PhD Program in Ecology

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"Ecology Symposium"

Program

A dispersing African wild dog watches the sun setting over a lagoon in the Okavango Delta, northern Botswana.

13 September 2018

RAA-G-01, Aula. Rämistrasse 59

Zurich, Switzerland

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PhD Program in Ecology

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13 September 2018

Session 1

Introduction: Owen Petchey, PhD Program in Ecology
Chair: Frédéric De Schaetzen, PhD Program in Ecology

13:30 – 14:15 **Keynote: Hanna Tuomisto**
'From ruined PhD plans to general understanding of Amazonian biodiversity patterns'
University of Turku, Finland

14:15 – 14:45 **PhD Program in Ecology Alumni: Simon Zeller**
'How to achieve positive environmental impact without going crazy'
Abteilungsleiter Natur und Landschaft, St. Gallen, Canton of St. Gallen, Switzerland

14:45 – 15:00 **Alejandra Parreño**
'Light, nutrients, diversity and biomass: controversies and the way forward'
PhD Program in Ecology; University of Zurich, Switzerland

15:00 – 15:15 **Ingrid Olivares**
'Determinants of beta diversity within and across different spatial scales'
PhD Program in Ecology; University of Zurich, Switzerland

15:15 – 16:00 **Coffee**

Session 2

Chair: Sarah Mayor, PhD Program in Ecology

16:00 – 16:15 **Chelsea Little**
'Biodiversity and ecosystem function across a large river's dendritic network'
PhD Program in Ecology; University of Zurich, Switzerland

16:15 – 16:30 **Gaurav Baruah**
'Environmental change can impact the stability of populations and consequently cause rapid decline in population size'
PhD Program in Ecology; University of Zurich, Switzerland

16:30 – 17:15 **Keynote: Peter Reich**
' Traits, functional diversity, and ecosystem processes in a globally changing environment '
University of Minnesota, USA

17:15 – 17:25 **Debra Zuppinger-Dingley**
'Closing'
PhD Program in Ecology; University of Zurich, Switzerland

17:25 – 19:00 **Apéro and Poster Session**

How to get there

Tram line number 10, stop ETH/Universitätsspital, walk downhill to the venue (Rämistrasse 59).

Tram Line number 9, stop Kantonsschule which is just in front of the venue (Rämistrasse 59).

Abstracts
Presentations

Environmental change can impact the stability of populations and consequently cause rapid decline in population size

Gaurav Baruah
PhD Program in Ecology; University of Zurich, Switzerland

Abundance-based early warning signals have been proposed to predict such declines, but these have been shown to have limited success, leading to the development of warning signals based on shifts in the distribution of fitness related phenotypic traits such as body size. The dynamics of such phenotypic traits in response to external environmental change are controlled by a range of underlying factors such as reproductive rate, genetic variation, and plasticity. However, it remains unknown how such ecological and evolutionary factors affect the stability of populations and the detectability of abundance and trait-based warning signals of population decline. Here, we take a trait-based demographic approach and investigate both trait and population dynamics in response to gradual changes in the environment. We explore a range of ecological and evolutionary constraints under which the stability of a population may be affected. We also show both analytically and with model-based simulations that strength of abundance-based early warning signals are significantly affected by the ecological and evolutionary factors. Finally, we include trait information alongside abundance-based early warning signals and show that a combined approach significantly improves our ability to predict population declines.

