
BOOK OF ABSTRACTS

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Impact of global warming and plastic leachates from conventional and biobased polymers on the growth of *Phaeodactylum tricornutum*

BY Anglada Segura, Sol

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Global warming and plastic pollution are two human-induced environmental stressors of rising concern due to their potential impacts on ocean health. To tackle plastic pollution, sustainable alternatives to conventional fossil fuel-based plastics are being developed, such as polylactic acid (PLA), a bio-based polymer made from natural-sourced feedstocks. However, in the marine environment, plastic additives and low molecular weight oligomers can be released, i.e. leached from the plastic to the surrounding seawater, and little is known about the toxicity of leachates from bio-based polymers on marine organisms. Plastics degrade because of ultraviolet (UV) irradiation, which is one of the most important triggers of polymer degradation, enhancing the chemical leaching process (i.e. release mixture of leached compounds). Currently marine organisms are exposed to a variety of environmental stressors besides plastic pollution, related to climate change like increased seawater temperature. Warming of the ocean can affect the growth, pigment content, photosynthesis, respiration and antioxidant systems of microalgae. The potential effects of plastic pollution combined with global warming is even less well understood. In this master thesis, we have three research objectives. The first aim is to assess the effect of plastic leachates from a bio-based polymer (i.e. Polylactic acid), in comparison to a reference conventional fossil fuel-based polymer (i.e. Polypropylene), on the population growth of a marine diatom. The second aim is to investigate whether the possible effect of plastic leachates is enhanced or diminished by the pre-exposure of the plastics to UV irradiation. The third aim is to understand the combined effects of leached compounds and increased water temperature (i.e. + 5 °C) based on the worst case scenario from IPCC, in the context of climate change, on the growth of a marine diatom. To do so, we exposed the marine diatom *Phaeodactylum tricornutum* to a dilution series of plastic leachates from pristine and weathered self-reinforced PLA (SR-PLA) and self-reinforced polypropylene (SR-PP) following the ISO 10253:2016 protocol. The UV-weathered plastic was obtained by exposing SR-PLA and SR-PP strips (0.13 x 2 x 7.5 cm) to artificial UV radiation for 57 days simulating 18 months of natural solar exposure. To obtain the leachates, we incubated the plastic strips in artificial seawater for 20 days in the dark. Following the leachate tests, we determined the EC50 (i.e. half-maximal effective concentration) to algal growth of four related plastic associated chemicals of PLA and PP, i.e., di-lactide,

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dodecan-1-ol, 2,4-di-tert-butylphenol, and tributyl O-acetylcrirate. Our results on SR-PLA leachates showed that neither pristine leachate nor UV-weathered leachate influenced the growth of *P. tricornutum*, and up to 57 days UV radiation had no effect on the toxicity of SR-PLA leachates. The results on SR-PP showed significant inhibition only at 100% volume of weathered PP leachates. The determined EC50 of di-lactide, dodecan-1-ol and 2,4-di-tert-butylphenol were 341 ± 30 mg / L, 1.86 ± 0.06 mg / L and 1.50 ± 0.01 mg / L, respectively. No growth inhibition was observed with tributyl O-acetylcrirate up to 98 mg / L. Experiments were performed with di-lactide at increased seawater temperature (i.e., +5 °C, worst case scenario according to IPCC) that showed effect of temperature on the growth of the diatom but no interaction when combined with substance exposure. We anticipate that our results will contribute to the risk assessment of plastic additives from bio-based and fossil-fuel based polymers and contribute to assess the link between multiple stressors under the context of global warming for phytoplankton growth and to assess the potential ecological impacts of new bio-based polymers.

Keywords: plastic pollution; bio-based polymers; global warming; ecotoxicology; phytoplankton; multiple stressors; combined effects.

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DISTRIBUTION OF PLATINUM AND OTHER TRAFFIC- RELATED METALS IN THE AQUATIC ECOSYSTEM OF FLEMISH RIVERS: EFFECT OF RUN-OFF FROM HIGH-WAYS

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CO-PROMOTER: Cara Byns

Twenty small rivers in Flanders were sampled for water, sediments, and resident macroinvertebrates to check the content level of Pt, Cd, Pb, V, Ni, Cu, Zn, Sb (traffic related metals) and Ag, Al, Cr, Mn, Co, As (non-traffic related metals) with a particular interest on investigating the presence of Pt since it has never been included in the past studies on aquatic environment metal monitoring programs in the region. In addition, zebra mussels (*Dreissena polymorpha*) were deployed in cages and exposed for six weeks at six sites to evaluate the difference of its metal load and physiological condition, as calculated through Tissue Condition Index and Shell Condition Index between upstream and downstream near the highways (three highways investigated). The metals found with the consistent record of highest concentration in all biotic and abiotic samples were zinc (Zn) and copper (Cu). Although no Pt has been detected in the mussel samples, the results revealed significant differences in Zn, Cu, Ni, As, Co concentration levels between upper and lower streams consistent in all sites, with higher concentrations on downstream (one site) than the upstream. Nonetheless, no significant differences were recorded with the physiological condition between upstream and downstream, and no significant relationship between the physiological condition and the mussel metal concentration. The water and sediments had also no significant relationship with the Multimetric Macroinvertebrate Index Flanders. However, a significant negative relationship of MMIF as a function of bioaccumulated metals in macroinvertebrates were found, with a p-value of 0.002 in Pb and Mn for *Asellus sp.*, a p-value of < 0.001 in Co for *Gammarus sp.*, and 0 p-value in V, Mn, and Cu for *Chironomus sp.* Therefore, the sampling areas of this study were evidently reached by the traffic-related metals, and it is recommended to take into consideration the down streams near the highways as the critical sites in selecting sampling locations for monitoring in the future.

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Genetic Population structure and gene flow in *Octopus cyanea* Gray, 1849 in the Western Indian Ocean

BY Barnes, Tatyana Kira

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CO-PROMOTER: x

The Western Indian Ocean (WIO), a marine biodiversity hotspot, provides food and income to millions of people living along the coast illustrating their economic importance. Artisanal Cephalopod fisheries are common and 99 % of their catch consist of *Octopus cyanea*. As international demand rises, fishing pressure increases jeopardising coral reef habitats and octopus stocks. To have a better understanding of population connectivity for sustainable fisheries management, gene flow assessment is essential.

This study focuses thus on the genetic population structure and gene flow of *O. Cyanea* in the WIO. Tissue samples from the tentacles of 410 *Octopus cyanea* sample were collected between 2014 and 2019, from landing sites and local fish markets in Kenya, Tanzania, Mozambique and Madagascar. Five Microsatellite loci were successfully used as markers to evaluate nuclear polymorphism

Although microsatellite data suggests panmixia through the Principal Component analysis (PCoA) for both sampling site and individuals and results show no genetic structure due to isolation-by-distance ($Z = 2666.1314$, $r = -0.1485$, $p \leq 0.9320$), results also show four weak but statistical significant ($F_{ct} = 0.002$, $p < 0.01$) genetic population cluster through both the Bayesian cluster analysis and hierarchical AMOVA. The following grouping is proposed for fisheries management units in the WIO for *O. cyanea*: (1) Kenya, Northern Tanzania mainland and WP (Ka, Sh, Ta, WP), (2) ST, Des, Ki, Mt (3) Madagascar (Bbay, Anda, Mor, Nb, Ram, SM, Tam, Fd), (4) Mozambique (Ibo, An, Vil, Mp).

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Forecasting impacts of sea level rise on the connectivity between wetlands and the consequences for migratory waterbirds along the East-Atlantic flyway

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Migratory waterbirds perform seasonal movements along the East-Atlantic flyway (EAF), using wetlands as their wintering and breeding grounds, and for regular stopovers along the journey. A continuous distribution of wetlands along waterbirds' flyway is crucial for migration success and for the fitness of birds. Over 35% of the world wetlands have been lost since 1970 (Courouble et al. (2021)), mostly due to land use change and climate change, and it is a concern for waterbirds populations. We investigate the effect of sea level rise on wetland availability and migratory waterbirds along the EAF. We use the International Panel on Climate Change Sixth Assessment Report (2021) estimations of likely sea level rise (SLR) scenarios by 2100. Additionally, we use the PC index to forecast connectivity decrease in the light of a rising sea level as well as the relative contribution of individual wetlands to overall connectivity. We find a connectivity decrease with wetland surface area loss for two bird migration strategy groups: hoppers and jumpers. We also find that individual wetlands mostly contribute to connectivity through migration flux.

Finally, we could not safely highlight the regions and wetland sites that contribute most to connectivity and suggest to perform the analysis again with different wetland data in order to select regions and sites that should be of particular conservation target. Further studies could complement this work by considering other impacts of SLR on wetlands like the shift in wetland type. Moreover, we highlight the regional and local factors that are important to include for future research and could possibly change the findings regarding inundation patterns and strengthen the knowledge around wetlands to be targeted for conservation along the flyway: coastal defense, the dynamic response of wetland to SLR, the establishment of new wetlands through inundation, vertical land movement and relative sea level rise, and wetland quality.

Keywords: Waterbird migration, sea level rise, wetland connectivity, East-Atlantic flyway

The effect of burrowing by the Chinese mitten crab on tidal marsh erosion: density evolution and structure from motion photogrammetry

BY Bultot, Elise

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INVESTIGATING SPATIOTEMPORAL PATTERNS IN CO-OCCURRENCE OF THE EUROPEAN SEABASS, THE ATLANTIC COD AND CETACEANS BY MEANS OF TWO TYPES OF ACOUSTIC TECHNOLOGIES

BY Calonge, Arienne Dino

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Our capacity to track the presence and movement of animals has grown in an unprecedented rate over the recent decades, induced by increasing human disturbance of natural environments. The value of ecosystem-based management approaches has led to studies of species co-occurrences vital in maintaining ecological community structures. Several species co-occurrence studies are motivated by the direct impact of anthropogenic activities on species commercially targeted for removal, and its indirect impact on non-targeted species such as cetaceans, which are protected under international conservation laws such as the EU Habitats Directive (1992/43/EC). Cetaceans as top predators are a key element of ocean health such that diminishing populations adversely affect ecosystem functioning. In this study, we explore the feasibility of investigating the spatiotemporal distribution and potential co-occurrence of the European seabass and Atlantic cod, two commercially valuable fish species, and cetaceans in the Belgian part of the North Sea (BPNS) using data acquired from two acoustic technologies—a passive acoustic monitoring (PAM) logger and an acoustic receiver jointly installed under the LifeWatch project. Different analyses were applied to identify patterns in occupancy and/or co-occurrence at different spatiotemporal scales. We found that seabass, cod and dolphins all co-occur with a porpoise within an hour-period within the 200 m detection range of the receiver/PAM logger. Dolphins had the highest proportion of detection positive hours (DPH) in co-occurrence with the harbour porpoise. Using logistic regression models, the probability that when a species/species group is present, another species/species group would be co-occurring, was predicted. In these models, significance of seasonal, diel and locational effects were tested. We found that during the colder seasons at night, when a cod or seabass is present, there is a higher probability of a harbour porpoise co-occurring at the same hour. The probability that when a dolphin is present, a porpoise would be co-occurring, is higher in stations close to the French border and during the night. We conclude that developing these monitoring networks while considering species co-occurrences would be a huge added value to the data we acquire from these technologies. Taking co-occurrence in mind when investigating species is a step towards an ecosystem-based management of our oceans.

