CRISPR/Cas9 and λ Red assisted genome editing.

The ability to make precise changes in the genome has broad implications with regards to both basic and applied research. In this project genetic engineering through homologous recombination, known as recombineering, assisted by CRISPR/Cas9 will be applied to engineer *Escherichia coli* for different applications. Marker-free site-specific mutations and gene deletions will be made. The aim is to engineer host strains that are tailored for the production of particular classes of proteins.

This project works for both one and two students.
Contact: Claes von Wachenfeldt (claes.von_wachenfeldt@biol.lu.se)
The impacts of urbanization on birds and invertebrates

Urban habitats and landscapes are markedly different from non-urban “natural” habitats. The major difference is the transformation of the land, from natural green areas to anthropogenic structures and impervious surfaces. These altered conditions have changed the ecosystems dramatically, with many species vanishing once an area is urbanized, thus resulting in a significant loss of biodiversity. However, some species seem to thrive in the city and these urban-dwelling species often show pronounced phenotypic differences to their rural conspecifics. Numerous phenotypic changes have been recorded in terms of behaviour, physiology, and morphology in response to urbanization. These phenotypic changes are often linked to urbanization per se, thus the impact of for example air pollution, artificial light at night, and noise on these differences have rarely been disentangled. Although the urban habitat is a large threat to biodiversity, it is also an exciting environment for studies of population divergence and evolutionary responses.

Suggested projects:

1) The impacts of urbanization on invertebrate abundance and biodiversity across multiple Swedish cities and its implication on breeding birds.
   Field work: mid-April to mid-June
   Driving licence is a requirement

2) How does the urban environment influence incubation behaviour of tits?
   Field work: mid-April to mid-June.
   Driving licence is a requirement

3) Do urban stressors (traffic noise, air pollution, light at night) affect sleep and stress behaviours of zebra finches?
   The experiment was conducted last year. Thus video recordings will be used to analyse behavioural differences across these groups.
   Time: Flexible

The above projects are some of the current projects that we are interested in pursuing. However, there are other possibilities to tailor projects to your specific interests. Please don’t hesitate to come and talk to us about the above suggested projects or other projects in relation to the effects of urbanization on wildlife.

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Potential co-supervisors: Hannah Watson (post doc), Ann-Kathrin Ziegler (PhD-student), Maria von Post (post doc, biodiversity)
What is it like to see through the eye of a bumblebee?

Main supervisor: Emily Baird
Co-supervisor: Pierre Tichit

Forty species of Bumblebees live in Sweden, and their buzzing flight can be heard everywhere in the country, in a wide range of environments, from dim temperate forests to sunny grasslands, from the top of the mountains near Abisko to the mild coasts of Skåne. But how is bumblebee vision tuned to this range of landscapes that look so extremely different? Could bumblebees’ eyes be adapted to forests, grasslands, or mountains?

If you choose to work with us, we will provide you with a database of several hundreds of high-resolution 3D-models of bee eyes to choose from! You will analyse the anatomy of these small organs in 3D, and using specialised programs, you will be able to reconstruct optical models of the eyes. Ultimately your work will tell us more about the way bumblebees see their world.
Evolution of decision making centers in insect brains

Animal brains are adapted to match the needs of each species. Animals with highly acute senses require brains with sufficient processing power to make use of the wealth of incoming information. Similarly, animals with complex behavior require the computational abilities to control these behaviors and make meaningful decisions weighting different possible behavioral strategies at each moment in time. How brains have adapted during evolution to account for the specific needs of a species, is generally unknown. Some aspects of neural circuitry, in particular those that are of fundamental importance, we can expect to find across all animals, while others will be unique for individual species. Yet others will exist in most species, but could be modified in some way to account for different computational demands. To begin unravelling such species specific changes, we will look at the neural composition of the brains in insects across a wide range of species within one insect order - the lepidoptera (moths and butterflies). Insect brains are comparably simple, small enough to study in detail, but nevertheless carry out many computations that also occur in more complex brains of, for instance, mammals. Moths and butterfly possess many different lifestyles, some are nocturnal, some day-active, some are migratory, some nomadic, others mainly use vision for navigation, while others largely follow their ‘noses’. We will therefore carry out three dimensional reconstructions of lepidopteran brains to obtain volume and shape data of all major brain areas. These will then be compared both qualitatively and quantitatively across the phylogeny of these insects to identify possible links between brain structure and lifestyle. We will pay particular attention to two higher integration and decision making centers of the brain, regions called the central complex and the mushroom body. Methods used will be confocal imaging, image segmentation (using the software Amira), processing of large confocal image stacks (using ImageJ/FIJI), volumetric analysis, surface rendering of segmented brain regions, image registration. All skills are highly transferable and will be useful independent of the future area of research.