Biodiversity and ecosystem function across a large river's dendritic network

Chelsea Little
PhD Program in Ecology; University of Zurich, Switzerland

River networks have a dendritic structure, leading to theoretical predictions of high beta diversity in headwater reaches, and higher alpha diversity downstream where different subcatchments' species pools can mix. Rivers also by nature have directional flow, transporting resources such as terrestrial litter input from upstream to downstream. These resources are processed by different communities, and their decomposition is essential to ecosystem function. To examine biodiversity in a dendritic river network and its effect on ecosystem functioning through subsidy processing, we studied 61 stream and river reaches in a 740 km2 area of the Thur drainage basin in eastern Switzerland. In each reach, we surveyed the macroinvertebrate community and measured breakdown rates of a standardized cotton strip. We also measured environmental conditions such as stream chemistry and temperature, and extracted geographic information about land use, topography, and position in the river network. We did not recover the theoretically-predicted pattern of low alpha and high beta diversity in headwaters. Environmental factors explained some variance in community structure, as did spatial relationships between sampling points. Biodiversity was also only moderately influential on decomposition rates. Instead, we found that the spatial structure of the stream network explained as much of the variance in ecosystem function as did biodiversity and environmental factors combined. Using a geospatial technique developed specifically for stream networks, we could also infer the scale over which ecosystem functioning is spatially correlated. We conclude that incorporating spatial relationships into analyses is essential if we are to understand how biodiversity and ecosystem function vary across landscapes, and that failure to do so will result in biased and incorrect estimates of different factors' influence on ecosystem functioning.

Determinants of beta diversity within and across different spatial scales

Ingrid Olivares
PhD Program in Ecology; University of Zurich, Switzerland

Understanding the distribution of biological diversity in space is a crucial topic of research in ecology, evolution, and conservation. Besides counts of local or regional species numbers (α and γ diversity), the geographical change in species composition (β diversity) is also relevant to understand the spatial distribution of diversity. In the present study, we explored how local and regional factors influence β diversity at each scale, and across them. We did so by analyzing a large data set of 1227 plots established in Bolivia that contains 916 fern species. We included three groups of explanatory factors, namely species richness, environment, and geographical distance. Their influence was assessed within and across scales mainly via Mantel correlations. We found that (1) variations in species richness and environmental factors were the strongest predictors of β diversity at both local and regional scales, (2) local β diversity was also well predicted by variation in regional environmental factors but not by variation in the regional number of species, and (3) regional β diversity was also predicted by variation in local species richness and to a lesser degree by local geographical distances, but not by variation in local environmental conditions. Our findings contrast with those from nearby lowland regions where geographical distance commonly has the strongest influence.
Our results highlight the importance of environmental heterogeneity on the distribution and evolution of biodiversity in mountain ecosystems and suggest that an effective conservation strategy in mountains should put a strong focus on habitat heterogeneity.

Light, nutrients, diversity and biomass: controversies and the way forward

Alejandra Parreño
University of Zurich, Switzerland

How does increasing or decreasing the supply of nutrients and light affect plant productivity and diversity? Should we rather focus on how the diversity of species affects the availability of nutrients and hence the overall productivity? What other variables are important for this system and should always be controlled for in experimental gardens?
These are the main questions driving my talk, where I present the results of a systematic review on the interplay between plant diversity, biomass and inorganic resources. Many alternative hypotheses have been proposed to explain the interactions between these variables, which has sparked an intense scientific debate. Some hypotheses suggest that resource availability or their spatial distribution drive both diversity and biomass changes. Others suggest that diversity is the main driver of resource availability, uptake and conversion to biomass. Many authors have considered interactions with other variables such as temperature or herbivory, although there are no uniform criteria behind the exclusion or inclusion of variables in this system.
In the absence of a general updated review, I collated and analyzed all hypotheses proposed and tested in the literature so far. Out of 69 published papers - 108 independent observations - I found 33 incompatible hypotheses; sufficiently different to preclude their use in a single quantitative analysis. In a second step, I excluded all variables other than the main 4 of interest and grouped the simplified hypotheses based on the proposed direction of causality. This resulted in 14 incompatible hypotheses; only 4 of those had been tested more than once (7, 10, 16 and 48 times, respectively). Results show that there are substantial differences in the hypotheses that have been proposed in the literature, none of which has been thoroughly tested, hindering the possibility of drawing general conclusions. Moreover, some of the most widely cited hypotheses have very seldom been tested. This issue has to be addressed first, in order to subsequently gather enough quantitative information on any of them. Contrasting quantitatively these hypotheses would greatly advance our understanding of natural systems, given that these variables are key in shaping the structure of plant

communities. In turn, this understanding could translate into better management decisions for production and conservation.
Key words: light, nutrients, plants, diversity, biomass, review

Traits, functional diversity, and ecosystem processes in a globally changing environment

