VLIZ pioneer in marine science

4 March 2026

VLIZ SPECIAL PUBLICATION #96

BOOK OF ABSTRACTS
VLIZ MARINE SCIENCE DAY 2026

This publication should be quoted as follows:
Jan Mees and Jan Seys (Eds). 2026. Book of abstracts – VLIZ Marine Science Day, 4 March 2026, Oostende. VLIZ Special Publication 96. Vlaams Instituut voor de Zee – Flanders Marine Institute (VLIZ): Oostende, Belgium. vi + 128 p.

Vlaams Instituut voor de Zee (VLIZ) - Flanders Marine Institute
InnovOcean Campus - Jacobsenstraat 1 - 8400 Oostende - Belgium
Tel. +32-(0)59-33 60 00 - Email: info@vliz.be - Website: www.vliz.be

Cover image © VLIZ – Photographer Nick Decombel

The abstracts in this book are published based on the information submitted by the respective authors. The publisher and editors cannot be held responsible for errors or any consequences arising from the use of information contained in this book of abstracts. Reproduction is authorized, provided that appropriate mention is made of the source.

ISSN 1377-095
https://dx.doi.org/10.48470/131

Table of Contents

Poster presentations

KEYNOTE PRESENTATIONS

Keynote presentation

Post Joanna

IOC UNESCO
Email: ioc.secretariat@unesco.org

Dr. Joanna Post is Head of the Ocean Observations and Services and Information and Data Exchange Sections at the Intergovernmental Oceanographic Commission (IOC) of UNESCO and is working to support Member States sustain and strengthen the Global Ocean Observing System (GOOS) and interoperable global ocean data and information exchange. Before IOC, she was with the United Nations Framework Convention on Climate Change (UNFCCC) secretariat for over a decade. Earlier in her career, she had a range of positions in science writing and communications. Dr Post holds a Ph.D. in environmental biochemistry from the University of Newcastle Upon Tyne, UK.

Keynote presentation

Opstaele Piet

De Blauwe Cluster – Blue Cluster
Email: info@blauwecluster.be

As CEO of the Blue Cluster, Piet Opstaele is one of the driving forces behind the development of a dynamic and sustainable blue economy in the North Sea.

With world-class knowledge and research institutions, a dense network of innovative SMEs, and leading international companies, Flanders has all the assets it needs to grow into a top region for the blue economy. The Blue Cluster—a network organisation bringing together some 200 companies and more than 20 knowledge institutions—is ideally positioned to help realise these ambitions and deliver breakthrough innovations.

Piet began his career in the 1990s at one of the Benelux's most successful start-ups: Tele Atlas, a producer of digital geographic data. The company was acquired by TomTom in 2008. In 2014, he joined the Port of Antwerp, where he was one of the frontrunners in the port platform Antwerp–Bruges' digital and innovation-driven transition towards a "Port of the Future".

Piet holds a master's degree in spatial planning and history, completed postgraduate programmes in energy and environmental management, and earned an MBA in International Business Management from Vlerick Business School. He is also Chair of the Wildlife Rescue Centre in Ostend.

SCIENTIFIC AWARD PRESENTATIONS

Developing and optimising a cost- and time-effective method for the detection and identification of microplastics in the marine environment

Meyers Nelle

Flanders Marine Institute (VLIZ), InnovOcean Campus, Jacobsenstraat 1, 8400 Oostende, Belgium
Email: nelle.meyers@vliz.be

Microplastics (MPs), defined as plastics particles between 1 µm and 5 mm in size, are an issue of concern due to the accumulation rates in the marine environment combined with the limited knowledge about their abundance, distribution and associated environmental impacts. However, surveying and monitoring MPs in the environment can be time consuming and costly. The development of cost- and time-effective methods is therefore imperative to overcome some of the current critical bottlenecks in microplastic (MP) detection and identification, and to advance MPs research. To address this issue, in **Chapter 2**, an innovative approach for MP analysis is presented that combines the advantages of high-throughput screening with those of automation. The proposed approach used Red Green Blue (RGB) data extracted from photos of pristine MPs (50 – 1,200 µm), which were subjected to fluorescent staining using the fluorescent dye Nile red (NR), to train and validate a 'Plastic Detection Model' (PDM) and a 'Polymer Identification Model' (PIM). These two supervised machine learning (ML) models based on decision tree (DT) algorithms predicted with high accuracy the plastic or natural origin of particles (95.8%), and the polymer types of the MPs (88.1%). Additionally, the PDM and PIM prove to be successful in detecting (92.7%) and identifying (80%) plastic particles in spiked environmental samples that underwent laboratorial processing.

Weathering processes to which MPs are subjected in the marine environment, such as mechanical weathering, ultraviolet (UV) radiation, biofouling and hydrostatic pressure, also present a challenge to their detection, identification and quantification, as these mechanisms can alter the physical structure and chemical composition of the particles, and as a result, affect the accuracy of analysis techniques. Nevertheless, the bulk of method development-focused research and effect studies still relies on pristine MPs, underlining the importance of implementing environmentally relevant MPs into MP research. Moreover, much remains to be uncovered regarding the abundance, behaviour, and potential effects of smaller sized MPs (< 150 µm). While methods capable of reaching this MP size threshold exist, the time and costs involved in analysis hinder routine assessments. A last significant challenge MP research faces is the interoperability of analysis methods, as a constant performance across different laboratories of is of paramount importance in scientific research.

In response to the identified knowledge gaps, in **Chapter 3**, the robustness of the semi-automated analysis technique which combines ML algorithms with fluorescent colouration of NR-stained particles was tested, by assessing its accuracy to detect and identify MP polymers weathered under semi-controlled surface water and deep-sea conditions. Moreover, DT algorithms were compared to random forest (RF) algorithms in terms of accuracy, model complexity and computational cost. Lastly, the size limit and the interoperability of the approach based on the best performing algorithm was determined. Decision tree and RF models were comparably accurate in detecting and identifying pristine plastic polymers (both > 90%). For the detection of weathered MPs, both yielded sufficiently high accuracies (> 77%), although only RF models were reliable for polymer identification (> 70%), except for polyethylene terephthalate (PET) particles. The RF models showed an accuracy > 90% for particle predictions based on 12 - 30 pixels, which translated to MPs sized < 10 µm. Results revealed that the knowledge rules generated by the RF classifier did not produce consistent results across different labs. Nevertheless, the inherent flexibility of the method allows for its swift adaptation and optimisation, ensuring the possibility to fine-tune the method to specific research goals through customised datasets, thereby strengthening its robustness.

The wide variety of existing analysis methods nowadays, even when using similar instrumentation, also hampers the comparability of obtained data, because of the inevitable variation in resolution, focus, and most importantly, quality. As with analytical methods, method validation is one approach to ensure the quality control of MP research. Analytical method validation is a means to demonstrate that the method is suitable for its intended purpose, and that it complies with the applicable standards. It allows to ascertain the reliability of a developed method as well as its ability to produce accurate findings. However, as of today, despite MPs being an important emerging global contaminant in a large variety of environmental matrices, for marine matrices, universal guidelines are non-existent.

In **Chapter 4**, the critical need for reliable and cost-effective MP analysis methods was addressed through validation of the newly developed, semi-automated workflow. To do so, environmentally relevant MPs were spiked into and recovered from marine fish gastrointestinal tracts (GITs) and blue mussel tissue, stained with NR, and automatically

detected and identified using the developed models. The validation enclosed the determination of the following parameters: trueness, precision, measurement uncertainty, limit of quantification (LOQ), specificity, sensitivity, selectivity, and method robustness. Overall MP recovery rates of 95 ± 9% for fish GITs and 87 ± 11% for mussels were achieved. In terms of polymer identification, the overall accuracies were 76 ± 8% and 80 ± 13%, respectively. Contrary to other polymers, recovery rates of PET fragments were more variable with lower accuracies for the prediction of plastic identity and polymer type. It is therefore recommended to include data from weathered PET particles in the models to achieve a consistently high level of accuracy. Through this method validation, potential end-users are provided with performance data, as well as limitations and uncertainties of the used MP analysis technique. The proposed validation parameters offer a step toward quality management guidelines, as such aiding future researchers and fostering cross-study comparability.

In **Chapter 5**, as a final step in the method development, the newly developed cost- and time-effective MP analysis technique was tested for MPs in environmental samples, together with the optimised sample processing protocols. Simultaneously, the use of an automated filtration system, developed by the

Andromeda project partners, was tested to make sampling of seawater quicker, more affordable and interoperable, with the aim of rendering the MP workflow fully cost- and time-effective. To do so, a case study was performed where the effect of dredging activity on MP contamination in seawater and sediment at the Br&WZE ('LZO' in Dutch) dredge disposal site in the Belgian Part of the North Sea (BPNS) was assessed. Accordingly, the performed study allowed for an update on MP contamination in the BPNS. The developed ML models were validated through µ-FTIR analysis to ensure the reliability and robustness of the developed method, as well as its applicability under the dynamic conditions encountered in the marine environment. In this way, their use for accurate MP detection and identification was verified. The optimised sample processing protocols, combined with the RF models, prove reliable in analysing non-fibrous MPs in real environmental seawater and sediment samples. Validation through µ-FTIR analysis indicated a high accuracy of the PDM for non-fibrous MPs: 87.9% for seawater and 90.5% for sediment. Most identified MPs (81% in seawater and 70% in sediment) belonged to the polymers incorporated in the PIM, with accurate predictions for specific polymer types (overall 77.6 ± 14.8% accurate). Elevated MP levels were detected in both seawater and sediment samples at the dredge disposal site compared to reference areas in the BPNS. Polyethylene (PE), polypropylene (PP), polystyrene (PS) and polyacrylonitrile (PAN) were the prevailing polymers in seawater at the reference areas, while sediments were characterised by a prevalence of polyester and polyvinyl chloride (PVC).

The myriad of existing MP analysis methods is also challenging for researchers and policy makers when tasked with choosing optimal methods for their research question and a given budget. In **Chapter 6**, a cost-effectiveness analysis of methods for MP analysis in seawater was performed using survey data acquired from experts. Total analysis cost per method was determined accounting for labour and equipment costs, while method effectiveness was scored based on the ability of a method to confirm the plastic nature of particles, its minimum detectable particle size, and other parameters. Results were validated and discussed during two workshops with scientists and policy makers. The resulting predictive tools allow to identify the most cost-effective methods for specific scenarios, and their associated cost. They mark an important step towards a more effective and informed approach to monitoring and managing MP pollution in the marine environment, ultimately contributing to the protection of marine ecosystems and human health.

Integrating climatic controls and dispersal to project mangrove dynamics at a rapidly-changing range limit

Enes Gramoso Lucia

Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium
Email: lucia.idalina.a.enes.gramoso@vub.be

Warming winter temperatures are driving the poleward expansion of tropical, cold-sensitive mangroves into temperate ecosystems1. Along the Atlantic coast of North America, the mangrove range limit is highly sensitive to climate variability, with extreme freeze events serving as the primary constraint on mangrove abundance and distribution across the temperate – tropical transition zone1,2.As climate change reduces the frequency of these freeze events, mangroves are increasingly expanding northward, often at the expense of cold-tolerant salt marsh species. These shifts in dominant coastal wetland vegetation are expected to substantially alter ecosystem structure and function3,4, highlighting the urgent need to identify future suitable mangrove habitat to guide conservation strategies and site-specific wetland management.

In **this study**, we combined ensemble forecasting of mangrove distributions, Lagrangian particle-tracking, hurricane data, phenological information (i.e., timing of propagule development and release) to project future mangrove expansion at this rapidly changing range limit. We also accounted for key physical constraints (e.g., tidal range, sediment type, coastal relief, and wave energy) that influence propagule establishment, ensuring that our projections reflect both climatic suitability and establishment potential.

Species distribution models for 2071–2100, across four Shared Socio-Economic Pathways (SSP1-2.6; SSP2-4.5; SSP3-7.0; SSP5-8.5), project substantial expansion of climatically suitable habitat beyond the current range limit, with the most pronounced increases under pathways associated with the strongest warming scenarios. These results indicate that ongoing warming will drive continued poleward mangrove expansion. Successful colonization of newly suitable habitat, however, depends on the ability of mangrove propagules to reach these locations. Mangroves produce hydrochorous propagules capable of dispersing via tidal, alongshore, and open-ocean currents over local-to-transoceanic scales5. To assess connectivity between established populations and future suitable sites, we simulated hourly propagule releases from present-day mangrove occurrences using high-resolution ocean current data in a Lagrangian particle-tracking model. Simulated propagule trajectories suggest that dispersal will not be limiting mangrove expansion as ocean currents can transport propagules from both leading-edge and more southern populations. Establishment may occur even from very low propagule densities reaching sites beyond the current range limit, as a single successful dispersal event can establish a new population6.

Although oceanic transport is the primary dispersal strategy of mangroves, extreme weather event such as hurricanes can act as high-energy “pulse” events, transporting high propagule densities over long distances. In our study area, peak propagule production and release coincide with the Atlantic hurricane season, increasing the likelihood of storm-driven dispersal5. Recorded hurricane tracks show that storms predominantly approach from the south-southwest, suggesting high potential for along-coast propagule transport toward northern regions.

Our results highlight the importance of integrating climatic and dispersal factors when assessing 21st-century range shifts. This integrated approach allows for more accurate projections of climate-change-driven mangrove expansion into temperate ecosystems and provides a foundation for anticipating mangrove-salt marsh ecotone shifts, thereby providing guidance for site-specific conservation and management strategies.

References

1 Saintilan, N. *et al.* Mangrove expansion and salt marsh decline at mangrove poleward limits. *Global Change Biology* **20**, 147–157 (2014).

2 Cavanaugh, K. C. *et al.* Climate-driven regime shifts in a mangrove–salt marsh ecotone over the past 250 years. *PNAS* **116**, 21602–21608 (2019).

3 Osland, M. J. *et al.* The impacts of mangrove range expansion on wetland ecosystem services in the southeastern United States: Current understanding, knowledge gaps, and emerging research needs. *Global Change Biology* **28**, 3163–3187 (2022).

4 Kelleway, J. J. *et al.* Review of the ecosystem service implications of mangrove encroachment into salt marshes. *Global Change Biology* **23**, 3967–3983 (2017).

[5] Van der Stocken, T. *et al.* A general framework for propagule dispersal in mangroves. *Biological Reviews* **94**, 1547–1575 (2019b).

[6] Nathan, R. *et al.* Mechanisms of long-distance seed dispersal. *Trends in Ecology & Evol*ution **23**, 638–647 (2008).

Comparison of in-situ and remotely sensed Particulate Inorganic Carbon in a coccolithophore bloom in the Iceland Basin (June 2024)

Timotheus Fügl

Marine and Lacustrine Science and Management, Ghent University, Antwerp University and Vrije Universiteit Brussel
Email: timothy.fugl@ugent.be

This master's thesis had two main objectives: (1) to assess the capability of NASA's PACE satellite to measure particulate inorganic carbon (PIC) concentrations, and (2) to evaluate whether the LISST-PIC - an optical sensor under development within the MarSens research group - can provide continuous in-situ data suitable for validating satellite-derived PIC observations. Furthermore, the capabilities of PACE hyperspectral data were tested on classical and novel bloom characteristics.

This study represents the first in-situ validations of NASA's PACE mission - launched in February 2024 - for PIC retrieval from space, combining novel hyperspectral satellite data with a prototype in-situ optical instrument. The in-situ data were collected during a research cruise through an *Emiliania huxleyi* coccolithophore bloom in the Iceland Basin. Measurements were obtained both as discrete water samples and using the first prototype of the LISST-PIC instrument.

To assess the performance of the LISST-PIC, its results were compared to discrete samples. PIC was measured with ICP-OES in Ghent University. Similarly, PACE-retrieved PIC concentrations were evaluated using the CI2 algorithm (Mitchell *et al.*, 2017). PACE PIC retrievals were then compared to the two in-situ datasets (LISST-PIC and discrete samples). To obtain deeper insights, both the discrete and LISST-PIC data were further compared with MODIS observations. A direct comparison between MODIS and PACE retrievals was also done to assess diUerences in satellite performance for PIC estimation.

Subsequently, hyperspectral PACE data were analyzed to explore the potential of novel hyperspectral satellite observations. The mathematical model developed by Neukermans and Fournier (2019), which describes reflectance spectra associated with diUerent coccolithophore bloom phases, was successfully applied to PACE hyperspectral reflectance data. Additionally, PACE hyperspectral data were used to estimate the bloom area of the sampled bloom.

The results demonstrated that PIC retrieval using the LISST-PIC is feasible, as indicated by high coeUicients of determination (R^2 values). However, improvements in both the sensor and data processing chain are necessary. The main limitations of the LISST-PIC were related to extensive data loss due to outlier removal, primarily caused by strong temperature sensitivity. Moreover, a pronounced spatial heterogeneity between LISSTPIC measurements and the PACE pixel size (1.2 km × 1.2 km) led to high coeUicients of variation, necessitating further filtering and contributing to data reduction.

PACE retrievals also showed strong agreement with discrete measurements. Comparisons between MODIS- and PACE-derived PIC concentrations indicated that PACE tends to overestimate PIC relative to MODIS. This bias can partly be attributed to the use of the CI2 algorithm, originally developed for MODIS multispectral data, which was applied here without modification to PACE's hyperspectral dataset.

In a further analysis, PACE hyperspectral data were used to test the applicability of the Neukermans and Fournier (2019) model for bloom-phase characterization. An interactive visualization tool was developed for this purpose, available on GitHub, enabling users to display hyperspectral PACE spectra for selected pixels on an RGB composite and generate corresponding PIC estimates. Although the model was not directly validated with in-situ data in this study, the results illustrate the potential of hyperspectral PACE data for distinguishing bloom characteristics - oUering biological insights previously unobtainable from multispectral satellites and reducing the need for costly field campaigns. The Python code for the interactive visualization tool can be found here: https://github.com/astrotheus/SATELLITE-DATA-PROCESSINGFILES/blob/main/interactive%20RGB.py

Furthermore, PACE data proved valuable for estimating classical bloom parameters. The bloom area was estimated to reach a peak of approximately 800,000 km^2, ranking it among the largest coccolithophore blooms ever recorded.

In conclusion, the thesis provides the following main findings: both PACE and LISST-PIC demonstrate strong potential for retrieving PIC from ocean color observations, though PACE requires sensor-specific algorithm optimization. Subsequent LISST-PIC prototypes have addressed temperature-related issues that led to data loss in this study. The comparative analysis revealed that MODIS currently outperforms PACE, largely due to algorithmic calibration on MODIS data. Nevertheless, PACE's hyperspectral capabilities open novel research possibilites, such as bloom phase

determination and refined bloom area estimation. The primary limitation of this study was the small dataset caused by persistent cloud cover and data quality control. Future algorithm development for PACE hyperspectral data will benefit from larger, cloud-free datasets to achieve more robust results. In any case, as the first study on PIC retrieval with PACE, this work demonstrates that PACE can successfully retrieve PIC and even opens the door to new, not yet fully explored bloom variables, such as bloom phase.

Beyond the scientific achievements of this thesis, I am pleased to announce that this work has enabled me to join the PACE research group at NASA Goddard Space Flight Center as a visiting scientist beginning in October 2026. I will pursue this opportunity as part of my PhD, which takes oU in February 2026 (MarSens, Prof. Neukermans), focusing on PIC retrieval algorithms for the PACE ocean color instrument.

Bibliography

- C. Mitchell, C. Hu, B. Bowler, D. Drapeau, and W. M. Balch. Estimating Particulate Inorganic Carbon Concentrations of the Global Ocean From Ocean Color Measurements Using a Reflectance Di!erence Approach. Journal of Geophysical Research: Oceans,122(11):8707–8720, Nov.2017. ISSN 2169-9275, 2169-9291. doi: 10.1002/2017JC013146.
- G. Neukermans and G. Fournier. Optical modeling of spectral backscattering And remote sensing reflectance from emiliania huxleyi blooms. Frontiers in Marine Science, 5, May2018. ISSN2296-7745. doi: 10.3389/fmars.2018.

DR DELCROIX PRESENTATIONS

Immersive Video Exposure to Coastal Environments: Effects on Valence, Arousal, Awe, and Connectedness to the Environment

De Craene Elias[1], Kinet Julia[2], Raes Filip[3], Buysse Ann[4] and Everaert Gert[1]

[1] Ocean & Human Health, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: elias.decraene@vliz.be
[2] Blue Growth Research Lab (BGRL), Ghent University, Ostend Science Park, Wetenschapspark 1, 8400 Oostende, Belgium
[3] Research Unit Behaviour, Health and Psychopathology, KU Leuven, Tiensestraat 102, 3000 Leuven, Belgium
[4] Department of Experimental Clinical and Health Psychology, Ghent University, Henri Dunantlaan 2, 9000 Gent, Belgium

While an increasing body of research points to beneficial effects of coastal environments on human health, their influence on affective and complex emotional experiences has so far received little attention. In addition, coastal settings are heterogeneous and consist of multiple sub-environments that may elicit distinct emotional responses. Gaining insight into how different coastal environments shape emotions is essential for clarifying their health potential and for supporting evidence-based coastal design and management.

In the present randomized crossover study, 60 participants were exposed to eight sub-environmental videos under two conditions: four coastal videos and four urban videos serving as a control condition. To make the exposure more immersive, the videos were projected using a beamer in an enclosed room with dimmed lighting, and audio was delivered via headphones. The coastal condition included videos of a breakwater, a beach, dunes, and a dike, whereas the urban condition consisted of two church scenes and two videos showing visually appealing façades. For each video, participants provided four emotional assessments: two during exposure and two immediately after. During video viewing, real-time valence and arousal were continuously reported using a joystick, capturing the two fundamental dimensions of affect. After each video, participants additionally rated their experienced levels of two complex emotions: awe and connectedness to the environment. Prior to the experimental session, participants completed online questionnaires assessing demographic characteristics and trait measures.

Consistent with our hypotheses, coastal videos were associated with higher valence, awe, and connectedness to the environment compared to urban videos. Contrary to expectations, however, arousal levels were also higher in the coastal condition. This combination of increased valence and arousal suggests that coastal scenes elicited more joyful and elated emotional states than urban scenes. When comparing the coastal sub-environments, the dike video resulted in lower scores across all outcome measures relative to the other coastal videos. A plausible explanation for this may be its more built character and the visible presence of passersby, making it appear less natural than the other coastal scenes. Furthermore, stronger trait-level emotional connectedness to the ocean was associated with higher emotional responses across all measures, indicating that individuals who already feel more connected to coastal environments experience stronger emotional reactions.

Overall, this study makes a valuable contribution by examining the effects of coastal environments on emotional experiences using a novel methodological approach. By demonstrating that specific coastal features can elicit distinct emotional responses, it advances understanding of how coastal environments support well-being and provides nuanced insights for policymakers, urban and coastal designers, and stakeholders involved in the management and preservation of coastal spaces.

Keywords

Coast; Affect; Emotions; Video Exposure

Yessotoxins as Anticancer Agents Due to Their Lysosome Targeting: A Comparative Study in Cancerous and Non-Cancerous Human Alveolar Epithelial Cell Lines

Dewulf Friedel and Asselman Jana

Ghent University, Blue Growth Research Lab, BlueBridge – Ostend Science Park, Wetenschapspark 1, 8400 Oostende, Belgium
Email: friedel.dewulf@ugent.be

Oceans are a rich source of bioactive compounds, providing indispensable and valuable resources for marine biodiscovery and pharmaceutical applications. Several compounds from microalgae possess significant bioactivities, including antioxidant, anti-inflammatory, anticancer, and antimicrobial properties, demonstrated through in vitro and in vivo research.

Lysosomal cell death has recently emerged as a therapeutic strategy for targeting cancer cells. Cancer cells frequently acquire resistance to apoptosis through mutations in pro-apoptotic proteins and overexpression of anti-apoptotic factors; however, cell death can still be induced via lysosomal membrane permeabilization (LMP). Consequently, lysosomotropic agents have been proposed as potential anticancer therapies. Moreover, lysosomes in cancer cells are particularly vulnerable compared to healthy cells, due to lysosome enlargement and oncogene-driven downregulation of glycoproteins that protect lysosomal membranes. Collectively, these features suggest that LMP inducers may preferentially target cancer cell lysosomes over those of normal cells.

Within the marine environment, YTX, a marine toxin produced by dinoflagellates, has already shown potential for its use as anti-cancer drug using the in vivo B16F10 melanoma mouse model. The study showed that YTX revealed a significant reduction in tumor growth, without any significant toxicity. In vitro studies have provided various insights into YTX's mode of action, but the exact mechanism still remains a mystery. The in vitro evidence for YTX anti-cancer potential is poor and inconclusive. Furthermore, we have recently demonstrated that the yessotoxins severely targeted the lysosomal membrane integrity, while leaving the metabolic activity and membrane integrity intact in human cell lines.

Therefore, we hypothesized that YTX may target lysosomes in cancer cells, therefore demonstrating anti-cancer potential. To validate the hypothesis, we executed a comparative research in two similar cell lines: the cancerous human alveolar epithelial cell line NCI-H441 and the recently developed non-cancerous alveolar epithelial cell line hu-Arlo. A combination of different cell viability assays and transcriptomics was applied to obtain comprehensive insights into the mode of action and anti-cancer mechanisms. The cell lines were exposed to a concentration range of yessotoxin and cell viability was assessed through a combination of different assays, namely Alamar Blue, CFDA-AM, neutral red and LDH. Moreover, RNA sequencing was carried out to gain insights into the mode of action.

We observed that in both cell lines, the lysosomal membrane integrity was again a key target of yessotoxin. Supporting our key hypothesis and building on prior literature evidence, our results show differential sensitivity towards yessotoxin across the cell lines. The cancer cell line was more sensitive, with substantially lower EC10 and EC50 values, than the healthy cell line. Transcriptomic data will reveal more insights into the mode of action and confirm whether YTX can function as an LMP agent in cancerous cells, while only limitly impacting healthy cells.

Keywords
Yessotoxin; Cell lines; In vitro

BMRI PRESENTATIONS

Time traveling: reconstruction of historical dietary changes in fish through stable isotope analysis of otoliths

Bui Tuan Anh[1,2], Bodé Samuel[3], Bekaert Karen[2], Depestele Jochen[2], Poos Jan Jaap[4] and De Troch Marleen[1]

[1] Department of Biology, Marine Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
Email: tuananh.bui@ugent.be

[7] Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Jacobsenstraat 1, 8400 Oostende, Belgium

[8] Department of Green Chemistry and Technology, Isotope Bioscience Laboratory (ISOFYS), Ghent University, Coupure Links 653, 9000 Gent, Belgium

[9] Aquaculture and Fisheries Group, Wageningen University and Research, Zodiac Building 122, De Elst 1, 6700 AH Wageningen, The Netherlands

Over recent decades, there has been significant variation in the growth rates of common sole (*Solea solea*) populations in the Northeast Atlantic. Whether, and to what extent, this variation is related to dietary changes within the population remains unclear due to a lack of long-term dietary data.

In this study, we aim to reconstruct historical dietary changes in sole using stable isotope analysis of otoliths, or fish ear stones, which act as a natural archive of an individual fish's lifetime. A total of 97 otoliths from two periods representing high growth (2004–2007) and low growth (2019–2022) in the Irish Sea were selected for analysis. All otoliths were obtained from age-2 fish within a size range of 250–280 mm, minimizing dietary variation associated with ontogeny, as larger and older sole tend to have more diverse diets. In addition, 39 age-2 otoliths from the 2022 cohort, spanning a range of body sizes from 198 to 331 mm, were selected to examine variation in isotopic composition associated with body size.

Prior to analysis, protocols for measuring $\delta^{13}C$ and $\delta^{15}N$ of the organic fraction were developed and tested using five otoliths. The results of these analyses, along with the challenges and opportunities associated with otolith isotope analysis, will be presented in this talk.

Keywords

Otolith; Stable isotope; *Solea solea*

Cracking the trophic code: Integrating DNA metabarcoding and isotope analysis to implement mud crabs *Scylla* spp. sustainable aquaculture

Fauziyah Arida

Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium
Email: arida.fauziyah@ugent.be

Conventional grow-out pond systems for mud crabs (*Scylla* spp.) have supported aquaculture production in Indonesia but contributed to extensive mangrove degradation and inconsistent culture performance. Co-stocking of morphologically similar species often results in variable growth and survival. These practices conflict with Indonesia's FOLU Net Sink 2030 commitment to halt mangrove deforestation and enhance carbon sequestration. South Sulawesi Regulation No. 4/2023 promotes mangrove-friendly silvofishery systems, including mangrove pens, yet implementation remains constrained by limited understanding of species-specific trophic niches of the two dominant cultured species, *Scylla olivacea* and *S. tranquebarica*.

This study identified and quantified trophic niches of juvenile *S. olivacea* and *S. tranquebarica* and translated niche differentiation into ecosystem-based site-selection criteria. An integrated molecular–biogeochemical approach was applied in estuarine mangroves of Maros (South Sulawesi) and Segara Anakan Lagoon (Central Java), spanning salinity gradients of 5–26 ppt. DNA metabarcoding (Oxford Nanopore Technology) assessed ingested prey, while stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) evaluated assimilated carbon sources. Multivariate analyses, Standard Ellipse Area (SEA), and MixSIAR Bayesian models quantified dietary breadth and source contributions.

Metabarcoding revealed no significant taxonomic prey differences (PERMANOVA, $p = 0.17$), indicating overlapping prey taxa. However, functional analyses demonstrated trophic segregation. *S. olivacea* primarily exploited heterotrophic, terrestrial–freshwater pathways, whereas *S. tranquebarica* relied more on autotrophic, mangrove-associated sources. Stable isotope results confirmed distinct basal carbon assimilation: *S. olivacea* derived nutrition mainly from detritus and biofilm (SEA = 3.11), while *S. tranquebarica* showed broader niche width (SEA = 9.29) and greater reliance on microphytobenthos and epiphyton.

These findings link trophic niche differentiation to estuarine salinity gradients and habitat characteristics. Operationally, *S. olivacea* is best suited to brackish–freshwater, organic-rich inner mangrove zones, whereas *S. tranquebarica* is more suitable for brackish–marine creeks with active microphytobenthic production. The study provides evidence-based guidance for species-specific mangrove pen design, supporting ecosystem-based aquaculture and the implementation of provincial and national mangrove restoration policies.

Keywords

Trophic niche differentiation; DNA metabarcoding; Stable isotope analysis; Silvofishery; Mangrove pen design; Ecosystem-based aquaculture; Estuarine salinity gradient; Functional feeding guilds; Basal carbon sources

When the ocean gets loud: Noise pollution disrupts macrofaunal bioturbation-microbiome coupling in benthic sediments

Guden Rodgee Mae[1,2], Van Colen Carl[1], Cours Marie[1], Slangen Ilan[1], Dixon Charlotte[1], Beerman Jan[3], Wrede Alexa[3] and Moens Tom[1]

[1] Marine Biology Research Group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
Email: rodgeemae.guden@ugent.be

[10] Center for Molecular Phylogeny and Evolution, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

[11] Biologische Anstalt Helgoland, Shelf Sea System Ecology, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Helgoland, Germany

Anthropogenic low-frequency noise (LFN) from shipping and offshore activities is transforming coastal soundscapes, but its effects on benthic microbiomes and their interactions with sediment-engineering fauna remain poorly understood. We performed a fully factorial mesocosm experiment to test how LFN and the bioturbating polychaete *Hediste diversicolor* jointly structure active sediment microbial communities in intertidal mud. Four treatments (NoHediste_NoNoise, NoHediste_Noise, Hediste_NoNoise, Hediste_Noise) were maintained for one week, after which we applied metatranscriptomic sequencing of rRNA and mRNA fractions to characterise taxonomic composition and functional activity of the microbial communities. *H. diversicolor* exerted the dominant control on microbial structure: its presence increased alpha diversity, reshaped beta diversity, and drove extensive genus-level turnover. In contrast, LFN alone did not significantly alter taxonomic richness or composition. Despite this taxonomic stability, LFN triggered marked functional reorganisation in non-bioturbated sediments, upregulating pathways related to amino-acid metabolism, chromatin and RNA-processing complexes, and cellular stress responses, while downregulating nutrient transport, cofactor biosynthesis, and central metabolism. Bioturbation by *H. diversicolor* strongly enhanced overall metabolic capacity and enriched pathways linked to carbon degradation, nitrogen and sulfur transformations, and membrane processes, and partially buffered noise-induced functional disruptions. However, stress-related signatures and reduced nutrient-cycling functions persisted under noise even in the presence of polychaete. Our results show that LFN primarily acts as a functional rather than taxonomic stressor in coastal sediments and that macrofaunal bioturbation confers resilience but not immunity to acoustic disturbance. Given the rapid global expansion of underwater noise in coastal zones, these findings highlight the urgent need to integrate microbial functional responses and macrofaunal activity into noise-impact assessments and benthic ecosystem management, as understanding how acoustic pollution interacts with sediment-engineering fauna will be essential for predicting future changes in coastal biogeochemistry, biodiversity, and ecosystem functioning.

Keywords

Low-frequency noise; Omics; Biodiversity; Ecosystem functioning; Hediste diversicolor

Exploring the impact of grazer pressure on growth and toxin production of harmful algae: A case study with copepods

Liu Wenxin[1], Van Renterghem Timon[2], Semmouri Ilias[3], Janssen Colin[2] and Asselman Jana[2]

[1] Department of Animal Science and Aquatic Ecology, Ghent University, Coupure Links 653, 9000 Gent, Belgium
Email: wenxin.liu@ugent.be
[2] Ghent University, Coupure Links 653, 9000 Gent, Belgium
[3] Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Gent, Belgium

Certain algal species produce potent toxins that accumulate through marine food webs, posing significant risks to fisheries, aquaculture, tourism, and human health. These toxins are responsible for harmful algal blooms (HABs), which are increasingly frequent in northern European coastal waters. Among human poisoning syndromes, diarrheic shellfish poisoning (DSP) and paralytic shellfish poisoning (PSP) account for the majority of reported cases, driven primarily by yessotoxins (YTXs) and saxitoxins (STXs), respectively. Ongoing climate change and anthropogenic pressures—such as rising atmospheric CO_2, ocean warming, acidification, salinity shifts, and eutrophication—are expected to further influence HAB dynamics. Specifically, HAB species (*Alexandrium minutum* and *Microcystis aeruginosa*) will be exposed to three sources of copepod cues—living copepods, copepod-conditioned water, and purified kairomones—across multiple concentrations and life stages. Two ecologically distinct copepods, the benthic *Nitokra spinipes* and the planktonic *Acartia tonsa*, will be compared. Algal responses will be assessed through growth rates, total carbon content, extracellular polymeric substance production, and intracellular and extracellular toxin concentrations quantified by Elisa kits. This integrative experimental framework will provide novel insights into grazer–HAB interactions, clarifying how copepods may modulate algal toxicity beyond abiotic drivers alone. The results will improve mechanistic understanding of HAB dynamics under global change and contribute to more accurate assessments of ecological and human health risks in marine ecosystems.

Keywords

Dinoflagellate; Cyanobacteria; Grazer Pressure; Toxin Production Phytoplankton; Zooplankton

Electric seafloors and the climate: Impact of cable bacteria on alkalinity dynamics in high CaCO3 sediments

Nasri Nada[1,2]

[1] Geobiology Research Group, University of Antwerp, Campus Drie Eiken, building C,Universiteitsplein 1, 2610 Wilrijk, Belgium

[12] Geology department, Laboratory of Mineral Resources and the Environment, Faculty of Science of Tunis, Campus Universitaire El-Manar, 2092 El Manar Tunis, Tunisia

Cable bacteria are filamentous, multicellular microorganisms capable of long-distance electron transport in sediments through electrogenic sulfide oxidation (e-SOx). This metabolism spatially separates sulfide oxidation in deeper anoxic layers from oxygen or nitrate reduction near the sediment surface, generating pronounced pH gradients and altering sediment biogeochemistry. Recent studies indicate that cable bacteria can enhance alkalinity release from sediments, thereby increasing the capacity of overlying waters to absorb CO_2. To date, this process has been investigated only in sediments with calcium carbonate ($CaCO_3$) contents up to ~22 wt%, leaving its relevance in carbonate-rich environments insufficiently constrained.

Here, we examine alkalinity cycling in sediments from the Ghar El Melh Lagoon (northeastern Tunisia), a southern Mediterranean coastal lagoon characterised by high salinity (>40) and high sedimentary $CaCO_3$ contents (>35 wt%). Sediments were incubated for 12 weeks in controlled microcosms, combining sediment–water flux measurements of total alkalinity (TA), dissolved inorganic carbon (DIC), O_2 and nutrients with microsensor profiling (O_2, pH, H_2S and electric potential) to assess cable bacteria activity, and fluorescent in situ hybridisation (FISH) to assess cable bacteria abundance.

Cable bacteria presence and activity were confirmed throughout the incubation by their characteristic geochemical fingerprint and increasing filament abundance. Sediment–water fluxes showed a progressive increase in TA during the initial phase of incubation, reaching a maximum during week three, coincident with peak cable bacteria abundance and electrical activity. This alkalinity production was driven by strong subsurface acidification induced by e-SOx, promoting $CaCO_3$ dissolution at depth. Dissolved Ca^{2+} and Fe^{2+} released in deeper sediment layers subsequently migrated upwards. From week three onwards, this upward transport resulted in the formation of a consolidated surface crust composed of $CaCO_3$ and iron oxides.

The development of this crust progressively retained alkalinity within the sediment, leading to declining TA fluxes and ultimately negative TA values by week eight of incubation. These results further elucidate the role of cable bacteria in regulating alkalinity dynamics in carbonate-rich sediments and demonstrate how high $CaCO_3$ availability modulates both the magnitude and temporal evolution of alkalinity release. This study extends current understanding of cable bacteria–driven biogeochemical processes to extreme carbonate-rich environments, with implications for coastal carbon buffering.

Keywords

Cable bacteria; Alkalinity; Calcium carbonate; Crust; South Mediterranean; Lagoon

Hybrid vigour for thermal tolerance in hybrids between the foundational European kelp species *Laminaria ochroleuca* and *L. digitata*

Peeters Sofie, Stock Willem, Vranken Sofie, D'hondt Sofie and De Clerck Olivier

Research Group of Phycology, Ghent University, Krijgslaan 281, 9000 Gent, Belgium
Email: sofie.peeters@ugent.be

Kelps, which are large brown seaweeds, are foundational organisms in cold and temperate marine ecosystems. They sustain an enormous amount of biodiversity, while also delivering numerous ecosystem services. Yet, kelps are under global decline due to warming oceans, eutrophication, and overgrazing. Understanding how these seaweeds function and interact with their environment is therefore crucial to anticipate future trends.

In Europe, the cold kelp species Laminaria digitata and the warm-temperate kelp species *L. ochroleuca* increasingly co-occur as *L. ochroleuca* loses habitat range in the south but expands northward due to climate change. Recent work demonstrated that *L. ochroleuca* and L. digitata can hybridize (De Clercq K. 2025), raising the possibility that hybridization may alter thermal tolerance as a result of unique, hybrid gene expression profiles. This study investigates the performance and thermal response of reciprocal hybrids to assess their potential ecological significance under future warming.

L. ochroleuca and L. digitata inter and intra crossings were created for this experiment using the same strains recently proven to hybridise. Hybridisation was confirmed with microsatellite markers. Juvenile kelps (3 months old) were exposed to four different temperatures (control: 12°C, 18°C, 22°C and 24°C), simulating increasingly intense heatwaves. Growth of the kelps was assessed through surface area calculation. After 18 days, the individuals were harvested for RNA sequencing to characterize transcriptional responses (analysis ongoing).

The hybrid kelp outperformed the cold parental kelp species L. digitata in terms of growth rate across all temperatures tested. Additionally, hybrids survived above 22°C as opposed to the intra L. digitata crossings which showed extensive bleaching. As the growth of hybrids with *L. ochroleuca* mothers matched or exceeded the performance of the other crosses across the entire temperature range, we have shown that maternal effects outweigh paternal effects on the thermal response and that hybridization can generate phenotypes with enhanced thermal resilience.

This research provides a first insight into the dynamics of hybridization and adaptation of two of Europe's most important kelp species, improving our ability to predict their vulnerability and resilience to our continuously changing oceans.

Reference

De Clercq K. Hybridization and microbiome compatibility of *Laminaria ochroleuca* and *Laminaria digitata*. Master thesis, Universiteit Gent.

