1: Effects of herbicides on the growth and photosynthesis of the eelgrass 
(*Zostera marina*)

Master project: 30-60 credits  
Place: Kristineberg  
Time frame: spring/summer 2015

Contacts:  
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**Background.** Eelgrass (*Zostera marina*) is the dominant marine angiosperm in shallow coastal areas of the northern hemisphere. These plants form dense meadows on soft bottoms where they provide an important habitat for a large variety of plants and animals, some of which are commercially important. Eelgrasses also affect their surrounding environment by reducing erosion of the bottom sediment, which provides protection for beaches and improves water quality. Furthermore, these plants absorb excess nutrients from the water column and sequestrate carbon, which reduce eutrophication and climate impacts, respectively.

The global distribution of eelgrass meadows have suffered extensive losses as a result of increased human pressure within coastal areas. Along the Swedish northwest coast, around 60% of the eelgrass have been lost since the 1980's. Nutrient pollution (eutrophication), which leads to a reduction in light available for the plant, is considered to be one of the major causes for the loss in Sweden. However, the possible effects on seagrasses from other pollutants, such as commonly used herbicides released from e.g. agriculture, golf courts and private homes into coastal waters have been poorly studied. Several studies have shown the presence of such compounds in the marine environment along the Swedish west coast. A better understanding on how these compounds affect eelgrass health could expand our knowledge on local eelgrass stressors, with important implications for the management of these important ecosystems.

**Project description.** This project aims to investigate the effects of herbicides on the growth and photosynthetic efficiency of eelgrass. The study will be conducted at the Sven Lovén centre for marine sciences – Kristineberg and involves an indoor experimental set-up where eelgrass shoots (or seedlings) will be subjected to treatment and control conditions of herbicides or herbicide mixtures. The herbicide Irgarol will be used as a positive control since its presence have been demonstrated in the water and its toxic mechanism shown. Irgarol affects PS2 in the photosynthetic chain. Growth parameters will be recorded and the photosynthetic efficiency measured for the duration of the study. The response in other parameters, such as enzyme activity and gene expression of relevant genes could also be measured if the student chooses to do a 60 hec project.

The results from this study can be related to existing data on eelgrass distribution and the ambient concentrations of herbicides along the Swedish coastline available within the research group.

Supervisor: *Joachim Sturve*  
Co-supervisors: *Per-Olav Moksnes, Louise Eriander*
**2: Do snail enzyme activities differ in different shore environments?**

**Subdiscipline:** Evolutionary Ecology

**Supervisors:**
Snuttan Sundell ([kristina.sundell@bioenv.gu.se](mailto:kristina.sundell@bioenv.gu.se)) and Kerstin Johannesson ([kerstin.johannesson@bioenv.gu.se](mailto:kerstin.johannesson@bioenv.gu.se))

**Background:** The snail *Littorina fabalis* has two ecotypes; one large that lives in relatively wave exposed shore environments, and one small confined to less wave exposed shores. The two ecotypes differ in size at maturity but also in what allozyme of arginine kinase they have. This enzyme is central in energy storage and use. Sequencing the gene coding for the enzyme in the snail, shows that there are several non-synonymous mutations difference, and that the allele coding for the gene most common in the small ecotype has spread very recently by a selective sweep. Both these observations support an hypothesis that this gene is under strong differential selection (one allele favoured in one shore environment and the other in the opposite environment). To confirm this hypothesis, it is essential to measure the activity of the two allozymes and show that these are different. Activity measurements may also indicate in what respect the activities differ, and from these results it may be possible to suggest a model that explain their different fitness.

**Project:** To set up and validate a kinetic enzyme assay for measuring arginine kinase activity in extracts from snails of different genotypes. (Genotypes will be scored after the measurements are done, but an approximate genotype will be assumed from the size of each snail, as indicated above.) Snails will be sampled in the area of Tjärnö while method development and analyses will be performed in Gothenburg.

