HIFMB NEWS #04/23

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TOP STORY

A Kind of Magic – the Diversity of the North Sea Fauna Revealed by Genetic Traces in Seawater

Do we have sufficient reference data and the appropriate methods and techniques to identify the biodiversity of marine fauna in the dynamic waters of the North Sea using genetic traces from seawater? The aim of a study by the HIFMB Focus Group Marine Molecular Ecology was to evaluate these uncertainties and to bring the method of environmental DNA (eDNA) metabarcoding into application for monitoring and questions on marine conservation in the North Sea. Equipped with canisters, pumps, sieves and lots of filters, we sampled and analyzed both the animals and eDNA over a period of nine days.

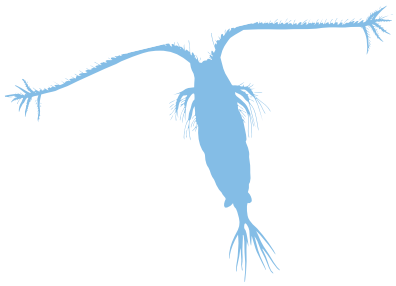
Understanding marine biodiversity and its changes due to cumulative effects is a high priority in marine science. Molecular genetic methods are increasingly applied to analyze the taxonomic diversity of marine fauna and complement the classical methods of species identification based on species-specific morphological characteristics. Ideally, we no longer inspect the animals, but identify the biodiversity non-invasively by analyzing their genetic traces in the water - the eDNA - in a standardized way to draw conclusions about the biodiversity.

The aim of this study was to examine the extent to which the prerequisites for such molecular monitoring already exist for the North Sea. We checked this with an integrative study that identified the model group zooplankton morphologically and with metabarcoding. We validated the marine metazoan multi-species identification by comparing the results and then, based on this validated methodology, analyzed the eDNA from seawater for the entire fauna.

We chose Helgoland Roads to evaluate this method because its fauna is very well described and there is a solid base of reference sequence data for this fauna in public sequence databases. →

» I am still amazed and relieved each time we finally end up with a solid species list after sampling some liters of water, continuing in the lab with dirty filters at first and then pipetting tiny amounts of colorless fluids for days. «

Alica Ohnesorge,
Molecular ecologist and main author of the study



→ On nine consecutive days, we analyzed the zooplankton from in total more than 120,000 liters of seawater and the eDNA from 288 liters from the Helgoland Roads to generate more than 10 Mio sequences for the marine fauna. We successfully identified the marine fauna in its whole complexity, in total 354 species from the zooplankton, benthos and nekton from 16 phyla. Of these, 96% are typical representatives for the North Sea, some of them have not been documented for 70-120 years. The remaining 4% are already described neozoans, species that are not expected and yet not described for the North Sea, such as the copepod species *Acartia (Acartiura) hudsonica* or species that were misidentified due to errors in sequence database entries.

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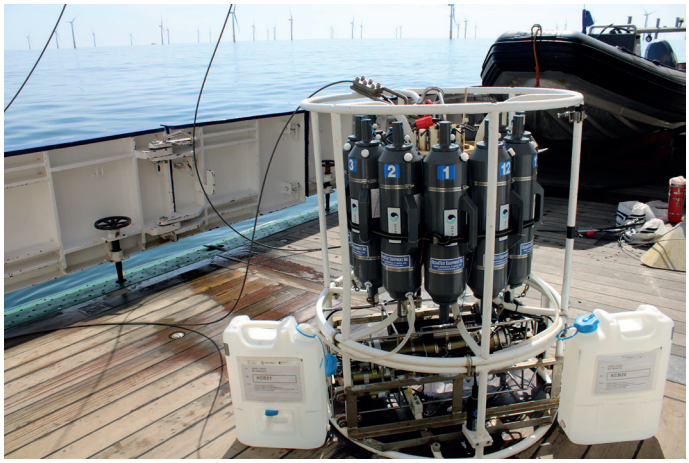


A CTD helps to sample water from different depths to identify the marine fauna based on the eDNA, as here on board of the RV Heincke near an offshore wind farm in the German Bight.