Keywords

Laminaria ochroleuca, *Laminaria digitata*, Climate change, Hybridization, Thermal tolerance

PRE-DOC PRESENTATIONS

Sediment organic carbon accumulation rates in a tidal marsh reach their maximum within the first two decades of growth

Abassi Faras[1], Pelckmans Ignace[2], Counye James[3], De Ridder Tinne[2], Bresseleers Seppe[2], Sarkar Siddhartha[2], Wang Guanxun[4], Belliard Jean-Philippe[2], Roland Marilyn[2], Bouillon Steven[4], Schwarz Christian[4], Van Der Stocken Tom[3], Janssens Ivan[2] and Temmerman Stijn[2]

[1] Departement Biologie, ECOSPHERE Research group, Universiteit Antwerpen, Belgium
Email: faras.abassi@uantwerpen.be
[2] Universiteit Antwerpen, Gebouw C, Universiteitsplein 1, 2610 Wilrijk, Belgium
[3] Vrije Universiteit Brussel, Building F, Pleinlaan 2, 1050 Brussel, Belgium
[4] Katholieke Universiteit Leuven, Celestijnenlaan 200E, 3001 Leuven-Heverlee, Belgium

Tidal marshes are among the most efficient ecosystems in sequestering carbon. Therefore, tidal marsh restoration is increasingly proposed as a nature-based climate mitigation strategy. Tidal marshes grow due to the deposition of sediments and organic matter brought in by tidal inflow of estuarine or marine water. It can take decades for a bare mudflat to develop into a vegetated, carbon-rich high marsh; yet how sediment organic carbon accumulation rates evolve over time remains largely unknown.

To address this knowledge gap, we conducted a field study in the Scheldt estuary (Netherlands) across an ecosystem age gradient, ranging from a bare mudflat, where no marsh vegetation has established yet, to marshes where first vegetation establishment occurred approximately 10, 20 and 40 years ago (= 'Space-for-Time substitution'). Along this marsh age gradient, we sampled sediment and biomass (below- & aboveground) and derived sedimentation rates from LiDAR-based Digital Terrain Models. This allowed us to calculate sediment organic carbon accumulation rates (OCAR) for the last decades.

Our results show decreasing sedimentation rates and increasing surface layer organic carbon contents (%) with increasing marsh age. After 20 years of marsh growth, OCAR reaches maximum values.

To further understand what controls OCAR and why it changes, we examined the origin of the carbon: It is either delivered as organic matter alongside sediment (allochthonous carbon) or derived from local vegetation inputs into the sediment bed (autochthonous carbon). We hypothesize that with increasing marsh age, the share of autochthonous carbon input increases, while the contribution of allochthonous carbon decreases.

Quantifying this variability could help improve estimates on expected C sequestration in new marsh restoration projects.

Keywords

Nature-based Solution; Tidal Marsh; Marsh Restoration; Carbon Sequestration; OCAR; Carbon Origin

Winners and losers in a warming Southern North Sea food web

Lorré Dries

Blue Growth Research Lab, Ghent University
Email: dries.lorre@ugent.be

Climate change has already altered marine ecosystems through rising temperatures, with profound implications for food web structure and fisheries' productivity. While many studies have documented climate-driven shifts in individual fish stocks, fewer have quantified how warming propagates through marine food webs and subsequently affects ecosystem structure and the capacity to provide preferred seafood. This knowledge gap is especially relevant for intensively used shelf seas such as the Southern Bight of the North Sea (SBNS), which has warmed rapidly over the past four decades and where fisheries provisioning remains a key ecosystem service.

Here, we assess how future ocean conditions may alter food web structure and fisheries provisioning in the SBNS using an ecosystem-based modelling approach. We developed and applied a temporally calibrated Ecopath with Ecosim (EwE) model representing 44 functional groups and multiple commercial and recreational fleets. The model was fitted to historical biomass and catch data for the period 1991–2023. Future ecosystem dynamics were projected between 2024–2100 using regionally downscaled CMIP6 projections of sea surface temperature and salinity under three Shared Socioeconomic Pathways (SSP1-2.6, SSP2-4.5, SSP3-7.0). Species-specific environmental response curves were used to translate monthly climate variability into annual limitations on species consumption rates, allowing temperature and salinity effects to propagate through the food web over time.

Projected warming drove pronounced and divergent responses across the SBNS food web, whereas projected salinity changes remained within species' tolerance ranges and therefore exerted negligible effects on species consumption rates. Cold-affinity and stenothermal species with low thermal optima, including Atlantic cod, herring, plaice, and key forage taxa such as carnivorous zooplankton, sandeels and copepods, showed declining foraging performance (i.e. reduced environmental suitability) under stronger warming scenarios. This was accompanied by consistent declines in biomass and catch, with the magnitude of decline increasing under more intense warming. These species emerged as clear losers under predicted future warming.

In contrast, several warm-affinity species were projected to benefit. Sole and European sea bass exhibited improved foraging performance under stronger warming, resulting in biomass increases of up to 14% and 80%, respectively, by the end of the century. Sprat showed quasi-stable biomass and catch under the least intense warming scenario (SSP1-2.6) and increasing biomass and catch under SSP2-4.5 and SSP3-7.0, despite its foraging performance remaining stable under SSP1-2.6 and SSP2-4.5 and declining only in the second half of the century under SSP3-7.0. Effects on dab, whiting, and mackerel were comparatively limited, with biomass and catch remaining largely stable across scenarios, except for moderate declines for whiting and mackerel late in the century under SSP3-7.0.

Importantly, biomass and catch responses did not always mirror physiological temperature responses, here modelled as limitations on species consumption rates. Mackerel, for example, exhibited declining temperature-based foraging responses with warming, yet showed largely stable biomass and catch. In contrast, sprat showed stable to increasing biomass and catch across all climate scenarios, with the magnitude of increase strengthening under warmer conditions, despite reduced consumption capacity under the strongest warming scenario.

These mismatches highlight the role of indirect trophic pathways and feedbacks, where warming-induced declines in predator condition reduce predation pressure, allowing prey populations to increase even when their own temperature-dependent (consumption) capacity is constrained. As such, food web interactions may amplify, buffer, or redirect the direct effects of warming on individual species.

These ecosystem-based projections indicate that warming is likely to reorganize fisheries provisioning in the SBNS rather than cause uniform declines. Climate change is projected to shift the balance from cold-affinity to warm-affinity species, creating distinct winners and losers within the ecosystem. By integrating climate projections, trophic interactions, and uncertainty analysis, this study illustrates the value of ecosystem-based approaches for anticipating climate-driven changes in complex marine food webs and supports the need for adaptive, climate-ready management strategies. It also highlights the importance of including climate change in future management plans.

Keywords

A 10-year time series analysis of plankton in the Belgian part of the North Sea

Eske Annika[1], Hablützel Pascal[1], Semmouri Ilias[2], Mortelmans Jonas[1], Janssen Colin[3], Deneudt Klaas[1] and Muñiz Carlota[1]

[1] Marine Observation Centre, Flanders Marine Institute, Jacobsenstraat 1, 8400 Ostend, Belgium
Email: annika.eske@vliz.be

[2] Laboratory of Environmental Toxicology and Aquatic Ecology, Faculty of Bioscience Engineering, Universiteit Gent, Coupure Links 653 Building F - 2nd Floor, 9000 Gent

[3] Blue Growth Research Lab, Ghent University, Universiteit Gent, Bluebridge Building, Ostend Science Park 1, 8400 Ostend, Belgium

Phytoplankton and zooplankton form the base of marine trophic webs. Therefore, factors that affect plankton dynamics often have far-reaching implications for the broader ecosystem, including higher trophic levels such as fish and marine mammals. In recent years, marine heatwaves (MHWs) have become more common, with MHW duration and frequency increasing globally over the last century[1]. In this study, we investigated the effects of MHWs on the plankton community in the coastal area of the Belgian part of the North Sea (BPNS) between 2014-2024. The analysis was conducted in three parts: (1) a long-term analysis of MHW detections and characteristics, (2) two generalized additive mixed models (GAMMs) of temperature components and their effects on plankton densities, and (3) a dynamic structural equation model (DSEM) to examine structural linkages between groups of interest from the GAMMs. These analyses allowed us to characterize MHWs, unravel community dynamics related to temperature, and define likely pathways of MHW effects on the trophic web in the coastal BPNS.

For MHW characterization, MHWs were defined as events during which the sea surface temperature (SST) surpasses the 90th percentile threshold of the seasonal climatology for ≥5 days[2]. SST data was taken from the European Space Agency Climate Change Initiative and Copernicus Climate Change Service reprocessed SST analyses, and the climatology baseline was established using 10 years of data (2014-2024). Long-term trends were extracted using seasonal trend decomposition with a 4-year smoothing window. Using the heatwaveR package[3], MHWs were investigated at nine coastal stations, aligning with available plankton datasets. For each MHW event, duration, intensity, and time of onset were calculated. MHW frequency displayed an increasing trend at most stations over the 10-year period. Stations that were more coastal as well as further from the Scheldt estuary were the most prone to heatwave events, and MHWs were most likely to occur in winter and summer. MHW events by station, seasonal climatology, and long-term trend were then incorporated into a multivariate GAMM model of plankton densities. Plankton data was collected from 2014-2024 across the nine coastal stations in the BPNS that are monitored monthly as part of the Belgian contribution to LifeWatch. A Working Party 2 net (mesh size 200-µm) and a Apstein net (55-µm) were used to target mesozooplankton and phytoplankton, respectively. Samples were processed with imagers and automatically classified (followed by manual validation), yielding densities for detected taxa[4,5]. Taxa with highest abundance were included as response variables and modeled using a hurdle model where zeroes were modeled using a negative binomial distribution and positive densities were modeled using log-transformed values on a Gaussian distribution. MHWs were accounted for using a rolling index (*intensity x duration*). The hurdle model highlighted that the MHW index had no effect on presence/absence. However, once taxa were present, the MHW effect on plankton abundance displayed high spatial heterogeneity. Weak negative correlations were found between the MHW index and Calanoida, Appendicularia, and *Noctiluca* spp. Finally, a subset of the biological and MHW data from the GAMM model was used in a DSEM, where plankton were grouped by trophic niche (e.g., primary producers, herbivores, carnivores) and linked accordingly. First DSEM analysis results supported that SST likely impacts the ecosystem at multiple levels (i.e. copepods, appendicularians, and *Noctiluca* spp.). This study indicates that SST seasonality and long-term SST trend are most related to plankton trends, and that MHWs are more likely to affect specific taxa at a scale that is highly local and context-dependent. Furthermore, we highlight a few key trophic links to consider when investigating the mechanism of temperature effects on marine plankton.

1 E. C. J. Oliver *et al.*, *Nat Commun*. **9**, 1324 (2018).

2 A. J. Hobday *et al.*, *Progress in Oceanography*. **141**, 227–238 (2016).

3 R. W. Schlegel, A. J. Smit, *Journal of Open Source Software*. **3**, 821 (2018).

4 R. Lagaisse *et al.*, *Sci Data* (2025), doi:10.1038/s41597-025-06278-w.

5 J. Mortelmans *et al.*, *Geoscience Data Journal*. **6**, 76–84 (2019).

Keywords
Plankton Ecology; Climate; Marine Heatwaves; Imaging

Pre-doc presentation

Detecting fish biodiversity and emerging taxa in the Belgian North Sea: the critical role of curated reference databases in eDNA metabarcoding

Tanghe Delphine, Cornelis Isolde, Maes Sara and Derycke Sofie

Animal Sciences Unit, Instituut voor Landbouw-, Visserij-, en Voedingsonderzoek (ILVO), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: delphine.tanghe@ilvo.vlaanderen.be

Monitoring fish biodiversity is essential for detecting shifts in species distributions, assessing ecological change, anthropogenic impacts, and achieving Good Environmental Status under the Marine Strategy Framework Directive. Environmental DNA (eDNA) metabarcoding has emerged as a powerful tool for assessing fish diversity and spatial patterns, especially when combined with conventional methods such as trawl or visual surveys. In most cases, eDNA surveys provide similar or even higher detection probabilities, notably for those that are elusive, rare, or occupy habitats less accessible to conventional techniques. However, the accuracy of eDNA-based species detections critically depends on the completeness and quality of reference databases used for taxonomic assignment.

In this study, the fish communities in the Belgian part of the North Sea (BPNS) were assessed using 12S eDNA metabarcoding of seawater samples collected in autumn 2024 at nine coastal, four transition, and seven offshore stations, including the area where the future Princess Elisabeth energy island (PEI) will be constructed. Beam trawl surveys were conducted at coastal and PEI stations to allow methodological comparison. eDNA metabarcoding using a reference database containing all fish species linked to the BPNS (based on Fishbase and more than 20 years of beam trawl monitoring data) revealed clear spatial structuring of fish communities across coastal, transition, and offshore zones, demonstrating its capacity to capture large-scale distributional patterns.

In the PEI zone, 34 fish species were detected by eDNA metabarcoding and 24 by beam trawling, with 14 species being shared between methods. While no distinct fish community unique to the PEI area was identified, eDNA metabarcoding detected several ecologically relevant taxa that were absent or rare in trawl catches. These included pelagic species such as *Sardina pilchardus* (sardine) and *Engraulis encrasicolus* (anchovy), as well as the rare *Alopias vulpinus* (common thresher shark). These findings confirm that eDNA metabarcoding can detect a broader range of taxa than beam trawling, including pelagic and rare species. Consequently, eDNA offers great potential for detecting shifts in species distributions and newly occurring taxa. This is exemplified by the detection of sardines in the BPNS with eDNA in 2021, a species which had so far not been detected in this area because pelagic trawling is rarely done in this shallow system. Importantly, new species in an area can only be detected with eDNA providing that the reference database contains species that occur outside the geographical area of sampling.

To further explore the potential of eDNA for detecting shifts in species distributions and newly occurring taxa, the 2024 dataset was re-analyzed using an updated and quality-controlled reference database, combined with taxonomic cross-validation against GenBank. This approach revealed the presence of two fish species (*Blennius ocellaris* and *Mola mola*), demonstrating how incomplete reference libraries can lead to overlooked biodiversity signals. The integration of curated databases with publicly available repositories, alongside rigorous quality control, is therefore essential for accurate species detections, particularly in the context of range expansions and potential non-indigenous species (NIS) introductions.

Beyond fish biodiversity, the early detection of newly occurring species is also relevant from a biosecurity perspective, as new species introductions may be accompanied by associated parasites or pathogens. Recent advances suggest that eDNA-based approaches could be extended to detect such organisms, offering a promising early warning tool for ecosystem health and food web integrity (Zaiko *et al.*, 2023).

Overall, this study demonstrates that eDNA metabarcoding is a valuable tool for detecting spatial patterns and shifts in fish species distributions in the BPNS. Crucially, it highlights that robust conclusions depend not only on sampling design and molecular protocols, but also on the use of well-curated and quality-controlled reference databases. As marine ecosystems continue to change, eDNA will be key for effective biodiversity monitoring and management.

Reference

Zaiko, A., Scheel, M., Schattschneider, J., von Ammon, U., Scriver, M., Pochon, X., & Pearman, J. K. (2023). Pest Alert Tool — A web-based application for flagging species of concern in metabarcoding datasets. *Nucleic Acids Research*, *51*(W1), W438-W442. https://doi.org/10.1093/nar/gkad364

Keywords

EDNA Metabarcoding; Fish Communities; North Sea; Biodiversity Monitoring; Reference Databases; Species Range Shifts

Maritime boundaries in motion: From Visserijblad to Marine Regions

Lonneville Britt[1] and Verheyde Fons[2]

[1] VLIZ Marine Data Centre, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: britt.lonneville@vliz.be
[2] Library, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium

"One world or none. There is no alternative." This was the message of the Belgian fisheries sector, voiced by het Visserijblad, during the negotiations of the United Nations Convention on the Law of the Sea (UNCLOS) in 1975.

Founded in 1933, Het Visserijblad quickly became the leading weekly newspaper for fishermen and coastal populations in Belgium, serving as a key medium for disseminating information on fisheries, science, regulation, and maritime affairs. In recent years, this series has been fully digitised and made accessible through Bronnen van de Kust, the result of collaboration between the VLIZ Library, Erfgoedcel Kusterfgoed, and academic partners, with article-level descriptions produced by volunteers.

Digitization and open access have encouraged scientific libraries to take a more active role in sharing knowledge. By creating digital environments, historical periodicals can become searchable, reusable, and accessible to diverse audiences. The use of volunteers to achieve some of the related goals strengthens public engagement with local maritime heritage and institutions. People get to know some of their own local past trajectories and feel involved. Digital availability obviously also greatly enhances the journal's value as a primary source for family history, ecological and coastal heritage research, and the historical study of fishing vessels and fisheries development.

For instance, in the newspaper statements concerning the ongoing negotiations of UNCLOS illustrate the high stakes attached to maritime boundary-making and the extent to which these processes were perceived as directly consequential for fisheries-dependent communities. Despite its entry into force in 1994, maritime boundaries have remained a persistent source of dispute. Contemporary controversies demonstrate that the legal framework established by UNCLOS has not resulted in a static or uncontested maritime order. Instead, maritime zones continue to be negotiated, interpreted, and challenged.

Against this background, the VLIZ project Marine Regions addresses the need for accessible and reliable geographic data on maritime boundaries by creating, sharing and maintaining significant maritime data products (including an open global dataset of maritime boundaries). The newest version of the Maritime Boundaries Geodatabase, released in 2026, integrates the most recent international treaties, court and arbitration rulings, and verified user feedback. Through this continuous process of updating and validation, Marine Regions aims to reflect the current legal and spatial configuration of maritime zones as accurately as possible, while transparently documenting uncertainty and change.

Taken together, Het Visserijblad and Marine Regions illustrate the complementary value of two distinct but connected VLIZ resources. The former provides historical insight into how maritime boundaries were debated and experienced by stakeholder communities, while the latter equips scientists, policymakers, and data users with the geospatial tools needed to conduct contemporary, evidence-based research within those same maritime frameworks.

Keywords

Het Visserijblad; Belgian Fisheries; Maritime Heritage; Citizen Science; UNCLOS; Maritime Boundaries; Geospatial Data; Marine Regions

Supporting the Transition to Low-Impact Fisheries

Van Vlasselaer Jasper

ILVO Marine, Flanders Research Institute for Agriculture, Fisheries and Food, Jacobsenstraat 1, 8400 Oostende, Belgium
Email: jasper.vanvlasselaer@ilvo.vlaanderen.be

Beam trawling remains a cornerstone of fisheries in the North Sea and surrounding seas, delivering high catches and supporting significant economic activity. At the same time, this fishing method is associated with substantial challenges, including high bycatch rates, disturbance of benthic habitats, and elevated fuel consumption. These impacts are increasingly scrutinised under evolving European policy frameworks, rising fuel costs, and growing societal expectations for sustainable seafood production. In parallel, competition for marine space is intensifying, notably through the rapid expansion of offshore wind energy, further constraining traditional bottom trawl fisheries. For smaller and more coastal fishing vessels, these combined pressures raise important questions about long-term economic viability and ecological sustainability. European initiatives such as the EU Green Deal and the Farm to Fork Strategy explicitly call for a transition toward low-impact, climate-resilient food systems, including fisheries that reduce environmental footprint while maintaining economic performance. Within this context, supporting a diversification of fishing methods may help spread economic risk, reduce dependency on fuel-intensive gears, and improve social and environmental outcomes.

Low Impact Fuel Efficient (LIFE) fisheries are increasingly recognised as a potential component of this transition. Among these, fishing with pots and traps offers several advantages, including minimal seabed disturbance, low bycatch, high product quality, and comparatively low fuel use. However, despite these benefits, pot fisheries currently play a limited role in many North Sea fisheries. A key barrier remains economic feasibility: for pots to serve as a realistic alternative or complement to bottom trawling, catch efficiency, operational reliability, and target species range must be sufficient to support viable fishing operations.

The research presented in this contribution aims to support this transition by addressing fundamental and applied questions related to pot fisheries. Central to pot fishing is the attraction of target species, traditionally achieved through the use of natural bait. While effective, conventional bait use can be costly, variable, and dependent on external resources, raising concerns about long-term sustainability and practicality. This work explores whether innovative attraction strategies can enhance or partially replace traditional bait, thereby improving efficiency while reducing bait-related constraints. A particular focus is placed on sensory-based attraction cues, specifically light and sound, as alternative or complementary bait concepts. Through a combination of laboratory experiments and field trials, the behavioural responses of several commercially relevant species—including cuttlefish, brown crab, lobster, common prawn, and shrimp—have been investigated. Controlled settings allow for detailed observation of movement patterns and attraction behaviour, while field deployments assess catch performance, species composition, and practical applicability under real fishing conditions.In addition to improving bait efficiency, this research also examines the potential to expand pot fisheries beyond their traditional target species. Identifying new species that can be effectively caught with pots may increase flexibility and resilience for fishers, particularly in regions where access to fishing grounds is changing due to spatial planning and offshore developments.

By integrating behavioural ecology, gear innovation, and policy-relevant objectives, this work contributes to the development of pot fisheries as a credible LIFE fishing option. The findings demonstrate how targeted innovation can help align economic viability with environmental objectives, supporting ongoing efforts to transition toward more sustainable, low-impact fisheries in the North Sea and comparable marine systems.

Keywords

Pot Fishing; LIFE Fisheries; North Sea; Fishing Gear; Artificial Baits; Passive Fishing; Fisheries In Transition

Uncoating the Problem: Leachates from Coatings Affect Estuarine Copepods Under Climate Change Scenarios

Grandjean Juliette[1], Kazour Maria[1], Wagner Stephan[2], Asselman Jana[3] and Catarino Ana Isabel[1]

[1] Ocean and Human Health, Flanders Marine Institute (VLIZ), InnovOcean Campus, Jacobenstraat 1, 8400 Oostende, Belgium
Email: juliette.grandjean@vliz.be
[2] Hochschule Fresenius, Standort Köln: Idstein, Hessen, Germany
[3] Ghent University, Bluebridge Ostend Science Park, Wetenschapspark 1, 8400 Ostend, Belgium

Antifouling coatings have been used to prevent the growth of fouling organisms on submerged vessels and structures. However, coatings undergo physical and chemical degradation, leaching the toxic biocides from their coating matrix. These leachates can have hazardous effects on aquatic organisms, such as copepods, cockles, and ragworms. In parallel, climate change, particularly rising seawater temperatures, exacerbates existing environmental stressors and introduces further ecological challenges. Yet, the combined effects of leachates from boat coatings and climate change-related stressors remain largely unexplored. The goal of this study was to investigate the combined effects of leachates from coatings and increased temperatures in the harpacticoid copepod *Nitokra spinipes*, a species with a relevant role in estuarine food webs. Paint items were produced by applying thin layers of a commercial coating onto silicone molds. Leachates were generated by immersing the paint items in a filtered 7 PSU aquatic medium for seven days, at room temperature (21 °C), in the dark. The toxicity was then assessed by exposing *N. spinipes* adults and *nauplii* to the leachates at 22 °C and 25 °C (+3 °C; RCP 8.5 scenario, IPCC 2021). To ensure that the organisms were responsive to the toxicants, a positive control was included using copper sulphate in acute toxicity tests on both the adults and *nauplii* at 22 °C. Our results showed a synergistic effect in adults resulting from combined exposure to coating leachates and higher temperature, expressed by a lower median lethal dose (LC50) at 25 °C (after 72-h, $LC_{50\_22°C}$ = 48.8 ± 2.92% and $LC_{50\_25°C}$ = 14.2 ± 10.00%). In contrast, the *nauplii* showed no significant temperature-related differences in mortality ($LC_{50\_22°C}$ = 22.3 ± 13.08%, and $LC_{50\_25°C}$ = 16.9 ± 1.57%), or larval development. Therefore, the tested leachates induced significant toxicity in both life stages. Interestingly, a significant hormesis effect was observed for the larval development ratio at both temperatures, showing a positive effect from the leachates at a low dose. Our findings suggest that the predicted increase in temperature may have additional effects on the leachate's toxicity in adult copepods, and could lead to cascading effects (e.g., at the population level). These results advance our understanding of the combined effects of coating leachates and climate change on aquatic organisms.

Keywords

Lethal Dose; Coatings; *Nitokra Spinipes*; Climate Change; Multiple Stressors

The nasal microbiome as exposome biomarker in Belgian coastal and inland inhabitants

Lambert Silke

Blue Growth Research Lab, Ghent University, Wetenschapspark 1, 8400 Oostende, Belgium
Email: silke.lambert@UGent.be

Sea spray aerosols (SSAs), generated by bursting bubbles from breaking waves, contain a complex mixture of inorganic salts, marine microbiota and bioactive molecules. According to the "old friends" hypothesis, exposure to diverse microbiota at low concentrations may support immune system regulation rather than cause disease. This study aims to identify which marine microbiota are present in inhaled SSAs, and to determine how SSA exposure shapes the human nasal microbiome. We seek to evaluate their potential as exposome biomarkers of coastal environmental exposure.

We recruited 62 healthy adults (18–50 years) in Belgium divided into two groups: individuals living at the coast (>1 year) and inland (>1 year). Nasal swabs of the participants were collected at four time points over eight weeks, alongside weekly sea air samples. DNA was extracted from the nasal swabs as well as the sea air samples and Illumina sequencing was performed. Climate and GPS data were integrated to explore associations with nasal microbiome composition.

Results reveal distinct 16S nasal microbiome profiles between coastal and inland groups, with shared genera typical of human nasal microbiota (24%) and unique genera specific to each group (17% for the coastal and 11% for the inland group). Importantly, genera overlapping between sea air samples and coastal nasal swabs (13%) suggest that marine microbiota are present in the nasal cavity of coastal residents.

These findings suggest that living near the coast may lead to inhalation of marine microbiota, potentially influencing human health. Functional analysis of these genera will assess their potential impact on human health. The temporal design allows investigation of microbiome stability, weather-driven fluctuations, and the role of individual behavior (e.g., time spent outdoors, physical activity) in shaping the nasal exposome. Focusing for example on nasal swabs from the coastal group, 27% of genera (16S) were consistently detected across weeks 0, 2, 4, and 8, reflecting a temporally stable core of the community. At the same time, genus richness increased over time, rising from week 0 (early August) to week 8 (late September), suggesting a gradual diversification of the nasal microbiota in this cohort.

This work highlights how environmental microbial dynamics at the ocean-atmosphere interface can shape human health outcomes—underscoring the need to protect both ecosystem and respiratory health in an era of rapid environmental change.

Keywords

Ocean; Air; Human Health; Exposome; Sea Spray Aerosols

Worth the gamble? Tourism and the embeddedness of gambling in seaside resorts: the case of Ostend at the Belgian coast (1878-1930)

Lambrechts Evert

Maritime Society & History, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: evert.lambrechts@vliz.be

This research examines the role of gambling and casinos in the development of seaside resorts (1878-1930). Despite its economic and social significance, tourism remains underexplored in historical research. The project focusses on Ostend, a booming well-connected European resort town that used gambling to spur its development before becoming increasingly contested, prohibited (1902) and permitted again (1920s). This context allows to uncover both how gambling established itself as a key sector of the coastal tourist industry and how seaside resorts functioned as hubs for elite mobility with global ramifications within a specific local context. This project adopts an actor-centered approach, analyzing (1) the transnational networks of casino-Kursaal concession holders and (2) the construction of Ostend's gambling climate by various stakeholders within changing legal contexts.

The study integrates transnational (Sûreté Publique files, foreign archives), national (parliamentary debates, court case files), and local (travel guides, newspapers, city council records) sources, enabling a global microhistorical perspective. By combining quantitative analysis with qualitative methods, this project reconstructs the processes that made gambling central to Ostend's tourist industry. Understanding the historical processes shaping seaside resorts provides broader insights into global trends that persist today.

Keywords

Tourism History; Seaside Resorts; Blue Economy

Physiological, Psychological and Cognitive Effects of Coastal versus Urban Environments in Older Adults: A Cross-Over Field Study

Kinet Julia[1], De Craene Elias[2], Vandamme Sara[1], Six Mazarine[1], Petrovic Mirko[3], Cardon Greet[4], Bourgois Jan[4], Janssen Colin[1], Everaert Gert[2] and Asselman Jana[1]

[1] Blue Growth Research Lab (BGRL), Ghent University, Ostend Science Park, Wetenschapspark 1, 8400 Ostend, Belgium
Email: julia.kinet@ugent.be
[2] Ocean & Human Health division, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Ostend, Belgium
[3] Section of Geriatrics, Department of Internal Medicine and Paediatrics, Ghent University, Corneel Heymanslaan 10, 9000 Ghent, Belgium
[4] Department of Movement and Sports Sciences, Ghent University, Watersportlaan 2, 9000 Ghent, Belgium

With populations ageing, maintaining functional ability through preventive strategies has become a key public health challenge. In this context, exposure to natural environments has been linked to improved physical and mental well-being. Coastal natural environments may play a key role in healthy ageing, as exposure to blue spaces has been associated with stress reduction, cognitive restoration and promotion of physical activity, all of which are highly relevant for ageing populations. Despite growing observational evidence on the health benefits of coastal environments, experimental research disentangling physiological, psychological and cognitive mechanisms remains scarce, particularly in older adults and with respect to the added value of environmental context beyond physical activity alone.

To address these gaps, a within-subject cross-over field study was conducted with 48 older adults (60–86 years, 54% male). Participants were exposed to both a coastal and an urban environment, each comprising a 15-minute seated phase followed by a 30-minute walk. Heart rate and heart rate variability were continuously measured during exposure, as well as at baseline and during recovery (20 min after the walk) using the Polar H10 chest band. Saliva samples were collected at four time points to determine cortisol levels. Self-reported stress and mood were assessed before and after exposure, alongside cognitive performance, including visual attention measured with the d2 Test of Attention and processing speed assessed using the Symbol Digit Modalities Test.

During recovery, parasympathetic activity remained elevated after coastal walking but decreased after urban walking (-13%, $p = .043$) and sustained reductions in cortisol were observed only after walking in the coastal environment (-15%, $p = .008$). Coastal walking was also associated with an overall reduction in perceived stress (post-pre contrast: -6.66, $p = .039$), improved visual attention (+38.91 test score points, $p < .001$) and larger gains in processing speed (+7.48 test score points, $p < .001$). Mood did not change significantly (all $p > .05$), possibly due to high baseline positive mood and low baseline negative mood scores, limiting sensitivity to change.

In conclusion, coastal walking was associated with stronger physiological, psychological, and cognitive benefits than urban walking in older adults. These findings indicate that coastal environments may function as a valuable health-supporting setting, providing restorative benefits beyond physical activity alone. Coastal walking may therefore represent an accessible, low-cost and scalable nature-based preventive strategy to support healthy ageing.

Keywords

Coastal Environments; Preventive Healthcare; Older Adults; Physiology; Cognitive Performance; Physical Activity

Extraction residue from brown seaweed *Fucus vesiculosus* as potential pesticide with antifungal properties

Minardi Carlotta[1], Chamekh Anissa[2], Declerck Nele[3], Pauwelyn Ellen[3], Sweygers Nick[3] and Appels Lise[2]

[1] CREaS, Campus De Nayer, KU Leuven, Belgium
Email: carlotta.minardi@kuleuven.be
[2] KU Leuven, Jan Pieter De Nayerlaan 5, 2860 Sint-Katelijne-Waver, Belgium
[3] Inagro, Ieperseweg 87, 8800 Rumbeke-Beitem, Belgium

Plant pathogens, including fungi, viruses, bacteria, and parasites, cause severe diseases in plant tissues such as leaves, stems, roots, vascular systems, and fruits. These infections significantly reduce crop yield and shelf life, threatening global food security. Chemical pesticides remain the main strategy for crops management with approximately 3.7 million tonnes used worldwide in 2022, reflecting a 13 percent increase in a decade, and a doubling since 1990 [1]. Their persistence in the environment, mobility, and activity on non-target organisms pose serious ecological risks [2].

Natural products have emerged as sustainable alternatives to chemical pesticides due to their low toxicity, biodegradability, and potent biocidal activity. Marine resources such as seaweed, microalgae, and cyanobacteria are increasingly recognized for promoting soil health, agricultural productivity, and pest control [3]. In particular, seaweeds produce a wide range of secondary metabolites such as phenols, phlorotannins, terpenoids, fatty acids, and polysaccharides which have antimicrobial properties. They can alter and disrupt cell membranes, inhibit enzymes, and reduce protein synthesis.

Brown seaweeds have received considerable attention for their high content in bioactive compounds such as phloroglucinol, mannitol, fatty acids and fucosterol [4]. However, most research focuses on liquid seaweed extracts formulations, with little attention given to the extraction residues.

Hence, this study investigated the antifungal activity of the brown seaweed *Fucus vesiculosus* extraction residue and its extract against three widespread phytopathogenic fungi: *Botrytis cinerea*, *Rhizoctonia solani*, and *Sclerotinia sclerotiorum*. The results revealed remarkable antifungal potential, achieving 100% growth inhibition of *B. cinerea* and 94.51% inhibition of *S. sclerotiorum* at 60% extract concentration, and 22.9% inhibition of *B. cinerea* for the seaweed residue powder in in vitro experiments

These findings highlight the promising role of *F. vesiculosus* extraction residues in sustainable plant disease management and demonstrate a valuable circular approach to seaweed utilization.

Reference

1 FAO. Pesticides use and trade, 1990–2022 [Internet]. Rome, Italy: FAO; 2024 [cited 2025 Oct 31]. https://doi.org/10.4060/cd1486en

2 Zhou W, Li M, Achal V. A comprehensive review on environmental and human health impacts of chemical pesticide usage. Emerging Contaminants. 2025;11:100410. https://doi.org/10.1016/j.emcon.2024.100410

3 Chanthini KM-P, Senthil-Nathan S. Marine weeds against fungal phytopathogens - Current agronomical implications and intriguing perspectives for a sustainable future. Physiological and Molecular Plant Pathology. 2024;130:102240. https://doi.org/10.1016/j.pmpp.2024.102240

4 Andrade PB, Barbosa M, Matos RP, Lopes G, Vinholes J, Mouga T, *et al.* Valuable compounds in macroalgae extracts. Food Chemistry. 2013;138:1819–28. https://doi.org/10.1016/j.foodchem.2012.11.081

Keywords

Brown Seaweed; Antifungal Activity; Biocontrol; Sustainable Agriculture; Circular Economy

Evaluating Substrate Suitability for Larval Settlement of the Tube-Building Polychaete Lanice conchilega in Relation to Hydrodynamic Modification

Islam Mazharul[1], Moens Tom[2], Schwarz Christian[3], A. Toorman Erik[3], Vercruysse Jeroen[4], Castaño Santiago Lopez[4], Peeters Patrik[4] and Van Hoey Gert[1]

[1] Animal Science Unit, Flanders Research Institute for Agriculture, Fisheries and Food, Jacobsenstraat 1 8400 Ostend, Belgium
Email: mazharul.islam@ilvo.vlaanderen.be
[2] Ghent University, Krijgslaan 281/S8, 9000 Ghent, Belgium
[3] KU Leuven, Kasteelpark Arenberg 40, Leuven 3001, Belgium
[4] Flanders Hydraulics, Berchemlei 115, 2140 Antwerp, Belgium

Lanice conchilega is a tube-building polychaete that is known as an ecosystem engineer because of its ability to change sediment structure, stabilise the seabed, and increase biodiversity in benthic communities. However, habitat degradation, bottom trawling, coastal development, and climate-induced changes in sediment dynamics are posing a growing threat to *Lanice* populations, resulting in a decrease in their natural beds. In order to restore *Lanice conchilega* aggregations and maintain their ecological roles in coastal environments, restoration and habitat improvement initiatives are crucial. The introduction of substrates at appropriate sites to act as a base for larval settlement can be a crucial step in the restoration of benthic organisms (such as oysters and mussels). The present approach to identifying suitable substrates for *Lanice conchilega* restoration is based on the flow reduction patterns observed within natural *Lanice* aggregations, which are known to stabilise sediment and create raised mounds. It is hypothesised that similar flow manipulation processes can be achieved using artificial substrates to promote larval settlement. Therefore, identifying substrates with optimal properties, such as those that reduce flow, stabilise sediment, and provide sheltered microhabitats, is critical for facilitating *Lanice conchilega* larval settlement and growth. To address this, we evaluated 31 substrates with varying material, texture, thickness, and structural complexity to determine their impact on hydrodynamics and settlement potential.

Experimental trials were carried out in a small scale Kriesel tank to determine how these substrates alter water flow and affect larval settlement. A sand-filled gutter was placed in the tank's centre to serve as a test platform for individual substrates in controlled hydrodynamic conditions. Substrate performance was evaluated using two complementary parameters: (1) hydrodynamic behaviour, which describes how surface structures influence near-bed velocity and turbulence, and (2) capture efficiency, which is measured by the settlement/capture of both living larvae and pellet mimics. Flow velocity was measured using a Vectrino acoustic Doppler system for fine-scale near-bed data. Capture of mimic particles was recorded at two-minute intervals over a 12-minute period, and a linear model (Capture rate ~ Time) was applied to derive the catchability slope as an indicator of substrate efficiency. Based on hydrodynamic data and mimic capture results, some of the best-performing substrates were selected for further testing with living larvae in 10-day trials to assess and verify the settlement success of *Lanice conchilega* larvae on different substrates.

Results indicate that substrate structure directly governs local hydrodynamics. While thick substrates with additional 3D structure (such as BESE and rope/tube materials) decreased flow and produced calmer microenvironments, thin or two-dimensional substrates with minimal mesh size (such as Basaltex: smooth, rough, mesh mesh), including control sand, showed higher near-bed velocities and turbulent kinetic energy (TKE). Catchability analysis revealed that intermediate mesh size and thickness (e.g., BAS grid, geotextile, and shell-mixed types) provided the highest settlement rates, suggesting that optimal settlement occurs under moderate hydrodynamic conditions in the kreisel tank set-up. High-velocity regimes probably enhanced larval encounters but hindered attachment, while very low velocities limited encounter rates despite offering stable conditions once settled. Further experiments with living larvae were tested on two substrates (BESE and BAS grid) against control sand and showed low survival rates, preventing definitive conclusions about substrate preference; however, the experimental setup proved effective for future testing.

Overall, these results show that the success of larval capture and retention is determined by hydrodynamic modification caused by substrate morphology. Balancing flow energy and surface complexity provides valuable insights for habitat engineering and restoration of *Lanice conchilega* populations.

Keywords

Tube Building Polychaete; Hydrodynamic Modification; Artificial Substrate; Larval Settlement

Artisanal seaweed farming in Kenya: Value chain assessments and community livelihoods

Holeh Gladys[1], Mees Jan[2], Asselman Jana[3], Njiru James[4], Mirera David[5], Janssen Colin[6] and Semmouri Ilias[6]

[1] Blue Growth Research Lab, Ghent University, Bluebridge Ostend Science Park, Wetenschapspark 1, 8400 Ostend, Belgium
Email: gladys.holeh@ugent.be
[2] Flanders Marine Institute (VLIZ), InnovOcean Campus, Jacobsenstraat 1, 8400 Oostende, Belgium
[3] Blue Growth Research Lab, Ghent University, Bluebridge Ostend Science Park, Wetenschapspark 1, 8400 Ostend, Belgium
[4] African Institute for Capacity Development (AICAD). P.O. Box 46179-00100, Nairobi, Kenya
[5] Kenya Marine and Fisheries Research Institute, P.O. Box 81651-80100 Mombasa, Kenya,
[6] Ghent University, Blue Growth Research Lab, Campus Coupure, Building F – 2nd Floor, Coupure Links 653, 9000 Ghent, Belgium

In many coastal regions worldwide, especially in the Global South, seaweed farming is growing as a critical source of income and sustenance, reinforcing food security and providing jobs for small scale actors. However, in the Western Indian Ocean region, the extent to which smallholder producers translate seaweed farming into stable, equitable income and decent jobs remains unclear. In Kenya, commercial seaweed farming is relatively recent and geographically limited to a few pockets along the south coast, and there is still little empirical evidence on how its adoption has affected the livelihoods and income dynamics of farming households. To identify leverage points for resilient and inclusive sector growth, we conducted an integrated socioeconomic and value-chain assessment of artisanal seaweed farming along Kenya's south coast, based on a structured survey of 158 active farmers across four active seaweed farming communities (Kibuyuni, Kijiweni, Mwazaro, Tumbe). We map the full pathway "from farm to market" covering farmer demographics, current farming practices, income dynamics, market relationships, post-harvest activities, training and support, and perceived environmental and economic challenges. Women were found to drive the sector (83.5% of respondents), often within larger households, underscoring the gendered importance of seaweed as an accessible livelihood. Median self-reported monthly household income rose from 2,000 KES (USD 15.50) before interventions on seaweed farming to 6,500 KES (USD 50.38) after adoption (+225%) of the farming, highlighting strong entry-level livelihood gains. However, most farmers are paid quarterly (50.6%), creating cash-flow gaps despite higher annual income. Seaweed cultivation primarily serves the hydrocolloid industry, with production dominated by *Eucheuma denticulatum*. In contrast, *Kappaphycus alvarezii* remains less prevalent due to its higher susceptibility to environmental stresses, disease and predation. Critically, market access is highly concentrated: a single export-oriented buyer accounts for 75% of reported sales, consistent with a "captive" chain structure in which price, quality, and payment terms are set by the lead firm. While this provides an outlet, it suppresses bargaining power and amplifies exposure to policy or demand shocks. On-farm value addition (e.g., soaps, shampoos, powders etc.) remains rare (20% of interviewed farmers), and local food use is uneven and low across communities signaling a missed opportunity to diversify markets and retain value locally. By assessing the socioeconomic benefits and constraints of seaweed farming, we propose pathways for regulators, researchers, and local communities to scale this practice as an inclusive and sustainable blue-economy livelihood. Targeted improvements in production, market, value-chain governance, and local processing could enhance farmer incomes while reducing vulnerability to climate and market shocks.