**Suitable as:** Bachelor degree project, 15/30 hp or Applied project in Biology, 15 hp
3: Phenotypic variation in *Fucus vesiculosus* and *F. radicans* along the Baltic Sea gradient.

**Subdiscipline:** Marine Evolutionary Ecology

**Where:** Tjärnö

**Supervisors:** Kerstin Johannesson & Rick Pereyra

Kerstin.johannesson@bioenv.gu.se

**Background:** The Baltic Sea is an excellent Darwinian laboratory with a very recent formation followed by a rapid colonization of marine and freshwater species. Studying adaptation to the Baltic Sea will help in understanding how basic processes of evolution adapt populations to changing environments.

In the EU funded project Bambi (www.bambi.gu.se) we investigate the phenotypic and genetic changes of some common Baltic Sea species. Now we invite a master student to join the project team and investigate the phenotypic evolution of Baltic populations of the brown algae *Fucus vesiculosus* and *F. radicans*. These are major species of the Baltic Sea ecosystem and their current distribution in this marginal marine environment is depending on their capacity to further adapt to predicted changes in temperature and salinity.

**Problem:** The master project is aimed to study the phenotypic (morphological) variation of *Fucus vesiculosus* and *F. radicans* throughout the Baltic Sea and relate the variation to environmental parameters such as temperature, salinity, ice-cover, grazing pressure etc. Samples have been gathered from around the Baltic Sea, including reference sites outside the Baltic Sea, and these will be analysed using various morphometric methods.

**Level:** Bachelor (30 hec) or Master (30 hec) level
4: Assessing genotype-environment interactions using twin-studies in the snail *Littorina saxatilis*

Where: Tjärnö  
Supervisor: Kerstin Johannesson  
Kerstin.johannesson@bioenv.gu.se

(The student will be part of the CeMEB project, www.cemeb.science.gu.se)

**Background:** A classical approach to the problem of separating environmental and genetic factors behind variation in phenotypic traits are twin-studies. These studies are commonly used in humans as well as in plants in which clones of the same genotype can be raised in different environments. In marine invertebrate species, twin studies are rare (or non-existent) due to the obvious problem to identify twins in mostly broad-casting species. The snail *Littorina saxatilis*, however, offers a hitherto unexplored possibility. This snail raise offspring in the female embryo pouch and twins (genetically identical offspring) are relatively common. Raising pairs of twins in different environments (high/low temperature, high/low pH, high/low salinity, with/without predators, etc.) would be an obvious way to assess the relative importance of inherited (genetic) and induced (environment) effects on various phenotypic traits, including behavioural traits.

**Problem:** To develop a method to raise twins from embryo pouches of wild-caught females and to use this method to assess the importance of genetic and environmental effects on phenotypic traits such as growth rate, shell shape, shell thickness, boldness, speed of movement etc.

**Level:** Master level (45-60 hec)
5: Phenotypic and genetic variation in the seaweed *Fucus vesiculosus* over small spatial gradients of wave exposure.

**Subdiscipline:** Marine Evolutionary Ecology

**Where:** Tjärnö

**Supervisor:** Kerstin Johannesson & Rick Pereyra  
(The student will be part of the CeMEB project, www.cemeb.science.gu.se)

**Kerstin.johannesson@bioenv.gu.se**

**Background:** The common brown algae *Fucus vesiculosus* (bladder wrack) is phenotypically variable with a more slender and less often vesiculated thallus in wave exposed areas, as compared to protected areas. This can be due to one or several of the following hypotheses; (1) phenotypic plasticity, (2) inherited differences accumulated in spite of strong gene flow between sites of different exposure, (3) inherited differences as a result of both isolation and differential selection.

**Problem:** To assess the importance of the three possible explanations outlined above requires a combined approach assessing both gene flow and the level of inheritance of trait differences. Gene flow will be assessed using so called microsatellite genetic markers (which are available for this species). Plasticity versus inheritance is best evaluated using a common garden approach, in which newly settled algae from different environments are brought into the lab and raised in a common environment. The phenotypes being analysed using morphometric approaches.

