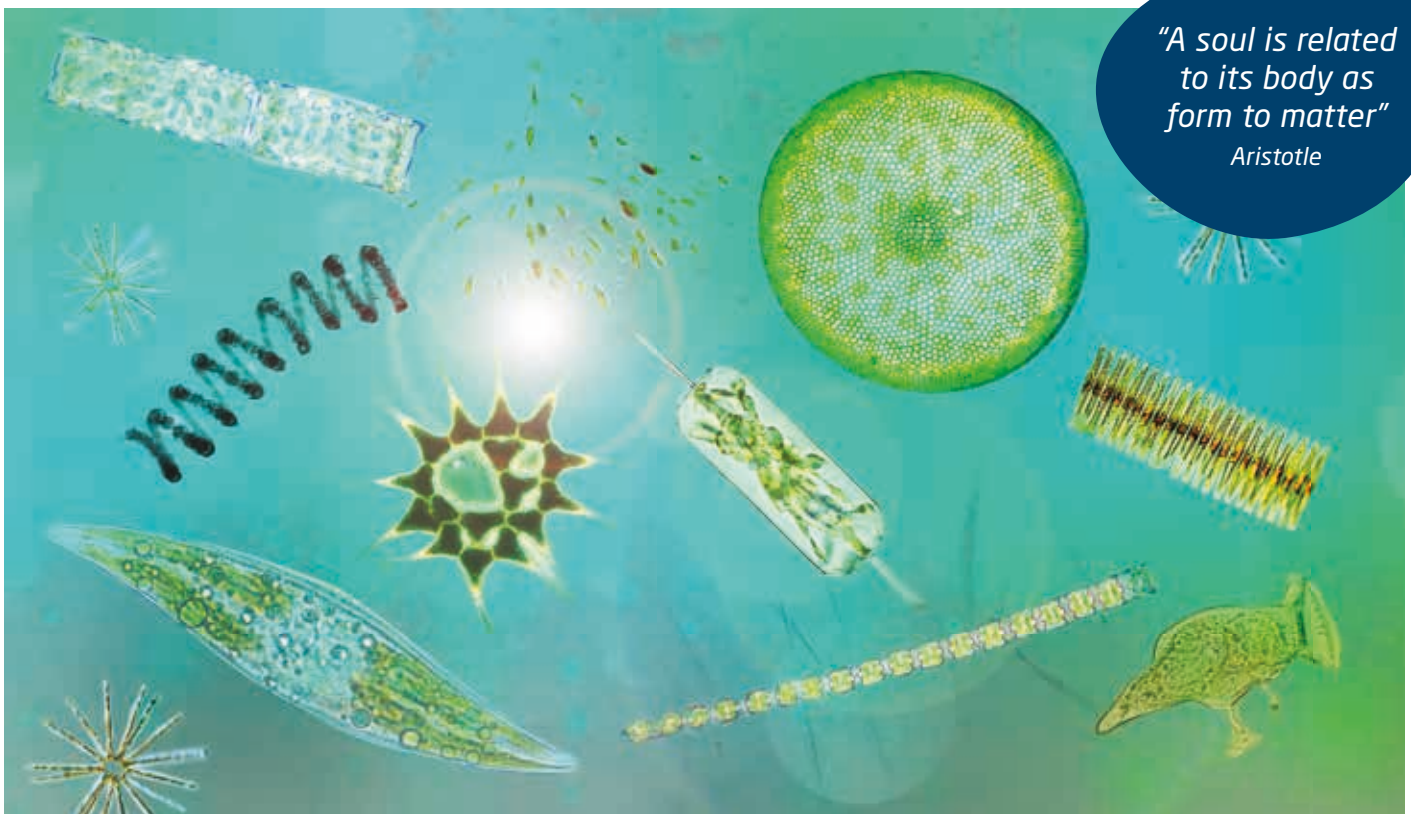
HIFMB NEWS #02/21

Top Story: Cell shape: the soul of phytoplankton + Event: 3rd Symposium on Functional Marine Biodiversity + Research: New global database for the genetic identification of marine zooplankton + Editorial: View from Northwest #8 + Open HIPP Call + HIFMB Team Fun Fact



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More than 5,700 cells of single-celled phytoplankton were extensively investigated regarding the range of size and shape.

TOP STORY

Cell shape: the soul of phytoplankton

Phytoplankton – unicellular photosynthetic microbes which are the major primary producers of the world's ocean – display a bewildering variety of cell shapes and forms. Surprisingly, not much is known about how its shape diversity relates to its taxonomic richness, evolutionary origin, and ecological function. This opens novel, as yet untapped, approaches to marine biodiversity research. Such research could potentially improve understanding about how accelerating changes in the marine environment might affect planktonic communities or, more fundamentally, lead to a better understanding of the evolutionary principles of life.

