BOOK OF ABSTRACTS

VLIZ MARINE SCIENCE DAY 2022

ONLINE EVENT | 2 MARCH 2022

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Table of Contents

POSTER PRESENTATIONS

KEYNOTE PRESENTATION

Keynote presentation

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Patrick Sorgeloos obtained his PhD in marine biology in 1975 from Ghent University in Belgium. In 1978 he set up the Artemia Reference Center and in 1986 he became the first professor of aquaculture at Ghent University. Until his retirement as emeritus professor in 2013 over 250 Master (from over 50 countries) and 70 PhD alumni (from over 20 countries) graduated at Ghent University in the field of aquaculture.

Patrick is a strong promoter of international networking in aquaculture and was/is involved with the World Aquaculture Society, the European Commission (DGs RTD, MARE, DEVCO, SANTE, TRADE) and the European Aquaculture Technology & Innovation Platform EATIP. He was involved in many cooperation projects in Europe, Asia, Latin America and Africa.

AWARD PRESENTATIONS

Beyond genetics, exploring the contribution of epigenetics to thermal adaptation in brown seaweeds

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Epigenetic modifications have the potential to buffer species and populations against rapid climate change. While efforts to examine these mechanisms in the marine realm have greatly increased during the past decade, epigenetic effects in seaweeds species are still in their infancy, with only one single-base methylome profile published so far. Nonetheless, these organisms are of great importance, both from an ecological perspective (e.g. as habitat engineers and primary producers) as well as from an industrial perspective (e.g. for the production of nutraceuticals and as food for human consumption).

Our project aims to address this important research gap by studying DNA methylation and its connection to gene expression levels in the different life cycle stages of the brown seaweed *Dictyota dichotoma*. Furthermore, we aim to link these molecular processes to observed differences in thermal performance, which represents a major challenge in the field of environmental epigenetics if we are to understand the full potential of species to adapt to changing conditions and the role of epigenetics herein.

The NeXus-10 MKII for holistic insights in the physiological drivers behind mental health restoration from virtual coastal landscapes

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Exposure to coastal environments has been shown to improve subjective and psychological indicators of human health and wellbeing. However, there is still very little known about coasts' impact on the physiological symptoms of relaxation. Therefore, the aim of this study was to investigate the changes in the physiological symptoms of relaxation, alongside those in mood and cognition, and in response to being exposed to beaches, and for comparison to beaches with litter, green spaces, and urban spaces. A randomized controlled cross-over experiment exposed each participant to two virtual-reality environments with sound: to beaches and to one of the other environments. The NeXus-10 MKII from MindMedia (acquired with the BMRI grant) was used to measure the physiological symptoms of relaxation (i.e. brain activity, cardiovascular functioning, respiration, muscle tension, skin conductance, temperature). This was complemented with the measures of perceived stress, perceived mental exhaustion, positive and negative mood, perceived restorativeness (via questionnaires) and of cognitive performance (i.e. Stroop, DSB). The participants were 164 healthy adults aged 18-65y, recruited via a media-campaign (www.uitzicht.org). A series of generalized linear mixed models investigated whether changes in the outcomes differed between the environments, while controlling for participant and study-design related covariates and random effects. The preliminary non-peer-reviewed results indicated that, compared to urban spaces, beaches positively influenced psychological outcomes (e.g. mood and restoration, not cognitive performance) and decreased brain activity and respiration rate. Compared to green spaces, beaches were associated with lower negative mood, better scores for attention inhibition, and lower brain activity. The presence of small representative amounts of litter resulted only in increased negative mood and a lower perceived restorativeness. In conclusion, this is the first study that measured the impact of coastal environments on a wide range of physiological symptoms of relaxation in combination with psychological measures. As such, it provides more detail about the widely-known perceived health benefits of coastal environments, which have remained largely under-investigated. Future efforts will be directed towards additional analyses on the acquired large dataset (e.g. moderation for participant's characteristics).

Keywords: Coast; Health; Virtual reality; Psychophysiology; Attention; Restoration

Integration of taxonomic and phenotypic fingerprints of marine plastic degrading communities

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Flow cytometry is a powerful tool to monitor microbial communities as it allows to follow changes in the phenotype of the community in combination with absolute abundances in high throughput at a very low price. This information can be combined in a so-called phenotypic fingerprint that can be used for diversity-analysis. In this research we use the phenotypic fingerprint to monitor how microbial communities change over time when exposed to plastics. As phenotypic fingerprinting is not always straightforward to link with taxonomic diversity, the idea rose to combine flow cytometry (FCM) with Fluorescent In Situ Hybridization (FISH). This allowed us to make a combination of taxonomic (FISH) and phenotypic (FCM) information to obtain an integrated fingerprint. By labelling a specific taxonomic group, we can not only add an extra dimension to the fingerprint, but we can also link the behaviour of the microbial community to this particular group. Thus, linking phenotype, taxonomy, and functionality when following the community over time.

Building with nature: Aeolian sediment input to engineered dunes

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Coastal managers are getting convinced of building with nature concepts, such as engineered dunes in front of traditional dikes, for coastal protection and as sand mitigation measure. For an optimal design of these marram grass planted dunes, a fundamental knowledge of the morphological changes of dune development is required. Hence, the characterization and prediction of aeolian sediment supply from the beach to the dune is a key component in the development of comprehensive models for beach and dune interactions. Observations of aeolian transport in coastal areas have largely focused on short-term experiments because of limitations imposed by instrumentation. This research uses a unique case study of the 120x20m² dune-in-front-of-a-dike pilot site in Oosteroever, Oostende, Belgium, to analyze how frequently and with which magnitude aeolian transport occurs at the beach over a complete year of measurements by using continuous records of wind from an erected monitoring station and weekly topographic RTK-GPS measurements and monthly high-resolution drone surveys. Occasionally, during storm events a camera setup was used to determine shoreline position, fetch distances, and possible storm erosion. The analysis of a set of 12 months at an hourly basis, for a total of 8784 hours, shows that the wind was above the threshold of transport (i.e., 6 m/s) 20.4% of the time (1793 hours), and approached the dune from a longshore to onshore direction 47.7% (4193 hours) of the time. Prevailing winds were from northeast, whereas the strongest winds were from west and southwest. The combined effect of both an appropriate wind speed and angle of wind approach for potential aeolian transport towards the dune resulted in a total of 1607 hours; this is 18.3% of the total time throughout the year. Transport rates varied between 0 and 300 kg m-1 h-1 with the majority (i.e., 67.7%) below 100 kg m-1 h-1 for moderate wind speeds between 8 and 10 m s-1. During winter period, there were a few occasions where strong winds occurred in combination with (spring) high tide inundating the beach hampering any aeolian sediment transport towards the dune and thus limiting dune growth. This supports the idea that potential aeolian transport is less than 18.3% of the year. The local wind speed measurements differ from the regional wind speed measurements suggesting that wind speed transformation is necessary when predicting aeolian sediment at the beach/dune interface. During longshore winds, wind speed at the beach is generally 1.1 to 1.35 times higher than in the landward dunes. Rainfall occurred 9.4% (825 hours) of the time with a cumulative total of 625mm but did not significantly influence aeolian sediment transport processes according to model predictions. The total volume of sand in the dune has increased significantly since the plantation of the marram grass (i.e., January 2021). In total 14 m³ m-1 of sand has been added due to the aeolian processes translating into a vertical elevation increase of 1 m. Moreover, the dune suffered from erosion where cliffs at the dune toe were formed up to 1.5 m exposing the underlying roots of the marram grass. Nearly 1.5 m³ m-1 of sand was eroded in a couple of hours. However, the dune proofs to be rather resilient as already new sand from the beach is getting deposited at the dune toe. Initial vegetation patterns in the dune disappeared giving the dune a more natural and dynamic behavior. Vegetation growth and density varied throughout the year and thus its sand trapping efficiency. Although there is less than one-fifth of the year for potential aeolian sediment transport at the beach, the results show a significant dune growth in the dune-in-front-of-a-dike pilot site which is encouraging for coastal protection. Marram grass proves to be a good mitigation measure to keep the sand on the beach. However, dune growth is influenced by supply limitations, vegetation characteristics, and sediment erosion by wind and storm events.

Keywords: Aeolian sediment transport; Dune development; Case study; Remote sensing; Beach/dune interaction

Intercepting invaders: metabarcoding for monitoring non-indigenous species in a North Sea harbour

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My thesis is embedded in the EU Interreg project GEANS (Global Ecosystem Health Assessment for the North Sea), which aims to facilitate the implementation of genetic-molecular tools for routine ecosystem assessment in the North Sea region. To this end, the project consists of various pilot studies that aim to compare DNA-based and traditional survey methods of the marine environment. One of the research areas of GEANS is monitoring of non-indigenous species (NIS) in harbours. NIS are a growing concern in coastal areas and have the potential to become invasive and displace native organisms and harm economic activities. Marine NIS are primarily spread via ballast water. Vessels are required by the International Maritime Organisation to treat their ballast water before entering a port. Exemptions to this requirement can, however, be granted if it can be shown that the voyage undertaken by the ship does not carry a significant risk of introducing new or dangerous alien species from one port to another. To evaluate the risk, a survey of the biota of all the harbours encountered during the voyage must be conducted. Biological surveys for NIS have traditionally relied on morphological identification of biota, but this approach is time- and labour-intensive and prone to errors or biases induced by a lack of taxonomic expertise. DNA-based survey methods, such as metabarcoding, have the potential to ameliorate these issues but are still not commonly implemented by stakeholders for the North Sea region.

In my thesis, I evaluated the performance of metabarcoding for detection of NIS in the harbour of Oostende (Belgium). I first compared the total numbers of native and non-native species detected from settlement plates via visual identification with the numbers reported from these plates via metabarcoding of the 18S rRNA gene. Next, I compared the performance of two different marker genes (COI and 18S rRNA) in detecting species composition from plankton samples via metabarcoding. Metabarcoding was able to detect many more species from the settlement plates than morphological examination alone, and it also enabled the rapid identification of planktonic species, which would otherwise be extremely difficult to identify morphologically. Non-native species were found from both planktonic and plate samples via metabarcoding. Some of these taxa were never recorded for the North Sea while others were well-known invasive species. However, the lack of consensus seen among the different species detection methods, coupled with many dubious identifications, indicate shortcomings of DNA-based methods. In this study, I demonstrated that metabarcoding may be feasible to detect NIS in North Sea harbours, but that current technical limitations of the method warrant caution and further explorative research.

Importance of the keels of boxfishes for passive stability during swimming

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Aquatic habitats are characterised by random disturbances in the flow field; therefore, during locomotion, aquatic animals will be subjected to a large number of external forces that may throw their body out of balance. Aquatic animals can actively correct these destabilising forces with fin or body movements. Furthermore, the general body proportions and/or the presence of specific structures on the body can also passively dampen disturbances. A distinction can be made between bodies that are hydrodynamically stable and hydrodynamically unstable. When a body is inherently stable it will be subject to passive course stabilisation: when it slightly deviates from its aligned position in the flow due to external factors, the body will automatically return to its equilibrium position in the flow, without active intervention. An inherently unstable body, on the other hand, would rotate even further away from its aligned position in the flow should there be no active intervention.

In boxfish, the body is completely covered by a shell of fused hexagonal bony plates, known as the carapace. This rare feature is shared by all members of the Ostraciidae family, even though the body geometry varies greatly between species. Boxfish have accurate control over manoeuvres which is essential for foraging in their spatially complex habitat such as coral reefs. In fish, propulsion is usually driven largely by undulation of the body. Since the rigidity of the carapace disallows bending of the body, boxfish depend solely on their five fins for locomotion; the body is also not streamlined. This situation is very similar to many rigid man-made aquatic vessels in which high movement efficiency is strongly pursued and thus boxfishes morphology has fuelled several studies of bio-inspired design in aquatic engineering sciences.

A general feature of the carapace of boxfish is the presence of longitudinal ridges, the keels. The keels on the carapace were hypothesised to be a critical factor for different hydrodynamic properties, namely, (H1) reduced drag for forwards swimming, (H2) generating stabilising yaw and pitch torques to help boxfish to maintain straight swimming trajectories, and (H3) providing resistance against rolling. Evidence for the drag reduction hypothesis (H1) was already found in other marine vertebrates, such as the leatherback sea turtle (Dermochelys coriacea) in which longitudinal ridges suppress separation of the boundary layer. Whether the keels of boxfish contribute to drag reduction, however, remained untested. The hypothesis that the keels contribute to stabilising rectilinear swimming by generating self-stabilising yaw and pitch torques (H2) was inferred from vortical flows and pressures measured experimentally near the keels of boxfish. However, recent studies demonstrated that the overall torque by the flow past the carapace under yaw and pitch angles of attack is not self-stabilising but rather destabilising. Considering that permanent course stabilisation would make manoeuvring energetically costly and boxfish spent a considerable part of their time manoeuvring, an unstable body may be energetically beneficial. However, whether the keels are involved with either increasing stability or increasing instability remained unstudied. Finally, the hypothesis that keels in Ostraciidae damp roll rotations (H3), corresponds to the function of keels in boats and other engineered aquatic vehicles. In these systems, keels are ubiquitous as a passive stability system to reduce the tendency to roll by increasing the hydrodynamic resistance against roll rotation.

The aim of this study was to gain more insight into the hydrodynamic function of the keels. For five boxfish species with different carapace shapes, we investigated the effect of the keels on: drag coefficients of the carapace (H1), induced moment coefficients of the carapace in a pitch or yaw angle of attack (H2), rotational drag moment coefficients and rotational added mass moment coefficients for imposed roll (H3). To do so, two sets of three-dimensional boxfish surface models were prepared: a first

set of control models (obtained by laser scanning museum specimen), and a second set of "modified models" (obtained by digitally reducing the size of the keels from the control models). Hydrodynamic properties were calculated using computational fluid dynamics (CFD).

In the first type of CFD simulations, a steady water flow was simulated over a stationary boxfish carapace model at different angles of attack. The drag force (H1) was determined for the models with their rostro-caudal axis parallel with the incoming water flow. To measure the (de)stabilising pitch and yaw moments in a static setup (H2), boxfish models were placed in a flow at a slight pitch or yaw angle, respectively. This was a representation of the boxfish no longer oriented in line with its direction of motion. In the second type of CFD simulations, the resistance against roll rotation (H3) was determined by calculating the roll moment as a function of time during a short period during which we imposed a roll rotation of constant acceleration on the body of the boxfish in stagnant water. This was a mathematical approach to simulate the effect of an external torque on the fish's body. In natural situations, this could be the result of variable water currents, or of the fish's fin forces during manoeuvring.

From the CFD output, we could calculate the drag coefficient (H1), the pitch and yaw moment coefficient (H2), and the rotational drag moment coefficient and rotational added mass moment coefficient (H3) for the control model and the modified model with reduced keels. To obtain a better understanding of the measured forces, moments and coefficients related to the presence of keels and the different body shapes, contour plots were created of the pressure experienced by the carapace surface, as well as 3D iso-surfaces of the vorticity.

This study confirmed that the boxfish body is inherently unstable for pitch and yaw rotation, although it seems unlikely that the keels play a prominent role in shaping these characteristics. No relationship could be discovered between the presence of keels and drag reduction or, passive stability, as these parameters were only very weakly affected by the presence of keels and differences being inconsistent. For all five species, the pressure patterns and 3D iso-vorticity surfaces were almost identical in the control models and the modified models. However, all species showed a strong increase in roll resistance by the presence of keels. Especially the damping of roll by drag torques increased considerably, with for some species the rotational drag moment coefficient for roll rotation being doubled, despite the reductions in keel height being relatively small. This demonstrates that the body in possession of keels will be brought out of balance less quickly. This was also reflected in the pressure plot, positive and negative high-pressure areas that counteract the roll rotation were larger in the control model than in the modified model. Our results strongly suggest that a significant part of the body's roll resistance can be attributed to the keels.

It can be stated that the objective of this study, to gain more insight into the function of the keels, was met. Some previous misunderstandings were clarified. The long-standing theory that keels cause drag reduction and enable passive stability for pitch and yaw, was proven incorrect. The roll-resistance-increase-hypothesis for keels in boxfish, which was tested for the first time, proved to be promising and was strongly supported by the obtained results. Further research is needed to capture how exactly this increased roll resistance is of use to the boxfish during certain swimming movements.

Effects of natural processes and human activity on North Sea sediment biogeochemistry

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In sediments of shelf seas, organic material of marine or terrestrial origin is recycled to free nutrients, available to processes in the water column (= mineralization). Thus, these sediments provide valuable ecosystem services in terms of nutrient cycling, eutrophication buffering and climate regulation. The intense human activities in these regions, bring sediments in an altered state, changing their nutrient recycling and storage capacity.

Sediment biogeochemistry is controlled by environmental conditions, such as the sediment type and hydrodynamics that determine deposition and retention of organic material. Likewise, benthic fauna play a pivotal role in the regulation of mineralization processes through various activities. The balance of these drivers, as well as the spatial variation they exhibit remain difficult to understand, and this hampers our capability to anticipate or predict the effects of anthropogenic activities on the workings of sediments.

This PhD thesis aimed to characterize sediment biogeochemistry in the North Sea, a heavily impacted shelf sea. Two studies, performed in a coastal area (the Belgian Part) and offshore (the Central and Northern North Sea) looked at the current biogeochemical functioning in relation to biology and environmental drivers. Models were developed based on these data and used to describe the effects of two anthropogenic activities on mineralization of organic matter (OM) in sediments: bottom trawling and offshore windfarm construction. Finally we tested in how far biological information can be used to derive biogeochemical characteristics, using a crucial faunal activity, bio-irrigation.

Fundamental work was discussed in Chapters 2 and 3. In Chapter 2, sediment characteristics and the benthic species community were determined in the Belgian Part of the North Sea (BPNS), along with the characterization of mineralization processes. Using variance partitioning, we found that anoxic mineralization processes were predominantly related to physical environmental parameters, whereas oxic mineralization processes were more strongly linked to the faunal component. Based on these data, we constructed linear models relating mineralization process rates to biotic and/or abiotic variables. Such models can increase our capacity to estimate how mineralization processes will change as a result of alterations to the biotic or abiotic environment.

An investigation of the greater North Sea was performed on a 670 km long transect spanning from Terschelling, 100 km from the coast, to the Fladen Grounds in the Northern North Sea (Chapter 3). Mineralization process rates were derived from on on-board core incubations and solute profiles through early diagenetic modelling. In contrast to the work performed in Chapter 2, mineralization processes correlated less to sediment characteristics, but were more related to water depth and bottom water concentrations of certain nutrients (NO3-). An offshore gradient of increased removal of nitrogen and decreased removal of phosphorus by the sediments was found.

The effects of specific anthropogenic impacts (bottom trawl fisheries, offshore windfarm development) were investigated in Chapters 4 and 5 using dynamic models of sediment diagenesis. In Chapter 4, bottom trawling impacts were implemented in the dynamic model as a combined erosion and mixing event. This affected the upper few centimeters of the sediment matrix, and also reduced faunal activity.

By evaluating the effects of continuous trawling events on mineralization pathways over a period of 15 years, our main results were that sediments became depleted in organic carbon and nutrients, regardless of the trawling frequency they were subjected to (1 – 5 trawls y-1). By simultaneously reducing the amount of bioturbating fauna, these effects were exacerbated. This has negative consequences for the buffering and eutrophication countering functions that sediments provide.

The effects of offshore windfarms (OWFs) on benthic processes (Chapter 5) were assessed by coupling our diagenetic model with an extended hydrodynamic model (in cooperation with Liege University). The redistribution of OM to sediments as a result of current and future OWF developments was calculated using a 3D hydrodynamic model of the Southern Bight of the North Sea. By coupling this output to a model of early diagenesis, changes to sedimentary carbon and nutrient cycling were assessed. This showed that sediments in OWFs can become sites of enhanced OM mineralization, where more carbon is stored in sediments as a result of an increased importance of anoxic mineralization processes. When integrated over the full area of the BPNS, alterations to C and N cycling were small, but of sufficient magnitude to be relevant in national greenhouse gas budgeting.

In Chapter 6 we describe a novel technique to quantify bioirrigation rates, the exchange of solutes between the sediment and the water column through organismal activities. Measurements from core incubations were combined with a mechanistic model of solute exchange. This improved on current measurements, by separating the bioirrigation process in an exchange rate, and a depth over which this exchange occurs. This technique was applied on field measurements collected in several sites in the Oosterscheldt estuary over the course of a year. We found similar pumping rates in subtidal and intertidal habitats, but shallower irrigation in the subtidal, linked to differences in species composition between both.

In the discussion (Chapter 7), we highlight that drivers of sediment biogeochemistry may vary strongly. Sometimes this relates to causes that are not currently observable, e.g. the historic context (e.g. biogeography, chronic bottom trawling) and connectivity of different habitats. We also point to ways in which more biology can be included in models of sediment biogeochemistry. Our novel measurement technique for bioirrigation is a first step, that may allow us to link species traits with faunal activity and biogeochemical consequences. Lastly, there remain understudied regions in the North Sea in which economic developments are being planned. In light of likely impacts, these are locations where the functioning of sediments needs to be described in order to anticipate future changes to the North Sea ecosystem.

