## MSc and BSc Theses in Geo-Ecology and Biology in the *Plant Ecology Group*

last update: 29.07.2025

**1) Trait evolution in response to land use and habitat heterogeneity**
(contact: katja.tielboerger@uni-tuebingen.de)

**When?** Spring-Summer 2026 and following years
**Who?** MSc and BSc students

**What?** This project relies on a large experimental setup in one of our common gardens at Heuberger Tor Weg. Here, we have manipulated habitat heterogeneity (HH) in artificially created grassland microcosms to test for its effect on plant species diversity. HH was manipulated by creating microcosms containing 1, 2, 4, 8, or 16 different habitat types, respectively, while keeping the total area constant, and by sowing into the microcosms standardized mixtures of common grassland plant species. The habitat types mimic common land use/habitat conditions in temperate grasslands and comprise a clipping treatment (mimicking grazing and mowing, *vs.* no clipping), fertilization (with *vs*. without), trampling (with *vs*. without), and soil depth (shallow *vs*. deep), as well as all combinations of these treatments.

The original hypothesis was that species diversity should follow a unimodal response to HH (so-called area-heterogeneity-trade-off, AHTO). A follow-up of the original experiment shall look at whether also intraspecific diversity is influenced by HH. A first step for showing this is to demonstrate that different habitat conditions select for different genotypes with different phenotypes. A second step is then to look at whether intraspecific trait diversity is affected by HH and possibly also by specific land use combinations. For approaching this question, we offer several theses that look at either of the above questions by means of greenhouse experiments (for testing for selection of traits by different habitat conditions) and field observations and measurements within the microcosms. On the long run, we also plan for in-depth genetic studies in collaboration with Uppsala University, if we find evidence that there is genetic variation with respect to traits related to land use. We capitalize on life history traits for which there is a sound theoretical basis as to why these traits should evolve in response to land use.

**2) How plants deal with heavy metals – the why of metal hyperaccumulation**
(contact: katja.tielboerger@uni-tuebingen.de)

**When?** Winter and/or Summer, starting Oct 2025
**Who?** MSc and BSc students

**What?** This project is a collaboration with several French groups and explores the phenomenon of metal hyperaccumulation (mh) in plants. MH has most likely evolved in response to biotic interactions, e.g. herbivory and competition, but also drought has been proposed as being buffered by plants with higher concentrations of heavy metals. It is the ability of certain plant species not only to tolerate but actively hyperaccumulate heavy metals. We are interested in why this trait has evolved and whether the 'why' can be generalized across different plant species (from the Brassicaceae family), heavy metals (Cd, Zn, Ni, Tl), and stress factors (herbivory, competition, drought). We are also interested whether this trait is

entirely constitutive or can be induced and mediated by biotic and abiotic stress. If inducible (i.e. plastic), we also ask whether there can be an intergenerational plasticity, i.e. whether exposure of maternal plants to stress can actually prepare the offspring for the same stress.

The basis requirement for doing experiments is that we have plant material that is not affected by so-called maternal effects. To that end, we have to raise a first plant generation under common conditions and only use the seeds of that generation for further experiments. Thus, a first BSc or MSc thesis would be devoted to raising plants from seeds collected in 2025 from different populations (that grow either on contaminated soil or not) in a greenhouse, phenotype them and generate seeds. If enough seeds are available from the field collections, this could be complemented by manipulations of the environment (making for possibly two parallel theses). This can be done in winter 2025/26. Follow-up experiments are planned for mostly the summer months, starting in 2026.

**4) Wind- an overlooked aspect of climate change and its effect on plants**
(contact: pierre.liancourt@gmail.com, or katja.tielboerger@uni-tuebingen.de)

**When?** Winter and/or Summer, starting Oct 2025
**Who?** MSc and BSc students

**What?** This project addresses the question of whether and how wind, an important climatic factor, affects plant individuals, populations and communities. As this topic is rather new, many experiments planned are of a 'proof-of-principle' type and include both methodological aspects (e.g. how to manipulate wind, how to measure plant response) as well as the test of specific hypotheses related to wind effects on plant individuals and populations. The experiments will be done either in the greenhouse or in a common garden. A first experiments dealing with acquiring basic information about plant species response to wind can be started in Winter 2025/26. The majority of experiments is planned for two to three consecutive growing seasons, starting in Spring 2026.

**5) Mapping intra/inter-specific diversity in phenological traits in the field**
(contact: max.schmid@uni-tuebingen.de)

**When?** Spring-Summer 2026 (possibly also 2027)
**Who?** BSc (or MSc)

**What?** The student maps phenological traits like flowering time in a small number of species throughout the growing season in/around Tübingen. The main purpose would be to look for intra-specific diversity in phenology (at the same spot!). This could indicate the onset of diversification by means of temporal niche partitioning. This would restrict this project to early spring to mid summer (depending on the focal species) but might be highly attractive to students. Besides the mapping, the main challenge then would be to make sense out of these data. As possible hypothesis, the student could ask whether phenology varies between north- and south facing slopes or between low- and high altitudes (Neckar-Spitzberg-Alb). This project then could also be used to collect seeds for future greenhouse experiments.

**6) Studying the evolution of phenological diversity by the use of IBMs**

**When?** completely flexible
**Who?** MSc (or motivated BSc)

What? A small simulation program in R is available which allows to study the diversification in phenological traits at the computer. The student then could study several topics from genetic mechanisms over the buildup of phenotypic covariance among traits to the effect of cue reliability on diversification. In a nutshell, the student would do a parameter exploration with an existing IBM (individual-based model) and learn something about this topic. A detailed project description / is available on demand. Might demand a bit of coding skills, but mainly to collect data and plot them. MSc students could benefit from taking the Computational Ecology I and/or II course.

**7) Bio-geo interactions: Do positive feedback loops mediated by erosion promote the invasion of plants along riverbanks?**
(contact: katja.tielboerger@uni-tuebingen.de)

**When?** Probably from Summer 2025
**Who?** MSc and BSc students

**What?** This project, will address the question whether positive feedback loops between the geo- and the biosphere may promote the rapid spread of invasive plant species along riverbanks. As many invasives die back in winter and displace native perennial vegetation, the riverbanks are exposed and thus prone to erosion during winter and spring floods. As disturbances facilitate invasion success, this may create a positive feedback loop whereby riverine invasive plants create their own habitat. Within this topic, we will perform field measurements or erodibility and vegetation characteristics along invaded river (jointly with geoscientists). Additionally, the project involves a series of common garden experiments with two invasive plant species.