Research Area **Ecology and Evolution**

UNIVERSITÄT SALZBURG

DSP DynamitE - MSc-PhD Seminar SS 2023 (LVA 230.340 and 796.300)

June 23rd, 2023 – Room C-006 (H34, 3rd floor)

Hosts: Supervisors of MSc- and PhD-projects, Dept. Environment and Biodiversity

09:15 – 09:30 **Welcome (Ulrike Berninger)**

Session 1 **Chair: Jana Petermann, Karin Gross**

09:30 – 09:45 **Anna Sommer**
Aquatic insects in urban space – a multicity study

09:45 – 10:00 **Mareike Mittag**
Multi-trophic interactions in a forest biodiversity experiment in China

10:00 – 10:15 **Maria Frankova**
Slightly sliding communities – The plant ecology of landslide areas in two alpine UNESCO Global Geoparks

10:15 – 10:30 **Anna Götz**
Assessing temporal and spatial patterns of fungal and algal symbionts in saxicolous crustose lichens on large-scale landslide dynamics

Coffee break (10:30 – 11:15, 45 Minutes)

Session 2 **Chair: Stefan Dötterl, Stephen Wickham**

11:15 – 11:30 **Andreas Fellner**
Fly into the light: treating fruit fly *Drosophila melanogaster* with photodynamic inactivation based on Na-Mg-chlorophyllin

11:30 – 11:45 **Fiona Strassl**
The population structures and habitat requirements of *Euphydras maturna* in the Untersberg region

11:45 – 12:00 **Florian Hohenberger**
Mechanisms driving species composition of high alpine lakes

12:00 – 12:15 **Pablo Molina-Rosillo** *(via Webex)*
Biogas plant feasibility study for a Portuguese waste management operator

Lunch break (12:30 – 14:00, 90 minutes)

Session 3 **Chair: Bea Apfelbeck, Andi Tribsch**

14:00 - 14:15 **Kathrin Mössler**
Insights into phylogeography and taxonomy of the sect. *Helleborastrum* Spach (Helleborus L., Ranunculaceae) incl. cultivated and wild populations in Austria

14:15 – 14:30 **Cristopher Kleinbruckner**
Unraveling the mystery of chlorophyll deficiency in *Salvia officinalis*: physiological, anatomical and molecular comparison of different chlorophyll-deficient mutants

14:30 – 14:45 **Nina Czipf**
Air-cooled sites as potential refuge areas for cold-adapted plants in times of climate change

14:45 – 15:00 D**aniel Lukic**
The bee-beetles' evolution – Novel techniques to enlighten the history of renowned celebrities

15:00 – 15:15 **Noreen Mutoro**
Modeling cheetah (*Acinomyx jubatus*) distribution before and after major habitat modification in south-eastern Kenya

Coffee break (15:15 – 15:45, 30 Minutes)

Session 4 **Chair: Jan Habel**

15: 45 – 16:15 **Maria Fungomeli**
Invited guest speaker – National Museums of Kenya
Biodiversity and conservation of the East African Coastal Forest

16:15 – 16:30 **Closing remarks: Jan Habel**

At the end of the seminar all attendants, guests, speakers, supervisors, etc. are invited to the *pizza and beer round table*

Anna Sommer

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Pablo Sandoval-Acuña, Jana Petermann, Jonas Eberle, Martin Gossner, Diane Srivastava, Marcela Rubio-Suarez, Swen Renner, Stefano Larsen

AQUATIC INSECTS IN URBAN SPACE – A MULTICITY STUDY

Water-filled tree holes are well known as breeding habitats for a range of insects and as useful model systems to investigate effects of anthropogenic change. Even in cities small standing waters serve as breeding sites. Due to increases in human population and subsequent urban development, it is important to understand how these habitats and inhabiting insects are affected by anthropogenic influence such as urbanization. In a previous study in the city of Salzburg we could reveal several effects on aquatic insects. High proportions of sealed surface could be shown to be beneficial for the larval development of certain adapted species such as mosquitoes. Additionally, species composition changed with higher urbanization, finding a higher diversity in more green areas. To investigate if our findings apply to other cities, we studied artificial tree holes in five cities. We tested if and how abundance, species richness and species composition were affected by the degree of sealed soil, building density, NDVI and environmental variables such as resource amount, pH, and water temperatures. The results show that urbanity-associated variables do not affect aquatic insects in general. Effects of urbanization were complex, varied between cities and showed different directions. Summarizing, our study provides novel insights that can be useful for urban planning.

