Förslag till
Marina exjobb
2018

Suggestions for exam projects 2018

Projects in chemical speciation modelling in seawater, to be carried out in Gothenburg

2 bachelor projects (15 credits) in marine chemistry are described below

Master projects are also possible: master students are welcome to discuss options for a longer project

Background

Several trace metals act as essential micronutrients in seawater, the most important being iron, copper and zinc. In the case of iron, it is well established that the concentrations of iron limit primary production in large areas of the ocean. The availability of these trace metals for uptake by marine organisms is dependent on the chemical forms present in seawater, in other words on their chemical speciation. Experimental studies of this chemical speciation at nanomolar concentration levels are both challenging and time-consuming. This experimental work is therefore complemented by the development of models that allow the chemical speciation to be calculated from the sample composition. This type of model is in increasing demand for incorporation into global models of trace metal biogeochemistry, and for assessment of the consequences of climate change for trace metal speciation and therefore also for the metals' biological availability. Our group is contributing to this development within the scope of two major international projects. We have access to state of the art chemical speciation modelling software which is suitable for implementing new expansions.

Project 1

This project will focus on modelling the inorganic speciation of Fe, Cu and Zn in seawater. This will involve (i) reviewing the available literature on the different metal-ligand interactions in order to define the current state of the art; and (ii) identifying key data gaps where new measurements should be carried out.

Project 2

This project will address the development of models for the complexation of trace metals by the natural organic matter present in seawater. These interactions are currently described in a simplistic way that does not allow the effect of changes of variables such as pH and temperature to be assessed. A continuum-based modelling approach developed by freshwater chemists will be assessed for application to seawater, making use of new experimental measurements of the interaction between trace metals and natural organic matter at different pH values.

Contacts

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Julián Gallego, 031-786 9053 julian.gallego@marine.gu.se

What does the Antarctic marginal ice zone (MIZ) ocean look like?

Suggested Masters project by Sebastiaan Swart (contact: sebastiaan.swart@marine.gu.se)

Scientific background

Direct observations of the Antarctic MIZ ocean are extremely sparse, which impacts our understanding of how upper ocean processes and their interaction with ice and atmosphere work. It is hypothesized that these ocean processes have a significant impact on the world's climate and ecosystems. Over the past few years, numerous sensor tags have been installed on seals to collect oceanographic data from the Antarctic and Sub-Antarctic regions. This data provides the first insights of the MIZ ocean, also understood as the greatest 'blind spot' in our current ocean knowledge.

Objectives and approach of project

- Search of any relevant literature on this topic and any new datasets that may be coming available (e.g. under ice floats, historical data, theory).
- Investigate the MEOP (www.meop.net) seal tag data to understand the distribution of seal tag data in relation to the MIZ
- Download this freely available data and start analyzing TS and potentially chlorophyll-a data of the upper ocean to give us first order insight into the characteristics of the upper ocean hydrography
- Analysis of this data to provide information about temporal change and seasonal progressing of physics and biogeochemistry, especially in periods that we have no information about, like in autumn, spring and winter.

Some competency in Matlab/Python or alternate code is needed.

The student may travel to Stockholm University briefly to collaborators dealing with seal data there. The student may have an opportunity to go on a research cruise if space is available and it does not interfere with course work.

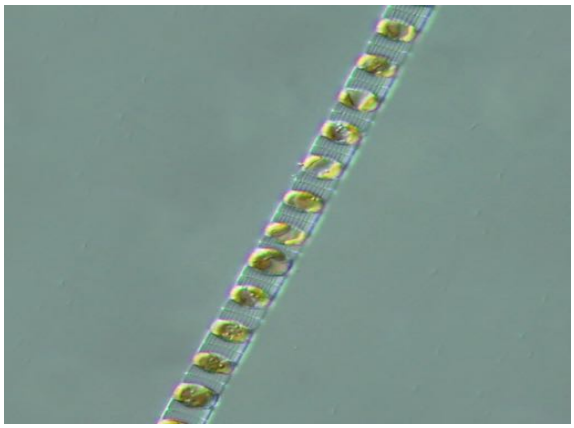
The project has prospects to lead into a PhD thesis.

Title: Life cycle specific modulations of cell division rates in diatom cultures

Background: Diatoms are among the most important primary producers on earth. They inhabit soils, lakes, rivers, sea ice, and probably most importantly, the oceans. Because of their prominent appearance and wide distribution, researchers have investigated diatoms for more than two centuries. A common approach to study diatoms and other unicellular algae is to grow clonal populations under well-controlled laboratory conditions. By this means we can measure cell division rates and other phenotypic traits to study treatment effects and build hypotheses about potential fitness consequences in natural populations facing environmental change. Although the story is usually much more complex, and the relationship between culture experiments and what happens in nature is not at all straight forward, this approach may also suffer from a very basic problem, which is intrinsic the diatom life cycle. Diatoms are covered by a silicate shell, which consists of a larger and a smaller part. This rigid shell may provide protection from grazing and other threats. During cell division the smaller part of each shell is re-built and consequently, dividing cells become smaller and smaller until they reach a critical size. That is when the cells usually undergo sexual reproduction and become large and start over again.

Problem: Earlier studies have shown that cell division rates in diatom cultures are affected by cell size. Larger cells divide slower than smaller cells. Consequently, a clonal diatom lineage will show variation in cell division rates, depending on the respective lifecycle stage. The issue becomes even more complex as diatom cultures maintained in culture are usually populations derived from a single cell but over time have diversified into various de-synchronized cell lineages. As cell division rates are usually assessed on a population level and not for single cells, this can result in an average cell division rate with complex variation patterns.

Methods: This project aims to use laboratory cultures of different strains of the common diatom *Skeletonema marinoi* to investigate life cycle specific modulations of cell division rates and other phenotypic traits, such as cell size, particulate organic carbon quota, chlorophyll content, and photosynthetic performance. It will involve a range of delicate techniques, including single cell isolation under the light microscope and microscopy in general, algal culturing techniques, preparation of seawater media, counting and measuring cells using the microscope as well as automated high-throughput cell counting techniques, and chlorophyll fluorescence measurements. The results are supposed to help evaluating potential consequences of life cycle depended growth rate modulations in diatoms and may allow developing new methods to improve future experiments.



Skeletonema marinoi in the light microscope

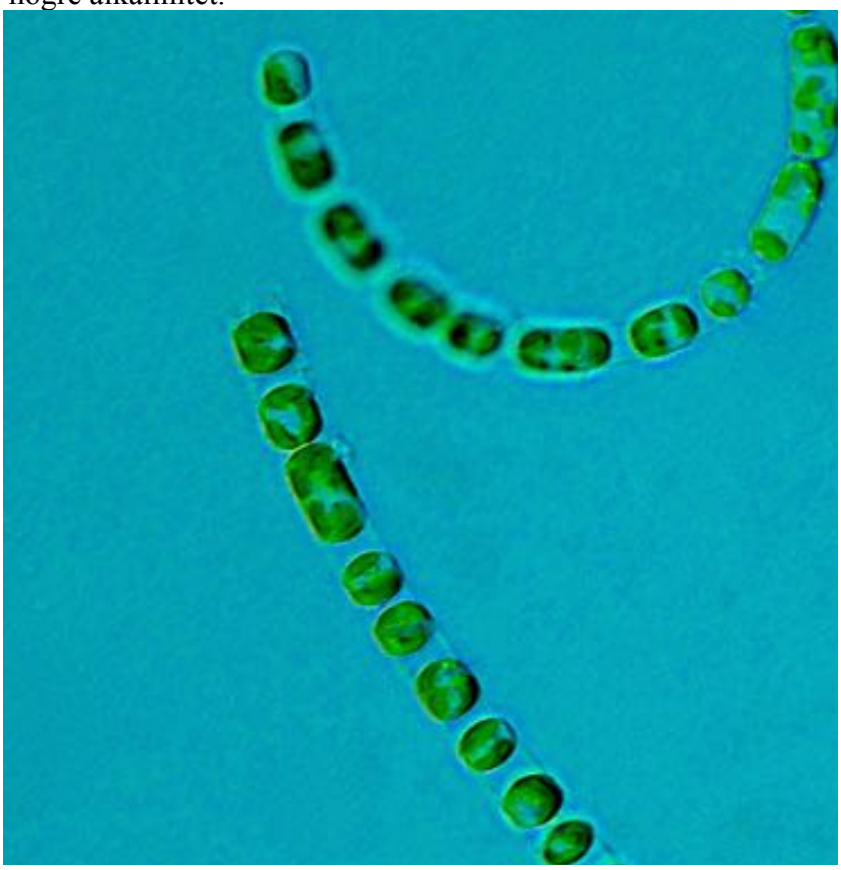
Contact: Anna Godhe / Department of Marine Sciences / University of Gothenburg / http://marine.gu.se / anna.godhe@marine.gu.se