Peter Reich
University of Minnesota, USA

Organismal traits and their diversity result from evolution and physiology, and reflect variation in ecological strategies. They provide a lens through which those ecological strategies, and their consequences, can be compared among taxa that co-occur locally, as well as across climate zones and ecosystem types worldwide. Traits are not random: not all trait combinations exist in nature, because they are selected against, are biophysically impossible, or both. Most taxa have traits that reside somewhere along a continuum from a 'slow' to a 'fast' return-on-investment design strategy relative to several important resource and stress axes. There is a diversity of successful strategies along that continuum because of trade-offs that confer fitness at different locations along those axes in different contexts and conditions. Moreover, the position (mean and variance) of taxa on those trait axes influences the dynamics, structure, and function of communities and ecosystems. Such links are relevant to both the historical ecological landscape of the past and to the dynamic and rapidly changing world of the 21st century, replete with its changing climate, chemistry and biota. Using data ranging from ecosystem-scale biodiversity experiments crossed with global change factors to cross-continental observations and global modeling, I provide an overview of the connections across some of these ecological strands.
[Note: to hear more about climate change and carbon cycling from leaf to ecosystem to globe, please come to my talk at ETH Zurich on September 14]

From ruined PhD plans to general understanding of Amazonian biodiversity patterns

Hanna Tuomisto
University of Turku, Finland

Sometimes a research project does not work out the way it was planned. I did my PhD together with a colleague with whom we made careful plans on how we would document structural and floristic heterogeneity of Amazonian rain forests in Peru. Once we got to the forest, we very soon realized that what we had planned to do was unrealistic. Especially my part failed miserably, so for the first few weeks I helped my colleague carry out the doable parts of his plans, while casting around for a new topic for my own PhD. Eventually I decided to focus on ferns, which I knew next to nothing about but they seemed relatively easy to spot in the forest and not too difficult to collect. Luckily, those early data showed that ferns are a very useful indicator group both for local environmental variables (especially soils) and for general floristic patterns. So, I continued to work on them. Now we have, with contribution from many collaborators, accumulated data on fern species composition from more than 1000 sites across the Amazon basin. Together with data from other plant groups, soils, geology and remote sensing, these data have revealed higher than expected heterogeneity and environmental determinism within the Amazonian forests. Now they are being used to draw general conclusions
about Amazonian ecology and biogeography. Sometimes plan B turns out to be just as good as (or even better than) plan A.

How to achieve positive environmental impact without going crazy
Simon Zeller
Abteilungsleiter Natur und Landschaft, St. Gallen, Canton of St. Gallen, Switzerland
Dr. Simon Zeller will share insights about his switch from basic science to more applied work in the fields of policymaking, nature protection and finally nature conservation. Which were the hard and soft skills that helped to reach his career goals. What are advantages and challenges of working for an NGO or the government. He will also talk briefly about his habitat restoration projects and the benefit of permaculture at his farm.

Posters

Dispersal and its demographic consequences in the endangered African wild dog (Lycaon pictus)
Dominik Behr
PhD Program in Ecology; University of Zurich, Switzerland
Dispersal of individuals is an important process governing the population dynamics of socially and spatially structured populations. However, there is a mismatch between our understanding of the complexity of dispersal and our representation of dispersal in models of population dynamics. This is largely due to technological limitation and our inability to follow the fate and whereabouts of dispersing individuals. In a rapid changing word, failure to incorporate the complexity of sociality and dispersal in population dynamic models can have severe conservation and management consequences. This is particularly undesirable for threatened species such as the highly endangered African wild dog (*Lycaon pictus*) whose population numbers less than 6000 individuals. Here I propose to bring together latest developments in radio-tracking technology and 25 years of individual-based data on within-group demography to provide an explicit investigation of dispersal in a socially and spatially structured population of African wild dogs in the Okavango Delta ecosystem in northern Botswana. Specifically, I aim to explore the patterns and mechanisms of dispersal, the resulting population-dynamic implications of dispersal, and present scientific evidence for the implementation of effective conservation strategies. For this I will deploy GPS/Satellite radio collars on a minimum of 30 dispersing individuals to closely follow their movements and monitor their dispersal success (e.g. survival rate and reproductive success after settlement). I will then use available long-term demographic data and novel dispersal data to investigate the population-dynamic and evolutionary consequences of dispersal in wild dogs at an unprecedented detail level. By placing dispersal into a wider ecological context, this project will increase our fundamental biological understanding of dispersal and help improve our ability to predict and manage the responses to environmental and anthropogenic perturbations of endangered carnivores living in socially and spatially structured populations. This project will provide an important scientific insight for evidence-based conservation of the African wild dog. The African wild dog is a charismatic and iconic symbol of conservation efforts of an entire continent. Our results will receive scientific and media coverage and help expose UZH research to wider public.

