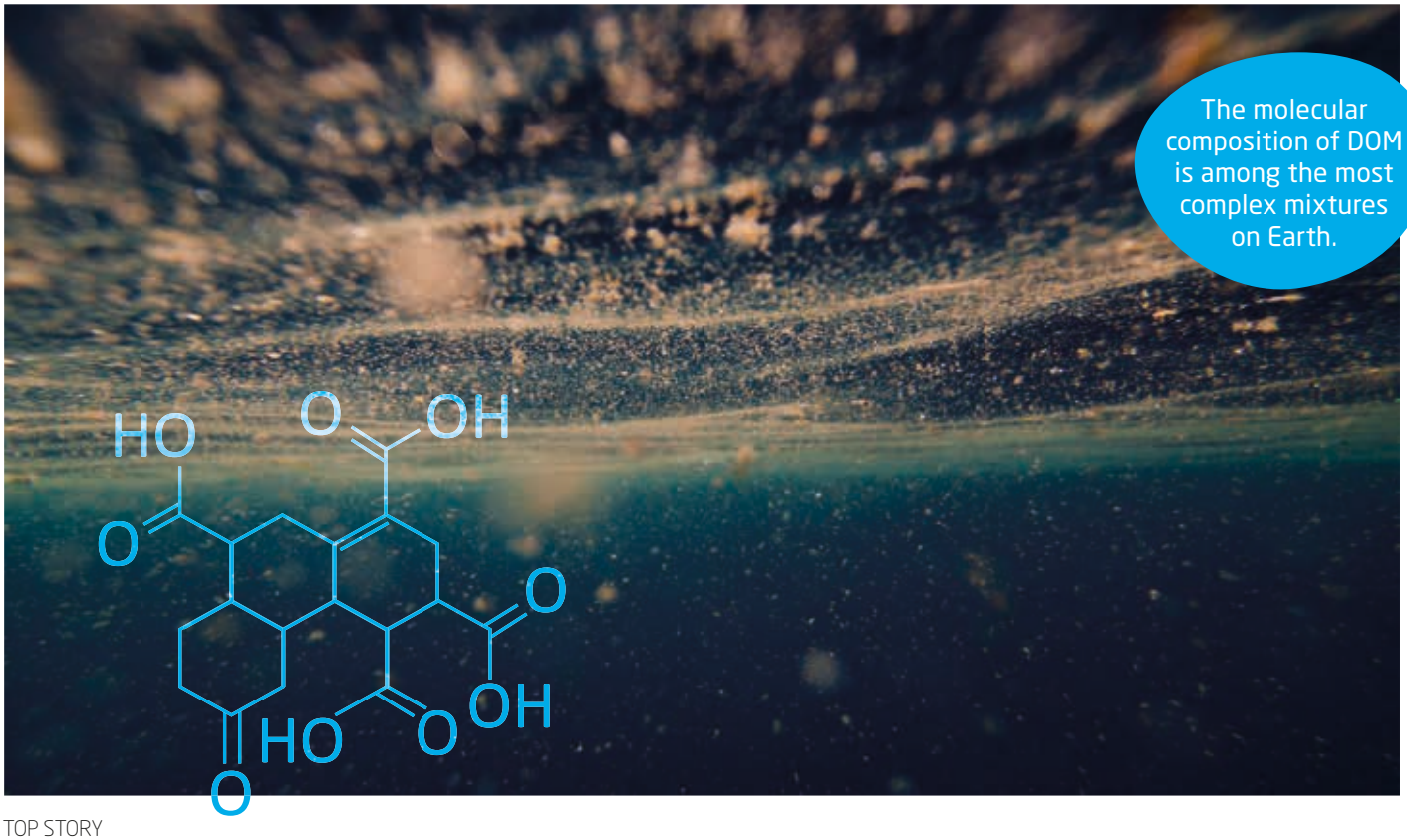
HIFMB NEWS #02/22



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TOP STORY

The Incredible Molecular Diversity of Non-living Matter in the Ocean

Microscopic algae in the surface ocean account for about half of the global annual carbon fixation. While they live and upon death, they release a myriad of organic molecules to the seawater.