To paraphrase Aristotle, we can say that form is the soul of matter, and therefore it should have a significant influence on the fate of that form's owner. Unicellular life has been formed over billions of years. We do not know how the first unicellular organisms looked, but we do know that the development of complex organisms (the Cambrian explosion) led in the beginning to an amazing variety of body forms. Although the number of species has increased since then, many of the original body shapes were later rejected by competition and evolutionary selection, which favor species with most ergonomic morphology. To understand what makes for a successful body shape, consider a related question: Which body shapes lead to the greatest abundance and species diversity, allowing these species to better adapt to natural conditions? →

» We expected to find the greatest species richness in elongated or flattened cells because, unlike, for example, spheres, these forms have a greater potential to build complex structures. But, to our surprise we found the greatest diversity in cells of compact forms with equal linear dimensions such as cubes or spheres. «

Alexey Ryabov, Mathematical Modeler

→ As the focus of HIFMB is on diversity in marine environments, we turn to algae, and since we are only at the beginning of the journey, limit ourselves to unicellular organisms. Marine phytoplankton make excellent candidates for such a study, being numerous enough to apply statistical laws, and exhibiting great diversity in species and shapes, yet readily amenable for calculating area, volume, and shape characteristics such as aspect ratio and deviation from spherical shape.

We expected to find the greatest species richness in elongated or flattened cells because, unlike, for example, spheres, these forms have a greater potential to build complex structures. But, to our surprise we found the greatest diversity in cells of compact forms with equal linear dimensions such as cubes or spheres. In particular, species at the extreme ends of the size spectrum, both very small and very large, were mostly spherical. In contrast, cells of intermediate size showed the greatest variation, from flat to extremely elongated shapes, even though for them, too, most species had compact cell shapes.

Of all shapes, a sphere has the minimum surface area for a given volume and any deviation from the spherical shape "extends" the cell surface. We found the surface extension (so-called sphericity), which compares a cell's surface to that of a sphere of equal volume, to be a convenient characteristic of cell shape. This measure is independent of cell volume and, besides, has a biological meaning in that it is proportional to the gains and losses caused by increasing surface area. It turned out that for almost all phyla the number of species exponentially decreased with surface extension: 25% of genera had spherical cells, 50% had compact shapes with a surface less than 50% greater than the corresponding sphere surface, and the surface of 75% of all genera exceeded the sphere surface by less than a factor of two. We observed similar laws for species abundance, so that species with compact cells were also the most abundant.

In terms of shape, diatoms stood out from all other phyla. While most algae had compact cells with ellipsoidal or conic shapes, most diatoms were cylindrical or prismatic with elongated or flattened shapes. Perhaps the appearance of silica cell walls in diatoms was an important evolutionary innovation that allowed diatoms to achieve such great shape diversity.

Our results paint a phenomenological portrait, but the mechanisms driving the success of various shapes are not yet fully understood. It also raises questions, looking beyond unicellular organisms, regarding effects of body shape in higher life forms. How, for example, do diversity and abundance of flowers depend on the form of leaves and petals, and which plant shapes lead to the greatest taxonomic richness? These and many other questions about the effect of shape on species fitness and diversity remain open.

Alexey Ryabov and Bernd Blasius
Ryabov, A., Kerimoglu, O., Litchman, E., Olenina, I., Roselli, L., Basset, A., Stanca, E. and Blasius, B. (2021), Shape matters: the relationship between cell geometry and diversity in phytoplankton. Ecology Letters, 24: 847-861. https://doi.org/10.1111/ele.13680

Event Timing:
September 7th + 8th, 2021

Event Address: **Online**

Language: **English**

Programme & Registration:
https://hifmb.de/event/3rd-symposium/

EVENT

3rd Symposium on Functional Marine Biodiversity – Register now!

The symposium brings together international researchers in order to discuss research needs, potentials and gaps in marine conservation research. The future directions will be communicated by invited speakers, who are all high-ranking, world-leading scientists. The symposium will cover the following topics:

SESSION 1:

Disturbance and Networks in Ecology / chair: Thilo Gross

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Ecology is fascinating because of its complexity, with diverse life forms interacting in a myriad ways. When it comes to understanding biodiversity we must untangle this complex web of interactions. Particularly in the face of disturbances, we must trace the initial causes to their final consequences. This session focusses of on such perturbations to diverse ecological systems and how they propagate across the complex network of interactions.