Natural selection on immune defence: a genome-wide gene expression analysis
Teo Cereghetti
PhD Program in Ecology; EAWAG, Switzerland
Parasites and pathogens present a serious threat for natural populations of free-living organisms. The host immune system is considered to be the main physiological barrier against infections, and therefore understanding the evolution of immune function is crucial for understanding host–parasite interactions. Genetic variation in immune defence traits has been frequently shown to be high in natural populations, but the relationship between variation in immune activity and fitness (i.e. natural selection on immune function) is generally less well understood. This limits our understanding of the adaptive evolution of host immune function, and thus of processes that are important for host–parasite ecology and evolution.
The main aim of this project is to comprehensively examine how natural selection shapes host immune defence traits at the level of gene expression using the freshwater snail *Lymnaea*

stagnalis as a model. The selected genes represent different immune processes important for snail defences in order to broadly quantify the activity of snail immune function. The specific goals of the project are to assess (1) the form and strength of selection on the level of expression of immune defence genes and pathways in the wild, (2-3) the role of infection risk and trade-offs related to immune function in determining the form of selection, and (4) responses of natural snail populations to selection imposed by trematode parasites. In general, theory predicts immune defence traits to be subject to positive directional and/or stabilizing selection. Since the function of the immune system is to prevent and eliminate harmful infections, a strong immune system can be assumed to be beneficial for fitness and thus evolve as a response to parasitism. However, immune defence is often energetically costly to maintain and use, which leads to trade-offs between immune function and life-history traits, as well as between different immune traits. Therefore, the combined effects of benefits and costs related to immune activity can be expected to define selection on immune function, as well as the observed level of immune expression in natural populations.
The proposed work is highly novel by combining quantitative genetic theory with modern functional genomics, thus being able to investigate evolutionary ecology of host immune function by broadly covering the expression of relevant immune pathways.

Quantifying motility and chemotaxis of marine bacteria in situ

Estelle Clerc
PhD Program in Ecology; *ETHZ, Switzerland*

Many marine microorganisms leverage chemotaxis and motility to navigate the complex and heterogeneous physico-chemical landscape they inhabit. This behavior is of great ecological importance as theoretical and laboratory experiments have suggested that rates of biogeochemical cycling by motile microbes within these microscale hotspots may considerably exceed the surrounding bulk rates. Despite advances in our understanding of microbial motility in the ocean, some pieces of critical information currently inhibit our ability to scale up the role of motility in key biogeochemical processes. Specifically, we still know very little about the fraction of actively swimming bacteria in the ocean, what environmental conditions promote motility, and over what timescales bacteria can deploy this behavior. To bridge this knowledge gap, we are employing the In-Situ Motility Assay (ISMA), a field-based microfluidic device to quantify in situ the abundance, identity, and functional potential of actively swimming cells. Here we present initial laboratory validation and field tests of the ISMA. Combined with a suite of ancillary environmental data, the ISMA promises to be a valuable new tool to study motility dynamics, the conditions that select for microbial motility and ultimately get a better handle on the ecosystem-consequences of this behavior.

