

sDiv sabbatical project report

“Trait-based community patterns in microbes”

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Scientific hosts: Profs Stan Harpole and Jon Chase

During my sabbatical I stayed at iDiv from June 1 to December 31, 2019 and worked on the project to develop trait-based approaches to microbes. I have interacted with my hosts, Profs Stan Harpole and Jon Chase, their lab members and other researchers at iDiv. The project on developing trait-based approaches has made progress in several directions. First, I've been working on developing a mechanistic, trait-based theory of microbial community ecology, second, in collaboration with Mark Westoby and others, I participated in the analyses of large databases of microbial traits, and, third, I am leading a group from the CESAB workshop on functional rarity organized by Cyrille Violle to explore the functional rarity in microbes, which is within the scope of the iDiv project.

The main results of the work I've conducted at iDiv are the following. For the mechanistic trait-based theory of microbial interactions and community assembly, we have developed a model of resource competition between the mutualistic and pathogenic bacterial taxa in the human gut that predicts different competitive outcomes and regime shifts under different resource supplies. For the analysis of microbial traits, together with several researchers from U Oldenburg and others, we found that not only the phytoplankton cell size but the shape dimensions influence taxonomic diversity. In collaboration with Mark Westoby and others, using probably the largest compilation of several bacterial and archaeal traits we found that major traits such as growth rate, cell size and genome size are not correlated, contrary to some previous studies based on much smaller datasets. Finally, the work on functional rarity (FR) in microbes shows that the notion of microbial FR has some similarities, as well as differences with the concept applied to macroorganisms. We explored how the FR is related to taxa abundances and how it depends on the traits considered.

During my sabbatical at iDiv, I have worked on several manuscripts related to the project. Some of them have been published and several more are either submitted/in revision or in preparation.

Madin JS et al. 2020. A synthesis of bacterial and archaeal phenotypic trait data. ***Nature Scientific Data***, 7: 1-8.

Van De Waal D and **E Litchman**. 2020. Multiple global change stressor effects on phytoplankton nutrient acquisition in a future ocean. ***Phil. Trans. R. Soc. B***. 275: 20190706.

Klausmeier CA, MM Osmond, CT Kremer and **E Litchman**. Ecological limits to evolutionary rescue. ***Phil. Trans. R. Soc. B***. In press.

Westoby M et al. Cell size, genome size and maximum growth rate are near-independent dimensions of ecological variation across bacteria and archaea. Submitted.

Ryabov A et al. Shape matters: the relationship between cell geometry and diversity in phytoplankton. In revision.

Guittar J, T Koffel, A Shade, CA Klausmeier and **E Litchman**. Resource competition and host feedbacks underlie regime shifts in gut microbiota. Submitted.

Aranguren-Gassis M* and **E Litchman**. Thermal performance of marine diatoms under contrasting nitrate availability. Revised version submitted.

Litchman E et al. Functional rarity in microbes. In prep.

The iDiv was a great place to spend a part of my sabbatical because of its very intellectually stimulating atmosphere and many opportunities to interact with a wide range of researchers. Regularly attending research seminars and group discussions benefitted my research through the exposure to new people, ideas and approaches. I was able to present my research several times and got useful feedback. In addition, I participated in two working group workshops during my sabbatical stay, one on microbiomes lead by Brajesh Singh and another one on food webs lead by Mehdi Cherif and Uli Brose. I plan to develop the ideas and collaborations started at iDiv back at my home institution.

iDiv is a very stimulating place that is beneficial for both the permanent staff, postdocs, PhD students and visitors. There are numerous opportunities for collaboration not only with the people at iDiv but with other iDiv visitors. The regular meetings of the iDiv visitors and postdocs (sDiv) lead by Marten Winter helped foster the sense of community. The annual retreat for sDiv members held in Sächsische Schweiz was excellent and highly enjoyable. In addition, German classes organized by and held at iDiv were very helpful for navigating life in Germany.

During the sabbatical, I interacted with Prof. Stan Harpole and his lab, mostly on the topics of phytoplankton diversity and community assembly. While no concrete project has been established, the plan is to keep interacting and possibly visiting iDiv again, once the travel restrictions have been lifted.

During my stay, I was involved in a collaborative effort with the iDiv affiliates (Ryabov, Blasius, etc.) on analyzing the links between phytoplankton diversity and cell shape. A manuscript on the topic is in revision.

After participating in a meeting on food webs, a proposal for an iDiv working group was submitted by Mehdi Cherif and others, including myself. Unfortunately, it was not funded this round but the group is looking for another sources of funding.

The next steps are to complete the ongoing studies that were initiated or developed at iDiv and submit them for publications. At the same time, I plan to continue interactions with several members of iDiv with a possibility of developing new projects.