SESSION 2:

Dispersal and Movement / chair: Gabriele Gerlach

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The importance of dispersal far outweighs the aspect of simple spatial distribution of organisms. In this session we would like to look at dispersal from different perspectives: Dispersal with respect to the existence of metapopulations; speciation despite or because of dispersal; potential for niche shift and niche construction; but also what dispersal of mobile organisms means for ocean governance.

SESSION 3:

Justice and Conflict in Conservation / chair: Katherine Sammler, Kimberley Peters

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In respect of biodiversity change, how can critical social science approaches help us towards more just approaches to conservation? What even is a 'just' approach and how can conservation be democraticised to include more voices? How can the data we access and use be wider and more equitable? This session explores contemporary questions, timely insights and careful reflections on processes relevant to management and governance.

SESSION 4:

Planning and Projection for an Uncertain Future / chair: Helmut Hillebrand

Photo © Pexels | Mathias P.R. Reding

Projecting biodiversity changes, its causes and consequences, into the future is a required step to create ecosystem management strategies that anticipate and adapt to uncertainties in human impacts and ecosystem responses. This session is about biodiversity in the Anthropocene, and how we can learn from ecological and evolutionary processes to mitigate biodiversity loss across spatial scales.

+ Feel free to contact us: symp2021@hifmb.de We look forward to seeing you in September!

RESEARCH

New global database for the genetic identification of marine zooplankton

Molecular genetic identification of entire marine communities or assemblages allows for new insights into marine metazoan biodiversity and its change. However, the assignment of sequences to species is an essential step that requires a high-quality sequence reference database for different taxa and regions validated by morphological and molecular identification. In a collaborative publication, Silke Laakmann, lead of the HIFMB Focus Group Marine Molecular Ecology, and zooplankton experts of the Scientific Committee for Ocean Research (SCOR) Working Group WG157: MetaZooGene, led by Ann Bucklin (University of Connecticut), reviewed species-specific sequences of zooplankton in open-access data bases and combined them in the MetaZooGene Barcode Atlas and Database (MZGdb, https://metazoogene.org/MZGdb). This reference database was created by Todd O´Brien (NOAA) and includes >150,000 mitochondrial cytochrome oxidase I (COI) sequences for ~5,600 described species of marine zooplankton. It allows the identification of species from DNA barcoding and metabarcoding of pelagic biodiversity, with advanced search functions by ocean region and taxonomic group.

Photos by R.R. Hopcroft and C. Clarke (UAF) and L.P. Madin (WHOI); see http://www.cmarz.org/galleries.html

+ Read more:
Bucklin, A., Peijnenburg, K.T.C.A., Kosobokova, K.N. et al. Toward a global reference database of COI barcodes for marine zooplankton. Mar Biol 168, 78 (2021).
https://doi.org/10.1007/s00227-021-03887-y

RESEARCH

Top Recent Publications

Gittins, J. R., Hemingway, J. R., & **Dajka, J. C.** (2021). Making Waves: How a water-resources crisis highlights social-ecological disconnects. Water Research, 116937.

Barter, E., Brechtel, A., Drossel, B., & **Gross, T.** (2021). A closed form for Jacobian reconstruction from time series and its application as an early warning signal in network dynamics. Proceedings of the Royal Society A, 477(2247), 20200742.

Schalm, G., Bruns, K., Drachenberg, N., Geyer, N., Foulkes, N. S., Bertolucci, C., & **Gerlach, G.** (2021). Finding Nemo's clock reveals switch from nocturnal to diurnal activity. Scientific reports, 11(1), 1-11.

Tilot, V., Willaert, K., Guilloux, B., Chen, W., Mulalap, C. Y., Gaulme, F., **K. Peters,** ... & Dahl, A. (2021). Traditional dimensions of seabed resource management in the context of Deep Sea Mining in the Pacific: Learning from the socio-ecological interconnectivity between island communities and the ocean realm. Frontiers in Marine Science, 8, 257.

Clark, A. T., Arnoldi, J. F., Zelnik, Y. R., Barabas, G., **Hodapp, D.**, Karakoç, C., ... & Harpole, S. (2021). General statistical scaling laws for stability in ecological systems. Ecology Letters.

+ More on google scholar:
https://bit.ly/HIFMB-publications

VIEW FROM NORTHWEST #8

Never in the same river twice

The discussion about reproducibility in science first didn't really ring a bell because for me as an empirical ecologist it is hard to envision how ecological field studies or experiments could be reproduced at all. Even in the most controlled setting, a repeated experiment will not have exactly the same organisms in exactly the same conditions - to paraphrase Heraclitus, no ecologist can step into the same study twice. Then it dawned on me that I had misunderstood the entire point.