Microbial Ecology Viewed Through a Macroecological Lens: Resource Ecology of Marine Bacterial Communities in Dynamic Heterogeneous Resource Landscapes

Frédéric de Schaetzen
PhD Program in Ecology; University of Zurich, Switzerland

In the ocean, microorganisms play a fundamental role in global carbon cycling through the degradation of organic matter. The concentration of this material varies greatly in space and through time, creating a landscape of resource gradients and hotspots in which marine bacteria thrive.
High throughput omics techniques have shaped modern microbial ecology and have provided valuable information on the diversity and metabolic activity of bacteria involved in ecological processes at the bulk scale. In contrast, due to methodological limitations, the traditional approaches of macroecology based foraging theory and landscape ecology have not been applied to microbial ecology.
My aim is to observe and quantify the individual and communal foraging strategies of marine microbial communities in heterogeneous landscapes of nutrient hotspot. A highly customizable microscale platform, based on microfluidic technologies, will provide a window to measure temporal and spatial dispersal patterns of a foraging microbial community across a range of dynamic heterogeneous resource landscapes and community compositions. I will use a model microbial community that is associated with the degradation of particulate organic matter (POM) in marine environments.

This approach promises to yield unique insights into the foraging behavior of microbial communities exploiting hotspots of organic matter in a complex resource landscape. It will therefore provide a mechanistic understanding of ecological processes that influence biogeochemical cycles of carbon in ocean ecosystems.

Habitat specialists in forests are in worldwide decline due to deforestation and intensive forest management.

Antonia Ettwein
PhD Program in Ecology; Vogelwarte, Switzerland

Habitat specialists in forests are in worldwide decline due to deforestation and intensive forest management. For developing conservation measures for these species, detailed knowledge of their biology and ecology is required. In this study I investigate aspects of the ecology of the white-backed woodpecker, a highly specialized and threatened species and umbrella species for inhabitants of natural broad-leaved or mixed forests, in a recently recolonized area. In contrast to areas previously studied, forests in this area are mainly managed.
I use radio telemetry to investigate 1) home range selection within a landscape, 2) home range size variation over the year, 3) the use of different habitat types, and 4) the relationship between reproductive performance and habitat quality/forest management intensity. Based on the results I aim to suggest measures for the conservation of this habitat specialist in managed forests.

Reasons for Planktothrix rubescens growth in Lake Zurich and Lake Constance

Antonia Ettwein
PhD Program in Ecology; Vogelwarte, Switzerland

Within the past 50 years the toxic cyanobacterium *Planktothrix rubescens* has become the dominant planktonic organism in Lake Zurich. The enormous *P. rubescens* biomass causes drastic declines in diatoms and cryptophytes and changes the total nutrient loading of Lake Zurich. In the past, deep water turnover (>90m) in winter was the main factor reducing P. rubescens biomass since the strongest type of gas vesicle *P. rubescens* contains can only endure pressure <10 bar. Increasing water temperatures in Lake Zurich have reduced the depth of water turnover which now allows higher proportions of the *P. rubescens* population to survive the winter months. Therefore, *P. rubescens* shows annually returning blooms in Lake Zurich over the past years, despite a drastic decrease of nutrients. With the sudden appearance of P. rubescens in Lake Constance in 2014 the question arose if similar processes (lake warming & changed nutrient ratios) as in Lake Zurich promote the growth of this cyanobacterium. My PhD aims to elucidate processes promoting the growth of *P. rubescens* in Lake Zurich and Lake Constance by comparison of long-term datasets, genetic analyses (gas vesicles & toxicity) and experimental approaches (nutrient stoichiometry).

Drivers of species dominance

Iris Hordijk
PhD Program in Ecology; ETHZ, Switzerland

Ecological communities consist typically of a few dominant and many rare species, and although there is growing evidence that many communities are highly uneven, it is unknown what drives evenness and if general characteristics of dominant species can be identified. A theoretical framework is proposed in which evenness is (in)directly influenced by species richness on the ecosystem level and dominance on the species level. Species richness is mainly affected by resource availability, productivity and spatial heterogeneity, and the ability of a species to become dominant is mainly affected by habitat adaptation, intraspecific trait variability and competitive ability. Reviewing literature on these relationships, the knowledge gaps and research priorities became clear. Therefore, the aim of this PhD project is to 1) understand the drivers of evenness, 2) identify which traits explain species dominance, and 3) explore how evenness affects ecosystem functioning.