Location: Göteborg (Anna Godhe lab, Botan building)

Time period: 2017 - 2018

Level: Master level (30-60 hec)

Local adaptation to pH changes in the marine diatom *Skeletonema marinoi*
Thesis project/Examensarbete 45 hp
Contact: Anna Godhe, anna.godhe@marine.gu.se
Project description (English):
Few species have been successful in adapting to the marginal habitat of the Baltic Sea. Many of the properties, e.g. salinity and alkalinity, in the Baltic Sea have a large gradient from south to north, which pose stress to the fauna and flora that reside in it. Several studies have previously investigated the effect of salinity however alkalinity has received far less attention. The alkalinity of water is the capacity to buffer against acidification. Projections suggest that ocean acidification may cause a more than 3 times increase in acidity in the Baltic Sea by 2100. In this project we want to investigate whether *Skeletonema marinoi* (marine diatom) origination from the Baltic Sea is better adapted to coping with lower alkalinity and pH changes, compared to *S. marinoi* that originate from Skagerrak (Swedish west coast).
Projektbeskrivning (Svenska):
Få arter har lyckats anpassa sig till den hårda miljön i Östersjön. Många miljömässiga faktorer såsom salthalt och alkalinitet har en stark gradient i Östersjön från söder till norr, vilka utgör stressfaktorer för faunan och floran som lever där. Flera studier har tidigare undersökt effekten av salthalt däremot har alkalinitet fått långt mindre uppmärksamhet. Alkalinitet är vattnets förmåga att buffra mot försurning. Prognoser tyder på att havsförsurning kan orsaka en mer än 3 gånger ökad surhetsgrad i Östersjön till år 2100. I detta projekt vill vi undersöka om populationer av *Skeletonema marinoi* (en marin kiselalg) från Östersjön är bättre anpassade till att hantera lägre alkalinitet och pH-förändringar jämfört med *S. marinoi* som har sitt ursprung från Skagerrak, som har högre alkalinitet.



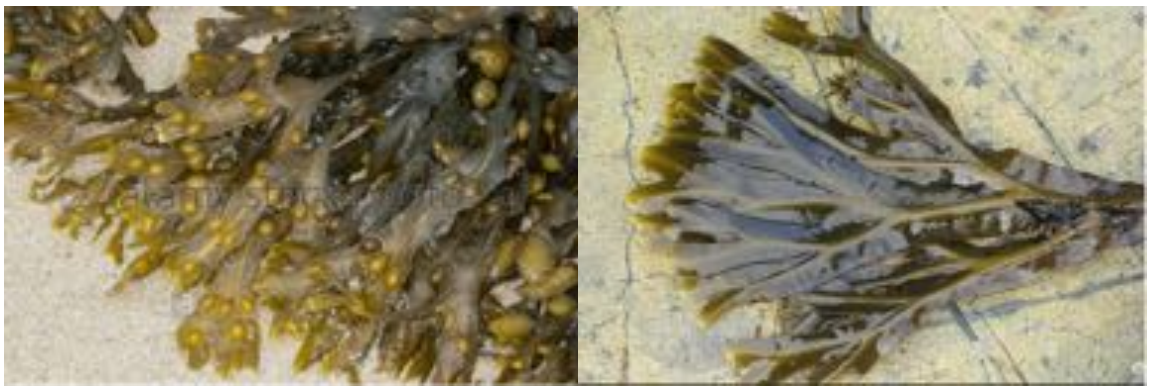
Adaption to wave exposure in bladder wrack

The bladder wrack, *Fucus vesiculosus* is a common brown seaweed on the rocky shores of the Northern Atlantic. The morphology of the plants varies with the grade of wave exposure; in sheltered areas the plants are larger, more bushy-like and have bladders whereas on more wave exposed sites they are smaller, have a flatter structure and lack bladders. The variation in morphology is hypothesised to be an adaption to the hydrodynamic climate where the morph found on exposed sites is expected to better withstand stronger water currents without braking or become detached. This hypothesis is however not previously tested.

This project aims at quantifying the differences in morphology among plants from sites with various hydrodynamic exposure and to test the plants performance in a high-speed laboratory flow channel. By measuring the force imposed on the plants by flowing water and compare this drag to the morphological differences, we hope to find out how much the morphology affects the flow induced forces and which aspects of the morphology that is most important to the observed drag. Since the algae are flexible in their structure, we will also monitor the change in shape with increasing flow velocity and investigate how this affect the drag coefficient. This work will except mapping differences in morphology and shape, and measuring drag forces in the flow channel also involve measurements of flow exposure in the field using gypsum erosion.

Master project starting summer or autumn at the Sven Lovén Centre Tjärnö

Supervisor: Ann Larsson (ann.larsson@marine.gu.se)



www.alamy.com www.aphotomarine.com

Title: The Marine Metabolome Project
Main supervisor: Göran Nylund goran.nylund@marine.gu.se
Focus of the project: This is a project in the intersection of marine chemistry and marine chemical ecology. You will get experience in liquid chromatography mass spectrometry (LC/MS) analysis and building databases on marine metabolites.
Location: SLC TJärnö
Background: Marine Chemical Ecology is entering the age of Big Data. Metabolic profiling is becoming a common tool in marine chemical ecology. It is useful to find candidate defense compounds, pheromones, etc. by cross referencing matrices of active and non-active extracts, or active fractions from orthogonal separation techniques. Identification of metabolites is a major bottleneck in metabolic profiling. Data largely consist of unidentified compounds. Large efforts have been launched to build useful databases but marine metabolites are poorly covered. You will contribute to a solution by building a database of marine metabolites using liquid chromatography coupled to time of flight mass spectrometry in the chemical ecology laboratory on Tjärnö.
Problem: We often run full screening of metabolites from extracts of biological active samples, the identification of compounds is very hard to achieve without extensive databases, and these are not available for marine metabolites.
Method: Common marine metabolites will be analysed with LC-MS with standard settings to build a searchable library of marine metabolites, the initiation of the Marine Metabolome Project.
Suitable level and length:) Project can be adapted to suitable education level e.g. Batchelor (15 hp)" or "Master (30, 45 or 60 hp)
Suitable time period: Project can be performed all year round.

Title: Signals in the Sea-Fundamentals of copepodamide signaling between plankton organisms

Main supervisor: Erik Selander E-mail:erik.selander@gu.se

Focus of the project: This is a marine biology project in the intersection between chemistry and biology.

Location: Göteborg (Botan building), with possibility of fieldwork on Kristineberg or Tjärnö

Background: In 2015 we discovered a novel class of signaling compounds, the copepodamides. The copepodamides come from the most common zooplankton organisms, the copepods. Phytoplankton sense the copepodamides and take measures to evade predation. Some produce the toxins that cause harmful algal bloom, others adopt cryptic behaviors such as slow swimming or shrinking. Tiny amounts of copepodamides can consequently affect the entire water column.

Problem: These compounds are new to science we lack fundamental knowledge about them. We do for example not know the exudation rates and content in the different copepods from the costal Skagerrak, the degradation rate, or how the production is affected by the food of the copepods. Join us in the exploration of these exciting new compounds.

Method: You will learn how to handle zooplankton samples, how to analyse trace amounts of signaling compounds using liquid chromatography coupled to a triple quadrupole mass spectrometer (LC-MS). You will work in a small dedicated group focused on chemical interactions between plankton organisms. The project has many openings, suitable for project/bachelor/master projects of any duration.