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Circumscribing the host-range of *Aphthona nonstriata* Goeze (Coleoptera: Chrysomelidae), a candidate biocontrol agent for the invasive wetland plant *Iris pseudacorus* L. (Iridaceae)

BY Cantarelli, Marco

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Iris pseudacorus L. (Iridaceae) is an aquatic plant species considered invasive in several countries around the globe and is currently the target of a biological control programme in South Africa. The flea beetle *Aphthona nonstriata* Goeze (Coleoptera: Chrysomelidae) was prioritised as a potential biocontrol agent for this species. The main goal of this research was to produce lists of plant species to be prioritized for host-specificity of this and other candidate biocontrol agents of *I. pseudacorus*. Two lists concerning species from the *Iris* genus and from closely related genera of Iridaceae were constructed based on the centrifugal phylogenetic method. These lists were built in order to facilitate host-specificity tests for both this study and future research around the world. Furthermore, the host-range of the candidate *A. nonstriata* was tested against some of the prioritized species. Short- and long-term no-choice host-specificity tests were conducted in order to understand the feeding preferences and development potential of this insect on non-target plants. During the short-term host specificity tests the biocontrol agent was exposed to several leaves belonging to plant species from different genera within the Iridaceae family. Analysis on the damaged leaves show that the agent feeding intensity tends to decrease with increasing phylogenetic distance from the target weed, and that *Iris* species are preferred to other genera. The candidate was further tested through long-term host specificity tests on eight species of which six belonged to the *Iris* genus and one each from *Gladiolus*, *Carex* and *Crocsmia* genera. These tests provided data concerning the full development of *A. nonstriata* on non-host plants. These data showed that the biocontrol agent is only able to fully develop on two species: *I. pseudacorus* and *Iris foetidissima* L. Additionally, analysis on the mortality rates displayed a higher mortality on species which do not belong to the *Iris* genus. The information gathered through this research constitutes a starting point for host-specificity testing of candidate biological control agent of *I. pseudacorus* in different countries, as well as providing valuable information concerning the safety of *A. nonstriata* in case of future release.

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Testing innovative technology for non-intrusive monitoring and tracking of salmonids

BY Contes, Martina

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This thesis aims at improving fish welfare and productivity, both tightly linked, by analysing and studying fish behaviour in Atlantic salmon. Indeed, unregulated aquaculture procedures can sometimes induce stress and disturbance, altering fish performance. For this scope, the behaviour of around one hundred salmon was considered. The fish group was kept in a recirculating aquaculture system (RAS). The concept is to test several factors (such as light, oxygen, flow, feed and more) by inspecting their instinctive actions when introduced to the V-tag, a pipe.

The goal is to find what helps fish to pass spontaneously and independently in the V-tag (the V-tag will be, in future, a sort of check-up zone to evaluate the health and growth of each fish passing by). The fish were tagged and each was considered a replicate, being able to repeat the action of passing into the tunnel several times if wanted.

The number of passages decreased over time. Thus, we must be careful in asserting that some testing had better results than others since it could be described by lessening time instead of the condition itself. A sickness event and the following antibiotic treatment probably impacted the fish's stress level. Anyway, most of the salmon passed through the V-tag at least once, meaning they had a certain interest in it. As fish might habituate to the situation, there is a necessity to find more attractive alternatives to keep their activity in the V-tag. The salmon sought more easily the V-tag when placed at a lower depth. In this sense, the V-tag shape could be designed in a more natural and curvy shape and positioned at the side of the tank wall, harmonising the environment more. The flow had a better response from fish when regulated around one body length in the V-tag. More research should be done on lights with white LED light and lower blue light intensity, being probably the most suitable setting for salmon.

In addition, some improvements are needed regarding the installation design to get more reliable results when testing oxygen gradients or a different feeding system.

Fish diversity patterns in the Belgian part of the North Sea using only a drop of water

BY Cornelis, Isolde

PROMOTER: Sofie Derycke (Universiteit Gent)

x The biodiversity in marine environments worldwide is changing rapidly, due to pressures such as climate variability and habitat destruction by trawl fishing, sand extraction and dredging. Regular monitoring is required to detect changes in fish community structures caused by these pressures. However, monitoring is often limited in time and space and most biomonitoring techniques disturb the habitats and cause harm to the marine organisms. Environmental DNA (eDNA) is able to capture spatial patterns in fish community structures in distinct marine environments without disturbing the habitat or collecting fishes. It remains unclear whether eDNA could also be used to monitor changes in fish communities in shallow and well mixed marine environments such as the Belgian Part of the North Sea (BPNS). During two field campaigns, water sampling and trawl surveys were performed in 12 coastal and 18 offshore sites inside and outside the offshore wind farms. eDNA metabarcoding against the mitochondrial 12S ribosomal DNA was able to detect similar fish diversity patterns as observed by the trawl surveys. In total 56 fishes were detected by both methods with an overlap of 31 species, whereas eight fishes were only detected by trawl surveys and 17 fishes were only detected by eDNA metabarcoding. Although the species richness between coastal and the offshore waters did not differ significantly, the relative abundance of the fish species in the two habitats significantly differed. The offshore waters were dominated by *Merlangius merlangus*, *Limanda limanda* and *Sardina pilchardus*, whereas the relative abundances in the coastal waters were more evenly distributed between species. Moreover, eDNA metabarcoding also revealed significant differences between the communities inside and outside the offshore wind farms which is in agreement with patterns observed in long term trawl data. Limitations of eDNA metabarcoding were the low sequencing depth due to the amplification of non-target 16S sequences, and the lack of resolution to species level for 16 fishes from six distinct families. Nevertheless, this thesis demonstrates that eDNA metabarcoding is able to capture differences in fish community structures in shallow and well mixed areas, even over short distances, less than three kilometres.

Keywords: eDNA metabarcoding, fish community monitoring, bottom trawl surveys, offshore windfarms, Belgian Part of the North Sea

Population genetics of *Octopus mimus* (*Octopodidae*) along the coast of Peru: A comparison of nuclear microsatellites with the mitochondrial COI gene

BY Coulembier Vandelannoote, Emma

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Species identification based on morphological characteristics is often challenging. Therefore, genetics are used to assess species identification and population structure. The goal of this research is to study the genetic structure and migration patterns for *Octopus mimus* along the Peruvian coast.

Two types of genes are used, the COI-gene and microsatellites. Because they have different inheritance patterns, both are assessed. Several samples of *Octopus mimus* were collected along the coast of Peru from fishermen. These samples came from different biogeographical regions, the Panamanian province, the equatorial front, and the Peruvian-Chilean province. For both datasets, a significant genetic structure was found using AMOVA's. However, no significant differentiation was seen between the different biogeographical regions. With microsatellites, a larger migration was observed. This migration pattern went against the major currents, while the migration for the COI-gene went with major currents. The differences found here are largely to be attributed to the different inheritance patterns between both markers.

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EFFECTS OF ALTERED VESSEL TRAFFIC (AND ANTHROPOGENIC OCEAN NOISE) ON THE PRESENCE OF HARBOUR PORPOISES IN THE BELGIAN PART OF THE NORTH SEA.

BY Debaveye,Line

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Over the past decades, interest has been sparked in the marine research field concerning noise pollution in the world's oceans. One of the main factors causing anthropogenic ocean noise is the presence of intense shipping activities. The produced noise coming from ships can travel and spread over long distances. This 'ocean noise', or sounds of anthropogenic sources can often interfere with or mask the natural ocean noises and therefore alter the ability of marine animals to navigate and communicate properly. In this research project, the subject of focus is the harbour porpoise (*Phocoena phocoena*) which is the most common toothed whale (Odontoceti) species present in the Belgian part of the North Sea (BPNS). The harbour porpoise utilises bio-sonar or echolocation (ultrasonic sound or 'clicks') to communicate with its peers, navigate in the marine environment and to find potential prey. To monitor the presence of the harbour porpoise, several C-pod sensor networks (falling under passive acoustic monitoring or PAM) were set up, as part of the VLIZ (Flanders Marine Institute) LifeWatch observatory and of the RBINS (Royal Institute of Natural Sciences) WinMon.BE project. Since several years this network registers porpoise activity and collects bio-sonar data at different stations in the Belgian part of the North Sea. In this thesis, research was done whether altered vessel route density (induced by the Covid-19 crisis) influenced the presence of the harbour porpoise presence in the BPNS. More specifically, we investigated (a) whether the Covid-19 crisis led to a change in vessel route density in the BPNS, (b) if this change in vessel route density had an influence on the presence of harbour porpoises. Our results showed that, even with many Covid-19 restrictions in place, the average vessel route density has intensified in 2020 (with a peak from June to August 2020). The main increase in overall vessel route density can be clarified by an increase in the vessel type 'Other' (containing research, maintenance and control vessels) in specific research zones. An explanation for this increase of 'Other' vessel route density can be linked to the construction of two Dutch offshore windfarm parks in the same period. The detections of harbour porpoises reach their peak in January – February and arrive at their lowest point during the months May to August. However, this is mainly linked to seasonality since similar findings, concerning seasonal porpoises distribution, come forward in literature (Haelters et al., 2013; Augustijns, 2018). Even though a significant relationship is found between the 'Other' vessel types and the presence of the harbour porpoises, only a weak negative correlation is present between the two variables. Further and different types of research will be needed in order to assess the true significance shipping traffic, and with it anthropogenic ocean noise, has on the presence of harbour porpoises in the BPNS.