SYSteMiC : System Efficiency of Microbial Consortia

Alizée Le Moigne
PhD Program in Ecology; University of Zurich, Switzerland

Aquatic systems provide important ecosystem services such as drinking water supply. These systems are very sensitive to climate change and the understanding of their functioning is essential to predict the changes that may be induced by climate change. Among ecosystem functions, microbial Carbon Use Efficiency (CUE) has gained importance in understanding global microbial CO2 emissions. Current research is largely focused on the relationships between CUE and abiotic factors at the community level. The project will explore the hypothesis that CUE is also related to the specific interactions between microbial taxa and that identical growth conditions may, due to stochastic community assembly processes, allow multiple stable assemblages with different interaction networks that could lead to vastly different CUEs. As a first step, numerous experimental consortia of freshwater bacterioplankton will be generated under the same abiotic conditions and their overall CUE will be studied. Then the research will focus on the analysis of consortia at the extremes of the efficiency distribution. Specific interactions will be investigated through biotic manipulation such as food web manipulation, rarefying and mixing consortia and define co-culture of keystone species. Finally, hypothesis and methods generated in the experimental systems will be tested in natural freshwater microbial assemblages.

Ecology and conservation of snow leopards in Bhutan

Dechen Lham
PhD Program in Ecology; University of Zurich, Switzerland

The snow leopard *Panthera unciais* one of world's rarest cats, and conservation of its remnant populations is faced with multiple threats and challenges, including habitat fragmentation and degradation, declining prey base, retaliatory killing, illegal trade, weak policies, insufficient transboundary cooperation, and lack of scientific information. Globally, snow leopards are found only in twelve countries. Bhutan lies at the southern periphery of the species' range and represents an important corridor between the Indian and Chinese populations. It is important to understand the basic ecology and life-history characteristics, population dynamics, predator-prey dynamics, genetic variation, movement ecology and spatial connectivity, and human-wildlife interactions in order to take appropriate and timely conservation action to prevent global extinction. In Bhutan, very little is known about the snow leopard's ecology, and basic information on distribution, abundance, diet, and degree of conflict with rural communities are lacking. My research, divided among four main chapters, aims to fill this important information gap for the conservation of the snow leopard in Bhutan. The first chapter will investigate the distribution and abundance of snow leopards across Bhutan and identify the underlying environmental and anthropogenic factors. The second chapter will investigate the genetic variation of snow leopards across Bhutan to assess the degree of connectivity among the protected areas of the country. The third chapter will characterize the regional and seasonal dietary habits of snow leopards with particular focus on the differences between wild and domestic prey. My fourth and final chapter will evaluate human perception towards snow leopards in Bhutan and determine the degree of human-wildlife conflict and its causes. As a result of this PhD work, I will provide evidence-based recommendations for conservation strategies and interventions, and develop an effective snow leopard management plan for Bhutan. The results from my project will shed light into the population health and life-history characteristics of this elusive cat, and also help meet Bhutan's national snow leopard conservation goal.

CO2 fertilization: its potential for carbon sequestration

Julia Maschler
PhD Program in Ecology; ETHZ, Switzerland

Throughout the last few decades, the atmospheric CO2 levels have risen to levels unseen in the last 20 million years. Short-term experiments suggest that an elevated atmospheric CO2 concentration increases plant growth. An increased carbon uptake by plants could have a climate change mitigating effect. However, it is unclear how the availability of other growth limiting factors, e.g. nitrogen and water, will change in the long run. Furthermore, even if there is a long-term stimulation of plant growth, the additional sequestration could still be outweighed by an increase in plant mortality. The aim of this PhD project is to gain additional insights into the potential long-term effects of CO2

fertilization and its implications for terrestrial carbon sequestration under future climate change scenarios.

Eco-evolutionary physiology of environmental stress: is corticosterone a "magic link" in rapid adaptive divergence of the moor frog (Rana arvalis)?