**Level:** Master level (45-60 hec)
6: Microplastic in the environment: occurrence and effects.

This project will be conducted at Zoology, Medicinaregatan 18. Contact: Bethanie Carney Almroth, email: bethanie.carney@bioenv.gu.se, tel: 031 786 3673

Plastic particles (PPs) on the macro and micro scale are increasing in the environment, both as a result of increased industrial production and product usage, as well as breakdown of larger plastic debris. These particles contain numerous organic pollutants including plasticizers. Little is known about the effects of PPs in fish. Recent studies indicate that polyethylene sorbs commonly occurring persistent organic compounds in the environmental (PAHs, PCBs, PBDEs), and that there compounds are transferred to tissues of fish fed a diet containing contaminated plastics. In addition, both native plastic particles as well as contaminant loaded plastics caused degrees of liver toxicity and pathology in the fish (Rochman, Hoh et al. 2013). It has also been demonstrated that some species of wild fish will consume plastics, including pelagic and demersal species in the English (Boerger, Lattin et al. 2010) channel (Lusher, McHugh et al. 2013) and planktivorous fish in the North Pacific (Boerger, Lattin et al. 2010). Sea birds are also known to ingest plastic debris, and it a recent study indicates that such plastics are likely responsible for uptake of polybrominated diphenyl ethers (PBDEs) in several species of seabirds (Tanaka, Takada et al. 2013). This project aims to answer the question: Are plastic particles toxic to fish? We can infer from studies with other plastics and nanoparticles that many effects are possible, ranging from mechanical (i.e. obstruction of the alimentary track and damage to gill membranes) to toxic (i.e. hormone disruption, induction of oxidative stress, immune system effects) but the toxic effects remain unknown. PPs are an emerging pollutant and as such, knowledge concerning toxicity is lacking but necessary. Knowledge of the fate of PPs in fish will aid in understanding the fate of PPs in the natural environment and therefore be useful in determining actions to minimize negative impact.

There are several possible projects that can be completed within this research, ranging from field work addressing occurrence, to effect studies on behavior, toxicological responses, etc. The final project plan will be decided based on the potential students’ background and interests.
7: Ageing in a common diatom

We propose a B.Sc/M.Sc project (30-60 credits) where we will investigate experimentally whether different individuals from the same genetic population of the diatom *Skeletonema marinoi* undergo physiological ageing. *Skeletonema* is a good model organism due to its great abundance in the plankton and the sediment. Under adverse conditions, this organism can form resting stages, which accumulate at the bottom of the sea. If collected from an anoxic site, sediment cores can be dated as sedimented layers will accumulate on top of one another. The dating information provides information about the age of the germinated cells. These cells can be brought into culture and thus one can experimentally test 100 year old individuals and compare the outcome with individuals isolated from today’s environment.

We will use clonal cultures that are germinated and isolated from sediment that accumulated in the early 19th century (40 000 diatom generations ago), and clonal cultures that are isolated from the same geographic site, but from sediment accumulated in during the last year.

To assess ageing, we will analyse growth rate in subcultures collected at different time points during clonal propagation. This will be done in both the ancient and younger founding clones. At culture intervals, samples will also be collected for analysis of ageing. We will use two different ageing markers: a product of protein oxidation reactions that is known to accumulate with age in many systems and a measure of telomere length. Protein carbonyl levels are used as a measure of accumulated oxidative damage. Telomeres are repetitive DNA sequences that function as chromosomal caps and prevent genetic instability. In humans, those caps are shortened for every cell division thereby serving as a cellular “clock”, where a cell enters senescence or undergoes apoptosis when the length reaches a critical minimum. They have also been shown to shorten in length in other vertebrates, in addition to clonal organisms.

Culturing will be done in the laboratory of Anna Godhe (Botanhuset, Gothenburg) and protein carbonyl analysis in the laboratory of Bethanie Carney Almroth (Zoologen).

