Bachelor project 1:

Title: Do generalist herbivores like foreign food? Using native and invasive plants to determining whether feeding preference has a biochemical basis

Group/Supervisor: Robin Collins  
Prof. Heinz Mueller-Schaerer

Project description: The success of invasive plants in their introduced range is often hypothesized to be because of an escape from coevolved enemies in the native range and the avoidance of new enemies in the introduced range (enemy release hypothesis). An extension of this hypothesis, the novel weapons hypothesis, proposes that introduced species gain an advantage over native species because native enemies are not adapted to detoxify their novel biochemistry. Yet, both of these hypotheses tend to focus more on the specialist enemies of invasive plants and few studies have examined whether the same hypotheses hold true for generalist enemies. Previous work in our lab indicates that generalist herbivores prefer native plant species more than invasive plant species but the mechanism remains unclear. This project involves isolating the defense compounds produced by 20 Asteraceae plant species (10 invasive, 10 native) to determine whether the preference of native plants by generalist herbivores has a biochemical basis.

In this project we will address two questions:
1) Do generalist herbivore feeding preferences have a biochemical basis?
2) Can we determine which groups of secondary metabolites are produced to a greater extent in invasive species?

To investigate the feeding preferences of generalist herbivores students will extract secondary metabolites with a series of hydrophilic to lipophilic solvents, condense them by evaporating the solvents under vacuum and then incorporated into an artificial diet presented in choice tests to the generalist herbivores (slugs and moth larvae). Using different solvents will allow students to determine which classes of secondary metabolites may be produced to a greater extent in invasive species. Students will gain valuable lab, statistics, research and writing skills as well as improve their knowledge of invasive species and chemical ecology.

Bachelor project 2:

Title: The root of the problem: Do geocytotypes of Centaurea stoebe differ in root development?

Group/Supervisor: Robin Collins  
Prof. Heinz Mueller-Schaerer

Project description: Centaurea stoebe is native to Europe where it occurs in diploid (EU2x, 2n=18) and tetraploid (EU4x, 2n=36) forms and is highly invasive in North America where it occurs in only the tetraploid form (NA4x). Previous studies comparing these three
different cytotypes (hereafter, geocytotypes) have found key differences in niche breadth and life history traits. Unfortunately, many of the field and greenhouse experiments conducted so far have not found differences in root biomass between geocytotypes. This is mostly due to the fact that harvesting the roots from soil is often difficult and unreliable because much of the fine root mass is lost during washing. This project involves growing the three geocytotypes in a nutrient supplemented agar medium so that the root development can be visualized and analyzed.

In this project we will address two questions:

3) Does the rate of root growth differ between the three geocytotypes?
4) Does the root architecture differ between the three geocytotypes?

To investigate how the rate of root growth differs between the three geocytotypes the student will measure the rate of root elongation of the three geocytotypes over a specified period of time. To investigate the root architecture the student will use the root scanning software WinRhizo to determine total root area and the number of branching roots. Students will gain valuable lab, statistics, research and writing skills as well as improve their knowledge of invasive species and plant physiology.

Bachelor project 3:

Title: Is it good to be eaten? A herbivory simulation experiment to study the role of tolerance in the invasive plant Centaurea stoebe

Group/Supervisor: Min Hahn
Prof. Heinz Mueller-Schaerer

Project description:
Sessile plants can respond to the attack of herbivores mainly with two mechanisms: resistance and tolerance. Following a release from herbivores during invasions, the EICA hypothesis postulates a decrease in resistance in favour of increased competitive ability. The expected response of tolerance however is less clear. Increased tolerance might be beneficial in the new range as well and contribute to the often observed super-abundance of biocontrol agents that failed to control their host.

In this study we explore the role of tolerance of root-herbivory in the invasive plant Centaurea stoebe. In the native range in Europe C. stoebe occurs in two cytotypes, diploids (EU2x) and tetraploids (EU4x), whereas in the invasive range in North America only tetraploids (NA4x) have been found. We expect that 2x and 4x in the native range show different strategies to cope with herbivores. Diploids might escape from herbivores by their monocarpic life-cycle, while polycarpic 4x might profit from increased tolerance. In NA4x increased tolerance might contribute to the invasion success and furthermore impose difficulties in biological control.

In this project we will address two questions:

1) Do geocytotypes differ in tolerance to artificial root herbivory?
2) Can low levels of herbivory stimulate overcompensation?
The experimental part will involve growing plants of the three geo-cytotypes (EU2x, EU4x, NA4x) in a nutrient-agar medium which allows us to apply artificial root-herbivory by removing parts of the root system. The degree of tolerance will then be assessed by comparing subsequent above- and belowground biomass compensatory responses to different levels of root herbivory (control, low, high herbivory). Besides practical work experience, students will improve their statistic and writing skills and gain further insights into invasion biology as well as general concepts in ecology and evolution.