Keywords: Harbour porpoise, Echolocation, Passive Acoustic Monitoring, C-pod, vessel route density, anthropogenic ocean noise, Covid-19 pandemic.

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Investigating Cryptic Diversity, Phylogeography and Genetic Connectivity of *Abyssorchomene Distinctus* in the Pacific Ocean and South East Indian Ridge

BY Dupont, Déborah Whitney Euselia

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Commercial interest into deep-sea polymetallic nodule mining has been steadily growing over the last three decades. In light of this, it is fundamental that accurate estimation of biodiversity takes place prior to any exploitation of minerals across the Clarion-Clipperton Zone (CCZ) in the Northeast Pacific Ocean. Scavenging amphipods represent a large group in the abyssal biota and form an essential component of the nutrient cycling system. This study uses both mitochondrial (COI) and nuclear (28S rRNA) DNA markers to investigate genetic diversity and connectivity in *Abyssorchomene distinctus* (Lysianassoidea – Uristidae) (Birstein & Vinogradov, 1960).

In total, 219 genetic sequences were obtained from 113 sampled individuals and 98 reference sequences of *Abyssorchomene distinctus*, which originated from the CCZ, the Discol Experimental Area (DEA), the Atacama Trench and the Southeast Indian Ridge. Phylogenetic trees and application of the Automated Barcoding Gap Discovery revealed the absence of cryptic diversity for *A. distinctus* on a global scale, contrasting with findings of cryptic species for other closely related scavenging amphipods. Population genetics analyses calculated a low haplotype diversity (Hd) within the *A. distinctus* population across the Pacific Ocean which was contrary to a high Hd found in the Indian Ocean populations.

This is the first study to date providing preliminary indications of a possible genetic connectivity of the scavenging amphipod species *Abyssorchomene distinctus* between the CCZ and DEA, being geographically separated by a vast distance of 5,000 km. Shared haplotypes were also found between the CCZ, DEA, Atacama Trench and the Southeast Indian Ridge in the COI mitochondrial DNA dataset, which was congruent with results from previous studies on other scavenging amphipods. The hypothesis of possible recent population expansion based on the haplotype network structures was confirmed by negative deviations from selective neutrality tests (i.e., F_u , F_s and Tajima's D) and also with a nucleotide mismatch analysis depicting a skewed unimodal distribution, which was also congruent with population expansion.

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Applicability of early aerial imagery for monitoring mangrove vegetation dynamics and land-use change

A case study from Bangka Island (or Banka), Indonesia, former Dutch East Indies

BY Gbongboui, Wilfried Yao Eliezer

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Mangrove ecosystems have faced several threats from different human activities and natural events over the past centuries. The application of remote sensing and GIS where historical records such as historical aerial images are used to complement recent satellite imagery helps to evaluate the changes in mangrove ecosystems which may have taken place over a longer period. In Indonesia, Bangka Island is recognised as the second largest producer of tin and one of the oldest and existing tin mining regions in the world, with tin mining majorly occurring in its onshore and offshore regions. The existence of a historical document possessing historical aerial images and maps of Bangka Island allowed to evaluate and quantify changes in land use/cover extent, as well as the changes in mangrove species extent occurring in seven coastal sites of the island in almost a century long. To achieve this, recent (2021) Sentinel-2 satellite images of the seven study sites were geo-processed and classified together with the historical images (1934) using the on-screen digitization (OD) method. The Sentinel-2 satellite images were also classified using the Random Forest (RF) method to assess the classification accuracy of the on-screen digitization method. In order to assess the potential decline in mangroves caused by tin mining, the global mining area datasets were also used. Varying changes in mangrove forest and mangrove species extent were recorded for each of the study sites, and potential explanatory factors identified and discussed. Field surveys and GIS analysis revealed that tin mining did not contribute to the recorded decline of mangroves on Banka Island. The RF method outperformed the OD method, with both being acceptable measures of classification performance. The study, therefore, suggests effective preventive measures to be taken toward the conservation of mangroves in these sites and the entire Bangka Island.

Keywords: Historical aerial images, Bangka Island, Tin mining, Mangroves, Random Forest classification, On-screen digitization

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Long-term changes in North Sea macrobenthic communities due to climate change vs. local drivers

BY Gerard, Stef

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CO-PROMOTER: Carl Van Colen

Impacts of climate change are intensively being studied on a global scale since the last decade, often using time series of biological communities as bio indicators to assess changes. Also, in the Belgian Part of the North Sea (BPNS) macrobenthic data are being collected to disentangle climate change effects vs. natural oscillations in a temperate coastal environment. However, long-term studies remain rare, despite the fact they are potentially the only reliable way to assess climate change induced shifts in ecosystems. With uni- and multivariate analyses, the effects of climate change related parameters (North Atlantic Oscillation, Sea Surface Temperature, Chlorophyll a, and salinity) vs. local factors (granulometry of the sediment) was investigated on a long-term macrobenthos dataset collected at 15 km offshore off Zeebrugge (Belgian coast). Over the years 2003-2020 the macrobenthic community composition has changed significantly on a species level driven by changes in the median grain size of the sediment. With decreasing median grain size and associated higher mud content, a trend towards a higher diversity, density, richness, and evenness was found with typical species such as *Abra alba*, *Lanice conchilega*, *Nephtys homberghii*, and *Lagis koreni* increasing in abundance since the year 2003. This is highly likely due to its close proximity to sand extraction sites such as the Thornton bank and Sierra Ventana. Climate change related effects were not detected possibly due to the limited dataset, calling for a continuation of the time series with the highest time resolution possible. This study emphasizes the required commitment to more long-term climate-based studies that includes environmental variables such as nutrients levels, contaminant concentrations, oxygen profiles, and radiation time.

Keywords: macrobenthos, Belgian Part of the North Sea (BPNS), climate change, granulometry, long-term study, sand extraction

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Late-Glacial Turbidites in Aysén Fjord (Chilean Patagonia): Glacial Lake Outburst Floods or Seismic Activity?

BY Hanifah, Dina

PROMOTER: Maarten Van Daele (Universiteit Gent)

CO-PROMOTER: Katleen Wils

Chilean Patagonia comprises a tectonically active area with its unique past climatic variability. Southern Westerly Wind-driven climatic features are known to contribute to glacier advances and retreats of the Patagonian Ice Sheet, allowing the presence of ice-dammed lakes spread across Patagonia. Rapid deglaciation mostly results into frequent occurrences of Glacial Lake Outburst Floods (GLOFS) due to ice-dam collapses, triggering the deposition of turbidites. Local movements of active tectonic features (e.g., Liquiñe-Ofqui Fault Zone; LOFZ) may also be considered in triggering turbidites as adequate shaking intensities may also lead to sediment collapses or mass movements, preconditioning turbidity currents. Study on Late Glacial turbidites from the outer part of Aysén Fjord aims to provide new insights of tectonic and glacial events based on a thorough analysis of geophysical properties, end-member modelling, XRF-based and organic geochemistry evaluation on the 13.72 m lower part of a 31.72 m long MD07-3115 core. Rapid deglaciation of North Patagonian Icefield (NPI) followed by drainage of Paleolake Cisnes-Nirehuao since 12.4 to 12.1 cal ka BP suggests frequent occurrence of high magnitude GLOFs followed by lower magnitude GLOFs intermittently, triggering the deposition of the lowest turbidites unit in this study, before ~12 cal ka BP. Followingly, a local postglacial reactivation of LOFZ may also be proposed as the potential trigger for the upper turbidites unit deposited since ~12 – 10 cal ka BP. However, rather than due to tectonic movement, this postglacial reactivation was proposed to be the consequence of uplift movement due to glacial isostatic adjustment, following rapid deglaciation.

Keywords: Turbidite, Patagonia, Glacial lake outburst flood, Post glacial rebound.

Long-term impacts of offshore wind farms presence on benthic communities in the Belgian part of the North Sea

BY Jamar,Christelle

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CO-PROMOTER: Ulrike Braeckman

SUPERVISOR: Nene Lefaible

This study investigates the long-term impacts of offshore wind farms (OWFs) on macrobenthic communities at a far distance (250-500 m) from wind turbines in the C-Power offshore wind farm, on the ThorntonBank (Belgian Part of the North Sea) over a time span of 15 years (2005-2020). We anticipated that due to the changes in hydrodynamics around wind turbines, together with the increase in depositional flow of faecal pellets produced by filter-feeding epifauna living on the foundation of the wind turbine, there will be an increase in macrobenthic abundance and species richness, as well as a shift in macrobenthos community composition. We also hypothesized that owing to fishery exclusion in offshore wind farms concession areas the ThorntonBank (impact area) and GooteBank (reference area) would grow apart from each other in terms of abundance and species richness, as well as in terms of species composition. Our 15 years analysis supported the hypothesis of an increase in macrobenthic abundance and species richness as fine sediment fraction and total organic matter content increase within the sediment of OWFs. The appearance and subsequent increase in *Terebellidae sp.* and *Ophelia borealis* suggested a shift in macrobenthos community composition when compared to the baseline study of 2005. However, changes in macrobenthic abundance, species richness and species composition were observed on both sandbanks, suggesting that either human activities that once took place on the GooteBank affected the communities there, or adding wind turbine does not generate strong impacts on macrobenthic communities. The observed fluctuations over the years could then be due to normal fluctuations in macrobenthos, or that other factors are at play such as climate change. However, in order to confirm these statements, additional studies on macrobenthos within the Belgian Part of the North Sea should be done on the long term. Further analysis should also be carried out in order to confirm the potential shift from a *Nephtys cirrosa* community toward an *Abra alba* community

Keywords: macrobenthos, Belgian Part of the North Sea (BPNS), offshore wind farms, long-term study, renewable energy, environmental impact.