Using high-frequent eDNA sampling alone, we recorded 260 species. Of these, we detected 22 species continuously, suggesting their occurrence in large numbers and a constant shedding of genetic material into the water column. In contrast to this, we identified a third of the 260 species on only one out of the in total 129 filters analyzed. This demonstrates the high patchiness and different concentrations/dilutions of the species-specific genetic material in dynamic waters and highlights the importance of water sampling replicating to assess regional biodiversity. The increasing cumulative species numbers over the entire sampling period not reaching saturation support this theory.

Based on our integrative approach and the comparative examination of different filter pore sizes, replicates, genetic markers, taxonomic assignment and sequence reference databases, we verified eDNA and zooplankton metabarcoding as reliable and sensitive tools to identify the marine fauna in the German Bight.

The findings of this study are now the basic element for our application of molecular monitoring of marine fauna with a clear conscience. In the North Sea, we apply these protocols to assess and to monitor the biodiversity of the marine fauna in marine protected areas (MPAs) as well as between MPAs to identify MPA connectivity. The latter is part of the CREATE project in the sustainMare research mission of the German Marine Research Alliance, funded by the Federal Ministry of Education and Research (BMBF) and the Federate States of Bremen, Hamburg, Lower Saxony, Schleswig-Holstein and Mecklenburg-Western Pomerania. Next year, these connectivity studies will be supplemented by biodiversity analyses in offshore wind parks to contribute to our understanding of the impact of offshore wind parks on biodiversity and MPA connectivity.

Beyond the boundaries of the North Sea, our protocols find application in the Beagle Channel observatory in Patagonia (DynAMo project, BMBF) as well as in collaborations with our colleagues from the Nelson Mandela University in Gqeberha, the partner university of the University of Oldenburg. Here, we apply eDNA metabarcoding to identify communities in and across stromatolite pools along the South African coast (German Research Foundation-funded project) and to identify marine mammals and cartilaginous fish in MPAs off South Africa. From copepods, comb jellyfish, Iceland clams, brittle stars, plaice, penguins to the great white sharks, every sample holds new surprises.

» I am fascinated with each new data set that the eDNA approach is working and that we are detecting the species that we find from standard sampling with nets, grabs and trawls. «

Silke Laakmann,
Head of the Focus Group on Marine Molecular Ecology

Ohnesorge A, John U, Taudien S, Neuhaus S, Kuczynski L & Laakmann S. (2023). Capturing drifting species and molecules—Lessons learned from integrated approaches to assess marine metazoan diversity in highly dynamic waters. Environmental DNA. https://doi.org/10.1002/edn3.478

3 Questions to: Thomas Brey

Prof. Thomas Brey has been co-director of the HIFMB since its foundation in 2017 and head of the Functional Ecology Section at the Alfred Wegener Institute until his retirement in September 2023. He played a leading role in the application process for the HIFMB and has therefore accompanied the institute since its earliest days.

© photo: Monika Feiling

1 + 1 is sometimes more than the sum of its parts. From your point of view, how does the HIFMB complement the research of our parent institutes AWI and the University of Oldenburg?

"To go where no marine ecologist has gone before" (to adapt the most famous phrase from Star Trek) was my first thought when the idea of HIFMB (a no-name institution at that time) came up. History shows that new scientific concepts thrive best in new structures, with as little as possible interference by established powers. Therefore, winning institutional funding for a new institute was the first important step. Right from the start it was obvious to me that merging natural and social sciences is challenging but also extremely promising. Funnily enough, with HIFMB I came full circle to my A-level time at grammar school, with my advanced courses in Biology/Chemistry and Social Sciences/History. Maybe therefore I see opportunities where other natural scientists don't (yet). The future will show: If HIFMB can pull through this synthesis, it will grow into a rather unique and leading position in international biodiversity science.

You are a full-blooded scientist, but in the last few years you have familiarized yourself with a field that is also quite new to you and have been responsible for the planning and construction of our new building from the scientific side. What do you take away from this? What surprises did this task hold in store for you?

Well, you should know that, during my last years at school and my first years at the university, I made some extra money as a construction worker, building streets, sewer tunnels and even houses during vacation. So, I know a thing or two about construction work and its social environment. It is completely different from the academic environment, and it was a refreshing alternation for me to get practical things done together with these folks. Any surprises? Yes, the incredible heap of regulations construction work has to comply with these days, a small wonder that anything is built at all.

Dear Tom, we wish you all the best for the future. Is there anything else you would like to leave us with?