PRE-DOC PRESENTATIONS

Polder2c's living lab: Toolbox for a better future of levee management

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Climate change is affecting countries in the 2 Seas region (Netherlands, Belgium, France, and the UK area) faster and more extreme than previously expected. The countries in this region face a major threat from increasing sea levels. Particularly because it is unknown how robust the flood defences are or how well the emergency response is organized in a real-life situation. There is also a scarcity of well-trained water managers, as well as a lack of knowledge transfer and societal awareness. The Hedwigepolder in the Netherlands, along with an adjacent part of the Flemish Prosperpolder, is the largest tidal area in Western Europe, covering 465 hectares. In function of the Sigma plan, the existing dike is in a phase of depoldering. The current "Scheldedijk" will be removed and replaced with a new levee further inland. Polder2C's approach to the development of flood resistance measures is unique. The depoldering of the Hedwige-Prosperpolder has created a six km² living lab environment where new and innovative techniques, processes, procedures, and products can be tested for practical validation. Implementing and successfully executing appropriate flood emergency procedures are critical to a successful flood emergency response. For this to succeed you need the right kind of tools and expertise. It is also critical that everyone participating follows the same set of guidelines. To answer this, the Polder2C's project knowledge and insights will be integrated with existing knowledge to provide a set of useful tools. These tools could then be used for flood defence and emergency response at levees and sites different from HPP and for different climate scenarios. Based on the findings obtained in this project, current practices and guidelines will also be evaluated and a proposal for an update to "The International Levee Handbook" and "International Handbook for Emergency Response to Flood Risk" will be addressed if shortcomings are observed. This toolbox will be made up out of a combination of information (e.g., wiki, data centre) and practicalities (e.g., calculation methods, inspection strategies, blueprints, checklists, …). As a result, it will be an invaluable tool for training flood-fighting and emergency-response personnel. It will present best practices and lessons learned from levees and dikes in various circumstances and climates throughout the world. This toolbox will give these "generally agreed tools," including flood defenses and emergency response management, as well as specialized issues such as failure mechanisms and intervention tactics. A team will be formed to oversee the development of this toolbox, including input from several stakeholders. The end result will be a knowledge website coupled with a data wizard to present everything in a user-friendly manner that is also informative for research institutions and students.

Keywords: Flood risk; Toolbox; Emergency response; Flood defences; Levees

Effects of offshore wind farms on the distribution, diet and condition of plaice *Pleuronectes platessa* in the Belgian part of the North Sea

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Offshore wind farms (OWFs) are built at high speed in European waters to meet the EU 2050 renewable energy production targets. The introduction of hard structures and scour protection layers in sandy environments, such as the Belgian part of the North Sea (BPNS), offers various opportunities for reef-associated fish and invertebrate species. Pouting *Trisopterus luscus* and cod *Gadus morhua,* for example, are locally attracted towards hard substrates of OWFs due to increased food availability, even leading to increased local production. For soft-sediment species such as like flatfish, our knowledge about their behaviour in relation to wind farms is still scarce.

We, therefore, investigated how the presence of OWFs affects the distribution of plaice *Pleuronectes platessa*, a commercially important flatfish species. We looked both at the medium (OWF) and small (turbine) spatial scale. At the wind farm scale, plaice were sampled on the sandy bottom in between the turbines (~ 200 m distance) and in reference zones by means of beam trawl catches following a BACI sampling design. Significantly increased abundances were detected for one of the wind farms, but this was less clear for the other. These results suggest that wind farms can act as refuge areas for plaice, at least under specific conditions. Plaice distribution at the turbine scale was studied by visual diving transects crossing the scour protection layer (SPL) and the surrounding sand around eleven monopile turbines. Four times higher plaice abundances were found on the sandy patches between the rocks of the SPL compared to the surrounding sand. The configuration of the SPL, i.e. an open rock field with sandy patches, facilitating the natural burrowing behaviour of plaice, in combination with increased food and shelter opportunities, are suggested to steer the attraction effect towards the hard substrates. In a next step, we investigated whether the attraction effect resulted in a different diet and/or a better condition of plaice near the turbines. Hence, plaice were sampled at four different locations around one OWF: (1) on the SPL around the turbines, (2) on the sand in between the turbines, (3) in control areas near and (4) further away from the OWF. Stomach and gut content analyses showed a significantly different diet for plaice feeding on the SPL, compared to the other groups. Stomach contents of individuals in the SPL-group were dominated by typical hard-substrate species, clearly showing that those fish fed on the SPL. Furthermore, the higher food availability on the SPL resulted in a significantly higher value of the Fulton's K condition index with heavier fish for a certain length. Additionally, a fatty acid (FA) analysis revealed a different FA profile for the SPL group compared to the control groups outside the OWF. This indicates that plaice present near the turbines not only feed sporadically on fouling organisms, but have an adjusted diet for longer time periods (several weeks), suggesting that plaice might reside on the SPL.

As such, we conclude that plaice is indeed affected by the presence of OWFs, both at small and medium spatial scales, related to the presence of an open rock field with sandy patches in between as scour protection layer, and resulting in a changed feeding behaviour coupled to the presence of hard-substrate fouling fauna.

Keywords: Offshore wind farms (OWFs); Attraction; Condition; Diet; Pleuronectes platessa; North Sea

Rapid and low-cost authentication of common sole (*Solea solea*): everyone, everywhere, every time!

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Fish consumption is responsible for 17 % of the global animal protein intake by humans, putting the fishing and aquaculture industry as a pivotal food provider. However, due to an ever-growing global population and increasing pressure on the industry, seafood is prone to fraudulent activities, such as the substitution of species. When a fish is stripped of its morphological traits, it becomes impossible to identify it by eye. Additionally, the complex supply chains make it easier for fraud to go unnoticed. To identify processed seafood, genetic approaches using DNA extraction and the Polymerase Chain Reaction (PCR) can be used. DNA barcoding is the most commonly used genetic method, but like most current molecular methodologies it is expensive, time-consuming, and requires both expensive lab equipment and expert knowledge. However, in the seafood industry, most products are consumed as fresh as possible, so limiting the time needed for authentication is key if the intent is to authenticate the food before consumption. In this study, we developed a fast, cheap, and easy to apply method for the identification of common sole (*Solea solea*), an expensive flatfish species that is known to be commonly substituted along the Belgian supply chain. First, three crude DNA extraction methods were compared with a commercial extraction method. Second, the PCR was replaced with Loop-mediated Isothermal Amplification (LAMP), which is both faster and technically less demanding because only a heating element is required and colorimetric detection of amplification is used. Third, the specificity of the LAMP assay was evaluated. A comparison was made between the commercial DNA extraction kit (Nucleospin® Food kit) with a dipstick-based, paramagnetic bead-based, and an alkaline-based DNA extraction method. The alkaline-based DNA extraction method turned out to be the most reliable and cheapest (1 Eurocent), capable of extracting DNA in less than 20 min, without requiring a centrifuge, as opposed to the Nucleospin® Food kit, which takes 1 h and costs over 5 Euro per sample. A *S. solea* specific LAMP assay for the mitochondrial *cytochrome b* gene was developed and validated within a working range between 1 and 0.1 ng of DNA. The alkaline-based DNA extraction method was combined with the LAMP assay and tested on ten common sole fillets under different preservation conditions (fresh, frozen, and ethanol stored) and ten previously identified sole meal products. The combination of the alkaline-based DNA extraction and LAMP correctly identified all sole samples as sole and no false positives were detected. The results demonstrate how the LAMP assay can be combined with alkaline DNA-based extraction for the rapid identification of common sole products. The entire authentication takes less than 1 h, costs less than 0.5 Euro, and can be performed on-site since it only requires a few consumables, a few hand tools, and a simple heating element that can reach 85 and 65 °C. We anticipate that our assay is a sound initial scan for sample prioritisation in large-scale audits and identifications or other cases where advanced equipment is not available. Additionally, our method represents a proof-of-concept for the development of similar methodologies for the identification of other important seafood species.

Keywords: CYTB; Authentication; DNA isolation; Isothermal amplification; Sseafood fraud; Substitution

How costly is active CO2 drawdown in marine systems? A socio-economic analysis of Coastal Enhanced Silicate Weathering

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The Paris climate agreement aims to reduce global warming by 1.5°C by the end of the century. This goal is only achieved through a collective and ambitious effort that requires not only "traditional mitigation" (avoidance of fossil CO_2 emissions) but also active CO_2 drawdown from the atmosphere (negative emissions). The latter is realized using "negative emissions technologies" (NETs), most of which are in an early stage of development. A number of technologies focus on CO_2 drawdown in the marine realm, which covers 71% of the earth's surface. One promising approach for achieving marine negative emissions is through coastal enhanced silicate weathering (C-ESW).

The geological rock record shows that the natural process of silicate weathering is able to take up large amounts of CO_2 from the atmosphere, thus stabilizing the climate. However, natural rock weathering is very slow, so the idea behind enhanced weathering is to stimulate this process by: [1] selectively mining fast weathering rocks such as olivine, [2] finely grinding these rocks so that more surface area is exposed to weathering, and [3] spreading these rocks in favorable locations with high dissolution rates. The coastal zone is potentially such a favorable environment, where wave and current action will naturally grind silicate particles, and biological activity stimulates silicate dissolution. A major advantage of coastal-ESW is that deployment can be done with current infrastructure, making it rapidly deployable and readily scalable.

Yet, to fully assess the potential of coastal-ESW as a NET technique, the following aspects need to be assessed: (1) the CO_2 sequestration efficiency, (2) the ecosystem impact, and (3) the economic feasibility. The first two aspects are currently investigated in a large-scale mesocosm facility operated by UAntwerpen and VLIZ at the Marine Station Oostende. The goal of the current study was to investigate the economic feasibility of C-ESW. For this purpose, we first created a weathering model that predicts the speed at which silicate particles weather and sequester CO_2 in coastal waters. This weathering model was subsequently integrated into an economic cost model that compares the investment costs from C-ESW with the future profits made from CO_2 credits (i.e. the price the market pays for a ton of CO_2 sequestration). The investment cost is determined by the mining, grinding, transport, and spreading costs as well as the external CO_2 emissions associated with these activities. The future profits depend on the temporal evolution of CO_2 sequestration and the future CO_2 price. The latter is a crucial but uncertain parameter, as it highly depends on our ambition to tackle climate change as a society. To encompass this uncertainty we modeled 3 separate socio-economic pathways: [1] a high generational inequality pathway, where we bet on future generations to solve the climate crisis, [2] a low generational inequality pathway, where society places greater weight on the well-being of future generations and hence acts more responsibly, and finally [3] the whatever-it-takes pathway, where society does everything needed to limit global warming to 1.5 °C by the end of the century.

Overall our analysis shows that coastal ESW can act as a cost-effective pathway for marine carbon dioxide removal, where the overall financial return on investment is positive. In my presentation, I will discuss the economic feasibility of C-ESW in more detail, highlighting the economic trade-offs present. These results can serve as a guideline for its implementation in future trial experiments. Furthermore, our analysis sheds light on the role C-ESW can play as a future technology for active CO_2 removal from the atmosphere.

An experimental assessment of the effect of sand extraction on benthic nutrient cycling and carbon storage

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The worldwide demand for sand exceeds that of all other minerals and metals. Sand is heavily needed for concrete production and for coastal protection to combat sea level rise. Nevertheless, mining of marine sands and aggregates comes at a price, as these activities leave a large footprint on the marine environment. By trailing a dredging drag head, the seafloor is heavily disturbed and large sediment plumes are created. The impact of these activities on benthic community structures and their physical habitat (seabed morphology and sediment characteristics) in the Belgian Part of the North Sea (BPNS) has already been closely investigated. However, sand extraction may not only change community structure, but also the functional traits expressed by the community, thereby affecting ecosystem functioning and its services, such as nutrient cycling or carbon storage.

The aim of this study was to investigate the effect of marine sand extraction on sediment biogeochemical processes such as organic matter mineralization and nutrient cycling. Sand extraction areas generally harbor coarse grained, permeable sediments which are known for their fast mineralization of organic matter, fast regeneration of nutrients to the overlying water column and hence low organic carbon stocks. Therefore, it is expected that disturbance of biological and sedimentological properties of the seabed will change these important ecosystem functions. We sampled three tidal sand banks on the BPNS, characterized by different sand extraction regimes: Thornton Bank (continuous and high intensity extraction regime), Oostdyck (continuous and low intensity extraction regime) and Noordhinder (periodic and high intensity extraction regime). Prior to sampling, seabed morphology and sand extraction impact were visualized by multibeam imagery. As such, a number of replicate sampling locations could be assigned with high accuracy in similar geomorphological settings in both impacted and reference zones. At each location, undisturbed sediments were collected using a boxcore, followed by sediment core incubations to measure sediment community oxygen consumption (SCOC), nutrient fluxes across the sediment-water interface, and faunal activity. Subsamples for granulometry, permeability and organic matter were taken as well.

The continuous high extraction regime had a clear effect on the seabed morphology with obvious one to two meter deep drag head tracks cutting through the sandwaves. First results showed a lower permeability and higher sediment oxygen consumption in the impacted area compared to the reference area, although not significant due to high spatial variability. In the areas with continuous low or periodic high extraction, dredging tracks were less apparent. Here, the sediments remained permeable too, which could partly explain the limited impact of sand extraction on the measured SCOC. Together with additional results from anticipated nutrient and organic carbon analyses, we will draw more holistic conclusions on how different sand extraction regimes affect ecosystem functions and how this translates to important ecosystem services such as primary productivity, nutrient cycling and carbon storage.

Keywords: Sand extraction; Ecosystem functioning; Seabed; Biogeochemistry; Carbon; Nitrogen

Detection and identification of microplastics in biota using Nile red and machine learning: validation of an innovative, cost-effective approach

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Plastic pollution has become one of the most ubiquitous threats the oceans are facing nowadays. Microplastics (MPs) are of special concern as it has been shown these are ingested by a wide range of marine species from different trophic levels [1]. However, the environmental implications of MPs ingestion, coupled to the toxicological relevance of different MP polymers and their chemical composition, remain poorly understood. This highlights the need for standardised, cost- and time-effective monitoring procedures to accurately and routinely determine the abundance, composition and distribution of MPs in the marine environment, to allow for effective management strategies.

An innovative approach for MP analysis in marine biota was developed, thereby combining the advantages of both high-throughput screening and automation. We evaluated the method in mussel samples. The presented method combines RGB-color quantification of emitted fluorescence of Nile red (NR)-tagged MPs with a simplified supervised machine learning (ML) classification model, which has been developed in an open source environment [2]. Our approach further enhanced the Nile red technique for the fast detection of MPs and included the identification of the polymer types.

For this MP analysis in biota, a two-step digestion was applied within the sample preparation to remove all lipid-rich animal tissue and plant and algae materials present. An alkaline digestion with potassium hydroxide (KOH, 10%) and an oxidative digestion with hydrogen peroxide (H_2O_2, 15%) was implemented, each for 48h at 50°C on a magnetic stirring plate. In between both digestion steps, the sample was filtered over a stainless steel filter and sonicated to loosen all particles adhering to the filter surface. The sample was then filtered over a PTFE-filter, stained with the fluorescent dye NR (1µg/ml acetone), and left to dry for 24h.

The automated detection of MPs and the polymer type identification was based on two machine learning decision models, the Plastics Detection Model (PDM) and the Polymer Identification Model (PIM), which both use recursive binary splits through simple decision rules inferred from emission spectra features [2]. Both models were trained and validated using stained reference MPs. The first model predicted with high accuracy whether a particle is plastic or of natural origin. The second model allowed to identify the polymer type of MPs. Both models use RGB colour data, extracted from the stained particles photographed through a fluorescence microscope under blue, green and UV filters.

The accuracy and precision of the analytical method was calculated using recovery tests. Six MP types were spiked into the mussels samples, varying in the combination of polymer type (polyacrylonitrile - PAN, polyethylene terephthalate - PET, polypropylene - PP, polystyrene - PS and polyvinyl chloride - PVC), size (250 – 1000 µm), and shape (particle/fibre). Next to accuracy and precision, the validation included the determination of the limit of quantification and detection (LOQ and LOD), selectivity, specificity, and robustness. Selectivity and specificity were assessed based on the performance of both ML models to detect plastic particles and to identify the polymer types, respectively. To assess the robustness of the overall procedure, sample type was varied across the experiments.

Preliminary results showed high recovery rates and good model performance. The combination of the emitted fluorescence of particles photographed under all three filters is unique for each particle type (plastic/ non-plastic as well as plastic polymer type) assessed in our analyis, not just in terms of fluorescence intensity but also in terms of colouration. In this way, the new approach solved the issue of co-staining of natural materials by Nile Red and allowed for the accurate, precise and selective determination and identification of MPs in mussel matrices.

References
[1] Bergmann, M., Gutow, L., & Klages, M. (2015). Marine anthropogenic litter. Heidelberg, Germany: Springer Nature. 447 p.
[2] Meyers, N., Catarino, A. I., Declerq, A. M., Brenan, A., Devriese, L., Vandegehuchte, M., De Witte, B., Janssen, C., Everaert, G. 2021: Microplastic detection and identification by Nile red staining: towards a semi-automated, cost- and time-effective technique. Manuscript submitted.

Keywords: Microplastics detection; Polymer identification; Machine learning; Nile red; RGB colouration

The life of sea sparkle: dynamics, drivers and interactions of *Noctiluca scintillans* in the Belgian part of the North Sea

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Climate driven changes and anthropogenic pressures on the marine environment have been shown to favor the increase in certain potentially harmful species. Among them, *Noctiluca scintillans*, a common dinoflagellate also known as sea sparkle, often blooms during warm summers and is known to affect plankton communities. *Noctiluca scintillans* is worldwide one of the most important and abundant red tide organisms and its blooms have been linked to increased fish and marine invertebrate mortality (Huang and Qi, 1997; Thangaraja *et al.*, 2007), affecting yields in fisheries and aquaculture. Its large size (0.2–2 mm) and voracious feeding behavior enable it to feed on a broad spectrum of organisms including fish eggs, phytoplankton, zooplankton, detritus and bacteria (Quevedo *et al.*, 1999). Other species feeding on the same food sources as *N. scintillans* can also be affected due to food competition (Quevedo *et al.*, 1999) which might explain the significant negative correlations observed between various soft-bodied zooplankton species and *N. scintillans* in the North Sea (Heyen *et al.*, 1998; Fock and Greve, 2002).

During bloom formation, *N. scintillans* can reach high densities and can often constitute a significant part of the plankton community. Because manually counting *N. scintillans* cells is too time consuming, the species is often excluded from microscopy counts. Hence, little is known about its dynamics in the Belgian Part of the North Sea (BPNS). Novel imaging techniques such as the ZooScan, however, allow for an accurate assessment of the densities and associated size measurements of such taxa. Due to the potential adverse effects of *N. scintillans* on the marine environment and its potential to increase in abundance as a result of climate change and ocean acidification (Moore *et al.*, 2008), substantial research is needed to gain knowledge on the blooms, drivers and effects of *N. scintillans* in the BPNS. Based on ZooScan observations from LifeWatch time series (Mortelmans *et al.*, 2019), this study explores the potential of ZooScan imaging for cell density and size estimates of species of interest such as *N. scintillans* and aims to unravel the population dynamics of *N. scintillans* in the BPNS, to determine the drivers of its dynamics, as well as to investigate the impact of the species on small soft-bodied zooplankton taxa (Ollevier *et al.*, 2021).

Through the analysis of ZooScan images from WP2 net samples taken monthly at stations throughout the coastal zone of the BPNS, this study is the first to present consistently counted *N. scintillans* cell numbers and measured cell lengths. We demonstrate that imaging methods such as the ZooScan are a powerful tool to monitor and study the *N. scintillans* population. The results show that *N. scintillans* had clear seasonal dynamics with both high densities and large cell sizes in spring/summer (May-July). The occurrence of *N. scintillans* in the analyzed plankton samples and the abundance of *N. scintillans* at the observed peak intensities nearly tripled over a period of 5 years. A zero-inflated model showed a correlation of *N. scintillans* abundance with temperature as well as with phosphate concentrations, suggesting that anthropogenic influences such as climate change and riverine nutrient inputs could affect the temporal dynamics of the species. The presence and density of *N. scintillans* are likely to increase in the future, notably due to global warming with warmer water temperatures (IPCC, 2021) forming the ideal growth condition for the species. The results, on the other hand, did not show any negative impact of *N. scintillans* on the soft-bodied plankton community.

References

- Fock, H. O., and Greve, W. (2002). Analysis and interpretation of recurrent spatio-temporal patterns in zooplankton dynamics: a case study on *N. scintillans* in the German Bight. *Mar. Biol.* 140, 59–73.
- Heyen, H., Fock, H., and Greve, W. (1998). Detecting relationships between the interannual variability in ecological time series and climate using a multivariate statistical approach – a case study on Helgoland Roads zooplankton. *Clim. Res.* 10, 179–191.
- Huang, C., and Qi, Y. (1997). The abundance cycle and influence factors on red tide phenomena of *Noctiluca scintillans* (Dinophyceae) in Dapeng Bay, the South China Sea. *J. Plankton Res.* 19, 303–318.
- IPCC (2021). "Summary for Policymakers," in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, eds V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, *et al.* (Cambridge: Cambridge University Press).
- Moore, S. K., Trainer, V. L., Mantua, N. J., Parker, M. S., Laws, E. A., Backer, L. C., *et al.* (2008). Impacts of climate variability and future climate change on harmful algal blooms and human health. *Environ. Health* 7(Suppl. 2):S4.
- Mortelmans, J.; Goossens, J.; Amadei Martínez, L.; Deneudt, K.; Cattrijsse, A.; Hernandez, F. (2019). LifeWatch observatory data: zooplankton observations in the Belgian part of the North Sea. *Geoscience Data Journal 6(2)*: 76-84.
- Ollevier, A.; Mortelmans, J.; Aubert, A.; Deneudt, K.; Vandegehuchte, M. (2021). *Noctiluca scintillans*: Dynamics, size measurements and relationships with small soft-bodied plankton in the Belgian Part of the North Sea. *Front. Mar. Sci. 8*: 777999.
- Thangaraja, M., Al-Aisry, A., and Al-Kharusi, L. (2007). Harmful algal blooms and their impacts in the middle and outer ROPME sea area. *Int. J. Oceans Oceanogr.* 2, 85–98.
- Quevedo, M., Gonzalez-Quiros, R., and Anadon, R. (1999). Evidence of heavy predation by *Noctiluca scintillans* on *Acartia clausi* (Copepoda) eggs off the central Cantabrian coast (NW Spain). *Oceanol. Acta* 22, 127–131.

