

Research Internship Proposal: Master 2

Investigating the interactions between biofilm communities and the globally-emerged amphibian pathogen *Batrachochytrium dendrobatidis*

Members from the BIOREF (Biodiversity, Trophic Networks and Flows in aquatic ecosystems) team from the *Laboratoire Ecologie Fonctionnelle et Environnement* (UMR 5245) and from the GloMEc (Global Change in Mountains Ecosystems) project are now looking for a suitable applicant for a Master project (M2) at the nexus between microbial ecology, disease epidemiology and freshwater ecosystem health.

Context: Biofilms form a very active and biodiverse component of freshwater ecosystems but their importance as to disease dynamics remains poorly investigated, although emerging infectious diseases are huge threats to ecosystems and sustainability. The amphibian chytridiomycosis (the most biodiversity-threatening disease, also largely human-mediated) is one example of great relevance to freshwater ecosystems since the causative agent *Batrachochytrium dendrobatidis* (Bd) has a free-living aquatic and motile stage (the zoospore) which can infect hundreds of different amphibian species worldwide, sometimes leading them to extinction. While biofilms are ubiquitous in freshwaters and environmental biotic factors, such as the presence of Bd micro-predators, can influence the dynamics of this fungal disease, the interactions between Bd and biofilms remains unknown. The goal of this project is to explore some of these interactions. On one hand, biofilms are known to shelter some aquatic pathogens; on the other hand, they are also known to shelter some of their predators and their matrix can act as a physicochemical trap for pathogens. This project will advance the fields of freshwater and disease ecology and might help biodiversity conservation.

Keywords: Biofilms, amphibian parasite, freshwater ecosystem health, microbial ecology, pathogen-environment interactions, disease pyramid

Work description:

- (1) A comprehensive review and compilation of the scientific literature relevant to the topic will be performed
- (2) Environmental biofilms found on natural substrates (rocks, decaying wood) will be sampled from various easily accessible water bodies (e.g. streams, lakes, ponds). These places will be chosen so that they differ by their hydrodynamic status (lotic vs. lentic) and nutrient richness (oligotrophic vs. eutrophic).
- (3) The student will perform visual species identification under the microscope with particular attention to known Bd predators, and make biodiversity measurements.
- (4) The samples will be added into solutions containing known numbers (determined with a haemocytometer) of Bd zoospores. After a given time period, Bd zoospores will be counted again and compared to controls. Some conclusions as to the interactions with biofilms components will be drawn.
- (5) Biofilm chunks will be added on Bd colonies to further explore interactions and test for antifungal activity.
- (6) Conclusions regarding the two following questions will be drawn and a report will be written:
-Can biofilms influence the fate of Bd in lab settings?

-Have the diverse kinds of sampled biofilms different ability to do so?

Workplace : Laboratoire d'écologie fonctionnelle et environnement - UMR 5245 -INP-ENSAT, Avenue de l'Agrobiopole, BP32607 Auzeville-Tolosane 31126 Castanet-Tolosan Cedex, France

Supervisors: Hugo Sentenac, Adeline Loyau, Joséphine Leflaive

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Examples of skills and experiences potentially gained at the end of the internship:

- In-depth introduction and familiarization to the world of scientific research through collaboration with a team of researchers. The student will see how an international scientific project is carried out (project GloMEc Global Change in Mountain Ecosystems, <https://www.p3mountains.org/>), and will considerably help their members through the completion of this master project.
- Literature reviewing / Scientific reading / Critical thinking / Scientific writing. All of these will improve the level of English proficiency throughout the project
- Introduction to project designing, completion of fieldwork, introduction to laboratory work (microscope counting, manipulation of microbial culture and so on),
- Statistical analysis: linear and generalized linear model (GLM) applied on count data, biodiversity measurement
- Theoretical and practical knowledge on ecology, microbial ecology (including on biofilm communities), disease ecology and epidemiology. The student will familiarize himself/herself with important concepts such as One Health/Ecosystem Health in the context of sustainability, the disease pyramid concept (host-pathogen-microbiome-environment), and the phenomenon of the emergence of infectious diseases which are all particularly relevant nowadays. Better, he/she will get the chance to apply these concepts while focusing on freshwater ecosystem health, with the study of biofilms communities and the most aggressive pathogen ever known (which, by the way, is thankfully not zoonotic). This knowledge will be transferable to other systems and, as such, will very likely prove useful for the student.