Suitable level and length: Batchelor (15 hp) or Master (30, 45 or 60 hp)

Suitable time period: “project can be performed all year round"

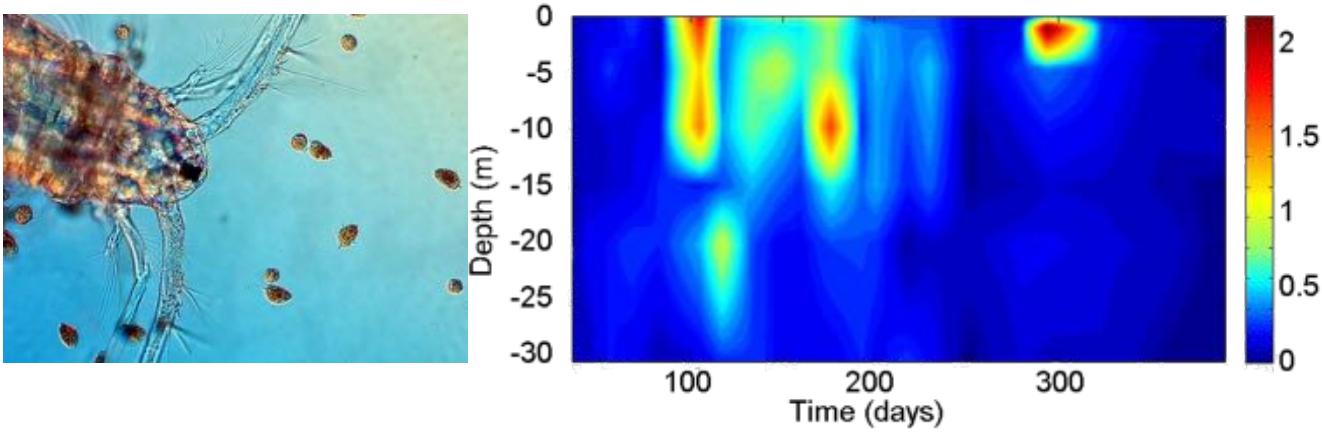


Figure 1 *Left panel*: female copepod together with *Prorocentrum micans* (elongated with spine), and the bloom forming toxic *Alexandrium minutum* (round) that produce neurotoxins causing paralytic shellfish toxins.
Right panel: Concentration of copepodamides at different depth over a full year in the Skagerrak. Green represents the threshold concentration that phytoplankton can react to.

The wrasse fishery on the Swedish west coast: good or bad?

The salmon industry has grown rapidly in Norway. The largest health issue in the farms is the Salmon louse, *Lepeophtheirus salmonis*. Current remedies include pesticides and the use of cleaner fish wrasse. Norwegian wrasse fisheries cannot support the salmon industry and Corkwing wrasse, Goldsinny wrasse, and Ballan wrasse are now fished from Strömstad to Kungsbacka on the Swedish west coast. The wrasses are transported in tanks to Norway for use as cleaner fish in salmon farms.
This is a new fishery in Sweden, and there is a lack of knowledge to establish a management plan. In order to obtain the necessary information for efficient management we are planning two larger experiments during 2017. One assesses the effect of wrasse removal in the algal belt. Wrasse densities will be manipulated in mesocosm experiments on Tjärnö from end of May 2017 until end of June. We will map the effect on mesoherbivores and fouling algae in the algal belt. In August 2017 there will be test fisheries in fished and un-fished areas in conjunction with sampling of epiphytes and mesoherbivores. The project is suitable for 30 to 60 ECT projects. Are you interested? Contact us for more information:

Erik Selander: erik.selander@gu.se or
Håkan Wennhage: hakan.wennhage@slu.se

Small-scale transport of microplastics: the role of hydrodynamics on particle dispersal and trapping

Supervisors: Therese Karlsson & Dr. Eduardo Infantes, **Where:** Kristineberg, Sven Lovén Centre for marine infrastructure, **Level:** Master level 30-60 hec, 1-2 students

Background

Pollution of the marine environment with plastic is an increasing worldwide problem, which has shown to have negative impacts on environmental, social and economic values. Bigger pieces of plastic can decompose into small fragments or particles called microplastics (<5 mm), additionally some plastic materials are produced in the microplastic size range as abrasive agents or preproduction pellets. In the environment, these particles are ingested by a wide variety of different marine organisms (eg. fish, turtles, mammals, birds). Microplastics often have long degradation times and during this time they can travel and disperse over large-scales by currents. On a small-scale less is known about the transportation patterns of different types of microplastics (eg. with different particle sizes, buoyancies, densities).

The west coast of Sweden is affected by microplastics that are transported from other coastal regions and accumulated in the area, but also by local point-sources. Little is known of the local small-scale transport of microplastic in our area and the effects that these pollutant particles can have on the local environment. Coastal habitats have different levels of hydrodynamic exposure and bottom complexity, for example, particles could more easily be transported in shallow coastal areas with higher waves and currents than deeper areas. In the same way, eelgrass beds have higher bottom roughness than sandy bottoms, which increase the trapping of small particles, thus being an environmental type where microplastics could accumulate. Information about these processes could be useful to increase general knowledge about plastic transport and trapping, but also provide some empirical parameters that can be used for oceanographic and coastal dispersion models.

Aim of the research project

The aim of the Master project is to 1) quantify the hydrodynamic conditions to disperse floating and submerge microplastics in the marine environment and 2) determine the level of bottom complexity or substrate type that will experience higher accumulation or trapping of particles. A hydraulic flume will be used to quantify small-scale transport of 3 different types of microplastics (eg. densities and sizes). Different environmental substrates will be reproduced in the flume representing common Swedish coastal habitats (eg. sandy bottom, rocky bottom, macroalgae, oyster/mussel beds and eelgrass meadows).

The student should have some knowledge on hydrodynamics and MATLAB/R.

Wind-front interactions as measured by Wave Gliders and Seagliders, simultaneously
Suggested Masters project by Sebastiaan Swart (contact: sebastiaan.swart@marine.gu.se)

Scientific background
The interaction between the ocean and atmosphere are extremely important to the processes that govern the upper ocean. These processes drive air-sea fluxes or heat and carbon that are critical to the global climate. One way in which these air-sea fluxes are moderated is through the interaction between surface winds and ocean flow fields, such as fronts and eddies. The energetics of the ocean flow field are particularly amplified at submesoscales (1-10 km) where they manifest in regions of large horizontal density gradients. We have valuable datasets of high frequency Wave Glider winds together with high-resolution temperature and salinity profiles of ocean from Seagliders that can be directly compared to each other to assess the interaction between the surface wind stress and the fronts of the Southern Ocean.

Objectives and approach of project
- Search of any relevant literature on this topic, specifically on air-sea interaction and wind-front interactions
- Analyze available datasets from Wave Glider and Seaglider multi-month deployments in the Southern Ocean
- Provide simple analysis and interpretation of the wind data with horizontal density gradients of the ocean

Some competency in Matlab/Python or alternate code is needed.
If it does not clash with course work, the student may have the opportunity to join a research cruise to the Southern Ocean/Antarctica.
The project has prospects to lead into a PhD thesis.

Wave Glider being prepared to be loaded onto ice breaker ship to head to Southern Ocean

Ocean glider data used to validate satellite sea surface temperature (SST)

Suggested Masters project by Sebastiaan Swart (contact: sebastiaan.swart@marine.gu.se) & Marjolaine Krug (University of Cape Town/CSIR, South Africa)

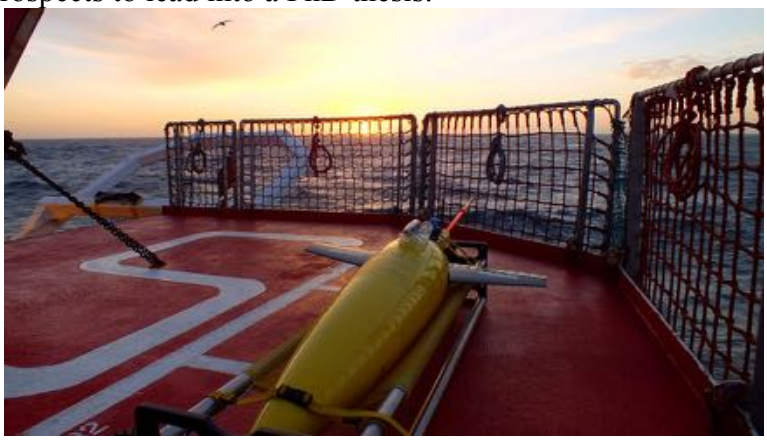
Scientific background

There are a number of different remotely sensed SST products that vary on a range of temporal and spatial scales. Currently there is little understanding of their accuracy at representing the 'true' in situ SST. We require validation approaches and datasets in order to assess the accuracy that these various products have and how well they define the variability of the SST. Ocean gliders provide large amounts of information about surface ocean, such as currents and SST and can be used as a great tool to compare in situ observed SST with those estimated by remotely sensed techniques.

Objectives and approach of project

- Search of any relevant literature on this topic, specifically on SST validation studies
- Download freely available satellite and merged SST products over the time and space range of the glider experiments
- Familiarize oneself with the glider scientific data and near surface temperature data
- Compare the glider SST data with nearest collocated satellite/reanalysis downloaded SST data
- Provide simple analysis and interpretation of the comparisons between the SST datasets

Some competency in Matlab/Python or alternate code is needed.
The student will also have the opportunity to engage remotely with scientists in South Africa and France on this topic. This may even lead to a short trip to Cape Town to collaborate with this researcher (M Krug) if it does not interfere with the students course work.
The project has prospects to lead into a PhD thesis.