Keywords

Seaweed Aquaculture; Blue Economy; Gender and Livelihoods; Value-chain Governance; Market Diversification

Reading the Seabed: What Sandbank Morphology Reveals About Sediment Scarcity

Heckmann Victoria, Kint Lars, Van den Eynde Dries and Van Lancker Vera

Operational Directorate Natural Environment, Institute of Natural Sciences, Street Vautier 29, 1000 Brussels, Belgium
Email: vheckmann@naturalsciences.be

Offshore tidal sandbanks are large, elongated sedimentary features providing ideal locations for marine aggregate extraction (Creane *et al.*, 2023). This is exemplified on the Belgian Continental Shelf (BCS) where such extraction has a history of near 50 years, but concerns are emerging on the depletion of medium- to coarse-grained sands (Van Lancker *et al.*, 2019). High-quality and easy-to-extract sands are also becoming scarcer globally, strengthening the call of the United Nations Environment Programme (UNEP) to consider sand as a strategic resource (UNEP, 2022).

Both long-term resource exploitation and the trajectory of post-extraction recovery depends on sediment thickness (Van Lancker *et al.*, 2010; Krabbendam *et al.*, 2022). However, direct information on sediment thickness is often sparse, or limited by insufficient vertical resolution. To pro-actively detect areas that are nearing depletion, and avoid irreversible recovery of seabed habitats, robust proxies for sediment scarcity are urgently needed. In the Dutch NWO project BANX (Roos *et al.*, 2024), we explore whether variability in offshore sandbank morphology and dynamics can serve as meaningful indicators of sediment availability.

Using high-resolution bathymetric datasets from the BCS, we adopt a multi-scale approach to quantify and classify morphological variability objectively, from the bank-scale down to superimposed bedforms. Two complementary strategies are tested: (1) using dense sets of bathymetric profiles extracted along and across sandbanks, and (2) analyses of Digital Terrain Models (DTM).

Morphological variability is quantified using a range of morphometric descriptors. Patterns within this variability are explored using an unsupervised clustering approach, enabling grouping of profiles with similar morphological characteristics. In parallel, to provide a complementary synoptic view of morphological variation, frequency-based analyses of selected DTM sectors are performed to identify dominant wavelengths and extract multi-scale bedform structures. Classifications are further examined in relation to available geological and hydrodynamical datasets to explore links between morphology, sediment composition and prevailing processes.

The research is primarily methodological and forms part of a broader effort to exploit long-term monitoring data from sandbanks subjected to varying extraction regimes, with the goal of developing transferable frameworks for assessing sediment availability in offshore environments. Results will be compared to modelling results on cross-sectional dynamics of tidal sandbanks in sediment-scarce environments (Van Veelen *et al.*, 2024), which is done in parallel in the BANX project.

References

- Creane, S., O'Shea, M., Coughlan, M., & Murphy, J. (2023). Hydrodynamic Processes Controlling Sand Bank Mobility and Long-Term Base Stability: A Case Study of Arklow Bank. Geosciences, 13(2), 60. https://doi.org/10.3390/geosciences13020060.
- Krabbendam, J. M., Roche, M., Van Lancker, V. R. M., Nnafie, A., Terseleer, N., Degrendele, K., & De Swart, H. E. (2022). Do tidal sand waves always regenerate after dredging? Mar. Geol., 451, 106866. https://doi.org/10.1016/j.margeo.2022.106866
- Roos, P. C., Van Lancker, V., Van den Eynde, D., van Veelen, T. and Hulscher, SJMH. Understanding Tidal Sandbank Dynamics and Impacts of Sand Extraction in Sediment-Scarce Environments. *21st International Conference on the Physics of Estuaries and Coastal Seas, PECS 2024*, 2024, 187–88.
- United Nations Environment Programme. (2022). Sand and sustainability: 10 strategic recommendations to avert a crisis. GRID-Geneva, United Nations Environment Programme, Geneva, Switzerland
- Van Lancker V, Francken F, Kapel M, Kint L, Terseleer N, Van den Eynde D, Hademenos V, Missiaen T, De Mol R, De Tré G, Appleton R, van Heteren S, van Maanen PP, Stafleu J, Stam J, Degrendele K, Roche M. Transnational and Integrated Long-term Marine Exploitation Strategies (TILES). Final Report. Brussels: Belgian Science Policy 2019 – 75 p. (BRAIN-be - Belgian Research Action through Interdisciplinary Networks (https://www.belspo.be/belspo/brain-be/projects/FinalReports/TILES_FinRep_AD.pdf)

- Van Lancker, V. R. M., Bonne, W., Velegrakis, A. F., & Collins, M. B. (2010). Aggregate extraction from tidal sandbanks: is dredging with nature an option? Introduction. Journal of Coastal Research, Special Issue 51, pp. 53-61.
- Van Veelen, T. J., Roos, P. C., & Hulscher, S. J. M. H. (2024). Modeling the cross-sectional dynamics of tidal sandbanks in sediment-scarce conditions. Journal of Geophysical Research: Earth Surface, 129(4), e2023JF007308. https://doi.org/10.1029/2023JF007308

Keywords

Sandbank; Bedform; Geomorphology; Seabed Dynamics; Scarcity

Marine Heatwaves Drive Seasonal Extremes in Air–Sea CO_2 Fluxes in the Belgian North Sea through Amplified Winter Sinks and Summer Sources

Keppens Maurie[1], Roobaert Alizée[1], Olivelli Arianna[1], Gkritzalis Thanos[1], Neukermans Griet[2] and Landschützer Peter[1]

[1] Research department, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Ostend, Belgium
Email: maurie.keppens@vliz.be

[2] Faculty of Biology, Ghent University, Krijgslaan 281 (S8) , 9000 Gent, Belgium

Coastal seas are dynamic interfaces where physical, chemical, and biological processes tightly control carbon exchange between the surface ocean and the atmosphere. Extreme events, such as marine heatwaves (MHWs), can strongly modify these carbon fluxes. While large-scale impacts of MHWs in the open ocean are relatively well documented, their short-term, fine-scale effects in the coastal seas remain poorly understood. The well-monitored Belgian part of the North Sea (BPNS), with extensive in situ observations of key marine carbonate system variables and recurrent exposure to marine heatwaves, offers an ideal setting to study their impact on coastal carbon cycling.

A total of 105 local MHW events were identified in this study (using ESA SST CCI and C3S data) over the BPNS. On average, these MHWs lasted about one month, with a mean intensity of +0.35 °C above the local 90th percentile, a mean peak intensity of +1.14 °C, and affected roughly 31% of the study area. By combining in situ measurements, satellite-derived data, and machine-learning techniques, we reconstructed daily, 1 km–resolution fields of sea surface partial pressure of CO_2 (pCO_2) in the BPNS from 2000 to 2024, and calculated air–sea CO_2 fluxes (FCO_2) based on the sea–air pCO_2 gradient using established gas-transfer formulations. Together, these analyses allow us to evaluate how MHWs modify sea surface pCO_2 and air–sea CO_2 fluxes at an unprecedented fine scale.

Preliminary results over the 25-year study period show that FCO_2 during MHWs was on average ~57.5 ± 22.5% higher than expected, calculated as the mean across both space and MHW days. This indicates that MHWs generally enhance fluxes, either by increasing CO_2 release to the atmosphere or by strengthening uptake by the ocean, depending on the sign of the climatological flux. The most extreme events show substantially larger anomalies (~115.5 ± 42.6%), with maximum local deviations exceeding 200%. These overall enhancements are accompanied by clear seasonal patterns: summer and autumn MHWs strengthen CO_2 outgassing due to reduced solubility under warmer conditions, whereas winter and spring MHWs unexpectedly tend to increase regional CO_2 uptake, potentially linked to enhanced biological CO_2 uptake and transport processes. These MHW-related changes in FCO_2 are primarily driven by variations in sea surface pCO_2, while wind-driven air–sea exchange plays a minor role, highlighting the importance of monitoring seawater pCO_2 and its associated biological, physical, and chemical processes in a changing climate.

Keywords

Coastal Carbon Cycling; Marine Heatwaves; Machine Learning; Air–sea CO_2 Fluxes

Wind Farms and Food Webs: 14 Years of Marine Change

Reynés-Cardona Abril[1], Vanaverbeke Jan[2], De Borger Emil[1], Marina Tomás[3], Buyse Jolien[4] and Braeckman Ulrike[1]

[1] Marine Biology Research Group, Ghent University, Krijgslaan 281, 9000 Gent, Belgium
Email: abril.reynescardona@ugent.be
[2] Marine Ecology and Management (MARECO), Institute of Natural Sciences, RBINS, Rue Vautier 29, 1000 Bruxelles, Belgium
[3] Centro Austral de Investigaciones Científicas (CADIC-CONICET), Bernardo Houssay 200, Ushuaia, Tierra del Fuego, Argentina
[4] ILVO, Jacobsenstraat 1, 8400 Oostende, Belgium

Offshore wind farms (OWFs) introduce artificial hard substrates into soft-bottom environments rapidly colonized by suspension feeders. The new biomass attracts fish and top predators and enriches macrobenthic communities in the surrounding area. However, this succession process is dynamic, evolving over time through shifts in community composition and dominance.

This study provides the first long-term, data-driven assessment of OWF impacts on food web structure and carbon flows, analysing 14 years (2009–2023) of data from the C-Power OWF (Belgium). Using Linear Inverse Modelling and topological network analysis, we demonstrate that OWF development locally decreases ecosystem stability. Over time, the ecosystem becomes more active with more intense but highly variable carbon flows, leading to a greater difference between dominant and weak energy pathways. A shift towards a suspension-feeder-dominated system leads to a reduced connectance, omnivory, and mean trophic level, decreasing trophic flexibility. While OWFs enhance fouling fauna secondary production, no clear pattern emerges regarding effects on the total secondary production.

Our findings emphasize the importance of adopting an ecosystem-based approach for assessing OWF impacts on the marine environment. It highlights the role of food web research to evaluate ecosystem stability, quantify energy flows and secondary production to inform sustainable management strategies.

Keywords

Offshore Wind Farms; Food Webs; Succession Dynamics; Ecosystem Functioning; Ecosystem Stability; Network Analysis

Advancing Marine Chemical Monitoring: Hazard Based Selection of Contaminants of Emerging Concern Using the CONTRAST Prioritisation Tool

Yulikayani Putu Yolanda[1], De Witte Bavo[1], Ali Aasim[2], Barber Jonathan[3], Bellas Juan[4], Briant Nicolas[5], Brooks Steven[6], Bruvold Are Sæle[2], French Megan Anne[7], Hylland Ketil[2], Kaberi Helen[8], León Víctor M.[9], Martins Samantha[10], Mauffret Aourell[5], Molinari Francesca[11], Reid Malcolm[12], Sturve Joachim[11], Van Poucke Christof[13], Valdersnes Stig[2], Walgraeve Christophe[14], Demeestere Kristof[14] and Wennberg Aina Charlotte[6]

1 Marine Research, Instituut voor Landbouw en Visserijonderzoek (ILVO), Jacobsenstraat 1, 8400 Ostend, Belgium
Email: putuyolanda.yulikayani@ilvo.vlaanderen.be
2 Contaminants and Biohazards, Institute of Marine Research (IMR), Nordnesgaten 50, 5817 Bergen, Norway
3 Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, Lowestoft NR330HT, UK
4 Centro Oceanográfico de Vigo, Instituto Español de Oceanografía (IEO-CSIC), Subida a Radio Faro 50, 36390 Vigo, Spain
5 Chemical Contamination of Marine Ecosystem, French National Institute for Ocean Science and Technology (IFREMER), Rue de l'Ile d'Yeu - BP 21105, 44311 Nantes, France
6 Ecotoxicology and Risk Assessment, Norwegian Institute for Water Research (NIVA), Økernveien 94, 0579 Oslo, Norway
7 National Institute of Oceanography and Applied Geophysics IT (OGS), Borgo Grotta Gigante 42/C, 34010 Sgonico-Trieste, Italy
8 Hellenic Centre for Marine Research, Institute of Oceanography (HCMR), Leoforos Athens Sounio 46,7 km, 19013 Attikia Anavissos, Greece
9 Centro Oceanográfico de Murcia, Instituto Español de Oceanografía (IEO-CSIC), C/ Varadero 1, 30740 Murcia, Spain
10 Norwegian Institute for Water Research, Økernveien 94, 0579 Oslo, Norway
11 Department of Biological and Environmental Sciences, University of Gothenburg, Box 463, 40530 Gothenburg, Sweden
12 Environmental chemistry, Norwegian Institute for Water Research (NIVA), Økernveien 94, 0579 Oslo, Norway
13 Technology and Food Science, Instituut voor Landbouw en Visserijonderzoek (ILVO), Brusselsesteenweg, 370, 9090 Merelbeke-Melle, Belgium
14 Department of Green Chemistry and Technology, Research Group Environmental Organic Chemistry and Technology (EnVOC), Ghent University, Coupure Links 653, 9000 Ghent, Belgium

Introduction

With a growth in societal and technological activities, more chemicals are synthesised and used, resulting in increased chemical pollution in marine environments [1]. Though some are part of (inter)national regulation and frequently monitored, most pollutants remain unregulated and poorly studied. These chemicals are known as contaminants of emerging concern (CECs) [2].

To address knowledge gaps, it is vital for policy-makers to consider less-known CECs. However, studies are hindered by the large number and diversity of chemicals. Thus, a prioritisation tool helps to focus on studying the most potentially harmful compounds. To tackle the lack of marine-specific prioritisation schemes, a novel prioritisation tool for CECs in the marine environment was developed within the European Union (EU) project “An Integrated Approach for Assessing Impacts on the Marine Environment (CONTRAST)”.

Materials and Methods

The CONTRAST prioritisation tool was developed by starting with a literature review, followed by an online survey distributed among project participants to select the prioritisation criteria. This resulted in a hazard-based filtering and ranking approach. As the aim of the present tool is to select CECs, the EU-regulated compounds were excluded in this prioritisation due to their well-known impact.

Filtering used three parallel schemes: 1) persistence and bioaccumulation (PB), 2) toxicity (T), and 3) persistence and mobility (PM). Selected chemicals were further assessed for mode of action, environmental occurrence, and emissions,

then ranked by their final score. The CONTRAST prioritisation tool was applied to the PikMe database containing 1.13 million chemicals, with support from the PikMe tool funded by the Norwegian Environment Agency [3]. Its performance was evaluated using positive (EU-regulated), negative (low-impact), and unknown controls. The proposed prioritisation tool was deemed effective if it correctly selected >50% of positive controls.

Results and Discussion

From the 1.13 million chemicals in the PikMe database, 8548 compounds were selected using one or more schemes and ranked. 6PPD, a common rubber antioxidant, was the highest-ranked compound. Along with its derivative 6PPD-quinone, these compounds are drawing attention for their environmental presence and potential harmful effects [4]. The top-100 ranked compounds comprised a high diversity of use categories, from which pharmaceuticals were the predominant category, followed by industrial chemicals. The CONTRAST tool proved effective, selecting 84% of positive controls.

The CONTRAST prioritisation is marine-specific, focusing on unregulated chemicals and emphasising marine sources and mode-of-action assessment. It used an extensive initial compound list and applied a distinct occurrence assessment compared to other schemes. This approach ensured the selection of CECs with knowledge gaps, diverse toxicity mechanisms, and potential detectability across sea regions.

Conclusions

The CONTRAST prioritisation tool was developed specifically to select CECs in the marine environment. Applied to 1.13 million chemicals in the PikMe database, it selected and ranked 8548 compounds, from which the top-100 span diverse use categories. While effective in selecting well-known harmful chemicals, its main purpose is to guide decisions on CECs that require further study to address knowledge gaps and justify monitoring and regulatory measures.

References

1 Nipen M, Vogt RD, Bohlin-Nizzetto P, Borgå K, Mwakalapa EB, Borgen AR, Schlabach M, Christensen G, Mmochi AJ, Breivik K (2022) Increasing Trends of Legacy and Emerging Organic Contaminants in a Dated Sediment Core From East-Africa. Frontiers in Environmental Science 9. doi:10.3389/fenvs.2021.805544.

2 James CA, Sofield R, Faber M, Wark D, Simmons A, Harding L, O'Neill S (2023) The screening and prioritization of contaminants of emerging concern in the marine environment based on multiple biological response measures. Sci Total Environ 886. doi:10.1016/j.scitotenv.2023.163712.

3 Wennberg AC, Rostkowski P, Reid M (2025) PikMe: a flexible prioritization tool for chemicals of emerging concern. Environ Toxicol Chem 44 (12):3450–3459. doi:10.1093/etojnl/vgaf237.

4 Chen X, He T, Yang X, Gan Y, Qing X, Wang J, Huang Y (2023) Analysis, environmental occurrence, fate and potential toxicity of tire wear compounds 6PPD and 6PPD-quinone. Journal of Hazardous Materials 452:131245. doi:10.1016/j.jhazmat.2023.131245.

Keywords

Contaminants Of Emerging Concern; Hazard-based Assessment; Persistence; Bioaccumulation; Toxicity; Mobility

Harbour porpoise distribution near operational offshore windfarms: a passive acoustic monitoring approach

Van Nieuwenhove Annelore, Aoufi Sofya and Rumes Bob

Marine Ecology, Institute of Natural Sciences, Vautierstraat 29, 1000 Brussel, Belgium
Email: avannieuwenhove@naturalsciences.be

The current offshore windfarm capacity in the North Sea, nearly 30 GW, is expected to increase significantly in the coming years to support the EU goal of 300 GW by 2050. Therefore, it is crucial to determine how these operational wind farms affect the marine environment. The harbour porpoise is the most common cetacean in these waters and relies on narrowband high-frequency (NBHF) echolocation clicks for navigation, foraging, and communication. This makes the species particularly sensitive to noise pollution, underscoring the need to understand how anthropogenic noise, especially from the expanding offshore wind energy industry, affects their distribution.

To determine small scale distribution patterns, tripod-mounted F-PODs were deployed during a one-year period in Belgian waters, along a gradient of increasing distance from the nearest operational offshore wind turbine, at four intervals ranging from 150 m to 800 m. Using generalized additive models, Detection Positive Minutes (DPM) and Hours (DPH) metrics (per hour and per day) are examined to study patterns in harbour porpoise presence in relation to distance from operational offshore turbines, which serves as a proxy for turbine noise.

Preliminary results show that DPM/day gradually increases from autumn onwards, with peak in late winter and early spring: a clear seasonal pattern in harbour porpoise presence that is consistent with the dynamics previously described outside windfarms. During these months a distinct diel pattern is observed consistent across distances. Exploratory analyses revealed differences in harbour porpoise detections across distances, being consistently lower at 800 m, non-significant or lower at 400 m and non-significant or higher at 600 m compared to 150 m, across both hourly and daily measures (DPM/DPH).

This research will provide insight in how operational windfarms influence the fine-scale distribution of harbour porpoises, providing insights to improve cetacean management and conservation in the intensively used North Sea. *This research is part of PURE WIND, an UN Ocean Decade endorsed project.*

Keywords

Harbour Porpoise; Operational Offshore Wind Farm Noise; Passive Acoustic Monitoring

Role of benthic fauna functional traits in iron cycling in two Icelandic fjords

Wittig Cathrin [1], Wagner Katrin [2], Kononets Mikhail [3], James Rebecca K. [4], Bui Winter [4], Reardon Jake [5], Balmonte John Paul [6], Hall Per O. J. [7], Hylen Astrid [8], Hidalgo-Martinez Silvia [8], März Christian [9], Reyniers Piet [10], Verweider Lotte [10], Braeckman Ulrike [1], van de Velde Sebastiaan [11]

[1] Marine Biology Research Group, Ghent University, Krijgslaan 281, Campus Sterre, Building S8, 9000 Gent, Belgium
Email: cathrin.wittig@ugent.be
[2] Environmental Geology Research Group, University Bonn, Nußallee 8, 53115 Bonn, Germany
[3] Research consultant, University of Gothenburg, Fredrikas Gård 2, 414 83, Gothenburg, Sweden
[4] Department Geosciences, Society and Environment, Université Libre the Bruxelles, Avenue Franklin Roosevelt 50, 1050 Brussels, Belgium
[5] External Relations Team, University of Southern Denmark, Campusvej 25 5230 Odense, Denmark
[6] Department of Earth and Environmental Sciences, Lehigh University, W Packer Ave, Bethlehem, PA 18015, US
[7] University of Gothenburg, Fredrikas Gård 2, 414 83, Gothenburg, Sweden
[8] Department of Biology, University of Antwerp, Universiteitsplein 1, 2610 Antwerpen, Belgium
[9] University Bonn, Nußallee 8, 53115 Bonn, Germany
[10] Department of Geology, Ghent University, Krijgslaan 281, Campus Sterre, Building S8, 9000 Gent, Belgium
[11] Department of Marine Science, University of Otago, 360 Leith Street Dunedin 9016 New Zealand

Iron availability limits marine primary productivity and CO_2 uptake in large parts of the ocean, including the North Atlantic. Lithogenic iron is an important iron source for the ocean and can be delivered via dust deposition or transitional systems such as estuaries, rivers and fjords. The activity of benthic fauna ("bioturbation") is known to promote benthic iron recycling in marine sediments and can be further divided into the up and downward transport of particles ("biomixing") and solutes ("bioirrigation"). The balance of these two processes controls the release of iron from the sediment and is ultimately determined by the faunal community present and their functional traits. Ongoing environmental changes are expected to alter the structure and functioning of benthic ecosystems, which could affect benthic iron cycling and thus the iron supply to the ocean. However, because we do not fully understand the link between benthic community structure, functioning, and seafloor iron cycling, it is impossible to predict how environmental changes will influence these faunal communities, the release of iron from the sediment and ultimately, the iron availability for marine primary productivity.

To address this, we investigated the benthic iron cycle and faunal activity in two non-glaciated high-latitude fjord systems from Iceland. Pore-water distributions of dissolved iron (Fe^{2+}), benthic iron mineralogy (FeS, FeS_2, Fe-oxides), as well as the sulfate reduction rates along a transect of each fjord were complemented by a quantitative assessment of the present faunal community and their functional traits. Despite their close geographical relation, both fjords differed distinctively in their present benthic faunal communities and sediment iron geochemistry. The first fjord was dominated by downward conveyors with an increasing abundance of surficial modifiers and biodiffusers closer towards the sea. The second fjord, however, showed a balanced abundance of upward and downward conveyors with mixed abundances of surficial modifiers and biodiffusers along the entire fjord transect.

Our results suggest that the fjord characterised by predominantly downward-conveying macrobenthos promoted the burial of iron as Fe-sulfides, leading to reduced upward transport and consequently weaker iron (re)cycling in the sediment. In contrast, iron (re)cycling was particularly stimulated in the second fjord with balanced upward and downward conveying macrobenthos and lower Fe-sulfide burial. This indicates that the balance of different bioturbation modes plays a key role in efficient benthic iron cycling and ultimately iron availability in the ocean.

Keywords

Benthic Iron Cycling; Benthic Fauna; Bioturbation; Icelandic Fjords

POSTER PRESENTATIONS

Long-term assessment of Lowest Astronomical Tide at Belgian North Sea Tide Gauges Based on Harmonic and Residual Spectral Analysis

Abdollahi Somayeh[1], Vanlede Joris[2], Verbeurgt Jeffrey[3], Verstraeten Johan[4], De Kuyper Alec[4], Gurdebeke Pieter[4] and De Wulf Alain[3]

[1] Department of Geography, Ghent University
Email: somayeh.abdollahi@ugent.be
[2] Flanders Hydraulics, BE-2140 Antwerp, Belgium, BE-2140 Antwerp, Belgium
[3] Department of Geography, Ghent University, BE-9000 Ghent, Belgium, BE-9000 Ghent, Belgium
[4] Flemish Hydrography, Agency for Maritime and Coastal Services, 8400 Ostend, Belgium

This study presents an updated assessment of the Lowest Astronomical Tide (LAT) at tide gauges in the Belgian part of the North Sea, based on 23 years (2001–2023) of high-resolution water-level observations. Data from four stations—Nieuwpoort, Oostende, Zeebrugge, and the offshore Westhinder platform—were analysed using a robust harmonic analysis framework. The length and quality of the dataset allow, for the first time in this region, a systematic comparison of several LAT estimation approaches, including long-term harmonic analysis, annual reconstructions, and averaged tidal constituent models.

The results reveal clear spatial variability in LAT values along the Belgian coast, underlining the importance of site-specific tidal representation and careful constituent selection. Comparisons with existing operational LAT surfaces from the Agency for Maritime and Coastal Services (MDK) show overall good agreement and confirm the internal consistency of the derived estimates.

In addition, an enhanced residual spectral analysis was applied to refine station-specific constituent selection, leading to improved representation of local tidal dynamics and reduced reconstruction residuals. A quantified uncertainty analysis indicates that the standard deviation of LAT estimates remains below 3 cm at all stations. Together, these results provide a practical and reproducible basis that can support future refinement of LAT reference surfaces for operational hydrography and nautical charting in the Belgian coastal zone.

Keywords

LAT; Belgian North Sea; Residual Spectral Analysis; Tide Gauge

From propagules to populations: exploring genetic connectivity of mangrove forests in Sri Lanka

Abeysinghe Nuwanka

Marine Biology, Vrije Universiteit Brussel (VUB)
Email: abeynk28@gmail.com

Sri Lanka, an island located in the Indian Ocean, is rich in productive coastal ecosystems, that host a diverse array of mangrove species. Mangrove ecosystems offer vital ecological and socioeconomic benefits, enhance coastal resilience, and store large amounts of blue carbon. Despite this importance, mangrove cover is rapidly declining due to human activities, prompting increased restoration efforts. Unfortunately, in some locations, restoration overlaps with naturally recovering areas, allowing propagule dispersal between connected sites modulated by ocean currents. This allows considerable proportion of gene flow within and between mangrove populations. If degraded mangrove forests remain genetically connected, SER (Society for Ecological Restoration) guidelines recommend facilitating natural recruitment over direct planting. Therefore, understanding genetic connectivity optimises restoration and implement better conservation strategies for the sustainable use of mangroves. Mangrove genetic connectivity has been extensively studied globally, however, no studies to date have specifically addressed genetic connectivity among Sri Lankan mangroves by utilising nuclear microsatellite markers. Therefore, the proposed study aims to investigate the genetic connectivity of common mangrove species across southern, western, northern and eastern coastlines of Sri Lanka. Co-functional mangrove forests which are in the neighbourhood of each other and have the possibility to exchange their propagules will be selected from each coastline including Rekawa, Kahandamodara and Kalametiya in the southern coastline; Mandathive island, Uppu Aru and Jaffna in the northern coastline; Puttalam, Mundel and Chilaw-Pumbala in the western coastline; and Trincomalee, Ullackalie and Uppar in the eastern coastline as major sample sites. Additionally, Panama, Batticaloa, Nayaru, Negombo lagoons, Madu Ganga, and Mannar area, will be sampled as minor sample sites. A common mangrove species will be selected for each neighbouring co-functional lagoon. At major sample sites, leaf samples will be collected from the selected mangrove species along four belt transects (length will be the size of the studied mangrove patch extending from water edge to landward side and 5 m width) covering different development stages. Three fresh, bright green, matured, healthy leaves per plant will be collected. Random sampling will be carried out for the minor sites with 25 samples per site. GPS coordinates of each sampled mangrove will be recorded, along with distances between sampled individuals and leaves will be stored separately in individual bags with silica gel. Total genomic DNA will be extracted from 20-30 mg of dried leaf tissue, and the quantity and purity will be determined using a Nanodrop spectrophotometer. Multiplex Polymerase Chain Reaction (PCR) will be performed using suitable microsatellite primers, followed by fragment analysis and allele size assessment. Genetic diversity, population structure and connectivity of common mangrove species will be examined. Finally, a hydrodynamic model (Delft3D-FLOW) will be developed to simulate propagule dispersal patterns driven by ocean currents and coastal geography. By integrating genetic data with hydrodynamic modelling, this study will reveal a comprehensive understanding of genetic connectivity among mangrove populations in Sri Lanka, elucidating natural recovery process to promote sustainable management, reducing restoration costs and improving restoration success rates.

Keywords

Mangroves; Microsatellite Markers; Population Structure; Conservation Management

Comparing reef fish community structure across protected and non-protected areas of coastal Kenya using ROV-based video surveys

Acevedo-Ramirez Paula

Marine Biology, Vrije Universiteit Brussels
Email: paula.andrea.acevedo.ramirez@vub.be

Coral reefs are biodiversity centers that support coastal communities by providing food security, livelihood, and supporting small-scale fisheries across the Western Indian Ocean. However, these ecosystems are under constant threat due to overfishing, habitat degradation, and climate-related disturbances, raising concerns about the effectiveness of the current management. Marine Protected Areas (MPAs) have been promoted as an integral part of conservation, but their ability to maintain ecosystem structure and reef fish diversity varies across space and levels of protection, emphasising the need for updated, site-specific assessments using reliable monitoring tools. The monitoring technique used potentially has an important influence on diversity results. For example: visual census performed by snorkelers or divers tends to favour the detection of conspicuous fishes and ignore more cryptic organisms. The use of eDNA, to the contrary, enables to detect the presence of elusive and less visible species, but makes it more difficult to account for abundance. Remotely operated vehicles (ROV), form a possible non-invasive alternative to diver-based methods, expected to reduce fish avoidance behaviour, particularly in highly fished zones.

In this study, we examine the differences in the reef fish community structure between protected and non-protected areas along the Kenyan coast, assessing the role of MPAs in maintaining functional composition and species diversity. Reef fish communities of seven sampling sites will be surveyed using a ROV and compared with reef fish community data derived from eDNA and video images taken by divers and/or snorkelers at the same locations. By comparing results using ROV with historical data and other approaches, this study aims to identify complementary and scalable monitoring strategies and increase the scientific evidence on the role of MPAs in sustaining reef biodiversity and inform sustainable fisheries management.

Keywords

East Africa; Fisheries Management; Species Diversity; Spill-over; Western Indian Ocean

Marine fungi as a source of bioactive enzymes with antifouling potential

Agustina Sri, Asselman Jana and Diopere Eveline

Blue Growth Research Lab, Ghent University, Wetenschapspark 1, Bluebridge, 8400, Oostende, Belgium
Email: sri.agustina@ugent.be

Marine fungi are renowned for producing a wide range of secondary metabolites that have been positively confirmed acting as antimicrobial, cytotoxic activity, anticancer, and antifouling. However, their potential for enzyme production has not been extensively investigated. Enzymes play a vital role across multiple sectors as environmentally sustainable catalysts and possess potential applications as antifouling agents. To evaluate the potential of marine fungal enzymes as antifouling compounds, nine fungal isolates were collected from various sites within the Ostende marine environment, including seawater, sediment, and seafoam. The isolates were cultivated on modified Czapek Dox solid medium at 28 °C for seven days to assess enzymatic activity. Positive enzymatic activity was indicated by the appearance of clear zones following staining with specific reagents. The results revealed that the marine fungal isolates secreted chitinase, amylase, and cellulase, suggesting their potential to interfere with biofilm formation during the fouling process. Nevertheless, further studies, including precise species identification, are required to draw comprehensive conclusions regarding the applicability of marine fungi–derived enzymes as alternative antifouling agents.

Keywords

Marine Enzymes; Chitinase; Amylase; Cellulose

Seasonal shifts in fatty acid production and composition in natural eukaryotic plankton communities traced by metatranscriptomic and lipidomic profiling

Ahmad Maqbool[1], Perneel Michiel[2], Scenna Lorenzo[3], Boyen Jens[4], Lagaisse Rune[5], De Troch Marleen[5], Van Belleghem Steven[6] and Hablützel Pascal I.[1]

[1] Marine Observation Center, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Ostend, Belgium
Email: maqbool.ahmad@vliz.be
[2] Department of Plant Biotechnology and Bioinformatics, Ghent University, 9052 Gent, Belgium
[3] Department of Life and Environmental Sciences, Università Politecnica delle Marche, 60121 Ancona, Italy
[4] Department of Biology, University of Antwerp, 2610 Wilrijk, Belgium
[5] Department of Biology, Ghent University, 9000 Ghent, Belgium
[6] Department of Biology, KU Leuven, 3000 Leuven, Belgium

Eukaryotic plankton contribute significantly to global production of long-chained poly-unsaturated fatty acids (LC-PUFAs), essential for food web functioning. Despite their ecological importance, our understanding of how plankton community composition drives fatty acids (FA) production across seasons remains limited. We integrated lipid profiling, metatranscriptomics, and high-throughput imaging to assess FA content and biosynthetic capacity in North Sea plankton communities over an annual cycle.

Twenty-three fatty acids were identified, dominated by saturated (65%) and monounsaturated (20%) fatty acids, and PUFAs (15%). The most abundant FAs were palmitic acid (16:0), myristic acid (14:0), and palmitoleic acid (16:1n-7), while PUFAs showed high variability and contributed substantially to seasonal differences. FA diversity varied seasonally from 13-19 per sample in summer to 4-9 in winter with eicosapentaenoic acid nearly absent from December to April. Regularized Canonical Correlation Analysis (RCCA) indicated a significant co-structure between microeukaryotic community composition (at genus level) and FA profiles and resolved distinct seasonal clusters.

Profile hidden Markov models (HMMs) targeting FA metabolism genes revealed from metatranscriptomics dataset that bloom-forming diatoms dominated desaturase and PUFA-elongase expression during summer, while heterotrophic taxa contributed substantially to elongase activity during winter, reflecting trophic PUFA recycling. Significant positive correlations between combined FED and PUFA-elongase expression with LC-PUFA concentrations identified these rate-limiting enzymes as primary molecular drivers of EPA and DHA synthesis.

Our results demonstrate seasonal coupling between community structure and essential FA production, with phytoplankton and zooplankton both contributing to biosynthetic capacity. These findings provide a quantitative framework linking community composition to nutritional quality, demonstrating the value of multi-omics approaches for understanding biogeochemical processes across trophic levels

Keywords

Fatty Acids; Microeukaryotic Plankton; Metatranscriptomics; Desaturases/elongases; Seasonal Dynamics; North Sea; Community Composition; LC-PUFA

The Hidden Pulse of the North Sea: Are Infragravity Waves Affecting Coastal Safety?

Alfaro Felipe[1], Gruwez Vincent[2], Ribeiro Clara[3], Ponzoni Leandro[3], Boone Wieter[3], Gurdebeke Pieter[4] and Troch Peter[5]

[1] Coastal Engineering Research Group, Ghent University
Email: luisfelipe.alfarocorrales@ugent.be
[2] Flanders Hydraulics, Antwerp, Belgium
[3] Flanders Marine Institute, Ostend
[4] Maritieme Dienstverlening en Kust, Antwerp
[5] Ghent University, Ghent, Belgium

Introduction: When we consider coastal hazards during storms, we usually focus on the clearly observable sea-swell (SS) waves (with periods between 3 and 20 seconds) crashing against coastal protection infrastructure. However, alongside these short waves, "infragravity" (IG) waves propagate, which are long-period waves with periods that are usually longer than 20 seconds. While often low in height offshore in deeper water these waves can become significant as they approach the shallow nearshore area and the shoreline (Reniers *et al.*, 2021), playing a critical role in nearshore processes such as wave run-up, coastal erosion, and wave overtopping at dikes (Akrish *et al.*, 2025). Despite their importance, IG waves are often disregarded in current coastal safety assessments.

The Role of the Belgian Sandbanks: The Belgian nearshore zone is characterized by the presence of shallow sandbanks. Rather than merely acting as a barrier, these sandbanks transform the waves arriving at the coast, acting as an additional source of incident IG energy. As SS waves shoal and break over the shallow bank crests, they release "free" IG waves which propagate shoreward, impact the coastline, and reflect off the coast to travel independently across the North Sea. Currently, many numerical models used for coastal safety assessments neglect these shoreward-propagating free IG waves in their boundary conditions, potentially underestimating the risk of overtopping at the dikes.

Innovative Field Measurements at Raversijde: To bridge the knowledge gap, we conducted a unique field campaign at the Living Lab Raversijde (Troch *et al.*, 2025) in Ostend. Simultaneous measurements of IG waves across the whole nearshore zone are crucial for validating safety design methodologies but are rare due to the technical complexity of the required setup. Our configuration consists of three Acoustic Doppler Current Profilers (ADCPs) collocated to measure surface elevation and velocities, positioned offshore, at the bank crest, and onshore with respect to the sandbank. This setup allows us to study the release and transformation of IG waves in-situ. We have collected data from the last two winters (2023–2024 and 2024–2025) and are currently measuring in the field to further enlarge the dataset.

Results and Coastal Safety Implications: To understand the characteristics of IG waves, we applied an advanced signal processing technique (Matsuba *et al.*, 2022) to our field data. The method allowed us not only to distinguish between waves linked to the SS wave groups ("bound" IG) and those traveling independently ("free" IG), but also to identify their direction of travel, whether shoreward or seaward. Our findings reveal that the free IG component significantly dominates over the bound component, a critical discovery given that typically only the bound component is accounted for in safety models. Furthermore, the energy transformation is highly dependent on the tidal cycle. During low tide, the water depth over the sandbanks decreases, forcing high SS waves to interact with the seabed. The resulting interaction triggers intense breaking and energy transfer, leading to a significant release of shoreward-propagating free IG waves. In contrast, at high tide, the greater depth reduces the release mechanism. The field measurements provide real-world evidence of how IG waves amplify due to sandbanks in shallow water. Quantifying the magnitude of IG waves is vital for improving numerical boundary conditions, ensuring that our coastal defence systems are designed to withstand the full spectrum of wave energy impacting the Belgian coast.

Keywords

Free Infragravity Waves, Coastal Safety, Shallow Sandbanks, Living Lab Raversijde, Field Measurements, Wave Overtopping

AQUASPECT: Enhancing plankton monitoring in the Belgian Part of the North Sea with continuous in-situ imaging

Amadei Martínez Luz[1], Decrop Wout[2], Mortelmans Jonas[2], Conings Bram[2], Boone Willem[2], Heyndericx Hanneloor[2], Walker Madeleine[3], Catalano Camille[3], Picheral Marc[3], Deneudt Klaas[2] and Muñiz Carlota[2]

[1] Marine Observation Centre, Flanders Marine Institute (VLIZ)
Email: luz.amadei@vliz.be

[2] Flanders Marine Institute (VLIZ), InnovOcean site, Oostende, Belgium

[3] Laboratoire d'Océanographie de Villefranche (LOV), Sorbonne Université, Centre National de la Recherche Scientifique, Villefranche-sur-Mer, France

Plankton plays a key role in aquatic food webs, making it essential for sustaining marine ecosystems. Consequently, monitoring plankton abundance and diversity is critical. Monitoring plankton abundance and diversity is required to comply with European legislation, such as the Marine Strategy Framework Directive (MSFD) and it is recognized as an Essential Ocean and Biodiversity Variable (EOV/EBV). This is because plankton is related to climate, ocean services, and ecosystem health. However, assessing the ecosystem health of aquatic systems accurately requires data at relevant scales. In highly dynamic areas like the Belgian Part of the North Sea (BPNS), traditional ship-based sampling is often resource-intensive and spatio-temporally limited. Such limitations restrict our ability to understand planktonic dynamics at the relevant scales, compromising ecosystem management and informed decision-making.