Mareike Mittag

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Jana Petermann, Andreas Schuldt

MULTI-TROPHIC INTERACTIONS IN A FOREST BIODIVERSITY EXPERIMENT IN CHINA

SP3: PLANT-ARTHROPOD FOOD WEBS, STOICHIOMETRY AND FUNCTIONS

The loss of tree diversity or extinction of tree species has enormous implications for ecosystem structures, functions, and associated stability. However, the exact relationships and active, critical interaction linkages are still largely unknown. Predicting and accurately analysing the responses of the plant-herbivore-predator multitrophic system is therefore a scientific topic of high relevance and an important step in moving closer to a complete understanding of processes of natural ecosystems.

The goal is to construct multitrophic community networks in a forest diversity experiment in China (Project MultiTroph, subproject 3, at the research platform BEF China), especially focusing on tritrophic effects (trees, herbivorous arthropods, and predatory arthropods) based on food web structure, trophic rates, and energy flows between trophic levels, and combine these as a function of tree diversity.

Three work packages combine different methods of data acquisition to aim at specific multitrophic and diversity related hypotheses.

Maria Frankova
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Dr. Jana Petermann, Maximilian Schröcker

SLIGHTLY SLIDING COMMUNITIES – THE PLANT ECOLOGY OF LANDSLIDE AREAS IN TWO ALPINE UNESCO GLOBAL GEOPARKS

Landslides are downhill mass movements of substrate that occur on disturbed slopes. They simultaneously erase whole landscape structures and create new environments that are colonized by microorganisms, insects, and plants. While significant research has been conducted in tropical areas, limited knowledge exists regarding the impact of landslides on plant communities in alpine regions, particularly concerning the influence of landslide types and herbivory.

Therefore, this study aims to achieve two primary objectives: (1) provide a detailed description of plant communities and their environmental parameters in landslide sites, and (2) compile a list of rare or endangered species that enhance the biological value of these geological sites. The research will be conducted in two alpine UNESCO Global Geoparks: Erz der Alpen (Salzburg) and Karawanken (Kärnten). Fieldwork will involve species assessment, measurement of aboveground primary productivity, and evaluation of invertebrate herbivory. Collaboration with my colleague, Maximilian Schröcker, focusing on insect communities will enable a more comprehensive analysis of herbivory patterns.

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ASSESSING TEMPORAL AND SPATIAL PATTERNS OF FUNGAL AND ALGAL SYMBIONTS OF SAXICOLOUS CRUSTOSE LICHENS CAUSED BY LARGE – SCALE LANDSLIDES IN SARY CHELEK, KYRGYZSTAN

The lichen symbiosis – a mutualistic interaction between fungi, algae and bacteria - is assumed to often be constrained by environmental conditions. Moreover, the interaction between fungal and algal symbionts is strongly shaped by the species-specific selectivity. Little is known about the influence of temporal and spatial habitat structuring caused by landslide events on the lichen species assemblages and symbiont network structure. Sary Chelek in Kyrgyzstan is one of the largest identified landslides in the Tien Shan. It is supposed that at least two large – scale landslide events and multiple smaller ones dammed up the Sary Chelek lake resulting in the Sary Chelek landslide dam. The different temporal distinct deposits constitute the perfect area to link the change in species composition, species interaction processes and network dynamics of lichen symbionts to mass movement processes. 200 saxicolous lichen species were sampled on distinct depositional zones, resulting from two major, temporal separate landslide events. The sampling areas differ in abiotic conditions and elevation. The mycobiont species and photobiont OTUs were identified using the barcode marker nrITS. Additional morphological determination was performed for the fungal symbionts. Environmental data for the sampling sites were obtained by remote sensing from Sentinel-2/Copernicus 30 data. The study shows an overall great diversity of saxicolous lichen on the Sary Chelek landslide dam in Kyrgyzstan. The most abundant species were part of the genera Aspicilia, Lobothallia, Circinaria and Thelidium. Furthermore, a locally highly abundant species (Aspicilia sp.1) could be newly described. Fungal and algal symbiont assemblages did not reflect the habitat structuring of the landslide processes. On this scale the species distributions might be driven by random factors (ecological drift). The results also indicate that the species distribution is not shaped by an elevational gradient. However, the study shows that large-scale mass movements (by generating habitat heterogeneity of habitat and frequent disturbances) may shape the structure of lichen symbiont networks regarding symbiont connectivity. It can be assumed that in this case the changes in species interaction and specificity are more likely caused by environmental filtering by the habitat heterogeneity caused by mass movements than by temporal patch dynamics on the landslide deposits.