Keywords: Plankton blooms; ZooScan; Gelatinous zooplankton

Pronounced seasonal and spatial variability in determinants of phytoplankton biomass dynamics along a near-offshore gradient in the southern North Sea

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Marine phytoplankton biomass dynamics are affected by eutrophication, ocean warming, and ocean acidification. These changing abiotic conditions may impact phytoplankton biomass and its spatiotemporal dynamics. In this study, we used a nutrient–phytoplankton–zooplankton model to quantify the relative importance of bottom-up and top-down determinants on phytoplankton biomass dynamics in the Belgian Part of the North Sea. Using four years (2014 – 2017) of monthly observations at nine locations of nutrients, solar irradiance, sea surface temperature, chlorophyll-a and zooplankton biomass, we disentangled the monthly, seasonal and yearly variation in phytoplankton biomass dynamics. To quantify how the relative importance of determinants changed along a near–offshore gradient, the analysis was performed for three spatial regions, i.e. nearshore region (< 10 km to the coastline), midshore region (10 – 30 km), and offshore region (> 30 km). We found that from year 2014 to 2017, phytoplankton biomass dynamics ranged from 1.4 to 23.1 mg Chla m^{-3}. Phytoplankton biomass dynamics follow a general seasonal cycle as in other temperate regional seas, with a distinct spring bloom (5.3 – 23.1 mg Chla m^{-3}) and a modest autumn bloom (2.9 – 5.4 mg Chla m^{-3}). This seasonal pattern was most expressed in the nearshore region. The relative contribution of factors determining phytoplankton biomass dynamics varied spatially and temporally. Throughout a calendar year, solar irradiance and zooplankton grazing were the most influential determinants in all regions, i.e. explained 38% – 65% of the variation in the offshore region, 45% – 71% in the midshore region, and 56% – 77% in the nearshore region. In the near- and midshore regions, nutrients are most limiting the phytoplankton production in the month following the spring bloom (44% – 55%). Nutrients are a determinant throughout the year in the offshore region (27% – 62%). During winter, sea surface temperature is a determinant in all regions (15% – 17%). The findings of this study contribute to a better mechanistic understanding of the spatiotemporal dynamics of phytoplankton biomass in the southern North Sea. The parameterized causal relationships allow estimating how the base of the southern North Sea food web will change under future climate change and/or blue economy activities that affect one or more determinants of the phytoplankton biomass dynamics.

Keywords: Primary production; Ecosystem model; Phytoplankton biomass dynamics; Environmental conditions

Marine plastic biodegradation: what is *Alcanivorax*'s role?

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The ocean plastic pollution is a worldwide detrimental problem, affecting organisms living in the marine environment, as well as (indirectly) terrestrial life. Plastics are generally build with polymers derived from crude oil, which is the sole carbon source of hydrocarbonoclastic bacteria such as the *Alcanivorax* genus. This genus occurs in very small numbers in clean natural seawater and becomes dominant in seawater polluted with aliphatic hydrocarbons. When investigating the plastisphere of different types of plastics in the marine environment, *Alcanivorax* are often identified. Despite their presence, the exact role of the *Alcanivorax* genus in marine plastic degradation is not well understood. It is not completely clear whether *Alcanivorax* are degrading the plastic material itself, or just growing on breakdown products of the plastic released by other microorganisms within the plastisphere.

To identify the role of *Alcanivorax*, we first needed to confirm their presence in the plastisphere. Therefore, we isolated oil degraders from plastic degrading seawater enrichments using the dilution to extinction technique. After 16S rRNA sanger sequencing, we identified two *Alcanivorax* isolates, most probably *Alcanivorax* DG881 and *Alcanivorax borkumensis*. This outcome was confirmed by mapping back the 16S rRNA gene sequence of the isolates to 16S rRNA gene sequencing data of the original enrichments; the *Alcanivorax* isolates were already present in the initial enrichments. Subsequently, we tested the activity of the isolated *Alcanivorax borkumensis* strain on nylon compared to a mixture of cyclododecane and dodecane. Growth was followed through time on the different carbon sources with flow cytometry. The degradation rate of both carbon sources was measured, using total organic carbon (TOC) analysis and gas chromatography equipped with a flame ionisation detector (GC-FID), for the fractions of nylon and the mix of cyclododecane and dodecane respectively. Moreover, the activity of the isolated *Alcanivorax borkumensis* strain was investigated with bioorthogonal non-canonical amino acid tagging (BONCAT) followed by fluorescence *in situ* hybridization (FISH).

To identify the importance of the *Alcanivorax* genus during plastic degradation further, additional experiments will be performed. The metabolic activity after exposure to fresh polymers of communities with *Alcanivorax* will be determined, after which the active fraction will be sorted and identified.

Keywords: Plastic pollution; Alcanivorax; Biodegradation; Isolation; Bacterial activity

Spatio-temporal dynamics in the gene expression of the copepod *Temora longicornis* in response to environmental stressors

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Due to their rapid responses to environmental variation, planktonic organisms are used as bio-indicators of ecosystem changes. With the need for better understanding the impact of a changing environment on zooplankton communities, zooplankton monitoring programs have been carried out in the marine environment globally since the early 20th century. Most zooplankton monitoring studies focus mainly on variability in biodiversity and biomass. However, this approach is hindered by challenges in the identification, which is time-consuming, complicated and requires biological expertise. Advances in practical, cost-effective molecular approaches, such as (meta)barcoding, helped overcome the issues with morphology-based biomonitoring. Yet, a more comprehensive molecular data set would be able to identify and assess the impact of the main drivers of changes in the marine ecosystem, rather than only determining species richness. Since responses to environmental stress are initially genome-driven, a genetic understanding on the physiological responses to stress can help predict potential responses to a changing environment in the future. In this project, we focus on the potential effects of various environmental stressors (changes in temperature, salinity and concentration of PCBs and PAHs as a proxy for chemical pollution) on the gene expression of the calanoid copepod species, *Temora longicornis*, the dominant zooplankton species of the southern part of the North Sea. Therefore, this study investigated transcriptome-level profiles of adult *T. longicornis* that were collected at four stations in the Belgian part of the North Sea (BPNS) at different time points in a four year sampling campaign. Zooplankton samples were collected with the research vessel (RV) Simon Stevin on 35 (bi)monthly sampling campaigns in 2018 till 2021. From the obtained data, we aimed to identify the most active metabolic pathways and we tried to place these results into a broader context of physiological activities. Next, we constructed gene-co-expression networks, identified hub genes and we tried to obtain a mathematical relationship between these networks/hub genes and (1) the measured environmental variables and (2) phenotypic characteristics of interest (i.e. densities and biomass), defined by a generalized additive model. As such, we aim to identify molecular endpoints that can be consistently anchored to phenotypic changes under multi-stress conditions and at the same account for potential biological variability.

Keywords: Zooplankton; Copepods; Monitoring; Environmental stressors; Transcriptomics; NGS

POSTER PRESENTATIONS

Phylogeography and cryptic diversity of *Charcotia* amphipods in the Southern Ocean

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Polar ecosystems are among the fastest changing regions on earth, causing a shift in species distributions, changes in food web dynamics and decreasing productivity (Harley *et al.*, 2006). A long history of oceanographic isolation has led to **high levels of endemism in the Southern Ocean** (SO) resulting in a hotspot of biodiversity for many crustaceans (Malacostraca) (Crame, 2018). Furthermore, it is expected that **species inventories in the SO are underestimated** due to high levels of eurybathy as adaptation to the oscillating ice caps in the past (Arntz *et al.*, 1994; Brey *et al.*, 1996). Molecular studies revealed that numerous species are in fact (cryptic) species complexes of morphologically similar individuals. **Cryptic speciation** has been documented across **all ecological groups of amphipods** (Havermans, 2016; Katouzian *et al.*, 2016). Amphipods are ideal model organisms to link evolutionary processes, with local ecological dynamics since their **limited dispersal capabilities** represent natural replicates (Fišer *et al.*, 2018). In this study we investigate the species composition of two *Charcotia* amphipods from the SO. The genus is part of the superfamily Lysianassoidea which is one of the most dominant gammarid amphipod groups in the SO (De Broyer *et al.*, 2004). The genus, formerly known as *Waldeckia* (Chevreux, 1906), contains 16 morphospecies of which two live in Antarctic waters, i.e. ***Charcotia obesa* and *C. amundseni*** (D'Udekem D'Acoz *et al.*, 2018). Both species are **strictly benthic scavengers**, but differ in depth range, 0-200 m for *C. obesa* and 150-1000 m for *C. amundseni*. They play an important role in the Antarctic trophic food web as scavengers and prey of higher trophic levels (Linkowski *et al.*, 1983; Offredo & Ridoux, 1986). We used mitochondrial COI DNA sequencing data to investigate species boundaries, based on phylogeny and haplotype networks in combination with DNA-based methods. **Preliminary results indicate higher levels of biodiversity than previously thought.** Further population genetic research based on single nucleotide polymorphisms (SNP) should help in defining conclusive species boundaries in combination with taxonomic studies. This knowledge on speciation supports sound biodiversity management and conservation of the precious biota of the SO.

References
- Arntz, W.E., Brey, T. and Gallardo, V.A. (1994). Antarctic zoobenthos. *Oceanography and Marine Biology: An Annual Review*, 32, p. 241-304
- Brey, T., Dahm, C., Gorny, M., Klages, M., Stiller, M. and Arntz, W.E. (1996). Do Antarctic invertebrates show an extended level of eurybathy? *Antarctic Science*, 8(1), p. 3-6
- Crame, J. A. (2018). Key stages in the evolution of the Antarctic marine fauna. *Journal of Biogeography*, 45(5), p. 986-994
- D'Udekem D'Acoz, C., Schon, I., & Robert, H. (2018). The genus *Charcotia* Chevreux, 1906 in the Southern Ocean, with the description of a new species (Crustacea, Amphipoda, Lysianassoidea). *Belgian Journal Of Zoology*, 148(1), p. 31–82
- De Broyer, C., Nyssen, F., & Dauby, P. (2004). The crustacean scavenger guild in Antarctic shelf, bathyal and abyssal communities. *Deep Sea Research Part II: Topical Studies in Oceanography*, 51(14–16), p. 1733–1752
- Fišer, C., Robinson, C. and Malard, F. (2018). Cryptic species as a window into the paradigm shift of the species concept. *Molecular Ecology*, 27(3), p. 613-635
- Harley, C. D. G., Hughes, A.R., Hultgren, et al. (2006). The impacts of climate change in coastal marine systems. *Ecology Letters*, 9(2), p. 228-241

- Havermans, C. (2016). Have we so far only seen the tip of the iceberg? Exploring species diversity and distribution of the giant amphipod Eurythenes. *Biodiversity*, 17(1-2), p. 1–14
- Katouzian, A.-R., Sari, A., Macher, J. N., Weiss, M., Saboori, A., Leese, F., & Weigand, A. M. (2016). Drastic underestimation of amphipod biodiversity in the endangered Irano-Anatolian and Caucasus biodiversity hotspots. *Scientific Reports*, 6, 22507.
- Linkowski, T. B., Presler, P. and Zukowski, C. (1983). Food habits of nototheniid fishes (*Nototheniidae*) in Admiralty Bay (King George Island, South Shetland. *Polish Polar Research*, 4, p. 79-95
- Offredo, C. and Ridoux, V. (1986) The diet of emperor pegnuins *Aptenodytes forsteri* in Adelie Land, Antarctica. Ibis, 128(3), P. 409-413

Creating a numerical twin for the brand new physical Coastal & Ocean Basin in Ostend, a waste of effort?

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The development of ocean energy convertors, such as wave energy converters, tidal energy convertors and offshore wind turbines has gained significant attention in the last decade to produce renewable and low-carbon energy. Designing such complex structures requires good knowledge of wave-current and wave-current-structure interactions (WCSIs). These interactions determine the loading conditions in operational seas. In 2014, Ghent University and KU Leuven successfully obtained funding from the Hercules Foundation to equip a wave-current basin. Together with Flanders Hydraulics, they convinced the Flemish Government to build the Coastal and Ocean Basin (COB) in the new Maritime Research Center in Ostend. Once fully operational, the COB is designed to generate waves and currents at arbitrary angles to each other. There exist very few basins where arbitrary angles between waves and currents are possible, so this is considered as a unique selling feature of the COB.

My research has the aim of creating a numerical equivalent of the physical COB. Since the goal of the COB is to investigate WCSIs, it is clear that my Numerical Wave Tank (NWT) needs to be able to simulate those WCSIs as well. Detailed modelling of the flow and flow-structure interaction is often needed in the immediate region near the structure to take into account the complexity of the flow. Computational Fluid Dynamics (CFD) models that solve the full Navier-Stokes equations coupled to structural dynamics models, can be used for this purpose. Unfortunately, these models involve high computational costs. Using such a CFD approach to make a numerical equivalent for the physical COB, would be prohibitive in terms of computational requirements. To overcome this issue, I am adapting the Higher Order Spectral – Numerical Wave Tank (HOS-NWT) [Ducrozet et al., 2012] to the specific needs of the COB. HOS-NWT is a free-surface potential flow (FSPF) model. Those models solve the Laplace equations based on the potential flow theory. HOS-NWT uses a modal expansion in the vertical direction to collapse the numerical solution to the two-dimensional horizontal plane, making it a very efficient model. However, the existing model only contains a wavemaker at one of the sides of the tank and cannot deal with currents. To mimic the situation in the COB, I adapted the model such that wave generation becomes possible at two sides of the basin and a uniform current can be accounted for. As a further optimalization, I would like to include the effect of steepness breaking on the wave evolution. Experiments in the COB will be set up to validate the adapted model. The combination of an efficient NWT (far-field) model and a nested CFD (near-field) model, will become a powerful tool.

If the final coupled model has the same features as the COB, will it replace the expensive testing facility? Fortunately not or unfortunately not, depending on the way one looks at it. The numerical model can be used to prepare physical model tests, sparing rare time available in the COB. It provides a rigorous way to account for scaling effects. The model can possibly cover a wider range of loading conditions than the physical COB and gives the solution for the entire computational domain. But physical testing will always stay an important step in designing offshore structures. It allows to validate the simulations for the specific structure you're interested in, to make sure the models aren't neglecting effects which turn out to be important in the given context. There is always a difference between theory and practice, so a hybrid modelling approach should be used to optimally combine the knowledge of both the physical and the numerical models.

Reference

- Ducrozet, G., Bonnefoy, F., Le Touzé, D. & Ferrant, P. (2012). A modified High-Order Spectral method for wavemaker modeling in a numerical wave tank. European Journal of Mechanics, B/Fluids, 34, 19–34.

Keywords: Design of offshore structures; Hybrid physical and numerical modelling approach; Wave-Current-Structure Interaction (WCSI); Free Surface Potential Flow (FSPF) modelling

Hydroacoustic imaging of underwater gas seepage: investigating the use of echosounders for fluid discharge detection in a nearby natural laboratory (Laacher See, Germany)

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The detection of fluid escape at the seafloor has been the subject of marine research for decades, with several geophysical techniques being used for mapping and visualization of gas migration and seepage in the water column, at the seabed, and in the shallow subsurface. To determine the most suitable set and configuration of geophysical equipment for gas seepage detection, a nearby testing site with active degassing is extremely useful for experimentation. The Eifel region in the west of Germany is such a location thanks to the presence of active CO_2-degassing phenomena related to volcanic activity, especially in the Laacher See volcanic lake. This lake, formed after a series of eruptions 13 ka BP (Reinig et al., 2021), provides a calm, lacustrine environment with a maximum water depth of 51 m that is highly suitable for testing out geophysical equipment (Goepel et al., 2014).

During two surveys in 2019 and 2021, several geophysical techniques and settings were used to image and monitor CO_2 seepage and migration, both in the water column and in the sedimentary infill of the lake. A Norbit WBMS multibeam echosounder was used to identify the bathymetric expression of gas escape features on the lake floor and to locate gas (bubble) seeps in the water column visible by their high backscatter intensity. High-resolution sub-bottom profiles, acquired with an Innomar SES-2000 quattro parametric echosounder (10 kHz), show the presence of accumulated gas in the subsurface, as evidenced by enhanced seismic reflections and acoustic blanking. Accumulated gas is present at different depths (5 to > 25 m below the lake floor) in the lake subsurface, making it possible to map areas with high concentrations of free gas at different levels. The results show that the subsurface gas accumulations often coincide with gas seepage in the water column, with subtle changes being identified over the two-year time interval.

Our data confirm that gas is actively migrating through the sedimentary infill and water column of Laacher See and illustrate that the integration of echosounder data from different sources can provide a complete picture of the CO_2 gas location and discharge in the lake. This set-up of echosounders has therefore the potential to also be applied in other (marine) environments for similar research goals. In the broader interest of volcanism-related research, the monitoring of these gas migration processes at Laacher See can ultimately contribute to a better volcanic hazard assessment in the Eifel region.

References
- Goepel, A., Lonschinski, M., Viereck, L., Büchel, G. & Kukowski, N., 2014. Volcano-tectonic structures and CO_2-degassing patterns in the Laacher See basin, Germany. Int. J. Earth Sci., 104, 1483–1495.
- Reinig, F., Wacker, L., Jöris, O., Oppenheimer, C., Guidobaldi, G., Nievergelt, D., Adolphi, F., Cherubini, P., Engels, S., Esper, J., Land, A., Lane, C., Pfanz., H., Remmele, S., Sigl, M., Sookdoe, A., Büntgen, U., 2021. Precise date for the Laacher See eruption synchronizes the Younger Dryas. Nature 595, 66-69.

Keywords: CO2 degassing; Gas migration; Multibeam echosounder; Sub-bottom profiler; Laacher See

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

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Global warming and plastic pollution are two human-induced environmental stressors of rising concern owing to their potential impact on the ocean health. To tackle plastic pollution, sustainable alternatives to conventional fossil fuel-based plastics are being developed, like polylactic acid (PLA), a bio-based polymer made from natural-sourced feedstocks. In the marine environment, plastic additives and low molecular weight oligomers can be released and leached from the plastic to the surrounding seawater. Ultraviolet (UV) irradiation, which is one of the most important triggers of polymer degradation, may enhance the chemical leaching process and potentially alter the characteristics of the leachates (i.e. mixture of leached compounds). However, knowledge gaps exist concerning the effects of UV-weathered leachates especially from bio-based polymers to marine life. Hence, their potential effects combined with global warming is even less well understood.

In this master thesis, we have three research questions. The first aim is to assess the effect of plastic leachates from a bio-based polymer, in comparison to a reference conventional fossil fuel-based polymer on the growth of a marine diatom. The second aim is to investigate whether the possible effect of plastic leachates is enhanced or diminished by UV irradiation. The third aim is to understand the combined effects of leached compounds and increased water temperature 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 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 known oligomers and additives of PLA and PP, i.e., di-lactide, dodecan-1-ol, 2,4-di-tert-butylphenol, and tributyl O-acetylcritrate.

Our preliminary 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 determined EC50 of di-lactide, dodecan-1-ol and 2,4-di-tert-butylphenol are 341 ± 30 mg/L, 1.86 ± 0.06 mg/L and 1.50 ± 0.01 mg/L, respectively. No growth inhibition was observed due to tributyl O-acetylcritrate up to 98 mg/L. Forthcoming experiments will be performed with these four compounds at increased seawater temperature (i.e., 25 °C) following a full factorial experimental design. We expect that our results contribute to assess the link between multiple stressors for phytoplankton growth and to assess the potential ecological impacts of new bio-based polymers.

Keywords: Ecotoxicity; Plastic pollution; Global warming; Phytoplankton

Physico-chemical parameters and bacteria as indicators of sewage pollution in Negombo lagoon, Sri Lanka

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The Negombo lagoon is one of the coastal lagoons in an urbanized city in the North-western province of Sri Lanka. The lagoon is heavily surrounded by human settlements, farms, aquaculture, and hospitals, which exposes it to sewage pollution. Locating and assessing the effluent discharge points into the lagoon is very important to know the ecological status in terms of fish health and water quality conditions. This research assesses the sanitary risk of the Negombo lagoon by using the concentration of fecal coliform and their closely correlated water quality parameters. It was hypothesized that the effluent discharge points with poor water quality conditions will have high fecal coliform concentrations compared to locations of moderate to good water quality conditions. It was also hypothesized that oysters (*Crassostrea* sp.) in the poorest water quality conditions will have high concentrations of fecal coliform in their bodies. The sedentary and filter-feeding behaviour of oysters makes them a perfect fit to understand the sanitary risk of the lagoon fauna. As a first step, the communities surrounding the Negombo lagoon will be interviewed using a snowball sampling technique to identify the locations of the lagoon that contain effluent discharge points after which those locations will be visited for field verification. The survey will be followed by a focus group discussion with various stakeholders whose activities contribute to the sewage effluent that ends up in the lagoon. All locations with human activities (e.g., piggery farms, swimming, hospital canals, etc.) that pose a sanitary risk will be selected for sampling. At each sampling location, triplicates of water samples will be collected at three different depths (i.e., 15-20 cm below surface water, 1 m depth and 2 m bottom depth) and *in situ* physico-chemical parameters (e.g., dissolved oxygen, etc.) will be determined. Six adult oysters will be handpicked at the bottom within a 2 m radius of each sampling location. The concentrations of fecal coliform will be determined from the water samples and oyster meat using the Most Probable Number (MPN) method. A water quality index (WQI) will be computed for the different sampling locations to determine their pollution level. A one-way ANOVA test will be performed to determine whether the water quality parameters are significantly different between the sampling locations. A Redundancy Analysis (RDA) will be performed on the physico-chemical and bacteriological parameters to determine whether the correlation between the level of pollution and the abundance of fecal coliform is significant. Moreover, a one-way ANOVA test will be performed to determine whether there is a difference between the concentrations of faecal coliform in the water column and the bodies of oysters. The results will reveal whether water quality parameters such as dissolved oxygen, nitrate and phosphate concentrations are significantly associated with the concentrations of fecal coliform in oyster meat and lagoon water samples. Furthermore, to ascertain whether the sanitary condition of Negombo lagoon is of public health significance.