Contact: Stanley Heinze, stanley.heinze@biol.lu.se
Understanding molecular processes in barley

In our research group we are trying to understand molecular processes in plants related to design of plant architecture, time to flowering, chlorophyll biosynthesis and wax biosynthesis. We often use historic barley (*Hordeum vulgare* L.) mutants which were isolated more than 50 years ago and analyze them with modern molecular techniques and biochemical methods. Thus, our research spans from DNA sequencing (both Sanger sequencing and next-generation sequencing) to characterization of proteins. Our projects address fundamental scientific questions but is also of applied interest for plant breeding.

The following three recent publications reflect what we are doing at present. Bachelor or master students participated in all three publications and ended up as co-authors.


We have a lot of ideas about possible bachelor and master projects, so please come and discuss with us. We want to hear what you want to learn and that help us to design a suitable master project. Please, contact Mats Hansson (mats.hansson@biol.lu.se).
Bachelor project – population ecology/conservation biology

House sparrow population development in the agricultural landscape

Agricultural intensification during the last four decades has had a major impact on biodiversity related to the agricultural environment. One of the negatively affected species is the house sparrow that has plunged by ca 60% since the mid 70’s. The population decline has been consistent in both urban and rural environments, but most likely from different causes. However, the species decline seem to have halted during the last ten years, at least in suburban environments. This student project aims at investigating the relative importance of different habitat components and population development in the rural landscape, following up on a previous inventory of house sparrow populations at farmsteads from 2008. Our previous study showed that the occurrence and density of house sparrows is related to a number of landscape and management factors. How has the population development progressed in the rural environment and how does this relate to changes in the environment during the last decade?

The project includes a large scale inventory of house sparrows on farmsteads in Scania and relating the results to previous data. The project is suitable as a bachelor project starting in March 2018. The plan includes roughly one month’s planning, 1,5 months field work surveying house sparrows (April-May) and the rest of the time for analyzing and writing. Driver’s license and fluid in Swedish is necessary due to regular contact with farmers.

Kandidatarbete – populationsekologi/bevarande biologi

Gråsparvens populationsutveckling i jordbrukslandskapet

Jordbruksintensifieringen som pågått under de senaste ca 40 åren har haft en negativ påverkan på biodiversitet kopplat till habitat i odlingslandskapet. En av de arter som har påverkats negativt av förändringarna i jordbrukslandskapet är gråsparven, vars population har minskat med ca 60 % sedan 70-talet. Artens populationsutveckling har varit negativ i både urbana och rurala miljöer, men sannolikt av olika orsaker. Rapporter från senare år tyder på att artens populationsutveckling har stabiliserats, åtminstone i suburbana områden. Detta projekt syftar till att undersöka den relativa vikten av olika habitatkomponenter samt populationsutvecklingen specifikt i jordbrukslandskapet genom en uppföljning av tidigare inventering av gråsparvar på gårdar från 2008. Våra tidigare studier visade att förekomst och antal bland annat är kopplat till jordbruksintensitet, produktionstyp och gårdskomponenter. Hur har populationsutvecklingen fortskridit i jordbrukslandskapet och relaterar populationsförändringen till eventuella förändringar i deras livsmiljö under de senaste tio åren?

Studien inkluderar en storskalig inventering av gråsparvar på gårdsmiljöer i Skåne samt att relatera resultaten till tidigare utförda inventeringsresultat. Projektet är lämpligt som kandidatarbete med start i mars 2018. Projektet omfattar ca en månads planering och förberedelser, 1,5 månads fältarbete med inventering av gråsparvar (april-maj) och resterande tid är för hantering av data, analyser och skrivande. Körkort och flytande svenska är ett krav eftersom projektet innebär daglig kontakt med lantbrukare under fältarbets utförande.

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