The AQUASPECT project (Advancing QUality Assessment of Spatial Patterns and Ecosystem Characteristics through Technological Advancements) aims to augment existing plankton monitoring capacity with high-resolution in situ imaging systems to develop regional Digital Twins of the Ocean (DTOs). These DTOs will allow us to better understand plankton dynamics in the Baltic Sea, the Balearic Sea, and the BPNS. A new instrument, the Underwater Vision Profiler (UVP6m) will be developed within the project to capture images of plankton and non-biological particles of 100–1,000 µm. The UVP6m will extend the current range of the UVP6 (500–10,000 µm) to allow it to capture microplankton.

In the BPNS, we will collect continuous measurements of plankton density and community composition by deploying UVP6 and UVP6m imagers on a bottom mooring. The resulting high-volume image data will be processed using AI classifiers based on convolutional neural networks (CNN). Key environmental parameters (e.g., temperature, salinity, and water velocity) will be simultaneously measured by deploying environmental sensors alongside the UVPs. Ultimately, these data will be used to better understand plankton dynamics in the BPNS at high temporal resolution. In addition, we will assess the potential of UVP-derived data to support the development of MSFD plankton indicators for our regional DTO, testing the calculation of indicators for the biological diversity of pelagic habitats, such as lifeform ratios and zooplankton abundance and biomass.

AQUASPECT will contribute to the development of a new sensor providing higher-resolution images of smaller plankton and other particles. By supporting the collection of EOV/EBVs, the project will deepen our understanding of plankton and particulate matter dynamics and strengthen the digital infrastructure of the European DTO with high-resolution data and solutions for regional systems. This will provide stakeholders with valuable information on biodiversity and ecosystem health to support a better management of coastal systems.

Keywords

Biodiversity Monitoring; Phytoplankton; Zooplankton; Image Analysis; DTO

Threatened coral reef megafauna: a genomic approach to support the conservation of giant clams

Chi Haojun

Marine Biology, Vrije Universiteit Brussel
Email: Haojun.Chi@vub.be

Giant clams (Bivalvia: Cardiidae: Tridacninae) are among the most iconic and ecologically important megafaunal invertebrates of coral reef ecosystems in the Indo-West Pacific. By filtering large volumes of seawater and hosting photosynthetic Symbiodiniaceae, they contribute substantially to reef productivity and nutrient cycling. Despite their ecological and economic importance, all extant giant clam species are threatened by overexploitation and climate change. Overharvesting has led to severe population declines and local extinctions, while increasing sea surface temperatures induce thermal stress and bleaching through the breakdown of the clam–symbiont relationship.

Although bleaching responses have been extensively studied in reef-building corals, the genetic basis and evolutionary mechanisms underlying thermal tolerance in giant clams remain poorly understood. In particular, little is known about how host genomic variation and symbiont diversity jointly shape stress resilience, or how these associations have evolved across species, regions, and environmental gradients. Emerging evidence suggests that giant clams associate with diverse Symbiodiniaceae lineages, that symbiont assemblages vary with temperature regimes, and that host transcriptomic responses to heat stress share similarities with those observed in corals, including the activation of oxidative stress and unfolded protein response pathways. However, the evolutionary and genomic context of these patterns remains largely unexplored.

This PhD project aims to advance the conservation and management of giant clams by integrating population genomics, phylogenomics, and host–symbiont co-phylogenetic approaches. Using whole-genome sequencing (WGS) data from multiple giant clam species, single nucleotide polymorphism (SNP) datasets will be generated to reconstruct robust species-level phylogenies and assess patterns of genomic divergence. In parallel, sequence-based phylogenies of associated Symbiodiniaceae will be established using established molecular markers and long-read sequencing approaches, enabling the detection of multiple symbiont lineages within individual hosts. By extracting symbiont genomic signals from host WGS data and comparing host and symbiont phylogenies, this project will investigate the degree of co-evolution, host specificity, and symbiont turnover across evolutionary and environmental scales.

By elucidating the genomic architecture of thermal adaptation and the evolutionary dynamics of giant clam–Symbiodiniaceae associations, this research will provide a mechanistic framework for understanding resilience to climate change. The results will inform conservation strategies for threatened coral reef megafauna.

Keywords

Giant Clams; Tridacninae; Symbiodiniaceae; Phylogenomics; Coral Reef Conservation

Advancing Polar Observational Research with Marine Autonomous Systems: A Multi-Approach Strategy by MRC-VLIZ

Cruz Novo Rita[1], Ponsoni Leandro[2], Langedock Kobus[2], Develter Roeland[2], Fourie Fred[2], Scheiterer Eduard S.[2], Maier Christophe Pierre[2], Zier Juergen[2], De Geeter Chiara[2], Meyer Rory[2] and Boone Wieter[2]

[1] Marine Robotics Center, VLIZ Flanders Marine Institute
Email: rita.novo@vliz.be

[2] Marine Robotics Center, VLIZ - Flanders Marine Institute, InnovOcean Campus Jacobsenstraat 1 8400 Oostende Belgium

Effective in situ observation of marine environments remains logistically challenging, particularly in remote and harsh regions such as polar and ice-influenced seas, where weather conditions, ice cover and limited access to conventional research infrastructure constrain year-round data collection. To address these challenges across a range of marine settings, the Marine Robotics Centre (MRC) at the Flanders Marine Institute (VLIZ) adopts a multi-approach observational strategy that combines autonomous in situ observatories with a versatile fleet of marine autonomous systems, including one Autonomous Underwater Vehicle (AUV), two Uncrewed Surface Vehicles (USVs) and two Gliders.

These autonomous platforms complement vessel-based operations by extending spatial and temporal coverage, reducing operational risk and lowering the environmental footprint of marine research. While this approach has proven particularly valuable for data-sparse polar regions, it is equally applicable to temperate and non-polar environments, supporting sustained observations from near-coastal areas (e.g., fjords and continental shelves) to offshore slope and deep-ocean systems. When integrated with satellite-based remote sensing, this framework enables more comprehensive and resilient marine monitoring across diverse environments.

This work presents ongoing and upcoming research activities at MRC-VLIZ, highlighting how advanced autonomous technologies and methodologies support the objectives of marine observational research.

Keywords

Marine Robotics; Autonomous Marine Systems; In Situ Ocean Observation; Polar And Remote Marine Environments; Long-term Marine Monitoring

Seaweed as a functional food ingredient

De Vlieger Liselot[1], Vancoillie Flore[1], Vynckier Kevin[2], Fraeye Ilse[3] and Foubert Imogen[1]

[1] Food and Lipids research group, KU Leuven, Etienne Sabbelaan 53, 8500 Kortrijk
Email: liselot.devlieger@kuleuven.be
[2] Food Processing research group, Vives, Oostnieuwkerksesteenweg 113, 8800 Roeselare
[3] Meat Technology & Science of Protein-rich Foods research group, KU Leuven, Gebroeders de Smetstraat 1, 9000 Gent

Seaweed, with its unique nutritional and techno-functional properties, is increasingly being explored as a sustainable food ingredient. In the European Union Novel Food Catalogue, more than 20 seaweed species are categorized as “not novel” and are therefore permitted for human consumption without additional regulatory approval. While mainly seaweed extracts are already added to food products for nutritional and techno-functional enhancement, this study focused on the potential use of full biomass as a food ingredient. Since seaweed encompasses a large group of different species, primarily classified based on pigmentation – green (*Chlorophyta*), brown (*Phaeophyta*) and red (*Rhodophyta*) algae – different properties of multiple batches of multiple seaweed species approved for consumption were characterized in this study. More specifically, this study assessed multiple seaweed species across nutritional, techno-functional and sensorial aspects to develop a foundational knowledge base for their integration into specific food applications. Nutritional and techno-functional aspects focused primarily on the antioxidant and structuring potential of seaweed, investigating various bioactive compounds. Sensory analysis emphasized color stability, particularly its sensitivity to temperature and pH changes. By systematically mapping these attributes in several species, this research establishes a detailed framework to guide the targeted use of full biomass seaweed in food products, supporting the development of innovative, sustainable food solutions that harness the full potential of seaweed.

Keywords

Seaweed, Full Biomass, Food Ingredient, Nutritional Properties, Techno-Functional Properties

Are all copepods equal? Evaluating the digestibility of benthic copepod species for larviculture

Degrande Sara[1], De Troch Marleen[1] and Declercq Annelies[2]

[1] Marine Biology, Ghent University, Krijgslaan 281, 9000 Gent
Email: sara.degrande@ugent.be

[2] Laboratory of Aquaculture & Artemia Reference Center, Ghent University, Coupure Links 653, 9000 Gent, Belgium

Copepods are increasingly explored as a source of live feed for larviculture, yet, not all copepod species seem equally suitable. Previous studies have shown that digestibility differs strongly among copepod species, with potential consequences for larval growth and survival.

Benthic copepods offer practical advantages for larviculture, such as favourable fatty acid composition, resilience to environmental variation and short reproduction cycles, allowing for higher harvesting rates. However, adaptation to benthic habitats often involves the development of thicker cuticles to withstand coarse sediment, which may reduce digestibility for fish larvae.

In this study, we developed an *in vitro* assay that allows quantitative evaluation of digestibility of multiple benthic copepod species. Selected species were chosen based on culturability and their ecological relevance in the estuarine benthic food web. *Artemia* nauplii and the pelagic copepod *Acartia tonsa* were included as reference live feeds commonly used in larviculture.

This approach enables direct comparison of digestibility across copepod types and provides a mechanistic framework to evaluate the suitability of benthic copepods as alternative live feeds for marine fish larvae. Comparative results and their implications for larviculture will be presented.

Keywords

Digestibility; Aquaculture; Copepods; Ecology

Reconstructing the submerged Middle and Late Pleistocene palaeolandscapes on the outer Belgian North Sea

Dekoninck Warre[1], De Batist Marc[2], Missiaen Tine[3], Plets Ruth[3] and Mestdagh Thomas[3]

[1] Onderzoek, Flanders Marine Institute (VLIZ)
Email: warre.dekoninck@vliz.be
[2] Geology, Universiteit Gent, Krijgslaan 297, Ghent, Belgium
[3] Flanders Marine Institute (VLIZ), Jacobsenstraat 1, Ostend, Belgium

During the Quaternary period, which began around 2.6 million years ago, the Earth experienced repeated cycles of cold (glacial) and warm (interglacial) conditions. During glacial periods, large ice sheets stored vast amounts of water on land, causing global sea-level to fall by up to 120 m compared to today. Because the North Sea is relatively shallow, these sea-level drops repeatedly exposed large areas of the seafloor as dry land. However, a land bridge between the UK and continental Europe existed even during periods when sea level was close to present-day conditions. The timing and mechanism of its breaching, which led to the formation of the Dover Strait, remain the subject of ongoing debate.

The breaching of this land bridge marked the onset of repeated flooding of the Belgian North Sea area during sea-level highstands, alternating with periods of exposure during lowstands. These environmental changes are recorded in the sediment layers preserved beneath the present-day seafloor. This study aims to reconstruct the evolving landscape from the time of the Dover Strait breaching onwards, using these sediments as a geological archive.

In recent years, new high-resolution two-dimensional seismic and acoustic datasets have been acquired for both scientific and commercial purposes in the offshore Belgian North Sea, an area where data coverage was previously limited. By integrating these datasets, we achieve a more detailed understanding of sediment distribution and erosion patterns. The erosional surface at the base of the Quaternary deposits has now been mapped and gridded in pseudo-3D with unprecedented detail. This mapping reveals a complex erosional history, including buried plateaus, escarpments, and elongated scours. Understanding the origin and sequence of these features is essential for reconstructing Quaternary palaeolandscapes.

Finally, this study aims to identify, sample, and characterise the various Quaternary sedimentary units in the area. Integration with complementary analyses—such as pollen and microfossil studies—and chronological techniques, including radiocarbon dating and optically stimulated luminescence (OSL), will ultimately allow the development of an updated and comprehensive reconstruction of the palaeogeographic evolution of the outer Belgian North Sea and adjacent regions.

Keywords

Paleolandscape Reconstruction; Seismic Stratigraphy; Belgian North Sea; Quaternary Geology

Elasmobranch community responses to early Eocene climate events in the North Sea Basin

Denné Erwan[1], Mollen Frederik[2] and Vellekoop Johan[3]

[1] Biogeology & Paleoclimatology Research Group, Division of Geology, KU Leuven
Email: Denne.erwan@gmail.com
[2] Elasmobranch Research Group, Belgium
[3] Biogeology & Paleoclimatology Research Group, Division of Geology,, KU Leuven, GEO-Instituut, Campus Arenberg, Celestijnenlaan 200E, B-3001, Leuven-Heverlee

Modern marine ecosystems are undergoing rapid warming, acidification, and deoxygenation, driving unprecedented declines in large predators such as sharks and rays. Understanding how marine predator communities respond to extreme warming is therefore a pressing challenge. Yet experimental and short-term ecological studies cannot capture long-term, community-level resilience or collapse dynamics. Deep-time climate analogues provide a unique opportunity to address this gap.

Here, in a new research project, we investigate how elasmobranch (sharks and rays) communities in the North Sea Basin responded to multi-scale climate warming during the Early Eocene (ca. 53-49 Ma). This interval encompasses both the sustained extreme warmth of the Early Eocene Climatic Optimum (EECO), lasting for millions of years, and short-lived hyperthermal events occurring over tens of thousands of years. One of these short-term events is hyperthermal P (~51 Ma), during which the sea water temperature in the North Sea Basin potentially attained the highest temperatures of the entire Eocene (up to 32.1*C, KU Leuven unpublished data). Together, the EECO and hyperthermal P represent natural experiments in gradual versus abrupt climate forcing.

Using extensive museum and curated private collections from Belgium and the UK, we are compiling the first abundance-weighted, trait-based reconstruction of early Eocene elasmobranch communities. Assemblages are placed into a high-resolution stratigraphic and chemostratigraphic framework ($\delta^{13}C$, $\delta^{18}O$, Mg/Ca), enabling direct alignment of ecological change with climate dynamics. We quantify shifts in diversity, functional guild composition, body-size structure, and dental morphospace across pre-, syn- and post-warming intervals.

Our project tests three central hypotheses: (1) warming disproportionately impacts benthic and durophagous predators, driving trophic restructuring toward smaller pelagic mesopredators; (2) rapid warming induces reductions in mean body size and morphological disparity; and (3) short-term hyperthermals trigger faster and more abrupt ecological change than long-term background warming, potentially revealing ecological tipping points.

By integrating paleoecology, functional morphology and paleoclimate, this project will deliver the first multi-scale assessment of marine predator resilience under extreme warmth. Beyond advancing elasmobranch paleobiology, our results will provide a deep-time framework for interpreting modern extinction risk and functional vulnerability of marine predator guilds in a rapidly warming ocean.

Keywords

Elasmobranchs; Early Eocene; North Sea Basin; Paleoclimate Change; Early Eocene Climatic Optimum (EECO); Hyperthermal Events; Marine Predator Communities; Functional Traits; Community Ecology; Paleoecology; Body-size Evolution; Morphological Disparity

Plastisphere biofilms as food for benthic grazers: biochemical quality and trophic transfer

Depoorter Lelie[1], Asselman Jana[2] and De Troch Marleen[1]

[1] Marine Biology, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
Email: lelie.depoorter@ugent.be

[2] Blue Growth Research Lab, Ghent University, Ostend Science Park, Wetenschapspark 1, 8400 Ostend, Belgium

Plastic pollution is a long standing and widespread anthropogenic pressure in marine ecosystems. While many studies examine direct toxic effects of plastic additives and leachates, plastics are often operationally treated as inert particles or passive vectors in experimental designs. Since the introduction of the term "*plastisphere*" to describe microbial communities colonizing plastic debris, plastics have been recognized as novel and persistent microbial habitats rather than biologically inactive materials. However, even with increasing attention to plastisphere community composition and succession, their functional and biochemical relevance within marine food webs remains largely unexplored. Plastisphere communities rapidly develop on plastic substrates, including bacteria, diatoms and other microalgae.

While the taxonomic diversity and temporal dynamics of plastisphere communities have been increasingly characterized across aquatic environments, gaps persist, particularly regarding differences across environmental conditions and polymer types. Little is known about the energetic and nutritional value of the plastisphere-associated biomass or if these communities represent a meaningful relevant food source for primary consumers. Working with larger plastic substrates such as pellets, which persist longer, accumulate substantial biofilms, and function as stable substrates in benthic ecosystems, offers a promising approach.

This research aims to investigate the plastisphere from an energetic perspective by quantifying its biomass production and biochemical quality, and assessing its potential contribution and potential effects to marine food webs. In a first phase, plastisphere communities will be grown on environmentally relevant plastic polymers common in benthic environments, such as polyethylene terephthalate (PET) and polystyrene (PS). Natural reference substrates (e.g. wood or mineral surfaces) will enable comparison with non-plastic biofilms. Plastisphere development will be monitored over time; harvested biomass will be quantified for productivity and biochemically characterized for total lipid content, and fatty acid composition using established extraction techniques. Comparisons across substrate types and durations will reveal influences of polymer characteristics and exposure time on energetic quality.

In a second phase, grazing experiments with primary consumers (benthic copepods) will test ingestion of plastisphere biomass and transfer of lipids/fatty acids to higher trophic levels. By linking plastisphere biochemistry to trophic processes, this work will reframe plastics as biologically mediated ecosystem components beyond only inert stressors.

Keywords

Plastisphere, Fatty Acid, Benthic Biofilms, Copepod

Unlocking marine biodiversity by integrating eDNA sampling into existing maritime activities

Derycke Sofie[1], Carneiro António[2], Marques Pedro[2], Martins Alfredo[2], Pape Daan[3], Vanhollebeke Joran[4], Maes Sara[4], Cornelis Isolde[4], Hostens Kris[4] and Maes Sarah[4]

[1] Animal Science Unit/ Marine Genomics Lab, ILVO
Email: sofie.derycke@ilvo.vlaanderen.be
[2] INESC TEC, Campus da FEUP, Rua Dr. Roberto Frias 4200-465 Porto, Portugal
[3] DP Technics, Westkapellestraat 396/44 8300 Knokke-Heist
[4] ILVO, Jacobsenstraat 1, 8400 Oostende

Global biodiversity is declining at an unprecedented rate, with marine ecosystems facing increasing pressure from climate change, overfishing, habitat degradation, and pollution. Effective conservation and management efforts critically depend on reliable, long-term biodiversity monitoring which in turn relies on the use of dedicated research vessels which are costly and limited in spatial and temporal coverage. Innovative, scalable approaches are urgently needed to expand biodiversity observations across marine ecosystems.

Environmental DNA (eDNA) offers a powerful, non-invasive approach to monitor marine biodiversity. Marine organisms release DNA molecules into the environment through tissues, excrements or slime. This environmental DNA (eDNA) allows to detect species by simply collecting seawater. As such, eDNA has tremendous potential for environmental research, especially when eDNA collection can be automated. Moreover, integrating eDNA collection into existing maritime activities provides unique opportunities to generate biodiversity data at unprecedented spatial and temporal scales. We demonstrate two complementary eDNA-based approaches developed and tested in close collaboration with the Belgian fishing fleet.

First, we deployed an automatic eDNA multi-sampler onboard a commercial fishing vessel. Fishing vessels and other ships of opportunity provide multiple advantages compared to in situ deployments of autonomous eDNA samplers: equipment cannot be lost at sea, the devices are far less susceptible to deterioration from the harsh marine environment, there is a continuous power supply available and the GPS signals of the vessel can be used to initiate the equipment, to log metadata and to transfer (meta)data in real time. These benefits reduce the cost of construction, installation, maintenance and retrieval of equipment. The eDNA multi-sampler was programmed to collect subsurface seawater samples in the Belgian part of the North Sea. The system autonomously filters seawater, preserves DNA on Sterivex filters using a fixative, and prevents cross-contamination through bleaching of common tubes between samples. The North Sea geographical area was divided into 5*5 km squares, and the sampler was programmed to filter 1L of seawater every time the vessel entered a new square. Over the course of two cruises, 28 samples were successfully collected. For each sample, the geographical coordinates and volume of filtered water were recorded. All Sterivex filters were successfully preserved and sequenced using 12S DNA metabarcoding, demonstrating the technical robustness of the sampler and its suitability for autonomous eDNA collection across widely spread geographical areas.

Building on these successful campaigns, the eDNA multi-sampler was further optimized to enable filtration of the required water volume even when the vessel pump is switched off, while allowing the collection of up to 45 Sterivex samples, currently the highest number of samples that can be collected with one sampler during one deployment.

Second, we investigated the use of low-cost passive eDNA samplers (“metaprobes”) during scientific surveys and commercial fishing trips to quantify commercial fish species. Practical sampling solutions were co-designed with commercial fishers to ensure feasibility during active fishing operations. Together with the results of replicate field tests using different preservation methods of the metaprobes, a simple sampling protocol has been created for fishermen and other non-scientific staff to collect eDNA using these passive samplers.

Together, these successful pilot studies open the door to large-scale eDNA data collection beyond the reach of conventional scientific cruises.

Keywords

EDNA, Autonomous Sampler, Fishing Vessels, Passive Sampler, North Sea

ELASMON: Towards Evidence-Based Management of Sharks and Rays in Belgian Waters

Desmidt Joanna[1], De Backer Annelies[1], Reubens Jan[2], De Clercq Wannes[3], Casals Blanch David[2], Kapasakali Danae-Athena[3], Podholová Pavlína[3] and Buyse Jolien[4]

[1] ILVO Marine Research, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Jacobsenstraat 1, 8400 Ostend
Email: joanna.desmidt@ilvo.vlaanderen.be

[2] Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Ostend

[3] Institute of Natural Sciences (RBINS), Vautierstraat 29, 1000 Brussel

[4] Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Jacobsenstraat 1, 8400 Ostend

Sharks and rays are essential components of marine ecosystems, where they contribute significantly to maintaining balances in the food-web. Despite their ecological importance, elasmobranchs attracted little management attention in EU waters until the late 1990s because of their low commercial value. As a result, few conservation measures were implemented, leaving these species highly exposed to pressures including overfishing, bycatch, climate change, and habitat degradation. In the southern North Sea, the combination of limited protection and intense human activity has caused a major shift in community composition: populations of larger species such as tope, spurdog, and thornback ray have declined dramatically, with some now regarded as locally extinct, while smaller and more resilient species, such as the small-spotted catshark, have become more abundant. Nevertheless, since around 2010, signs of recovery have been observed for certain larger species, including blonde ray and thornback ray.

In Belgian waters, the scarcity of information on elasmobranch distribution, habitat preferences, and migration routes has impeded the development of an effective management strategy. The ELASMON project was established to overcome these limitations. The project seeks to fill key knowledge gaps by integrating analyses of existing datasets (including eDNA, beam trawl surveys, and tagging data) with the development of a species-specific monitoring framework. This framework combines non-invasive video techniques, such as a baited remote underwater video (BRUVs) and a towed videoframe, with electronic tagging. BRUVs, adapted to the turbulent conditions of the North Sea, will be deployed at sites selected using existing data to assess elasmobranch abundance and diversity. Videoframe footage will be used to detect egg cases and shark and ray aggregations, supporting the identification of potential spawning and nursery areas, while also providing information on habitat use. In parallel, the most common elasmobranch species in Belgian waters, *Scyliorhinus canicula*, *Raja clavata*, *Mustelus asterias*, and *Raja brachyura,* are being tagged with acoustic transmitters and data loggers to investigate their spatial behaviour, habitat use, and migratory patterns in the Belgian North Sea. By integrating these complementary data sources, ELASMON aims to deliver a robust scientific basis for an effective management plan to protect vulnerable elasmobranch species in Belgian waters.

Keywords

Telemetry; Monitoring; BPNS; Connectivity; BRUV

Molecular reassessment of giant clams (Tridacna) in Sri Lanka reveals a deeply divergent cryptic lineage in the Central Indian Ocean

Dissanayake P. A. Kushlani N.[1], Huyghe Filip[1], Akbal Keskin Sezgi[1], Bergacker Stephen[1], Bandularathna A. M. Nadun Nayantha[2], Kumara P. B. T. P.[3], Kodikara K. A. Sunanda[4] and Kochzius Marc[1]

[1] Marine Biology, Vrije Universiteit Brussel (VUB), Pleinlaan2, 1050 Brussels, Belgium
Email: kushlani.dissanayake@vub.be

[2] Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Wellamadama, Matara (81000), Sri Lanka

[3] Department of Oceanography and Marine Geology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Wellamadama, Matara (81000), Sri Lanka

[4] Department of Botany, Faculty of Science, University of Ruhuna, Wellamadama, Matara (81000), Sri Lanka

Accurate species identification is fundamental to reliable biodiversity assessments and effective conservation planning. In marine invertebrates, species misidentification remains common, with giant clams (*Hippopus* and *Tridacna*) representing a classic example. High phenotypic plasticity, obscured diagnostic characters caused by epibiont fouling, and the presence of cryptic diversity frequently hinder reliable in situ identification, highlighting the necessity of molecular approaches for taxonomic resolution. Despite their ecological and socio-economic importance, the species identity of giant clams in Sri Lanka has not previously been evaluated using molecular data. Here, we present the first comprehensive molecular reassessment of Sri Lankan giant clams within the context of a global *Tridacna* phylogeny. A total of 123 mantle tissue samples were collected non-lethally from seven reef locations around Sri Lanka, and the mitochondrial cytochrome c oxidase subunit I (mtCOI) gene was sequenced. A Maximum Likelihood phylogenetic tree was constructed, including all ten currently recognized *Tridacna* species, with nodal support assessed using 1,000 bootstrap replicates. Species of *Hippopus* were used as the outgroup to root the tree. Phylogenetic analyses recovered a deeply divergent, well-supported monophyletic clade comprising all Sri Lankan samples. Contrary to previous field-based identifications, no individuals corresponding to *T. maxima* or *T. squamosa* were detected. Instead, the Sri Lankan lineage formed a sister clade to *T. noae* with 100% bootstrap support, indicating a close evolutionary relationship but clear genetic separation. A median-joining haplotype network further revealed that the Sri Lankan haplogroup was separated from other Indo-Pacific *T. noae* lineages by 11 mutational steps, consistent with long-term isolation and restricted gene flow. However, Sri Lankan specimens lack the distinctive white marginal coloration surrounding teardrop-shaped mantle patches that have been described as a unique morphological feature of *T. noae*. In addition, the pairwise genetic distance between the Sri Lankan lineage and *T. noae* was 0.0543, supporting the hypothesis that the Sri Lankan population represents a distinct cryptic lineage or potentially an undescribed species. By resolving species identity using molecular evidence, this study provides a critical baseline for revising regional biodiversity inventories and highlights the risk of relying solely on morphology-based identification in giant clams. These findings have direct implications for conservation planning, fisheries management, and future taxonomic work on *Tridacna*, while contributing new insights into the phylogeny and biogeography of giant clams across the Indo-Pacific.

Keywords

Giant Clams; Cryptic Species; DNA Barcoding; Management Units; Population Connectivity

Sand preferences of dune visitors: Management implications for nature-based solutions (NbS)

Dupont Rémi[1], Van Schoubroeck Sophie[2], Vrebos Dirk[1], Staes Jan[1], Van der Biest Katrien[1] and Anougmar Soukaina[2]

[1] ECOSPHERE Research Group, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
Email: remi.dupont@uantwerpen.be

[2] Department of Engineering Management, University of Antwerp, Prinsstraat 13, 2000 Antwerp, Belgium

To prevent sand shortages in the coming decades for coastal management and the construction industry, it is essential to use sand judiciously. Both the circular use of sand (i.e. beneficial reuse) and a more targeted application (i.e. resource efficiency) can contribute to this objective. For example, rather than relying solely on high-quality offshore sand, coastal management measures such as beach nourishment and dune-in-front-of-dike projects should explore the potential of alternative sand sources. However, as alternative sand sources possess different properties and coastal areas serve as recreational spaces, visitor experiences could be affected either positively or negatively. To this end, as part of the SUSANA project (2023-2026), a discrete choice experiment (DCE) was conducted on the Belgian coast in Ostend to determine the effect of using alternative sand sources on the recreational experience of dune visitors. Numerous sand properties were incorporated in the DCE, including colour, grain size, shell material content, and sinking depth. A total of 312 responses were collected during two campaigns held in spring and summer 2025. The results indicate a clear preference for light-coloured sand that contains little shell material and is easy to walk on. Interestingly, grain size is of much less importance to dune visitors. However, the results also suggest that people's preferences are influenced by their awareness of the sand's origin and ecological impact. Sand with a low ecological impact at the extraction site is generally favoured, particularly among young people. The results reveal that, from a recreational perspective, there are opportunities to use alternative sources of sand to implement Nature-based Solutions (NbS), such as dune-in-front-of-dike projects. However, to facilitate their large-scale implementation with public support, well-considered dune design and awareness campaigns are essential.

Keywords

Nature-based Solutions (NbS); Sand Dunes; Sand Extraction; Beneficial Reuse; Coastal Protection; Recreation; Discrete Choice Experiment (DCE)

Reefcovery: Integration of active oyster restoration into marine infrastructure

El Rahi Joe[1], Stratigaki Vicky[1], Cockaert Phara[2], De Leener Elinka[2], Petit Simon[2], Hughes Molly[3], Hancock Boze[4], Santinelli Giorgio[5], Iannou Rafail[5], Shabani Ben[5], Ramaekers Michaël[6], Van Tittelboom Kim[6], De Belie Nele[6], Boel Simon[7], Huygens Marc[7], Sterckx Thomas[7], Meylemans Celine[7], Crijns Wouter[8], Diquélou Youen[8], Bahrami Masih[8], Fordeyn Jan[1], Declercq Annelies[3] and Troch Peter[9]

[1] Project development and conceptual design department, Jan De Nul Group, Tragel 60, 9300 Aalst, Belgium
Email: Joe.elrahi@jandenul.com
[2] Marine Environmental department, Jan De Nul Group, Tragel 60, 9308 Aalst, Belgium
[3] Laboratory of Aquaculture and Artemia Reference Center, Ghent University, Coupure links 653, 9000 Ghent, Belgium
[4] The Nature Conservancy, Rhode Island, USA
[5] Coastal Engineering Research Group, Ghent University, Technologiepark-Zwijnaarde, 9000 Ghent, Belgium
[6] Structural Engineering Research Group, Ghent University, Technologiepark-Zwijnaarde, 9000 Ghent, Belgium
[7] DEME nv, Scheldedijk 30, 2070 Beveren-Kruibeke-Zwijndrecht
[8] ResourceFull BV, Rozenstraat 5A, 9810 Eke Nazareth, Belgium
[9] Structural Engineering Group, Ghent University, Technologiepark-Zwijnaarde, 9000 Ghent, Belgium

Before 1900, European flat oysters (*Ostrea edulis*) were widespread across Europe. Due to bottom-disturbing fishing practices and parasites, they almost completely disappeared. Yet they are extremely valuable habitats. Flat oysters are also known as ecosystem engineers because they form reefs that serve as shelter and feeding grounds for many other species. In doing so, they support diverse marine life and enhance biodiversity. Moreover, they provide various other ecosystem services: they purify the water, capture excess nitrogen and stabilise the seabed, which increases our resilience to the impacts of climate change.

To restore oyster reefs, we need a hard substrate or surface for the oysters to attach to. In marine construction projects, rocks, gravel, and other hard materials are often used, for example to protect the foundations of wind turbines, caissons, or subsea cables against erosion from currents and waves, or from anchors and fishing nets. This material is therefore well suited for the development of oyster reefs.

Within Reefcovery, we explore how oyster reef restoration can be integrated into the nature-inclusive design of offshore infrastructure. To achieve this, we are developing innovative techniques that enable the large-scale construction and implementation of oyster reefs. In this way, we integrate nature restoration into our core activities in the North Sea and beyond, and we enhance the positive impact of our offshore projects on a large scale, such as the future Princess Elisabeth Island.

In recent months, we investigated which substrates are best suited to support the development of new oyster reefs. We specifically focused on reef substrates commonly used in offshore infrastructure and designed artificial substrates. This research is led by three research groups from Ghent University.

At the facilities of ResourceFull and the Magnel-Vandepitte Laboratory for Structural Engineering and Building Materials, we developed artificial cementitious substrates with surface characteristics to enhance flat oyster settlement according to the state-of-the-art. We focused on pH, colour, roughness, porosity and $CaCO_3$-content, while reducing the CO_2-impact by using sea sand and substituting the cement with oyster shell powder. In addition, 3D-printing of the material was explored. In the laboratory of the Aquaculture & Artemia Reference Center, we used the 'remote setting' technique to allow oyster larvae to attach to various types of substrates. This means the oysters were able to settle on these substrates in a controlled environment. We tested both the artificial reef substrates and natural materials such as rocks used in marine infrastructure construction.

We also used a fall-pipe scale model from the Coastal Engineering research group to study how to efficiently install large volumes of reef substrate material using fall-pipe vessels. In addition, hydrodynamic CFD and physical modelling of oyster reefs and their hard substrates is being developed in order to investigate feasibility, stability, oyster survival, and efficiency of nature-inclusive-designs for marine infrastructure. The most promising materials and concepts will later be installed in the North Sea and actively monitored.

In addition, stress tests for oysters attached to rocks going down a quasi full-scale fall-pipe model have been carried out to evaluate oyster survival during handling and installation. The stress experiments also include physical simulations of

transporting oysters attached to rocks using a conveyor belt. The results of these tests will inform the development of large-scale deployment methods and help scale up oyster reef restoration efforts while keeping mortality as low as possible.

Within the Reefcovery project, we work closely with experts from the Native Oyster Restoration Alliance (NORA) and The Nature Conservancy, and we follow international guidelines. This ensures that we apply the most advanced technologies, leading expertise, and best available knowledge in oyster reef restoration.

Finally, Reefcovery aligns with European directives aimed at improving the environmental status of our seas. Reefcovery (HBC.2023.0394) is an 'interdisciplinary cooperative research' project (ICON-Interdisciplinair Coöperatief ONderzoek), supported by the Flemish Government through VLAIO ("Flanders innovation & Entrepreneurship"). Jan De Nul coordinates the project in collaboration with partners DEME, ResourceFull, and Ghent University.

Keywords

Large-scale Oyster Reef Restoration; Upscaling Offshore Oyster Reef Deployment; Substrate Inoculating Methods Using Oyster Larvae; Oyster (Ostrea Edulis) Reef Substrates; Nature-inclusive-design Of Marine Infrastructure

21st-Century Mangrove Expansion Along the Southeastern United States

Enes Gramoso Lucia[1], Carroll Dustin[2,3], Cavanaugh Kyle[4], Bardou Rémi[5], Osland Michael[6] and Van Der Stocken Tom[1,3]

[1] Department of Biology, bDIV: Ecology, Evolution & Genetics, Vrije Universiteit Brussel, Brussels, Belgium
Email: lucia.idalina.a.enes.gramoso@vub.be
[2] Moss Landing Laboratories, San José State University, Moss Landing, California, USA
[3] Earth Science Section, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA
[4] Department of Geography, University of California, Los Angeles, California, USA
[5] Institute for Global Change Biology, University of Michigan, Ann Arbor, Michigan, USA
[6] U.S. Geological Survey, Lafayette, Louisiana, USA

Warming winter temperatures are driving range expansion of tropical, cold-sensitive mangroves into temperate ecosystems. Along the Atlantic coast of North America, the mangrove range limit is particularly sensitive to climate variability and historical data demonstrate that the mangrove-salt marsh ecotone on this coast has shifted recurrently during recent centuries. However, a comprehensive understanding of how this mangrove-salt marsh ecotone may shift in the future remains lacking. Here, we combine ensemble forecasting of mangrove distribution for the next century with high-resolution oceanographic dispersal simulations, phenological observations, and historical hurricane data to project future mangrove-salt marsh dynamics at the rapidly changing range limit in northeastern Florida (USA). We show that warming winter temperatures will drive continued poleward expansion of mangroves along North America's Atlantic coast, potentially reaching South Carolina by 2100. With ongoing climate change, suitable mangrove habitat is projected to expand beyond the current range limit, and dispersal simulations suggest successful colonization of these sites from established mangrove populations. Additionally, patterns in hurricane directionality and intensity and field reports of propagule presence reveal that these high-energy events may significantly contribute to future mangrove range expansion by facilitating long-distance, storm-driven propagule dispersal. The encroachment of mangroves in salt marsh-dominated latitudes is expected to substantially modify wetland ecosystem function and structure, emphasizing how the identification of newly colonizable habitat can inform conservation strategies and site-specific decisions on mangrove management.

Keywords

Climate Change; Coastal Wetland; Ecosystem Services; Habitat Suitability Modeling; Lagrangian Particle-tracking; Ocean Dispersal; Range Expansion

Where do new mangrove expansion occur across a large tropical river delta? The key role of foreshore geomorphology

Espinoza Celi Maria-Esther[1], Belliard Jean-Philippe[1], Fivash Gregory[1], Dominguez-granda Luis[2], Pelckmans Ignace[1], Ramos-Veliz John[2], Peñaherrera Campoverde Jorge[3] and Temmerman Stijn[1]

[1] ECOSPHERE, Department of Biology, University of Antwerp, Antwerp, Belgium
Email: mariaesther.espinozaceli@uantwerpen.be
[2] Centro del Agua y Desarrollo Sustentable, Facultad de Ciencias Naturales y Matemáticas, Escuela Superior Politécnica del Litoral (ESPOL), Guayaquil, Ecuador
[3] Facultad de Ciencias Naturales, Universidad de Guayaquil, Guayaquil, Ecuador

Mangroves are increasingly recognised as valuable ecosystems for biodiversity conservation, mitigation of flood risks and sequestration of carbon at exceptionally high rates. Yet mangroves have been lost due to human impacts such as land conversion. Therefore, mangrove restoration is increasingly proposed as a nature-based solution addressing both the biodiversity and climate crises, but mangrove restoration projects reveal large failure rates.

Understanding the environmental conditions facilitating mangrove expansion across the large scale (~100 to 1000 km²) of entire deltas or estuaries remains limited, despite its relevance for upscaling mangrove restoration strategies targeting sites for active planting or the conservation of sites where natural expansion can occur. In this study, we investigate the environmental conditions facilitating mangrove development across the Guayas delta in Ecuador, a large tropical river delta (~ 3200 km²) where young mangrove forests are expanding across extensive intertidal mudflats. We combined satellite-based remote sensing, drone-based field verification, and statistical modeling, to quantify differences in environmental conditions between mudflats showing active mangrove expansion versus mudflats with stable mangrove edges. We analyzed key variables including mudflat elevation, slope, curvature (i.e., shape of the slope), wind fetch, mudflat length, and tidal inundation duration, frequency and depth.

Our results reveal that the morphology of the tidal flat foreshore (i.e. seaward edge of the tidal flat) is a key determinant of mangrove edge dynamics, and a stronger predictor than more commonly used tidal inundation metrics such as the elevation, inundation duration, frequency, and depth at the mangrove edge. In general, mangrove expansion is favored at wide foreshores that have low slopes and straight profile shapes, which are attributed to more efficient attenuation of waves and tidal currents. In contrast, mangroves are much less likely to expand at lower intertidal elevations, where they experience increased tidal inundation stress, and where they border narrow, steeper, and concave foreshores that provide minimal protection.

These findings provide practical guidance for large-scale mangrove restoration, particularly in tropical river deltas, by identifying sites where (1) mangroves can potentially expand in the future, (2) conditions are favorable for active mangrove planting, and (3) restoration of the intertidal zone is required (e.g., in terms of tidal hydrology, sediment dynamics) prior to natural regeneration or planting. Notably, the presence of a mudflat in front of existing mangroves is not sufficient, but practitioners should prioritize sites with low tidal inundation stress and sheltered mudflat foreshores, and avoid low intertidal areas with strong tidal inundation, and narrow, steep and concave foreshores. In particular, geomorphic characteristics of the foreshore may serve as more reliable indicators to target suitable restoration sites at a large deltaic scale.