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Suggested start date: sometimes during 2015
8: Crustaceans in a changing environment
Contact: Susanne Eriksson susanne.eriksson@bioenv.gu.se

Climate change has led to a significant change in a number of abiotic factors, such as, temperature, ocean acidification, oxygen saturation and salinity. Invertebrate early life stages are generally considered most vulnerable to these changes, but only few studies have concerned brooding species such as the Norway lobster *Nephrops norvegicus* and the European lobster *Homarus gammarus*. During early life history the lobsters undergoes several habitat shifts, and thus encounter a range of ambient conditions. The lobsters response to the intensified abiotic stressors due to future climate change will have a large economic as well as biological impact. At Kristineberg we are currently running several projects associated with the early life stages of these two large decapod lobsters. Most of the work is focusing on laboratory studies on ecophysiological and health effects of multiple stressors on early life stages.

Individual projects can be suited for most seasons and can range from 15 to 60 ECT. The experimental part of the project will be conducted at the research station Sven Loven Centre – Kristineberg. Analysis and writing can be done both at the station and in Gothenburg, whatever is most convenient.

Juvenile European lobster and Norway lobster in the laboratory.
Aquaculture is becoming increasingly important to provide animal protein to the growing global population. Several projects are now attempting to develop a sustainable strategy for Swedish marine aquaculture with focus on environmental and economic sustainability. At the research station Sven Loven Centre – Kristineberg we currently focus our aquaculture projects on the European lobster (*Homarus gammarus*). Several challenges are addressed such as novel feed to reduce dependence on fish oil and fish meal for aqua-feed, recirculating systems to limit environmental impact and animal health.

Projects can be suited for most seasons though there is a wider range of possibilities during the peak season in the autumn. Projects may range from 30 to 60 ECT. The experimental part of the project will be conducted at the Sven Loven Centre – Kristineberg station. Analysis and writing may be done both at the station and in Gothenburg, whatever is most convenient.
10: Studying climatic effects on species distribution.

The project may be suitable for 15-60 hp,
Place: Zoologen building and/or Sven Lovén center at Tjärnö.
Supervisors will be Matthias.Obst@gu.se (Zoologen) and Åsa Strand asa.strand@gu.se (Tjärnö).

Background: Statistical correlation approaches such as species distribution modelling (SDM) are invaluable methods to predict the effect of climate change on the distribution of marine species. This can be used for predicting the impact of invasive species, anticipate changes in food webs, and for refining the commercial potential of marine species. The Department of Biological and Environmental Sciences offers research opportunities to interested students who want to analyse such climatic effects on the distribution of marine populations across wider taxonomic and geospatial scales. Examples may be studies of the impact of the invasive oyster (C. gigas) on local fauna in the North East Atlantic (Mytilus edulis, Ostrea edulis) or analysis of optimal sites and species for aquacultures in the North East Atlantic under climate change scenarios. This approach will imply integration of taxonomic, ecological, and environmental information, followed by species distribution modelling under present and 2050 climate scenarios. In longer projects (BSc, MSc) this approach can be combined with laboratory experiments on the species in question as well as with field work in order to test hypotheses generated from the modelling approaches. Software used will be openModeller, BioClim, GIS, and R. Here is an example for inspiration: http://onlinelibrary.wiley.com/doi/10.1111/jbi.12395/abstract.

Fig. Mussel bed with native blue mussels (M. edulis) and invasive oysters (C. gigas)
11: The role of microorganisms in the natural oil biodegradation process in the Artic.

MSc project 45 - 60 ECTS
Place: Tromsø and Svalbard (Svea/Longyearbyen)
Contact: Maria Granberg (maria.granberg@npolar.no)

Background
In case of an oil spill in the Arctic, remediation actions will involve either mechanical recovery, addition of dispersants or in-situ burning of the spilled oil. The impact of residues created during these remediation actions will be investigated as frozen into sea ice. In a large scale project, mesocosms will be frozen into the ice in Svalbard and residues from the different remediation actions will be added as the ice forms. Chemical and biological responses to these treatments will be investigated during the polar night and until the return of sunlight. As one part of this large scale project we will investigate the fate of the oil and the role of microorganisms in the natural oil biodegradation process in the Artic. We aim to answer crucial questions concerning the oil weathering processes, biodegradation rates, oil behavior and migration through the ice, biodegradation potential of the in-situ microbial communities and their response to the oil. Moreover, the impact of the different treatment scenarios on the microbial populations, oil biodegradation and fate of the oil will be evaluated.