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FLY INTO THE LIGHT: TREATING FRUIT FLY *DROSOPHILA MELANOGASTER* WITH PHOTODYNAMIC INACTIVATION BASED ON NA-MG-CHLOROPHYLLIN.

Fruit flies spoil crops in agricultural settings. As conventional pesticides may generate negative off-target effects on humans or the environment existing treatment methods need eco-friendly and safe alternatives. Photodynamic Inactivation (PDI) is based on the photosensitizer-mediated and light-induced overproduction of reactive oxygen species in harmful or unwanted targets. We here explore the potential of PDI for combatting fruit fly pests. *Drosophila melanogaster* as well-established model organism was employed in this study. We here introduce two different experimental approaches, the feed assay, where Na-Mg-Chlorophyllin (Chl, approved as food additive E140) is offered to the fruit flies as food in combination with sucrose (3%) and the spray assay, where the photosensitizer is sprayed onto the insects. We show that PDI based on Chl is able to induce mortality rates of *Drosophila melanogaster* of more than 99% with 5 mM Chl and LED illumination (8 hours incubation in the dark, radiant exposure 78.9 J/cm²) with the feed assay, or more than 95% after exposure to sunlight with the spray assay (14 hours dark incubation with 5 mM Chl and 5 hours of sunlight illumination, 532 J/cm²). For the anti-insect PDI to be effective, a drug to light interval of several hours is required, which would translate to spraying the photosensitizers in the evening for the field application. In conclusion, PDI causes high mortality rates of *Drosophila melanogaster* in both tested assays.

Fiona Strassl
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THE POPULATION STRUCTURES AND HABITAT REQUIREMENTS OF EUPHYDRAS MATURNA IN THE UNTERSBERG REGION

Habitat loss and degradation is one of the greatest threats to biodiversity worldwide. Many animal and plant species depend on certain habitats and environmental conditions to survive and reproduce. An example of a species severely affected by habitat degradation is the scarce fritillary (*Euphydryas maturna*). It prefers to inhabit sparse moist deciduous forests with clearings and heterogeneously structured open areas. The species has been severely declined in many regions due to habitat loss and intensive land use. The area of the Untersberg foothills is home to one of the few remaining large populations of the scarce fritillary.
In this master thesis we will investigate and analyse the population ecology, habitat requirements and fluctuations in the populations still present there. Potential habitats will be mapped and located using GPS at the beginning. Hereby all ash trees in the area will be investigated. Furthermore during the flight period, a of the adult butterfly all found individual will be marked and counted. To better understand the habitat conditions, the habitat parameters will be recorded in detail and the microclimate will be analysed using microclimate loggers. The habitat structures will also be surveyed from the ground and analysed with a laser scanner. To get an overview of the further development of the population, the caterpillar nests on the ash trees will also be mapped and located using GPS. To better understand the population dynamics of the scarce fritillary butterfly, the newly collected data will be combined with existing historical data and statistically analysed. The goal of the master thesis is to answer the following questions. How large is the population? How is it structured? Another important point is the evaluation of the habitat quality or the determination of the exact habitat requirements of *E. maturna*. Furthermore, by including historical data, long-term trends could be studied, thus improving protected areas, and helping to gain a better understanding of the exact needs of the species.