Keywords

Mangrove Expansion; Restoration; Tidal Flats; Remote Sensing; Foreshore Geomorphology

Influence of light spectrum and salinity on growth and sexual reproduction in Gracilaria cf. bursa pastoris

Garcia Peran Roberto[1], Macías Andrade Manuel[2], Malta Erik-Jan[2], Sweygers Nick[1], Appels Lise[1] and Dewil Raf[1]

[1] Department of Chemical Engineering, KU Leuven, Jan der Nayerlaan 5, 2860 Sint Katelijne Waver, Belgium
Email: roberto.garciaperan@kuleuven.be

[2] Fundación Centro Tecnológico Acuicultura de Andalucía, Muelle Comercial S/N, 11500, Cádiz, España

Gracilaria is a species-rich genus of red macroalgae comprising over 190 identified species worldwide (depending on taxonomy) [1]. It is one of the most economically important macroalgae worldwide, with a production of 3.7 million tons in 2019, mostly concentrated in China [2]. It is mainly used for the extraction of agar, a hydrocolloid used extensively in various industries, including food (gelling agent, stabilizer, and thickener), pharmaceutical, cosmetic, and biotechnology (as a microbial culture medium) [3].

Most of the *Gracilaria* cultivated is propagated asexually through vegetative fragmentation, which allows for rapid biomass growth. However, a drawback is the lack of genetic diversity and the cost of cultivation due to the elevated amount of manual labor required in the line-seeding. *Gracilaria* has a triphasic life history, with free-living haploid gametophytes and diploid tetrasporophytes, plus a diploid carposporophyte developing on the female gametophyte. The release of the diploid carpospores by the female gametophyte is via cystocarps, which are induced when spermatia released by the male gametophyte reach the female gametophyte. It is believed that environmental triggers induce both the release of spermatia and the production of cystocarps in the female gametophyte. However, the specific trigger conditions are not well known [4]. Studies have shown that the spectral composition of light is a critical factor in inducing fertilization in *Gracilaria* species (*Gracilaria birdiae*) [5].

In this study, we aimed to induce sexual reproduction and cystocarp formation in *Gracilaria cf. bursa-pastoris* by modifying the light spectrum (6000 K / 3500 K) and salinity conditions (25 / 40 PSU). Six replicates were evaluated under controlled laboratory conditions, assessing parameters such as cystocarp appearance (visually), growth rate, medium composition, and seaweed appearance.

The culture medium was sterilized seawater (40 PSU) and sterilized seawater diluted with distilled water to obtain 25 PSU. Both media were enhanced with 0.25 mL L^{-1} Von Stosch solution and 0.025 mL L^{-1} vitamin cocktail solution. *G. cf. bursa-pastoris* was collected from the Bay of Cádiz (Spain), randomized stocks of the algae were selected, and the apical tips (3-4 cm) were cut. These tips were mixed and allocated to each of 24 reactors. Constant aeration was maintained throughout the experiment, temperature was kept at 20 °C, and light intensity at 30 µmol m^{-2} s^{-1}. Medium was partially changed every four days. 1 L of the medium was removed from each reactor, and 1 L of freshly prepared medium was added to replace it. Before and after the replacement of the medium, 30 mL of it was collected and filtered using a 0.45 µm syringe filter for later analysis. The duration of the experiment was 40 days, with 4 days for initial acclimation. No apparent cystocarps, carpospores, or tetraspores were observed during the experiment, indicating that the conditions tested did not induce sexual reproduction. Absence of reproductive cues may also reflect a starting material dominated by tetrasporophytes or a starting material lacking compatible male/female gametophytes. Nevertheless, salinity was observed to greatly affect the daily growth rate and appearance of the seaweed, with a 3.3 % daily growth rate and a translucent and elastic appearance at 40 PSU compared to 1.3% and a dark and rigid appearance under 25 PSU. The color of the light did not affect any of the measured responses.

References

[1] P. Torres, J. P. Santos, F. Chow, D. Y. A. C. dos Santos, Algal Res. 2019, 37, 288–306. DOI: https://doi.org/10.1016/j.algal.2018.12.009.

[2] Global Seaweeds and Microalgae Production, 1st ed., FAO, Rome, Italy 2021.

[3] W.-K. Lee, Y.-Y. Lim, C.-L. Ho, in Sustain. Glob. Resour. Seaweeds Vol. 2 Food Pharm. Health Appl. (Eds: A. Ranga Rao, G. A. Ravishankar), Springer International Publishing, Cham 2022.

[4] V. A. Mantri, C. R. K. Reddy, B. Jha, in Seaweeds Their Role Glob. Chang. Environ. (Eds: J. Seckbach, R. Einav, A. Israel), Springer Netherlands, Dordrecht 2010.

[5] J. B. Barufi, F. L. Figueroa, E. M. Plastino, Sci. Mar. 2015, 79 (1), 15–24. DOI: https://doi.org/10.3989/scimar.04049.12A.

Keywords

Gracilaria; Sexual Reproduction; Cultivation; Salinity; Red Macroalgae; Growth

Elucidating the Cellular and Tissue-level Responses of Mussels (*Mytilus edulis*) to Aged Polyethylene Terephthalate (PET) Micro- and Nanoplastic Particles

Hara Jenevieve[1], Vercauteren Maaike[2], Oraño Gethrie[1], Schoenaers Sébastjen[3], Mubiana Kayawe Valentine[1], Janssen Colin[2], Blust Ronny[1], Asselman Jana[2] and Town Raewyn[1]

[1] ECOSPHERE, Department of Biology, University of Antwerp, Groenenborgerlaan 171, Antwerp 2020, Belgium
Email: jenevieve.hara@uantwerpen.be
[2] Blue Growth Research Lab, Ghent University, Wetenschapspark 1, Ostend 8400, Belgium
[3] IMPRES, Department of Biology, University of Antwerp, Groenenborgerlaan 171, Antwerp 2020, Belgium

Micro- and nanoplastic particles (MNPs) are contaminants of global concern due to their persistence, ubiquity, and associated risks. Laboratory studies, however, have predominantly focused on pristine MNPs, which do not adequately reflect the characteristics of environmental plastic debris. To address this gap, this study integrates *in vitro* and *in vivo* approaches to investigate the cellular and tissue-level responses of the blue mussel (*Mytilus edulis*) to chemically aged polyethylene terephthalate (PET) microplastics (MPs, ~1.9 µm) and nanoplastics (NPs, ~0.68 µm). The particles' physicochemical characteristics and stability in exposure media were analyzed using a combination of advanced analytical techniques, such as Single Particle Extinction and Scattering, Raman Spectroscopy, Scanning Electron Microscopy, and Dynamic Light Scattering. *In vivo* exposure assessment was conducted using environmentally relevant concentrations (10, 10^3, and 10^5 particles/L) over 14 days, followed by 3- and 10-day recovery periods. Complementary *in vitro* assays were performed on isolated hemocytes across multiple exposure durations (6–48 h) and concentrations (10, 10^3, and 10^5 particles/mL). Flow cytometry and histopathological analyses were employed to evaluate hemocyte functional responses and tissue-level alterations. *In vitro* findings revealed concentration- and size-dependent changes in lysosomal stability, oxidative activity, and hemocyte mortality, with granulocytes and hyalinocytes exhibiting differential sensitivities to aged PET particles. *In vivo* results demonstrated both immediate cellular perturbations and recovery potential to alleviate particle-induced effects. Histopathological analyses revealed significant structural alterations, particularly in gill tissues, indicating potential impairment of essential physiological functions. No mussel mortality or significant changes in growth metrics were observed under the tested conditions. Overall, this study demonstrates that aged PET MNPs induce sublethal yet systemic effects in *M. edulis*, highlighting the importance of employing aged test particles and integrated approaches for realistic MNP effect assessment.

Keywords

Aged Micro-and Nanoplastics; Polyethylene Terephthalate; Functional Assays; Histopathology; Immunotoxicity

Effects of artificial food provisioning on Carcharhinus melanopterus juvenile population around Mo'orea, French Polynesia

Herbots Elke

ECOSPHERE, Universiteit Antwerpen
Email: elke.herbots@uantwerpen.be

Sharks are vital for marine ecosystem health and hold significant economic and cultural value. Considering their role as indicators of system health, the observed 71% decline in populations since the 1970s is deeply concerning. Coastal species are exposed to direct anthropogenic activities, including artificial provisioning: the feeding of sharks to attract them for ecotourism. This practice is associated with shifts in spatial patterns, altered microbiota, pathogen spreading, and biting accidents. Sexually mature females might experience greater energy demands, due to increased sexual harassment and daily migration.

This study focuses on two coastal species subjected to this practice: Carcharhinus melanopterus (blacktip reef shark) and Negaprion acutidens (sicklefin lemon shark) around Mo'orea, French Polynesia. Despite a 2017 shark-feeding ban, activity targeted at Pateobatis fai (pink whipray) continued at two sites, feeding opportunistic sharks. Following a 2019 biting incident, one site's activities ceased, while the other continues up to this day, although interrupted for 41 days during a COVID-19 lockdown. Considering both species are matrotrophic, meaning energy for initial survival is provided by maternal energy allocation, this thesis hypothesized that provisioning negatively impacts juvenile shark survival and body conditions due to the adverse effects on females.

Comparison of pre-and post-ban data across the impacted sites and varying provisioning regimes, focusing on sex ratio, neonate-to-juvenile ratio, Catch Per Unit Effort (CPUE) and Fulton's K suggested that provisioning might be beneficial for populations, as it was associated with higher juvenile abundance (CPUE) and health (Fulton's K). Adult distribution, habitat characteristics, and intra- and interspecific competition were suggested as key drivers rather than solely matrotrophy. Moreover, provisioning seemed to actually increase maternal energy reserves due to regular food inputs. The intensity of provisioning appeared to be an indicator of the significance of post-ban change.

The findings suggest that provisioning in Mo'orea may not directly harm future shark populations, although further research to address remaining uncertainties is necessary. This study contributes to the knowledge necessary for comprehensive and effective shark conservation.

Keywords

Ecotourism; Shark; Conservation; Artificial Provisioning

Seasonal origin modulates short-term experimental thermal stress responses in the benthic copepod Platychelipus littoralis

Herman Iene[1], Carreer Laura[1], Asselman Jana[2] and De Troch Marleen[1]

[1] Marine Biology Research Group, UGent, Campus Sterre S8, Krijgslaan 281 – S8, 9000 Ghent, Belgium
Email: iene.herman@ugent.be

[2] Blue Growth Research Lab, UGent, Bluebridge, Wetenschapspark 1, 8400 Ostend, Belgium

Seasonal baselines in fatty acid (FA) composition and epigenetic profiles can shape how benthic copepods respond to environmental stress. We experimentally investigated the effects of short-term thermal stress in function of seasonality in the harpacticoid *Platychelipus littoralis*, a dominant meiofaunal species in Western European intertidal mudflats. Field-collected copepods analysed immediately after sampling revealed clear seasonal differences in lipid allocation: winter individuals invested a larger fraction of FAs in storage, whereas summer individuals invested more in membrane lipids. Copepods incubated under ambient conditions showed higher total FA concentrations in winter compared to summer, with absolute levels of saturated, monounsaturated and polyunsaturated fatty acids (SFA, MUFA and PUFA) following this seasonal pattern. Relative FA profiles, however, showed contrasting trends, with lower relative SFA levels in winter compared to summer. Temperature deviations of ±3 °C from the average sea surface temperature revealed no significant changes in total FA, SFA or MUFA concentrations. In contrast, PUFA and omega-3 FAs showed clear seasonal sensitivity. Summer warming reduced PUFA (absolute) and omega-3 (absolute and relative) concentrations and increased the ARA/EPA ratio, an indicator of physiological stress. At the level of individual FAs, summer warming reduced relative concentrations of oleic acid (OA, 18:1n-9), a precursor for long-chain ($\geq C_{20}$) PUFA, and eicosapentaenoic acid (EPA, 20:5n-3), a key nutritional component. Epigenetic analysis revealed higher global DNA methylation levels (5-mC %) in summer compared to winter, which may indicate increased stress or phenotypic plasticity under warmer conditions. Further work will assess methylation patterns in genes involved in LC-PUFA biosynthesis pathway to directly link FA composition with epigenetic regulation. Together, these findings demonstrate that the thermal sensitivity of *P. littoralis* is strongly context-dependent, with seasonal baselines in FA composition and epigenetic profiles jointly modulating resilience to temperature stress.

Keywords

Harpacticoid Copepod; Fatty Acids; DNA Methylation; Thermal Stress; Polyunsaturated Fatty Acid Biosynthesis

Lipid unsaturation correlates with population dynamics of the copepod Platychelipus littoralis in intertidal mudflats

Herman Iene, Martin Bram, Vigliano Relva Julieta, Vafeiadou Anna-Maria, De Troch Marleen

Marine Biology Research Group, Ghent University, Campus Sterre S8, Krijgslaan 281 – S8, 9000 Ghent, Belgium
Email: iene.herman@ugent.be

This study provides a one-year baseline dataset for the copepod species *Platychelipus littoralis*, one of the most abundant benthic copepods inhabiting intertidal mudflats in Western Europe. As a key member of the meiofaunal community, *P. littoralis* plays an essential role in the estuarine and coastal mudflat ecosystems, particularly through its interactions with microphytobenthos at the base of the food web. This study aims to track seasonal dynamics in the intertidal copepod community and identify key drivers of population abundance for this harpacticoid species. Absolute fatty acid concentrations and unsaturation of *P. littoralis* were maximal in winter and lowest in summer. The copepods' fatty acids match the homeoviscous thermal adaptation response of diatoms as their main food source. Rather unusual for copepods, *P. littoralis* primarily reproduced in winter, with the number of egg-carrying females doubling and egg sacs being 50 % larger compared to summer. We hypothesized that this reproductive strategy maximalizes egg production by aligning with the seasonal availability of diatom-derived polyunsaturated fatty acids (PUFAs) during the colder winter months. During winter diatom blooms, *P. littoralis* reached up to 25 % of total copepod population abundance, with local variability driven by the mudflat patchiness. Its reproductive success appears to be indirectly temperature-dependent, suggesting a high vulnerability to rising seawater temperatures predicted under climate change scenarios. Given its large geographical range, its temperature sensitivity as a winter breeder, and close association with diatom fatty acid unsaturation, the species shows strong potential as an indicator species for climate change monitoring.

Keywords

Fatty Acids; Biomarkers; Reproduction; Chlorophyll; Meiofauna

Population expansion and genetic structure of Scylla olivacea in the Indian Ocean and Pakistan revealed by nuclear and mitochondrial markers

Hinna Hinna, Kochzius Marc Kochzius, Huyghe Filip Huyghe

Marine Biology – Ecology, Evolution & Genetics (bDIV), Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
Email: Hinna.hinna@vub.be

The mud crab *Scylla olivacea* supports an important fishery and therefore a better understanding of its genetic diversity and connectivity throughout the Indian Ocean (IO) and Western Pacific Ocean (WPO) is necessary for an optimal management of this resource. At present, not much is known about the genetic diversity of this mud crab in Pakistan and its genetic connectivity with other populations in the IO and WPO. To fill this knowledge gap, sampling of 157 mud crabs was conducted at five different sites spanning the Pakistani coast. A fragment of 480 base pairs of the mitochondrial cytochrome oxidase subunit I gene (COI) was sequenced and aligned with 593 sequences from 18 populations throughout the IO retrieved from GenBank. Population structure in Pakistan was further analysed using 19 microsatellite markers. In the data set of 750 COI sequences, 229 haplotypes were identified. Nucleotide diversity was moderate (1.3 %) , whereas haplotype diversity was high (0.87). Neutrality tests indicated a possible recent population expansion event in nearly all populations. We detected significant population structure using COI ($\phi st = 0.14$, $\phi ct = 0.12$, $p < 0.001$) and identified six differentiated groups throughout the IO and WPO: (1) Arabian Sea, (2) Bay of Bengal, (3) Andaman Sea, (4) Strait of Malaca, (5) South China Sea and (6) Java Sea. Microsatellite analysis in Pakistan revealed two genetic clusters (Fst = 0.063, Fct = 0.035) corresponding to NW and SE regions. Genetic structure in the IO and WPO can be explained by historical or present barriers to dispersal, such as the Ganges River outflow , land bridges formed during glacial maxima and complex current pattern within the Indonesian archipelago. Within Pakistan, genetic structure might be a result of different environmental conditions along the coast, including the freshwater outflow from the Indus River, which can act as a partial barrier to larval dispersal.

Keywords

Universal Primers; Population Genetics; Mangrove; Central Indian Ocean; Phylogeography; Stock Definition

Diurnal variation of bioactive compounds in Kenyan red seaweeds: Implications on optimal harvest timing

Holeh Gladys[1], Mees Jan[2], Asselman Jana[3], Njiru James[4], Mirera David[5], Janssen Colin[6] and Semmouri Ilias[7]

[1] Blue growth research laboratory, Ghent University
Email: gladys.holeh@ugent.be
[2] Flanders Marine Institute (VLIZ), Flanders Marine Institute (VLIZ). InnovOcean Campus, Jacobsenstraat 1, 8400 Oostende, Belgium
[3] Blue Growth Research Lab, Ghent University, Bluebridge Ostend Science Park, Wetenschapspark 1, 8400 Ostend, Belgium
[4] African Institute for Capacity Development (AICAD). P.O. Box 46179-00100, Nairobi, Kenya
[5] Kenya Marine and Fisheries Research Institute, P.O. Box 81651-80100 Mombasa, Kenya
[6] Ghent University, Blue Growth Research Lab, Campus Coupure, Building F – 2nd Floor, Coupure Links 653 – B-9000 Ghent, Belgium
[7] Ghent University, Blue Growth Research Lab, Campus Coupure, Building F – 2nd Floor, Coupure Links 653 – B-9000 Ghent, Belgium

Diurnal light and temperature cycles are known to regulate the production of certain high-value bioactive compounds in seaweeds, yet fine-scale temporal patterns in biochemical composition remain poorly resolved for tropical seaweed species. On the south coast of Kenya, in Msambweni, we conducted a high-frequency *in situ* diurnal study on two red algae species: *Eucheuma denticulatum* and *Gracilaria salicornia*. The former is actively cultivated by local communities for the hydrocolloid industry, while the latter holds commercial potential as an agar source. To investigate both effect of time and water temperature, seaweed were exposed to two tidal pool temperature regimes: (1) a fluctuating "flexible" regime, mimicking the situation in shallow intertidal pools that warmed up to 33–35 °C at low tide, and (2) a "controlled", stable regime kept at early-morning subtidal temperatures (26–28 °C). Seaweeds were incubated in 72 transparent 500 mL bottles, each containing a single 20 g wet-weight specimen. The bottles were arranged across two semi-transparent beach basins, each representing a distinct temperature regime and holding 36 bottles. From 06:00–00:00 we logged temperature and dissolved oxygen (DO) concentrations every 2 hrs and harvested three replicate bottles to determine changes in moisture content, as well as key bioactive pools – the light-harvesting pigments R-phycoerythrin and R-phycocyanin, the natural UV-screening mycosporine-like amino acid (MAA) porphyra-334, and the osmolyte floridoside. The experiment was repeated on a second day for each species. Using linear mixed-effects models we evaluated the contribution of time-of-day and temperature regime on the seaweed composition. As such, this study provides one of the first diel-scale datasets linking microhabitat thermal regimes, oxygen dynamics and bioactive compound production in macroalgae from the Western Indian Ocean and is relevant to both marine ecologists and stakeholders in bio-based economies.

Keywords

Diurnal Variation, Mycosporine-like Amino Acids, Phycobiliproteins, Heterosides, Kenyan Seaweed Aquaculture; Blue Economy

Geochemical preservation of organic-walled dinocysts during extreme climatic events: A new project with insights from experimental and paleontological approaches

Ishkokani Rahaf[1], Vellekoop Johan[1], Semmouri Ilias[2], Asselman Jana[2], Meyvisch Pjotr[3], Penaud Aurélie[4] and Mertens Kenneth[5]

[1] Biogeology & Paleoclimatology research group, KU Leuven, Celestijnenlaan 200e, BE-3001 Leuven
Email: rahaf.ishkokani@kuleuven.be
[2] Blue Growth Research Lab, Ghent University, Campus Coupure Coupure Links 653 - block F B-9000 Gent
[3] Department of Geology, Ghent University, Krijgslaan 297, 9000 Gent
[4] GEO-OCEAN UMR6538, Université de Bretagne Occidentale, Univ. Brest, CNRS, Ifremer, Univ. Bretagne Sud Place Nicolas Copernic, F-29280, Plouzané, France
[5] LITTORAL, Ifremer, F-29900 Concarneau, France

Dinoflagellates are eukaryotic protists that play a central role in marine food webs, primary production, and biogeochemical cycling. Moreover, they are known for the production of organic-walled cysts (dinocysts), which play a crucial role in reconstructing palaeoceanographic and climatic variability due to their highly resistant nature. Chemical analyses based on infrared spectroscopy, in particular Attenuated Total Reflection Micro–Fourier Transform Infrared Spectroscopy (ATR–micro FTIR), have identified dinosporin as the primary component of the dinocyst wall. Dinosporin is a chemically stable, carbohydrate-based biomacromolecule that may exhibit variable contributions from specific functional groups (Meyvisch *et al.*, 2023).

Recently, we assessed the compositional stability of dinosporin during early diagenetic processes associated with the fossilization of modern dinocysts (bio-molecules) into geo-molecules across shallow- to deep-marine settings, spanning the Upper Pleistocene to Holocene. Our findings demonstrate that dinosporin remains largely unaltered, thus reaffirming its remarkable compositional consistency and long-term biomolecular stability. Nevertheless, the integrity of dinosporin under extreme climatic and oceanographic perturbations remains poorly constrained. Therefore, in this project we further aim to investigate the response of dinocyst wall molecular chemistry to global warming by integrating experimental and palaeontological approaches. Cultures of living dinoflagellates will be subjected to controlled environmental stressors analogous to geological events, namely the Palaeocene–Eocene Thermal Maximum (PETM; ~56 Ma) and the Late Maastrichtian Warming Event (LMWE; ~66 Ma). In parallel, fossilized dinocysts from these intervals will be analysed.

A combination of spectrochemical techniques, including ATR–micro FTIR, and mass spectrometric methods such as Inductively Coupled Plasma Mass Spectrometry (ICP-MS), will be employed to characterize molecular modifications, trace element incorporation, and potential adaptive responses in cyst wall chemistry. By combining experimental and fossil evidence, this research will refine our understanding of dinocyst resilience under rapid climate change and contribute to the development of novel biomarkers for monitoring past and future climate variability.

Keywords

Dinoflagellate Cysts; Molecular Biology; Molecular Paleobiology; Organic Geochemistry; Infrared Spectroscopy; Mass Spectrometry

First integrated assessment of sedimentary carbon cycling in the North Sea

Ivanov Evgeny, Gregoire Marilaure

MAST-AGO, University of Liège, Quartier Agora Allée du 6 Août, 19 - Bât. B5a B-4000 Liège 1 (Sart-Tilman) Belgique
Email: evgeny.ivanov@uliege.be

Continental shelf seas play a disproportionate role in the global carbon cycle, yet sedimentary carbon burial remains poorly constrained at basin scale due to the complexity of benthic–pelagic coupling and strong spatial heterogeneity. Here we present the first fully integrated, process-resolved assessment of sedimentary organic-carbon cycling across the Greater North Sea.

We employ a coupled ROMS–CSTMS–Fennel–OMEXDIA modelling framework that resolves three-dimensional hydrodynamics, pelagic biogeochemistry, sediment transport, and early diagenesis within a single, mass-conservative system. The model explicitly links bottom shear stress, stratification, oxygen supply, and organic-matter lability, allowing burial efficiency and redox partitioning to emerge from resolved processes rather than empirical tuning.

Modelled benthic oxygen-consumption rates (8–17 mmol C m^{-2} d^{-1}) and redox pathway partitioning closely match chamber observations from de Borger *et al.* (2021), reproducing the observed transition from oxic remineralisation on energetic sandy banks to oxygen-limited cycling in muddy, low-energy basins. Spatial patterns of carbon burial span more than an order of magnitude, from <5 g C m^{-2} yr^{-1} on shallow southern banks to >60 g C m^{-2} yr^{-1} in the Norwegian Trench, with less than 10% of the seafloor accounting for over half of total burial.

By combining basin-scale circulation, tides, sediment dynamics, and diagenesis, this work provides a coherent mechanistic picture of how seasonal forcing and regional facies control long-term carbon retention on a temperate shelf. The modelling workflow was supported by AI-assisted tools for analysis, visualisation, and manuscript development under full scientific supervision. These results establish a quantitative baseline for assessing future impacts of climate change and offshore activities on shelf-sea carbon sequestration.

Keywords

Benthic-Pelagic Coupling; North Sea; Marine Carbon Cycling

Genome size variation in the giant clam genus Tridacna

Januarius Maud[1], Huyghe Filip[1], M. Tawfeeq Mohammed[2], Flot Jean-François[2] and Kochzius Marc[1]

[1] Marine Biology, Vrije Universiteit Brussel (VUB), Brussels, Belgium
Email: maud.januarius@vub.be

[2] Evolutionary Biology and Ecology, Université libre de Bruxelles (ULB), Brussels, Belgium

Giant clams (subfamily Tridacninae) are the largest known molluscs, fulfilling various ecological roles, making them important ecosystem engineers for coral reefs. However, in recent decades, demand for giant clams has increased substantially due to a growing aquarium trade and the use of shells to produce jewellery. They are principally collected in the wild, resulting in extensive destruction of the coral reefs in which they are imbedded and contributing to biodiversity loss and the decline of overall ocean health. In addition to direct exploitation, giant clams are threatened by climate change. Rising sea surface temperatures have led to bleaching events, during which symbiotic unicellular dinoflagellates (family Symbiodiniaceae) are expelled from the Zooxanthellae Tubular System (ZTS). Because giant clams rely heavily on the algae for nutrient supply, bleaching can over time cause mortality in these giant clams.

Currently, 12 species of giant clams are described, based on morphology and DNA. Because of their vulnerability, all of these species are listed in Annex II of the CITES treaty, regulating their international trade. There is a high degree of phenotypic plasticity, making identification based on shell morphology complicated. Furthermore, certain widespread species such as *Tridacna maxima and T. squamosa* display highly differentiated genetic lineages and might contain cryptic species. Failure to recognise cryptic species is detrimental to conservation efforts, because of inaccurate species identification and therefore misinterpretation of population dynamics, hampering trade regulation.

This research explores genome size (GS) as a potential tool to improve species identification and contribute to giant clam conservation. GS is defined as the DNA content in a single set of haploid chromosomes and varies among species and taxa. Recent studies have revealed distinct GSs among two giant clam species, with *T. crocea* having an estimated GS of 1.049 billion base pairs (Gbp) and *T. maxima* of 1.32 Gbp.

Feulgen Image Analysis Densitometry (FIAD) is a fast, cheap, precise and reliable method developed by Robert Feulgen in 1924 to detect DNA in a nucleus and estimate GS. It allows for accurate DNA quantification without any bias, such as incompletely assembled genomes lacking repetitive elements. It can be easily applied to live specimens, which is important in view of the assessment of traded aquarium organisms.

Giant clams are exported and imported, but to evaluate the pressure on species and populations, an accurate and reliable track record of the species traded internationally must exist. Given the challenges of identifying giant clams based on morphology and the distinct GSs of the two currently assembled genomes, noting that estimates of GS can be biased by repetitive DNA, there is potential to develop GS as a cheap and fast species identification tool for giant clams. Additionally, it would be interesting to compare GS evolution with tridacnid phylogeny and to attempt to detect trends in GS evolution throughout the evolution of giant clams. While GS does not correlate with an organism's complexity, symbiosis can drive unique genomic adaptations by influencing various elements of the giant clam genome, such as the expansion of transposable elements and modifications in immunity-related gene families. This study addresses the following two questions: Can giant clams be identified based on genome size? Are genomes from more evolved giant clams longer or shorter than genomes from basal species? We analysed the GS of 114 giant clams, divided over 7 different species, including potential cryptic species. Small pieces of tissue were stained using FIAD and the DNA content of 30 cells per sample was quantified under a light microscope using ToupView and ImageJ software.

Keywords

Indo-Pacific; Chromosomes; C-value; Ocean Acidification; Biodiversity; Co-evolution

Guiding European flat oyster (*Ostrea edulis*) reef restoration in Belgian waters: From concept to implementation

Kapasakali Danae-Athena[1], Kerkhove Thomas[1], De Clercq Wannes[1], Stechele Brecht[1], Podholová Pavlína[1], Kerckhof Francis[1], Trabulo Rita[1], Delhaye Louise[2], Taymans Céline[2], Van Lancker Vera[2], Haelters Jan[3], Vanaverbeke Jan[1] and Degraer Steven[1]

[1] Marine Ecology and Management (MARECO), Royal Belgian Institute of Natural Sciences, Brussels/Ostend
Email: dkapasakali@naturalsciences.be
[2] Suspended Matter and Seabed Monitoring and Modelling (SUMO), Royal Belgian Institute of Natural Sciences, Brussels
[3] Scientific Service Management Unit of the Mathematical Model of the North Sea (MUMM), Royal Belgian Institute of Natural Sciences, Ostend

With the EU Nature Restoration Regulation (NRR) entering into force, restoring species populations and habitats has become a cornerstone of Europe's environmental strategy, turning ecological goals into binding obligations. However, implementing restoration at scale is a major challenge, requiring robust science and ecologically relevant plans.

The restoration of European flat oyster (*Ostrea edulis*) reefs illustrates this complexity. Once widespread across the North Sea, this unique and ecologically important habitat has been virtually lost due to decades of overexploitation and seafloor disturbance. In Belgian waters, both the habitat and the species itself had completely disappeared by the first decades of the 20th century. Today, the recovery of this habitat depends on coordinated initiatives across Europe, supported by networks such as the Native Oyster Restoration Alliance (NORA) and accelerated under the NRR.

In Belgium, the Institute of Natural Sciences has been shaping flat oyster reef restoration from the very beginning, by providing the scientific expertise needed for effective implementation and assessment. Our involvement covers habitat suitability mapping, operational planning, scientific research and monitoring, and policy and management support.

We used unique historical marine collections such as the Gilson collection, sampled in Belgian waters between 1899 and 1933, holding *O. edulis* specimens and reef-associated species, to reconstruct historical distribution patterns, provide insights into the drivers of decline, and partly characterise associated species communities (Haelters *et al.* 2007, Houziaux *et al.* 2008). Building on this foundation, we conducted the first feasibility study (De Mesel *et al.* 2018) and confirmed that the environmental conditions for restoring *O. edulis* reefs are still present in Belgian waters. Furthermore, we reported on, and continue to monitor, the unexpected reappearance of the species in Belgian waters following a period of at least 64 years without records (Montereale Gavazzi *et al.* 2024, Kerckhof and Kerkhove 2025).

Our multidisciplinary team is actively involved in several *O. edulis* pilot restoration projects in Belgian waters. Our work includes (i) conducting site selection in the gravel beds where *O. edulis* historically formed extensive reefs, (ii) ensuring compliance with national and European legislation, (iii) avoiding conflicts with other sea users and (iv) designing and implementing robust monitoring frameworks. Crucial to ensure the success of these restoration efforts, we have developed monitoring techniques adapted to the challenging North Sea environment while closely following key metrics proposed by NORA (including oyster growth, reproduction, water quality, habitat substrate, biodiversity and ecosystem services), ensuring that data outcomes are compatible with other European restoration initiatives. With large-scale restoration on the horizon, we aim to apply lessons learnt from these pilot projects while continuously improving monitoring protocols for this next phase of marine restoration.

References

- De Mesel I., Kapasakali D., Kerckhof F., Vigin L., Lacroix G., Barbut L. & Degraer S. (2018). *Ostrea edulis* restoration in the Belgian part of the North Sea: Feasibility study. Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Marine Ecology and Management, pp. 89.
- Haelters J., Kerckhof F. & Houziaux J.-S. (2007). De aanduiding van mariene beschermde gebieden in de Belgische Noordzee: een mogelijke uitvoering van OSPAR Aanbeveling 2003/3 door België. Federaal Wetenschapsbeleid, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Beheerseenheid Mathematisch Model Noordzee (BMM), Brussel.

- Houziaux, J.-S., Kerckhof F., Degrendele K., Roche M. & Norro A. (2008). The Hinder banks: yet an important area for the Belgian marine biodiversity? Final scientific report of the SPSDII project, Belgian Science Policy Office. Brussels, Belgium, pp. 259.
- Kerckhof F. & Kerkhove T.R.H. (2025). De inheemse Platte oester (*Ostrea edulis*, Linnaeus, 1758), terug van (nooit?) weggeweest? *De Strandvlo* 45(1): 15-27.
- Montereale Gavazzi G., Kapasakali D.-A. & Degraer S. (2024) The ecological status of subtidal natural hard substrate biotopes in Belgian waters. Indicator report. In: Belgische Staat (2025). Mariene Strategie Deel 1 voor de Belgische mariene wateren. Staat van Belgische mariene wateren, goede milieutoestand en milieudoelen. Kaderrichtlijn Mariene Strategie - Artikel 8, 9 en 10. Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu & Instituut voor Natuurwetenschappen, Brussel, België

Keywords

Ostrea Edulis; Oyster Reef Restoration; Monitoring; Historical Collections; Belgian Waters; North Sea

Towards Harmonized and Open Data Reporting on Litter Monitoring in Inland and Transitional Waters

Kazour Maria[1], Nogueira Miranda Mariana[2], Dhondt Charlotte A. L.[2], De Keukelaere Liesbeth[3], Nitschke Therese[2], Meyers Nelle[2], Maas Gita[4], González Fernández Daniel[5], Sánchez-Guerrero-Hernández Miguel Jorge[6], Muth Luca[7], Wagner Stephan[7], Petelin Marko[8], Zidaric Samuel[8], Asselman Jana[9], Amara Rachid[10], Doyen Périne[11], Veillet Guillaume[12], Martin-Cabrera Patricia[13], Van Emmerik Tim[14], Rondelez Jelle[2], Devriese Lisa[2], Everaert Gert[2] and Catarino Ana[2]

1 Research Department, Ocean and Human Health Division, Flanders Marine Institute (VLIZ)
Email: maria.kazour@vliz.be
2 Flanders Marine Institute (VLIZ), InnovOcean Campus, Jacobsenstraat 1, 8400 Oostende, Belgium
3 Flemish Institute for Technological Research (VITO), Boeretang 200, 2400 Mol, Belgium
4 Stichting De Noordzee, Utrecht, The Netherlands
5 Department of Biology, University of Cádiz (UCA), University Marine Research Institute INMAR, Av. República Saharaui s/n, 11510, Campus de Puerto Real, Cádiz
6 University of Cádiz (UCA), University Marine Research Institute INMAR, Av. República Saharaui s/n, 11510, Campus de Puerto Real, Cádiz
7 Hochschule Fresenius, Idstein, Hessen, Germany
8 Infordata Sistemi (INFOR), Italy
9 Blue Growth Research Lab, Ghent University, Ghent, Belgium
10 Laboratoire d'Océanologie et de Géosciences, Univ. Littoral Côte d'Opale, Wimereux, F-62930, France
11 UMRt 1158 BioEcoAgro, Univ. Littoral Côte d'Opale, Boulogne-Sur-Mer, 62200, France
12 Univ. Littoral Côte d'Opale, Wimereux, F-62930, France
13 International Oceanographic Commision (IOC)- Ocean Best Practices System Manager, UNESCO, Paris, France
14 Hydrology and Quantitative Water Management Group, Wageningen University, Wageningen, The Netherlands

Litter surveying and monitoring in aquatic environments (e.g., freshwater, estuaries, coastal areas) continue to rely on fragmented and inconsistent reporting methodologies. While the Marine Strategy Framework Directive (MSFD) and other technical reports provide guidance for marine environments, comparable requirements are limited under the Water Framework Directive (WFD) and have not been implemented yet, resulting in heterogeneous datasets and reduced comparability across studies. To address this gap, we developed FAIR-compliant and openly accessible dataset templates for micro-, meso-, and macrolitter monitoring in aquatic environments, that align with existing international best practices for gathering and managing (meta)data, including the guidelines of the European Marine Observation and Data Network (EMODnet). The templates were created following a structured development workflow informed by European legislation, technical guidance documents, and controlled vocabularies. They were tested using pilot datasets and refined through multiple local and European projects (e.g., PLUXIN, PLASTFLOW, TREASURE, INSPIRE) to ensure applicability across diverse sampling environments and methods. Provided in a machine-readable format (*.CSV), the templates capture campaign-level (meta) data—such as spatial and temporal coverage, environmental context, and responsible institutions. Litter observations are reported at the sample or item level, with standardized descriptions of material, size, count, and other key characteristics. By enhancing transparency, interoperability, and long-term reusability, these harmonized templates support robust spatial and temporal assessments of litter pollution in aquatic systems. This work supports a consistent, FAIR, and open workflow for litter monitoring and reporting in inland and transitional waters.

Keywords

Litter; Dataset Templates; FAIR Data; Inland And Transitional Waters; Plastic Pollution

Buried MIS 3 glaciolacustrine deposits in the southern North Sea: evidence for pre-LGM Weichselian ice-sheet influence

Kyriakoudi Despina[1], De Batist Marc[2], Vervoort Morgan[2], Mestdagh Thomas[1], Missiaen Tine[1] and Plets Ruth[1]

[1] Seascapes Past & Future, Flanders Marine Institute (VLIZ), InnovOcean Campus, Jacobsenstraat 1, 8400, Oostende
Email: despina.kyriakoudi@vliz.be

[2] Renard Centre of Marine Geology (RCMG) - Department of Geology, Ghent University, Krijgslaan 281, 9000 Gent, Belgium

The southern North Sea experienced repeated glacial–interglacial cycles during the Quaternary, resulting in continually changing depositional environments. During the last glaciation, the Weichselian (115–11.7 ka BP), global sea levels fell by up to ~130 m below present at the Last Glacial Maximum (LGM; ca. 26–19 ka BP), exposing large parts of the southern North Sea[1,2]. Offshore evidence for early Weichselian glacial influence (pre-LGM) remains sparse and discontinuously preserved, as most reconstructions of ice-sheet extent in the region primarily focus on the LGM[3,4,5]. Here, we document the presence of buried glaciolacustrine deposits south of Dogger Bank, which provides new offshore evidence for the Weichselian ice-sheet influence during Marine Isotope Stage 3 (MIS 3; ca. 27–60 ka BP). The lake deposits were mapped using high-resolution 2D acoustic reflection and core data and acquired as part of the WALDO* project, enabling reconstruction of their geometry, stratigraphic architecture, and depositional setting.

Seismic mapping reveals a lacustrine basin (~68.8 km²) characterised by an acoustically semi-transparent infill. Core data show that this infill consists predominantly of massive, homogeneous silts containing abundant ice-rafted debris (dropstones), underlain by a thin interval of laminated sediments at the lake base, indicating low-energy conditions. Dropstones comprise a wide range of lithologies, sizes, and shapes, up to pebble-sized clasts, providing strong evidence for iceberg rafting and proximity to an active ice margin during lake sedimentation. Chronological constraints from optically stimulated luminescence and microfossil analyses indicate deposition during MIS 3 (~30–32 ka). In certain cores, the lake sediment is overlain by glaciofluvial outwash deposits associated with subsequent LGM ice retreat. In other areas, the lake sequence is truncated and directly overlain by younger incised channels and marine sediments of Holocene age (MIS 1). These stratigraphic relationships record an environmental transition from ice-proximal lacustrine conditions to subaerial incision during deglaciation, followed by marine inundation.

This study provides robust offshore evidence for MIS 3 ice-proximal lake development in the southern North Sea and demonstrates that Weichselian glacial influence extended into the region prior to the LGM. These findings emphasise the value of integrating high-resolution seismic imaging with sedimentological and chronological data to resolve early glacial phases preserved within buried offshore landscapes.

* This study is part of the BELSPO-funded research project “WALDO” (Where are All the (proglacial) Lake seDiments in the NOrth Sea Basin?) led by the Flanders Marine Institute (VLIZ) and Renard Centre of Marine Geology (RCMG) of Ghent University. Ship Time RV Belgica was provided by BELSPO and RBINS-OD Nature.