References

- Barile, P.J., 2018. Widespread sewage pollution of the Indian River Lagoon system, Florida (USA) resolved by spatial analyses of macroalgal biogeochemistry. *Marine Pollution Bulletin*, *128*, pp.557-574.
- Bilgin, A., 2018. Evaluation of surface water quality by using Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) method and discriminant analysis method: a case study Coruh River Basin. *Environmental monitoring and assessment*, *190*(9), pp.1-11.
- Wolswijk, G., B. Satyanarayana, L.Q. Dung, Y.F. Siau, A.N. Bin Ali, I.S. Saliu, M.A. Bin Fisol, C. Gonnelli & F. Dahdouh-Guebas, 2020. Distribution of mercury in sediments, plant and animal tissues in Matang Mangrove Forest Reserve, Malaysia. Journal of Hazardous Materials 387: 121665.
- Zu Ermgassen, P.S., Mukherjee, N., Worthington, T.A., Acosta, A., da Rocha Araujo, A.R., Beitl, C.M., Castellanos-Galindo, G.A., Cunha-Lignon, M., Dahdouh-Guebas, F., Diele, K. and Parrett, C.L., 2021. Fishers who rely on mangroves: Modelling and mapping the global intensity of mangrove-associated fisheries. *Estuarine, Coastal and Shelf Science*, *248*, p.107159.

Cytotoxicity of sea-dumped chemical munitions in rainbow trout gill (RTgill-W1) and human colon adenocarcinoma (Caco2) cells

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Following the First and Second World Wars colossal amounts of munition, including conventional explosives and chemical warfare agents, were sea-dumped in coastal and off-shore sites all over the globe. As a consequence of decades of exposure to seawater, munition shells are expected to be highly corroded thus allowing the release of toxic chemicals to the environment. Despite the growing environmental concern, the toxic potential of dumped munition and their reaction products is largely unkown.

In this study, the cytotoxicity of thiodiglycol, 1,4-oxathiane and 1,4-dithiane, three metabolites of the chemical warfare agent sulphur mustard frequently detected in environmental samples from dumpsites, was assessed in rainbow trout gill (RTgill-W1) and human colon adenocarcinoma (Caco2) cells following 24 hours and 24 and 48 hours exposure, respectively. For that, a combination of three viability assays was used following the test guideline 249 from OECD.

The obtained results for RTgill-W1 allowed the estimation of the LOECs of 50 mg/L and 100 mg/L for 1,4-dithiane and 1,4-oxathine, respectively, which correspond to the 96 hours LOEC in fish, while a NOEC of 100 mg/L was estimated for thiodiglycol. Similarly, for Caco2, 1,4-dithiane also proved to be the most toxic of the tested chemicals with the LOECs of 6.25 mg/L and 100 mg/L, following 24 and 48 hours exposure. Furthermore, LOECs of 100 mg/L were estimated for 1,4-oxathiane and thiodiglycol following both exposure periods.

This first insight on the cytotoxic potential of three relevant sulphur mustard related products reveals that 1,4-dithiane is the most toxic of the tested chemicals, even though all estimated LOECs are well above the concentrations detected in environmental samples, which normally range µg/L.

Keywords: Dumped munition; Cytotoxicity; RTgill-W1; Caco2

Time and cost efficient DNA-based monitoring of marine non-indigenous species in the harbour of Ostend (Belgium) using nanopore sequencing

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Non-indigenous species (NIS) continue to be a major threat for the ecological health of our environment and often are a nuisance for society. Regular monitoring is a key factor for prevention and mitigation of negative impacts caused by NIS. In many countries, including Belgium, monitoring programs for NIS in marine environments are limited in spatio-temporal scope as well as taxonomic coverage. DNA-based monitoring is a promising approach to solve this problem as it is potentially time and cost efficient as well as scalable for high spatio-temporal coverage. In the framework of the GEANS and LifeWatch projects, we conducted a quick survey of the fauna in the harbour of Ostend (Belgium) using traditional microscopic examination of the collected specimens. In parallel, we metabarcoded environmental samples (settlement plates and plankton net samples) at two genetic markers (the mitochondrial COI and nuclear 18S rRNA). The two approaches detected different subsets of the NIS pool present in the harbour. But the DNA-based approach significantly outperformed its morphology-based counterpart as it detected more NIS and was also more time efficient. We show that recent advances in sequencing technology and the availability of fast bioinformatic tools for data analysis allow a rapid turnover time of potentially less than two working days between sample collection and final results. Decreasing sequencing costs and increasing training of practitioners in molecular genetic techniques enable large scale NIS monitoring, leaving the lack of embedding in national and regional monitoring plans and corresponding funding schemes as the primary bottlenecks for implementation.

Keywords: Non-indigenous species; Biodiversity monitoring; Metabarcoding; Nanopore sequencing

Shallow gas at the Paardenmarkt WWI munition dumpsite

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Preliminary research has shown that the Paardenmarkt WWI munition dumpsite contains a substantial amount of shallow gas. The source, composition, concentration and potential implications for buried grenade shells, however, have barely been studied. Therefore, project DISARM focuses on the analysis of gas in both sediment samples and seawater from the Paardenmarkt area, using basic sedimentological analysis techniques as well as gas headspace GC-MS, IC and in-situ sensor measurements. Vibrocores are largely composed of an alternation between sand and organic silt. Flaser beds and rhythmic layers dominate the depositional architecture, which typically reflects a dynamic depositional environment characterised by phases of accumulation and erosion, associated with a range of coastal processes, such as wave action, storms, tidal currents and anthropogenic disturbances. Results of a Principal Component Analysis (PCA) reveal i.a. strong positive correlations between silt fraction, water and organic content, which, in turn, are negatively correlated with sand fraction and density. These sedimentological properties, together with burial depth and oxygenation level, control most of the dataset's variability. Projections of CH_4 and CO_2 relate positively to the absence of oxygen and an increased organic content; anaerobic circumstances are preferred by the majority of biomass-degrading and gas-producing microbes. Methanogenesis is expected to play an important role in the subsurface, explaining the very high methane concentrations measured. However, methanogen abundance in the studied deposits remains limited, potentially pointing towards a main source area that is located deeper down the stratigraphy, beyond the cores' reach. A high-sulphate zone in the topmost 0.5 m suggests the presence of sulphate reducing bacteria, of which some likely operate via a methanotrophic pathway. Dissolved oxygen, salt water, and biogenic gases at the Paardenmarkt can definitely influence corrosion rates of buried munition shells. Methane is unlikely to play an important role in this process, because of its balanced electron-configuration, but a lot of the microbiologically-associated products and gases (mostly CO_2 and H_2S) and their derivative ions can significantly acidify porewater, driving the formation of a coating on metal alloys. Both sensor and GC-MS measurements have shown that seawater as well contains different gases, however, in much lower concentrations than in sediment. Sediment-water flux rates are currently hard to quantify and will need more extensive measurements and advanced modelling in order to obtain accurate results.

Keywords: Paardenmarkt; Shallow gas; Methanogenesis; Sulphate reduction; Munition

A parasitic Platyhelminthe *Flexophora ophidii* Prost & Euzet, 1962 (Monogenea: Diclidophoridae): 58 years later

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The Diclidophoridae Cerfontaine, 1895 is a cosmopolitan family of marine monogenean Platyhelminthes, infecting gills, operculum, and gill cavity of teleosts and elasmobranchs. To date, 53 nominate genera are assigned to this family (WoRMS, 2022) with 15 genera belonging to the subfamily Diclidophorinae Cerfontaine, 1895 (Cruces et al., 2017).

Among the Diclidophoridae, *Flexophora* Prost & Euzet, 1962 was erected to accommodate *Flexophora ophidii* Prost & Euzet, 1962, from gills of the snake blenny *Ophidion barbatum* L. off France, northern Mediterranean (Prost & Euzet, 1962). *Flexophora* and its type- and only species, *F. ophidii*, remains poorly known. Limited references to the genus were made in the literature, including in the descriptions of new genera (Zhukov & Mamaev, 1985; Cruces et al., 2017; Mamaev, 1976; Payne, 1986) and a checklist (Euzet et al., 1993). The only existing record of the species and the genus is that of the original description, which unfortunately omitted a diagnosis of the genus.

In the course of a parasitological survey of helminths of fishes off the Southern coast of the Mediterranean Sea, we collected representatives of a monogenean similar to *F. ophidii* on gills of *O. barbatum*. The specimens were described here and compared to the original description of the species. Our specimens collected from *Ophidion barbatum* off Algeria showed a morphoanatomy similar to that of *F. ophidii*. However, we have highlighted the presence of a constriction at the level of the pharynx in the anterior part and an additional pair of hamuli at the level of the terminal lappet in our specimens. These two features were neither mentioned nor illustrated in the original description. However, the morphological differences highlighted are subtle and could not be used to differentiate a new species. Hence, with such high resemblances and overlaps in measurements and counts, diclidophorids from *Ophidion barbatum* from off Algeria were considered conspecific with *F. ophidii*. A diagnosis of *Flexophora* was provided for the first time.

References
- Cruces, C. L., Chero, J. D., Sàez, D., Iannacone, J., & Luque, J. L. (2017). *Olivacotyle hemanthiasi* n. gen. n. sp. (Monogenea: diclidophoridae) from the gills of damsel bass *Hemanthias signifer* (garman, 1899) (teleostei: serranidae) in the South American Pacific Ocean. Neotropical Helminthology, 11, 387–394.
- Euzet, L., Combes, C., & Caro, C. (1993) A check list of Monogenea of mediterranean fish. In: Second International Symposium on Monogenea, Montpellier/Sète, 1993.
- Prost, M., & Euzet, L. (1962). *Flexophora ophidii* n. gen. n. sp. un Diclidophoridae (Monogenea) parasite d'*Ophidium barbatum* (L.) (Teleostei). Annales de Parasitologie Humaine et Comparée, 37, 210–215.
- Zhukov, E., & Mamaev, Y. L. (1985). A new member of high monogeneans from gills of *Synodus foetens* from the Gulf of Mexico. Parazitologiya, 19, 250–253.
- Payne, R. (1986). *Lampanyctophilus wisneri* gen. et sp. n. (Monogenea: Diclidophoridae), a gill parasite of *Lampanyctus ritteri* (Myctophidae) from the eastern Pacific and an emended description of *Myctophiphilus sprostonae* (Martin, 1973) comb. n. Proceedings of the Helminthological Society of Washington, 53, 157–161.

Keywords: Monogenea; Parasites; Platyhelminthes; Diagnosis

Integrative taxonomy of some digenean Platyhelminthes, parasites of marine fishes of Sweden

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Our project based at the Swedish Natural History Museum aims to significantly increase the number of digeneans known from Sweden through an intensive survey of the most important host group for these parasites: the teleost fishes. During an ongoing effort to explore the diversity of trematodes parasites of fishes off Sweden, we collected 335 marine fishes from Skagerrak, North Sea through collaboration with SLU-Aqua. The examined fishes belong to 4 families: Pleuronectidae; Scombridae; Gadidae and Clupeidae. The digestive system was carefully examined for parasitic flatworms using the quick washing method. In a first attempt to evaluate the digenean fauna of Swedish fishes with an integrated morphological and molecular approach, we generated sequences of four genetic masquers for the collected trematodes: partial 28S ribosomal RNA, Cytochrome c oxidase subunit COI, and Internal transcribed spacers ITS1 and ITS2. Five species of Digenea attached to five different families were identified. 1. Within Fellodistomidae Nicoll, 1909, we collected *Steringophorus furciger* (Olsson, 1868) from the witch flounder *Glyptocephalus cynoglossus* for which the latest morphometric and morphoanatomical data were provided over 40 years. 2. Within Lepocreadiidae Odhner, 1905, we collected *Lecithocladium excisum* (Rudolphi, 1819) from the Atlantic mackerel, *Scomber scombrus* from Skagerrak and from the southwestern Mediterranean to verify the occurrence of this trematode in two distinct localities. 3. The Opecoelidae Ozaki, 1925 are represented by *Bathycreadium elongata* (Maillard, 1970) from the Norway pout *Trisopterus esmarki*. Our trematodes from *T. esmarki* were similar to *B. elongata* in most characteristics such as the extension of vitellaria and position of posterior testis whereas a phylogenetic analysis using our newly generated sequences of internal transcribed spacers 1 and 2 showed that our sequences of *B. elongata* from *T. esmarki* were distinct from those reported on another host forkbeard *Phycis phycis* questioning the occurrence of this trematode on several gadid fishes. Our report represents a new host record of *Bathycreadium* cf. *elongata* on *T. esmarki*. 4. Within Hemiuridae Looss, 1899, we collected few specimens of *Hemiurus levinseni* Odhner, 1905 on one Clupeidae, possibly *Clupea harengus* for which we will provide a modern redescription using morphological data supplemented with four genetic markers. 5. The Lepocreadiidae Odhner, 1905 *Opechona bacillaris* (Molin, 1859) known for its large geographic distribution was collected on *Scomber scombrus* and we report it for the first time from the coasts of Sweden.

Keywords: Digenea; Taxonomy; COI; ITS; Teleosts

Citizen observation of plastic pollution in coastal ecosystems to address data gaps in marine litter distribution

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The accumulation of plastic litter in coastal environments has become an issue of high priority for policymakers due to the potential hazardous effects of plastic pollution to biota and human health, and to the impact on ecosystem services and local economies. To develop effective mitigation measures to restrain plastic pollution, it is critical to acquire knowledge on the distribution and accumulation of plastic litter. However, in many regions, such as West Africa, the exact quantity of plastics reaching coastal areas is still poorly known.

To address the data gaps in marine plastic litter distribution worldwide, citizen science programs are instrumental in complementing shoreline assessments, and are effective in increasing public awareness of plastic pollution.

The Citizen Observation of Local Litter in coastal ECosysTems (COLLECT) project is a citizen science initiative which aims to acquire distribution and abundance data of coastal plastic debris in seven countries, in Africa (Benin, Cabo Verde, Côte d'Ivoire, Ghana, Morocco, Nigeria) and Asia (Malaysia). The project consists of training students (15-18 years old) from local secondary schools on sampling and analysing macro-, meso- and microplastic in beach sediments, using scientific procedures. The project will also measure the impact of the citizen science intervention by assessing shifts in ocean literacy and pro-environmental behaviour.

The COLLECT project contributes to the United Nations' Sustainable Development Goals (SDGs) by focusing on the sustainability of communities (SDG 11) and the sustainable use of the ocean (SDG 14). Besides, the project relates to the impact on good health and wellbeing (SDG 3), and gender equality

(SDG 5), while promoting a responsible disposal of consumer goods (SDG 12). COLLECT also reaches to the UN Ocean Decade challenges on understanding and beating marine pollution (#1), promoting the development of skills, knowledge and technology for all (#9), and the change of humanity's relationship with the ocean (#10).

The results from COLLECT will contribute to establishing baseline information on coastal plastic debris, with citizen science being an enabler of open science, allowing data to be freely available to the public, academics and policymakers. Results will further contribute to the identification of hotspots of plastic coastal litter, and bring awareness to local communities on the potential consequences of plastic pollution.

Keywords: Plastic pollution; Marine litter; Observations; Citizen science; Ocean literacy; Pro-environmental behaviour

Marine Station Oostende extends its size and capabilities with "Ocean Innovation Space"

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VLIZ is expanding its research facilities at the Marine Station Oostende (MSO) with a three storey building that was baptised "Ocean Innovation Space". The occupation and use of the current facilities and space at MSO had become to limiting and inadequate for the growing atmosphere of VLIZ. The new building will host new laboratories, an electronics lab for marine technicians and a vehicle hangar housing the vehicles of the Marine Robotics Centre. between the Ocan Innovation Space and the other buildings at MSO a WW2 bunker will be renovated to house a biobank that VLIZ is building and a Virtual Reality room that will function both as a research infrastructure as for outreach and educational purposes. The builiding will be taken in to operations end 2022.

Keywords: Research Infrastructure; Marine Station Oostende

How do faecal pellets from fouling fauna contribute to the marine organic matter pool in offshore wind farms?

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Nowadays, the demand for renewable energy is increasing. One option to respond to this demand is to build Offshore Wind Farms (OWFs). However, the presence of the turbines changes the marine habitat. The hard structures provide new habitat that is rapidly colonized by epifaunal marine organisms. This fauna consists mainly of suspension feeders, organisms feeding on organic particles in the water column. In the shallow subtidal zone, the communities are dominated by the blue mussel (*Mytilus edulis*). Deeper down, there are high numbers of tube building amphipods (*Jassa herdmani*), and closer to the seafloor, anemones (*Metridium senile*) can be found. They filter suspended particles as well as phyto- and zooplankton and produce faecal pellets (FP), which are thought to play a crucial role in the local organic matter (OM) dynamics and possibly also in carbon sequestration in the sediment surrounding the turbines.

Within this scope, the general objective of the OUTFLOW (Quantifying the cOntribUTion of Fouling fauna to the Local carbon budget of an Offshore Windfarm) project is to assess the importance of FP within the OWFs ecosystems by estimating their contribution to the pelagic and benthic organic matter pools. To reach this goal, tracers of FP of the dominant organisms (*M. edulis, J. herdmani,* and *M. senile*) will be developed. This will be done by applying stable isotope analysis of amino acids (AA) in the FPs.

This is done because as the AA transfer from primary producers to consumers, they follow different pathways. These possible changes can be observed on the $\delta^{15}N$ of the AA. Some AAs suffer little change (defined as "*Source*" amino acids), and others undergo significant metabolic alterations (defined as "*Trophic*" amino acids). This change is not only associated with a specific AA, but also depends on the possible alteration due to passage through the metazoan gut. Based on previous research (Doherty el at., 2021)[1], specific AA ratios will be selected together with the determination of the trophic position, to produce a multivariate fingerprint to apply in a Bayesian Mixing Model.

Together with the analysis of the ^{15}N signals in the AA of other OM sources (phytoplankton, zooplankton, and bacteria-degraded OM), the developed fingerprints will be used to differentiate between the contributors to the OM pool and provide the means to estimate the contribution of FP to the OM pool both in the water column and the sediment from the OWFs, model the potential spatial dimensions of FP enrichment of sediments, determine the fate of FP in the sediment, estimate the carbon sequestration potential of altered OWF sediments, and investigate the effect of OWFs on OM dynamics at a larger geographical scale.

Reference
[1] Doherty, S. C., Maas, A. E., Steinberg, D. K., Popp, B. N., & Close, H. G. (2021). Distinguishing zooplankton fecal pellets as a component of the biological pump using compound-specific isotope analysis of amino acids. *Limnology and Oceanography*.

Keywords: Fouling fauna; Faecal pellets; Organic matter dynamics; Isotope analysis; Amino acids; Mytilus edulis; Jassa herdmani; Metridium senile; Offshore wind farm

Microalgae as flavouring agents in plant-based food

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In a search for more sustainable food systems, microalgae are believed to be one of the most promising sustainable food sources (no arable land requirement, capture of CO_2,…) while having an interesting nutrition profile such as high protein content, omega-3 fatty acids and vitamins (1). Furthermore, the growing trend in the development of new plant-based foods by industry goes hand in hand with the increasing numbers of vegan, vegetarian and flexitarian consumers which opens opportunities for microalgae in plant-based diets (2). Numerous plant-based meat and dairy alternatives have entered the food market, while the development of plant-based seafood products is still in its infancy (3). Microalgae could have the potential to be used as plant-based seafood flavouring ingredients because of their high protein content, which could elicit umami taste (4), and the presence of volatiles important for seafood aroma (e.g. sulphur compounds, fatty acid-derived compounds) (5,6). However, one of the main barriers for introducing new plant-based food products to become mainstream is the acceptance of the flavour by consumers.

In the framework of the Interreg project ValgOrize, we tackle this barrier by investigating the flavour properties of different microalgae species and study the effect of processing and cultivation conditions on it. An expert panel was trained to quantify specific flavour characteristics of microalgae (e.g. odour, taste). Furthermore, chemical taste and aroma compounds were analysed and correlated with the sensory profiles. Based on the sensory and chemical analysis, microalgae were added with matching food products. Eventually, the appreciation of these food products was compared with the original product by a consumer panel (approximately 45 people) to evaluate how the addition of microalgae influences the flavour.

Based on the sensory and chemical data, microalgae *Rhodomonas salina*, *Tetraselmis chui* and *Phaeodactylum tricornutum* were characterized with highest seafood aroma (crab and fishy) and umami taste, while possessing less off-flavours such as grassy and earthy aromas. Therefore, these microalgae were chosen to be incorporated into self-made veganaises (based on sunflower oil, soy milk, vinegar and mustard) and commercial vegetable broths to evaluated the addition of their seafood flavour. Furthermore, microalgae *Dunaliella salina* was characterized with a floral flavour by the expert panel. Self-made cookies were developed with *D. salina* and will be tested on appreciation (in progress).

Interestingly, the addition of microalgae in veganaises as well as in vegetable broths significantly increased the seafood flavour without being too intense. These results will be further used in the development of plant-based seafood alternatives. Within this proof of concept we illustrate the way to follow for the development of algae-based food products and for a more diverse microalgae food in future.