Seaglider on deck is ready to be deployed in the ocean for 6 months.

Investigating submesoscale processes in the mixed layer under a sea ice covered ocean
Sebastiaan Swart, Louise Biddle

Background

The Marginal Ice Zone (MIZ) surrounding the Antarctic continent covers a huge area of ocean, and yet is poorly observed and understood due to the difficulty in obtaining measurements during winter months under ice cover. Sea ice growth and melt change the freshwater content in the ocean, and this can trigger submesoscale mixing in the upper ocean. This mixing can help transport carbon and heat from the atmosphere into the deep ocean through the mixed layer, yet the magnitude of this process is poorly understood due to the sparse measurements. The submesoscale mixing may be influenced by drivers such as atmospheric fluxes (heat, freshwater and wind), sea ice growth or melt, or ocean advection. The relative importance of these drivers is crucial to understand in order to develop future field campaigns.

Project

In order to build up our knowledge of winter-time processes, we can use models to simulate the mixed layer and sea ice growth and melt. Using existing ocean observations (from seal tags, ship observations or float arrays) and atmospheric reanalysis products, you will initiate and run a simple one-dimensional ocean model, to identify the effect that local forcings (atmospheric and sea ice drivers) may have on the mixed layer. Further modifications to the model and model inputs can be made to further explore the connections between atmospheric forcing, sea ice, and upper ocean mixing.

This project will expose you to state-of-the-art observing technologies such as seal tags and ocean gliders from the polar regions.

Skills required

- Confident with Matlab
- Some previous experience with physical oceanography and meteorology (not compulsory)

DEVELOPMENT OF ANALYTICAL METHODOLOGY FOR STUDIES OF INTRA-CELLULAR PROCESSES IN MARINE ORGANISMS WITH CONFOCAL RAMAN SPECTROSCOPY

Contact: Katarina Abrahamsson, katarina.abrahamsson@gu.se

Alexandra Walsh, alexandra.walsh@gu.se

Where: Botany Building, Gothenburg

BACKGROUND

There is a need to advance methodology to decode how changes in environmental factors and industrial processes influence ecosystems and human health, i.e. increase our understanding of cellular processes from molecules to organisms to ecosystems. Environmental factors alter molecules, cells and physiological processes inside organisms. Therefore, one major challenge is to develop an increased understanding of the different responses to environmental changes at many biological levels including molecules, cells, cellular communities, tissues and organisms.

Raman spectroscopy, especially in its combination with microscopy, is a tool for advanced studies on a molecular level in environmental research. It has unique features, including little or no sample preparation, non-destructive, etc. Raman spectroscopy is unique in the sense that it is possible to perform detailed studies of cells in their natural state without perturbations of e.g. dyes, mechanical sectioning or other preparation procedures.

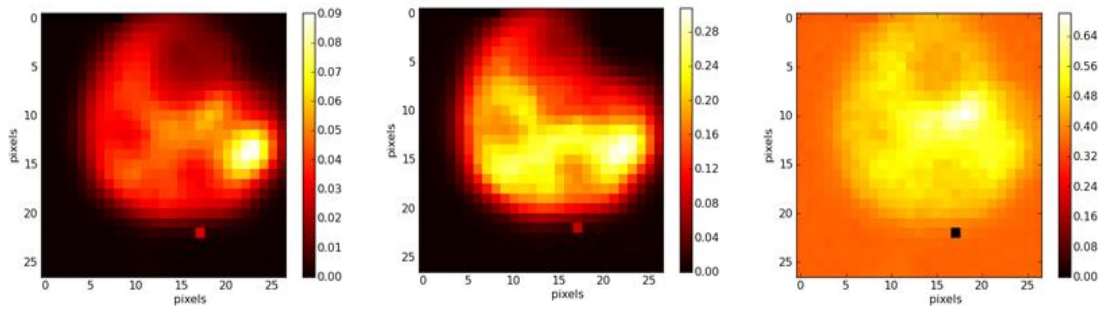
AIM

The aim of this master thesis project is to optimize the introduction of gold or silver colloids in algae cells. The colloids are necessary to achieve singal enhancement of individual molecules. You will specifically study the enzymatic formation of ozone depleting compounds such as bromoform.

METHODOLOGY

The instrumentation used is our confocal Raman spectrometer equipped with three laser lines. The reults will be evaluated with multivariate statistics such principal component analysis.

Katarina.abrahamsson@gu.se tel: 031 7869051



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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.

Miljöeffekter av utsläpp från konstgräsplaner: hur påverkas fiskar av partiklarna som hamnar i våra vattendrag?

Fotbollsplaner med konstgräs blir vanligare allt eftersom naturligt gräs ersätts med dessa produkter, som är gjorda av nyproducerad och återvunnen gummi. Studier har visat att konstgräs släpper ifrån sig en del farliga kemikalier som tex PAHer och metaller. Kemikalierna är kända mutagener och cancerogena ämnen. Vi vet inte exakt vilka mängder gummi som hamnar i miljön och en del av projektet gäller undersökningar av dagvatten samt dess utlopp i Göteborgs hamn. Vi vill också använda gummipartiklarna i toxicitets tester för att mäta effekter av dessa på magtarmkanelens fysiologi och barriäregenskaper hos fisk. Studenten kommer att få möjlighet att arbeta delvis med fältprovtagningar samt laborativt. Projektet är baserat på fysiologiska samt ekotoxikologiska frågeställningar.

Projektet bäst lämpad för masters nivå. Kan göras vilken tid på året som helst.

Plats: Zoologen i Göteborg.

Kontakta
Bethanie.carney@bioenv.gu.se eller henrik.sundh@bioenv.gu.se

Plasticity of snail fitness - will exercised snails perform better than other snails?

Main supervisor: Kerstin Johannesson (Kerstin.Johannesson@marine.gu.se)

Focus of the project: Marine biology

Location: Tjärnö

Background: Humans perform better in physical activities after some physical training. Physical performance is thus a highly plastic trait. If this is a potential or not in snails, is however never investigated.

Problem: Do snails that have been exercised in a snail "fitness-centre" perform better under stress from physical wave than snails that have not been trained?

Method: Snails are sampled and divided into two groups. One is exercised each day during 1-2 weeks in water that is moving, and the other is not. Both groups are fed surplus of food. After a week, the ability of the snails to resist water flow in a high-speed flume is measured and compared. There are possibilities to also vary food availability and time of exercise, or other parameters like age of snail.

Suitable level and length: Batchelor (15 hp)

Suitable time period: Project can be performed all year round

Natural and sexual selection: size and shape matter

Supervisor: Samuel Perini (samuel.perini@gu.se)

Co-Supervisor: Kerstin Johannesson

(kerstin.johannesson@marine.gu.se)

Focus: Evolutionary biology and Mathematics

Location: Tjärnö and Gothenburg

Background. The morphology of organisms is an evident and established target of both natural and sexual selection. Sizes and shapes of adaptive traits have been changing over time under the influence of fluctuating environmental conditions. Organisms carrying the most suitable and preferred morphology for a specific habitat and partner exhibit high reproduction rate and increased fitness. For example, the evolution of the shell has provided gastropods with crucial functions such as protection against predators and harsh environments. Besides these structural attributes, shell morphology has also contributed to the barrier effect of mating behaviour in diverging populations. The rough periwinkle, *Littorina saxatilis*, is an excellent model for the investigation of the role of shell size and shape in local adaptation of its two ecotype populations. The snails exposed to the wave action have evolved a smaller and thinner shells than the snails subject to crab predation. The distinct selective pressures have further influenced the shell morphology of the two ecotypes. The wave-type shows a relatively large aperture to improve attachment to the rock whereas the crab-type presents a narrower one to prevent damages of its soft body parts by the crab. Previous studies have addressed the occurrence of mate choice in *Littorina* species. Essentially, individuals of one ecotype tend to mate more frequently with those carrying similar phenotypes. However, the production of hybrids raises the question about patterns of shell morphology implicated in offspring viability and fertility.

Aim. The project involves the evaluation of shell size and shape from one parental line and the first generation of offspring of the marine species *L. saxatilis*. Estimation of shell morphology will complement previous results on mating behaviour and simultaneously introduce compelling information to the evolution of mate choice.

Method. A morphometric analysis will be performed on the shells of both parental and offspring individuals reared under laboratory conditions. Data have been already collected from the pictures of the shells and they will need to be examined using software packages built in the R environment. The main challenge consists to apply morphometrics strategies in order to capture significant differences in shell morphology between ecotypes and across generations.