References

1. Gibbard, P., & Cohen, K. (2015). Quaternary evolution of the North Sea and the English Channel. *Proceedings of the Open University Geological Society*, *1*, 63–74.
2. Lambeck, K., Rouby, H., Purcell, A., Sun, Y., & Sambridge, M. (2014). Sea level and global ice volumes from the Last Glacial Maximum to the Holocene. *Proceedings of the National Academy of Sciences - PNAS*, *111*(43), 15296–15303. https://doi.org/10.1073/pnas.1411762111
3. Carr, S. J., Holmes, R., van der Meer, J. J. M., & Rose, J. (2006). The Last Glacial Maximum in the North Sea Basin: micromorphological evidence of extensive glaciation. *Journal of Quaternary Science*, *21*(2), 131–153. https://doi.org/10.1002/jqs.950
4. Clark, C. D., Ely, J. C., Fabel, D., & Bradley, S. L. (2022). *BRITICE-CHRONO maps and GIS data of the last British-Irish Ice Sheet 31 to 15 ka, including model reconstruction, geochronometric age spreadsheet, palaeotopographies and coastline positions*. PANGAEA. https://doi.org/10.1594/PANGAEA.945729
5. Sejrup, H. P., Clark, C. D., & Hjelstuen, B. O. (2016). Rapid ice sheet retreat triggered by ice stream debuttressing; evidence from the North Sea [Article]. *Geology*, *44*(5), 355–358. https://doi.org/10.1130/G37652.1

Keywords

North Sea; Quaternary; Seismic Stratigraphy; Geomorphology; Sedimentology

Genetic structure and parasite diversity of the invasive Atlantic blue crab Callinectes sapidus in Moroccan coastal ecosystems

Lamkhalkhal Amal

Research Group Zoology: Biodiversity and Toxicology, Hasselt University
Email: amal.lamkhalkhal@uhasselt.be

Crustaceans play a fundamental role in the structure and functioning of coastal ecosystems. Their health is closely linked to that of local biodiversity and human activities. In Morocco, the native species *Carcinus maenas* and *Afruca tangeri* are crucial components of the marine environment and fisheries. *Carcinus maenas* plays a key role in regulating benthic communities by preying on various invertebrates, thereby maintaining ecological balance. Meanwhile, *A. tangeri* contributes to sediment stabilization and bioturbation, which enhances nutrient cycling and supports the productivity of local fisheries. Since 2017, the non-native Atlantic blue crab *Callinectes sapidus* has been introduced to Moroccan coastal waters, raising concerns about its effects on the native fauna and ecosystem balance, particularly with respect to parasite-associated diseases, alongside its impact on fisheries and native crustacean populations.

The main objectives of this study are to determine the origin and structure of Moroccan populations of *C. sapidus*, track their introduction pathways, and investigate the diversity of parasites. Knowledge about the symbionts associated with these populations will enable us to assess their effects on native biodiversity and associated marine diseases.

Overall, 110 specimens of *C. sapidus* from Morocco were analyzed, including 30 from the Marchica Lagoon (Mediterranean coast), and 80 specimens from the Atlantic coast (30 from Merja Zerga Lagoon, 30 from Sidi Moussa Lagoon, and 20 from Oualidia Lagoon). Molecular analyses were performed on a 572 bp fragment of the Cytochrome c oxidase subunit 1 (COI) marker. Comparison with previously published sequences from both native and non-native areas revealed a high genetic variation within Moroccan *C. sapidus* populations, suggesting multiple introduction events from the native range in the eastern coast of North America, rather than a single colonization. Comparative analyses further suggested ongoing gene flow between regions. These results provide key insights into introduction pathways and potential sources of parasite co-introduction.

To assess parasite diversity, 165 crab specimens (*C. sapidus*, *C. maenas*, *A. tangeri*) from Merja Zerga were examined through screening of hemolymph and various internal organs. *Hematodinium* sp., a parasitic dinoflagellate of major concern in crustacean health, was detected in all three species. Haplotype network analysis revealed a central haplotype shared by *Hematodinium* among multiple crab hosts and locations in Moroccan coastal lagoons. However, parasite community composition and infection levels differed markedly between hosts. *Callinectes sapidus* showed the highest overall parasite diversity and the lowest *Hematodinium* prevalence, additionally harboring digenean trematodes and microsporidians that were absent in *A. tangeri*. In contrast, *C. maenas* exhibited the highest prevalence of *Hematodinium*, with only occasional haplosporidian infection. *A. tangeri* ranked intermediate, presenting moderate haplosporidian and *Hematodinium* infections, but lacking trematodes and microsporidians. Preliminary results suggest potential parasite exchange between native and invasive hosts, spillback risk, and possible implications for marine disease transmission affecting native biodiversity and fisheries.

Results of the project emphasize the need for ongoing genetic surveillance and coordinated management efforts to mitigate the ecological and socio-economic impacts of *C. sapidus* invasion in the studied region. Future research should focus on expanding sampling to additional sites following the non-native distribution range of *C. sapidus* and integrating nuclear markers for a more comprehensive understanding of invasion dynamics.

Keywords

Morocco; Invasion; Parasites; Hematodinium

Do restored wetlands mitigate climate change?

Lamond Manon[1], Pelckmans Ignace[1], Janssens Ivan[1], Maris Tom[1], Van Ryckegem Gunther[2] and Temmerman Stijn[1]

[1] Department of Biology, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
Email: manon.lamond@uantwerpen.be

[2] INBO, Herman Teirlinckgebouw, Havenlaan 88 bus 73, 1000 Brussel, Belgium

Wetlands are among the most efficient ecosystems in sequestering carbon due to high plant productivity and permanently high groundwater tables which limit aerobic respiration. Tidal wetlands in particular are recognized as key "blue carbon ecosystems", as daily flooding during high tide causes high sedimentation rates, burying organic matter originating from local vegetation or delivered through sediments. However, these anaerobic conditions and frequent dry-wet cycles also make them natural sources of greenhouse gases, especially methane and nitrous oxide, which have 27 and 273 times the warming potential of CO_2 over a 100-year period. Although natural wetlands are often considered to mitigate climate change because of their high carbon sequestration rates, methane and nitrous oxide emissions could shift wetlands towards being net radiative sources. As wetland restoration is increasingly being implemented, not only for carbon sequestration but also for flood protection and increasing biodiversity, it is crucial to quantify their potential to mitigate or contribute to climate change. As part of the Sigmaplan, multiple wetlands in the Scheldt basin have been restored in the past decades by breaching of the dikes and are back under the influence of the tides, whether or not controlled by sluices. With my PhD research, I will quantify the carbon storage potential and greenhouse gas balance of these restored areas and couple these to different controlling factors such as restoration strategy, vegetation and inundation regime.

Keywords

Restored Wetlands; Greenhouse Gases; Carbon Sequestration, Climate Change Mitigation

Building Belgium's Early Career Polar Science Community: The Role of APECS Belgium

Leseurre Coraline[1], Novo Rita[1], Geels Alexis[2], Delhaye Louise[3] and APECS members team

[1] Flanders Marine Institute (VLIZ), Ostende, Belgium
Email: coraline.leseurre@vliz.be; apecsbelgium@gmail.com
[2] Université Libre de Bruxelles (ULB), Brussels, Belgium
[3] Royal Belgium Institute of Natural Sciences (RBINS), Brussels, Belgium

The Association of Polar Early Career Scientists (APECS) Belgium is a national branch of the international APECS network, dedicated to supporting early career researchers working on polar and cryosphere science. APECS Belgium provides a dynamic platform for PhD students, postdoctoral researchers, and early career professionals from diverse disciplines to connect, collaborate, and grow within the Belgian and international polar research communities. Through scientific workshops, career development events, outreach activities, and networking opportunities, APECS Belgium fosters interdisciplinary exchange and promotes excellence in polar research. The association also acts as a bridge between early career scientists and senior researchers, research institutions, and policy stakeholders, helping members develop both scientific and transferable skills. By encouraging community building, knowledge sharing, and inclusive participation, APECS Belgium contributes to strengthening Belgium's role in Arctic, Antarctic, and cryosphere research, while empowering the next generation of polar scientists to address the pressing environmental and societal challenges facing high-latitude regions.

AquaForest: A Nature-Based Approach for Mangrove Restoration, Climate Adaptation, and Carbon Mitigation in the Guayas Delta

Ligot Noa

Jan de Nul Group
Email: noa.ligot@jandenul.com

Leveraging long-term maintenance dredging in the Access Channel to Guayaquil, the project repurposed loam-rich dredged sediments to construct a 50-ha geomorphologically stable land mass designed to facilitate the development of a self-sustaining mangrove ecosystem. During the preparation phase, hydrodynamic modelling, sediment analyses, and eco-engineering design ensured that substrate composition, inundation regimes, and morphological stability were conducive to assisted natural regeneration.

The project integrates a multidisciplinary follow-up programme targeting three key dimensions. **Climate mitigation** is quantified through carbon sequestration assessments associated with mangrove biomass accumulation and soil organic carbon storage. **Climate adaptation** is evaluated via vegetation establishment dynamics, sediment accretion rates, hydrodynamic modification, and shoreline stabilization. Simultaneously, **biodiversity development** is monitored since 2024 to characterize the assembly of a novel ecosystem, including measurements of nutrient fluxes, primary productivity, and trophic network formation as benthic invertebrates, fish communities, and avifauna progressively colonize the site.

Early ecological indicators suggest robust ecosystem development. Propagule retention and seedling survival rates confirm the suitability of the engineered substrate, while hydrodynamic observations demonstrate the buffering capacity of the newly created landform. Importantly, the combined colonization of terrestrial pioneer species in elevated zones and mangrove species in intertidal areas contributes to land-mass stabilization by enhancing root cohesion, reducing erosion, and promoting sediment trapping. Rapid proliferation of benthic communities provides foundational trophic support for higher trophic levels, including bird species that have begun nesting on the elevated dike structures. Initial comparative analyses show that trophic pathways, community composition, and functional attributes are beginning to converge toward those of mature mangrove reference sites.

By integrating engineering, ecological restoration, and continuous monitoring, AquaForest functions as a living laboratory for evaluating and scaling mangrove Nature-based Approaches in tropical and subtropical environments.

Keywords

Nature-Based Solution, Mangrove Restoration, Eco-engineering, Sustainability, Ecuador

Diffusion of micro- and nanoplastic particles through the mucus barrier and its effects on bioavailability

Linera Canedo Camila del Rosario[1], De Keersmaecker Herlinde[2], Lin Xiaohui[3], Asselman Jana[1] and Vercauteren Maaike[4]

[1] Blue Growth Research Lab, Faculty of Bio-science engineering, Ghent University, Coupure Links 643, 9000 Gent, Belgium
Email: clinera001@ikasle.ehu.eus

[2] Ghent Light Microscopy (GLiM) CORE, Faculty of Pharmaceutical Sciences, Ghent University, Ottergemsesteenweg 460, 9000 Gent, Belgium

[3] Biostime Institute for Nutrition and Care, South China University of Technology, China

[4] Food Technology, Safety and Health And Blue Growth Research Lab, Faculty of Bio-science engineering, Ghent University, Coupure Links 643, 9000 Gent, Belgium

Micro- and nanoplastics are a heterogeneous and ubiquitous environmental pollutants widely detected in various marine food sources, through which humans are predominantly exposed via ingestion. Once ingested, these particles begin their travel through the gastrointestinal tract (GIT), where they must cross the mucus layer to be bioavailable and interact with the cells. The mucus barrier is the first line of defense in the gastrointestinal tract. Its mesh-like structure selectively allows nutrients to pass while blocking harmful substances via physical (pores in the mucus mesh) and chemical (binding) interactions. To reach the epithelial cells and potentially enter systemic circulation, MNPs must cross this barrier. This process is hypothesized to be mainly influenced by physicochemical properties of particles such as size, surface charge, and possible changes in the surface during digestion. Despite the importance of this mucus layer, little is known about these interactions for the heterogeneous MNPs. Therefore, the aim of this work was to evaluate how physicochemical properties and particle digestion influence the diffusion of MNPs through a simulated gastrointestinal mucus barrier and consequently improve our understanding on their potential bioavailability in the human gastrointestinal tract.

The influence of size on particle diffusion was analyzed using 200, 500 and 750 nm fluorescent polystyrene nanoparticles in a gastrointestinal mucus model based on porcine gastric mucin at a physiologically relevant viscosity to mimic the human gastrointestinal tract. The role of surface charge was evaluated by comparing Amine-modified and pristine polystyrene nanoparticles. The effect of particle digestion was studied by comparing the diffusion of digested vs non-digested polystyrene nanoparticles through the mucus. Particles were incorporated into the mucus model and imaged in real time using spinning disk confocal microscopy to capture individual particle trajectories. Particle transport was quantified by single particle tracking (SPT) and diffusion behavior was characterized through Mean Square Displacement (MSD) analysis to determine the diffusion coefficient. Based on these diffusion parameters, particle passage times across the mucus barrier were calculated. Finally, to assess the potential bioavailability of the particles, we estimated the passage time required for each particle to cross the mucus layer. These were then compared to reported mucus turnover times in different regions of the gastrointestinal tract allowing us to evaluate whether particles could reach the epithelial surface before being cleared.

Generally, particles showed sub-diffusive behavior indicating that particle diffusion through the mucus was hindered. Results showed strong size-dependence behavior; smaller particles diffused more slowly compared to bigger particles, likely due to their higher surface-to-volume ratio interactions with the mucus network. Amine-modified particles with near neutral surface charge exhibited higher diffusion rates than negatively charged pristine particles. Interestingly, particles that went through a simulated digestive fluid showed enhanced diffusion through mucus compared to pristine particles, presumably linked to the formation of a protein corona upon digestion.

In conclusion, MNPs heterogeneity plays a key role in determining their behavior through the GIT mucus and, consequently, their diffusion, potential bioavailability and toxicity. Particle size, surface charge and particle digestion were shown to be important factors influencing particle transport through the mucus layer. However, additional properties not addressed in this study, such as particle shape, may be studied further. Overall, this knowledge contributes to a better understanding of MNPs interactions in the human body and is highly relevant for improving future risk assessment frameworks for human exposure to MNPs.

Keywords

Diffusion; Mucus; Micro- And Nanoplastics; Physicochemical Characteristics

Generating genome-scale reference data for marine nematodes using genome skimming.

Lolivier Marianne[1], Callens Martijn[1], Derycke Sofie[1] and Moens Tom[2]

[1] Marine Genomics Lab, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: marianne.lolivier@ilvo.vlaanderen.be

[2] Marine Biology Research Group, Ghent University, Krijgslaan 281, 9000 Gent, Belgium

Nematodes represent one of the most ubiquitous, abundant, and diverse of all animal phyla, and are present in virtually every ecological niche. Despite their key ecological roles in marine benthic environments, free-living marine nematodes remain poorly characterized due to the time-consuming and challenging process of describing microscopic organisms and the scarcity of taxonomic experts. More than 1 million nematode species are predicted to exist, but only about 30,000 have been formally described. Genomic resources for nematodes remain even more limited: to date, around 220 genomes are publicly available, and these are largely restricted to terrestrial and parasitic nematodes, leaving marine nematodes underrepresented.

DNA-based approaches, mainly metabarcoding (i.e., simultaneous identification of many species using universal DNA barcodes), have advanced the study of nematode communities by bypassing the time-consuming morphological identification. However, metabarcoding introduces both taxonomic bias (limited resolution between barcodes at the species level) and quantitative bias (distorted abundance estimates due to differences in PCR amplification efficiency). Metagenomics (i.e., the direct analysis of all the genomic content of an environmental sample) offers a PCR-free alternative, but its application is hindered by the lack of genome-scale reference data available. Even as sequencing costs continue to decrease, generating high-quality assembled genomes remains expensive due to the time-consuming and labor-intensive process of assembling and annotating the DNA sequences.

Here, we propose genome skimming (i.e., low-coverage sequencing) as a cost-effective alternative for generating genome-scale reference data for marine nematodes. We generated low-coverage whole-genome sequencing reads (i.e., genome skims) for specimens from both laboratory cultures and field sediment samples. Using DNA extracted from single specimens, we prepared libraries for Illumina sequencing, yielding high-quality sequencing data. From these genome skims, mitochondrial genomes and ribosomal DNA were de novo assembled, from which marker genes (e.g., 18S, COX1) could be recovered. Additionally, the unassembled reads provide an additional genome-scale reference resource.

Scaling this approach to numerous vouchered specimens would generate the basis for a comprehensive marine nematode reference database that integrates assembled mitochondrial genomes, marker genes, and unassembled reads from low-coverage whole-genome sequencing. This would expand the genomic resources for marine nematodes and allow the application of metagenomics for monitoring the ecologically important marine nematode communities. Moreover, the recovered marker genes and assembled mitochondrial genomes could be used in multigene phylogenetic studies, advancing both biodiversity assessment and evolutionary studies of nematodes.

Keywords

Nematodes; Genome Skimming; Metagenomics; Reference Genome

Growing up on ecstasy: Developmental and behavioural effects of environmentally relevant MDMA exposure in zebrafish

Martin Rios Leonardo Davier

Department of animal sciences and aquatic ecology, University of Ghent
Email: leonardodavier.martinrios@ugent.be

Psychoactive substances (PAS) are now consistently detected in aquatic environments as a result of continuous human use and their incomplete removal in wastewater treatment plants (Zhang *et al.*, 2024). Many of these compounds are neuroactive at very low concentrations, raising concern about their potential effects on aquatic organisms under chronic exposure scenarios. Experimental studies have shown that prolonged exposure to PAS can alter the expression of genes involved in neurodevelopment, synaptic function, and stress-related pathways, even after relatively short exposure periods (Subedi *et al.*, 2021). Among these substances, 3,4-methylenedioxymethamphetamine (MDMA, "ecstasy") has been frequently reported in European surface waters, particularly downstream of urban areas and wastewater discharge points, where it persists at nanomolar concentrations (Muñiz-Bustamante *et al.*, 2022). However, the consequences of sustained MDMA exposure during early vertebrate development remain poorly understood.

In this study, zebrafish (*Danio rerio*) were used as a vertebrate model to assess the developmental and behavioural effects of chronic MDMA exposure during sensitive early life stages. Zebrafish are widely employed in ecotoxicological research due to their rapid development, conserved neurochemical systems, and suitability for quantitative behavioural analyses. Embryos were exposed continuously from fertilisation until 32 days post-fertilisation to two MDMA concentrations: 0.1 nM, reflecting environmentally relevant levels reported in European surface waters, and 100 nM, included as a supra-environmental concentration to explore potential concentration-dependent responses.

A broad range of developmental, physiological, and behavioural endpoints was evaluated. Developmental assessments included hatching success, survival, cardiac function, and somatic growth. Behavioural endpoints focused on habituation to repeated vibrational startle stimuli and dark-flash visual stimuli as indicators of sensorimotor integration and non-associative learning, as well as social behaviour assessed through mirror-directed interaction assays. Automated tracking was used to quantify locomotor activity, spatial distribution, and rotational behaviour across experimental phases.

Chronic MDMA exposure resulted in a significant reduction in hatching success and measurable alterations in cardiac function during early developmental stages, indicating that early ontogenetic processes are sensitive to sustained low-level exposure. In contrast, survival, somatic growth, and gross morphology were not affected, suggesting the absence of overt toxicity at the tested concentrations. Behavioural analyses showed that all groups exhibited normal habituation to repeated vibrational and visual stimuli; however, MDMA-exposed fish displayed subtle, phase-specific modulation of behavioural responses, consistent with altered sensorimotor plasticity. These effects were more apparent in dynamic behavioural parameters than in baseline locomotor activity. No significant changes were observed in social interaction patterns.

Taken together, these results indicate that chronic exposure to MDMA at environmentally relevant concentrations can induce subtle developmental and behavioural alterations in zebrafish without causing mortality or gross morphological defects. When considered alongside evidence that PAS can modify gene expression following chronic exposure (Subedi *et al.*, 2021), the observed behavioural effects are more consistent with early neurofunctional disturbance than with structural toxicity. The findings support the use of behavioural endpoints as sensitive early warning indicators of sublethal contaminant effects and highlight their relevance for environmental risk assessment of psychoactive pollutants in freshwater ecosystems.

References

- Zhang, Y., Guo, C., Wu, R., Hou, S., Liu, Y., Zhao, J., ... & Wu, F. (2024). Global occurrence, distribution, and ecological risk assessment of psychopharmaceuticals and illicit drugs in surface water environment: A meta-analysis. *Water Research*, *263*, 122165.
- Subedi, B., Anderson, S., Croft, T. L., Rouchka, E. C., Zhang, M., & Hammond-Weinberger, D. R. (2021). Gene alteration in zebrafish exposed to a mixture of substances of abuse. *Environmental Pollution*, *278*, 116777.

- Muñiz-Bustamante, L., Caballero-Casero, N., & Rubio, S. (2022). Drugs of abuse in tap water from eight European countries: Determination by use of supramolecular solvents and tentative evaluation of risks to human health. *Environment international*, *164*, 107281.

Keywords

MDMA; Zebrafish; Chronic Exposure; Behaviour; Environmental Risk

Plastic cleanup innovation at water's edge: insights from first in-situ efficiency assessments in ports in Belgium and Netherlands

Miranda Mariana[1], Catarino Ana[1], Grandjean Juliette[1], Stiers Xiebe[1], Zoete Lieselot[1], Bossaer Mattias[1], Everaert Gert[1] and Triantaphyllidis George[2]

[1] Research department, Ocean and Human Health division, Flanders Marine Institute (VLIZ), InnovOcean Campus, Jacobsenstraat 1, 8400 Oostende, Belgium
Email: mariana.miranda@vliz.be

[2] MINDS Technologies & Environmental Sciences PC, 2nd km Lavriou-Souniou Avenue, GR 195 00 Lavrion, Greece

Ports suffer from many anthropogenic pollution pressures, being considered multisource emission hotspots for numerous pollutants, including plastics. Since major ports have been historically located at river mouths or at the river lower stretches, these pollutants can spread along the river and reach the sea or Ocean. Thus, under the scope of the INSPIRE project (Innovative Solutions for Plastic Free European Rivers, funded under the call HORIZON-MISS-2022-OCEAN-01), major European ports were included as case study sites for testing the deployment of plastic cleanup technologies and their cost-benefit at these locations. Plastic cleanup technologies are being developed and deployed, with increasing interest as one of the solutions to remove plastic items or particles, and other litter, that pollute waterways. Consequently, identifying and developing metrics to evaluate their performance is critical, as they play a role in decision-making of the most suitable solution. The aim of this work was to explore the insights gained from the deployment in the Port of Ostend (North Sea coast, Belgium) and the Port of Rotterdam (Rhine-Meuse Delta, Netherlands) of two technologies (main mechanism is a rotary drum or water wheel and collection in net or bin) which targeted floating macrolitter (> 2.5 cm) and/or plastic pellets (fraction 2 – 5 mm). The two ports were selected as testing sites, since they offer distinct testing conditions because they have very different sizes, geographies and economic activities. The specific objectives of this work were to: i) apply new protocols designed to assess *in-situ* the plastic removal efficiency of cleanup technologies, based on release-catch experiments for the case of ports and harbours, ii) quantify the plastic removal efficiency of the two distinct technologies in two selected docks where plastic pollution accumulation occurs, and iii) identify the benefits and limitations of conducting release-catch experiments *in-situ*. For the two technologies assessed, we observed removal efficiencies for macroplastic items (N = 45 - 105 items per release-point and representative of the top 15 plastic litter categories) ranging from 49 to 83% (i.e., the percentage of items collected from the total number released). These efficiencies were noted under favourable weather and tide conditions and across multiple experiments, which involved the release of items at three different distances from the technology. The results were affected by the characteristics of the technologies tested and by the litter categories present and their contribution to the total number of items released. However, they were also strongly dependent on interception efficiency which is affected by hydrological and meteorological conditions: site-specific conditions. When normalising the results to exclude the impact of the interception, the technology-specific efficiencies reach values between 66 and 98% (i.e., percentage of items collected from the total intercepted). Similar conclusions were drawn from the plastic pellet release-catch in Rotterdam (N = 300 particles), which demonstrated a removal efficiency of 82 ± 7% under site-specific favourable conditions, reaching technology-specific efficiencies of 90 ± 3%. We identified many additional benefits of conducting release-catch experiments such as the identification of categories of litter (i.e., Joint List of Litter Categories for Marine Macrolitter Monitoring) for which the technology is less efficient, as well as the limitations of the technology and elements of its design that can be further improved, among others. Some limitations related to the assessment itself include the impact of sporadic algae or jellyfish blooms as well as parameters related to the tidal cycle and wind conditions. We also identified ethical considerations that need to be addressed to minimise the impact of each release-catch (e.g., using environmental litter previously collected at the testing location). This work facilitates progress towards standardisation in the evaluation of the plastic cleanup technologies by providing a scientific approach to measure their performance and compare them using clear and well-defined metrics that distinguish between site-specific and technology-specific results. These metrics can be utilised by researchers but also by technology-providers, decision-makers and relevant stakeholders.

Keywords

Plastic Pollution; Cleanup Technology; Removal Efficiency; Cost-benefit; Waste; Rivers

High-throughput image classification and morphometry through the VLIZ Pi-10 imaging pipeline

Mortelmans Jonas, Decrop Wout, Fernandez Muñiz Carlota, Heynderickx Hanneloor and Deneudt Klaas

Marine Observation Centre, Flanders Marine Institute, Jacobsenstraat 1, 8400 Oostende
Email: jonas.mortelmans@vliz.be

Plankton are a key component in marine food webs and are vulnerable to climate-driven changes. Their phenology, distribution, and body size are essential factors influencing the biological carbon pump and higher trophic interactions. Plankton research in the Belgian part of the North Sea (BPNS) has seen a recent technological leap with the introduction of the Plankton Imager 10 (Pi-10), which enables high-frequency, high-resolution in-situ imaging using a line-scan camera. This system supports near real-time assessments and yields up to 100,000 georeferenced images per minute. This work assesses the practicalities and on-board implementation of the Pi-10 on the RV Simon Stevin, exploring its integration with the ship's existing underway system, while generating the first collection of high-resolution Pi-10 imagery and curated annotations for the BPNS. A fully open-access data processing pipeline and classification framework is presented combining geotagged imaging, deep learning (CNN-based), image-based metrics and a multi-label taxonomic system. We suggest on best-practices for documenting Pi-10 datasets in Darwin-Core Archives (DwC-A). This initiative represents a step towards automated, real-time data collection and downstream ecological assessments in coastal systems - with its applicability well beyond the BPNS. By quantifying plankton size at high resolution, critical insights into community structure are detected - making size not just a descriptor, but a key ecological indicator of change.

Keywords

Plankton; Imaging; High-throughput; Pi-10

Predicting jellyfish blooms in the North Sea: A climate-driven early warning system

Musimwa Rutendo[1], De Troch Marleen[2], Everaert Gert[3] and Luca Stijn[1]

[1] Department of Data Analysis and Mathematical Modelling, Ghent University, Coupure links 653, B-9000 Ghent, Belgium
Email: Rutendo.Musimwa@Ugent.be
[2] Marine Biology Research Group, Ghent University, Campus Sterre – S8, Krijgslaan 281, B-9000 Ghent, Belgium
[3] Ocean Health and Human Health, Flanders Marine Institute, Jacobsenstraat 1, 8400 Ostend, Belgium

Jellyfish blooms are increasing in frequency and intensity as climate-driven extreme events such as marine heatwaves, salinity anomalies and acidification recur. These blooms can disrupt food webs, compete with other biota, damage coastal infrastructure and pose growing risks to maritime industries, fisheries, aquaculture and tourism. Despite their impacts, the timing and magnitude of jellyfish blooms remain difficult to predict due to their non-linear ecological responses to environmental stressors. This research develops a hybrid early warning system for jellyfish blooms by integrating mechanistic ecosystem models, machine-learning forecasts, and experimental evidence. Long-term oceanographic and biodiversity datasets will be combined with mesocosm experiments on jellyfish and key zooplankton taxa to identify physiological thresholds and tipping points under acute climate stressors. These empirical insights will be used to parameterise hybrid models that merge long short-term memory neural networks (LSTM) with Nutrients-Phytoplankton-Zooplankton-Detritus (NPZD) and species-distribution frameworks to forecast bloom onset, intensity, and spatial distribution. Model performance will be evaluated against historical extreme events. Finalised models will then be translated into a stakeholder-oriented decision-support tool for fisheries, aquaculture operators, and coastal managers. By linking climate extremes to jellyfish bloom dynamics, this project advances predictive models and supports adaptive, climate-resilient management in a changing North Sea.

Keywords

Jellyfish Blooms; Climate Extremes; Hybrid Modelling; Machine Learning Forecasts; Early Warning Systems; North Sea

Unveiling Western Antarctic zooplankton biodiversity using eDNA

Narciso Mezones Alexa

Marine Biology, Vrije Universiteit Brussel (VUB)
Email: alexa.patricia.narciso.mezones@vub.be

Zooplankton forms a key group in marine ecosystems, acting as intermediaries between primary producers and higher trophic levels, and is involved in most important biogeochemical cycles, particularly in the carbon flux. The Southern Ocean, especially the Western Antarctic Peninsula (WAP), is a region with unique environmental conditions that supports dynamic zooplankton communities. This area is being impacted by climate change, exhibiting positive temperature anomalies, particularly in its northern region, which sustains a high Antarctic krill biomass, a key species in the food web and for fisheries. Climate change causes distributional changes that can alter carbon flux and disrupt food web dynamics. An accurate identification of zooplankton communities is vital for monitoring and anticipating such changes in carbon cycling.

Morphological identification of zooplankton requires taxonomic expertise across a wide range of taxa and is time-consuming. Molecular tools offer a suitable and potentially cheap alternative. Non-invasive techniques such as environmental DNA (eDNA), which involves extracting DNA fragments from environmental samples (e.g., water or sediment) are particularly valuable. Surveys using eDNA metabarcoding of the COI gene have successfully identified zooplankton communities to species level in various ecosystems, including Antarctica. The COI gene offers a larger reference database and a sufficient mutation rate for species-level discrimination, providing an advantage over other markers such as 18S or 28S rRNA, even though the success rate in identification per marker varies among groups.

Most eDNA studies have employed Illumina sequencing, which offers low error rates but typically yields short reads. In contrast, third-generation sequencing platforms (e.g., PacBio and Nanopore) can generate longer sequences and have recently achieved improved accuracy. Based on prior morphological surveys in the Bransfield Strait and Elephant Island region, key zooplankton groups expected to be detected include dominant euphausiids such as Antarctic krill (*Euphausia superba*) and *Thysanoessa macrura*; copepods including *Calanus propinquus*, *Metridia gerlachei*, and *Oithona similis*; salps (*Salpa thompsoni*); and various gelatinous zooplankton and pteropods. The combination of COI and 18S markers is designed to capture this broad taxonomic range effectively.

In this study, we aim to assess the zooplankton species composition in this area by analysing 29 samples collected in December 2024 during the ANTARXXXI expedition. Collection was done at 100 meters depth using a Niskin bottle after which five litres of water were filtered and eDNA was captured with Sylphium double 0.45 and 0.22 µm filters. Metabarcoding using COI and 18S markers will be performed on the Oxford Nanopore MinION sequencing platform. Results will be compared with zooplankton caught with 100 µm and 200 µm mesh size bongo nets deployed at the same depth as the Niskin bottle and identified using microscopes.

Keywords

Copepods, Nutrient Cycling, High Throughput Sequencing, Species Identification, Antarctica

Combining GPS Drifters and Hydrodynamic Models to Investigate Litter Pathways at the IJzer River Mouth

Nitschke Therese[1], Breugem Alexander[2], Koutrouveli Theofano[2], Decrop Boudewijn[2], Defraeye Thijs[3], Devriese Lisa Ines[4] and Catarino Ana Isabel[1]

[1] Research Department - Ocean & Human Health Division, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: therese.nitschke@vliz.be
[2] IMDC, Van Immerseelstraat 66, 2018 Antwerp, Belgium
[3] Empa Materials Science and Technology, Lerchenfeldstrasse 5, 9014 St. Gallen, Switzerland
[4] Department of Valorisation & Innovation - Policy & Innovation, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium

Estuaries and harbours are key environments for understanding floating litter pathways, as litter carried seaward by rivers, stormwater, and urban or industrial runoff is often retained here due to tidal trapping. Understanding how litter moves through and accumulates within river–sea interfaces is essential for designing effective mitigation or collection strategies. In this study, we combined a hydrodynamic litter transport model with in-situ GPS tracking experiments to investigate floating litter pathways at the IJzer River mouth. Our goals were to (i) mimic litter pathways to identify litter accumulation zones and to (ii) provide independent field data for validating a floating litter model.

The process based mathematical **model** [1] simulated the transport of floating litter objects (i.e., plastic bottle) influenced by river discharge, tidal currents, wind, atmospheric pressure, and water density effects (i.e. salinity), and included 60-day simulations in which 20 objects were released every hour at random positions within the Ganzepoot sluice complex (hereafter called 'Ganzepoot') and another release location downstream (hereafter called 'City') on the left bank side across the nature reserve IJzermonding. Model outputs, including final item distributions and concentration maps, indicate pronounced retention within the harbour area and limited export to the sea.

To generate **observational *in-situ* data** for model evaluation, we designed floating plastic containers equipped with GPS trackers. Two drifter types were deployed: lightweight plastic food containers with cellular GPS tracking, and more robust polycarbonate cubes with satellite-based GPS tracking. We conducted a 7-day and a 14-day GPS tracker experiment in Autumn 2025. In both experiments, we released ten floating containers (cellular GPS tracking) at the Ganzepoot and six floating containers at the 'City' (satellite-based GPS tracking. The two experiments yielded similar results: All ten drifters released at the Ganzepoot moved slowly seaward but eventually moved back upstream and stranded within a harbour area on the right bank side, predominantly in the marina or along vegetated shorelines of the nature reserve IJzermonding. All six floating containers that were released at the 'City' location on the left bank side stranded relatively quickly on the opposite riverbanks at the nature reserve IJzermonding, within a few days. Preliminary trajectory data shows daily positions progressing from the release locations toward the river mouth before moving upstream again and turning into different vegetated riverbanks or anthropogenic infrastructure, where the floaters were ultimately retained. None of the released floaters exited into the open sea during the 7- or 14-day experiment.

The **field observations** align closely with the **model predictions**, suggesting that the IJzer river mouth functions primarily as a retention zone rather than a source for seaward plastic flux. Accumulation hotspots appear linked to vegetation patches and anthropogenic infrastructure [2-4]. These results are consistent with existing literature reporting that estuaries and ports often serve as reservoirs for floating anthropogenic litter [5,6].

Our combined modelling–field approach showed that low-cost GPS-equipped drifter can validate hydrodynamic litter transport models and reveal spatially explicit accumulation zones. The results provide critical insights for targeted clean-up strategies and upstream mitigation in river-sea environments.

References

1. Breugem, A. *et al.* Macro Plastic Modelling in the Scheldt Estuary. in 1380–1386 (Vienna, Austria, 2023). doi:10.3850/978-90-833476-1-5_iahr40wc-p0201-cd.
2. Gallitelli, L. *et al.* Monitoring macroplastics in aquatic and terrestrial ecosystems: Expert survey reveals visual and drone-based census as most effective techniques. *Sci. Total Environ.* **955**, 176528 (2024).

3. Lotcheris, R. A. *et al.* Plastic does not simply flow into the sea: River transport dynamics affected by tides and floating plants. *Environ. Pollut.* **345**, 123524 (2024).
4. Sawan, R. *et al.* Temporal dynamics and tidal influences on plastic deposition, remobilization, and accumulation in an estuarine mixing zone in Northern France. *Environ. Monit. Assess.* **197**, 760 (2025).
5. van Emmerik, T., Mellink, Y., Hauk, R., Waldschläger, K. & Schreyers, L. Rivers as Plastic Reservoirs. *Front. Water* **3**, (2022).
6. Chen, Z., Li, G., Bowen, M. & Coco, G. Retention of buoyant plastic in a well-mixed estuary due to tides, river discharge and winds. *Mar. Pollut. Bull.* **194**, 115395 (2023).

Keywords

Macroplastic; Pollution; Litter Pathways; Tides; GPS; Hydrodynamic Model

Monthly and decadal habitat suitability predictions of four marine mammal species using an ensemble model approach

Nowé Jo-Hannes, Deneudt Klaas, Debusschere Elisabeth and Muñiz Carlota

Marine Observation Centre, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Ostend, Belgium
Email: johannes.nowe@vliz.be

To support effective management and conservation under the European Union's Habitats and Birds Directives, it is essential to understand both the current distribution of protected marine species and how their suitable habitats may shift under a changing climate. Habitat suitability models provide a practical way to link species occurrences and their favourable environmental conditions with changing environmental boundaries. However, their application at large spatial and temporal scales is challenged by heterogeneous data sources, sampling bias, and uncertainty in future projections.

Within the MARCO-BOLO project, an ensemble habitat suitability modelling workflow was developed to relate observed marine mammal occurrences to environmental drivers and generate habitat suitability predictions for regions II, III and IV of the OSPAR Maritime Area. These predictions show the relative probability of occurrence based on environmental conditions: (1) at a monthly resolution for current predictions, and (2) at decadal resolution based on the Shared Socioeconomic Pathways (SSPs) scenarios for the decades 2020 until 2100. Four marine mammal species protected under EU legislation were targeted: harbour porpoise *(Phocoena phocoena),* harbour seal *(Phoca vitulina),* common dolphin *(Delphinus delphis),* and bottlenose dolphin *(Tursiops truncatus*). Presence-only occurrences were obtained from EurOBIS for the years 2000-2019 and matched monthly to environmental predictors describing bathymetry, sea surface temperature, salinity, and primary productivity obtained from EMODnet and CMEMS. For the decadal predictions, environmental predictors were downloaded from Bio-ORACLE for the decades 2000 until 2100. Several methodological choices were implemented to address the variable spatial sampling intensity of the occurrence dataset, including target-group background sampling, and filtering and thinning of records to one presence per grid cell and time step.

Habitat suitability was modelled using an ensemble approach combining different algorithms, including: Random Forest, Multivariate Adaptive Regression Splines, Maximum Entropy, Extreme Gradient Boosting, and Generalized Additive Models, allowing robust estimation of species–environment relationships while reducing dependency on any single modelling technique. Model performance was assessed using cross-validation and standard evaluation metrics for presence-only data, indicating reasonable ability to distinguish observed presences from background locations. However, no independent validation dataset was available, and model output should therefore be interpreted as relative indicators of habitat suitability rather than precise predictions of species occurrence.

Monthly habitat suitability predictions showed seasonal variation for all species across the study area, with a general alignment between model predictions and occurrence records for all species. However, the results seemed to be sensitive to individual occurrence records in sparsely sampled regions, underlining the importance of cautious interpretation when drawing ecological conclusions from presence-only data. The decadal predictions allow to assess long-term trends, showing an overall shrinkage of the current suitable habitat for all four species which is most prominent under the SSP5-8.5 future climate scenario, possibly linked to the increasing temperatures forecasted for the study area. For porpoises and seals, the decline is projected to be most notable in the southern North Sea. For the two dolphin species, a potential shift in habitat suitability is predicted, with offshore and northern areas becoming more suitable, although the bias in occurrence records may be artificially skewing these results. Nevertheless, these predictions are limited by the environmental predictors used and ignore important biological links for top predators such as food availability or suitable reproductive grounds, which are key to understand the actual impact in the future populations. In conclusion, this work demonstrates the value of open-access data alongside the need for long-term standardised monitoring programs. The ensemble habitat suitability modelling predicts changes in suitable habitat for the four marine mammal species at monthly and decadal resolution. These findings visualise the climate-induced pressure on marine mammal populations which needs to be incorporated into a future-proof conservation and management plan.