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INVENTORIZING THE SPATIO-TEMPORAL OCCURRENCE OF VARIOUS ALGAE SPECIES IN SHRIMP CATCHES OF DUTCH BEAM TRAWLERS

BY Joris, Margot

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

CO-PROMOTER: Sven Sebastian Uhlmann

Shrimp fishery is one of the most common types of fisheries in the Netherlands. However this type of fishery is also well-known for its problems surrounding bycatch (Kaiser et al., 2003). They use nets with small mesh sizes and poor selectivity of attached on twin-rigged beam trawls that are dragged across the seabed on either side of the vessel, causing a high number of bycatch within each haul (Revill et al., 2004). To help limit bycatch to a minimum the Dutch government has obligated fishermen to fish with a sievenet, which has a substantial downside of easily getting clogged up by algae during the summer (Slijkerman et al, 2015). Furthermore, Fishermen are now stating that the clogging problem is extending over the summer period as a result of climate change. Therefore, in this study we firstly identified which species of algae were causing the most of the clogging problem, then we assessed whether the clogging of the nets increase throughout the summer and lastly we assessed whether clogging of the nets affects catches of marketable shrimp. We could conclude that the species of algae causing the most hinder are free-floating species like *Chaetomorpha linum* and *Ulva lactuca*. The relationship between amount of clogging and the week within the summer period differs significantly when looking at different datasets: inverse relationship for bobbinwire and anterior panel scores, positive for the catch scores. Lastly, no significant correlation was found between the amount of catch and the amount of algae clogging up the net, meaning the catches are not affected by the nets getting clogged.

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Microplastics Transfer from the Ocean to the Atmosphere Through Aerosolization: First Insights Under Controlled Laboratory Conditions.

BY Leon Duque, Maria Camila

PROMOTER: Ann Vanreusel (Universiteit Gent)

CO-PROMOTER: Gert Everaert, Ana Catarino, Maarten De Rijcke

SUPERVISOR: Yunmeng Li

Plastic debris do not readily degrade. Their accumulation in marine environments is recognized as a high-priority issue for environmental research and policy. Microplastics (MPs) are plastic particles in the size range of 0.001 - 5 mm, from diverse polymer matrices and shapes, either produced by fragmentation of larger debris or manufactured as microbeads. Currently, MPs can be found in all aquatic environments, including rivers, ponds, lakes, oceans, and even drinking water for human consumption. Besides, MPs have been detected in the atmospheric compartment and can be transported all around the globe, even to remote locations (e.g., the arctic, deep sea, high mountains, and great lakes). Until now, water currents, runoff, wave action, and wind have been assumed to play the most significant role in transporting plastic particles to accumulation areas. Recent research has however hypothesized that the ocean can also transfer particles to the atmosphere through aerosolization processes via bubble burst ejection and wave action; some plastic particles can leave the sea and enter the atmosphere along with sea salt, bacteria, viruses, and microalgae. Nevertheless, little is known about the aerosolization role on the pathway of MPs from the ocean to the atmosphere. Our work intended to demonstrate that MPs are aerosolized via SSAs. To assess MPs aerosolization, we have used a sintered air stone to form aerosols through bubble production, and a Miniature Marine Aerosol Reference Tank (miniMART), i.e., a portable system designed to mimic the naturally occurring physical mechanisms producing SSA particles accurately. Our results indicate that aerosolization by bubble bursting of MPs up to 10 μm of lowdensity polystyrene is feasible and occurs under artificial settings. This phenomenon is represented by enrichment factors of MPs in aerosols up to 58. Furthermore, our results suggest that particle size may act as a proxy for the number of MPs that can be transferred from the seawater to the atmosphere. In this order, the ocean could significate an important source of MPs entering the air compartment. We expect that our results will contribute to understanding the transport and fate of microplastics in the environment and give first insights for future research in MPs aerosolization.

Keywords: Microplastics, aerosolization, miniMART, sea spray aerosols, atmospheric compartment, enrichment factor.

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Meiofaunal communities and food availability in two contrasting sub-Arctic fjord settings.

BY Lolivier, Marianne

PROMOTER: Ann Vanreusel (Universiteit Gent)

CO-PROMOTER: Ulrike Braeckman, Lara Macheriotou

SUPERVISOR: Marius Buydens

In the Arctic, climate change is twice as fast as in other regions of the world due to the Arctic amplification. Under a warming atmosphere and increasing precipitation, the Greenland Ice Sheet is losing mass at an accelerating rate since the nineties, and glacier retreat is widespread over the island. The expected shift from marine-terminating glaciers to land-terminating glaciers will induce important changes in water circulation in fjords and a decrease in productivity following the absence of nutrient-rich water upwelling resulting from sub-glacial discharge. Since the benthic-pelagic coupling is tight in the Arctic, changes in overlying water productivity will strongly impact benthic communities. To investigate how differences in organic matter vertical export will impact the benthos, we sampled two contrasting fjord settings in Southwest Greenland in summer: Godthåbsfjord, which predominantly receives meltwater from marine-terminating glaciers and Ameralik, which is influenced by one land-terminating glacier. We explored organic matter composition in terms of quantity, quality, and origin and benthic meiofaunal communities, with a focus on nematodes. As such, we identified a gradient in biogenic compounds in both fjords, with a decrease in fatty acids and pigment content towards the head of the fjords. Moreover, there is a mismatch between organic matter quality and quantity within fjords. In Godthåbsfjord, the low organic matter amount in the sediment near the glacial outlet was of lower quality compared to the larger amounts found in the middle part of the fjord. Inversely, in Ameralik, organic matter quality increased towards the head. Organic matter quality prevailed over quantity as a driver of meiobenthic communities. Overall, richness and diversity were higher in Godthåbsfjord, where communities followed the distribution expected with the Intermediate Disturbance Hypothesis under glacially induced disturbances. The nematodes community in the middle part of Ameralik strongly differed from every other station and displayed a lower richness and diversity. A land-terminating influenced fjord sustained a less diverse and rich meiofauna community compared to a fjord influenced by a marine-terminating glacier where organic matter was of higher quality.

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Protecting the marine environment whilst installing offshore windfarms: the effect of scour protection layers on benthic biodiversity

BY Lopez Lopez, Lucia

PROMOTER: Jan Vanaverbeke (Universiteit Gent)

CO-PROMOTER: Mirta Zupan

The North Sea will soon see the installation of a higher number of wind turbine foundations, greatly expanding the habitat options for reef species. These offshore structures constitute a new, artificial, hard substratum habitat on the Belgian continental shelf, where the seafloor is primarily made up of muddy and sandy sediment. The possibility of co-designing offshore wind farms with more microhabitats through increasing habitat complexity is one method for the multiple uses of wind farms. This method is known as nature-inclusive building. The structure and dynamics of ecological communities are significantly influenced by habitat complexity. Hence, an increased complexity frequently results in greater species variety and abundance.

The objective of this study was to investigate whether adding complexity to the scour protection layer (SPL) increased the diversity and functionality of the ecosystem already present at the bottom of wind turbines (macrobenthos community). To study this, three different variables of 76 species were analysed: richness, biomass, and abundance. Despite being the first time to manipulate the SPL of wind farms, it has been possible to observe and demonstrate that the complexity of these structures affects the ecosystem's richness. Of the four different treatments, a greater number of species were observed in the most complex ones (3 and 4) compared to the others. In addition, although there were no significant differences, trends of higher biomass of certain species (belonging to decapods and sea anemones) were observed in the presence of higher complexity. Conversely, the constant presence of amphipods was observed across all the treatments.

With this study, we wanted to emphasise the importance of the artificial reef effect of the SPL and, together with the microhabitats that it can provide, if at the time of its construction, an attempt is made from an "eco-friendlier" perspective, combining the knowledge of ingested together with the biological. In addition, it provides more knowledge and understanding of this methodology by improving it and obtaining results more similar to those expected in the future.

Keywords: habitat complexity, artificial reef, scour protection layer, microhabitats, macrobenthos

COMPARATIVE ASSESSMENT OF LONG-TERM CARBON STORAGE IN CONTRASTING FJORDS OF SOUTHWEST GREENLAND

BY Makio, Charles Lucas

PROMOTER: Ann Vanreusel (Universiteit Gent)

CO-PROMOTER: Ulrike Braeckman

SUPERVISOR: Marius Buydens

Deep Arctic marine environments receive significant organic matter and hence are potential long-term carbon burial systems. There still remain information gaps, however, on their capacity to adapt to current changes as a consequence of global warming. In this study we compared the carbon storage capacity between land-terminating (LTG) and marine-terminating glacier (MTG) influenced fjords (Godthåbsfjord (GF) and Ameralik fjord (AM)) in southwest Greenland. The comparison was done based on ^{210}Pb dating, sediment characteristics, macrofauna, chlorophyll-*a* and its derivatives (CPE) content, TOC and TN content in samples collected in stations close to the fjord head (AM10 and GF12) and those in the middle of both fjords (AM5 and GF6). Sediments in both fjords were mainly characterised by very fine silt (>65%). However, Ameralik fjord displayed a higher sand content while sediments in Godthåbsfjord contained a relatively higher clay fraction. Sediment accumulation rates were higher in Ameralik fjord than in Godthåbsfjord as well as in stations relatively close to the fjord head. Ameralik fjord displayed a higher percentage of TOC and TN content than Godthåbsfjord. This was supported by chlorophyll-*a* and its derivatives (CPE) content which were significantly higher in Ameralik fjord (AM10=5.45±2.32µg/g, AM5=20.95±3.70µg/g) than in Godthåbsfjord (GF12=3.98±1.22µg/g, GF6=2.48±4.74µg/g). The C:N ratios ranged between 6-8 in both fjords, indicating mainly marine sourced organic matter with little terrestrial inputs. Consequently, the organic carbon burial rates were higher in Ameralik fjord (AM10=38.38 g/m²/year, AM5=32.05 g/m²/year) compared to Godthåbsfjord (GF12=8.72g/m²/year, GF7=1.61g/m²/year) but also higher in stations close to fjord head than those far off. However, Godthåbsfjord had on average higher macroinvertebrate diversity (GF12=0.86±0.07, GF6=0.67±0.34) than Ameralik fjord (AM10=0.62±0.08, AM5=0.46±0.35) but there were no statistical significant differences between fjords and stations. The dominant polychaete families were Spionidae and Lumbrineridae in all stations except for station AM5 which was dominated by Chaetopteridae and Oweniidae (57±34% and 20±18%, respectively). The results of this study suggest that, the LTG influenced fjord showed a higher potential and capacity for long-term organic carbon burial than the MTG influenced fjord. Additionally, this capacity is significantly higher in stations close to fjord heads. However these results are based on only two fjords so further research on different fjords should further confirm this trend.