Funding: in accordance with existing regulations – ca. 560€/month

Period: January to June (6months)

Note:

This master project will be part of a larger project focusing on the same elements applied to mountain freshwater ecosystems. This means that the master student will benefit from significant advantages throughout his/her internship, namely:

- continuous help provided throughout the project
- potential to be part of scientific publications if this master project leads to new findings helpful for the GloMEc project.
- should the internship be seriously disturbed e.g. by a COVID19 lockdown, the student who will work with us will still be able to perform a Master thesis (and learn many things). Within the GloMEc project, we have several interesting datasets to analyse (for instance, taxonomic datasets of mountain biofilms communities obtained through marker gene analysis, which would form a good introduction to biomolecular studies and train the students in applied biodiversity statistics)
- if interested and available, the student could help the supervisors during the next mountain fieldwork over late spring and summer 2021 (we have many study sites in the Pyrenees) and get to know more about Pyrenean ecosystems and wildlife, in particular amphibians (good hiking level required)
- Potential for further collaboration, provided this master project runs smoothly

For further information (GloMEc website + good introduction readings*):

- BIOREF team website: <https://www.eco.omp.eu/research-team/biodiversite-reseaux-trophiques-et-flux-dans-les-ecosystemes-aquatiques-bioref/>
- GloMEc project website: <https://www.p3mountains.org/>

- (1) Fisher, M.C., Garner, T.W.J. (2020) '**Chytrid fungi and global amphibian declines**', *Nature Reviews Microbiology*, 1–12. *There are tons of papers on amphibian chytridiomycosis and Bd, and to a lesser extent Bsal. This one is a recent (so it is up-to-date) review giving a good overview*
- (2) Flemming, H.-C., Wuertz, S. (2019) '**Bacteria and archaea on Earth and their abundance in biofilms**', *Nature Reviews Microbiology*, 17(4), 247–260. *I really like this paper. Although the main goal of the paper does not concern us too much, it is well written and splendidly illustrated, and it provides wonderful and clear definitions. Again, it is recent so you can find cited in here many good references. If you have to choose one, I would strongly recommend:*
- (3) Battin, T.J., Besemer, K., Bengtsson, M.M., Romani, A.M., Packmann, A.I. (2016) '**The ecology and biogeochemistry of stream biofilms**', *Nature Reviews Microbiology*, 14(4), 251–263. *The title speaks for itself. Again, great illustrations*

To know more about the history and context of our project(s) in mountains:

- (4) Schmeller, D.S., Blooi, M., Martel, A., Garner, T.W.J., Fisher, M.C., Azemar, F., Clare, F.C., Leclerc, C., Jäger, L., Guevara-Nieto, M., Loyau, A., Pasmans, F. (2014) '**Microscopic Aquatic Predators Strongly Affect Infection Dynamics of a Globally Emerged Pathogen**', *Current Biology*, 24(2), 176–180. *It links the composition of species in the "plankton" of Pyrenean lakes with the dynamics of infection by Bd. Because in some lakes there are competent predators of Bd, and in others, there are not. Basically, here, we want to see if this is the same with biofilms communities.*
- (5) Schmeller, D.S., Loyau, A., Bao, K., Brack, W., Chatzinotas, A., De Vleeschouwer, F., Friesen, J., Gandois, L., Hansson, S.V., Haver, M., Le Roux, G., Shen, J., Teisserenc, R., Vredenburg, V.T. (2018) '**People, pollution and pathogens – Global change impacts in mountain freshwater ecosystems**', *Science of The Total Environment*, 622–623, 756–763. *To get a larger picture of the context of our project*
- (6) Bernardo-Cravo, A.P., Schmeller, D.S., Chatzinotas, A., Vredenburg, V.T., Loyau, A. (2020) '**Environmental Factors and Host Microbiomes Shape Host–Pathogen Dynamics**', *Trends in Parasitology*. *Introduction to the disease pyramid concept with the Bd-amphibian system as an example, amongst others*

About ecosystem health:

- (7) Rapport, D.J., Costanza, R., McMichael, A.J. (1998) '**Assessing ecosystem health**', *Trends in Ecology & Evolution*, 13(10), 397–402. *The basis*

If you have difficulties to access the full version of the papers, contact

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