Jelena Mausbach
PhD Program in Ecology; EAWAG, Switzerland

Physiological processes, as immediate responses to the environment, are important mechanisms of phenotypic plasticity and can influence evolution at ecological time scales. In stressful environments, physiological responses are manifested as release of stress hormones, such as corticosterone (CORT), which enables energy mobilization to multiple stress response traits and influences gene expression. Moreover, as CORT influences multiple fitness traits (e.g. growth and immune function), it may be a key mediator of rapid adaptation to multiple stressors (i.e. be "a magic link") during environmental change – such as acidification. Environmental acidification causes selection through disrupted physiological balance (e.g. ion uptake/loss) as well as altered biotic communities (e.g. predators and parasites). Accordingly, the moor frog, *Rana arvalis*, shows adaptive divergence in larval life-histories and predator defense traits along an acidification gradient in Sweden. As a first step to understanding the role of CORT in this adaptive divergence, we conducted a common garden laboratory experiment (rearing of tadpoles at benign, pH 7.5, versus stressful, pH 4.2, conditions) and investigated to what extent three phenotypically divergent populations differ in their CORT profiles, and CORT-phenotype (morphology, metamorphic size /age) correlations, at benign versus stressful pH. We discuss the findings in light of environmental stress mediated selection on physiological traits.

The diversity-ecosystem functioning relationship at the landscape scale across different environmental contexts

Sarah Mayor
PhD Program in Ecology; University of Zurich, Switzerland

The large-scale alteration of ecosystems by anthropogenic activities has homogenized and critically reduced species richness worldwide, leading to a reduction in the benefits people derive from nature. Indeed, biodiversity loss is now ranked among the top global stressors affecting species and ecosystems, with potential impacts on ecosystem functioning and services as quantitatively significant as those expected from climate change (Hooper et al., 2012). However, there are still substantial uncertainties when attempting to predict the direction and intensity of how biodiversity loss will affect ecosystem functioning. This is especially true at the larger spatial and temporal scales at which people experience and manage them, as past studies have mostly focused on small scale, artificial experiments. In this project, I will be investigating the relationship between biodiversity and ecosystem functioning in "real-world" landscapes at scales which incorporate the natural spatial flows of energy, materials and organisms circulating across the mosaics of patches that form meta-ecosystems, otherwise ignored by plot level experiments. In particular, I will be exploring the role of landscape heterogeneity in a meta-ecosystem – used here as a proxy for biodiversity – and its relationship with primary productivity and seasonal phenology. By bridging approaches from remote sensing, community ecology and biogeography, I aim to assess (1) whether landscape diversity promotes productivity, (2) whether it is mediated or independent of local species richness and (3) whether the relationship varies with environmental context and (4) across scale. This study is important to uncover to which extent the patterns found for species in plot-scale experiments can be extrapolated to larger scales of space and organizational units to help mediate the ongoing loss of ecosystem functions and services associated with the homogenization of our planet.

Feedbacks between biodiversity and climate through plant traits and light interaction

Elena Plekhanova
PhD Program in Ecology; University of Zurich, Switzerland

The interaction of shortwave radiation with vegetation influences key mechanisms (i.e. plant physiology, species interactions through competition) driving biodiversity changes under future conditions, and related feedbacks to climate. We study how do climate change influence to plant functional traits, their optical properties and vegetation distribution. For this purpose, we establish 3-

year experiment in Siberian tundra, testing different precipitation regimes. Further, we investigate their effect to albedo through modelling different species distributions with different traits. Then we will use this foretasted albedo to predict future climate changes.

Differential response of arbuscular mycorrhizal and rhizobial symbionts to soil management: Can we link it to host plant performance?

Josep Ramoneda
PhD Program in Ecology; ETHZ, Switzerland

Recent observations have proved that the roots of rooibos (*Aspalathus linearis*, *Crotalarieae, Fabaceae*), an endemic legume crop from South Africa, are colonized by arbuscular mycorrhizal fungi (AMF). AMF are obligate symbiotic fungi with specialized structures called arbuscules that transfer mostly phosphorus (P) to the plant, while extra-radical hyphal growth enhances water acquisition. Since rooibos is cultivated in extremely nutrient and organic matter poor soils, threatened by desertification, there is a great need to investigate whether different levels of AMF root colonization, under different soil management practices, can influence rooibos nutrition and growth. Using molecular methods, we have characterized the structure of the rooibos AMF communities, and related the relative abundance of the different taxa to the plant nutritional response in a soil mixing experiment. We show compositional differences in the AMF colonization of rooibos roots depending on soil N and P levels, indicating soil management has an impact on these communities. The functional outcomes for the plant's P nutrition, however, are not evident from our data, pointing at a weak dependency on AMF by rooibos.