The work will involve field sampling of ice cores in Svalbard and measurements of bacterial production and oil component degradation on ice, seawater and sediment samples. These measurements will be complemented with bacterial community identification using DNA/RNA sequencing as well as with chemical measurements of oil components during biological and chemical weathering.
12: Bio-physical interactions between eelgrass and hydrodynamics.

**Master student project:** 30-60 credits  **Place:** Kristineberg.
**Time frame:** March - Sep 2015.
**Contact:** Eduardo Infantes (eduardo.infantes@gu.se)

Eelgrass meadows and the ecological and economical services that they provide are declining worldwide as a result of human perturbations. *Zostera marina*, L. (ålgräs in Swedish) is the dominant macrophyte on soft bottoms in the Swedish coast. Along the Swedish W coast, almost 60% of the eelgrass has been lost since the 1980’s, representing a loss of approximately 190 km². The decrease in eelgrass worldwide has lead to many restoration programs but efforts to restore eelgrasses have been successful for some regions, but have generally failed to alter the declining trends, particularly in Europe. In order to enhance recovery of eelgrass in this region, it is necessary to understand the basic eelgrass ecological processes as well as to develop new eelgrass restoration techniques. Eelgrass restoration can be performed with seeds when large areas are to be recovered. Many factors are involved in the seed germination and seedling development which have been already described, although, many are still not know, such as the bio-physical interactions between hydrodynamic-sediment on seed trapping, root development and root anchoring.

**Project description**

The project aims to investigate the effect of hydrodynamics on seed transport, seedling establishment and seedling survival. The task will include research on 1) the effect of hydrodynamics on seed transport at on different bottom surfaces, 2) seed trapping by bottom structures, 3) seedling root development and anchoring capacity on different sediments. The project will be performed at the Kristineberg Marine Station involving laboratory work using hydrodynamic channels (flumes) and fieldwork to carry underwater experiments and measurements. The results of this project will provide basic knowledge on eelgrass ecology and will be applied to current restoration activities.
13: Microbiome in diatom

Contact person: sylvie.tesson@gu.se
Suggested start date: during spring 2015

We propose a B.Sc/M.Sc project (30-60 credits) where we will investigate experimentally which bacteria are associated with a diatom microbiome and where they are located. The diatom we use as a model species is **Skeletonema marinoi**. The project is part of a larger project of *de novo* genome sequencing from which bacterial sequences have been identified. We need to assess more precisely if these bacterial sequences belong to evolutionary events (such as gene transfer into the nucleus) or to parasites/symbionts (e.g. sequences from the cytoplasm and/or from the outer membrane of the diatom).

We will use clonal cultures of the model-strain of **Skeletonema marinoi** treated with and without antibiotic, extract the gDNA and amplify it using high throughput methods (Illumina sequencing) in order to identify the microbiome associated with the outer/inner compartment of the unicellular diatom. Specific probes will be designed to further assess the relation of these sequences with the nucleus, cytoplasm or plastid present in the unicellular diatom using epifluorescent microscopy (including Fluorescent *in situ* hybridization technique).

We propose the master student to gain a broad range of experience from lab culturing – bioinformatics basic – to single cell analysis. The master project will be supervised by Sylvie Tesson and co-supervised by Olga Kourtchenko. Axenic and non-axenic culturing will be performed in the laboratory of Anna Godhe under the supervision of Olga Kourtchenko (BioEnv, Gothenburg). DNA extraction, bioinformatics analyses and imaging analyses will be performed under the supervision of Sylvie Tesson (Chemistry and Molecular Biology, Lundberg, Gothenburg).