Level, length. Flexible project for a 15hp applied project, 30hp bachelor thesis or 60hp master thesis. Required basic knowledge of R.

Time period. All year round.

PHOTOSYNTHETIC PERFORMANCE IN SELECTIVE BREEDING OF THE BROWN SEAWEED, SUGAR KELP

What: Master or Bachelor student project
Where: Tjärnö
Contacts: Wouter Visch (wouter.visch@marine.gu.se)
Göran Nylund (göran.nylund@marine.gu.se)

Objective

The main goal of this project is to measure photosynthetic performance of gametophytes of Sugar Kelp (*Saccharina latissima*) under stress conditions. And ultimately link this to cultivation performance (e.g. yield) out in the field.

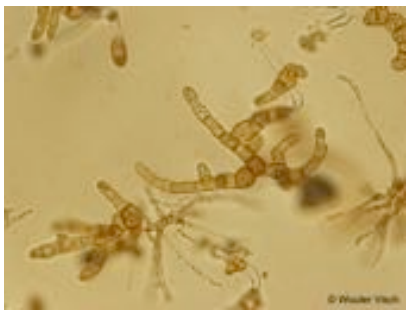
Background

The worldwide interest in seaweed products has increased in recent decades, so that in addition to the harvesting of natural resources, the cultivation of seaweeds from aquaculture is gaining more and more importance. Algal cultivation in East Asia globally dominates the market. In order to make seaweed cultivation an important industry also in Europe, an increased focus on breeding (techniques) is needed.

Material & Methods

The brown algae Sugar Kelp, *Saccharina latissima*, will be the main species of interest. Understanding its life cycle is of major importance in cultivating and breeding of this species. Photosynthetic performance will be measured in gametophytes using pulse-amplitude modulation (PAM) fluorescence measurements. Gametophytes will be exposed to different stress levels (e.g. heat, high/low light, nutrient depletion etc.) and look at the effect of these stressors on their health.

The student will get hands on experience in algal culturing techniques and photosynthetic PAM measurements. The project can be adjusted to a 15 hp applied project, 15 or 30 hp bachelors thesis or 60 hp masters thesis.



Title: DNA barcode species determination of canned tuna

Main supervisors: Thomas Dahlgren, thomas.dahlgren@marine.gu.se
Sara Hornborg, sara.hornborg@sp.se

Focus of the project: Marine Biology
Location: Göteborg
Background: Seafood is the most traded food commodity, with long and complex supply chains. In the EU, tuna is the top consumed seafood product, with canned tuna being one of the most popular tuna products. Today, a range of tuna species are fished around the world, and products from the global tuna fishing industry has world-wide spread. Producers are in general required to label the cans with what species it contain, if it is cultured or from fisheries and what area the content was fished or from which country it was cultured. This is important so that the aware consumer can make informed choices and avoid vulnerable species. The meat of some species of tuna is also more likely than others to contain high levels of mercury, due to bioaccumulation by higher trophic level species.
Problem: Miss-labeling occurs in the seafood industry, in many cases found to be around 30% of the products. The reasons are many-facetted: long and complex supply chains, illegal fisheries, market less-popular species as more-popular ones, etc. Miss-labeling cause problems in many ways, such as illegally fished products can enter the market and contribute to overfishing of stocks, and some seafood products may pose health risks to certain consumer groups and must thus be correctly labelled. Most recently, a study of canned tuna reported in Swedish newspapers showed interesting results on mercury content, which may indicate mislabeling and would be interesting to follow up on.
Method: A sample of tuna cans will be purchased from local stores. The contents will be DNA extracted. To determine the species composition of the content DNA barcode genes (the CO1 marker) will be sequenced and resulting data compared with publicly available databases (GenBank).
Suitable level and length: project can be adapted to suitable education level
Suitable time period: project can be performed all year round

Title: Characterizing the presence of proteinaceous particles in marine snow aggregates

Contacts: Eva-Maria Zetsche (eva-maria.zetsche@gu.se)
Helle Ploug (helle.ploug@marine.gu.se)

Focus of the project: Marine biology and biogeochemistry

Location: The student will be located at the Botan building with potential stays at one of the Marine stations.

Background: The continuous rise in carbon dioxide levels means that it is crucial to better understand the Earth's carbon cycle. One key aspect is the ocean's so-called "biological carbon pump", which is the biologically driven sequestration of atmospheric carbon to the deep ocean and its sediments. Major vehicles for this transfer of organic matter from the surface to the deep are so-called "marine snow aggregates". Diatoms are the most common type of phytoplankton found in the ocean, and hence it is these diatom aggregates which dominate the particle flux to the ocean floor. The diatoms themselves also produce so-called transparent exopolymeric particles (TEP). These are gel-like transparent sugary particles which act as a glue for the aggregates and are made visible by staining techniques using a stain called Alcian Blue. In addition to these polysaccharides, there are, however, also so-called Coomassie Stained Particles (CSP) present in the water column. These are proteinaceous particles stained with the stain Coomassie Brilliant Blue.

Problem: Much work has been carried out on understanding the release and presence of TEP in the world's oceans and their role as a glue matrix in marine snow aggregates. In contrast, very little work has been carried out on CSP since their description by Long and Azam in 1996. In particular, we know very little about the presence and abundance of CSP within marine snow aggregates.

The purpose of this project is thus to:

- Evaluate available methods for CSP measurements and how they apply to CSP associated with marine snow aggregates
- Obtain novel measurements of CSP content for both man-made as well as natural aggregates.

Method: We will use rolling tanks to produce aggregates in the laboratory as well as collect natural aggregates from the field. We will undertake standard measurements on these aggregates such as their size, shape, sinking velocity, etc., but, more importantly will also measure the CSP content. Microscopy techniques will be used to measure bacterial numbers and to characterize the aggregate structures.

Suitable level: BSc, MSc
Suitable time period: Can be performed all year round, although preferably in the summer and/or autumn
Requirements: The student has to speak English.

Title: Understanding the production of transparent exopolymeric substances (TEP) in permeable diatom aggregates

Contacts: Eva-Maria Zetsche (eva-maria.zetsche@gu.se)
Helle Ploug (helle.ploug@marine.gu.se)

Focus of the project: Marine biology and biogeochemistry

Location: The student will be located at the Botan building with potential stays at one of the Marine stations.

Background: Diatoms play a key role in the carbon cycling on earth and account for approximately 20% of the primary production on Earth. Diatoms follow a bloom-and-bust cycle with blooms terminated with the formation of fast-sinking aggregates (> 0.5 mm). These diatom aggregates comprise a significant component of vertical carbon fluxes to the deep sea and sediments, and are the dominant form of "marine snow". Hence, these aggregates play a significant role in the ocean's "biological carbon pump", sequestering carbon to the deep ocean. Diatoms release extracellular polymeric substances including so-called "transparent exopolymeric particles" (TEP), which is the 'glue' of all marine aggregates. TEP have the characteristics of marine gels, are very sticky and consist mostly of sugars. Given their stickiness, TEP have the ability to scavenge and aggregate particles via coagulation and provide a substrate for bacteria and other microbes. Diatom aggregates are thus hotspots for microbial activities in the water column.

Problem: Diatom species vary in how much TEP they produce and how they aggregate. Both cell-cell stickiness or cell-TEP stickiness are found in diatom aggregates. *Skeletonema costatum*, for example, tends to produce compact aggregates due to its limited production of TEP and cell-cell stickiness, whilst aggregates formed from *Chaetoceros* sp. can be highly porous ("fluffy") with high concentrations of TEP acting as a connector. Frequently, our knowledge has been gained from laboratory-made aggregates, which are commonly quite compact in shape and size. However, we still lack a good understanding of so-called permeable aggregates.

Method: We will use rolling tanks to produce diatom aggregates from different species and natural water samples. We will undertake standard measurements on these aggregates such as their size, shape, sinking velocity, etc., but, more importantly will also measure the TEP content. Microscopy techniques will be used to measure bacterial numbers and to characterize the aggregate structures.

Suitable level: BSc, MSc, i.e. the project can be adapted to a suitable education level
Suitable time period: Can be performed all year round.
Requirements**:** The student has to speak fluent English.

Developing and applying methodolody for microplastic abundance in arctic sea ice cores from North Svalbard.

Main supervisors: Martin Hassellöv, Department of Marine Sciences, GU, Kristineberg, martin.hassellov@marine.gu.se, and Maria Granberg, Norska Polarinstitutet, Tromsö.