Keywords: Carbon storage, marine-terminating and land-terminating glaciers, South-West Greenland

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Ecosystem Services of Mangroves in Tiko and Limbe, Southwest Region of Cameroon ; An insight for Conservation

BY Manla,Isabella

PROMOTER: Professor Farid Dahdouh Guebas (Vrije Universiteit Brussel)

CO-PROMOTER: Etchu Kingsley Agbor

Through direct and indirect functions, mangrove ecosystems provide essential services to human and local communities. In this study, we determined the use of mangrove species, described mangrove use between users (e.g. by gender), and examined the importance of the mangrove ecosystem in relation to fisheries-related activities. The study focused on the cosmopolitan towns of Tiko and Limbe hosting municipal councils and with lots of coastal activities like fisheries, mangroves as source of energy etc in Cameroon. A household ethnobiological survey was conducted (n = 59). Results showed that communities made their livelihoods from several mangrove-dependent income-generating activities, of which charcoal, construction, and fishing were the main occupations. The preferred mangrove species were *Rhizophora spp.* and *Conocarpus erectus*, which were widely used, while few used *Nypa fruticans* for roofing their houses. The stems of *Rhizophora spp.* and *A. germinans* are commercially important in the coastal regions of Cameroon, while their branches are selected for domestic use. Other uses of mangroves such as chemical and medicinal properties have been reported to a lesser extent. Regarding the use of mangrove resources, there was a significant difference between the two study areas, with more charcoal and construction activities in Tiko, while more fishing in Limbe. With the emergence of mangrove community projects, respondents were optimistic about the future of mangrove forests, although they mentioned that this is only possible through the actual implementation of rules and regulations.

Keywords: Ethnobiology, Mangroves, Ecosystem services, Cameroon, multiple use.

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Global patterns of biodiversity and phylogeny of the Echinodermata

BY Matthys, Sarah Maria

PROMOTER: Ann Vanreusel (Universiteit Gent)

CO-PROMOTER: Lara Macheriotou

This paper deals with different aspects of the Echinodermata, which have not been extensively studied in the past. It deals with their species diversity over depth through the analysis of a barplot representing the number of taxa over depth. The species diversity over depth pattern is analyzed in order to determine if it corresponds with the unimodal pattern that has been observed in the past. The paper considers the phylogenetic community structure in terms of countries, oceans and depth ranges in which the echinoderms occur. The last aspect of the analysis is the phylogenetic tree that has been constructed of the echinoderms. The aim is to determine if it corresponds to previous phylogenetic relationships, namely the Asterozoan or the Cryptosyringid hypothesis.

In order to provide the results, all the available sequences of the Echinodermata have been uploaded from The Barcode of Life Database and analysed in RStudio for the construction of the barplots and the calculation of the Mean Pairwise Distance, Mean Nearest Taxon Distance and Pairwise Distance. The phylogenetic tree was constructed through FastTree and Mega11.

The species diversity over depth which was visualized through the barplots did not show a clear unimodal pattern. This could be due to the fact that not all the species were associated with their corresponding depth and it seems that there are almost no echinoderms to be found in the hadal zone, which seems quite surprising. In terms of phylogenetic community structure, the main phylogenetic community structure characterizing the Echinodermata seems to be the clustering phylogenetic community structure. This is plausible due to the fact that the echinoderms adapt to the changing environmental conditions, but this still needs to be confirmed through further investigations. Finally, the phylogenetic tree, which contained a high number of branches and made the determination of a relationship complicated, tends to go towards the Asterozoan hypothesis, which is the hypothesis that seems to be the most probable according to the scientists.

To conclude, the species diversity analyses had to contain more species that are associated with their corresponding depth in order to get a clear representation of the species diversity as it seems quite unlikely that echinoderms are absent at greater depths. For the phylogenetic community structure, comparison could not be made with previous researches as it has not been done in the past, but the clustering phylogenetic community structure seems to be a possibility in terms of phylogenetic community structure. For the phylogenetic tree, it tends to go towards the same conclusion as previous researches. Overall the research corresponds to previous results, but more data have to be incorporated for the species diversity over depth and the investigation of phylogenetic community structure could be interesting to be made for future researches.

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Enhancing the understanding of the effect of phosphate limitation on benthic diatom microbiome assembly

BY Mindiola Reyes, Kevin Alexis

PROMOTER: Koen Sabbe (Universiteit Gent)

CO-PROMOTER: Yeseren Kayacan

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Genetic population structure of five species of the genus *Thunnus* at a global scale

BY Moya Serrano, Ana

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

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Understanding cyclic patterns in social-ecological capital, connectedness and resilience in the mangroves of Gazi Bay (Kenya) through the Adaptive Cycle heuristic.

BY Musimwa, Rutendo Roselyn

PROMOTER: Farid Dahdouh-Guebas (Vrije Universiteit Brussel)

CO-PROMOTER: Jean Hugé

The Adaptive Cycle is a conceptual model for predicting and explaining social-ecological systems. This study focuses on the application of the Adaptive Cycle on mangroves. Through the Adaptive Cycle lens, this study aims to explain, understand, and predict the cyclic patterns occurring in the Gazi Bay mangrove in Kenya. Based on previous reforestation and natural vegetation regime dynamics, three zones were selected in Gazi Bay. The study area's key components included built capital, population, and vegetation dynamics. A combination of historical imagery and a literature review were used to conduct a thorough and systematic analysis of the landscape changes that have occurred over time. Built capital has been observed to have a logarithmic growth rate of $20927 \ln x - 158915$. Cyclic patterns were observed at all three sites, but site 1 and site 2 were in a constant loop of returning to the reorganization stage. Zone 3 was identified as being in the conservation stage, with the restoration projects reducing its resilience. The Adaptive Cycle has proven to be an effective conceptual model for comprehending long-term dynamics of change in ecological and social-ecological variables in Gazi Bay. This study noted that the Adaptive Cycle does not always run in the expected double loop but sometimes resorts to going on a constant loop around certain stages.

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Marine litter dynamics at the Mangroves of Mida Creek, Kenya: Distribution, Sources and Transport Mechanism

BY Ndwiga, Joy Ruguru

PROMOTER: Nico Koedam (Vrije Universiteit Brussel)

CO-PROMOTER: Tom Van Der Stocken

Marine Litter surveys were carried out in three mangrove sites at Mida Creek, Kenya, in Magangani, Mayonda and Uyombo locations. Marine litter was collected on three different sampling zones (seaward, middle and landward zones) per site, and the litter quantified and characterized to determine the composition, distribution, density and their possible sources. Questionnaire responses were analyzed to determine the local peoples' knowledge and attitude towards marine litter and their possible sources. The results showed that plastics were the dominant marine litter (79.21%) followed by fishing gears (13.49%), clothing (3.22%), and foam fragments (2.49%). The top three plastic materials were soft plastics (27.76%), hard plastics (21.88%) and strings & ropes (12.86%) based on counts. Magangani site had a relatively higher marine litter density by count (0.42 ± 0.3 items/m²) compared to Uyombo (0.37 ± 0.38 items/m²) and Mayonda (0.08 ± 0.07 items/m²) sites. The different sampling zones differed in the marine litter density and there was a significant difference in the marine litter count per sampling zone and between the sites. Questionnaire responses showed that the residents of Mida Creek had knowledge of marine litter, with 62% reusing their plastics, while 78% agreed that burning and burying (98%) of plastics was not a good idea. The study confirmed the assumption that mangroves act as traps to marine litter, and that short term and long term solutions that focus on improved waste management in both developed and developing countries are not only needed, but also recognised by local residents.

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A human risk assessment by heavy metal and pesticide exposure by fish consumption at the Galápagos islands

BY Nezami, Camila

PROMOTER: Gudrun De Boeck (Universiteit Antwerpen)

CO-PROMOTER: Paola Calle, Peter Goethals

SUPERVISOR: Andrée De Cock

Galapagos archipelago is not immune to global and regional pollution. A diverse range of contaminants have been found in marine biota. The present work reports the determination of pesticides and mercury in three different species of fish swordfish (*Xiphias gladius*), Galapagos mullet (*Mugil galapagensis*) and Thoburn's mullet (*Xenomugil thoburni*). The objectives were to assess: (a) the feeding habits of local people on Santa Cruz Island; (b) the levels of persistent organic pollutants and Hg in muscle and liver; (c) the potential human health risk exposure to Hg through a human health risk assessment. The outcome of this study could serve as a baseline for future studies to implement a food safety regulation in Ecuador to avoid possible health risks caused by the ingestion of pesticides and heavy metals. The mercury quantification was performed using the DMA method which allows limits of detection of 0.005ng. For the quality control, we used a certified reference material (SRM DORM – 4: Fish protein certified reference material for trace metals, National Research Council of Canada (NRC - CNRC). Regarding the pesticide analysis, the LC-MS/MS pesticides were processed with the QuEChERS method and the (GC-ECD) with an Agilent Technologies 6890N gas chromatograph equipped with an Agilent Technologies 7683 Series autosampler injector. The mercury concentration expressed as wet sample weight varied from 0.010 ug g⁻¹ to 1.168 ug g⁻¹. After performing the health risk assessment indices for mercury concentration (EWI) and the calculation of the risk to our data our results explained no risk to human health of the local population on Santa Cruz Island. The results showed no presence of pesticide residues in the samples. The survey results showed no frequent consumption of mullet and swordfish within the Santa Cruz community. People preferred the yellowfin tuna as a food source.

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Genetic differentiation and clonal diversity of *Stuckenia pectinata* in the Netherlands' polder areas

BY Nguyen, Dieu Lien Huong

PROMOTER: Ludwig Triest (Vrije Universiteit Brussel)

CO-PROMOTER: Jasper Dierick

Stuckenia pectinata is a perennial, cosmopolitan, submerged macrophyte that inhabits shallow brackish water. The species can be found dominant in rivers, ponds, irrigation channels and ditches of different environmental settings. The plant was reported to be versatile and adaptive both phenotypically and genotypically in various environmental conditions thanks to the capacity to reproduce sexually (seeds and fruits) and clonally (tubers, rhizomes, and plant fragments). Using seventeen microsatellite primers, this study revealed high genetic diversity with 118 unique Multilocus genotypes in 300 individuals collected from 10 locations in the polder area of the Netherlands. All populations had relatively high heterozygosity uHe (from 0.293 to 0.697), inbreeding coefficient was low and slightly negative. Two major gene pools were found with high genetic differentiation among populations within regions which can identify as: (1) the central region behind the dike system (VB, LI, BER, DHE) and (2) Southern populations in the Scheldt delta (TER, BA, ZI) and the northern region with samples collected from Den Helder port and Texel Island (DHE2, TE_DW, TE_OO, TE_DC). Furthermore, clonal structure analysis showed a large clonal subrange indicating asexual propagation might be the main reproductive strategy. Fine-scale genetic structures were identified in most of the population, indicating that the populations were constrained by both pollen and seed limitation and clonal aggregation.

