies of terrestrial movements in alpine amphibians led to our interest in using this technological approach to study and follow catadromous Pacific eels (Genus *Anguilla*) to their offshore marine spawning areas. Freshwater eels are major ecological components in the freshwater habitats of the islands across the South Pacific region and have been important mythical creatures for human societies there. Yet, very little is known about their biology. After two years of tagging and releasing silver eels in Vanuatu (giant mottled eel - *Anguilla marmorata*, Polynesian long-finned eel - *A. megastoma*, Polynesian short-finned eel - *A. obscura*) with pop-up satellite archival transmitters, a potential spawning area (460 x 250 km; 8–12°S, 170–175°E) has been discovered south of the equator at the border of the South Equatorial Current and the South Equatorial Countercurrent. Our genetic studies showed that 15% of the analyzed *A. marmorata* and *A. megastoma* eels sampled were hybrids and thus must spawn in the same area. A salinity maximum at the eels' upper nighttime migration depths (150 m) was discovered that may serve as a landmark to help eels locate their spawning area. In a present

research project we are evaluating potential hydrographic signposts at all known and presumed spawning areas of the 19 species and subspecies of eels. The efforts to understand the evolution of long-distance oceanic migrations and the spawning ecology of eels have become recognized as a necessity to begin to understand and prepare to manage the collapse of eel stocks. Some populations have shown alarming declines, and the European, American, and Japanese eels are now classified as “endangered” in the IUCN Red List. Concurrently, the pressure on unexploited tropical stocks is growing, so increasing understanding about them as our research is achieving is important for the future of these species.

Schill Ralph:

Life without water - a peculiar state of biological organization

Certain organisms across a range of taxa, including bacteria, yeasts, plants and many invertebrates such as rotifers, nematodes and tardigrades, are able to survive almost complete loss of body water. This process, known as anhydrobiosis (‘life without water’), leads to an ametabolic state in which organisms can withstand unfavourable environmental conditions for decades without apparent damage. When water again becomes available, anhydrobiotes rapidly rehydrate and resume active life. In addition to the remarkable stress tolerance associated with the anhydrobiotic state, tardigrades can also survive large daily temperature fluctuations without dehydration; this allows them to cope with subzero temperatures in their environment, for example. The adaptations that enable tardigrades to withstand such stresses, in both the hydrated and dehydrated states, are still unclear, although anhydrobiosis was first described more than 300 years ago. In this presentation, I will outline our current understanding of stress tolerance mechanisms in tardigrades and describe current and planned research aimed at providing a more complete picture of this ecologically and evolutionarily important phenomenon.

Alexander Wacker, University of Potsdam

Title: Co-limited in a changing world

Abstract: In my presentation I will focus on the importance of explanatory variables that potentially constrain an efficient transfer of energy and nutrients through aquatic food webs. The decisive factors are acting in a complex manner which may result in simultaneous limitations (multiple resource limitation, *co-limitation*) of organisms by two or more essential resources. Abiotic factors such as the globally expected increase in average temperature associated with more frequent temperature extremes and fluctuations will alter the multiple resource limitations further. Using a combination of computer simulations and experiments (the latter done with the water flea, *Daphnia*) I will show how temperature fluctuations interact with simultaneous changes in e.g. food density. The results reveal the importance of the degree of synchrony between temperature and food fluctuations, and shows the complexity of climate change effects on organisms when more factors than only temperature means are considered.

Assessing the protist communities in the Baltic Sea with a special focus on its oxygen depleted waters

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The Baltic Sea is situated in the transition area of Atlantic marine and Eurasian continental climate systems, which determines the hydroclimatic conditions of the sea. The most essential are salinity and oxygen, both of which have significant gradients. The salinity regime of the Baltic Sea is determined by two major events: amounts and frequencies of saline water inflows (with high oxygen content) from the North Sea through the Danish Straits and riverine (freshwater) inflows. The deep basins of the central Baltic Sea are characterized by anoxic and sulfidic bottom water and steep vertical pelagic redox gradients. The highly active prokaryotic assemblages of this and other redox transition zones have been intensely studied, while knowledge on the protistan communities remains fragmentary.

We characterized protist communities in the redox transition zones of the Baltic Sea and compared them with those of the Black Sea that exhibits similar conditions. The used RNA-based approaches like clone library, DGGE fingerprints and next generation sequencing mainly include real organisms living there. Molecular data were complemented by abundance surveys using counting of stained samples and fluorescence in situ hybridization as well as cultivation approaches. Our aim was to link morphological and quantitative data of cell counts with environmental sequences that are often hard to match with each other. First overall results highlight the potential importance of protists as top-down regulators in suboxic and interface zones, and demonstrate the constraints of deeper anoxic/sulfidic waters for protist communities.