

Sujet de Stage de Recherche Master 2 SEP 2021-2022

Unité et équipe d'accueil :

Titre : Adaptation of liverworts from the genus *Marchantia* for dispersal by raindrops

Directeur du stage : Stéphanie DREVENSEK and Arezki BOUDAUD (Ecole Polytechnique);

Encadrant supplémentaire (éventuellement et 1 max) : Claudine AH PENG (Université de la Réunion)

Sujet (1/2 page à 1 page maximum) :

1) Problématique

Plants have evolved astonishing mechanisms to ensure reproduction and dispersal. For instance, rain drops bouncing off cup-shaped reproductive bodies might disperse seeds in flowering plants, and antherozoids or asexual propagules in bryophytes (Brodie, 1951). Liverworts from the genus *Marchantia* reproduce vegetatively by producing clonal propagules known as gemmae, that are protected in gemma cups. In the model species *Marchantia polymorpha*, the cups are funnel-shaped and a pouch below the funnel contains immature gemma; the edge of the cup is decorated by triangular crenellation with each triangle terminated by a multicellular hair. The development of cups has been characterized (Kato, 2020) and droplets falling on cups are ejected at velocities of the order of a few m/s (Edwards, 2019). Whereas the role of rain drops in dispersing gemmae in *Marchantia* spp. has been long recognized, it is still unclear what is the function of specific features of gemma cups, such as morphology and dimensions. Our preliminary data indicate differences in cup geometry between species from la Réunion and the model species *M. polymorpha* found in temperate climates. In addition, the conical geometry of the inside of *M. polymorpha* cups appears well-suited to deflect rain drops into jets that propel gemma a few meters away from the mother plant. Based on this, we hypothesize that the morphology of the gemma cup is optimized for dispersal and the main goal of the internship will be to start testing this hypothesis.

The main goal of the internship will be to test the hypothesis that gemma cup morphology is an adaptive trait. The main aims are as follows.

- (i) Characterization of variations in gemma cup morphology across *Marchantia* species and across natural populations along the elevational gradient in the forest ecosystems of Réunion Island.
- (ii) Testing whether cup morphology is related to micro-environment, notably taking advantage of significant variations along the elevation gradient in Reunion Island.

(iii) Analysis of drop bouncing off cups from different species and natural populations.

(iv) Evo-devo analysis of the main genetic factors underlying variations in gemma cups.

The intern will first focus on aims (i) and (ii). Aims (iii) and/or (iv) will be addressed according to progress and to student preferences.

2) Méthodes

Several of the following methods may be used according to the student preferences and to the sanitary situation (for field work in Reunion Island)

- Collection of plants from natural populations in Réunion Island
- Collection of data on rain in Reunion Island
- Optical microscopy
- Morphometry
- Statistical analyses
- Investigation of the bouncing of drops off gemma cups using a high-speed camera
- Cloning of the main genes involved in gemma cup development (based on genes identified in *M. polymorpha*)
- Phylogenetic and/or expression analyses of these genes

3) Références

Amador, G.J., Yamada, Y., McCurley, M., and Hu, D.L. (2013). Splash-cup plants accelerate raindrops to disperse seeds. *Journal of the Royal Society, Interface / the Royal Society* **10**: 20120880.

Brodie, H.J. (1951). The splash-cup dispersal mechanism in plants. *Canadian Journal of Botany-Revue Canadienne De Botanique* **29**: 224–234.

Bruijnzeel, A., Scatena, F.N., Hamilton, L.S. eds. (2010). Tropical montane cloud forests: science for conservation and management, Cambridge University Press, 740pp

Edwards, J., Laskowski, M., Baskin, T.I., Mitchell, N., and DeMeo, B. (2019). The Role of Water in Fast Plant Movements. *Integrative and Comparative Biology* **59**: 1525–1534.

Kato, H., Yasui, Y., and Ishizaki, K. (2020). Gemma cup and gemma development in *Marchantia polymorpha*. *The New phytologist* **228**: 459–465

1) portée (préciser s'il débouche ou non sur un sujet de thèse) : oui

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Gratification acquise ou demandée : acquise

Rapporteurs suggérés (3-4, plutôt MNHN et SU ou IdF) :
Dr. Catherine Reeb (ISYEB)