Focus of the project: marine chemistry

Location: Kristineberg

Background: Microplastics and other contaminant particulates is receiveing increased attention due to the reported accumulation zones in e.g. subtropical gyres. But in addition to these 5 great gyre accumulation zones, there has also been forecasted, from current drifter data and simulations, an accumulation in the Barents sea and waters around Svalbard. This is yet to be confirmed though, since almost no microplastic studies have been carried out in the region.

Method: In the summer 2015 the Norwegian Polar Institute collected sea ice cores from North Svalbard that now will be subjected to microplastic analysis. Some method optimization is needed before cores are sectioned, melted and filtered prior to visual optical identification and microspectrometric identification using μ-FTIR.

Suitable level and length: The project is most suitable as a Master project but could also be considered as a "Batchelor (15 hp)". For a longer Master project the study can be adapted and extended in scope with more method developments and further analytical characterization techniques.
Suitable time period: project can be performed all year round

Title: How does environmental change affect the gut microbiome of *Idotea balthica*?

Main supervisor: Pierre De Wit: pierre.de_wit@marine.gu.se

Focus of the project: Marine biology

Location: The Sven Lovén Centre for Marine Sciences - Tjärnö.

Background: The Baltic Sea ecosystem is predicted to undergo dramatic changes within the next 100 years. Large parts of the Baltic currently at salinities around 7 psu will see a decrease to less than 4 psu. In addition, the effects of global warming could be particularly severe in the Baltic, with models indicating an average increase by about 3-5 degrees C, which could have dire consequences for the organisms living there. One of the most important grazers in this ecosystem is the isopod *Idotea balthica*. A recent study has shown that these grazer have different gut microbes depending on their food source, suggesting that the microbes help them break down the refractory algal material.

Problem: We currently have no knowledge on how the digestive capability of *Idotea* will change as the environment changes in the Baltic. If they lose the ability to digest *Fucus*, there will be large-scale changes to the Baltic Sea ecosystem. Step one in understanding these changes must be to characterize the gut microbiome by studying which species are there and how the composition varies along the Baltic Sea gradient in salinity and temperature.

Method: Individuals of *Idotea balthica* will be collected in choice locations in the Baltic Sea, which will then be kept in different environmental conditions in the lab. There is also already a large collection of samples in the freezers on Tjärnö from 2014, for temporal comparisons. The gut microbiome will be assessed using 16S rDNA amplicon sequencing, so part of this project will be molecular lab work, as well as bioinformatics.

Suitable level and length: Master (30-45 hp).

Suitable time period: Spring 2018

The Ecotron system at the Lovén Centre Tjärnö.

Parametrisering av primärproduktionens ljusberoende i svenska marina områden.

Bakgrund:
Fytoplanktons upptag av koldioxid genom fotosyntesen är en av de viktigaste processerna inte bara för att det är grunden för de marina näringskedjorna utan även för att det är en av de största omsättningarna av växthusgaser på jorden. Att kunna uppskatta och beskriva denna är därför av fundamental betydelse både för den marina ekologin och för klimatforskningen.
Den metod som generellt används är att man, vid en station, tar vatten på olika djup, fyller det på flaskor, som sedan inkuberas under ett antal timmar varefter men tar upp dem läser av hur stor fotosyntes som skett. Detta kan mätas antingen som producerad syrgas eller upptag av radioaktivt märkt koldioxid.
Från dessa mätningar kan man göra integreringar över hur stor den sammanlagda fotosyntesen är i hela vattenpelaren eller man kan (om man har ljusdata tillgängligt) parametrisera det hela en ljusmättnadskurva som exv enligt ekvation av Jassby and Platt (1976):

$$P = P_m(1 - e^{-\frac{\alpha E}{Pm}})$$

P är där produktion; P_m (maximala produktionen); α lutningen vid origo i en ljusmättnadskurva; E är ljusstyrkan.

För långsiktiga och globala uppskattningar så krävs det att man kan generalisera dessa parametriseringar till att vara giltiga för flera tider och positioner än just då de är mätta. Det är så man har gått till väga för uppskattning av den globala produktionen. Man identifierar ett antal olika biogeokemiska domäner där man antar att man kan använda samma ljusmättnadskurva och då ljuset och biomassa kan uppskattas med hög upplösningen från satellitdata så ger det globala uppskattningar av produktionen. Dessa uppskattningar blir dok, med nödvändighet, väldigt grova och för en mer tillförlitlig beskrivning av omsättningarna på lokal nivå krävs större upplösningar i både tid och rum.

Projektets målsättning
Det har inom den marina övervakningen gjorts regelbundna mätningar av primärproduktionen på ett antal platser. Dessa har i viss mån bearbetats till integrerade produktioner men har systematiskt parametriseras enligt ljusmättnadskurvor så att man kan uppskatta möjligheter till att göra generella uppskattningar av hur homogen produktionskapaciteten är och om det finns vissa perioder/lokaler som avviker. Projektets målsättningar skall därför vara att genomföra sådana parametriseringar med samma teknik för tillgängliga data och utifrån det göra utsagor om möjligheter till generaliseringar. De data som kommer i första hand är den serie med mätningar i Gullmarsfjorden som sträcker sig 30 år tillbaka med minst en mätning per månad. Andra serier finns inom den generella övervakningen och från fältstationer i Östersjön.

Framtid
Detta arbete kommer att vara en del av den utbyggnad av kompetenser då det gäller användningen av satelitdata för uppskattning av fytoplantonsammansättning och produktion som vi planerar att bygga upp på marina institutionen.

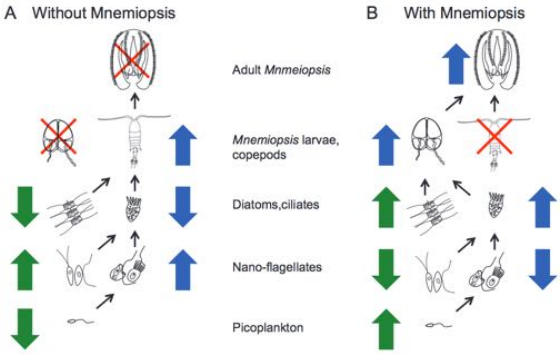
Omfattning
Arbetet lämpar sig väl som ett kandidatarbete inom marin vetenskap (15 hp). Skulle kunna expanderas till ett masterarbete eller längre kandidatarbete (30hp) om fler aspekter tas upp.

Förkunskapskrav
Det krävs att man har viss känsla för och kunnighet då det gäller fytoplanktons fotosyntes. Vad som mera krävs är beredskap att hantera databaser och kunnighet att hantera data med exv Matlab eller R.

Handledare
Sten-Åke Wängberg (samverkan med Peter Tiselius), sten-ake.wangberg@marine.gu.se

Marine pelagic food web structure

The lower trophic levels of the marine pelagic environment are a highly dynamic part of the coastal ecosystem. My research focus on clarifying the ecological function of the smallest plants and animals in this system. A lot is known about the zooplankton larger than 1 mm and also of the phytoplankton smaller than this size. But there is a general lack of understanding of what controls the trophic levels of these small organisms. I can supervise projects involving experiments, observations and field studies of the plankton in the Gullmar fjord and work based at Kristineberg.



A suggested scenario how copepods and *Mnemiopsis leidyi* may affect the lower trophic levels of the food web. A. In years without *M. leidyi* the copepods are abundant controlling the ciliate biomass and reducing the larger phytoplankton. This creates a flagellate dominated base for the food web. B. When *M. leidyi* removes the copepods, ciliates thrive and reduce flagellates while supporting *M. leidyi* larval growth. In order to start the rapid reproduction of *M. leidyi*, a sufficient fraction the copepod biomass needs to be removed to relieve ciliates from their predation pressure. Green arrows indicate changes in phytoplankton biomass, blue arrows indicate changes in zooplankton biomass.

Recently, we have discovered potential trophic structure among the microzooplankton and we would like to study this in more detail. Correlation studies indicate an intermediate grazing level between ciliates and small autotrophic phytoplankton. Student projects can be developed to suit your interest in this field.

Interested? Contact: peter.tiselius@bioenv.gu.se

For more background info, see: http://plankt.oxfordjournals.org/cgi/reprint/fbw096?ijkey=m22pNm0OJQAfz9z&keytype=ref

Exam projects within the OPTIMUS (Optimization of mussel farming cultures for fish feed in in the Baltic Sea) **project**

Background

OPTIMUS is a 3-year project with the focus on various aspects of mussel farming and its environmental impacts. The overall goal of the project is to provide scientific documentation for the potential and impact on the coastal environment of mussel aquaculture.