Most of these compounds are rapidly consumed by heterotrophic microorganisms within hours to days. A minor fraction of the released dissolved organic matter (DOM), however, escapes immediate utilization, decomposing slowly enough to be transported by currents across the globe for thousands of years. These persistent molecules add up to 660 billion tons of carbon globally, exceeding the carbon in Earth's marine and terrestrial biota combined.

The long-term persistence of DOM in the ocean is puzzling, because microorganisms could obtain energy and make a living from the oxidation of DOM, as these chemically reduced compounds are in thermodynamic disequilibrium in the oxygen- and nutrient-replete deep ocean. Paradoxically, bacterioplankton that depend on the supply of organic matter for their survival are surrounded by an enormous pool of DOM that appears to remain untouched for thousands of years. Microbes in the deep ocean seem to starve in a sea of substrate.

The paradox doesn't seem so paradox anymore if one takes a closer look at the molecular composition of DOM, which is among the most complex mixtures on Earth. →

» The differences in the structural fine-print of DOM indicate that microbes in the deep ocean continuously rework DOM, leaving their molecular fingerprints behind. «

Thorsten Dittmar, Marine Geochemist

→ Exact estimates on the number of different compounds in DOM are lacking, but we have identified more than 20,000 molecular formulae in DOM so far. There are many options to arrange the elements of a molecular formula in space. In previous studies we found out that there are 30 or more different compounds (isomers) per molecular formula in DOM. While this sums to >600,000 different compounds, there are possibly many millions of different organic compounds in DOM, each presumably below pico-molar concentrations. At this low concentration, the encounter between a substrate molecule and a microbe is a very rare event. Even a generalist strategy of consumers does not bring much alleviation.

Microbes can't find their food in the haystack of molecules, and an enormous pool of organic carbon has accumulated. So far, so good. But our latest study casts doubt on this explanation. When we looked closer at the molecular structure of DOM with help of a novel nuclear magnetic resonance (NMR) approach, we were puzzled to find major compositional differences between DOM sampled from the abyss of the Pacific and Atlantic Oceans.

These differences in the structural fine-print of DOM had been hidden so far. They indicate that microbes in the deep ocean continuously rework DOM, leaving their molecular fingerprints behind. This continuous reworking was unexpected because DOM is old with radiocarbon ages exceeding 5000 years. Concepts from ecological theory helped to solve the riddle. DOM persistence emerged in in silico experiments from complex ecological interaction between microbes and non-living molecules. Stay tuned. The DOM story is complicate and full of surprises.

Photo © Thorsten Dittmar

DOM concentrated 10,000 times

Dittmar, T., Lennartz, S.T., Buck-Wiese, H., Hansell, D.A., Santinelli, C., Vanni, C., Blasius, B. & Hehemann, J.H., 2021. Enigmatic persistence of dissolved organic matter in the ocean. *Nat. Rev. Earth. Environ.* 2: 570-583. doi.org/10.1038/s43017-021-00183-7

Seidel, M., Vemulapalli, S.P.B., Mathieu, D. & Dittmar, T., 2022. Marine dissolved organic matter shares thousands of molecular formulae yet differs structurally across major water masses. *Environmental Science & Technology* 56: 3758-3769. doi.org/10.1021/acs.est.1c04566

OPEN CALL

Art Waves

HIFMB and the Hanse-Wissenschaftskolleg, Institute for Advanced Study (HWK), jointly offer a fellowship for one freelance artist.

The overall goal of the fellowship is to support the successful applicant in his or her work, providing opportunities for projects of their own choice. These projects shall deal with aspects of Marine Biodiversity Change and foster public understanding of marine biodiversity in a changing world through art.

We offer

Artist in Residence fellowship

- International and multi-disciplinary community of researchers
- Integration in HIFMB working groups
- Monthly stipend of 2.500 € and travel allowance
- Free accommodation and workspace at HWK Delmenhorst
- Duration between 3 and 4 months

Apply by June 30: hifmb.de/air

Spatialising Approaches to Marine Governance

This year has marked an exciting time for the Marine Governance Group at HIFMB, one of the core groups of the institute, feeding one of the key pillars of research: conservation and management.

