Microbial community responses to host-derived substrate change M1 or M2 Internship

**Contract type:** Internship

**Level of qualifications required:** Master's or equivalent

**Fonction:** Internship Research

**About the research centre or Inria department**

The Inria Université Côte d'Azur center counts 37 research teams as well as 8 support services. The center’s staff (about 500 people) is made up of scientists of different nationalities, engineers, technicians and administrative staff. The majority of the center’s research teams are located in Sophia Antipolis and five of them are based in an Inria antenna in Montpellier. The Inria branch in Montpellier is growing in size, in accordance with the strategy described in the institution's Contract of Objectives and Performance (COP).

**Context**

In their natural environment, plants are surrounded by a huge number of microbes, both above and below ground. Although some can be pathogenic, many microbial communities can have substantial beneficial effects on the plant host, including improved acquisition of nutrients, accelerated growth, protection against pathogens, and improved resistance against abiotic stress, such as heat, drought, and salinity. The functional benefits of a microbial community depend on its composition i.e. the presence and abundance of individual (class of) microbial species. Plants indeed have evolved the ability to shape their associated microbiome by means of a vast array of specialized metabolites, that are released near plant roots or at the leaf surface. These molecules often represent carbon and nitrogen substrates for microbial growth, but can also act as attractants/repellents, stimulants/inhibitors for specific microbial groups.

In addition to their interaction with the host, microbes exert a strong influence on each other by nutritional competition, exchange or cross-feeding. Cooperative or competitive interactions among the community members have profound effects on microbiome composition and can therefore determine the outcome of plant microbiota interactions in a given condition. A variety of mathematical approaches have been used to investigate the dynamics and functioning of microbial communities. Generalized consumer resources (CR) models are particularly well-suited to investigate host-microbiota interactions as they allow for an explicit modelling of resource dynamics and species metabolism (resource consumption rates, metabolic by-products, maintenance). CR models indeed have been used to characterize the behaviour (coexistence, diversity, resilience) of microbial communities as a function of the network topology (size of the community, cross-feeding matrix), members preferences (specialist vs generalist) and environmental richness (number of available substrates).

Most of these studies however have focused on the microbial community only, in a fixed environment, disregarding the interaction with the host. Here we would like to go a step further by considering the case of a microbial community in a dynamic environment. In particular, we will focus on a microbial community growing on a set of host-derived substrates that can change in composition (novel substrate) or in abundance (change in host secretion rate) during time. The aim of the project is to conduct a computational study on a statistical ensemble of simulated communities of increasing complexity, in order to address the following questions:

- Can the addition of a new substrate induce a shift in community composition (species relative abundance)?
- How does the quantitative effect of substrate addition depend on the community structure (specialist vs generalist, niche overlap, cross-feeding)?

**Ref.**

van den Berg et al. Nature Ecology and Evolution (2022)


https://team.inria.fr/macbes/

The students will develop the simulation code (Python or Matlab), perform computational
experiments and define appropriate indicators to measure the impact of a substrate change on the community composition. Community simulators codes are available from previous studies. These codes have to be adapted to the case under study but can serve as an useful starting point.

**General Information**

- **Theme/Domain**: Modeling and Control for Life Sciences
  - Scientific computing (BAP E)
- **Town/city**: Sophia Antipolis
- **Inria Center**: Centre Inria d’Université Côte d’Azur
- **Starting date**: 2024-02-01
- **Duration of contract**: 6 months
- **Deadline to apply**: 2024-02-29

**Contacts**

- **Inria Team**: MACBES
- **Recruiter**: Gouze Jean-luc / Jean-Luc.Gouze@inria.fr

**About Inria**

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

**The keys to success**

**Location and Practical information**

The internship will take place at Inria, in the Macbes team, specialized in mathematical modeling applied to biology and ecology, under the supervision of Valentina Baldazzi and Jean-Luc Gouzé.

- **Address**: Centre Inria Université Côte d'Azur, MACBES team
- **2004 route de Lucioles**
- **Sophia-Antipolis**

The internship student will receive a gratuity of 4,05€ per hour worked on a basis of 35 hours weekly (~567€/month). For non-local candidates, a few rooms may be available at the International Centre Valbonne (CIV) at attractive rentals.

**Duration**

4-6 months, starting from February 2024 or later.

**How to apply**

Please, send a CV and a motivation letter to valentina.baldazzi@inria.fr and jean-luc.gouze@inria.fr

**Warning**: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

**Instruction to apply**

**Defence Security**

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy**

As part of its diversity policy, all Inria positions are accessible to people with disabilities.