Harnessing the full potential of the **"blue economy"** is seen today as one of the most promising means to boost growth, employment opportunities and competiveness. In marine systems like the Baltic Sea that already are heavily exploited and subject to multiple anthropogenic pressures, it is of key importance for the long-term sustainability of the blue growth that it does not add to the pressure factors. Aquaculture of extractive species like mussels and seaweed is an example of a blue growth potential that will not add to the pressure on the Baltic ecosystem but in contrast has the potential to mitigate some of the effects of excess load of nutrients.

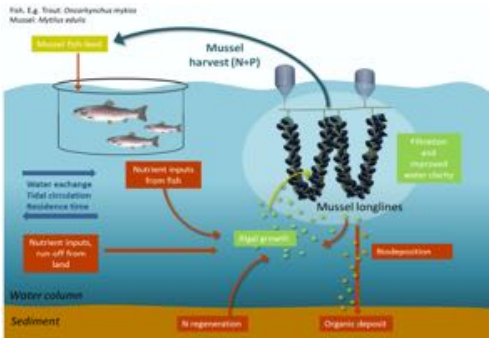


Figure 1. The Mussel mitigation concept

Before mussel farming can be accepted as a mitigation tool by the public, stakeholders and managers, there is a need for a robust demonstration of the ecological feasibility of using the tool in different types of environments in the Baltic Sea. Mussel farms not only remove nutrients by harvesting, but in addition have positive effects on the environment by improving water clarity and reducing Chl. *a* and seston concentrations. There may on the other hand be negative effects through increased sedimentation of biodeposits below the farms increasing the oxygen consumption and changing the sediment chemistry and benthic fauna. The impact is known to depend on mussel density and environmental conditions such as hydrography, water exchange, sediment type, and eutrophication status.

As OPTIMUS is a project that deals with a wide range of aspects of mussel farming, there are many different questions that can be performed and evaluated as an exam project. Below are some different suggestions but we are **open for discussion about any suggestions from students** regarding potential projects related to bivalve aquaculture.

Potential projects

Project A: *Growth and survival*

This project focuses on experimental studies on the survival and growth of potential mitigative species under mussel farms and their utilization of the biodeposition of faeces and pseudofaeces. These studies will allow for identification of species likely to survive and growth well under the conditions present at mussel farm sites and thus might have a potential to function as species mitigating the effects of biodeposition from the farms on the sediment surface.

Project B: *Mitigative effects*

Here the focus is on the effects of different potentially mitigative species on biogeochemical fluxes across the sediment-water interface. By studying how a specific species affects the fluxes of nutrient in environment affects by biodeposits from mussel farms vs environments that are unaffected an idea of the effect the species will have on sediment below mussel farms if used in remediation efforts.

Project C: *Environmental impacts of mussel shells*

One potentially big impact on the sediment below mussel farms is deposition of shells from the farm. This project includes studies on how the accumulation of shells on the sediment surface influence the fluxes of nutrients across the sediment-water surface and the potential of different bioturbating species to

survive, grow and thrive in sediment affected by high organic load, such as under a mussel farm.

Project D: *Impact on the benthic organism community*

By studies of the macrofauna below mussel farms located in areas with different environmental conditions the environmental parameters, influencing the effect of mussel farms on the macrofaunal communities can be evaluated. This study is preferably conducted during 2018 when a more extensive sampling is planned for the most mussel farming intensive area on the Swedish west coast.

Project E: *Caging*

Before any mitigative efforts can be performed in field, methods for caging of species need to be tested. This project focuses on development and testing of caging methods for different potentially interesting mitigative species.

Length of projects

Preferably, master level (30-60 hp) but shorter projects can also be discussed depending on the preferred research question.

Time frame

Depending on the specific research question(s) selected for the projects.

Location

Experimental part:

Tjärnö Marine Field Station and depending on the project potentially partly also at collaborating mussel farms.

Analysis and writing:

Preferably at Tjärnö but can be partly done elsewhere depending on the student.

Contacts

Mats Lindegarth
Epost: mats.lindegarth@marine.gu.se
Tel : 031-786 9672

Per Bergström
Epost: per.bergstrom@marine.gu.se

MSC project:

"Investigation of molecular clock genes of the European shore crab *Carcinus maenas*"

Contact: Marlene Jahnke, marlene.jahnke@gu.se

This project is part of a VR-financed project of Prof. Per Jonsson and Associate Prof. Per-Olav Moksnes and you will be directly supervised by the PostDoc Dr. Marlene Jahnke. You will investigate molecular clock genes, a topic that won the Nobel Prize in 2017! The big topic of the project is "**Local adaptation driven by evolution of dispersal traits in marine larvae**".

Most marine invertebrate disperse during a planktonic larval stage that may last for many weeks while drifting with the ocean circulation. A challenge for larvae of coastal species is to stay close to the coastline or return at the time of recruitment. Most larvae may control their vertical position in the water column and can perhaps exploit depth-dependent variations in water transport to modify their net dispersal.
Carcinus maenas shows a **cline in larval behavior** (vertical migration) along a gradient in tidal influence from the English Channel to the Kattegat. In areas where tides are significant, shore crab larvae display an inherited endogenous vertical migration rhythm with local tides, which is believed to facilitate cross-shelf transport and recruitment. In areas where the tide is insignificant, larvae show instead migration to deeper waters during the day, possibly reducing predation.

Oceanographic modelling and behavioural data collection is ongoing and we have collected samples from the English Channel up to the Baltic for genetic analyses (SNP genotyping). We will therefore have a good knowledge of population genetic structure and want to add RNA-based studies on genes that may be involved in the regulation of the above described larval behaviour. Recently, it was found that a family of neuropeptides in crabs (pigment-dispersing hormones, PDHs) likely is involved in the **molecular clock that controls circatidal rhythm**. We will use published sequences of shore crab PDHs and other potential clock genes to screen for differences in expression of these genes among tidal and a-tidal crabs. Additionally we will also investigate potential changes in DNA sequences of these candidate genes and will investigate differences in methylation patterns, to also investigate the potential role of epigenetics in driving larval behaviour.

Lab techniques that will be used include RNA- and DNA- extraction, qPCR, PCR, gel electrophoresis and enzyme digestions. The project will also involve bioinformatics for screening available transcriptomes, genomes and sequence data-bases for potentially interesting candidate genes and for analysing DNA and RNA-based results. The position is based on Tjärnö.

Mussel farming – down below

Level: Master, 60 hp, starting in the summer/autumn of 2018
Where: Gothenburg and Horsens (Denmark)
Supervisors: Astrid Hylén and Per Bergström

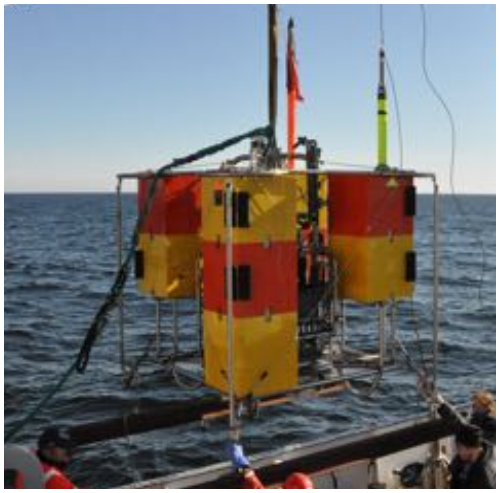
Background

Mussel farming is seen as a promising tool to mitigate eutrophication in the ocean. Phytoplankton take up nutrients from the water and are then eaten by the mussels, which are later harvested. In this way, nutrients are removed from the sea. However, the full environmental impact of mussel farms has only been investigated in a few studies. Before it can be accepted as a mitigation tool by the public, stakeholders and managers, more information from mussel farms are needed to assess the ecological feasibility of the method. One major question is how the mussels affect the sediment below the farm. Mussels produce organic matter that falls down on the sediment, which can lead to increased oxygen consumption and changes in the sediment chemistry. As oxygen concentrations go down, the sediment can start releasing nutrients to the water column and thereby counteract the nutrient removal by the mussels.

Project

The purpose of this master project is to investigate how the sediment biogeochemistry is affected by the establishment of a mussel farm. At three occasions (approx. June, September and December), a mussel farm in the Horsens fjord on the eastern coast of Denmark will be visited, to follow the mussels' growth cycle from settling to harvest. Benthic chamber landers will be used to measure *in situ* sediment-water fluxes of nutrients, gases and metals. Sediment incubations with ^{15}N will also be performed to study nitrate reduction processes.
This project is part of the OPTIMUS (*Optimization of mussel farming cultures for fish feed in in the Baltic Sea*) project. OPTIMUS is a 3-year project with the focus on various aspects of mussel farming and its environmental impacts. The overall goal of the project is to provide scientific documentation for the potential and impact on the coastal environment of mussel aquaculture.