Keywords

Habitat Suitability Modelling; Ensemble Modelling; Marine Mammals; Climate Change

Environmental drivers of carbon uptake and growth in mudflat benthic diatoms

Paepen Robbe[1], Van den Hauwe Tom[2], Semmouri Ilias[1], Pinseel Eveline[3], Janssen Colin[1] and Asselman Jana[1]

[1] Blue Growth Research Lab, Ghent University, Bluebridge Ostend Science Park 1, 8400 Oostende, Belgium
Email: robbe.paepen@ugent.be
[2] Ghent University, Campus Coupure, Coupure Links 653, 9000 Ghent, Belgium
[3] Protistology & Aquatic Ecology, Ghent University, Krijgslaan 297 - S8 9000 Ghent Belgium

Tidal flats are highly productive coastal ecosystems, often found near estuaries, that play a fundamental role in nutrient cycling, sediment stabilization, and biomass production. Their biomass production is driven almost exclusively by microphytobenthos, primarily benthic diatoms, as few other photosynthetic organisms can thrive in these dynamic intertidal environments. These benthic diatoms account for up to 86% of organic carbon sequestration in marine sediments. Despite covering only 0.028% of the Earth's surface, tidal flats remove an estimated 40–47 million tons of CO_2 each year, underscoring their importance as a blue-carbon sink. However, habitat loss and degradation driven by sea-level rise and coastal development, combined with the ecological sensitivity of tidal flats to abiotic and anthropogenic stressors, have caused dramatic global declines in tidal flat extent. Therefore, understanding how changing environmental conditions influence the physiology of tidal flat diatoms is essential to predict and protect their contribution to coastal carbon dynamics. This study investigates the combined influence of temperature, irradiance, salinity, and N:P ratio on the growth rate, carbon uptake, and chlorophyll *a* content of benthic diatoms isolated from Belgian mudflats. Laboratory cultures were exposed to controlled gradients of each factor in an orthogonal setup to quantify the effects on cellular productivity and photosynthetic efficiency. A full factorial design was performed with the two most influential parameters. Preliminary results on the model diatoms *Cylindrotheca closterium* and *Navicula phyllepta* indicate a significant influence of each of the factors on growth. For *C. closterium*, an especially strong positive relationship between temperature and growth was observed up to an optimal threshold, beyond which the temperature resulted in rapid cell mortality. On the other hand, increases in irradiance led to higher intracellular carbon content, while having less influence on growth rate. Higher N:P ratios further enhanced growth and chlorophyll *a* content, and N:P was the only factor that significantly increased the chlorophyll *a*–to–carbon ratio. These findings contribute to a mechanistic understanding of how multiple environmental drivers shape benthic diatom performance and, consequently, the carbon sequestration potential of mudflats.

Keywords

Mudflats; Benthic Diatoms; Environmental Stressors; Carbon Sequestration; Primary Production

When mudflats feel the heat: How heatwaves shape benthic diatom productivity

Paepen Robbe[1], Larrangé Iben[2], Semmouri Ilias[1], Pinseel Eveline[3], Asselman Jana[1] and Janssen Colin[1]

[1] Blue Growth Research Lab, Ghent University, Bluebridge Ostend Science Park 1, 8400 Oostende, Belgium
Email: robbe.paepen@ugent.be

[2] Ghent University, Campus Coupure, Coupure Links 653, 9000 Ghent, Belgium

[3] Protistology & Aquatic Ecology, Ghent University, Krijgslaan 297 - S8, 9000 Ghent, Belgium

Tidal flats are highly productive coastal ecosystems that play a crucial role in nutrient cycling, sediment stabilization, and carbon storage. Their productivity is driven almost exclusively by microphytobenthos, primarily benthic diatoms, as few other photosynthetic organisms can thrive in these dynamic intertidal environments. These benthic diatoms account for up to 86% of organic carbon sequestration in marine sediments. Despite covering only 0.028% of the Earth's surface, tidal flats remove an estimated 40–47 million tons of CO_2 each year, underscoring their importance as a blue-carbon sink. However, these communities are increasingly threatened by climate-driven stressors. Marine heatwaves (MHWs) in particular are a major threat, as they are becoming more frequent and of greater intensity. Yet, the physiological responses and recovery capacities of benthic primary producers that are exposed to such short-term temperature anomalies remain poorly understood. This study investigates the effects of simulated marine heatwaves on the growth rate, intracellular carbon content, and chlorophyll *a* concentration of benthic diatoms isolated from Belgian mudflats. Cultures of model species, such as *Cylindrotheca closterium*, *Navicula phyllepta*, and *Seminavis robusta*, were maintained in the laboratory and exposed to controlled heatwave events of varying duration and intensity, followed by recovery periods and repeated exposure. For *C. closterium,* we found that exposure to 30 °C for 5 days or longer results in reduced growth and carbon assimilation, or even the complete collapse of the population. In contrast, fluctuating temperatures (simulating low and high tides) have no significant effect on the measured parameters (even at 6-hour peaks of 30°C every day for 14 days), indicating strong resilience to temperature fluctuations due to tidal inundation. For *N. phyllepta* and *S. robusta*, however, tidal temperature variation did result in reduced growth, with *N. phyllepta* showing growth inhibition even at 25 °C, indicating species-specific differences in thermal sensitivity. The results of this research provide new insights into the thermal tolerance and resilience of benthic diatoms under extreme temperature events, and ultimately contribute to a better understanding of how climate change may alter the carbon sequestration potential of mudflats.

Keywords

Mudflats; Benthic Diatoms; Marine Heatwaves; Carbon Sequestration; Primary Production

Effects of electromagnetic fields from an alternating current power cable on the embryogenesis of three benthic associated marine species

Paoletti Silvia[1], Brabant Robin[2], Strammer Ilona[3], Sigray Peter[4], Rolleberg Niklas[4], Stewart Brian[5], Aerts Johan[6], Degraer Steven[7], Hutchison Zoe[8] and Gill Andrew[9]

[1] Marine Ecology and Management (MARECO), Royal Belgian Institute of Natural Sciences
Email: spaoletti@imedea.uib-csic.es
[2] Royal Belgian Institute of Natural Sciences, Vautierstraat 29, 1000 Brussel
[3]
[4] Royal Institute of Technology in Stockholm, Stockholm
[5] Strathclyde University, 16 Richmond St, Glasgow
[6] Ghent University, Department of Biology, Stress Physiology Research Group (StressChron), Ghent
[7] Royal Belgian Insitute of Natural Sciences, Vautierstraat 29, Brussel
[8] Scottish Government, Offshore Wind Directorate, Atlantic Quay, Glasgow
[9] Australian Institute of Marine Science, Dalkeith, Western Australia

The global expansion in offshore renewable energy, primarily through offshore wind, is associated with the proliferation of subsea power cables (SPCs) throughout marine and coastal benthic environments. The transmission of electrical power through these SPCs will introduce electromagnetic fields (EMFs) into the seabed and the adjacent water column, which raises questions regarding the potential impact on benthic fauna, particularly during critical developmental early-life stages for which research considering the effects of both the electric and magnetic components of SPC EMFs is lacking. We conducted an experiment on three benthic egg-laying species, – the elasmobranch Scyliorhinus canicula, the cephalopod Loligo vulgaris, and the cephalopod Sepia officinalis – found in areas under consideration for the routing of SPCs. We exposed the embryos to realistic EMF levels (magnetic field 4–6 μT) recreated in the laboratory using an AC power cable set-up that simulated the EMF conditions, and examined the morphological, physiological, and behavioural responses. Our findings indicate subtle responses to EMF exposure in S. canicula and L. vulgaris with faster growth rates and morphometric differences, but no responses in S. officinalis. Our results highlight the value of a multiple end point approach to determine the potential influence of chronic exposure to EMFs on embryogenesis in benthic fauna and provide a baseline for future studies to build upon. Although our study cannot extrapolate the consequences of individuallevel effects to population-level impacts, it does underscore the necessity of realistic and longer-term studies to assess the potential consequences of EMFs to marine fauna.

Keywords

EMFs; Subsea Power Cables; Embryogenesis; Behaviour; Offshore Wind Farms; Elasmobranch; Cephalopod

Integrating stationary split-beam Echosounders and eDNA to optimise Sandeel Monitoring

Parmentier Irene[1], Derycke Sofie[2], Calonge Arienne[3], Debusschere Elisabeth[3] and De Backer Annelies[2]

[1] AMK, Instituut voor Landbouw-, Visserij- en Voedingsonderzoek (ILVO)
Email: irene.parmentier@ilvo.vlaanderen.be

[2] Instituut voor Landbouw-, Visserij- en Voedingsonderzoek (ILVO), Jacobsenstraat 1, 8400 Oostende

[3] Vlaams Instituut voor de Zee (VLIZ), Jacobsenstraat 1, 8400 Oostende

Sandeels (Ammodytidae) are considered key species in marine ecosystems serving as an important link between lower and higher trophic levels. However, their spatial distribution and the factors influencing their habitat use remain poorly understood. Their patchy distribution, coupled with their unique life style, spending part of their time buried in the sediment and part in the water column, makes accurate monitoring difficult. This study explores the combined use of stationary split-beam echosounders and environmental DNA (eDNA) to improve sandeel detection and quantification.

Stationary bottom moored autonomous echosounders are used to track pelagic fish in the water column on a semi-continuous duty cycle. Within the Apelafico and BAR Kustvloot projects acoustic backscatter datasets were collected. For this study, a subset of these data (4 locations) has been selected for regions expected to be sandeel-rich in the Belgian part of the North Sea (BPNS). The acoustic data were analyzed using Echoview software to detect single targets and fish schools. Schools were predominantly observed during day time, with most heights between 1-3 m, but some reaching up to 20 m, whereas single targets were observed both during day and night. A number of 1028 schools were further examined for variability in volumetric backscattering strength (Sv) across the frequency range of 185-255 kHz, alongside morphometrics and spatiotemporal dynamics. Machine learning techniques, including density based clustering (DBSCAN) and UMAP were then applied to explore underlying structures within the data, reduce dimensionality and automate classification. First results showed a range of 9 distinct clusters based on frequency response curves combined with volumetric backscatter strength. To gain further insights in these school clusters, the schools were linked to environmental variables such as the chlorophyll concentration, water temperature, tide and bathymetry. Chlorophyll and bathymetry appeared to be important factors in characterizing the clusters. While distinct schools emerged, a key challenge remains assigning these acoustic clusters to taxonomic identities.

eDNA, with its high taxonomic resolution, can help resolve this challenge. Therefore, eDNA was collected at four locations, which are generally known to favor sandeel presence, and which were mostly in proximity to the echosounder mooring locations. At each location, five water samples were collected, mainly during the night, and analyzed using 12S metabarcoding, a widely used genetic marker for fish detection. Additionally, at one station, water samples were also collected during the day to test whether the night-burying behaviour of sandeel can be detected through eDNA from water. The results indicate a high relative abundance of sandeel across all sampled locations, with sandeel DNA detected both during the day and night condition. Sandeel presence was especially evident around the Oostdyck sandbanks and the western part of the Princess Elisabeth Zone. Also other (pelagic) schooling fish species were detected, with the most common being whiting, sardine, sprat and horse mackerel, and to a lesser extent, seabass, pouting and herring.

Further research will integrate acoustic data with 12S metabarcoding results from eDNA samples at echosounder locations, to identify the taxonomic groups contributing to the acoustic clusters. With this interdisciplinary approach, we aim to establish an optimal sandeel monitoring strategy for the BPNS while improving our understanding of their spatial and temporal habitat dynamics.

Keywords

Sandeels; Ammodytidae; Bottom-mounted Echosounders; Target Classification; EDNA; 12S Metabarcoding; Integrative Monitoring Strategy; BPNS

Cracks in our foundations: The nature and origin of fissures in the Kortrijk Formation

Piret Loic[1], Van Daele Maarten[1], Stuyts Bruno[2], De Batist Marc[1], Dewaele Stijn[1], Kheffache Anis[2] and Payan Meghdad[2]

[1] Department of Geology, Ghent University, Krijgslaan 281, Ghent, Belgium
Email: loic.piret@ugent.be

[2] UGent Geotechnical Institute (UGGI), Ghent University, Technologiepark 68, 9052, Zwijnaarde, Belgium

The stiff Ypresian clays of the Kortrijk Formation occur extensively throughout the subsurface of the Princess Elizabeth Zone (PEZ), North Sea. The formation is pervasively deformed with large-scale polygonal fault networks, so-called Clay Tectonic Features (CTF; Henriet *et al.* 1988; Verschuren 2019). Moreover, recently acquired samples from the Kortrijk Formation in the PEZ suggest a heavily fissured internal structure of these clays at the centimeter scale. The presence of faults and fissures in this formation have strong implications for its geotechnical properties, such as strength and stiffness, which may pose challenges for the foundations of the planned offshore wind energy farms.

As part of the ETF FISSCK ('*Fundamental Investigation into the strength and stiffness of clays of the Kortrijk Formation*') project, we study the physical, mineralogical and chemical properties of the Kortrijk Formation in high-resolution using a multi-methodological approach including X-ray CT scanning, organic and inorganic geochemical analyses (LOI, organic material, calcimetry, pH, stable carbon isotopes, pXRF, XRD and ICP-OES) and sedimentological investigations (grain size, thin sections). The first samples were collected from a 20m deep borehole with alternating rotary coring and hydraulic push sampling in Rumbeke (from a section that is considered stratigraphically equivalent to the PEZ) and multiple drilling campaigns at other locations are planned.

Initial X-ray CT scans of these samples reveal a heterogenous internal architecture containing four main feature types: bioturbation, concretions, fissures, and faults. Bioturbation occurs throughout the cores, often appearing as millimeter-thick, centimeters-long, high-density features, likely reflecting the presence of precipitated minerals such as pyrite, following microbially-mediated sulfate reduction. In contrast, concretions (siderite-fluorapatite) are rare in the core sections, consistent with their observed scattered presence in land-based observations. Fissures are recognized as low CT-density features which do not occur throughout all the core sections but are concentrated in localized zones, leaving intervening volumes of clay intact. The observed cm-scale normal faulting structures point to a local extensional regime. The geometry, pattern, and textures of the observed fissures and fractures are tested against established criteria (e.g. radial and axisymmetry, bending near the core rim, etc.) to conclusively differentiate natural features from coring-induced artifacts (Adriaens *et al.* 2024). To quantitatively analyze all features, the X-ray CT data are processed using a comprehensive workflow involving filtering, segmentation, and grouping of features based on multi-ROI analysis using 3D connectivity. Following isolation, we perform a detailed analysis of the morphological characteristics (e.g., volume, surface area) and the three-dimensional orientation of the segmented features. The high-resolution 3D model of the features in the clay derived from CT scanning will be used to inform numerical models which will test the stiffness and long-term mechanical stability of the Kortrijk Formation clays under different geotechnical loading scenarios.

By combining detailed sedimentological, mineralogical and geochemical characterization with the high-resolution CT-based structural analysis, we aim to establish the origin of the fissures and faults in the Kortrijk Formation, thereby providing the geological context for their impact on geotechnical stability.

References

- Adriaens, R, H Van Baelen, N Vandenberghe, and L Wouters. 2024. "Drilling-and Coring-Induced Artefacts in Poorly Indurated Clays." *Geoenergy* 2 (1): geoenergy2024-001.
- Henriet, JP, M De Batist, W Van Vaerenbergh, and M Verschuren. 1988. "Seismic Facies and Clay Tectonic Features of the Ypresian Clay in the Southern North Sea." *Bulletin van de Belgische Vereniging Voor Geologie* 97: 457–72.
- Verschuren, Mark. 2019. "Outcrop Evidence of Polygonal Faulting in Ypresian Marine Clays (Southern North Sea Basin) Leads to a New Synthesis." *Marine Geology* 413: 85–98.

Keywords

Kortrijk Formation; Fissures; Clay Tectonic Features; X-Ray CT; Offshore Foundations

Mitigating ecosystem disservices by integrating One Health approaches into Nature-based Solutions

Ridley Alexandra[1], Fourchault Léa[1], Hugé Jean[1], Olefs Layla[2], Vanhove Maarten[3], Cruz-Laufer Armango[1], Gryseels Sophie[4] and Dahdouh-Guebas Farid[1]

[1] Systems Ecology and Resource Management Research Unit, Département de Biologie des Organismes, Université Libre de Bruxelles, ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium
Email: alexandra.ridley@ulb.be

[2] Systems Ecology and Resource Management Research Unit, Département de Biologie des Organismes, Université Libre de Bruxelle, ULB, Av. F.D. Roosevelt 50, CPi 264/1, 1050, Brussels, Belgium

[3] Research Group Zoology: Biodiversity & Toxicology, Centre for Environmental Sciences, Hasselt University, Agoralaan z/n, Gebouw D, 3590 Diepenbeek

[4] Vertebrates Unit, OD Taxonomy and Phylogeny, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, B-1000, Belgium

Ecosystem restoration has emerged as a critical Nature-based Solution for addressing today's pressing issues of climate change, biodiversity loss, and associated socio-ecological challenges. Restoration efforts are increasing in alignment with the Bonn Challenge, the New York Declaration on Forests, and the UN Decade on Ecosystem Restoration. When restoring ecosystems, however, health risks that originate or can be exacerbated at the animal-human-ecosystems interface, as outlined by the One Health paradigm, are vital considerations. This is especially pertinent for restoration projects (primarily) funded by the Global North and implemented in the Global South; power imbalances can mean that livelihoods and well-being of local communities living on restorable lands are not properly safeguarded. Here, we explore the degree to which funders and implementers consider ecosystem disservices (*e.g.* pathogen spillover, human-animal conflict) when restoring ecosystems such as mangrove forests in the Global South. This, alongside the generation of ecosystem services. We are carrying out this research using the Delphi technique, where we iteratively survey a panel of experts. The experts comprise three categories: Global North and South financers of restoration projects (including government agencies, NGOs, and private companies), Global South implementers of restoration projects, and academics investigating Nature-based Solutions under Global North-South contexts. We test how these different stakeholders perceive the identification and mitigation of potential ecosystem disservices linked to restoration projects. Additionally, we explore which tools experts use to assess the benefits and costs of restoration projects, and whether ecosystem disservices are systematically considered alongside services. Overall, our study aims are twofold. First, to promote a more systematic integration of human-animal-ecosystem risk mitigation strategies when funding restoration efforts, in alignment with the One Health approach. Second, to determine whether there is consensus or differing perspectives and practices among stakeholder groups when considering disservices, especially along a Global North-South nexus.

Keywords

Ecosystem Disservices; Nature-based Solutions; One Health

Developing eDNA as a tool for assessing fish diversity on East African coral reefs

Sarwar Tara[1], Trigallez Amélie[1], Kochzius Marc[1], Otwoma Levy[2], Migwi Christine[2], Abae Rose[3] and Huyghe Filip[1]

[1] Marine Biology, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussel, Belgium
Email: tara.sarwar@vub.be
[2] Kenya Marine and Fisheries Research Institute (KMFRI), P.O. BOX 81651, Mombasa, Kenya
[3] Coastal and Marine Research and Training Centre, Wildlife Research and Institute, Malindi, Kenya

Coral reef ecosystems are known for their high biodiversity and the ecosystem services they provide to coastal communities, including fisheries, coastal protection, and food security for millions of people globally. The Western Indian Ocean (WIO) is a region within the Indo-Pacific recognised as a major biodiversity hotspot that supports highly diverse fish communities. However, these fish populations are threatened by several factors, such as global warming, resource exploitation, and human-induced habitat degradation, resulting in abundance declines of certain species. These pressures highlight the importance of proper management and the need for improved biodiversity monitoring tools. Fish abundance is widely used to assess the health of coral reef ecosystems.

As a non-invasive monitoring tool, environmental DNA (eDNA) analysis is increasingly used to study ecosystems, including assessing the impacts of fishing pressure on coral reef diversity. This approach analyses DNA released by organisms into environmental samples such as water, sediment, soil, and faeces. It has proven particularly effective at detecting a broader range of fish diversity, including cryptic, rare, and low-abundance species that are often overlooked by traditional survey approaches. However, its performance is influenced by environmental conditions, sampling design, and the completeness of reference databases. Here, we will compare fish identification using eDNA samples taken at twelve different locations along the Tanzanian and Kenyan coast with identification done using underwater videos.

The performance of eDNA analysis greatly depends on the markers used. In aquatic eDNA metabarcoding studies, the mitochondrial cytochrome c oxidase subunit I (COI) is considered the standard marker for animals, largely due to its extensive reference database. However, the effectiveness of the standard COI barcode can be limited due to DNA degradation preventing successful amplification of longer fragments. Universal primer cocktails have been developed to increase this efficiency, but fragment length remains a significant variable. When degradation is severe, mini-barcodes are viable alternatives that can identify specimens with high success rates even when only short DNA fragments remain. Despite this, shorter fragments lose their specificity required for broad fish surveys. In contrast, the 12S MiFish-U marker has shown improved performances for fish identification, although its reference database remains incomplete. This study therefore aims to compare the accuracy of these two markers in our dataset through Nanopore sequencing. The development of a performant monitoring tools based on eDNA will greatly improve the efficiency, accuracy, cost and time efficiency of coral reef monitoring in the WIO.

Keywords

Coral Reef Ecology; Fish Community Monitoring; Biodiversity Monitoring Tools; Metabarcoding

What Happens After the Blast? Pollution Dynamics of Blast-in-Place Operations at the Belgian Coast

Schütte Wyona[1], Droissart Olivier[2], Neyts Marijke[3], Parmentier Koen[3] and De Rijcke Maarten[4]

[1] Research department, Flanders Marine Institute
Email: wyona.schutte@vliz.be
[2] DOVO-SEDEE Dienst voor Opruiming en Vernietiging van Ontploffingstuigen, 3053 Haasrode Oud-Heverlee, Belgium
[3] Institute for Natural Sciences, Ecosystems Physico-Chemistry (ECOCHEM), 8400 Ostend, Belgium
[4] Flanders Marine Institute, 8000 Ostend, Belgium

Unexploded Ordnance (UXO) from the First and Second World War remains present across large parts of Europe, both on land and at sea. As a former part of the Atlantik Wall, an extensive coastal defense system of Nazi Germany against an Allied invasion, the Belgian coast still contains unknown numbers of artillery grenades, mines and other types of ammunition. They are discovered during systematic surveys on the beach or surface after natural events such as storms. UXO encountered today still bears the risk of uncontrolled explosions or can leak toxic and carcinogenic explosives in the environment. High-order Blast-in-Place operations (BiPs) are widely used for the disposal of UXO. For this practice, a donor charge is placed next to the munition and initiates its detonation. However, the environmental pollution dynamics and spread of toxic explosives of this mitigation measure are poorly understood.

In this study, we investigated the spread of explosive compounds from 12 BiPs at two locations at the Belgian coast. Sediment samples were collected by Belgian Defence's explosive ordnance disposal unit (DOVO) before and at different locations of the blast crater after each detonation. Additionally, the two sites were resampled after 12 weeks to assess potential long-term pollution. Explosive compounds such as 2,4,6-trinitrotoluene (TNT) and its metabolites were measured by chromatography with mass spectrometry (GC-MS). Our results show highly variable concentrations of explosions measured in sediments taken directly after each detonation. For example, TNT was detected after one detonation only in trace amounts, and in another one up to 1.6mg/kg. This variation is likely resulting from an uneven spread of explosives due to blasting. We could find no accumulation of explosives in sediments over time due to repeated BiPs at the same location or correlation between type of munitions detonated and concentration of certain explosive compounds. After 12 weeks, only trace amounts of explosive compounds were detected. Our results highlight the highly variable, temporal environmental impact of high-order BiPs, but could not identify significant long-term effects that would give cause for concern, especially in environments like beaches used by tourism.

Keywords

Unexploded Ordnance, Blast-in-Place, TNT, Marine Pollution

Evaluation of nutrient dynamics and performance of whiteleg shrimp larvae in conventional and recirculating hatchery systems

Semmouri Ilias[1], Nachtergale Flor[1], Vermeylen Vincent[2], Asselman Jana[1], Declercq Annelies[2] and Janssen Colin[1]

[1] Blue Growth Research Lab, Ghent University, Coupure Links 653, 9000 Gent
Email: ilias.semmouri@ugent.be

[2] ARC, Ghent University, Coupure Links 653, 9000 Gent

Nutrient accumulation is a common issue in traditional shrimp culture systems, primarily resulting from inefficient feed management and the low assimilation efficiency of the cultured species. Yet, empirical data on nutrient dynamics in shrimp larval recirculating aquaculture systems (RAS) are scarce. This study conducted a 21-day trial comparing nutrient cycling, retention, and shrimp performance between a traditional batch hatchery system and a hatchery-scale RAS. *Litopenaeus vannamei* were reared from nauplius to postlarva 10 (PL10) stage in four tanks per treatment. Survival was low in both systems (7–9%), consistent with high mortality during early stages, and growth did not differ significantly. Shrimp assimilated only a small fraction of feed nutrients, particularly in RAS, likely due to feed losses. However, RAS maintained superior water quality, with markedly lower ammonia and phosphate concentrations through continuous filtration and biofiltration. In the batch system, ammonia accumulated until day 14 before nitrite and nitrate increased, indicating delayed nitrifying bacterial activity. Experimental data informed a nitrogen and phosphorus mass balance model: in the batch system, most nutrients remained in the water column (53.8% N; 65.0% P), whereas in RAS, concentrations were lower in the water sections, including incl. buffer tank etc. (22.1% N; 35.7% P), with a substantial portion unaccounted for. These findings highlight that while RAS improves water quality, its efficiency depends on enhanced feed retention via optimized formulations, precise delivery, or co-culture strategies.

Keywords

Shrimp Hatcheries; Nutrient Flows; Eutrophication; Aquaculture

Optimization of extraction of phenolic compounds from *Fucus spiralis* (Phaeophyceae) using Natural Deep Eutectic Solvents

Semmouri Ilias[1], Mansinhos Inês[2], Rodríguez-Solana Raquel[3], Janssen Colin[1], Asselman Jana[1], Gonçalves Sandra[2] and Romano Anabela[2]

[1] Blue Growth Research Lab, Ghent University, Coupure Links 653
Email: ilias.semmouri@ugent.be
[2] University of Algarve, Campus de, Gambelas, 8005-139 Faro, Portugal
[3] Instituto Andaluz de Investigación y Formación Agraria, Pesquera, Alimentaria y de la Producción Ecológica (IFAPA)
[4] Carretera Cañada de la Loba (CA-3102) PK 3,1. Apartado de Correos 589 Jerez (Cádiz)

Brown seaweeds (Phaeophyceae) have received considerable attention as a rich natural source of bioactive compounds including polysaccharides, vitamins, carotenoids and polyphenols. The phenolic composition of these seaweeds is characterized by the prevalence of phlorotannins, which are oligomers of phloroglucinol recognized for their diverse bioactivities, including antioxidant properties. The present study aimed at evaluating the effectiveness of different natural deep eutectic solvents (NADES) on the extraction of phenolic compounds from spiral wrack, *Fucus spiralis*, and its antioxidant properties. Firstly, using ultrasound-assisted extraction (UAE), we compared the extraction capacity of different NADES with those of conventional solvents. The results obtained demonstrated that extracts prepared with NADES (glycerol:urea; 1:1, and glucose: lactic acid; 1:5) exhibited significantly higher total phenolic contents in comparison with extracts with conventional solvents. Subsequently, an attempt was made to optimize the ultrasonic extraction of phenolic compounds using a Box-Behnken design, with total phenolic content, as well as the extracts' antioxidant activity (by different chemical assays), designated as the response variables. The optimization process was conducted with three key factors in mind: extraction temperature (ranging from 20 to 50 °C), extraction time (ranging from 30 to 120 minutes), and liquid-to-solid ratio (ranging from 5 to 55 mg mL^{-1}). Highest phenolic content was achieved at the highest temperature, with the longest extraction time, and an intermediate liquid-to-solid ratio. The experimental findings substantiate the hypothesis that the integration of UAE and NADES can serve as a viable substitute for conventional organic solvents, thereby facilitating a more sustainable extraction of bioactive compounds from seaweed.

Keywords

Phaeophyceae; Phenolic Content; Marine Natural Products; Bioprospecting

Identification of sharks and rays from coral reef fisheries using DNA barcoding

Sitka Amy

Marine Biology Lab, Vrije Universiteit Brussel
Email: Amy.Victoria.Sitka@vub.be

Around the globe, elasmobranchs have been impacted by excessive fishing and habitat degradation, resulting in many species being at high risk of extinction (Bornatowski *et al.*, 2014; Holmes *et al.*, 2008). The data currently available on elasmobranchs in fisheries is insufficient to properly make plans for conservation, especially in the Western Indian Ocean (MacNeil *et al.*, 2020). This leads to the research proposed as the topic of this thesis, which is DNA barcoding of sharks and rays in Kenya to add to the existing genetic database of elasmobranchs. This project builds upon a foundation of research done on elasmobranchs and fish in the area (Kenya and Tanzania) over the past few years in the framework of a finished VLIR-UOS Short Initiative project with Sokoine University of Agriculture (SUA, Tanzania; Rumisha *et al.* 2023) on sharks and rays, and the currently running VLIR-UOS Teams project SAVE-FISH (Supporting marine small-scale fisheries sustainability as a basis of safeguarding food security and livelihoods in East African region) with the Kenya Marine and Fisheries Research Institute (KMFRI), Technical University of Mombasa (TUM, Kenya), and SUA. If enough data are obtained, the data from Tanzania and Kenya could potentially be combined to do population genetic studies. Shark and ray samples were collected from fish markets in Kenya to be used for the DNA barcoding in the lab. The tissue samples were collected from sharks and rays from various landing sites along the entire coast of Kenya over the span of a month. The tissue samples are kept in ethanol until the lab work is done. The DNA barcoding will target the mitochondrial cytochrome c oxidase I (COI) sequence to differentiate species from tissue samples since it is often hard to distinguish between species just from the samples from fish markets (Hebert *et al.*, 2003; Holmes *et al.*, 2008; Kochzius *et al.*, 2010). The research combines field sampling with molecular analysis to evaluate species diversity, which will be valuable to propose management strategies, which is particularly important in this region of the world where they are heavily reliant on marine resources for livelihoods.

Literature list

- Bornatowski, H., Braga, R. R., & Vitule, J. R. S. (2014). Threats to sharks in a developing country : The need for effective simple conservation measures. *Natureza & Conservação*, 12(1), 11-18. https://doi.org/10.4322/natcon.2014.003
- Hebert, P. D. N., Cywinska, A., Ball, S. L., & deWaard, J. R. (2003). Biological identifications through DNA barcodes. *Proceedings - Royal Society. Biological Sciences/Proceedings - Royal Society. Biological Sciences*, 270(1512), 313-321. https://doi.org/10.1098/rspb.2002.2218
- Holmes, B. H., Steinke, D., & Ward, R. (2009). Identification of shark and ray fins using DNA barcoding. *Fisheries Research*, 95(2-3), 280-288. https://doi.org/10.1016/j.fishres.2008.09.036
- Kochzius, M., Seidel, C., Antoniou, A., Botla, S. K., Campo, D., Cariani, A., Vázquez, E. G., Hauschild, J., Hervet, C., Hjörleifsdóttir, S., Hreggviðsson, G. Ó., Van Kappel, K., Landi, M., Magoulas, A., Marteinsson, V., Nölte, M., Planes, S., Tinti, F., Turan, C.,. . . Blohm, D. (2010). Identifying Fishes through DNA Barcodes and Microarrays. *PloS One*, 5(9), e12620. https://doi.org/10.1371/journal.pone.0012620
- MacNeil, M. A., Chapman, D. D., Heupel, M. R., Simpfendorfer, C. A., Heithaus, M. R., Meekan, M. G., Harvey, E. S., Goetze, J., Kiszka, J. J., Bond, M. E., Currey-Randall, L. M., Speed, C. W., Sherman, C. S., Rees, M. J., Udyawer, V., Flowers, K. I., Clementi, G. M., Valentin-Albanese, J., Gorham, T.,. . . Cinner, J. E. (2020). Global status and conservation potential of reef sharks. *Nature,* 583(7818), 801-806. https://doi.org/10.1038/s41586-020-2519-
- Rumisha C, Simwanza RJ, Nehemia A, Mdegela RH, Kochzius M (2023) DNA barcoding reveals endangered and protected elasmobranchs in Tanzanian fish markets. *Western Indian Ocean Journal of Marine Science* 22: 57-65

Keywords

Sharks; Rays; DNA Barcoding; Conservation

Subtidal mussel beds in the Belgian North Sea: carbon sinks or sources?

Stevens Martha[1], Everaert Gert[1] and Braeckman Ulrike[2]

[1] Ocean and Human Health, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, Oostende, Belgium
Email: martha.stevens@vliz.be

[2] Marine Biology Research Group, Ghent University, Campus Sterre, S8, Krijgslaan 297, B-9000 Gent, Belgium

Subtidal mussel reefs are often suggested as a potential nature-based solution for coastal protection in the Belgian part of the North Sea and beyond. In the Coastbusters Finesse project, the potential co-benefits of such reefs are assessed to enable their inclusion into a holistic economic valuation model. Within this context we aim to answer to following question: are subtidal mussel beds a net carbon source or sink?

The presence of mussel reefs on soft sediments affects the cycling of carbon through a variety of processes, which has made the assessment of their potential as a net carbon sink or source debated. For example, respiration and shell formation (i.e. calcification) release CO_2 into the water column, decreasing the sea's capacity to take up atmospheric CO_2. Shell dissolution on the other hand, decreases pCO_2 which enables increased atmospheric CO_2 uptake. Alternatively, mussel biodeposits could facilitate increased carbon burial in the sediment. In addition to these carbon related processes, blue mussels can emit other greenhouse gases, namely methane (CH_4) and nitrous oxide (N_2O) through various metabolic pathways. The balance between the emissions of CO_2, CH_4 and N_2O compared to the potential burial of carbon in the sediment determines whether mussel beds can be considered a net source or sink of carbon and other greenhouse gases.

A three-month trial experiment has been conducted to test the viability of small-scale mussel patches on sandy sediments in a laboratory setting. One control treatment of bare sandy sediments was compared to sediments with a blue mussel (*Mytilus edulis*) patch covering a surface area of approximately 0.02m^2 (189 mussels; individual size range 0.5-5 cm). Based on preliminary results from this experiment, we aim to design a mesocosm experiment with simulated mussel beds to measure sediment-water fluxes of carbon, methane, nitrous oxide, alkalinity and nutrients. This will provide a first insight into whether subtidal mussel beds in the Belgian part of the North Sea act as a source or sink of carbon and other greenhouse gases.

Keywords

Blue Mussel; Greenhouse Gas; Carbon Cycle

Innovative monitoring techniques of macro- and microplastic litter across the water column

Stiers Xiebe[1], Praet Nore[2], Zoete Lieselot[1], Catarino Ana[1] and Vandorpe Thomas[2]

[1] Research department, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium
Email: xiebe.stiers@vliz.be

[2] Research Infrastructure, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium

Monitoring plastic litter is important because plastic pollution in the aquatic realm might have detrimental effects on organisms and ecosystems. The striking diversity of plastic litter, across shapes (fibers, films, irregular shapes, etc.), sizes (macro- to nanoscale), and densities, makes the use of multiple detection methods essential for monitoring the entire water column. The SSPIRIT project (From Seabed to SPace: Identifying and quantifying plastic litteR with Innovative remote sensing Technologies) addresses this challenge by developing and testing a cost-efficient suite of methodologies to map plastic pollution throughout the water column. Two of the specific objectives of the project are to assess and improve the underwater macrolitter detection, as well as to assess microplastic hotspots.

Underwater macrolitter is detected using acoustic (BlueView) techniques. The BlueView (Teledyne) is a dual-frequency sonar device (900 kHz and 2250 kHz) that generates high-resolution acoustic images of the water column at centimeter resolution. Within the SSPIRIT project, the higher frequency (2250 kHz) is used to detect macro-sized litter in the water column. Initially, a controlled experimental setup was conducted in a seawater tank to assess the detectability of different (plastic) litter types. Results from this experiment indicated that various (plastic) litter types produce a clear acoustic backscatter signal, highlighting the potential of the method. Additional acoustic detections will form the basis for the development of a learning dataset to be used in machine learning models. In the longer term, this approach may enable the in-situ detection of macro-sized litter.

Microplastic hotspots are assessed by investigating their link with suspended particulate matter (SPM) concentrations. During two campaigns with the RV Abbé Mann, water samples were collected inside and outside the ports of Oostende and Zeebrugge, at multiple depths. After laboratory processing, SPM and microplastic concentrations were quantified and compared across locations. Microplastic concentrations ranging from 0.0 - 52.5 particles m^{-3} were observed in areas characterized by lower SPM concentrations (9.5 ± 0.94 mg L^{-1} to 15.34 ± 1.06 mg L^{-1}), whereas higher microplastic concentrations (103.5 – 182.7 particles m^{-3}) were observed in areas with elevated SPM concentrations (9.8 ± 3.56 mg L^{-1} to 42.2 ± 4.74 mg L^{-1}). These preliminary results hint at a possible positive relationship between SPM and microplastic abundances. Further sampling and expanded data analysis will be necessary to confirm and quantify this relationship.

Within the broader context of the SSPIRIT project, these presented approaches highlight the value of developing and combining different techniques to detect plastics of diverse sizes and at varying depths within the water column. The BlueView experiments demonstrate the feasibility of detecting macrolitter items acoustically, providing a foundation for future applications supported by machine learning methods. In parallel, the preliminary relationship between SPM and microplastic concentrations indicate that SPM may serve as a useful proxy for the identification of microplastic accumulation zones.

Keywords

Plastic Pollution; BlueView; Macrolitter; Microplastics; Suspended Particulate Matter

Towards large scale oyster reef restoration in the Belgian part of the North Sea: the BELREEFS project

Stratigaki Vicky[1], Cockaert Phara[2], De Leener Elinka[2], Petit Simon[2], Nevejan Nancy[3], Stechele Brecht[4], Wille Mathieu[5], Fordeyn Jan[1], Deschutter Yana[6], Kerkhove Thomas[4], De Clercq Wannes[4], Aertbeliën Senne[6], Oeyen Merel[6], Van Lancker Vera[7], Kapasakali Danae-Athena[4], Hein Sas[8] and Degraer Steven[4]

1 Project development and conceptual design department, Jan De Nul Group, Tragel 60, 9308 Aalst, Belgium
Email: Vicky.Stratigaki@jandenul.com
2 Marine Environmental department, Jan De Nul Group, Tragel 60, 9308 Aalst, Belgium
3 Shells&Valves, Kortrijkstraat 81, B-8550 Zwevegem, Belgium
4 MARECO, Royal Belgian Institute of Natural Sciences, Brussels/Ostend, Belgium
5 Mantis Consulting, Kerkstraat 108, 9050 Ghent, Belgium
6 Marine Environment, Federal Public Service Health, Food Chain Safety, Environment, Belgium
7 ECODAM, Royal Belgian Institute of Natural Sciences, Brussels/Ostend, Belgium
8 Sas Consultancy, The Netherlands

In 2025, the BELREEFS consortium, bringing together Jan De Nul Group, the Institute of Natural Sciences, Shells & Valves, and Mantis Consulting, reached an important milestone in the restoration of European flat oyster (*Ostrea edulis*) reefs in the Belgian part of the North Sea. The project relied on a close partnership between scientists, industry and the government, merging ecological expertise, policy with offshore installation know-how. This collaboration resulted in the deployment of degradable reef structures carrying more than 200,000 juvenile *O. edulis* oysters.

The project was commissioned by the Federal Public Service Health, Food Chain Safety and Environment within the framework of action T4.8 of the LIFE B4B project (101069526) and represents the first offshore restoration effort of this scale in Belgian waters. This project also aligns with the broader objectives of the Nature Restoration Regulation, which aims to accelerate the recovery of degraded ecosystems across Europe.

The restoration initiative focuses on the offshore gravel beds of the Hinder Banks, where *O. edulis* beds once naturally flourished. During the initial phase of the project, optimal sites were identified through extensive seabed evaluation and monitoring using multibeam echosounder data collected in 2024 and earlier. Natural protection of the pilot sites, especially with regard to human activities at sea, but also terrain characteristics and hydrodynamic conditions and human activities at sea, also played an important role in the final site selection. One of the selected sites lies near the SS Kilmore, a protected shipwreck within a gravel bed area, lying at approximately 31 km offshore. This location was prioritized to kick-start new oyster reefs given its physical protection for the developing reef.

In the second project phase, oyster larvae were allowed to settle under controlled conditions onto degradable clay bricks (Mother Reef® by Oyster Heaven) at Stichting Zeeschelp (NL) and in Ostend (so-called remote setting). The bricks were stacked on wooden pallets, producing so-called spat-on-substrate that eventually formed reef units.