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MECHANISMS DRIVING SPECIES COMPOSITION OF HIGH ALPINE LAKES

High alpine lakes are extreme environments. Species must be adapted to these harsh conditions, with short winters and long ice-covered periods. Due to warming in alpine regions these hostile environments will become relatively more friendly with earlier ice out, increasing water temperatures and changes in productivity, which may occur with climate change. This might alternate species composition in the lakes. Within our transdisciplinary ÖAW-funded project AlpLakeChange, the zooplankton community or the lakes will be investigated. Three experiments will be conducted to address potential mechanism controlling current and future plankton biodiversity in high alpine lakes: 1. The ability of large zooplankton species to preclude invasion by new lowland species; 2. The hostile environment of some high alpine lakes limiting the colonization success of invading species; 3. Species sorting, where the species or clones found in a lake are those best adapted to the habitat in which they were found. Based on the results of the long-term monitoring of 18 lakes of the National Park Hohe Tauern, Salzbodensee and Sulzsee will serve as model systems for the experimental design. The concept of the project will be presented.

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FEASIBILITY STUDY OF A SMALL-SCALE BIOGAS PLANT FOR WASTE TREATMENT AND RESOURCE RECOVERY: A CASE STUDY OF A WASTE MANAGEMENT OPERATOR IN PORTUGAL

A waste management operator specialized in the collection and treatment of various residues, including used cooking oil as well as fats and greases performs physical separations to pretreat these residues before sending them for biofuel production, specifically sustainable aviation fuels (SAF) or biodiesel, during these processes another residue consisting of water mixed with impurities and fats and oils in a low concentration is produced. These water residues are currently sent to local wastewater treatment plants (WWTP) for treatment, leading to cost-related challenges and logistical complexities due to inconsistent acceptance by WWTPs. The objective of this thesis project is to assess the feasibility of installing a small-scale biogas plant within the waste management company. Such a facility would enable the treatment of the aforementioned residues as well as the acceptance of additional waste materials from clients that are currently unattainable.

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INSIGHTS INTO PHYLOGEOGRAPHY AND TAXONOMY OF THE SECT. *HELLEBORASTRUM* SPACH (HELLEBORUS L., RANUNCULACEAE) INCL. CULTIVATED AND WILD POPULATIONS IN AUSTRIA.

Within the genus Helleborus L. (Ranunculaceae) a highly diverse section, known as *Helleborastrum* Spach is recognized, which includes about 15 taxa. However, reported numbers and taxonomic rank vary among authors, leading to taxonomic confusion within this section. The wide range of partly overlapping morphological traits makes delimitation and recognition challenging. All taxa are endemic to Europe, restricted to specific distributional areas, adjacent to each other but including overlapping regions. Hybridization could potentially occur based on physiological terms, but its occurrence in natural environments remains unknown. Previously, chloroplast and ITS markers have failed to provide phylogenetic information, as genetic divergence is low. Thus, population genetic methods could serve to gain insights into the phylogeographic history and evolutionary processes of diversification. Our study is based on a very comprehensive dataset, encompassing all species within the section covering nearly the entire distributional range. AFLP data including populations around Vienna have already been generated and generously shared with me. We further aim to produce RADSeq data across the section, addressing phylogeographic inquiries, shedding light on evolutionary processes, biogeographic and taxonomic issues. This research project contributes to the knowledge on plant evolution, biogeography and diversification.

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UNREVALING THE MYSTERY OF CHLOROPHYLL DEFICIENCY IN SALVIA OFFICINALIS: PHYSIOLOGICAL, ANATOMICAL AND MOLECULAR COMPARISON OF DIFFERENT CHLOROPHYLL-DEFICIENT MUTANTS

In this study three different Salvia officinalis cultivars were compared. The three cultivars all have a chlorophyll deficient phenotype and differentiate in the appearing colorations of the variegated tissue.
Chlorophyll deficiency in plants can result in striking visual variations, offering valuable insights into the complex machinery of photosynthesis. Salvia, commonly known as sage, presents an interesting group of mutants with chlorophyll deficiency. This study aims to investigate the genetic, physiological, and anatomical differences on three distinct chlorophyll deficient Salvia mutants: Green Sage, Yellow Variegated Sage, and White Variegated Sage.
The main interest of this study was to compare the alterations of chlorophyll deficient mutations beyond their phenotypical aspects. Through comprehensive analysis of genetic data and phenolic compound profiling this study provides insights into the underlying mechanisms responsible for the color mutations in Salvia officinalis. The findings shed light on the complex interplay between genetic mutations and plant secondary metabolism, with potential implications for plant breeding and medicinal plant utilization.