References
(1) Barsanti L., Gualtieri P. (2018). Is exploitation of microalgae economically and energetically sustainable? Algal Research, 31, 107–115.
(2) van Vliet, S., Kronberg, S. L., & Provenza, F. D. (2020). Plant-Based Meats, Human Health, and Climate Change. *Frontiers in Sustainable Food Systems*, 4(October). https://doi.org/10.3389/fsufs.2020.00128
(3) SPINS. (2020). Overall plant-based food market. Retrieved from https://gfi.org/marketresearch/ . Accessed December 15, 2021.

(4) Fuke, S. (1994). Taste-active components of seafoods with special reference to umami substances. *Seafoods Chemistry Processing Technology and Quality*, (pp. 115–139).

(5) Achyuthan, K. E., Harper, J. C., Manginell, R. P., & Moorman, M. W. (2017). Volatile metabolites emission by in vivo microalgae an overlooked opportunity? *Metabolites*, *7*(3). https://doi.org/10.3390/metabo7030039

(6) Josephson, D. B. (1991). Seafood. In H. Maarse (Ed.), Volatile compounds in foods and beverages (pp. 179–202). (1st ed.). New York: Marcel Dekker Inc.

Spatial planning of global mangrove ecosystems for conservation and fishing

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Mangrove forests are located in tropical and subtropical coastal areas and provide fundamental ecosystem functions, goods and services, including coastal protection, carbon sequestration, aesthetic and recreational benefits. They also support fisheries by providing spawning grounds, shelter and feeding areas for commercial and small-scale species that support local communities, particularly in developing nations. Anthropogenic activities – including land conversion and climate change – are threatening the future of these ecosystems. We will develop a climate-smart global network of protected areas to secure the conservation of these habitats, preserving their ecological, social and economic value. To prioritise areas for including in the marine protected areas network we use the R package *prioritizr*. We will select areas that permit the protection of all the mangrove species from each geomorphic setting and marine province. We will also prioritise the conservation of areas for blue carbon, to preserve present carbon sinks and future carbon sequestrations, coastal protection, to reduce future disaster risk, and fisheries benefits, to guarantee food security in particular for local communities. The approach developed is novel because it seeks to maximise both fisheries and conservation benefits, rather than the typical approach of minimising conflict between fisheries and conservation as is the common practice. Areas are prioritised based on climate-smart principles, by selecting mangroves that will be able to migrate landward in response to sea-level rise and by defining larger marine protected areas in regions more impacted by extreme climatic events. The outcomes of this work could inform conservation and sustainable fisheries practices.

Keywords: Conservation planning; Spatial prioritisation; Data science; Ecosystem services; Mangroves

Does moonlight affect newborn reef sharks in a tide-free environment?

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Synchronised behaviours of animals with the monthly phases of the moon have been demonstrated in a wide range of taxa, and the effects of the lunar cycle appear to be particularly important in the marine environment. In coastal ecosystems, the two main processes through which the lunar cycle can influence the movements and behaviour of marine animals are tidal variation and moonlight availability. The island of Moorea, however, is located within the South Pacific amphidromic system and only experiences a very narrow tidal range (ca. 0.2 m). Effects of lunar-induced tidal variation are therefore largely absent from the shallow reef flats fringing Moorea, and changes in moonlight availability can be expected to be the major factor in the entrainment of behavioural rhythms to the lunar cycle. Moorea therefore provides for a unique location to tease the effects of moonlight availability on the activity and foraging behaviour of newborn tropical reef sharks unconfounded by a tidal effect. Newborn sharks can often be considered as mesopredators in their ecosystem, but whether moonlight availability affects these sharks – through variation in foraging success, variation in predation risk, or a combination of both – is unclear.

In the present study, we used capture data and stomach content data from a long-term fisheries-independent survey of blacktip reef (*Carcharhinus melanopterus*) and sicklefin lemon (*Negaprion acutidens*) shark neonates at Moorea, French Polynesia to assess whether the foraging activity and predation success of the newborn sharks is affected by moonlight availability. Our results reveal no influence of the lunar cycle on the foraging activity or predation success of the studied shark neonates, suggesting that moonlight availability does not appear to affect the behaviour of these sharks off Moorea. As present-day shark neonates represent adult populations of the future, a sound understanding of the effects that environmental conditions may or may not have on the early life of these fishes may prove crucial for the conservation of future shark populations.

References
- George, L. W., Martins, A. P., Heupel, M. R., and Simpfendorfer, C. A. (2019). Fine-scale movements of juvenile blacktip reef sharks *Carcharhinus melanopterus* in a shallow nearshore nursery. *Marine Ecology Progress Series* **623**, 85-97.
- Guttridge, T. L., Gruber, S. H., Franks, B. R., Kessel, S. T., Gledhill, K. S., Uphill, J., Krause, J., and Sims, D. W. (2012). Deep danger: intra-specific predation risk influences habitat use and aggregation formation of juvenile lemon sharks *Negaprion brevirostris*. *Marine Ecology Progress Series* **445**, 279-291.
- Hammerschlag, N., Skubel, R. A., Calich, H., Nelson, E. R., Shiffman, D. S., Wester, J., Macdonald, C. C., Cain, S., Jennings, L., Enchelmaier, A, and Gallagher, A. J. (2017). Nocturnal and crepuscular behavior in elasmobranchs: a review of movement, habitat use, foraging, and reproduction in the dark. *Bulletin of Marine Science* **93**(2), 355-374.

- Lea, J. S., Humphries, N. E., Bortoluzzi, J., Daly, R., Von Brandis, R. G., Patel, E., Patel, E., Clarke, C. R., and Sims, D. W. (2020). At the turn of the tide: space use and habitat partitioning in two sympatric shark species is driven by tidal phase. *Frontiers in Marine Science* **7**, 624.

Mangrove management in Northern Sri Lanka: A Social Network Perspective

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In the context of accelerating global environmental change, sustainable management of tropical coastal social-ecological systems requires some form(s) of collaboration between a wide range of stakeholders. Mangrove forests provide multiple ecosystem services to local communities (e.g. timber, fuelwood) and beyond (e.g. carbon sequestration). Yet, research on collaborative stakeholder networks and their linkages with sustainable mangrove management strategies is lacking. Through social network analysis (SNA), we analyzed mangrove management stakeholders' perspectives and their informal and formal relationships in the Northern Province of Sri Lanka. Questionnaire surveys were carried out with 19 different stakeholders who were closely related to mangrove management in Sri Lanka's Northern Province. Our findings indicate that the government departments mandated to conserve mangroves are not only formally appointed key stakeholders but are also perceived as central by other stakeholders in the reality of day-to-day mangrove management. Private organizations are perceived to play a less important role, despite existing resource extraction. Communication barriers, lack of awareness regarding the importance of mangroves, and shortages in staff and resources for mangrove conservation were highlighted as major constraints that need to be addressed in future mangrove management plans. We recommend that the inclusion of a bridging entity to connect all stakeholders such as the universities along with the development of a common platform (e.g. websites) to exchange ideas can help to improve the networks and foster mangrove conservation.

References
- Bodin, Ö., 2017. Collaborative environmental governance: achieving collective action in social-ecological systems. Science 357 https://doi.org/10.1126/science.aan1114.
- Bodin, Ö., Tengö, M., 2012. Disentangling intangible social–ecological systems. Global Environmental Change 22, 430-439 https://doi.org/10.1016/j.gloenvcha.2012.01.005.
- Borgatti, S.P., Everett, M.G., 1996. Models of core/periphery structures. Sunbelt International Social Networks Conference, Charleston, SC.

Keywords: Collaborative governance; Mangrove management; Stakeholders; Stakeholder Network Analysis; Sri Lanka

Is there a conflict between tourism and conservation? An investigation of participatory management of sea turtles in Sri Lanka

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Sea turtles play a significant role in the Sri Lankan tourism industry. There are currently two existing models of sea turtle conservation in Sri Lanka, hatchery based *ex-situ* conservation of eggs and community-based management of sea turtle nesting grounds on the Southern Coast of the island nation. The former is practiced by a few private hatcheries in the Galle district which has a high influx of tourists. Community-based conservation in Rekawa beach, Hambantota district by the Sri Lankan NGO Turtle Conservation Project (TCP) was established in 1993. Both conservation models generate their main income through sea turtle tourism (SST), volunteer programs, and guided education programs for visitors. However, the hatcheries are more influenced by tourism which has led to undesirable conservation practices such as retaining hatchlings in tanks which has a detrimental effect on the survival of hatchlings upon release. Firstly, we aim to assess the value and importance of sea turtles in attracting tourists and how SST influences conservation practices in Sri Lanka. This will be done through semi structured interviews with tourists visiting the conservation centres and by evaluating user generated content from Tripadvisor. Secondly, we will focus on a Social Network Analysis (SNA) and a discourse analysis using Q Methodology to assess the roles, interactions, and attitudes of each stakeholder involved in the two conservation models. Through these, we expect to gain insights on conflicts related to tourism and how it affects management practices, compliance to regulations, and local community participation in sea turtle conservation. Overall, this ongoing study will assist in identifying a sustainable participatory model that would ensure optimal sea turtle conservation and support local livelihood through regulated tourism.

Keywords: Sea turtles; Sea turtle tourism; Conservation conflicts; Social Network Analysis; Q Methodology

The importance of grid resolution, temperature and salinity for modelling the hydrodynamic regime in the Gulf of Guinea

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The hydrodynamic regime of the Gulf of Guinea is rather well studied. However, knowledge of the local hydrodynamic regime of the coastal waters of Benin and Lake Nokoué is less known despite its importance for the local fishermen and the general safety at sea. The hydrodynamic regime in lake Nokoué (Benin), a lagoon permanently connected to the Beninese coastal waters by means of a channel, is quite particular and the influence of the ocean is not well known. To study this, a nested chain of hydrodynamic models is developed. The chain starts with a model for the Gulf of Guinea, the consecutive models of the chain are higher in resolution and zoom in to the Beninese coastal waters. In this work, the first model that simulates the hydrodynamic regime in the Gulf of Guinea is discussed and preliminary results of the 3D numerical model are presented.

The modelling of the Gulf of Guinea, which extends from 8°W to 14°E and from 8°S to 7°N, is constructed with COHERENS (COupled Hydrodynamical and Ecological model for REgioNal and Shelf seas) model in 3D mode with a horizontal grid resolution of 1/4°. The depth is discretized into 75 sigma levels using a non-uniform s-grid. The model bathymetry has been generated by linearly interpolating the bathymetry data obtained from the GEneral Bathymetric Chart of the Oceans (GEBCO) with a spatial resolution of 15 arc-second. At the open sea boundary, the model was forced by daily sea surface current and sea elevation as well as salinity and temperature field, provided by forecast system GLO-CPL. The runoff forcing is provided from Global Flood Awareness System (GloFAS) and LISFLOOD model. The seven major rivers (Congo, Niger, Ogooué, Sanaga, Cross, Sassandra and Volta) of the region are prescribed in the model at the river boundaries. For river salinity and temperature, daily mean values are considered. Wind at 10m, mean sea level pressure and humidity were prescribed at the surface, and provided by the weather forecasts ERA5.

The first results showed that the number of vertical layers is critical in modelling the surface current correctly. Furthermore, the importance of temperature and salinity for a correct representation of the bottom currents also was crucial. Our results show good agreement with the model HYCOM and the satellite observations.

To improve the forecasting capabilities of this model, a dynamic bathymetry and tidal constituents as boundary conditions will be added. This model will be nested to a model with a high resolution (200m) that describes the connection between coastal waters and lake Nokoué in order to examine the impact of the hydrodynamic regime of the Gulf of Guinea on water circulation in lake Nokoué and the living world.

Keywords: Hydrodynamics; Numerical modelling; Sea level rise; Gulf of Guinea; Temperature; Salinity; West-Africa

Customizing sequence databases for system level analysis of gene expression in marine microbial plankton

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High-throughput sequencing of environmental samples is significantly improving our understanding of the molecular activities of complex microbial communities in their natural environment. For instance, by enabling taxonomic profiling and genome-wide differential gene expression analysis, meta-omics analyses have shed new light on the relationship between community structure and ecosystem functions. However, the ability to accurately mapping the activity of physiological pathways in natural microbial ecosystems from high-throughput sequencing data is constrained by the quality and completeness of reference sequence databases.

Here, we applied well-established bioinformatics tools to leverage publicly available genome sequences for creating a custom planktonic database suitable for a systems biology-oriented analysis of environmental samples using the popular HUMAnN workflow, which has proven effective at reverse-engineering molecular phenotypes putatively involved in ecosystem functions. To test the effectiveness of database customization, we reanalyzed previously published metratranscriptomics datasets and demonstrate that significant improvements can be gained in terms of mapping dominant metabolic activities that may be key drivers of community behavior.

By further expanding on the taxonomic and functional complexity of our draft database with newly released high-quality genome assemblies for marine microbes, the hope is to increasingly improve our ability to map the molecular traits that drive changes in marine microbial community composition and function through space and time.

Keywords: Systems biology; Meta-omics analysis; Metabolic pathway; Marine plankton; Molecular database

Finding psychological restoration along the Belgian coast: spatial variation and the influence of the environment's physical constituents

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Introduction

Living in a coastal area and spending time at the coast has been shown to benefit psychological health and wellbeing. However, the amount of psychological restoration may be highly location-specific, and may differ both between (e.g. beach vs. town) and within (e.g. different proximities to the waterline at the beach) coastal environments. Furthermore, it is still unknown how much the physical constituents of the environment influence the experienced psychological restoration. Therefore, this study aimed to quantify the inter- and intra-environment variation in the experienced psychological restoration along the Belgian coast, and to determine the influence of the physical constituents of the environment hereon.

Methods

Ten coastal environments were identified represented by 52 pictures, in which beach environments were subdivided into five types. The pictures were rated by students (N=102, 18-30y, 83% female) in random order on a five-item perceived restorativeness scale (PRS). The type and relative proportion of the physical constituents of the environment were quantified by manually drawing polygons on the pictures, calculating their surface area, and classifying them hierarchically under natural/urban/people and lower-level constituents. The analyses included regression-based general linear mixed modelling, standardized for various individual and study-design-related covariates and random effects.

Results

The PRS-scores varied gradually across the ten coastal environments: salt marshes > dunes > beaches > green parks > piers > historical sites > dikes > docks > recreational harbors > towns. Average PRS-scores differed up to 30% between very high and neutral, and no detrimental effects were detected. Furthermore, additional intra-environment variation occurred at the beach: the PRS was lower for 'in a beach bar' and 'between beach cabins' compared to 'on a breakwater'. Lastly, the PRS associated positively with the relative proportion of natural content (i.e. vegetation, sky, and natural underground) and negatively with the relative proportion of urban content (i.e. buildings, vehicles and hardened underground).

Discussion and conclusion

The results of this study confirm that considerable inter- and intra-environment variation exists in the psychological restoration potential of the Belgian coast, and that the natural and urban components of coastal environments play a substantial role in this. As such, the current perspectives about the restorative potential of coastal environments are refined, and recommendations for future research and applications are proposed.

Environmental change and trophic ecology explain different THg bioaccumulation in two subpopulations of the Arctic ringed seal *Pusa hispida*

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Mercury (Hg) is categorised as one of the top ten chemicals of human health concern by the World Health Organization; therefore, the "Minamata Convention" was ratified in 2017 to regulate Hg emission. Arctic predators such as marine mammals show a more than tenfold increase in Total Hg (THg) concentration over the past 150 years (Dietz, Outridge and Hobson, 2009). Indeed, the Arctic is considered a global sink for Hg and, moreover, the Arctic Hg concentration is rising due to global warming (AMAP, 2021). THg accumulation trends in Arctic predators are spatially and temporally variable due to a myriad of ecological and environmental factors. Identifying the role of these drivers is crucial to implement proper Hg management mitigation plans, especially in the Arctic receiving multiple pressures.

The objective of the present study was to assess the importance of certain climatic and ecological factors as drivers of spatiotemporal THg variability in an endemic Arctic marine mammal species: the ringed seal *Pusa hispida*. We measured THg levels in muscle of two subpopulations, in North-west (NWG) and East Greenland (EG), collected from the mid-1980s up to 2016. We investigated the potential influence of physical factors (i.e., sea ice extent, North Atlantic Oscillation, sampling year) and trophic ecological proxies (i.e., $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$) on muscle THg concentrations. We measured THg concentrations using Absorbance Spectrometry (DMA 80 Milestone) while $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$ values were obtained using isotope ration mass spectrometry (Isoprime). We used Multivariate Linear Mixed Models (MLMM) to correlate temporal THg trends with trophic and environmental factors. Hg levels of ringed seal muscle in both subpopulations did not show a significant linear temporal trend (linear regression, p in EG =0.14 and p in NWG=0.25). THg in EG ringed seal muscle were lowest in the mid-80s (994 ng g^{-1} dw) and increased until 2012 (1,185 ng g^{-1} dw), reaching a plateau thereafter. THg in NWG ringed seal muscle increased from the mid-1980s (709 ng g^{-1} dw) to 2006 (1,406 ng g^{-1} dw). For EG ringed seals the MLMMs indicated THg to increase with smaller sea ice extent and higher $\delta^{15}N$ and $\delta^{13}C$. For NWG ringed seals the MLMMs showed THg to increase with larger sea ice extent and higher $\delta^{15}N$.

Our results suggested an increase of EG ringed seals' THg bioaccumulation due to the influence of sea ice melting to release deposited Hg from the underlying sea ice layers, trophic level, and habitat shift from coastal to offshore waters. For NWG ringed seals, the MLMMs showed a rise of THg with more sea ice extent and $\delta^{15}N$. Variations of muscle THg in NWG ringed seals seemed to be related with sympagic associated food webs. The rate of climate change impacts on feeding ecology and exposure to Hg at the local scale differed between the EG and NWG ringed seals. Our findings align with the effect of spatio-temporal variations of species habitat use and trophic ecology on the Hg bioaccumulation in Arctic marine mammals (Riget *et al.*, 2012 and Dietz et al., 2021). This underlines the necessity of a local-scale and species-specific focus in future Hg management efforts.

References
- AMAP, 2021. 2021 AMAP Mercury Assessment. Summary for Policy-makers. *Arctic Monitoring and Assessment Programme (AMAP)*, Tromsø, Norway. 16 pp
- Dietz, R., Desforges, J., Rigét, F., Aubail, A., Garde, E., Ambus, P., Drimmie, R., Heide-Jørgensen, M. and Sonne, C., 2021. Analysis of narwhal tusks reveals lifelong feeding ecology and mercury exposure. *Current Biology*, 31(9), pp.2012-2019.e2.

- Dietz, R., Outridge, P. and Hobson, K., 2009. Anthropogenic contributions to mercury levels in present-day Arctic animals—A review. *Science of The Total Environment*, 407(24), pp.6120-6131.
- Rigét, F., Dietz, R. and Hobson, K., 2012. Temporal trends of mercury in Greenland ringed seal populations in a warming climate. *Journal of Environmental Monitoring*, 14(12), p.3249.

Keywords: Arctic; Hg temporal trend; Stable isotopes; Sea ice; Ringed seal

Tracking the downstream migration of an aquatic invader: preliminary results on the spatio-temporal movement behaviour of the Chinese mitten crab in the Scheldt Estuary, Belgium

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The Chinese mitten crab (*Eriocheir sinensis*) is an aquatic invasive species in western Europe with a catadromous life cycle. In Flanders (Belgium), management measures have been put into place to catch and remove the crabs during their migrations. However, thorough spatio-temporal knowledge on species behaviour during their migration within estuaries is still lacking, which hampers focused and effective management on a wider spatial scale.

In this study we investigated the timing and routes of the downstream migration of adult Chinese mitten crabs in the Scheldt Estuary with the use of acoustic transmitters. After perfecting the tagging technique in laboratory conditions, eight female crabs were tagged and released in October 2020 on different locations within upper tributaries of the estuary. To the best of our knowledge, this is the first time that a decapod migration was monitored over such a large distance (~115 km).

Valuable data were retrieved from seven of the eight crabs and enabled us to calculate parameters such as migration speed, time spent in certain areas and the exact route. Additionally, using this technique for the first time in this context, paves the way for more elaborate studies using acoustic telemetry to gain insight in the spatio-temporal movement behaviour of aquatic invasive species.

Keywords: Crustacea; Decapod; Invasive species; Acoustic telemetry; Migration; Estuary

Working in a new era of automated classification in micro- (phyto)plankton monitoring: a FlowCAM case study

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Since 2017, VLIZ monitors micro- and phytoplankton in the Belgian Part of the North Sea within the LifeWatch framework. Monthly campaigns to onshore locations and seasonal campaigns to more offshore locations, lead up to around 140 samples per year. To deal with analyzing such large amounts of samples, VLIZ uses a FlowCAM device. This automated imaging device combines the principles of flow cytometry and microscopy to take traditional particle counting to the next level. As sample material is pipetted in the device, particles are brought in a constant fluid stream by a dosage pump and tubing system. Particles are then pulled through a photo chamber where each particle is captured in a unique image. In this way, the FlowCAM can create an image library of a sample in under 30 minutes. On a yearly basis, this yields several hundreds of thousands of images, all of which have to be identified by a taxonomist. Needless to say, this takes up a huge amount of time, not only hindering fast data releases to the public but also counteracting the fast and automated lab work with the FlowCAM device. To deal with this issue, we explored the use of deep learning approaches to analyze these image libraries.

In 2019, a prototype classifier was explored and implemented in the data-pipeline. Over the years, improved model versions were trained on yearly gathered FlowCAM data and all model predictions were verified, and corrected when needed, by a taxonomist. This fine-tuning has led to a current classifier with an accuracy around 88% and that can distinguish between 90 different microplankton classes, mainly belonging to diatoms, dinoflagellates and ciliates. So far, this automated approach to micro- (phyto)plankton monitoring has yielded over 2 million validated images, covering the full spatial scale of the Belgian Part of the North Sea at a monthly time interval[1].