Interested? Contact Astrid Hylén at astrid.hylen@marine.gu.se




Nivå: Kandidat, 15 hp, läsperiod 4 2018
Var: Göteborg och Östersjön
Handledare: Astrid Hylén och Per Hall
En student söks till ett av de två nedanstående arbetena.

Bentiska kväveflöden i Östersjön

Östersjön, världens näst största bräckvattensystem, består av flera olika bassänger som i vissa avseenden är relativt olika. I Bottenviken och Bottenhavet är salinitet, artrikedom, närsaltskoncentrationer och mängden sedimenterat organiskt material låga, samtidigt som bottnarna generellt är väl syresatta. I Egentliga Östersjön och Finska viken är saliniteten, artrikedomen och närsaltskoncentrationerna högre, men stora områden lider av syrebrist. I nästan två decennier har gruppen för bentisk biogeokemi gjort provtagningar med bentiska landare i olika delar av Östersjön. Detta har gett ett stort set med både publicerade och opublicerade data om bentiska kväveflöden. Syftet med projektarbetet är att sammanställa dessa data, eventuellt i kombination med andra studier, för att ge en bild av vad som styr de bentiska kväveflödena i Östersjön. Är samma biologiska, kemiska och fysiska faktorer viktiga i alla delbassängerna, eller är olika miljöfaktorer dominerande på olika ställen? I projektet ingår en expedition till Östra Gotlandsbassängen under de två sista veckorna i april 2018.

Kvävecykeln *in situ – ex situ*: metodjämförelse

Kväve är ett livsviktigt ämne för alla organismer. Under 1900-talet har vi på stor skala börjat påverka kvävecykeln och de många processer som ingår i den. För att förstå hur ekosystemen påverkas är det därför angeläget med goda kunskaper om kvävecykeln. För att mäta processer i kvävecykeln används ofta isotopen ^{15}N. Detta är särskilt ett viktigt verktyg för att mäta nitratreduktionsprocesser: denitrifikation (NO_3^- -> N_2), anaerob ammoniumoxidation (anammox, NO_3^- + NH_4^+ -> N_2) och dissimilatorisk nitratreduktion till ammonium (DNRA, NO_3^- -> NH_4^+). ^{15}N tillsätts till sedimentkärnor eller slurries, varefter mätningar görs för att se hur mycket ^{15}N som kan återfinnas i respektive slutprodukt. Med hjälp av bentiska landare kan man dock göra *in* situ-inkubationer med 15N. Denna metod verkar ha flera fördelar, till exempel ökad känslighet för låga nitratreduktionshastigheter. Projektets mål är att jämföra data från inkubationer av sedimentkärnor i labb med *in situ*-inkubationer med bentiska landare. I projektet ingår en expedition till Östra Gotlandsbassängen under de två sista veckorna i april 2018.

Intresserad? Kontakta Astrid Hylén, astrid.hylen@marine.gu.se.

Student project (can be BSc or MSc level):

Comparative Life Cycle Assessment study of mussel products

Background: The SEAWIN project (seawin.earth), is a five year Formas-funded research collaboration between the The Beijer Institute of Ecological Economics, Stockholm University, Research Institutes of Sweden (RISE), Uppsala University and a number of other international research and national industry partners. The overall project aim is to map the environmental footprint of Swedish seafood consumption and production and identify pathways towards more sustainable seafood consumption. To reach this objective, case studies analysing environmental performance of a number of seafood products that can be produced in a variety of ways, such as mussel products, will be performed.
Task description: One or several mussel supply chains (depending on interest and time available) will be studied using Life Cycle Assessment (LCA) methodology. LCA is a methodology for quantitative assessment of environmental impacts of products and their supply chains from raw material extraction over production, distribution, use and until waste treatment.
Possible chains are fished and farmed blue mussels (*Mytilus edulis*), being fished in Denmark and farmed in Sweden. Another mussel product widely found in Swedish supermarkets are New Zealand Green mussels, which could be added as a case study. Also the large volumes of mussels imported from e.g. Chile and Korea could represent alternative chains to study. The value chains should ideally be describe from grow-out, to harvesting, processing, distribution, retail, consumption, and landfilling.
Qualifications: A suitable educational background could be environmental, biological sciences, fisheries biology or engineering. Knowledge or interest in Life Cycle Assessment (LCA) methodology is of course beneficial. An open and curious mind helps!
Time plan: Flexible, but preferably during 2017-2018, can be scaled up or down from a three-month to a half- or even a one-year research project.
Location of work: Preferably in Gothenburg (RISE office at Delsjömotet), but project partners are located in Lund (RISE) and Stockholm (KVA) and can also host the student(s).
Contact person: Friederike Ziegler, RISE, 010-5166654, 0704-205609, friederike.ziegler@ri.se

Student project (can be BSc or MSc level):

Comparative Life Cycle Assessment study of scallop products

Background: The SEAWIN project (seawin.earth), is a five year Formas-funded research collaboration between the The Beijer Institute of Ecological Economics, Stockholm University, Research Institutes of Sweden (RISE), Uppsala University and a number of other international research and national industry partners. The overall project aim is to map the environmental footprint of Swedish seafood consumption and production and identify pathways towards more sustainable seafood consumption. To reach this objective, case studies analysing environmental performance of a number of seafood products that can be produced in a variety of ways, such as scallop products, will be performed.

Task description: One or several scallop supply chains (depending on interest and time available) will be studied using LCA methodology. Life Cycle Assessment is a methodology for assessment of environmental impacts of products and their supply chains from raw material extraction over production, distribution, use and until waste treatment.

Possible chains are scallop dredged inshore and offshore in the UK and in France. Scallop farming (as well as dredging) in the US/Canada could be added. Similarly, diving for scallop in Norway could be added as one of the major chains delivering scallop to Sweden at present. The value chains should ideally be describe from grow-out, to harvesting, processing, distribution, retail, consumption, and landfilling.

Qualifications: A suitable educational background could be environmental, biological sciences, fisheries biology or engineering. Knowledge or interest in Life Cycle Assessment (LCA) methodology is of course beneficial. An open and curious mind helps!

Time plan: Flexible, but preferably during 2017-2018, can be scaled up or down from a three-month to a half- or even a one-year research project.

Location of work: Preferably in Gothenburg (RISE office at Delsjömotet), but project partners are located in Lund (RISE) and Stockholm (KVA) and can also host the student(s).

Contact person: Friederike Ziegler, RISE, 010-5166654, 0704-205609, friederike.ziegler@ri.se

Student project (can be BSc or MSc level):

Comparative Life Cycle Assessment study of shrimp products

Background: The SEAWIN project (seawin.earth), is a five year Formas-funded research collaboration between the The Beijer Institute of Ecological Economics, Stockholm University, Research Institutes of Sweden (RISE), Uppsala University and a number of other international research and national industry partners. The overall project aim is to map the environmental footprint of Swedish seafood consumption and production and identify pathways towards more sustainable seafood consumption. To reach this objective, case studies analysing environmental performance of a number of seafood products that can be produced in a variety of ways, such as shrimp products, will be performed.
Task description: One or several shrimp supply chains (depending on interest and time available) will be studied using LCA methodology. Life Cycle Assessment is a methodology for assessment of environmental impacts of products and their supply chains from raw material extraction over production, distribution, use and until waste treatment.
Possible chains to study are demersally trawled Norwegian and Greenlandic northern shrimp (*Pandalus borealis*). The same species is also caught using traps in Norway on an experimental basis and in the US on a commercial basis. The company Vegafish recently started farming of tropical shrimp in a closed system in Sweden (*Penaeus sp.*) and using pilot data from their start could also be an option, Vegafish is one of the industry partners of the project. Data collected in the project will be modelled to be comparable with existing shrimp LCA studies for warmwater shrimp farmed in Asia.
Qualifications: A suitable educational background could be environmental, biological sciences, fisheries biology or engineering. Knowledge or interest in Life Cycle Assessment (LCA) methodology is of course beneficial. An open and curious mind helps!
Time plan: Flexible, but preferably during 2017-2018, can be scaled up or down from a three-month to a half- or even a one-year research project.
Location of work: Preferably in Gothenburg (RISE office at Delsjömotet), but project partners are located in Lund (RISE) and Stockholm (KVA) and can also host the student(s).
Contact person: Friederike Ziegler, RISE, 010-5166654, 0704-205609, friederike.ziegler@ri.se