New staff at PhD and Postdoctoral level have arrived and Masters students have begun to undertake original research projects. Together they (we!) have been quickly shaping the group, raising critical questions about governing ocean *spaces*. But what is marine governance? How do the group approach it? And why do we say ocean *spaces*, and not just use the word 'oceans' alone?

Let's begin with the term 'governance'. It is often understood that those working in marine governance fields *produce* policy or management tools to conserve, preserve, or protect the oceans. Whilst some studies of marine governance do end up leading to such measures, this commonplace perspective washes over the meaning of governance, which is not so concerned with tools or eventual goals but with the *practices and processes of governing* that *lead* to those tools or goals. This subtle distinction is important. Seeing governance scholars as producers of policy disguises the more critical and useful work they (we!) do in quizzing the dynamics that lead to particular governance outcomes and shape responses to oceanic and planetary change.

In other words, marine governance scholars do rigorous and careful research to understand *how* governance measures come to be, *why* they operate as they do, *what* assumptions, forces and dimensions of power drive and shape them, *who* is included and excluded from governance decisions, and crucially for this group – *where* this happens. Governance is not an automatic 'good'. Nor does it happen *nowhere.* This is where the word 'space' takes on particular meaning.

Distinctive to the Marine Governance Group of the HIFMB is that 'governance' is understood as a spatial process. We talk of ocean *spaces* to appreciate how governance does not just happen anywhere, but *somewhere*. The Group examines how governance is shaped by spatial processes and practices and how what we seek to govern, or do govern, is shaped by location, the character and qualities of place, and relations with surrounding spaces.

As such, whilst 2021 and 2022 have been a time of establishing and building the Governance Group, 2023 and beyond will see where this work will lead. In short: watch this *space*!

You can find out more about our staff and specific projects on the following blog, on our website: hifmb.de/margov

Photo © Stefanie Wilmer

The Marine Governance Group

HIFMB INSIDE

Digital Foundation Stone Laid

A very special foundation stone marks the progress of the construction work for the new HIFMB building. The time capsule, which the Institute's Directorate placed as a symbolic foundation stone in the building's future entrance, is a sediment core drill and thus a piece of marine research equipment. Before Prof. Dr. Helmut Hillebrand, Prof. Dr. Gabriele Gerlach and Prof. Dr. Thomas Brey placed this „push corer" behind a plate for posterity, the time capsule had travelled through Bremerhaven, Hanover, Bonn and Oldenburg and been filled by partners and congratulators. Completion and occupation of the building are planned for autumn 2023. With more than 2,100 square metres of floor space, the building houses 85 office workplaces, with just under a third serving as laboratory space. The journey of the time capsule can be followed in the video at hifmb.de/new-building/.

Photo © eventfive | Joachim Hofmann

Film shooting on the construction site

RESEARCH

Top Recent Publications

Moran, M. A., Kujawinski, E. B., Schroer, W. F., Amin, S. A., Bates, N. R., Bertrand, E. M., **Eren, A. M.**, ... & Vardi, A. (2022). Microbial metabolites in the marine carbon cycle. Nature microbiology, 7(4), 508-523. doi.org/10.1038/s41564-022-01090-3

Krauß, A., **Gross, T.**, & Drossel, B. (2022). Master stability functions for metacommunities with two types of habitats. Physical Review E, 105(4), 044310. doi.org/10.1103/PhysRevE.105.044310

Gadsden, G. I., **Peters, K.**, & **Dajka, J. C.** (2022). Academic Engagement With Wadden Sea Stakeholders: A Review of Past Foci and Possible Futures. Front. Mar. Sci, 9, 816609. doi.org/10.3389/fmars.2022.816609

Massing, J. C., & **Gross, T.** (2022). Generalized Structural Kinetic Modeling: A Survey and Guide. Frontiers in Molecular Biosciences, 9. doi.org/10.3389/fmolb.2022.825052

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

OPEN HIPP CALL

The Great Poleward Shift

For this call, HIFMB is announcing an exciting, cross-disciplinary cohort project with postdoctoral researchers from humanities, social and natural sciences together considering how climate change affects ecosystems and global biodiversity.