This large set of validated data with model predictions allows us to take a next step in the automated image classification, where we explore the use of different measures indicating the quality of predictions and set thresholds for valuable observations. Currently, a first set of values explored are precision and recall. Precision is the proportion of model predictions that were correct for a model class. Recall is the proportion of true images of a class, according to a taxonomist, that the model also was able to retrieve, i.e. how many of the images of a class could the model recognize? Combining measures like these, and aiming for thresholds that indicate high quality predictions, can help us identify chunks of data that can be excluded from the manual validation check. This promising new approach would allow images with high quality predictions to be made available to the public within just a few days after laboratory processing, facilitating faster data releases while also providing a quality score for each validation to the user. Images that don't meet the required thresholds and still need a manual validation check can either be made available later, or immediately with a flag indicating the poor quality of the prediction. This new analysis allows us to evaluate different model versions used over the years and their performance, set standards for qualitative model predictions, and further automate the monitoring pipeline, which is crucial in the long-term context of the monitoring of micro- (phyto)plankton.

Reference
[1] https://rshiny.lifewatch.be/flowcam-data/

Keywords: Phytoplankton; Microplankton; CNN; Modeling; FlowCAM

Do we inhale aerosolized microplastics on the beach?

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A lot of microplastics (MPs) enter aquatic ecosystems, with estimated amounts between 19 and 23 million metric tons (Mt) or 11% of the plastic waste generated globally in 2016. Under business as usual, plastic waste entering the world's aquatic ecosystems could, according to predictions, reach 90Mt per year by 2030. Thus oceans, and aquatic ecosystems in general, are known to be sinks for plastic pollution. This plastic pollution contains microplastics (MPs), plastic particles with sizes between 1µm and 5mm, and nanoplastics (NPs), plastic particles with sizes smaller than 1 µm. MPs are used in applications such as personal-care products and cosmetic products or are the result of fragmentation of bigger plastics due to photodegradation, physical abrasion, hydrolysis and biodegradation. The plastic particles may pose a risk to the aquatic environment and can be a potential threat to human health. The particles itself may pose a risk as well as potential pathogens and persistent organic pollutants that can be associated and transported with the particles.

However, what if these MPs do not stay in the ocean, but are transferred into the air? Then, the ocean is not only a sink for MPs but also a source. A possible pathway into the air could be the transfer of micro- and nanoplastics in sea spray aerosols (SSAs). When waves in the ocean break, underwater air bubbles are created. When these bubbles come to the surface, they burst and aerosols are ejected into the air. Research has already shown that these SSAs introduce particulate matter, microorganisms, fatty acids and many more organic and inorganic compounds into the atmosphere. Nonetheless, little to no information is available on the presence of plastics in SSAs. If micro- or nanoplastic particles are indeed capable to be included in these SSA, plastics from the ocean could be transferred to the air and transferred to terrestrial environments.

The aim of this study was to investigate the possible presence of micro- and nanoplastics in SSAs and study the influence of different polymer types and sizes on this process. An experimental set up that simulates the aerosolization process at sea was set up, based on Masry et al. (2021, doi: 10.1016/j.envpol.2021.116949), where air bubbles bursting at the surface of the water was created on a small scale. The water was spiked with a known concentration of MPs. Aerosols were created and the MPs present in these aerosols were collected onto a filter and particle concentrations were counted under the microscope or with the use of flowcytometry. Different size classes and different types of microplastics were tested. Afterwards an enrichment factor of MPs was calculated, relative to the sodium concentration, which is used as a proxy for the amount of sea spray aerosol.

From the performed experiments, we can observe that only the small microplastics particles seem to be incorporated in the SSAs, but the bigger particles will not be introduced in the air via sea spray aerosols. Thus, as expected, the size of the plastics has an impact on the aerosolization, but further experiments with particles in wider size ranges (100 nm-5µm) will be able to provide more information on the size-thresholds for aerosolization. The importance of the type of plastics on their aerosolization behavior, is currently being investigated.

Keywords: Microplastics; Nanoplastics; Sea spray aerosols; Air

Detecting windmill parks in the ocean based on Sentinel satellite imagery

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In this paper we try to identify windmill parks in the ocean based on satellite imagery. A convolutional neural network (CNN) was trained to detect individual windmills and boats. Land coverage maps and noise reduction techniques were applied in the preprocessing phase to improve training. Density-based clustering algorithms (DBSCAN and OPTICS) were compared in order to optimize the intermediate results. The final result is a generated ESRI shapefile that encircles all identified parks with a polygon.

Keywords: Windmill park; Satellite imagery; Convolutional neural network; Clustering algorithm; Sentinel

Microplastics transfer from the ocean to the atmosphere through aerosolization

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Microplastics have become a topic of concern in the last decade, as their occurrence in the environment is a potential threat to organisms, ecosystems, and human health. Plastic debris do not readily degrade, and their accumulation in marine environments is now recognized as a high priority issue for environmental research and policy. Microplastics (MPs) are small plastic particles (0.001 - 5 mm) produced by fragmentation of larger debris or manufactured as microbeads and directly released into the environment. Currently, MPs can be found in all aquatic environments, including rivers, ponds, lakes, oceans, and even drinking water for human consumption. Furthermore, MPs have recently been reported in the atmosphere. They can be transported all around the globe, even to remote locations (e.g., the arctic, deep sea, high mountains, and great lakes). There are still important knowledge gaps about the distribution and fate of MPs in the marine environment. Up to now, water currents and runoff, wave action, and wind have been assumed to play the most important role in the transport of plastic particles to deposition locations. However, recent research has hypothesized that the ocean can transfer particles to the atmosphere through aerosolization processes. Allen et al. (2020) suggested that, along with sea salt, bacteria, viruses, and algae, some plastic particles leave the sea and enter the atmosphere through bubble burst ejection and wave action. Nevertheless, there is no evidence yet to fully support the role of SSAs in the transfer of MPs from seawater to the atmosphere, and very little is known about the role of aerosolization on the pathway of MPs from the ocean to the atmosphere. Preliminary results show that aerosolization of small MPs (1 µm) by bubble bursting is feasible and occurring under artificial settings. In the next phase, we will use a Marine Aerosol Reference Tank (MART), a portable system designed to accurately mimic the naturally occurring physical production mechanisms for SSA particles. We expect that our results will contribute to the understanding of the transport and fate of microplastics in the environment.

Reference
- Allen, S., Allen, D., Moss, K., Le Roux, G., Phoenix, VR, et al. (2020) Examination of the ocean as a source for atmospheric microplastics. PLOS ONE 15(5): e0232746

Keywords: Microplastics; Atmosphere; Aerosolization; Marine environment; Marine Aerosol Reference Tank (MART)

Bayesian Belief Networks to reduce unintentional bycatch in riverine and estuarine plastic removal systems

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Every year vast amounts of plastic waste enter our ocean transported by inland waterways. To prevent plastic debris from reaching the marine environment plastic clean-up technologies are being increasingly designed and developed. However, to date, the possible impact of clean-up technologies on riverine environments is not fully understood. In fact, various are the variables that could influence the chances of biota being unintentionally caught by a plastic clean-up installation. In the presented doctoral research, we aim to test the influence of four groups of variables on the probability of plastic and biota being removed by a clean-up system. A first central cluster of variables refers to the riverine conditions such as the flow velocity in which the clean-up device should be deployed. The next group of variables assembles the traits of the biota present in the river, such as their sizes, buoyancies, or adhesiveness. We identified the traits of plastic items (i.e., plastic size, shape, density, weathering) present in the riverine system as a third cluster of variables. Besides, and as a last group of variables, we will investigate the effect of the operational mechanism of the clean-up device (e.g., curtains of air bubbles, water wheels), which is expected to influence the chances of plastic and biota being collected. To carefully examine the impact of each group of variables on the probability of plastic removal and bycatch, we will collect data from scientific literature, experts and we will conduct mesocosm experiments to integrate missing information. We then suggest the integration of these data into a Bayesian Belief Network (BBN) model for an evidence-based trade-off between plastic removal and bycatch. In this study, we present how BBN probabilistic models can become a beneficial tool in guiding stakeholders in their choice of deploying a clean-up technology in a river or estuary.

Keywords: Bayesian Belief Networks; Plastic clean-up technologies; Rivers; Estuaries

Hyperspectral reflectance of dry, wet and submerged plastics polymers under environmentally relevant conditions

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Harbours, rivers, and coastal areas are focal points for economic development and crucial areas for maritime transport. However, due to poor waste management or accidental release of debris, these areas are hotspots for marine litter, including plastics. To improve plastic-related mitigation policies there is a need to develop methodologies that provide an efficient yet large-scale quantification of plastic litter in aquatic environments with as little disruption of maritime transport as possible.

In recent years, progress has been made on innovative solutions for the detection and tracking of plastics by using remote sensing techniques. Currently, most techniques are mainly based on the analysis of images and spectral information acquired from pristine polymers in laboratory settings with limited field validation. To obtain environmentally relevant and realistic information there is a need to assess empirical data on diagnostic spectral properties of not only pristine but also weathered and biofouled plastics. Particular attention should be given to their reflectance when in water since water is strongly absorbing light in the near-infrared (NIR) and the short-wave infrared (SWIR) spectra, modifying the reflected signal. In addition, the reflected signal could also be altered by particulates in suspension such as algae or sediment.

In this study, as part of the Plastic Flux for Innovation and Business Opportunities in Flanders (PLUXIN) project, we collected hyperspectral reflectance information of plastic polymers (e.g., polyethylene - PE, polypropylene - PP, polystyrene - PS, polyethylene terephthalate - PET) under environmentally relevant settings and treatments. To conduct all the measurements, we used the Analytical Spectral Devices (ASD) FieldSpec 4 equipped with either an 8° or 1° field of view. Samples analysed consisted of pristine, artificially weathered, and biofouled plastics. To mimic the effect of solar radiation, pristine plastic polymers were exposed to UV radiation in an Atlas SunTest CPS+ weathering chamber for 917 h. To investigate the influence of biofilm on the spectral reflectance, we induced biofilm growth on pristine plastic polymers. An aquarium was filled with seawater, kept at an average of 20 degrees, and aerated by an air pump. In addition, field-collected plastic items from the Port of Antwerp (Belgium) and the area of the Temse Bridge in the river Scheldt (Belgium) were analysed. The spectral reflectance of each sample was measured in dry conditions in the Flemish Institute for Technological Research (Mol, BE) optical calibration facility. For a subset of the samples, the hyperspectral reflectance was measured in wet and submerged conditions in a silo water tank at Flanders Hydraulics Research (Borgerhout, BE). In the silo, we mimicked environmentally relevant conditions by testing clear water, and by adding freshwater microalgae and sediment in suspension.

Our preliminary results indicate that: (i) the strong absorption of the water results in lower reflectances of wet plastic in the near and short-wave infrared and almost negligible values when the plastic is submerged; (ii) weak difference is found in the spectral reflectance of clear water and water with added concentrations of freshwater algae; (iii) weathered plastics have a higher reflectance in the first short wave infrared region compared to the pristine sample; and (iv) biofouling influences the reflectance in the visible portion of the light. To quantify the degree of spectral shape similarity between the measured reflectances, we will calculate a spectral contrast angle by converting the spectra of two samples into a multi-dimensional vector, only depending on the shape of the spectra. This angle (θ) is ranging from 0°,

which indicates a high degree of similarity, to 90° indicating no similarity. We expect that our results will contribute to defining optical spectral bands and developing algorithms for the detection and discrimination of plastics in a (semi-) operational environment.

The global diversity of electricity-producing cable bacteria

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Around 10 years ago, it was discovered that electrical currents are naturally running through the seafloor. Soon thereafter, it was found that long, multicellular filamentous bacteria are generating these currents. These so-called "cable bacteria" belong to the family *Desulfobulbaceae* and consist of centimeter-long chains encompassing 1000's of cells. Cable bacteria display a unique "electrogenic" metabolism via which electrons are transported from one end of their filamentous body to the other, thus creating large currents that span centimeter distances. A better understanding of these enigmatic cable bacteria would benefit microbial ecology, but could also spur new applications in bio-electricity. One important question is whether the capability of long-distance electron transport has evolved only once, and is limited to a narrow group of bacteria, or whether it is present in multiple groups of bacteria. Cable bacteria can be found worldwide but the knowledge regarding their diversity and abundance is still fragmented. Thus far, two genera of cable bacteria have been described: *Candidatus* Electronema, which inhabits freshwater sediments, and *Candidatus* Electrothrix which lives in marine sediments. Recent observations show that different cable bacteria morphotypes exist (varying in diameter size) and co-occur within the same marine sediment. Likely, the diversity of cable bacteria is underestimated by the currently available data.

The objective of this study was to improve the understanding of the diversity of cable bacteria. To this end, we screened a variety of different marine sediment environments, and sequenced the 16S rRNA gene of resident cable bacteria. The existing phylogenetic tree was amended with these new sequences as well as with sequences acquired from 16S rRNA sequence archives.

Sediment sampling was conducted in the Belgian zone (St. 130, St. 700) aboard the RV Simon Stevin and at a brackish site in Sicily, Italy. In order to enrich the cable bacteria, sediment cores were incubated in the laboratory. As it is possible to extract single cable bacteria from the enrichment incubations, 16S rRNA gene sequences can be obtained for individual filaments. Additional sequences were obtained from multiple sites in The Netherlands, Australia and the USA. A multiple sequence alignment was conducted to compare the sequences and to enable subsequent phylogenetic analysis.

The new phylogenetic tree presents a substantially expanded diversity of cable bacteria and shows branches that link to several hitherto undescribed genera and species. In particular, Station 130 in front of the Belgian coast, emerged as a treasure chest for undiscovered cable bacteria diversity. Cable bacteria filaments extracted revealed several 16S rRNA gene sequences that cannot be assigned to the two previously described cable bacteria genera (94.5 % sequence identity cutoff).

In conclusion, our results show that the diversity of cable bacteria is still greatly underestimated. Even though cable bacteria are distributed worldwide, their local diversity seems to be higher than expected, with several different species and genera occurring at the same geographic sites. Future studies will show if and how cable bacteria genera can be distinguished from each other in terms of morphology and physiology.

Keywords: Cable bacteria; Microbial biodiversity; Electrical sediments; Phylogeny; Sequencing

People who live by the sea can get healthier by breathing?

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There are shreds of epidemiological data suggesting that living by the sea can have positive effects on human health, but the causal factors are still unknown. Sea Spray Aerosol (SSA) is one of the major atmospheric aerosol particle types, which residents of seaside cities are exposed to on a daily basis, may provide an explanation.

While most of the research on human exposure to SSA focused on the negative health effects during Harmful Algal Bloomings (HBA), there are some papers that suggest the bioactive substances in SSA can regulate the mTOR pathway which is related to several diseases including lung cancer, therefore have can have potentially positive effects on human health.

In this research, we collected SSA samples in different environmental conditions from Apr. 2019 to Apr. 2020, then exposed the extracts of SSA to both normal (BEAS-2B) and adenocarcinomic (A549) human lung epithelial cell lines, along with city aerosol and blank as control groups. The total RNA of each sample was sequenced, and mRNA expression profiles were analysed.

This is the first report indicating the differences of gene expression response to the SSA exposure, which may provide inspiration for research on the ocean and human health.

Keywords: Sea spray aerosol; Human health; Lung cancer; BEAS-2B; A549; Biogenics hypothesis

The World's 230 Exclusive Economic Zones from largest to smallest

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Ever wondered what the largest and smallest Exclusive Economic Zones are? And how large the Exclusive Economic Zone of your home country is compared to its neighbours? Well, the wait is finally over with this infographic, which ranks the world's 230 Exclusive Economic Zones from largest to smallest!

Flanders Marine Institute developed this infographic using the Marine Regions Maritime Boundaries Geodatabase as a basis. The Maritime Boundaries Geodatabase contains several geographic data products on the world's boundaries at sea, among which the Exclusive Economic Zones (EEZ), Territorial Seas and, the most recent addition, the High Seas. These data are being used in a wide number of applications, from biodiversity databases such as the World Register of Marine Species (WoRMS) over global fisheries initiatives such as Global Fishing Watch, to the maritime intelligence of Marine Traffic. Moreover, it also forms an indispensable part of the LifeWatch Species Information Backbone. And you can very easily use them for your own purposes, as the datasets are free and available to use for everyone.

Did you know that our brave little Belgium only takes the 215th spot in the ranking, that the Nicaraguan EEZ looks somewhat like a monster, and that the French Polynesian EEZ has more than ten times the size of the French one? Dive in, and you just might discover some other surprising results!

Keywords: EEZ; Exclusive Economic Zone; Marine Regions; Law of the Sea; UNCLOS

Mangrove forest dynamism at Galle-Unawatuna in Sri Lanka: a case study based on high resolution remote sensing data

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Mangrove forests all over the world are threatened due to climate change and sustained anthropogenic pressure (*1,2*). The Galle-Unawatuna mangrove forest located on the Southern coast of Sri-Lanka is one of these dynamic systems. This makes its long-term monitoring important to understand the spatio-temporal species dynamism taking place here, as well as the underlying causes hereof. In the context of better understanding the dynamism of mangrove forests, a pioneering study started a long-term case study on this forest (*3*). It predicted a future dominance of *Bruguiera gymnorrhiza* (L.) that by a follow-up study could already be detected in the young vegetation layer (*3,4*). Additionally, this follow-up study added an elaborate future structural scenario for the Galle-Unawatuna mangrove forest (*4*). In this study, we will attempt to evaluate the current mangrove species distribution in the Galle-Unawatuna mangrove forest, in order to evaluate species patterns and dynamism during recent years, as well as to compare this to previous iterations of this case study. To achieve this, sequential GIS analyses will be performed on VHR, HR and moderate-resolution imagery in the form of Google Earth historic imagery, Corona declassified images and Landsat imagery. As the availability of the different types of recent satellite data is not yet fully known, exact methodology details cannot yet be provided. We will, however, attempt to perform these sequential analyses up until the most recent available imagery, ideally to assess vegetation differences between 2014 and 2022. For this, a ground-truth control will be performed by Nyandwi et al. (2022) (*5*). Afterwards, this study will combine the newly discovered knowledge together with that gathered during the previous iterations of this case study to get a holistic view on this systems' species dynamics. By doing all this, predictions made in the past will be verified and new predictions will be made in the form of a new structural scenario for future follow-up. Ultimately, we will continue this long-term case study in an attempt to contribute to the species dynamism knowledge that can eventually be used for the protection of this threatened system.

References
[1] Nicholls R. J., Cazenave A. Sea-level rise and its impact on coastal zones. *Science* 328: 1517–1520 (2010).
[2] Polidoro, B.A. et al. The Loss of Species: Mangrove Extinction Risk and Geographic Areas of global Concern. *PLoS ONE* 5(4): e10095 (2010).
[3] Dahdouh-Guebas F., Verheyden A. , De Genst W., Hettiarachchi S., Koedam N. Four decade vegetation dynamics in Sri Lankan mangroves as detected from sequential aerial photography: a case study in Galle. *Bulletin of Marine Science* USA 67(2): 741-759 (2000).
[4] Satyanarayana B. et al. Long-term mangrove forest development in Sri Lanka: early predictions evaluated against outcomes using VHR remote sensing and VHR ground-truth data. *Marine Ecology Progress Series* USA 443: 51-63 (2011).
[5]   Nyandwi A. Vegetation succession in the mangroves of Unawatuna, Galle, Sri Lanka: comparisons of the current and historic vegetation structure and stratification. [Manuscript in preparation] (2022).

Keywords: Mangrove; GIS; Remote sensing; Forest succession; Ecosystem functioning; Social-ecological system; Forecasting

Slippery Mess: Macroplastic Pollution in Slipways at the Port of Ostend

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Marine litter has become a growing issue of environmental concern, globally. Marine litter refers to any processed or discarded item that has been deliberately or accidentally discarded, disposed of, or abandoned, ending up in the marine environment. Plastic litter, which is the most persistent litter, makes up approximately 80% of all marine litter, a result of the expansive usage of plastics in everyday life, their affordability, versatility, ease of production and durability in the environment. Plastic litter has the potential to pose major threats to ocean and human health including entanglement, suffocation, and injuries to marine organisms, reduced aesthetics of the landscape and the breakdown of macroplastics to microplastics which may affect biota. Understanding the fate of plastics in the marine environment is essential, to assess the current state or level of marine plastic pollution and provide necessary information to implement suitable mitigation measures. Information about the accumulation zones and rates in and around port banks, for example, is required for port managers to take action and implement proper waste management solutions. The Port of Ostend is located along one of the busiest shipping routes in Europe, hosting a wide range of commercial ships and fishing vessels. The all-year-round seaport activities can however result in the gradual accumulation of various types of debris, either from land, the port itself or from the sea.