Breeding Ecology and Population Dynamics of a Highly Specialized Alpine Passerine

Christian Schano
PhD Program in Ecology, University of Zurich, Switzerland

Species with obligate affiliation to extreme environments have to match similar physiological requirements as those living under more constant conditions, but are often faced with more energetically demanding circumstances. Disproportionate warming of alpine habitats as well as resulting changes in seasonal snow and species composition potentially hold unforeseeable difficulties for the highly adapted needs of alpine specialists. The passerine white-winged snowfinch (henceforth snowfinch), *Montifringilla nivalis*, inhabits nival habitats across the Palearctic and is resident to alpine mountain ranges of Central and Southern Europe with its nominotypical subspecies. Snowfinches primarily feed granivorously but adults may partly feed on insects in summer. Nestlings are mainly reared on cranefly larvae (Tipulidae) caught in close proximity to melting snow patches. Over the past 20 years, snowfinch densities decreased to a variable extent in Switzerland caused by mechanisms yet to be understood. Consequently, there is an urgent need to understand the impact of environmental changes on the population dynamics of this poorly studied species. My PhD therefore focuses on determining the underlying factors causing such declines and to grasp the adaptiveness of snowfinches to their rapidly changing environment. Therefore, I will analyze long-term data from the Swiss Ornithological Institute as well as newly gathered data from the institute`s snowfinch project, originally started in 2016. During three breeding seasons, I will use point counts and transects to gather data on the metapopulation level. Individual data will be collected conducting feeding observations, morphometric measurements and ringing nestlings as well as adults. Firstly, a long-term citizen science dataset will be analyzed to test for a possible correlation between the onset of breeding and snow cover per year in order to realize the effect of snow on the breeding phenology in snowfinches. Secondly, factors influencing abundance will be analyzed comparing bird atlas data and long-term survey data as well as using own point count and line transect data. After establishing a base for understanding population status and development on a general basis, research will proceed using individual data. Therefore, I aim to finding factors influencing reproduction and breeding success. Finally, I will use ringing data from nest ringing and trapped adults to estimate dispersal and survival and assess their relation to environmental factors. This research therefore aims for a better understanding of the ecological mechanisms of population development of this highly specialized alpine passerine

Landscape Heterogeneity as an Indicator of Biome Transition Zones?

Leila Schuh
PhD Program in Ecology; University of Zurich, Switzerland

The world's biomes are changing due to multiple anthropogenic and ecological drivers (De Jong et al. 2013a). Climatic and environmental conditions determine the spatial range of individual ecosystems, vegetation characteristics enable us to distinguish them from each other (Whittaker 1970) (Fig.1). The Normalized Difference Vegetation Index (NDVI), derived from satellite imagery, has proven a good proxy for photosynthetic vegetation activity (Pettorelli et al., 2005). While temporal trends of individual pixel values have been studied extensively, we analyze dynamics in spatial configuration over time.

The Coevolved Web of Life - How Coevolution Affects (and is Affected by) the Structure of Species Interaction Networks

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The “Web of Life” is a metaphor for the complex networks arising from species and their diverse interactions. Studies on the structure of these networks have revealed certain general patterns, such as nestedness in mutualistic networks or a modular organization of food webs. While it was found that such structural properties have crucial implications on ecological processes, their effect on species evolution as well as their potential evolutionary origin are less understood. In my PhD, I will explore how the network structure of species interaction networks affects coevolution and how coevolution itself can account for general patterns in these networks (e.g. nestedness). I will do this by means of computational models and the application of concepts form network and evolutionary game theory. By considering our knowledge on how genetic changes translate into changes at the phenotypic level (e.g. interaction relevant traits), this work is intended to expand current modeling paradigms in research on (co)-evolution.