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AIR-COOLED SITES AS POTENTIAL REFUGE AREAS FOR COLD-ADAPTED PLANTS IN TIMES OF CLIMATE CHANGE

As confirmed in the recent assessment report of the Intergovernmental Panel on Climate Change the global warming is more accelerating than expected. In the Euro-pean Alps it is twice as fast as the global average. But most alpine species are specialized to extreme living conditions. Already small impacts can imply greater effects on them. In contrast to mobile organisms plants are sessile and their responses to changing conditions are limited. Migration is one possible way of reaction, but it also depends on various factors and in mountain landscape migration upwards is finally stopped by reaching the summit area. Thermophilisation of upper mountain habitats, a temporary increasing biodiversity in summit areas and therefore a new competitive situation for native plant species are further problems in this context. But there are also scientists who don´t assume a general upward migration. They point out the role of topographic heterogeneity resulting in different microniches within an altitudinal zone. They consider these niches possible to buffer regional climate changes and to be refuge areas. This research project aims to provide answers to alternative habitats for cold-adapted plants outside their common range. The research question therefore relates to the possible function of air-cold sites in lower altitudes as refuge areas.

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THE BEE-BEETLES' EVOLUTION – NOVEL TECHNIQUES TO ENLIGHTEN THE HISTORY OF RENOWNED CELEBRITIES

With their very bright and eye-catching aposematic colouration nearly every coleopterist is aware of the genus *Trichodes* (Cleridae, checkered beetles). Yet up to now it has never been possible to infer the evolutionary history of this genus, including biogeographical considerations like the spatial and temporal origin of the genus as well as the investigation of a potential mimicry co-evolution with poisonous blister beetles (Meloidae) of the genus *Mylabris*. The reason for this is the lack of information on the phylogenetic relationships among the 91 described *Trichodes*-species.
This project aims at the inference of a robust molecular phylogenetic hypothesis, by overcoming prevailing sampling issues utilizing historical collection material and using state of the art DNA-sequencing methods. Unlocking this treasure trove to gather DNA out of dry museum specimens, besides ethanol samples, offers great opportunities for molecular studies and is a promising method to make research on rare or globally distributed species possible. The gained phylogeny is the essential part of this project and will be then used to address long pending questions on the biogeography and evolution of these renowned celebrities.

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MODELING CHEETAH (ACINONYX JUBATUS) DISTRIBUTION BEFORE AND AFTER MAJOR HABITAT MODIFICATION IN SOUTH-EASTERN KENYA

Kenya's cheetah population consists of approximately 1,200 individuals which mainly occur outside designated protected areas. Limited studies have focused on free-ranging cheetahs beyond Kenya's protected areas. Consequently, little is known about the cheetah's habitat preference and potential distribution in landscapes where they co-occur with humans. This study investigated the potential distribution of suitable cheetah habitats before and after major habitat modification in the Salama/ Athi Kapiti area of south-eastern Kenya. MaxEnt-based distribution models were run using presence-only cheetah data and a combination of environmental, anthropogenic and biotic-spatial covariates. The results showed that suitable cheetah habitats were fragmented and widely distributed in the study area before major habitat modification. These habitats mainly shifted to less disturbed areas (in the west) after the study area experienced major habitat modification. Our study thus provides insight on how cheetahs respond to various predictive factors in human-dominated landscapes. Findings from this study can be used to infer future changes that are likely to occur in Samburu, northern Kenya, where a major linear infrastructural development project will cut across an important resident cheetah population range.