This study, in the scope of the Plastic Flux for Innovation and Business Opportunities in Flanders (PLUXIN) project, aimed at quantifying and characterizing plastic litter on four slipways (the Marine Station Ostend (MSO), Fisheries, Ferry and Eastern stretch dam (beach) slipways) at the port of Ostend during the summer of 2021, to get a better understanding of the type, sources, accumulation rate and polymer content of plastic litter. The Oslo/Paris Convention (OSPAR) Commission Guideline for Monitoring Marine Litter was the protocol used for this study. The initial standing stock of plastic litter was quantified, followed by an accumulation survey, conducted twice, with a two-week interval. All site descriptions and conditions were recorded, as additional information that could influence the amount and type of litter at the slipways. The litter collected was sorted into different OSPAR litter categories, counted, weighed, brand audited, and the data recorded. In the laboratory, the polymer content of the plastics was analyzed, using the Fourier Transform Infrared Spectroscopy (μFTIR) machine. Results indicate that geographical location, in relation to wave and wind dynamics influences litter accumulation rate at the study site. The more exposed slipway, beach slipway, had the least amount of litter (0.05 ± 0.008 items/m²) while the less exposed fisheries slipway had the highest litter count per slipway with a total value of 36.75 ± 10.07 items/m² and the highest accumulation rate of 225.3 items/day. The dominant polymers in the plastic items were Polyethylene (54.9%), Polypropylene (39.2%), and Polystyrene (39.2%). We observed evidence of human influences, with the deliberate discarding of plastics and cigarette butts at the Ferry slipway, COVID-19 waste deliberately abandoned or brought in by currents and wind, while discarded fishing ropes and nets were found tied on rocks and boulders at the Eastern stretch dam slipway.

The brand audit indicated that the dominant litter sources were from European countries (46%), International sources at 30% while 24% originated from Belgium. Fishing gears made up 21.1% of the total litter collected. The COVID-19 pandemic has introduced new types of waste such as covid masks, disposable gloves and disinfectant gel and it is advisable to include them in monitoring protocols and the available management strategies.

Our research only comprised of two months of data collection, but based on the protocol we followed and fine-tuned, long-term observations could be performed in a systematic way. Information about the types of marine litter, their quantification, and identification of pollution hotspots can support tailor-made waste management strategies to mitigate pollution not only on the port of Ostend, but also in other coastal ecosystems and seaports.

Microplastic formation from a bio-based composite after ultraviolet irradiation

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Concerns have arisen about the environmental persistence and biological impacts of microplastic (MP, < 5 mm) in the global ocean. An important source of MP in the marine environment is originating from the degradation of petroleum-based polymers such as polypropylene (PP) induced by important weathering processes especially ultraviolet (UV) radiation. Polymers and composite materials made from a natural-sourced feedstock, like polylactic acid (PLA) known as bio-based polymers and composites, are seen as more sustainable alternatives to petroleum-based polymers because of their assumed lower environmental impacts. However, to date, few studies have focused on the microplastic formation from bio-based polymers and composites during their degradation in the marine environment. As part of the Interreg 2 Seas Mers Zeeën project SeaBioComp (seabiocomp.eu), we aimed to compare and quantify the MP formation of a newly developed bio-based composite and a reference petroleum-based polymer during artificial weathering under UV radiation. To do so, we exposed 3D printed cylinders (1 x 1 x 1 cm) of self-reinforced PLA (SR-PLA) and PP respectively, immersed in natural seawater, to UV radiation simulating natural solar exposure of 18 months in central Europe. Dark controls (i.e. in sealed vials from the UV radiation) were incubated under the same conditions. To identify and characterise the formed MP particles (> 50 µm), we applied a combination of fluorescence microscopy, infrared technology (µFT-IR) and image analysis. We observed that 263 ± 285 PP MPs and 14 ± 9 SR-PLA MPs were formed in UV treated samples, while 3 ± 4 PP MPs and 7 ± 3 SR-PLA MPs were formed in dark control samples. As such, UV irradiation, equivalent to 18-month solar exposure, accelerated the MP formation of PP ($p < 0.05$, Kruskal-Wallis) but not SR-PLA ($p = 0.29$, Kruskal-Wallis), suggesting that the bio-based composite SR-PLA is more resistant to releasing MPs than the reference petroleum-based polymer. We anticipate that our results will contribute to assessing the sustainability of future bio-based polymers and composites applications and to supporting a transition process to more sustainable plastic materials.

Keywords: Microplastic formation; Bio-based polymer; Ultraviolet; Plastic pollution; SeaBioComp

Forever intimate : Investigating the evolutionary implications of seaweed-bacterial symbiosis in *Bryopsis*

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Seaweeds are important marine primary producers and ecosystems engineers, supporting diverse marine organisms, including bacteria. Ties between bacteria and algae actually date to the origin of eukaryotic algae themselves, millions of years ago! A chloroplast symbiosis event between a Cyanobacterium and a non-photosynthetic eukaryote kick-started what would become a world-changing collaboration. From this single interaction, a chain of events was set in motion, giving rise to the amazing algal and plant diversity that we enjoy today.

Interactions between seaweeds and bacteria, however, are not limited to the enslavement of a Cyanobacterium eons ago. Current day seaweeds also associate with bacteria resulting in diverse benefits and drawbacks for the partners involved. Nutrient exchange, protection from predators, disease causation and nitrogen fixation are just a few of the roles played by bacteria hosted by seaweeds. On the other hand, the macroalgae provide an organic-matter-rich home for the bacteria and photosynthetically generate oxygen required by the bacteria for respiration. Associations between bacteria and seaweeds can be permanent or temporary.

Our study is an exploration of the diversity and evolutionary history of the bacteria associated with one remarkable macroalga - *Bryopsis*. The alga is characterized by a tubular structure which is essentially one giant cell with a large centralized vacuole surrounded by a cytoplasmic region teeming with bacteria. *Bryopsis* has a very wide distribution, which might be due to its bacterial symbionts that enable it to adapt to a broad variety of ecological conditions.

The bacterial communities living within different *Bryopsis* species sampled from several locations along the European coast haven't been characterized. Our first goal is to relate the bacterial community composition genetic relatedness between hosts so as to understand the role of the symbioses in shaping their evolutionary histories. Subsequently, we shall investigate the nature and stability of the symbiosis between *Bryopsis* and its different bacterial symbionts through *in vitro* monitoring of the temporal changes that occur in the bacterial diversity throughout the life history of the algae. Novel high throughput amplicon sequencing techniques are being applied to identify and quantify the bacteria present in different *Bryopsis* strains at different stages in their complex life history.

Preliminary findings show significant variations in bacterial communities hosted in *Bryopsis* samples collected from different sites, implying the role of the environmental parameters in shaping bacterial - macroalgal symbioses. The findings of this work will not only enable further understanding of the diverse bacteria associated with *Bryopsis* but also provide insights into the bacterial transmission mechanisms and evolutionary implications of bacterial - algal symbioses.

Keywords: Symbiosis; Seaweeds; Algae; Bryopsis; Bacteria; Diversity; Evolution

Vegetation succession in the mangroves of Unawatuna, Galle, Sri Lanka: comparison of current and historic vegetation structure and stratification

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Galle-Unawatuna is a dynamic mangrove ecosystem in Sri Lanka that is under threat from both natural and sustained anthropogenic factors[1]. This ecosystem is well-known for its socio-economic and ecological significance in providing ecosystem processes, functions, goods, and services[3]. Long-term monitoring is thus necessary to assess the pattern of species succession and to understand underlying factors.

A pioneering study predicted that *Bruguiera gymnorrhiza* (L.) would eventually dominate the mangrove forest's surface cover[1]. A follow-up study revealed that the dominant layer of young species and went on to predict that a decade later, *B. gymnorrhiza* would supplant other species and dominate the mangrove adult forest[2]. This decade later is "now" and the main objective of this study is to therefore test these predictions made ten years ago in Galle-Unawatuna mangrove forest. Thus, the current comparative research is designed to: 1) assess the structure and stratification of mangrove species composition, 2) investigate the potential link between vegetation composition and selected environmental factors.

The ground truth survey will use a plot-based method to revisit historical transects and collect vegetation structural parameters from a total of 120 plots. Within each 10 × 10 m² plot along the transects, we will identify species, count individuals, and measure tree height and diameter (D_{130}) for both young and adult trees. Within each main plot, we will set up a 5 × 5 m² subplot to determine the percentage cover of juvenile species. In addition, within each main plot, we will record topography/water level, crab borrowing diameter, and snail density in 1 m² subplots. Finally within a 20 × 50 m² section of the forest a detailed triangulation of all trees will be done in an area that was already investigated about 20 years ago to document vegetation dynamics on tree level. Therefore, we will gain an understanding of the current complexity, succession, and stratification of the forest by calculating stem density, basal area, frequency, and their relative values, as well as the importance value and complexity index. We will use non-metric multidimensional scaling (NMDS) to identify the link between species composition in different locations and the relationship of species with selected environmental variables. Understanding species composition, shifts in distribution, structure, and stratification is critical for the scientific management of dynamic mangrove.

References
[1] Dahdouh-Guebas, F., Verheyden, A., De Genst, W., Hettiarachchi, S., & Koedam, N. (2000). Four decade vegetation dynamics in Sri Lankan mangroves as detected from sequential aerial photography: A case study in Galle. Bulletin of Marine Science, 67(2), 741–759.
[2] Satyanarayana, B., Koedam, N., Smet, K. De, Nitto, D. Di, Bauwens, M., Jayatissa, L. P., Cannicci, S., & Dahdouh-guebas, F. (2011). Long-term mangrove forest development in Sri Lanka : early predictions evaluated against outcomes using VHR remote sensing and VHR ground-truth data. 443, 51–63. https://doi.org/10.3354/meps09397

[3] Satyanarayana, B., Mulder, S., Pulukkuttige, L., & Dahdouh-guebas, F. (2013). Ocean & Coastal Management Are the mangroves in the Galle-Unawatuna area (Sri Lanka) at risk ? A social-ecological approach involving local stakeholders for a better conservation policy. Ocean and Coastal Management, 71, 225–237. https://doi.org/10.1016/j.ocecoaman.2012.10.008

Ecosystem health scores to aid in conservation and restoration project reporting

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Conservation and restoration initiatives are lacking in reporting approaches that engender themselves towards easy implementation, short- and long-term impact and cost-effectiveness. Composing an interdisciplinary perspective for reporting on, and evaluating ecosystem health is expected to help close the gap from knowledge generation to management action. The objective of this research is to identify a new score-based methodology to assess ecosystem health through biodiversity, socio-economic and public awareness metrics. This will be done through a combination of an extensive literature review and the surveying of conservation professionals and academics.

Six pillars of conservation impact have been identified as; *fauna and flora, biotic and abiotic factors, threat management, community involvement, public awareness, and ecosystem services*. Several indicators will be developed for each pillar based on the results of the literature review and survey responses. These indicators will then be analysed to receive a low, medium or high score in relation to optimal conservation or restoration outcomes. Then the indicator scores will be added together to generate a pillar score and an overall ecosystem health score that is project-specific. As a result, we expect to find a general consensus among professionals and academics for indicator use in this methodology. We hope to see an increase in understanding of conservation and restoration challenges among the general public who have interacted with this new assessment methodology.

Keywords: Ecosystem health; Biodiversity; Conservation; Scientific reporting

Mangroves social-ecological system in Jaffna Peninsula: mapping stakeholder perceptions for mangroves conservation

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Mangrove forests provide key ecological processes which support the livelihoods of local communities and beyond, through the provision of a diverse set of ecosystem goods and services (Dahdouh-Guebas et al., 2021).

In recent years, mangroves in Northern Sri Lanka have been exposed to increasing anthropogenic stressors that led to their degradation (Karunathilake, 2003). Additionally, three decades of civil war and a destructive tsunami in 2004 contributed to worsen the state of the mangrove forest and threaten the livelihood of the communities living in proximity of this ecosystem (Dahdouh-Guebas et al., 2021). With this study, we investigated the most important mangrove goods and services that local communities benefit from, and derived possible mangrove forest management solutions.

We collected data from: (i) a stakeholder questionnaire, to investigate the well-being of the population, which include social, material and health concerns (White, 2010); (ii) an ethnobiological survey, to assess the mangrove forest's goods and services used by the local population and their perception of the mangrove forest. We found that the degree of dependence of the local population to the mangrove ecosystem varies among the respondents, with a majority placing high importance on wood consumption and fish nursery. Moreover, the local communities have a general positive perception of the mangrove ecosystem, especially related to coastal protection and tourism attraction; they expressed willingness to be involved in conservation projects but also showed a low understanding of regulations and legal enforcement. Therefore, we investigated the roles of authorities in mangrove management and conservation on the Jaffna peninsula. A Delphi survey (to identify expert opinions) and a Q methodology (to map perceptions) are currently being performed in the area. These data combined with bibliography will allow us to gain deeper insights of the local mangrove social-ecological system, and to lay the basis for collaborative, multi-actor conservation initiatives.

References
- Dahdouh-Guebas, F., Hugé, J., Abuchahla, G. M. O., Cannicci, S., Jayatissa, L. P., Kairo, J. G., … & Wodehouse, D. (2021). Reconciling nature, people and policy in the mangrove social-ecological system through the adaptive cycle heuristic. Estuarine, Coastal and Shelf Science, 248, 106942.
- Karunathilake, K. M. B. (2003). Status of mangroves in Sri Lanka. Journal of coastal development, 7(1), 5-9.
- White; S. C. (2010). Analysing wellbeing: a framework for development practice. Development in practice, 20(2), 158-172.

Keywords: Mangroves; Social-ecological-systems; Questionnaire surveys; Community-based management; Sri Lanka

Influence of changing water temperature and plastics leachates on an individual and molecular level of the harpacticoid copepod *Nitokra spinipes*

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In the last decades human activities have affected the ocean environment. Due to anthropogenic release of greenhouse gasses, atmospheric CO_2 levels have been rising to a current concentration of over 400 ppm, which has led to an average increase in the Earth's sea surface temperature of 1.5 °C compared to pre-industrial times. The increasing seawater temperatures can impact marine biodiversity and the functioning of the ocean. Besides the potential effects of climate change, plastic debris has the potential to cause adverse effects on marine life. An indirect effect of plastics is related to associated chemicals that leak from polymers. These chemicals have the potential to cause adverse effects to the base of the marine food web. To date, these effects have not been tested yet in a relevant and realistic scenario in combination with potential climate change effects. Indeed, so far, research lacks knowledge about the combined effects of increasing water temperature and plastic leachates. The aim of this project is to assess the effect of plastic leachates and increasing water temperature of the copepod *Nitokra spinipes* on an individual and molecular level. The harpacticoid copepod *N. spinipes* is an ecologically important group of crustaceans with a well-studied larval development. Larval development tests were conducted to track the development from the larvae stage to the copepodite stage while the organisms are exposed to leachates at two different temperatures (22 ºC and 24 ºC). In our work, newly hatched *N. spinipes* larvae were exposed to a dilution series of leachates from a bio-based following polylactide (PLA) following the ISO/TS 18220:2016 protocol in combination with an increased water temperature (+2 ºC). To test the effect of PLA leachates and an increased temperature on a molecular level, we will look at biomarkers, since they act as an early warning indicator for toxicity. We will assess the expression of multiple chaperoning genes, reproduction genes and oxidative stress genes by conducting quantitative reverse transcription polymerase chain reactions (RT-qPCR) and comparing expression levels of target genes with that of housekeeping genes ($2^{-\Delta\Delta Ct}$ method). Experimental work on the combined effects of temperature and leachates are currently ongoing. We anticipate that our results will contribute to assessing the effect of leachates and increasing water temperature on molecular and individual organism levels.

Keywords: Plastic pollution; Plastic leachates; Global warming; Nitokra spinipes; Gene expression; Larval survival rate; Larval development rate

European Marine Biological Resource Centre (EMBRC): Support and services for marine biological research and innovation

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The European Marine Biological Resource Centre (EMBRC) is a research infrastructure that enables researchers to better understand the ocean's biodiversity. EMBRC aims to advance fundamental and applied marine biology and ecological research, while promoting the development of blue biotechnology. This is achieved by facilitating access to marine organisms and ecosystems, experimental facilities, technological platforms, and relevant services in its 46 marine stations and research institutes in nine European countries including Belgium.

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Each institute provides unique infrastructure and services in line with the goals of EMBRC. All institutes contribute with fundamental, expert-based and state-of-the-art services such as provision of marine biological resources via access to culture collections at UGent and UHASSELT; sample collection facilities at VLIZ and RBINS; access to North Sea marine ecosystems and experimental facilities at RBINS, UGent and VLIZ; and omics and imaging technology platforms at KU Leuven and UGent. UGent coordinates the EMBRC activities for training and education via the MarineTraining platform (marinetraining.eu) and the coordination of an International Master programme in Marine Biological Resources (imbrsea.eu).

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Keywords: EMBRC; Research infrastructure; Marine research; Innovation

Are all beaches alike? Alongshore variability of the Belgian coast

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At first sight all beaches look similar, they gently slope down from land to the sea. However, if you have ever visited different parts of the Belgian coast, you might have noticed some clear differences; such as the presence of dunes, a sea dike or groynes. Then, how closely related are the different beaches along the coast?

In engineering practise it is often assumed that the coast is rather uniformly shaped at least within a section (~250 m) or even over several kilometres. On the other hand, locations only a few kilometres apart may exhibit different response to storms or other extreme events (Crapoulet et al., 2017, Houthuys, 2012). Due to the availability of high-resolution surveys of the coastal area, the validity of these assumptions can be tested.

The Belgian coast's topography is surveyed each year with lidar from an aeroplane (Eurosense, 2020). This results in a high-resolution point cloud or digital terrain model (DTM), from which profiles perpendicular to the coastline are taken. These profiles can be obtained as either a local cross-section or averaged over a distance along the coastline. In a local context it is investigated over which distance the beach profile remains the same within a coastal section. In the regional context resulting profiles for each coastal section are correlated to find out where similar profiles exist along the coast.

In areas without groynes local and averaged beach profiles differ only several centimetres, which is close to measurement accuracy. This confirms profile uniformity within a beach section. However, groynes locally disturb the beach. As a result, the local beach profile near a groyne can deviate more than 0.5 m from the mean. However, on more than approximately 10 m from the groynes the profile is uniform. For dunes alongshore uniformity does not hold. Deviations there range to several metres, underlining the complex shape of dunes.

Bibliography
- Crapoulet, A.; Héquette, A.; Marin, D.; Levoy, F. & Bretel, P. 2017. Variations in the response of the dune coast of northern France to major storms as a function of available beach sediment volume. Earth Surface Processes and Landforms, Wiley, 2017, 42, 1603-1622.
- Eurosense 2020. Eindrapport LiDAR missie Belgische Kust, Najaar 2020. Monitoring topografie strand en dynamische duinen, slikken en schorren.
- Houthuys, R. 2012. Morfologische trend van de Vlaamse kust in 2011. Agentschap Maritieme dienstverlening en Kust, Afdeling Kust.
- Roest, L.W.M. 2021, Combined topography and bathymetry of the Belgian coast, schematised to cross-shore transects 1997-2020.

Keywords: Coastal morphology; Beach profile; Topography

An inter-order comparison of copepod fatty acid composition and biosynthesis in response to a long-chain PUFA-deficient diet along a temperature gradient

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Copepods are a key trophic link in marine food web dynamics, connecting primary producers to higher trophic levels. Recent warming conditions have reduced the concentrations of essential fatty acids (EFAs) in phytoplankton, and it remains unknown if copepods have the adaptive capacity to cope. Calanoid species, *Temora longicornis,* and harpacticoid, *Platychelipus littoralis,* from the North Sea and Westerschelde mudflat respectively, were chosen to characterize the fatty acid (FA) biosynthesis response to a polyunsaturated FA (PUFA) deficient diet (*Dunaliella tertiolecta*) along a temperature gradient. Copepods were fed ^{13}C-labelled *D. tertiolecta* to quantify assimilation and *de novo* FA production at 11, 14, 17, 20, and 23 °C. FA composition and ^{13}C isotope incorporation were determined using gas chromatography mass spectrometry (GC-MS) and GC-combustion carbon isotope ratio-MS (GC-C-IRMS) respectively.

To compensate for poor quality food organisms can increase the carbon incorporation efficiency (1). Through the use of labelled food we are able to discern this effect on the assimilation and thereby what is retained by the individuals. *T. longicornis* has higher overall rates of assimilation, and maintains this across all temperatures, likely to compensate for the high metabolic costs. This indicates that either this process is independent of temperature in the calanoid, or the experimental stress was heightened enough at 11 °C to induce maximum ingestion rates, to compensate for the stressors. In comparison, *P. littoralis* has relatively low assimilation, only increasing at the highest temperature treatment (23 °C). This in conjunction with the retention of relative field EFA concentrations may indicate that *P. littoralis* does not need to increase assimilation to meet their metabolic demands until the extreme of 23 °C. Standardized per day, carbon assimilation in *P. littoralis* ranges from 0.075 to 0.214% day^{-1} at 11 and 23 °C respectively, whereas in *T. longicornis* it is 2.014% day^{-1} on average. Interestingly, the deviation of *T. longicornis* ^{13}C assimilation per total lipid increased with temperature, this heightened variability between replicates is recognized as a biochemical indicator of environmental stress (2).

P. littoralis did not assimilate ^{13}C readily, and consequently did not exhibit high bioconversion rates. *T. longicornis* displayed higher rates of *de novo* bioconversion for eicosapentaenoic acid (EPA, 20:5ω3) and docosahexaenoic acid (DHA, 22:6ω3) than *P. littoralis* at all temperatures, with the exception of DHA at 23 °C. This temperature was the most stressful for the calanoid displaying a higher mortality with warming, comparatively the harpacticoid was eurythermal, with survival independent of temperature. The relative EPA, an important EFA, in *P. littoralis* did not change between the field and the experimental samples, therefore we hypothesize that this species is able to maintain the required amounts necessary, thus not needing to allocate energy towards these costly metabolic processes.

Although there may be a reduction in absolute omega-3 availability in primary producers, it is important to consider that complete absence, as in our experiment, is not a realistic scenario. Despite the fact that *T. longicornis* demonstrated higher *de novo* production, albeit not in sufficient amounts, individuals depleted their field EPA stores more rapidly. This indicates that *T. longicornis* is not able to biosynthesize EPA at a rate necessary for basic metabolic functioning, yet *P. littoralis* has maintained its relative stores, suggesting these extremes are within their coping capacity. Under the stressors imposed, *P. littoralis* has a greater potential for adaptive resilience when faced with extreme conditions in comparison to *T. longicornis*. This is the first experiment to quantify the *de novo* production of FA in the

dominant North Sea calanoid *T. longicornis* and monitor EFA *de novo* production along a thermal gradient in a comparative study with both harpacticoid and calanoid copepods.