The cohort will investigate marine communities on the move and evaluate the consequences of those movements for nature and people through varying disciplinary approaches.

We offer

6 PostDoc positions (m/f/d)

- Salary level: E13 TVöD (100%)
- 3 year fixed term
- from 1.1.2023 to 31.12.2025
- Oldenburg/ Germany

Apply by August 15:
hifmb.de/news/jobs

VIEW FROM NORTHWEST #12

Biodiversity Research is Rocket Science with a Screwdriver

Biodiversity research is in a rapid shift, with ever more and better biodiversity observations (molecular, acoustic, optical) available from more and more places. Computational and technological advances allow faster assessment of these data and FAIR data initiatives increase the availability of this information. But this marvellous world of big data then meets a well-known but non-trivial problem when trying to separate the signal of (anthropogenic) biodiversity change from the massive inherent biases in most metrics used to characterize biodiversity. The situation compares to providing all the super-modern parts for a rocket to Mars, but only a screwdriver may be used to assemble them. The same problem arises in the quest for SMART (Specific, Measureable, Ambitious, Realistic and Time-bound) biodiversity targets in the post-2020 strategy for the Convention for Biological Diversity, as measurable means "reliably measurable".

In March, HIFMB hosted a working group that aimed at developing more advanced indicators for one aspect of biodiversity change, the temporal turnover in species composition. The group organized by Malin Pinsky (Rutgers University) involved researchers from USA, Canada, Finland, Spain, and Germany. While it is still a way to go for a publishable product (stay tuned), the discussions were insightful and the analysis of simulated and real biodiversity data offered a clearer view on the magnitude of the issue. It cannot be overemphasized how much complexity is added by not having generally accepted and unbiased metrics. Understanding and predicting climate change is daunting, but it starts from a common understanding that CO_2 concentrations and temperature are important variables that have defined meaning and units. Moreover, the accuracy of the ground truth is high as, e.g., different thermometers will deviate only slightly in their measurements, contrasting the effort- and method-dependent assessment of biological diversity. By contrast, measuring biodiversity is sample based and most (if not all) biodiversity metrics are sensitive with respect to representativeness and completeness of the sampling. Additionally, all metrics are abstractions of some facet of biodiversity focusing on the relative proportion of species (dominance), the change in composition (turnover), richness (loss or gain), or regional differentiation (beta-diversity). All of these metrics can be applied to species composition, but may also vary within species (genetic variation) or in functional traits.

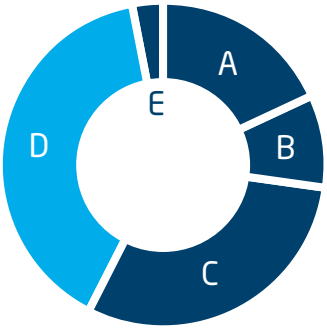
The prevailing uncertainty on biodiversity change is a challenge to science, but it also is a communication issue. Within the German research initiative for the conservation of biodiversity (www.feda.bio/en/), I am happy to be part of the initiative to assess biodiversity in Germany (www.feda.bio/en/faktencheck-artenvielfalt/). The project had its first full in situ author meeting at iDiv Leipzig in April 2022, discussing approaches to capturing biodiversity trends, direct and indirect drivers, trends, consequences and measures. The evidence-based assessment covers all types of habitats (including the coast, for which Dorothee Hodapp at HIFMB carries out the synthesis) and will provide a first national overview on the magnitude and history of biodiversity change. This report will also allow us to mainstream the message on the complexity of the task. Our inability to make concise future predictions on biodiversity change at a general level is not a sign of scientific inaptness but is a consequence of biodiversity itself, as it reflects the myriad of potential solutions by which life can adapt to changing conditions.

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

HIFMB TEAM

Fun Fact*

If you could bring one aspect of working remotely back into the office, what would you bring?



A 18 % Work in pyjamas
B 9 % Having my pet around
C 30 % My snacks
D 40 % A couch
C 3 % Nothing

* answered by HIFMB employees

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