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Who is next? Predicting potential introduced species in the North Sea using traits-based analysis

BY Nguyen, Mai Huong

PROMOTER: Steven Degraer (Universiteit Gent)

CO-PROMOTER: Francis Kerckhof

Introduced species are posing significant threats to the global biodiversity and environment. Therefore, marine invasion research has significantly increased in recent years. However, many studies encounter uncertainties. Most researches focus on introduced species that are already present and invasive. Future invaders, nevertheless, are still in the early stage of marine invasion research. This raises important questions in invasion ecology on (1) which life-history traits influence invasion processes and (2) which species have the potential to become the next invaders. Here we propose a method based on life-history traits analysis and invasiveness score which can be used to predict potential introduced species. Our exploratory research examines 16 biological and ecological traits of selected molluscs, including 38 native to the East coast of America, and 11 species that are introduced into the North Sea. Using hierarchical cluster analysis, we predict there are 15 native species from a tentative list that might become introduced to the North Sea. These potential introduced species share some similar traits with non-indigenous species in this area, such as high fecundity, brooding behaviour, long period of reproduction, having a larval stage, and a long life span. Analysis indicates that the most distinctive/different traits between native species and introduced species are salinity and fecundity. Introduced species have a high number of eggs and a high level of tolerance for salinity compared to native ones.

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PALEOECOLOGY OF OSTRACODA AND DAPHNIID CLADOCERA IN LAKE NAIVASHA (KENYA): DOCUMENTING 7000 YEARS OF AQUATIC ECOSYSTEM DYNAMICS

BY Nguyen,Thi Minh

PROMOTER: Dirk Verschuren (Universiteit Gent)

CO-PROMOTER: Thijs Van der Meeren

The understanding of how inland aquatic ecosystems and individual species of aquatic biota function and change in response to both natural and anthropogenic drivers at the time scale relevant to those drivers is critical for the conservation or restoration of these ecosystems. The sedimentary record of Crescent Island Crater (CIC) in Lake Naivasha (Kenya) offers us an opportunity to investigate both evolutionary and ecological changes in its aquatic biota over multiple millennia. The deep basin of CIC acts as a sediment trap, ensuring a high rate of sediment accumulation and thus high temporal resolution of its sediment record. In this study, we use a 22.9-m long composite sediment core retrieved from CIC to elucidate the paleoecology of the local Ostracoda (seed shrimp) and Cladocera (water fleas) communities over the past ca 7000 years. A total of 12 ostracod taxa and 13 cladoceran taxa were identified in the studied materials, which focused on the lower 15 m of the sediment core and were then combined with existing data from the upper 8 m. The changes in fossil ostracod and cladoceran assemblages through time were tentatively linked to different factors including climate events, the evolution of lake hydrology and species interactions. Fluctuations in lake level over the past ca 7000 years explained 8.0% of the variation in fossil ostracod assemblages. Lake level also affected the presence of some cladocerans. Both the ostracod and cladoceran communities experienced a developmental crisis with low diversity before ca 2800 BP followed by explosive population growth in later periods.

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CHASING BACTERIA IN THE GREEN ALGA *BRYOPSIS PLUMOSA*

BY Njeru, Josephine Marigu

PROMOTER: Olivier De clerck (Universiteit Gent)

CO-PROMOTER: Willem Stock

Bryopsis is a siphonous green marine macroalga characterized by a complex life cycle including both sexual and asexual reproductive stages. While the diverse bacterial communities associated with *Bryopsis* have been extensively studied, little is known about the stability of these bacterial communities. We investigated the bacteria associated with *Bryopsis spp.* from different sites along the European coast. Our aim was to understand the stability of the bacterial communities over time and host reproduction. We therefore focused on tracking bacteria across selected life stages in *Bryopsis spp.* We characterized the *Bryopsis*-associated bacteria using high throughput 16S rRNA amplicon sequencing. Symbiont stability was tested by characterizing cultures which had been in the lab for an extended amount of time. Bacterial transmission during sexual reproduction was monitored by screening *Bryopsis* gametes using transmission electron microscopy (TEM). The potential for the acquisition of novel bacteria during protoplast formation, an asexual reproduction strategy, was tested using fluorescent bacteria. Proteobacteria (mostly Alphaproteobacteria and Gammaproteobacteria), Bacteroidetes, and to a lesser extent Cyanobacteria and Firmicutes dominated the communities associated with *Bryopsis*. *In situ Bryopsis* samples hosted the highest bacterial species richness while communities present in the *Bryopsis* cultures which had been maintained in the lab for at six months were the most diverse. Significant differences in the alpha and beta diversity indices of the bacterial communities hosted by the different *Bryopsis* sample types and reproductive stages in our study illustrated limited bacterial symbiont stability over time and life cycle transitions. Spatial variations were also observed among communities associated with *in situ Bryopsis* strains. Bacterial communities associated with hosts from a single location, Marseille (France) were more similar than those found on hosts from other sites. Vertical bacterial transmission was not observed using TEM on *Bryopsis* gametes. Fluorescent bacteria were not stably acquired (horizontal transmission) during *Bryopsis* protoplast formation, suggesting that *Bryopsis* employs a selectivity mechanism against foreign bacteria during protoplast formation which possibly influences horizontal bacterial transmission. The phylogenies of *Bryopsis* did not reflect the similarity between bacterial communities associated with those hosts, implying a lack of a host-symbiont evolutionary signal which is characteristic of transient symbioses. Our study sheds light on the stability of the bacterial communities associated with *Bryopsis sp.* and how this is impacted by cultivation and the potential for (directed) horizontal and vertical transmission. Functional characterization of these bacterial communities is recommended to improve the understanding of factors determining bacterial stability in *Bryopsis*.

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Status of marine litter at the coast of Dar es Salaam, Indian Ocean, Tanzania.

BY Peter, Florence Jovinary

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

Marine litter accumulation poses a significant threat to marine biodiversity as a whole caused by industrial production and resulting waste. Growing cities in the world are facing also the same problems of waste littering in the streets, including the study site Dar es Salaam. This litter ends up in the ocean via rivers due to poor waste management plans and policy, contributing to marine litter accumulation. Therefore, this study focused on the quantification of marine litter and the influence of rivers on marine litter accumulation during the rainy and dry seasons. The study took place along the coast of Dar es Salaam at Mbezi rainbow and Salenda beach close to Mbezi and Msimbazi river during the rainy season (April) and dry season (July) from 2019 to 2020. Transects of 250 m length and 10 m width were conducted along the beach in the supratidal and intertidal zone. A net of 2 mm mesh size fixed on a metal frame of 2 m length, 1 m height and 1 m width were used to collect litter in the river. A total of 127,658 counts of marine litter with an average weight of 440 kg and 1365 counts of riverine litter were sampled. Clustering and MDS, ANOSIM, and one way-ANOVA were used for data analysis. A higher density of marine litter was found in rainy seasons from both sites Mbezi and Salenda beach. Also plastic and foam objects showed higher density in rainy season than other marine litter and Locations (Mbezi and Salender) showed no significant differences ($F(1, 106) = 2.63$, $p = 0.11$ and there was no significant difference among zones ($F(1, 106) = 3.8581$, $P = 0.05$ but seasons showed significant differences $p = 0.016$. And the most marine litter is produced locally in Tanzania by 70% compared to foreign countries yet the marine litter trend decreased in three years from 5.7 ± 0.45 litter/m² to 2.2 ± 0.54 litter/m² at a rate of 0.4 per year. But PEP and SL contribute more than 30 % to the total form of plastic founds while ML and LDPE showed lower percentage contribution. The study suggests that proper policy management, marine litter action plans and the collaboration of other entities such as NGOs, government, industries, suppliers society and the neighboring country will help to minimize and reduce marine litter.

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Manganese Nodule Fields benthic communities and the challenges of monitoring deep-sea mining activities in poorly known remote habitats

BY Podholová, Pavlína

PROMOTER: Ann Vanreusel (Universiteit Gent)

CO-PROMOTER: Francesca Pasotti, Ellen Pape

In recent years there has been an increasing demand for precious metals accelerated by population growth resulting in the search for alternative sources of metals and new ways of metal extraction. Relatively unexplored deep-sea sediments containing large deposits of polymetallic nodules provide a potential alternative that could (partially) release the pressure on terrestrial environments and transfer it to the bottom of the abyss out of human sight. The abyss is a vast ecosystem that is yet to be fully explored and understood, with very slow geological, chemical, and biological processes forming the seabed for millions of years, hosting possibly hundreds of species that are new to science and which might contribute to ecosystem services. The Clarion Clipperton Fracture Zone (CCFZ), in the Pacific Ocean, is an area with the largest deposits of commercially viable polymetallic nodule deposits on Earth, where deep-sea mining might take place in the coming decade(s). Megabenthos (> 1 cm) and macrobenthos (>1mm) was sampled during the Patania II trial in the Belgian Global Sea Mineral Resources (GSR) and the Federal Institute for Geosciences and Natural Resources Privacy Policy (BGR) contract areas. Individuals were vouchered, photographed, and sorted out into morphospecies. Out of 134 individuals, 11 classes, 11 orders, 8 genera, and 5 species were identified in the preliminary morphological identification. We decided to put focus on the 4 most abundant taxa, i.e., Cnidaria, Ophiuroidea, Mollusca, and Porifera. Individuals were sequenced using mitochondrial COI and nuclear 18S ribosomal RNA markers. Our results showed that universal primers have a low amplification success rate and that more taxon-specific primers are needed to successfully identify species. Due to time constraints, only Anthozoa (Cnidaria) and Ophiuroidea taxa were selected for phylogenetic analysis because of their high individual abundances and high DNA amplification success rates. The preliminary morphological assessment overestimated species present, especially, for Ophiuroidea class. Nonetheless, the correction was provided by the species delimitation programmes. Maximum likelihood (ML) and Bayesian inference (BI) tree approaches were performed resulting in trees with relatively high bootstrap and posterior probabilities values (0.7-1). However, polytomy was overly present in all displayed trees. The ML tree offered better tree resolution than the BI for Anthozoa, while the ML and BI were comparable for Ophiuroidea class. The thesis also aimed to check the probability of cryptic species present within our ingroups of Ophiuroidea and their population status. All our species groups displayed hypothetical cryptic species present. Both Ophiuroids and Anthozoans are deemed to be suitable candidate indicator species of deep-sea mining disturbance as species-level identification can be efficiently done by non-expert if relevant keys are used. Finally, constraints and recommendations for rapid biodiversity assessment were identified.