Right before the deployment of the reef units near the SS Kilmore shipwreck in summer 2025, they were transported to the multicat vessel. There, the reef units were kept moist using a watering system and shielded from direct sunlight with protective fabric. Subsequently, the reef units were carefully lowered to the seabed, with a hydraulically steered lifting beam, and placed in close proximity to each other to stimulate reef formation. To evaluate the project's success, a comprehensive monitoring programme was established to track reef development, associated fauna, and the effect of the restoration structures composed of the reef units on the surrounding gravel bed habitat over time.

The first monitoring took place two months after installation and yielded promising results. While oyster survival and growth were confirmed, the observations also indicated active ecological interactions on the substrate. Signs of competition for space and presence of potential predators were recorded. These processes will be examined in more detail during future monitoring campaigns. The coming years will also reveal whether the developing oysters can establish a self-sustaining reef. The observed colonization by wild oyster spat further strengthens this perspective and is highly encouraging for future restoration efforts.

Keywords

Large-scale Oyster Reef Restoration; Offshore Oyster Reef Deployment; Oyster Larvae Setting Methods; Oyster Reef Substrates; LIFE Belgium For Biodiversity

Predicting marine corrosion rates of carbon steel using machine learning

Tegegn Mihret[1], Witteveen Wikke[1], Meskens Raf[1], Gelareh Shahin[2], Neamatian Monemi Rahimeh[3] and Potters Geert[1]

[1] AMACORT, Antwerp Maritime Academy, Noordkasteel Oost 6, 2030 Antwerp, Belgium
Email: mihret.tegegn.girma@hzs.be

[2] Réseaux et Télécommunications IUT de Béthune, Université d'Artois, 1230, Rue de l'Université, F-62408, Béthune, France

[3] Sharkey Predictim Globe, 5 Rue Molière, 59650 Villeneuve-d'Ascq, France

Corrosion in marine and brackish environments leads to substantial economic and structural damage, underscoring the need for improved predictive tools. This study applies machine learning (ML) to model the corrosion rate of S235 carbon steel under real-world conditions along the Ghent–Terneuzen Canal. A field dataset from 46 locations was compiled, incorporating environmental variables including temperature, pH, dissolved oxygen, chlorophyll concentration, oxidation–reduction potential (ORP), salinity, and exposure duration. Six ML algorithms—LightGBM, Gradient Boosting, Random Forest, XGBoost, and others—were evaluated before and after environmental feature selection.

The results demonstrate that feature engineering exerts a far greater influence on predictive accuracy than model choice. Prior to feature selection, all models performed poorly ($R^2 \leq 0.14$). After targeted feature selection, performance improved dramatically across all algorithms ($R^2 = 0.70–0.81$), with a 64% reduction in inter-model variability and substantial decreases in prediction error (48% in RMSE; 74% in MSE). LightGBM achieved the strongest performance (MSE = 0.003, $R^2 = 0.80$).

Feature-importance analysis revealed that several parameters traditionally assumed to be dominant—particularly salinity and depth—had minimal predictive value in this system. Instead, exposure duration, temperature, pH, dissolved oxygen, chlorophyll concentration, and ORP emerged as the primary drivers of corrosion behaviour. These findings highlight the decisive role of environmental context and feature selection in corrosion modelling, suggesting that optimizing input variables may yield greater benefits than increasing model complexity.

This work provides a data-driven foundation for more efficient corrosion monitoring and management strategies in marine environments, and underscores the value of ML-based approaches tailored to site-specific environmental dynamics.

Keywords

Corrosion; Machine Learning; Feature Analysis

Non-targeted screening of marine sediments in offshore wind farms

Vanavermaete David[1], Zapata-Corella Pablo[2], De Cauwer Karien[3], Castro-Jiménez Javier[2], Hengstmann Elena[4], Kirchgeorg Torben[4], Parmentier Koen[3], Van Poucke Christof[1], Yulikayani Putu Yolanda[1] and De Witte Bavo[1]

[1] Animal Sciences Unit - Aquatic Environment and Quality, Flanders Research Institute for Agriculture, Fisheries and Food, Ostend, Belgium
Email: David.Vanavermaete@ilvo.vlaanderen.be
[2] Chemical Contamination of Marine Ecosystems (CCEM), IFREMER, Nantes, France
[3] Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Brussels, Belgium
[4] Marine Sciences Department, Federal Maritime and Hydrographic Agency (BSH), Hamburg, Germany

Offshore wind farms (OWFs) play a crucial role in reducing carbon emissions, and the dependency on fossil fuels and their expansion is essential for meeting European energy and climate targets. While many environmental impacts of OWFs are systematically monitored, chemical emissions remain largely overlooked.

To address this gap, sediment samples were taken in and near eight OWFs within the Belgian and German parts of the North Sea to identify potential emissions. Three types of reference locations were considered: offshore reference samples at an area where low human impact is expected, aiming to capture background concentrations; ship reference samples, taken offshore near a shipping lane, aiming to correct for effects of ship traffic; and near-shore references, where a larger impact of multiple human activities taking place within 12 nm of the shoreline can be expected. Non-target screening using GC-MS-EI and LC-HRMS-ESI+/- detected over 8,000 compounds. These compounds were further categorised into impact, background, high-ref and ship-ref compounds.

Background (and historical) compounds are defined as those detected consistently across all reference and impact areas, without a clear discernible spatial distribution. The majority of compounds detected in the Belgian (6,483 features) and German (6,271 features) parts of the North Sea fall into this category and range from background contaminants to naturally occurring chemicals. The anthropogenic impact samples (high ref area) are situated near shore (<12 NM), close to different anthropogenic activities such as dredge disposal. Compounds detected at the high ref area have potential applications in polymer resins, surfactants, cosmetic formulations or as contraceptives, and other pharmaceuticals. Most of these compounds are released during human activities (household waste, industry, etc.) and are often transported by rivers to the marine environment. To distinguish shipping as a separate source, samples were also collected near shipping lanes (ship ref) with no other anthropogenic activities in the vicinity. This resulted in a lower number of compounds compared to the high ref area.

A wide variety of chemicals was found in the OWFs, with a clear difference between each OWF. More than 1000 compounds were identified as OWF-related chemicals with a significantly higher abundance in at least one of the OWFs compared to each reference area. The majority of the compounds that were tentatively identified belong to the diols, alcohols, carboxylic acids, or amines and could be linked to the use of polyurethane and epoxy coatings applied to wind turbines for corrosion protection. However, most compounds remain unidentified. Therefore, it remains difficult to assess the risk of these (unidentified) leachates on the marine environment. Biological effect monitoring or dedicated exposure experiments could help to understand the ecotoxicological effects of the mixture of leachates without the immediate need to identify the separate compounds. To ensure a safe environment, however, hazardous substances should be identified and monitored on a regular basis, which would require further research.

Acknowledgement: The authors acknowledge the project Anemoi (Project number 41-2-13-22), an Interreg North Sea project co-funded by the European Union.

Keywords

Chemical Monitoring; Offshore Wind Farms; Organic Contaminants; Non-targeted Analysis

Revealing the gut microbiome of *Orcinus orca* as indicator of pollution impact

Van de Moortel Broos[1], Das Krishna[2], Jauniaux Thierry[3], Haelters Jan[4], Yadav Rakeshkumar[5], Krzynowek Greffe Anna[6], Springael Dirk[5] and Decaestecker Ellen[1]

[1] MicrobiomeEcoEvo, KU Leuven, Etienne Sabbelaan 53, 8500 Kortrijk
Email: broos.vandemoortel@kuleuven.be
[2] FOCUS - Freshwater and OCeanic science Unit of reSearch, Université de Liège, Quartier Agora allée du six Août 11, 4000 Liège
[3] FARAH - Veterinary public health, Université de Liège, Bâtiment B42 Quartier Vallée 2 Avenue de Cureghem 7A-7D, 4000 Liège
[4] Management Unit of the North Sea Mathematical Models, Royal Belgian Institute of Natural Sciences, 29 Rue Vautier, 1000 Brussels
[5] Soil and Water Management, KU Leuven, Campus Arenberg Kasteelpark Arenberg 20 B-3001 Leuven-Heverlee
[6] Laboratory of Molecular Bacteriology, KU Leuven, Herestraat 49 - box 1030 B-3000 Leuven

Orcas (*Orcinus orca*) are sentinels of marine ecosystem health, yet their high vulnerability to anthropogenic contaminants places many populations at risk. Microbiome disruption is a plausible mechanism linking pollutant exposure to declining health, but the gut microbiome of orcas remains unknown. We applied whole-metagenome sequencing and long-read 16S rRNA profiling to gut content samples collected along the full intestinal tract (small and large intestine) of a stranded orca in Belgium (October 2023). Metagenomic functional analysis identified 21 genes involved in degradation of organic pollutants, including an almost complete DDT degradation pathway (five of six genes), a partial lindane (HCH) degradation pathway, and a complete atrazine degradation pathway. These findings reveal that orca gut microbes possess pollutant-metabolizing potential, highlighting microbiome functional profiling as a promising tool for assessing contaminant impacts in threatened cetacean populations.

Keywords

Microbiome; Gut Microbiome; Pollution; Contaminants; Orca; Cetacean; Sequencing; Stranding

Tracing mercury sources down the European coast through speciation and isotopic analysis

Vandermeiren Mathias[1], Abou-Zeid Lana[1], Vanhaecke Frank[1], Suárez Criado Laura[1], Frantzen Sylvia[2] and Maage Amund[2]

[1] Atomic & Mass Spectrometry Research Group, Ghent University, De Pintelaan 270, building S12, 9000 Ghent, Belgium
Email: mathias.vandermeiren@ugent.be

[2] Norwegian Institute of Marine Research, Nordnesgaten 50, 5005 Bergen, Noorwegen

Mercury (Hg) is known as a global environmental pollutant, and due to its persistence, toxicity, and continuous release from both natural and anthropogenic sources, there is concern about the effect of Hg exposure on human health. Its most toxic form, **methylmercury**, bioaccumulates and biomagnifies within food webs, posing severe risks to apex marine predators and humans. Once in the environment, Hg enters a complex **biogeochemical cycle**, undergoing transformations that influence its mobility, bioavailability, and toxicity.[1]

While traditional concentration and speciation measurements of Hg provide essential information, they offer limited insight into its sources and biochemical transformations in the environment. Hg **isotopic analysis** serves as a complementary tool, offering valuable information on its sources, methylation and demethylation processes, trophic transfer, and detoxification pathways. However, the Hg cycle is influenced by a wide range of environmental variables, and **data gaps** in Hg isotopic signatures in environmental compartments and marine organisms still limit our understanding of its sources and its detoxification pathways.[2] The lack of comparable isotopic datasets, particularly across consistent species over a widespread geographical area, impedes progress. Previous marine biota studies are geographically or species-specifically constrained, hindering **cross-study comparison** because of species- and habitat-specific variability.[3,4] As a result, our understanding of marine Hg cycling and detoxification remains incomplete.

In this study, **brown crabs** (*Cancer pagurus*) were collected from various locations along the **European coastline** (Norway, France, Scotland, Portugal and Sicily) and **cusk** (*Brosme brosme*) were caught along the **Norwegian coast**. By using multi-collector inductively coupled plasma-mass spectrometry (**MC-ICP-MS**) for high-precision isotopic analysis, we aimed at (i) revealing the Hg sources along the European coast and studying the element's biochemical transformations and (ii) providing an initial Hg isotopic baseline over a broad geographical range (European coast line) that can be used as a reference for future research and monitoring purposes by the scientific community. Hence, through Hg isotopic analysis, we aim to advance our understanding of Hg cycling in marine ecosystems, supporting more effective environmental monitoring and risk assessment.

References

[1] H. Young-Seoub, L. Kyung-Eun, *J. Preventive Medicine & Public Health*. **2012**, 45, 353-363

[2] J. Blum, M. Johson, *Annual review of Earth and Planetary Sciences.* **2014**, 42, 249-269

[3] A. Vecchio, F. Vanhaecke, *Chemosphere*. **2025**, 373, 144-157

[4] J. Masbou, D. Point, *Earth & Space Chem.* **2018**, 2, 5, 479-490

Keywords

Heavy Metal Pollution; (methyl)mercury; Marine Biota; Isotopic Analysis

More Than the Sum of Its Parts Seabed Habitats Under Cumulative Human Pressure - Why Sediment Management Matters

Van Lancker Vera, Kint Lars, Lepers Ludovic, Legrand Sébastien and Van den Eynde Dries

Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, 1000 Brussels, Belgium
Email: vera.vanlancker@naturalsciences.be

In the Belgian Part of the North Sea, intensive bottom-disturbing activities, including bottom trawling, aggregate extraction, dredging, and sediment disposal, cause repeated sediment resuspension and plume dispersal in the water column, but also seabed morphological alterations. Most commonly, individual pressures are assessed in isolation, though their cumulative effects may exceed natural variability and trigger non-linear responses in biogeochemical cycling and in benthic habitat dynamics, changing their intrinsic nature.

As a first of its kind, the four bottom-disturbing activities were parameterized and their sediment dispersal (encompassing both mud and fine sand) was modelled over a full annual cycle (VLAIO SUSANA; Lepers *et al.*, 2023). This resulted in daily grids of time-integrated particle presence (kg × s) which provides a quantitative basis to assess cumulative exposure and persistence, and allowing spatio-temporal analyses of the pressures against habitat types (Van Lancker *et al.*, 2023). This enables evaluation of where and when anthropogenic disturbance may push habitat nature and dynamics beyond seasonally-dependent natural background conditions.

The poster presents first results on how ecosystem services are affected by cumulative sediment dispersal. This is most critical for sensitive habitats such as gravel beds, a recognized 1170 Habitat in Belgian waters (Directive 92/43/EEC). Two services are analyzed: water quality regulation and habitat provision. Analyses identify exposure frequencies and plume persistence patterns. For water-column variability published data are used; for the seabed new analyses combine substrate characteristics, seabed morphology, and hydrodynamics (e.g., bottom shear stress). Resulting metrics form the basis for risk-based assessments that aim to identify pressure levels and exposure characteristics at which anomalous changes in water-column and seabed properties are likely to occur (e.g., depositional hotspots).

Results indicate that, on a relatively small continental shelf, the accumulation of multiple pressures can generate disproportionate impacts on seabed habitats, highlighting the need to move from pressure mapping towards threshold-based assessment. Outcomes are therefore applicable to seafloor-integrity evaluations under the Marine Strategy Framework Directive (Directive 2008/56/EC; https://odnature.naturalsciences.be/msfd/), as well as to targeted seabed change assessments, such as related to sand extraction (ZAGRI). These monitoring programmes allow in-situ validation of water-column and seabed properties, a.o. along a seafloor integrity monitoring network (SI-NET) crossing all major human activities (Van Lancker *et al.*, 2024). Such an evidence-based approach is needed to move from exposure and risk to field impact assessment informing further managerial actions.

We argue that explicitly resolving disturbance–dispersal–deposition linkages, and their impacts, is essential to begin defining acceptable levels of cumulative pressure. Doing so is a necessary first step towards developing offshore sediment management strategies, capable of identifying where mitigation may be required and which would support more effective habitat protection and restoration in heavily exploited shelf seas.

References

- Lepers, L., Baetens, K., Kint, L., Van den Eynde, D., Van Lancker, V., & Legrand, S. (2024). Cumulative sediment dispersal mapping of seafloor-disturbing activities. Deliverable D3.3. VLAIO SUSANA (Sustainable Use of SAnd in Nature-Based Solutions), 20 pp. Brussels, Institute of Natural Sciences.
- Van Lancker, V., Kint, L., & Montereale-Gavazzi, G. (2023). Seabed substrate map, surficial sediments Belgian part of the North Sea [map]. 1:100.000 [Dataset]. Royal Belgian Institute of Natural Sciences (RBINS), Directorate Natural Environment (OD Nature), Belgian Marine Data Centre (BMDC). [https://doi.org/10.24417/bmdc.be:dataset:2820]
- Van Lancker, V., Franken, F. & Kint, L. (2024). Areal extent of EUNIS level 2 habitats and gravel beds. Indicator report. In: Belgische Staat (2025). Mariene Strategie Deel 1 voor de Belgische mariene wateren. Staat van Belgische mariene wateren, goede milieutoestand en milieudoelen. Kaderrichtlijn Mariene Strategie - Artikel 8, 9 en 10. Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu & Instituut voor Natuurwetenschappen, Brussel, België.

Keywords

Seabed Habitats; Gravel Beds; Seafloor Integrity; Ecosystem Services; Cumulative Effect Assessment

New Global Marine Ecological Biomes to Better Resolve Biological Controls on the Ocean Carbon Cycle

van Langen Rosón Andrea[1], Roobaert Alizée[2], Goyens Clémence[3], Olivelli Arianna[2], Landschützer Peter[2] and Neukermans Griet[3]

[1] Past, Present and Future Marine Climate Change group, Flanders Marine Institute (VLIZ)
Email: andrea.van.langen@vliz.be
[2] Research department, Past, Present and Future Marine Climate Change group, Flanders Marine Institute, Jacobsenstraat 01, 8400 Oostende
[3] Biology Department, MarSens Group, Gent University, Krijgslaan 281, 9000 Gent

The ocean mitigates climate change by absorbing ~25% of annual human-made carbon dioxide (CO_2) emissions. This CO_2 uptake is mediated by a complex interplay of physical, chemical, and biological processes. While physical and chemical drivers of oceanic CO_2 uptake are relatively well studied and understood, the role of biological activity and its change in time remain poorly constrained. To be able to accurately monitor and predict climate-driven changes and human perturbations to the ocean carbon cycle it is imperative to improve our understanding of the biological controls on carbon dynamics.

Biomes, i.e. regions of coherent oceanographic structure, have proven essential for studying the ocean carbon cycle, supporting applications ranging from model evaluation to climate impact assessments. However, existing biome classifications rely heavily on oceanic physical variables (e.g. sea surface temperature) and provide limited representation of biological structure and function. Their application to contemporary carbon cycle research is further limited by aspects such as coarser spatial resolutions (~1°) or the omission of critical coastal regions. This study presents a new biologically informed global biome segmentation at 0.25° resolution based on 26 years of satellite-derived ocean color data (ESA Ocean Colour Climate Change Initiative) encompassing both the open ocean and coastal seas. We provide one core and four seasonally-resolved biome maps. This new biome segmentation captures key spatial and seasonal features of surface marine ecosystems, including distributions of primary productivity, particulate organic carbon and phytoplankton community structure.

We further demonstrate its relevance to carbon cycle research by providing first-order estimates of biome-scale seasonal biological modulation of surface ocean partial pressure of CO2, a key variable to understand air-sea CO2 exchange dynamics. Overall, this new classification offers an ecological observation-based framework to better constrain biological controls of marine carbon dynamics in support of climate monitoring and modeling efforts.

Keywords

Carbon Cycle, Ocean Colour, Satellite Remote Sensing, Primary Production

Fish community structure and diversity in the Tampolo Lagoon, Madagascar: an integrative ichthyological inventory

van Ypersele Martin[1], Fourchault Léa[2], Segers Brigitte[3], Gaspar Julien[3], Van Steenberge Maarten[3], Tsiresy Gaëtan[4] and Frédérich Bruno[5]

[1] Laboratory of Evolutionary Ecology (FOCUS), University of Liège
Email: martin.vanypersele.119@gmail.com
[2] OD Taxonomy and Phylogeny,, Royal Belgian Institute of Natural Sciences, 29 Vautierstraat, Brussels-1000, Belgium
[3] OD Taxonomy and Phylogeny, Royal Belgian Institute of Natural Sciences, 29 Vautierstraat, Brussels-1000, Belgium
[4] Analanjirofo University, Route de Mananara, Fénérive Est, Analajirofo, Madagascar
[5] Laboratory of Evolutionary Ecology (FOCUS), University of Liège,, Quartier Agora, 11 Allée du Six Août, 4000 Liège, Belgium

Transitional ecosystems such as coastal lagoons, floodplains, and mangroves play a crucial socio-ecological role, but remain largely under-protected. Madagascar, isolated from mainland Africa for approximately 88 million years, is recognized as a global aquatic biodiversity hotspot, with a high degree of endemism. The eastern coast of Madagascar harbours many of these transitional ecosystems, which are exploited as fishing grounds. The current lack of data hinders policy recommendations to preserve these ecosystems. In this context, the Tampolo Lagoon was investigated to better understand its fish community structure. Specifically, this study aimed at (i) conducting an integrative fish inventory combining morphological identification using FishBase, and DNA-barcoding, and (ii) assessing species diversity, community composition, and demographic structure. Standardized fish sampling was complemented by purchases from local fishers. All fishes were measured, weighed, and their tissue were sampled for genetic analyses. Twelve eDNA water samples were also collected, to verify the presence of relict populations of *Paretroplus polyactis* (analysis in progress). A total of 12 morphospecies was captured in experimental nets, representing 364 individuals and ~2.19 kg of biomass. Including fisher catches and pseudo-cryptic species identified through DNA-barcoding (e.g., *Gerres filamentosus* and *Gerres methueni*, indistinctively referred to as 'Fiampotsy' by local fisherpeople), 17 species were recorded. The universal barcoding COI fragment was adequate to identify most species, but the endemic *Sauvagella madagascariensis* could only be identified through 12S barcoding.

This study enriched GenBank by generating novel sequences for the following species: *Ambassis ambassis*, *Leiognathus equula*, and *Gerres methueni* (12S), *Sauvagella madagascariensis* (COI), *Scatophagus tetracanthus* (COI and 12S). Among the recorded species, 14 are native to Madagascar, and two are strict endemics: *Ptychochromis grandidieri* and *Sauvagella madagascariensis*. The presence of the invasive *Oreochromis mossambicus* was also confirmed, suggesting anthropogenic introduction and potential ecological risk. Community composition was heavily dominated by *Ambassis ambassis*, accounting for over 87% of total abundance and up to 83% 72of biomass. A comparison with FishBase's theoretical lengths and lengths at sexual maturity revealed that most of sampled fishes were juveniles or sub-adults, with adults representing < 2%.

These findings underscore the biological richness and ecological vulnerability of the Tampolo Lagoon. Two priority management actions are proposed: protecting large carnivorous species through minimum catch size regulations, and establishing no-fishing zones or seasonal closures to enhance ecosystem resilience.

Keywords

Madagascar; Ichthyological Inventory; DNA Barcoding (COI, 12S RRNA); Environmental DNA (eDNA); Small-scale Fisheries; Fish Assemblages

Boosted Regression Tree machine learning algorithms for predicting microplastic toxicity

Vercauteren Maaike[1], Antonio Vital Ana Leticia[2] and Mair Magdalena[2]

[1] Department of Food Technology, Safety and Health, Ghent University
Email: maaike.vercauteren@ugent.be

[2] Statistical Ecotoxicology, University of Bayreuth, Universitätsstr. 30, 95447 Bayreuth, Germany

Unlike chemicals, which typically have well-defined molecular structures and stable properties, micro- and nanoplastic particles (MNPs) are too variable to be grouped in a similar way. Each MNP particle has its own set of distinctive traits, including shape, size, polymer type, surface charge and plastic-associated chemicals. Linking the physicochemical properties with toxicological responses is crucial for effect assessment. However, applying classical toxicity testing to evaluate the influence of each physicochemical property of MNPs would result in an impractically large number of trait combinations to test, making such an approach inefficient and costly. Consequently, an alternative, hypothesis-driven strategy is required to streamline efforts while maintaining scientific rigor.Machine learning models could be employed as a powerful tool to establish correlations between the effects of MNPs and their specific traits. Similar as Quantitative Structure-Activity Relationship (QSAR) models for chemicals, these models would be able to predict the toxicity of MNPs with trait combinations that have not been tested directly in the lab. This study aimed to predict MNP toxicity based on MNP properties and experimental setup, and to evaluate how data pre-processing, dataset size, and data quality influence the predictive performance of the models, as well as to highlight the most important features when predicting MNP toxicity.

The recently compiled Toxicity of Microplastics Explorer (ToMEx) 2.0 database was used, consisting of studies investigating MNP effects related to human health (7499 data points, 78 studies) and effects in aquatic organisms (11,590 data points, 261 studies). Four datasets were derived from the database on human health, (1) data set with only studies reporting all information (complete_case, 2875 observations, 30 studies), (2) dataset with imputed missing values (7499 observations, 78 studies), (3) dataset containing only high quality data (1384 data points, 12 studies), (4) a dataset containing only the low quality data (987 datapoints, 18 studies). Using the derived datasets, a Boosted Regression Tree (BRT) machine learning algorithm was trained to predict the toxicity (presence/absence of effects) of untested MNPs using a blocked cross-validation approach. Methods of explainable AI (average marginal effects) were used to gain insights into associations of toxic outcomes with MNP traits, experimental parameters, and species traits. The same analysis was previously performed for the database on aquatic organisms, and results will be compared.

Our results demonstrate the feasibility of using machine learning methods to predict MNP toxicity, as well as provide the most important features when predicting microplastic toxicity, offering a promising alternative to traditional ecotoxicological testing. We highlight that high-quality data would improve predictive performance while minimizing data mining efforts and computational costs. Our results demonstrate the feasibility of using machine learning methods to predict MP toxicity, offering a promising alternative to traditional ecotoxicological testing. Endpoints, concentrations and species appear to have a high importance to explain the predictions. Based on the comparison between the different datasets, we highlight that high-quality data would improve predictive performance while minimizing data mining efforts and computational costs. More standardized experiments, detailed MP characterization, and high reporting standards (i.e., high-quality data) would likely enhance toxicity prediction and facilitate the disentanglement of the specific effects of MP properties on organisms.

Keywords

Predictive Modeling; Microplastic; Nanoplastic; Toxicity

Marine based alginate/chitosan polyelectrolyte beads effectively adsorb pharmaceutical pollutants in wastewater

Verelst Luca [1], Fardim Pedro [1], Sweygers Nick [2] and Appels Lise [1]

[1] Department of Chemical Engineering, KU Leuven, Jan De Nayerlaan 5, Sint-Katelijne-Waver, Belgium
Email: luca.verelst@kuleuven.be

[2] Chemical Engineering CREaS@DeNayer, KU Leuven, Jan De Nayerlaan 5, Sint-Katelijne-Waver, Belgium

Removing pharmaceuticals from wastewater remains a challenge within the scientific literature. Though some pharmaceuticals can be effectively removed by traditional wastewater treatment plants, others such as diclofenac (DCF) are known to be more persistent with an average removal efficiency of 20-40% [1]. Since European environmental levels exceed concentrations harmful to animals and plants tenfold (4 µg L^{-1}), continued research remains vital [2]. Adsorbents are among the alternatives explored in the literature attributed to (i) overall simplicity, (ii) ease of use and (iii) limited to no (harmful) byproducts [3], [4]. One such underexplored category of adsorbents is polyelectrolyte beads. This network of polyelectrolyte pairs, i.e. cationic and anionic polymers, is widely covered in the context of drug release applications and emerging in the context of wastewater treatment [5], [6]. In this study, alginate and chitosan, two polysaccharides of **marine origin** (i.e., brown seaweeds and crustacea, respectively), were used to synthesize this hybrid adsorbent without the addition of any harsh or toxic chemicals. Where alginate mainly provides strength to the beads, chitosan and its primary amines function as active adsorption sites for the anionic DCF molecules. To produce the beads, medium molecular weight alginate was dripped in low molecular weight chitosan while maintaining constant stirring. Subsequently, the obtained polyelectrolyes were submerged in a 0.1 M $CaCl_2$ solution to provide additional strength. The experimental part focuses on investigating influencial parameters such as adsorbate concentration (4, 12 & 20 ppm), adsorbent mass (50, 100 & 150 mg), stirring speed (100, 200 & 300 rpm) and different pH values. The prelimenary results of the adsorption tests have indicated batch removal efficiencies of up to 81% (150 mg beads, 20 ppm) and surface loading of up to 6.35 mg g^{-1} beads. This result was obtained with a chitosan to alginate ratio of ±4.72%, indicating excellent removal efficiencies for the amount of free amines present. Further experiments and research is needed to understand the full potential of these hybrids and determine the influence of environmental parameters.

References

[1] Y. Zhang, S. U. Geißen, and C. Gal, “Carbamazepine and diclofenac: Removal in wastewater treatment plants and occurrence in water bodies,” Nov. 2008. doi: 10.1016/j.chemosphere.2008.07.086.

[2] G. Maack, A. Hein, P. Schröder, and M. Dębiak, “Diclofenac: Kleine Wirkung für den Menschen – großer Schaden für die Umwelt,” *Umwelt und Mensch*, no. 01/2023, Apr. 2023.

[3] J. O. Eniola, R. Kumar, M. A. Barakat, and J. Rashid, “A review on conventional and advanced hybrid technologies for pharmaceutical wastewater treatment,” Jul. 01, 2022, *Elsevier Ltd*. doi: 10.1016/j.jclepro.2022.131826.

[4] N. Prasetya and C. Wöll, “Removal of diclofenac by adsorption process studied in free-base porphyrin Zr-metal organic frameworks (Zr-MOFs),” *RSC Adv*, vol. 13, no. 33, pp. 22998–23009, Jul. 2023, doi: 10.1039/d3ra03527a.

[5] J. K. Bediako, Y. El Ouardi, E. S. Massima Mouele, B. Mensah, and E. Repo, “Polyelectrolyte and polyelectrolyte complex-incorporated adsorbents in water and wastewater remediation – A review of recent advances,” *Chemosphere*, vol. 325, p. 138418, Jun. 2023, doi: 10.1016/J.CHEMOSPHERE.2023.138418.

[6] V. S. Meka, M. K. G. Sing, M. R. Pichika, S. R. Nali, V. R. M. Kolapalli, and P. Kesharwani, “A comprehensive review on polyelectrolyte complexes,” *Drug Discov Today*, vol. 22, no. 11, pp. 1697–1706, Nov. 2017, doi: 10.1016/J.DRUDIS.2017.06.008.

Keywords

Beads; Wastewater Treatment; Diclofenac; Chitosan; Alginate; Polyelectrolyte

Modelling long-term corrosion of World War I ammunition at the Paardenmarkt, North Sea

Verhasselt Katrijn, Witteveen Wikke, Horvath Joeri and Potters Geert

AMACORT, Antwerp Maritime Academy, Noordkasteel Oost 6, 2030 Antwerp, Belgium
Email: katrijn.verhasselt@hzs.be

Ammunition disposed of at the Paardenmarkt has been exposed to a marine environment without corrosion protection since dumping in 1919–1920. Corrosion therefore began immediately and has continued for 105 years. To evaluate the current condition of this ammunition—comprising a brass cartridge case, steel shell body, and zamak fuse—a three-year experimental program was conducted. Metal coupons representing these materials were deployed in different configurations (buried, surface-laid, and partially upright) and across salinity regimes (seawater, freshwater, and brackish water).

Experimental results were used to construct predictive corrosion models based on the power-law relationship, $D(t) = k.t^n$ where D(t) represents corrosion damage (e.g., mass loss or pit depth) in millimeters at time t (years), k is a material- and environment-specific constant, and n characterizes corrosion progression. Model parameters were fitted using the SciPy library in Python (Jones, Oliphant, & Peterson, 2001) and applied in Monte Carlo simulations to estimate cumulative corrosion over a 106-year period.

Simulated accumulated corrosion losses for zamak were estimated at (0.544 ± 0.048) mm when coupled with steel, compared to (15.2 ± 3.2) mm for zamak alone. For steel, losses of (5.78 ± 0.79) mm were estimated when coupled with zamak and (2.5 ± 1.2) mm when isolated. Only zamak exhibits average corrosion losses exceeding its assumed original thickness, indicating a high probability of leakage. The simulations suggest that approximately 95% of the ammunition is already leaking, primarily due to corrosion of the zamak fuse, which accounts for 98% of penetrations. Remaining intact munitions are expected to fail within the next 30 years. These results are consistent with observed contamination in the water column and leakage evidence from the Poelkapelle dismantling facility.

Keywords

Modeling; Long-term Corrosion; Ammunition; Paardenmarkt

Re-evaluating the Quaternary stratigraphy of the southern North Sea: new constraints on the formation and evolution of the Axial Channel

Vervoort Morgan[1], Plets Ruth[2], Kyriakoudi Despina[2], Mestdagh Thomas[2], Missiaen Tine[2] and De Batist Marc[1]

[1] Renard Centre of Marine Geology (RCMG) - Department of Geology, Ghent University, Krijgslaan 297, 9000 Ghent, Belgium
Email: morgan.vervoort@ugent.be

[2] Seascapes Past & Future, Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Ostend, Belgium

During the Quaternary, the North Sea region has experienced constantly changing environmental conditions (climate, sea-level). These changing conditions had a major impact on southern North Sea landscapes that are presently submerged, and often buried below the present-day seafloor. Our current understanding of these environmental changes, and their effects on ice-sheet extents, coastline positions and drainage networks, is largely based on large amounts of geophysical and geological data that were acquired in the 1960s to 1990s. Despite the fact that the current-day stratigraphic framework is based on these data sets, major questions regarding the southern North Sea palaeo-landscape evolution still remain. The rapid development in the past decades of offshore wind farms and other commercial projects allowed for new densely spaced, high-resolution geophysical and ground-truth data. Increasingly, these state-of-the-art data are also available for geoscientific research. However, these newly released commercial datasets lack the interconnectivity to allow a regional-scale stratigraphic appraisal.

In the framework of the WALDO-project*, multiple surveys have been conducted in 2022-2025 during which additional high-resolution geophysical data (Sparker, sub bottom – TOPAS, and parametric echosounder – PES) combined with ground-truth data (vibrocores) were acquired. These data have been used to re-evaluate the current stratigraphic framework. Seismic-stratigraphic units have been examined in unprecedented detail and interpreted in the context of the current understanding of the evolution of the southern North Sea during the Quaternary. As a second step, these data have been used to study the Axial Channel, a prominent geomorphological feature seen on the present-day sea floor, as its formation and evolution is nowadays still uncertain. Our seismic-stratigraphic framework revealed a more complex geology in the Axial Channel region, that was validated by sedimentological, environmental an chronological analysis of acquired vibrocores. One of those vibrocores (AC07) is located inside the main branch of the Axial Channel. OSL dating revealed an age of c. 30 kyrs (MIS3), whereas they were previously classified as the Brown Bank Formation (MIS4-5). Another vibrocore (VC09) aided in our understanding of a widespread erosional surface in the study area, that can possibly be linked to the formation of the Axial Channel itself. This study illustrates the need for a new and/or updated stratigraphic framework, and the importance of combining seismic and ground-truth data to understand large-scale geomorphological features such as the Axial Channel.

Keywords* *This study is part of the BELSPO-funded research project "WALDO" (Where are All the (proglacial) Lake seDiments in the NOrth Sea Basin?) led by the Flanders Marine Institute (VLIZ) and Renard Centre of Marine Geology (RCMG) of Ghent University. Ship Time RV Belgica was provided by BELSPO and RBINS-OD Nature.*

Keywords

Southern North Sea; Axial Channel; Quaternary; Seismic Stratigraphy

MOZES - how the nearshore gully-bank system influences the coastline, and thus coastal protection, in Belgium

Verwaest Toon[1], Houthuys Rik[2], Nnafie Abdel[3], Nguyen Diem[4], Röbke Björn[5], De Bakker Anouk[5] and Dan Sebastian[1]

[1] Waterbouwkundig Laboratorium, Departement Mobiliteit en Openbare Werken, Berchemlei 115, 2140 Antwerpen, Belgium
Email: toon.verwaest@mow.vlaanderen.be
[2] Geoconsultant, Nachtegaalstraat 71, 1501 Halle, Belgium
[3] Utrecht University, Heidelberglaan 8, 3584 CS Utrecht, The Netherlands
[4] Antea Group Belgium, Roderveldlaan 1, 2600 Antwerpen, Belgium
[5] Deltares, Rotterdamseweg 185, 2629 HD Delft, Zuid-Holland, The Netherlands

The MOZES project (2020-2026) is morphological research on the interaction between the nearshore and the coastline carried out by a team of coastal morphologists and numerical modellers from Belgium and The Netherlands.

Data-analysis was carried on older bathymetric and topographic maps, going back in time to the begin of the 19th century. Several numerical models were developped and applied to better understand the causes of observed morphological trends.

Shoreface connected ridges are nearshore sand banks that are pathways of sand transport from offshore towards the coastline. We name this process natural feeding. By studying the morphological changes of these banks during the past 200 years the MOZES research has resulted in better understanding of how this sand transport occurs. Smaller bedforms on top of such a sand bank move along the sand bank axis and after some time reach the coastline. Unfortunately we did not achieve to establish a numerical model that reproduces this phenomenon. Future research on this topic is proposed to focus on morphological monitoring of the only one still active system at the Belgian coast (the Trapegeer-Broersbank-Den Oever complex at the west coast).

Data-analysis of morphological evolution of the shoreface connected ridges in the past 200 years also revealed a landward movement of the complete banks, which seem to accelerate in time, synchronous with accelerated sea level rise. Nearshore gullies show a linked morphological evolution, but are also pressured from landside by coastline maintenance and even progradation in the last 40 years by coastal protection works. This coastal squeeze results in steepening of the lower part of the foreshore. The development of an idealised morphological model has started to investigate how large will be the challenge to continue nature-based coastal protection of the Belgian coast given the moving nearshore gully-bank system for different scenarios of sea level rise until 2100.

References

- Nnafie, A., de Swart, H. E., Boersma, J. M., Verwaest, T., Falqués, A., & Calvete, D. (2024). Presence and position of sand ridges on the shelf strongly impact decadal evolution of adjacent shorelines: A model study. Journal of Geophysical Research: Earth Surface, 129, e2024JF007814. https://doi.org/10.1029/2024JF007814
- Houthuys, R.; Nnafie, A.; Röbke, B.; Nguyen, D.; Dujardin, A.; de Bakker, A.; de Swart, H.E.; De Maerschalck, B.; Dan, S.; Verwaest, T. (2026). MOZES – Research on the Morphological Interaction between the Sea bottom and the Belgian Coastline: Final report. FH Reports, 20_079_4. Flanders Hydraulics: Antwerp (in draft)
- Verwaest, T., Dujardin, A., Montreuil, A.-L., & Trouw, K. (2022). Understanding coastal resilience of the Belgian west coast. Water, 14(13), 2104. https://doi.org/10.3390/w14132104

Keywords

Coastal Morphology; Coastal Protection

Assessing (microbial) corrosion in ports, rivers, canals: Lessons from a major campaign in the canal Ghent-Terneuzen

Witteveen Wikke, Verhasselt Katrijn, Horvath Joeri and Potters Geert

AMACORT, Antwerp Maritime Academy, Noordkasteel Oost 6, 2030 Antwerp, Belgium
Email: wikke.witteveen@hzs.be

Monitoring Microbially Induced Corrosion (MIC) in large public water-bound infrastructures remains challenging despite the availability of established analytical methods. A nine months-long monitoring campaign along the Ghent–Terneuzen Canal (Belgium) illustrates both the practical and conceptual hurdles involved. The study focused on *Gallionella ferruginea*, previously suspected of accelerating corrosion on small yachts in the Zelzate marina. Forty monitoring sites were equipped with SA 2½ sandblasted S235 carbon-steel coupons, exposed and retrieved monthly. Mass-loss measurements combined with microbiome analyses showed no evidence of elevated MIC risk for typical canal infrastructure, suggesting that the earlier observations in the marina were site-specific rather than system-wide.

The campaign revealed several methodological considerations essential for future large-scale MIC monitoring:

- the consistent use of properly prepared sandblasted coupons is critical for obtaining reliable corrosion data.
- strong seasonal variation—affecting both microbial activity and environmental conditions—necessitates staggered deployment, ideally introducing new coupons every three months to capture early-stage corrosion under varying seasonal regimes
- macrofouling emerged as a major confounding factor. Algal and invertebrate colonization fluctuated markedly throughout the year, prompting the development of a standardized mapping procedure based on ASTM D3623 and photographic documentation. Organisms were classified at higher taxonomic levels, and vegetation coverage was quantified to assess its influence on corrosion outcomes.
- ensuring sufficient statistical power remains a key challenge. Natural variability in the field far exceeds that observed in laboratory settings, implying that substantially more replicates per time point are needed to model corrosion processes reliably across large assets.

Additional lines of evidence, such as on-site electrochemical measurements, are feasible but require robust instrumentation and strict procedural standardization to withstand field conditions. Together, these insights form a practical framework for designing future MIC monitoring campaigns in industrial and public water infrastructures.

Keywords

Corrosion; Microbially Influenced Corrosion; Methodology; Macrofouling