Yes. Remain open minded, always, as there is no "settled science". I am of the opinion that during recent years science developed an unhealthy tendency away from sound principles (as formulated by Karl Popper) towards a policy/narrative confirming attitude. This development compromises not only our work, but also our ability to provide proper scientific advice to governments.

» I woke up this morning, feeling round for my shoes
Know 'bout 'at I got these, old walking blues
Woke up this morning, feeling round for my shoes
But you know 'bout 'at I, got these old walking blues «

Robert Johnson

www.youtube.com/watch?v=_oL_pCjPgUg
Walking Blues, Robert Johnson

New Focus Group – Open Call

We are calling for applications from early-career researchers who hold a PhD degree to form a new Focus Group in the institution to establish themselves in the domain of marine sciences. This is an open-topic, non-tenure track position with 5-years of support, and is meant to serve the successful candidate with a productive environment to develop their research program in a young and dynamic institution with support from senior scientists.

Application deadline: **March 15, 2024**
Start: **August 2024**
More info: hifmb.de/focus-group-call24

IN THE FIELD WITH...

Vani Sreekanta: Gathering Southern Ocean Stories

Sometime in 2019 in a paper titled "The ocean in excess: Towards a more-than-wet ontology" Kim Peters and Phil Steinberg invited readers to think about where the ocean actually is, whether it is the blue between land masses or whether it is more than that. I took that and made it my whole personality. Consequently, it became the framework for my thesis. So, I chase the ocean, the Southern Ocean to be specific, everywhere; From Bremerhaven to New York, Helsinki to Hobart, where I presently find myself.

My project thinks about the many ways in which the Southern Ocean defies its presumed boundaries and exists in relation with the world challenging any imagination of ocean spaces as bounded. By exploring conceptual and material social connections between Marine Protected Areas (MPA), both currently under development and implemented, to the larger global 'centres' across three continents, this project pushes current ocean space governance further to consider crucial external social dynamics.

I'm in Hobart, which situated at 42.8°S latitude is still quite a distance from the most commonly accepted boundaries of the Southern Ocean at 60°S latitude. Yet, it is home to the secretariat of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), the intergovernmental body that governs the Southern Ocean. Delegates of member countries (27 members and 10 acceding members) as well as various observers gather in Hobart every year around October. I'm in Hobart to meet and interview CCAMLR participants.

Talking to people is my method. Strike that. Listening to people's stories is my method. CCAMLR governs 10 percent of global oceans. I sit down with some of those who have been institutional leaders and experts to collate a publicly accessible database of oral histories to add much needed context to the reports. The oral histories, after fulfilling legal requirements, will be housed at the Archive for German Polar Research (Archiv für deutsche Polarforschung - AdP) and will provide data for future humanities and qualitative social sciences research on the Southern Ocean.

RESEARCH

Top Recent Publications

Di Cavalho J A, Roenn L, Prins T C & **Hillebrand H.** (2023). Temporal change in phytoplankton diversity and functional group composition. Marine Biodiversity, 53, 72. doi.org/10.1007/s12526-023-01382-9

Wu-Woods N J, Barlow, Jacob T, **Trigodet F,** Shaw D G, Romano A E, Jabri B, **Eren A M** & Ismagilov R F. (2023). Microbial-enrichment method enables high-throughput metagenomic characterization from host-rich samples. Nature Methods, 20, 1672-1682. doi.org/10.1038/s41592-023-02025-4

Bahlburg D, **Hueppe L**, Boehrer T, Thorpe S E, Murphy E J, Berger U & **Meyer B.** (2023) Plasticity and seasonality of the vertical migration behaviour of Antarctic krill using acoustic data from fishing vessels. ROYAL SOCIETY OPEN SCIENCE, 10: 230520. 230520. doi.org/10.1098/rsos.230520

Clark M S, [...], **Meyer B**, [...], **Wohlrab S**, [...], **John U**, Karsten U, Kempf S, Lucassen M, Paijmans A, Schimani K, Wallberg A, Wunder L C & Mock T. (2023). Multi-omics for studying and understanding polar life. JO - Nature Communications 14, 7451. doi.org/10.1038/s41467-023-43209-y

Garcias-Bonet N, **Roik A**, [...], Voolstra C R & Peixoto R S. (2023). Horizon scanning the application of probiotics for wildlife. Trends in Microbiology. doi.org/10.1016/j.tim.2023.08.012

+ More on Google Scholar: scholar.google.de/citations?user=uCoLTyAAAAAJ&hl=en

VIEW FROM NORTHWEST #18

It's the Language, Stupid!