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Genetic diversity and connectivity of Giant Mangrove Crabs (*Scylla* spp.) in the Indo-Malay Archipelago

BY Ronse, Michaël Johan K

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

The giant mud crab *Scylla* spp. is widely distributed in the Indo-Malay Archipelago (IMA). For the past decades, the mud crab resource has become commercially important for fisheries and aquaculture production in the region, providing a source of income for the growing coastal population. Due to the increasing demand, signs of overexploitation and mangrove degradation are threatening the wild stocks.

Knowledge about population connectivity is required to support the implementation of marine protected areas and support the sustainable management of the mud crab fisheries. This study investigates the population structure of *S. tranquebarica* and *S. serrata* in the IMA by analyzing a fragment of the cytochrome oxidase subunit I (COI) gene and nine microsatellite loci from 79 samples of *S. tranquebarica* and 70 samples of *S. serrata*. Analyses of molecular variance (AMOVA) revealed a strong genetic population structure with both markers (COI: Φ_{st} = value 0.306, $P < 0.001$; microsatellites: F_{st} = 0.123, $P < 0.001$) for *S. tranquebarica*. Indicating restricted gene flow, these results were further supported by a Bayesian clustering STRUCTURE analysis and principal component analysis (PCoA). No significant genetic differentiation between populations of *S. serrata* was suggested by the AMOVA for both markers (COI: Φ_{st} = 0.042, $P = 0.012$; microsatellites: F_{st} = 0.001, $P = 0.351$), showing panmictic conditions in the central and eastern IMA. Despite its high dispersal potential, populations of mud crab present consistent differentiation patterns observed in the IMA explained by the combination of the historical lowered sea level during the Pleistocene and the major surface current patterns. Further research must be conducted to study the diversity patterns and connectivity among the sympatric congeneric species and provide useful information for conservation and the sustainable management of the genus *Scylla* in the IMA.

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THREE DECADES OF MANGROVE UTILIZATION DYNAMICS IN GAZI BAY, SOUTH COAST KENYA

BY Rumba, Saumu Mkambe

PROMOTER: Farid Dahdouh-Guebas (Vrije Universiteit Brussel)

CO-PROMOTER: Cosmas Munga

Mangrove ecosystems continue to be important worldwide in maintaining coastal and marine biodiversity, mitigating climate impacts and providing ecosystem services. However, mangrove forests have declined due to natural and anthropogenic stressors. Recording changes over a timescale requires considerable periodic efforts, which may not be possible for most mangrove ecosystems in the world. Gazi Bay in south coast Kenya provides an important example to study the dynamics in mangrove usage. This study assessed the variability of mangrove utilization in Gazi Bay within the last three decades (2000s, 2010s and 2020s) using semi-structured questionnaires and interviews. The questionnaires addressed ethnobiological utilization of mangroves, fishery-related activities and the perception of the local community towards changes in the forest. A total of 82 interviews in 2003, 82 interviews in 2014 and another set of 98 in 2021 were accomplished to cover three decades. Results show that usage of mangrove species has changed over time. The usage of *Avicennia marina* and *Xylocarpus granatum* for fuelwood increased in 2021. Usage of *Rhizophora mucronata* has been constant while usage of other species has reduced. The usage of mangroves for medicinal and chemical properties as well as fodder for animals and food for humans has decreased over time. Results have shown erosion of Traditional Ecological Knowledge (TEK). Overall, there is a shift in mangrove utilization patterns over the three decades, most likely due to the regulations and conservation initiatives put in place. A decrease in fish catch was also reported over the three decades attributed to environmental disturbance over time. Changes in the mangrove areas was noticed by the local community due to improved regulations, increased conservation awareness, and community led initiatives. Findings from this study highlight the need for stricter regulations enforcement to control possible illegal harvesting of mangroves, advocate for sustainable alternatives of mangrove produces and more effort should be directed to raising awareness on mangrove conservation.

Keywords: Mangroves, Ethnobiology, Utilization, Gazi Bay, South coast Kenya

BLURRY BOUNDARIES: DOES HYBRIDIZATION CAUSE MORPHOLOGICAL SIMILARITIES AMONG *LAMINARIA HYPERBOREA* AND *LAMINARIA DIGITATA*?

BY Schübert, Clara

PROMOTER: Olivier De Clerck (Universiteit Gent)

CO-PROMOTERS: Kathryn M. Schoenrock, Stacy A. Krueger-Hadfield

Kelp forests have always fascinated biologists, giving rise to extensive research in the field. Kelp ecosystem services are important ecological and economical resources, which makes these habitats conservation and restoration targets. In this study, we first assessed the connectivity of two kelps found in the North Atlantic: intertidal-dominant *Laminaria digitata* and subtidal-dominant *Laminaria hyperborea*, which are currently seen as distinct species with diagnostic morphological characteristics. Second, we investigated genetic differences of *L. digitata* along a depth gradient and between individuals growing on benthic substrata or those growing on *L. hyperborea* as epiphytes. Third, we compared the genetic diversity of a *L. hyperborea* population in west Ireland across sampling years (2017-2018 and 2021). Finally, we measured gene flow and genetic diversity of intertidal *L. digitata* across Ireland and compared these patterns to those found from the same species in Brittany. We found a similar morphology between subtidal *L. digitata* and *L. hyperborea* and discovered hybridization among them. Intertidal benthic, subtidal benthic, and subtidal epiphytic *L. digitata* could be genetically differentiated, which might be driven by hybridization of the species or adaptation to a subtidal habitat. The investigated *L. hyperborea* population showed an increase in genetic diversity and inbreeding over four years. *L. digitata* populations were more diverse and less connected in Ireland than in France. Since intertidal *L. hyperborea* and *L. digitata* can exhibit the same morphology, researchers should be aware that the phenotype is insufficient to differentiate the species in the subtidal. The cause of their morphological and genetic aberrations and whether this is limited to Ireland remain unclear, and need further investigation.

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How do native aquatic communities of macrophytes, zooplankton and invertebrates respond to the biological control of invasive weed *Azolla filiculoides*? Case study on shallow temperate ponds in Belgium

BY Singh, Kanika

PROMOTER: Iris Stiers (Vrije Universiteit Brussel)

CO-PROMOTER: Gianmarco Minuti

The socio-economic and ecological impacts of invasive alien aquatic plant (IAAP) species have been well studied globally. However, less is known about response of the ecosystem and component native biological communities following the management of IAAP species. *Azolla filiculoides*, the second most widely distributed alien plant in Europe, with a local abundance and potentially invasive status in Belgium, is one such water weed.

This study investigated changes in native macrophytes, zooplankton and macroinvertebrate communities following the control of *A. filiculoides*, at two field sites in Belgium. Environmental parameters were also studied at each site for invaded and reference uninvaded ponds to see if they had stronger influences on the biological indicators. It was hypothesized that the presence of *A. filiculoides* would have a negative impact on the ecosystem implied by low species richness and diversity indices, and that following *A. filiculoides* control, the systems would show positive ecosystem recovery. While few significant correlations of invasion status or time representing the process of biocontrol with species richness, Shannon diversity were found, influences of environmental parameters on the communities were strong. Discussions of qualitative changes in terms of species and possible anomalies in the experiment have been done.

Keywords: Invasive alien aquatic plants, *Azolla filiculoides*, biological control, *Stenopelmus rufinasus*, species richness, Shannon diversity, abundance

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Using drone and laser scanning techniques for mapping vegetation and soil development in a young tidal marsh

BY Stuurman, Léon Patrick

PROMOTER: Stijn Temmerman (Universiteit Antwerpen)

CO-PROMOTER: Bert Gielen

SUPERVISOR: Ken Schoutens

Tidal marshes have highly dynamic bio-geomorphological processes, which are most of the time, studied at large spatial scales or in flume experiments. In this study, an unmanned aerial vehicle (UAV) equipped with a digital 48.0-megapixel camera and terrestrial laser scanner (TLS) are compared with each other and airborne LiDAR data by surveying a young brackish tidal marsh in the Scheldt estuary in Belgium. The three DSMs produced, two by UAV, one with the use of 16 ground control points (GCP) and one with 8 GCPs and the DSM produced by TLS were compared to each other and the LiDAR DEM in terms of the root mean square error RMSE in vertical (z) direction. For each method, the elevation data was extracted for each land class. The RMSEz values compared to LiDAR for these land classes were a measure of their performance. In extent to the surveys, soil properties such as grain size distribution, LOI (loss on ignition), moisture content and bulk density are determined in perpendicular transects from the creek. The best overall results are the UAV survey with a DSM resolution of 1.22cm/pixel. The vegetation caused the highest RMSEz in the UAV survey. Overall, it can be concluded that UAV-SfM and TLS produce accurate results in a higher spatial resolution than airborne LiDAR and can help to track small changes in the spatial land configuration in young tidal marshes.