This context dependence is shared between ecology and the biomedical & psychological sciences initially at the heart of the reproducibility crisis discussion some 10 years ago. So ecology rarely - if ever – produces laws, but rather moves towards "general" conclusions based on the aggregated knowledge of central tendencies and their variances across case studies. Ecologists produce marbles, diverse and beautiful case studies, which lead to a bigger picture when evaluated together, using tools such as systematic reviews and quantitative meta-analyses to inspect its marble collections.

However, in order to come to such general conclusions, we need to rely on the assumption that our marble collection is unbiased – which it isn't. Researchers are less prone to spend time writing papers on non-conclusive experiments, and publishers are more prone to publish exciting & novel results, leading to publication bias against non-significant results. Thus, what we see in the scientific literature may be an overestimation of the true effects. While ecological synthesis has developed tools to deal with this bias, other biases are less easy to grapple. When doing a systematic literature review on an ecological question, one will inevitably meet the geography bias: Inevitably, most case studies will be from temperate latitudes written by authors from the Global North publishing in the same language, and published by a small set of publishers. So if our marbles are context specific, but we only accept marbles from a limited set of contexts, our collection and our general conclusion must be biased. Additionally, there is a "lack of incentive" bias against re-testing already tested hypotheses, which works at many different levels: most researchers (explicitly including me) want to gain novel insights, which makes it less attractive to redo an experiment, perhaps even in a setting where observations render the hypothesized mechanisms less likely or important. As supervisor, I would badly advise junior scientist to build their career on re-doing others' experiments. Therefore, we need to admit in ecology that our pervious marble collection is shifted to the shiny ones, whereas the boring uni-coloured ones are not picked up at all.

Therefore, I am a bit of a late incoming participant in this discussion and these thoughts are part of my own learning trajectory building on others' thoughts (I recommend the resources offered by the newly founded Society for Open, Reliable, and Transparent Ecology and Evolutionary biology (SORTEE), https://www.sortee.org/resources/). Given the traction these ideas receive, the discussion on reproducibility might change ecology towards a more open science. Publishing all data and code already has become standard, where version control helps reproducing the analysis steps. The idea, to pre-register studies can be helpful to avoid that non-significant studies remain unpublished and unnoticed, or that hypotheses are developed after results are known. Doing this broadly will lead us towards the best marble collections we ever had.

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

OPEN HIPP CALL

Biodiversity of Anthropocene Oceans:

Networks, Flows and Systems Approaches for Boundary Crossing Research / 6 Postdoc Positions (3 yrs)

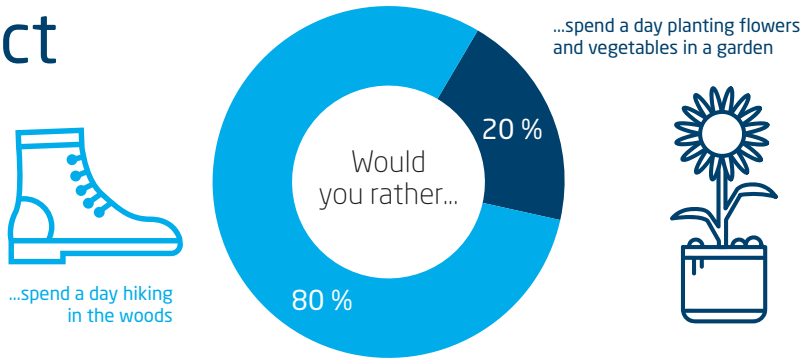
The Anthropocene centres the role of humans in creating, but also responding to, the current state of planetary precarity. Research is thus needed that crosses boundaries in examining environmental problems, transcending the borders of typical disciplinary approaches by asking fresh questions, drawing on novel methods, innovative tools of analysis, and expanding critical theories (UN Ocean Decade, 2020). This call for postdoctoral positions encourages proposals situated within and across areas of our institutional expertise: biodiversity change, ecosystem functions and conservation and management to understand our anthropocene oceans.

We welcome applicants from diverse disciplinary backgrounds and particularly welcome interdisciplinary projects that cross and transcend the natural and social sciences – governance, ecology, management, biodiversity theory, conservation, data science.

We look forward to your application by June 30th 2021.
Further information: http://bit.ly/HIPPcall2022

HIFMB TEAM

Fun Fact



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