Recently, I was able to participate in a workshop on "Biocultural Diversities" organized by natural (Katrin Böhning-Gaese) and literature (Roland Borgards) scientists from Frankfurt. In a broad range of discussions and interactions, we focused on the Wadden Sea as a joint topic to elaborate how science features in literature, which language(s) are used and how (not so) obvious characteristics of the ecosystem are featured in fiction. There was also the obvious turnaround question, which language(s) do we use in science and how do these different perspectives contribute to a biocultural view on diversity. We hope to find more time to explore this further in the future.

One spin-off of this discussion is a reflection on how we scientists (or personally I as a scientist) write. There are obvious questions. What does it mean that the majority of scientific literature is written by authors not using their mother tongue? Career advice often is that "[s]cientists with a different first language could benefit from mentoring and support to help them communicate their research clearly"[1]. I wonder whether we could instead reflect on the fact that Marie Curie and Albert Einstein published in their first languages and what it means to our ability to do science that scientific literature databases do almost completely ignore non-English texts. I have to admit that I really struggle with German myself when I write science, because I never did, but in times of Deep L and Google translate, could we not allow higher cultural diversity in language again?

A second question is about the art of storytelling and whether or not narratives have a place in scientific literature. There is a quite contested debate[2] between on the one side the accusation that storytelling distorts data presentation and reduces empirical complexities up to leading to misinformation, whereas on the other side it better engages with audiences (in- and outside academia) and increases the impact of science. Ecology (in the broadest sense) has gone quite a way from naturalist descriptions that interwove findings and personal experience, to a pseudo-objectivity reflected by excessive use of passive voice and the absence of any researcher-research relationship, back to using "we" or "I" in a more active and individual description. There is certainly a whole field to explore about how the language(s) we use tell about us personally being involved into our results.

A third question is about the famous first sentence. For fiction, we are aware and even expect that the first sentences are of uttermost importance for bringing up the stance of the entire piece. By contrast, many scientific papers (and mine are a "great" example for this) start with dull facts. Therefore, I end this with my favourite first two sentences from a science paper, which I often use in my lectures as David Tilman[3] manages to evoke 150 years of research by starting: "The most striking feature of Earth is the existence of life, and the most striking feature of life is its diversity. This biological diversity, or biodiversity, has long been a source of wonderment and scientific curiosity, but is increasingly a source of concern."

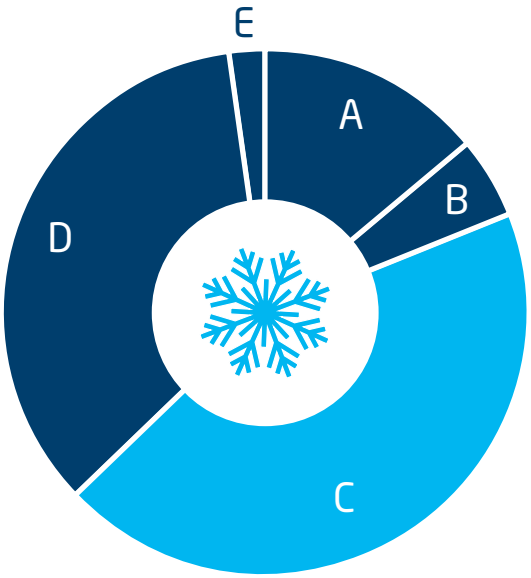
Sincerely, Helmut Hillebrand
Director — Professor of Pelagic Ecology
helmut.hillebrand@hifmb.de

1 https://www.nature.com/articles/d41586-021-00899-y
2 https://www.pnas.org/doi/10.1073/pnas.1914085117
3 https://www.nature.com/articles/35012217

HIFMB TEAM

Fun Fact*

Oh no, it's winter again! What are you dreading the most?



A	14 %	Everyone around me has a cold
B	5 %	Scarping ice off the car again
C	44 %	Cycling in the rain and cold
D	35 %	Going out in the dark and coming home in the dark
E	2%	Good intentions that you know you won't keep

* answered by HIFMB employees

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