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COMPARING THE IMPACTS OF DIFFERENT SEA LEVEL RISE RATES ON SOIL CARBON ACCUMULATION IN AMELAND AND SCHIERMONNIKOOG SALT MARSHES (DUTCH WADDEN SEA, THE NETHERLANDS)

BY Temmerman, Daan

PROMOTER: Stijn Temmerman (Universiteit Antwerpen)

CO-PROMOTER: Rey Harvey Suello

Salt marsh ecosystems are highly efficient in long-term sequestration of carbon that originates from both within and far beyond its own boundaries. They are therefore considered to be major blue carbon sinks with great potential for climate change mitigation strategies. As a consequence, scientific interest has gradually increased over the past decades and recent studies are now acknowledging promising carbon-climate feedbacks. However, many studies on sea level rise (SLR) induced carbon accumulation in tidal marshes are in most cases limited to a certain extent in their comparability and unambiguity due to various methodological and geographical-related constraints. The present study aims to address these recurring issues by studying two nearby minerogenic marshes on the back-barrier islands of Ameland and Schiermonnikoog in the Dutch part of the Wadden Sea. Both islands experience similar environmental conditions, yet also significantly different rates of SLR (9.7-11.7 mm yr⁻¹ and 2 mm yr⁻¹) due to severe land subsidence near Ameland. Consequently, the effects of accelerated SLR on local carbon sequestration processes along multiple levee-basin gradients for various rates of SLR could be examined. Sampling campaigns were organized during the summer and winter months of 2021 to collect water, sediment and above- and belowground biomass samples. Similar data from previous studies were reanalyzed. Thorough statistical analysis was carried out in Rstudio on various sedimentological, elemental (OC%, N%, C:N) and stable isotopic ($\delta^{13}C$) parameters and resulted in the following findings. Mean organic carbon accretion rates (OCAR) were quantified for Ameland (110.54 g m⁻² yr⁻¹) and Schiermonnikoog (60.12 g m⁻² yr⁻¹). Estimations of sediment organic carbon (SOC) stocks ranged between 35.96±7.52 and 73.35±15.99 Mg OC ha⁻¹ on Ameland and between 20.83±3.44 and 24.94±4.55 Mg OC ha⁻¹ on Schiermonnikoog. Furthermore, increases in relative SLR (RSLR) primarily affected sedimentological parameters, whereby sediment accretion, silt layer depth and sediment bulk density would experience two- to threefold increases. Mean OCAR and SOC stocks would double in size as a direct result. OCAR and SOC stocks were uniformly distributed in space across the marsh under low rates of RSLR, but displayed a growing imbalance between the levees and basins under accelerated RSLR. Levees were disproportionately affected and became hotspots of subsurface carbon sequestration. Moreover, negative and non-linear relationships between RSLR and OCAR/SOC along the small RSLR-gradient on Ameland indicated the beginning of marsh drowning at SLR rates between 10.7 mm yr⁻¹ and 11.7 mm yr⁻¹. Finally, the SOC stocks originated predominantly from old and recalcitrant marine allochthonous POC. Enhanced RSLR only intensified the marsh's dependence on allochthonous sediment inputs in order to survive.

Keywords: sea level rise, climate change, salt marsh, soil organic carbon (SOC), soil organic carbon stocks, allochthonous, autochthonous, levees, basins

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Effect of intertidal versus subtidal origin of the stony coral *Pocillopora damicornis* on growth and survival during a bleaching event.

BY Wamwachai, Mgeni

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

CO-PROMOTER: Ewout Knoester

Climate change continues to impact coral reefs at both regional and global scales. Coral bleaching and mortality in the Western Indian Ocean (WIO) region has been well documented and studies have predicted even higher mortality rates with increasing temperatures. With fast degrading reefs, restoration perhaps provides an answer to this challenge. However, it is important to study coral resilience and any consequences that the corals face after being translocated from one zone to another. This study takes a look at how the origin of the coral plays a role in its growth and survival using the species *Pocillopora damicornis*, and if there are any potential tradeoffs that exist once they are translocated to either the intertidal to subtidal zone and vice versa. Coral fragments were collected from the intertidal area and transplanted to the subtidal while others were taken from the subtidal zone and transplanted to the intertidal. Controls were also set up in both the intertidal and the subtidal zones. A total of 288 *P. damicornis* were attached to 36 coral nurseries and deployed into the four treatments. Growth and Condition measurements were taken on average every four months for 412 days. In this study, growth and survival were influenced by the zone in which the corals are cultured in, as opposed to their origin. We see a clear trend of corals cultured in the intertidal zone, regardless of origin, having a higher growth rate than those cultured in the subtidal zone. Despite their fast initial growth, the corals from the Intertidal control treatment had low survival of 27% by the end of the experiment. Corals with a subtidal origin were able to have > 50% survival rate at the end of the experiment, indicating that subtidal populations possess acclimatization potential to be able to survive in both intertidal and subtidal zones, therefore widening their potential use in coral reef restoration. These results suggest that the intertidal zone provides optimal conditions for the growth and survival of the *P. damicornis* species.

Keywords: Thermal tolerance, bleaching, tradeoffs, coral restoration, growth, survival.

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ENHANCING IN VITRO GERMINATION OF THE SEAGRASS *ZOSTERA MARINA*: IMPLICATIONS FOR SEED-BASED RESTORATION

BY Whatley, Lawrence Francis

PROMOTER: Marleen De Troch (Universiteit Gent)

CO-PROMOTER: Riccardo Pieraccini

Worldwide declines in seagrass meadows have had knock-on effects on the functioning of coastal ecosystems and provision of ecosystem services. Consequently, the field of seagrass restoration is gaining attention as an attempt to reverse these declines and reinstate lost ecosystem services. However, low rates of germination and seedling establishment in species such as *Zostera marina* often affect the feasibility and cost-effectiveness of restoration projects, representing a major bottleneck. This study investigated the effects of light and hormone seed treatments on the germination rate, germination time, and seedling development in *Z. marina* with the aim of identifying treatments which maximise the germination rate and production of viable seedlings for use in seed-based restoration. Seeds were incubated in solutions of one of five concentrations of gibberellic acid (GA3; 0, 10, 50, 500, and 1000 mg/l) and in one of five light conditions (darkness, and red and white light with 12h:12h and 24h photoperiods) in two fully crossed experiments. There was a positive effect of all GA3 treatments on the germination rate in the nonaseptic experiment, but only the 500 mg/l GA3 treatment in the aseptic experiment. The GA3 treatments also reduced the mean time of germination in the non-aseptic experiment. The light treatments had no effect on germination in either experiment. The highest germination rate in each incubation experiment (30.43% and 33.33%) was recorded from the 10 mg/l GA3 and 500 mg/l GA3 treatments. No consistent effect of GA3 concentration on germination was found, suggesting that presence/absence of GA3 plays a more important role in determining germination than its concentration. Apart from a possible negative effect of the 1000 mg/l GA3 treatment on the maximum leaf length of seedlings, no significant effects of treatments on seedling development were found. To increase efficiency, seed-based restoration projects should therefore consider targeting the hormonal pathways controlling germination in *Z. marina* by treating seeds with medium-low (10-500 mg/l) concentrations of GA3.

Keywords: *Zostera marina* · Germination · Gibberellic acid · Light quality · Seagrass restoration

The chemo-stratigraphic record of DDTs in global sediment cores, temporal /spatial signals and the role of production, use and regulation.

BY Yang, Shuai

PROMOTER: Steven Eisenreich (Vrije Universiteit Brussel)

The stratigraphic record of legacy organic pollutants such as DDT in aquatic sediments can accurately reflect production and use patterns at regional, continental and even global scales. DDT was widely used in global agriculture and disease control from the 1940s to the 1970s with global production estimated at 600 000 tonnes. The physical and chemical properties of DDT (e.g., low aqueous solubility, low vapor pressures, high K_{ow} - tendency to partition into OM) suggest that DDT is transported from areas of use to non-target areas via the atmosphere, rivers and oceanic currents and accumulates in bottom sediments of lakes and rivers. The objective of this thesis is to examine the relationship of the time-dependent accumulation of DDT in sediment cores from lakes around the world (sediment chronology) to DDT global production and use, and how DDT chronology reflects environmental policies and controls (e.g., ban). DDT profiles in aquatic sediment represent signals of the Anthropocene surprisingly well (source strengths), and insights how emission controls and regulations influence their temporal signal in water bodies.

Here, I construct the temporal signal of the production and use of DDT and compare it with the temporal signals of DDT in dated aquatic sediment cores around the world. The production and use of DDT began in the early 1940s, with a peak \sim 1960, after which the concentration/accumulation gradually declined. DDT was banned in many areas of the globe in the 1970s. The temporal distributions of DDT in many lake sediment cores are coincident with global production and use trends. Sediment cores in some aquatic systems show DDT concentration patterns where DDT remains high in surface sediments compared to production trends. These 'modified' DDT signals are attributed to glacial melt waters reaching basin lakes, illegal use, exceptional use, surficial bio-mixing and basin-scale floods. The sedimentary record of DDT, especially in North America and Europe, accurately reflects production and use, and the DDT ban in the 1970's in most areas of the world is reflected in a decrease in DDT sediment accumulation. DDT producers reached peak production and use in \sim 1960, but DDT was not politically banned until more than a decade later having moved away to next generation substitutes such as the pyrethroids.

Keywords: DDT, sediment, production and use, spatial signal

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Optimizing the knowledge on life cycle control and cryopreservation of *Porphyra umbilicalis* in function of the potential in mariculture

BY van der Linden, Arthur Wim K

PROMOTER: Olivier De Clerck (Universiteit Gent)

CO-PROMOTER: Jessica Knoop

Macroalgae, also called seaweeds, are found in the littoral and sublittoral zones all around the world where they fulfill key ecological functions. However, the potential of seaweeds in the food, feed, agricultural, cosmetical, pharmaceutical and biotechnological industries as raw or processed products is gaining more recognition. Asian countries have been cultivating seaweeds for over a 100 years, while European interest is growing but large scale cultivation is still in its starting stages. Before being able to upscale seaweed aquaculture in the European region, increasing knowledge on the life cycle control and optimal growing conditions for local species is required. The genera *Porphyra*, also referred to as 'nori', contains promising aquaculture species that are locally found in European waters although their complex lifecycles are not yet fully understood and cultivation bottlenecks, such as the mass release of conchospores, still remain. *Porphyra umbilicalis* is a species showing great potential for aquaculture due to its high nutrient uptake and assimilation rates together with high growth rates. Further, asexual strains of the species are found which have potential to circumvent some of the bottlenecks in the sexual lifecycle that still occur. The goal of this study was to optimize and improve the current knowledge on the life cycle control and optimal growing conditions of an asexual strain of *P. umbilicalis*. Further, I tested the tolerance of the species to being frozen in function of cryopreservation. Experiments conducted tested the effects of temperature (10°C, 15°C, 18°C and 23°C) and photoperiod (16:8 light:dark and 8:16 light:dark) on the daily growth rates, time until maturity and time until spore release. Another experiment, tested the effect of freezing at -20°C on *P. umbilicalis* blades and their released neutral spore quantity and quality. Lastly, I studied the effects of different nutrient ratios on the daily growth rates and carbon:nitrogen ratio of the tissue. Daily growth rates, time until maturity and time until spore release were significantly affected by temperature and photoperiod. Freezing had no significant effect on neutral spore quality and quantity. Further, I found a significant effect of different nutrient ratios on the C:N ratios of samples tissue but not on their daily growth rates. Optimal growing conditions for *P. umbilicalis* are identified as being temperatures between 15°C and 18°C while using a long day 16:8 photoperiod. A short photoperiod with cooler temperatures between 10°C and 15°C are identified as inducing maturation and spore releases. To optimize the protein content within the seaweed blades, I identified a 5:1 N:P ratio with ammonia as the main nitrogen source for rapid uptake.

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