References
[1] Gulati, R., Demott, W. (1997). The role of food quality for zooplankton. *Freshwater Biology*, **38**: 753-768.
[2] Werbrouck, E., Bodé, S., van Gansbeke, D., etc. (2017). Fatty acid recovery after starvation: insights into the fatty acid conversion capabilities of a benthic copepod. *Marine Biology*, 164-151.

Keywords: Calanoida; Harpacticoida; Climate-change; Fatty acids; Bioconversion; Food quality; Warming

Investigating chemical settlement cues and their interactions for Pacific oysters (Magallana gigas) using video analysis

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Coastal environments are subject to intense anthropogenic pressure worldwide. Many species occurring in this habitat, including reef-building bivalves, have relevant ecosystem functions and provide socio-economically ecosystem services such as coastal protection and improving ecological resilience. While some species struggle to survive in anthropogenic habitats and populations are diminishing, others thrive, become abundant or even invasive in areas where they did not previously occur. Such species include many bivalves, one of those being the Pacific oyster (*Magallana gigas*) which colonized large parts of western Europe during the 20th century.

Many factors contribute to the successful colonization of new substrate by bivalves. A key factor is settlement preference. Understanding how ecological cues influence larvae settlement will help potential restoration efforts as well as broaden ecological understanding of the species.

This research focuses on how the interaction of multiple ecological cues steer behaviours of pacific oyster (*Magallana gigas*) larvae during settlement. The influences of both olfactory chemical cues, and physical substrate properties are studied here for a more robust view of settlement in the natural environment. This experimental research project seeks to answer questions such as:
- Will preference of settlement substrate change in the presence of chemical cues?
- Do predator cues result in a delay in settlement time and does an increase in cue strength affect this response?
- How does the presence of both predator and conspecific cues change settlement behavior?

In the first phase of this project, an experimental setup has been developed in which settlement and behavior of the pediveliger stage larvae is measured using video recording and automated image analysis. Videos of larvae are taken using multiple Raspberry pi HQ cameras and computers, and particle tracking software is used to analyze settlement time and larvae behaviors prior to settling. This technique for assessing larvae settlement improves time-consuming manual settlement assessments enabling complex experimental setups that can investigate multiple settlement cues and their interactions.

Keywords: Larvae settlement; Settlement cues; Bivalves; Coastal systems; Pacific Oyster; Video analysis

A qualitative study on emotions experienced at the coast and their influence on well-being

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An increasing number of studies have demonstrated that residential proximity to the coast is associated with a better health and well-being. Research on putative factors contributing to the well-being benefits of living near the coast has mainly focused on physical, social, and cognitive mechanisms but less so on emotional mechanisms. To create a more comprehensive framework of how and why the coast benefits well-being, the present study explored how coastal residents make sense of the emotions they experience at the coast and how these emotions influence their well-being.

We conducted semi-structured individual interviews with a purposive sample of eight Flemish adults aged between 21 and 25 years old, who had grown up near the Belgian coast and/or were currently residing near the coastline. The interviews took place from October to December 2020 via Skype and lasted between 40 to 60 minutes. A predetermined interview guideline was set up and involved asking participants to describe their relationship with the coast, the specific emotions they feel at the coast, and what effect these emotions have on them. Questions remained flexible and participants were encouraged to speak freely, to bring up areas that were not considered by the researchers.

The interviews were analyzed according to the Interpretative Phenomenological Analysis framework. This approach led us to identify five superordinate themes that emerged from the interviews: emotional restoration, awe, nostalgia, emotion regulation processes, and the coast as a 'safe haven'. The themes demonstrate that for our participants, the coast represents a place that facilitates emotionality and vulnerability and provides the means to cope with difficult thoughts and feelings, through contemplation and exteriorization for example. Prominent emotions were mostly regarded as positive, but our participants also reported ambivalent emotions containing facets of both positive and negative affect.

The study highlights experiences of complex emotions and adaptive emotion regulating processes facilitated by the coast's multisensory and symbolic qualities. These experiences appear to have a beneficial impact on the participants' well-being and should therefore be considered as potential contributors to the coast's therapeutic potential.

Keywords: Coast; Well-being; Emotions; Emotion regulation; Interpretative Phenomenological Analysis

Spatio-temporal distribution of shrimp species in the lake Nokoué-Cotonou channel complex in southern Benin

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The aim of this work was to study the spatio-temporal distribution of shrimp species in the lake Nokoué-Cotonou channel complex in southern Benin. On five stations (North, South, Center, East and West) of lake Nokoué, the sampling was carried out thanks to the creel and the net every fifteen days following each station.

The results of seven months showed the following specific proportions: *Penaeus notialis* 87%, *Macrobrachium macrobrachion* 5%, *Penaeus Kerathurus* and *Macrobrachium vollenhoveni* 2% followed by the species *Penaeus monodon*, *Macrobrachium felicinum* and *Macrobrachium sp1* which occupy 1%. The rest of the species *Macrobrachium zariquieyi*, *Macrobrachium equidens*, *Macrobrachium sp2* and *Macrobrachium sp3* being less than 1%. The highest size frequency [60, 70[mm was observed in *Penaeus notialis* with an abundance west of lake Nokoué. Large specimens with a size frequency of [120, 130[mm were sampled east of lake Nokoué in April and May. The largest size sampled from *Penaeus notialis* was 125.9 mm with a body mass of 16.5 g. The abundance of species of the genus *Penaeus* is positively correlated with salinity, transparency, and dissolved solids concentration, while the abundance of species of the genus *Macrobrachium* is negatively correlated with salinity. The highest 7-month average salinity of 32.3±2‰ was obtained in the south of lake Nokoué while the lowest 7-month average salinity of 8.35±7.028‰ was observed in the east of lake Nokoué. A high specific diversity of shrimps is observed during the months of November and December more precisely in the North (1.17±0.044‰) and East (0.6±0.54‰) of lake Nokoué. However a low specific diversity of shrimps dominated mainly by *Penaeus notialis* is observed in lake Nokoué from January to May (period of high salinity).

From these preliminary results, we suggest to concentrate fishing effort in the eastern part of the lake to favour a judicious management of the shrimp stock in the lake Nokoué-Ocean complex.

Keywords: Crustacea; Decapoda; Palaemonidae; Penaeidae; Penaeus; Favorable habitat; Salinity; Southern Benin

Interaction of marine algae and nanoplastics, and the possible impact on the bioavailability of nanoplastics to primary consumers through the food-pathway

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Plastic pollution is a global problem. While macro- and microplastics are largely studied in terms of environmental concentrations and toxicity, a knowledge gap exists regarding nanoplastics (1-1000 nm diameter). Nanoplastics enter our environment both as primary products, engineered for cosmetic and pharmaceutical purposes, and as secondary degradation products. However, due to deficient sampling methods and analytical identification methods, information on environmental concentrations is lacking. Nevertheless, it is assumed that the exposure route, extent and rate of bio-uptake, and the nature of adverse effects will differ from those of microplastics, due to the reactivity features of nanoscale entities and the fact that they are small enough to cross biological barriers.

The aim of the study is to investigate the interaction between marine algae species and nanoplastics. We want to analyze whether there is an interaction, and what sort of interactions (aggregate formation, adsorption of the particles on the algal cell surface or absorption of the particles into the algae cell). Analysis of the quantity of particles that interact with algae is done using flow cytometry and visual inspection of the interactions is performed using fluorescence microscopy. Subsequently, we will analyze EPS (extracellular polymeric substances) production to investigate whether algae-aggregate formation is affected by the nanoplastics' presence. This is done using the Bradford assay, a colorimetric method for total protein determination. Data will be collected for two algae species and three different plastic types in three concentrations, every day during the exponential part of the growth curve, and every other day during the stationary phase of the growth curve.

The algae species used for the experiment are *Rhodomonas salina* and *Isochrysis galbana*, which are relevant algae species for the North Sea food web. Both species are exposed to concentrations of nanoplastics that are assumed to be environmentally realistic, using data on micro-plastic concentrations from measurements in the Port of Ostend.The nanoplastics used are fragmented hydrophilic PET, PP and PE, with a broad unimodal size distribution: diameters in the range from 40 nm to 5 µm. For PET, 90% of the particles have a diameter smaller than 1 µm, and for PP, 90% of the particles have a diameter smaller than 2.9 µm.

As it is yet unknown how fast and to what extent microparticles will degrade in nature, the calculation of the factor to convert observed microplastic concentrations to assumed nanoplastics concentrations is based on mass conservation principles. The factor is determined for the fragmentation of spherical microparticles with an average diameter of 250 µm to spherical particles with the size distribution of the plastic dispersions present in the lab. The starting point of 250 µm is based on measurement data in the Port of Ostend.

This research will be valuable for studying the effect of algae-NP interaction and provides relevant information on algae as a potential exposure pathway for marine copepod species such as *Nitocra spinipes* and *Acartia tonsa*.

Keywords: Nanoplastics, Marine algae, Aggregates, Interaction

The 1st ICOS OTC pCO$_2$ instruments Inter-Comparison 2021: Initial results

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In summer 2021, with one year delay, the Ocean Thematic Centre (OTC) of the European research infrastructure "Integrated Carbon Observation System" organized an inter-comparison exercise for pCO$_2$ instrumentation. The exercise focused on surface applications and took place at the Flanders Marine Institute's (VLIZ) Marine Station Ostend in Ostend/Belgium. The goal was the rigorous assessment of instrument capabilities and documenting their measurement uncertainty. Following this exercise, we aim to improve the quality and aid the processing of ocean pCO$_2$ data, enabling better estimates of ocean CO$_2$ uptake and ocean acidification. Furthermore, the ongoing interaction between manufacturers and the extensive user group that this experiment enabled facilitates continuous instrument improvement. During the 2 week exercise, we deployed 29 instruments of 18 different types in a temperature-controlled water tank containing ca. 5 m^3 seawater. The water pCO$_2$ was manipulated by changing the temperature or by adding chemicals (acid or base). This allowed us to compare the pCO$_2$ measurements at different temperatures (10 – 30°C) and pCO$_2$ levels (200 – 800 µatm). Here we present the first results from the inter-comparison and provide suggestions for future experiments and sensor development.

Flow cytometry for microplastic observation in the marine environment

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In recent years, there is a growing concern about the accumulation of microplastics in the environment and the associated risks for ecological and human health. To date, multiple physical and chemical identification methods are widely used to assess plastics concentrations in different environmental matrices. However, current methods are usually time consuming, subjective to human bias and often focussed on the analysis of relatively large particles (> 100 µm). However, in ecotoxicological assessments the focus is often on smaller sized particles (< 100 µm). There is a growing need to develop time- and cost-effective methodologies to identify, characterise and quantify microplastics in the field. The combination of flow cytometry with fluorescent dyes, specifically Nile red, is a promising methodology that can enable high-throughput detection of micro- and nanoplastics. Flow cytometry is an extremely fast method with which thousands of cells can be identified in a few seconds, and that is widely used in different ecological applications such as the screening of phytoplankton in seawater. The fluorescent dye Nile red, frequently used to stain lipophilic cellular components in histology, is strongly fluorescent when adsorbed to plastics. Although the combination of flow cytometry and Nile red is expected to be suitable for the detection, quantification and identification of smaller size ranged microplastics, only few studies have investigated this technology in microplastic research.

In this work, we aim to optimize the observation and identification of microplastics (20 µm – 250 µm) using a combination of Nile red staining methods and flow cytometry. As a first step, we developed a microplastic quantification method for small particles to enable verification of the flow cytometer results. In a next step, we assessed how to stain microplastics in a way suitable for flow cytometric analysis, but without affecting the plastics themselves. We developed a method to concentrate the sample volumes and to ensure that the Nile red-stained plastics are homogeneously distributed in the sample volume taken up by the flow cytometer. Autofluorescent polyethylene (PE) and polystyrene (PS) beads will be used to trial the methodology, and this analysis will be followed by Nile red-staining of PE and PS pristine beads, heterogeneously shaped PE and PS particles, and eventually heterogeneously shaped particles of other, abundantly produced polymer types. In the coming months, spiked artificial seawater samples with mixtures of known particles will be tested. We expect our approach to detect and identify polydisperse plastic particles of unknown size and concentration, and we think it can pave the way for a fast and robust in-situ monitoring method of microplastics in the marine environment.

Keywords: Microplastics; Surveys; Marine environment; Flow cytometry; Nile red, In-situ quantification; method development

A new VLIZ workboat: increased seagoing capacity for Flemish researchers

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With the RV Simon Stevin and the RHIB Zeekat, VLIZ operates two complementary vessels, both intensively used by the Flemish research community. The RV Simon Stevin is a 36-meter-long research vessel, equipped with state-of-the-art acoustic devices and sampling equipment, while the RHIB Zeekat is a 6-meter-long rigid inflatable boat, especially suitable for nearshore environments and work at monopiles. Over the last 5 years, the Simon Stevin averaged 180 days at sea each year, while the RHIB Zeekat saw an increase in deployments from 30 to 70 days each year. Both vessels have reached their operational capacity, while more and more applications for shiptime are being received each year. This indicates that the seagoing capacity should be increased to optimally serve the Flemish marine scientific community. Hence, the need for a cost-efficient, complementary, flexible workboat was detected, allowing to perform more near- and offshore research.

VLIZ has acquired the necessary funds to obtain such a workboat and has started the tendering process. Three main general activities are envisaged for this new workboat. First, diving activities should be possible from the afterdeck, which should be equipped with a diving platform. Second, the workboat should contain a moonpool and ample cabin space, to optimize (geophysical) surveys. Third, the workboat should be equipped with sufficient lifting capacities to easily deploy the VLIZ marine robotics and recover/deploy small equipment from and into the water.

A final decision is expected in Q3 of 2022 and the arrival of the new workboat can be expected in the summer of 2023 (timeline subject to changes). With this new workboat, additional and competitive research will be possible, and Flanders will be able to maintain its position at the top of the European marine science community.

Tropical Excellence: Erasmus Mundus Joint Master Degree in Tropical Biodiversity and Ecosystems (TROPIMUNDO)

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TROPIMUNDO is the **Erasmus Mundus** Joint Master Degree in Tropical Biodiversity and Ecosystems funded by the European Commission's excellence programme Erasmus Mundus. It is the first MSc program (2 yrs, 120 ECTS) that integrates the knowledge and skills related to four adjacent interlinked tropical ecosystems under threat (**tropical rainforests and woodlands, wetlands, - both terrestrial and coastal such as mangrove forests, seagrass beds and coral reefs**). Study of these ecosystems is crucial to understand, protect and manage tropical biodiversity in an era characterised by an international **biodiversity crisis** with imminent risks of extinction of species due to global warming and anthropogenic impacts such as habitat destruction and changes in land use.

TROPIMUNDO is unique in incorporating a **2nd semester** (with theoretical courses and a significant field course) in the tropics in **Guadeloupe**, France (Université des Antilles – UdA), **Cameroon** (Université de Dschang – UDsch), **Kenya** (Technical University of Mombasa – TUM), **Madagascar** (University of Antananarivo – UNIVANTA), **Reunion Island** (Université de La Réunion - UNIRé), **Sri Lanka** (University of Ruhuna – RUH) or **Malaysia** (Universiti Malaysia Terengganu – UMT). These institutions cover specialisations in Caribbean insular ecosystems, Central African terrestrial ecosystems, Malagasy forest ecosystems, Tropical forest ecosystems of Reunion Island and the South West Indian Ocean Region, Sri Lankan terrestrial and aquatic ecosystems, Malaysian mangrove ecosystems and other South-East Asian terrestrial and coastal ecosystems, covering a wide choice of skills and qualifications in tropical biodiversity and ecosystems.

Furthermore TROPIMUNDO brings together European expert higher education institutes, with long-standing worldwide expertise in tropical rainforests and woodlands and in coastal ecosystems in Belgium (**Université Libre de Bruxelles – ULB**, **Vrije Universiteit Brussel – VUB**), France (**Sorbonne Université** - SU, **Muséum National d'Histoire Naturelle** – MNHN and **Université de Guyane** – UdG) and Italy (**Università degli Studi di Firenze** – UNIFI). They integrate world class scientific education and research expertise on the aforementioned tropical ecosystems and experience in designing and teaching in international MSc programs. The 1st semester primarily aims at teaching basic courses in Europe, whereas the 3rd semester focuses on specialised courses at one of the European partners. The 4th and final semester is dedicated to the thesis. Graduates obtain a **joint degree**, a joint Europass Diploma Supplement, a Europass Mobility and a Europass Language Passport. TROPIMUNDO's **learning outcomes** stretch far beyond academic knowledge and insight, but also aim at demonstrating enhanced capabilities in effective analysis and communication, independence, creativity and assertiveness, critical judgement, and ethical and social understanding.

During the two years of the Master program TROPIMUNDO students can concentrate on **botany**, **zoology** and **integrative ecosystem approaches** in institutions worldwide. Multiple specialisations are included, such as the evolution of tropical **flora** and **vegetation**; faunistic assemblages; **informatics tools** to treat and manage biodiversity data and **databases** (biogeographical, genetic, geographical information systems) including the **management** and **conservation** of historic collections such as herbarium sheets; the study of **diversity**, **dynamics** and **evolution** of tropical and subtropical ecosystems (with a focus on four related systems, namely tropical rainforests and woodlands, savannas, mangrove forests, seagrass beds and coral reefs, including the interactions between flora, fauna, man and the environment within and between each of these adjacent ecosystems); conservation and **restoration ecology** of natural habitats and their biodiversity including competences in sustainable management and governance of biodiversity, and finally, in tropical **ethnobotany**, exploitation and valorisation of **the functions, goods and services of natural habitats** and their resources, and conservation of **traditional ecological knowledge**.

TROPIMUNDO maximises the inclusion of **European languages** by offering a content and language integrated learning program (English or English + French), and it is delivered in a society that is French, English, Dutch, Italian, Malagasy, Sinhala, Tamil or Bahasa Malaysia, which is valorised using buddy programs and Tandem Learning. This aims at improving the students' language capabilities for which facilities are provided by all partners.

TROPIMUNDO management is handled by a multi-level and shared responsibility involving **5 decision bodies** (Steering, Selection, Jury, Internal Evaluation and External Evaluation), and **1 main execution structure** (Coordination Office), all operating with equal commitment by the partners. A series of **Associated Partners**, including scientific institutes, governmental and non-governmental organisations responsible for conservation or management of tropical ecosystems and their biodiversity, and public authorities, agreed to advertise the program, to provide or to communicate existing placements, jobs, internships or thesis perspectives and scholarships, and to assist in evaluating the program. This links TROPIMUNDO to the real and professional world.

Keywords: Master in Science

Study of the biodiversity of Monogenea and Digenea (Metazoans, Platyhelminthes) Parasites of Sparus aurata (Sparidae, Teleosteans) of the Algerian coast

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Sparus aurata (sea bream) is a Sparidae marine teleost of great economic interest. Frequently harbor various groups of parasites, particularly Platyhelminthes, often causing infections decreasing their commercial value and sometimes causing massive mortalities.

Three species of Monogenea and three species of Digenea were identified from the gills and the intestine respectively. The collected Monogeneans belong to three families: *Lamellodiscus echeneis* Wagener and Hesse 1857 (Diplectanidae Monticelli, 1903*), Encotyllabe vallei Monticelli*, 1907 (Capsalidae Baird, 1853) and *Sparicotyle chrysophrii* Van Beneden and Hesse 1863 (Microcotylidae Tashemberg, 1879).

The collected Digeneas belonging to the same family Opecoelidae Ozaki, 1925 represented by *Allopodocotyle pedicellata* Stossich, 1887; *Macvicaria obovata* Molin, 1859 and *Macvicaria maillardi* Bartoli, Bray & Gibson, 1989.

Allopodocotyle pedicellata Stossich, 1887*; Macvicaria obovata* Molin, 1859 we report this two species for the first time from the coast Algerian.

This study has allowed knowing the biodiversity of the parasitic Monogenea and Digenea in Teleostean fish.

References
- Bartoli, P., Gibson, D. I., & Bray, R. A. (1988). The Opecoelidae (Digenea) of sparid fishes of the western Mediterranean. I. *Pachycreadium* Manter, 1954. *Systematic Parasitology*, 12(3), 231-239.
- Bartoli, P., Bray, R. A ., & Gibson, D. I. (1989). The Opecoelidae (Digenea) of sparid fishes of the western Mediterranean. III. *Macvicaria* Gibson & Bray, 1982. *Systematic Parasitology*, 13(3), 167–192.
- Euzet, L., & Noizy, D. (1978). Parasite du téléostéen *Sparus aurata* : précisions morpho-anatomique sur l'adulte et l'oncomiracidium. *Vie Milieu*., 28/29(4), 569-578.
- Kardousha, M. M., Al-Ansi, M. A ., & Al-Khayat, J. A. (2003). Monogenea of Arabian Gulf fishes. 3. *Encotyllabe spari* and *E. kuwaitensis* (Capsalidae) from qatari waters. *Rivista di Parassitologia.*, 193, 227–235.
- Mahmoud, N.E., Mahmoud A.M., & Fahmy M.M. (2014). Parasitological and Comparative Pathological Studies on Monogenean Infestation of Cultured Sea Bream (*Sparus aurata*, Spariidae) in Egypt *Oceanogr*., 02(04), 4–9.

Keywords: Biodiversity; Monogenea; Digenea; Metazoans; Platyheminthes; Algerian Coast