



# CHEMICAL COMMUNICATION IN ECOLOGICAL SYSTEMS

## Application Call 2024 - Project 4

### **Sensing the Unseen: How Diatoms Detect and Respond to highly dilute Sex-Inducing Pheromones**

#### **Supervisors:**

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#### **Background:**

Diatoms are abundant unicellular microalgae that contribute approximately 20% of global photosynthetic CO<sub>2</sub> fixation. Despite their vital role in regulating Earth's climate, fundamental aspects of their biology, such as sexual reproduction, remain poorly understood. Pheromone-mediated chemical communication plays a key role in ensuring successful mating in diatoms. Several years ago, we identified an attraction pheromone in the diatom *Seminavis robusta*. However, until recently, the metabolites responsible for priming cells for sexual reproduction and coordinating mating behaviors had remained elusive. By combining advanced chemical analysis with ecological experiments, we successfully determined the structure of the first Sex Inducing Pheromone (SIP). This breakthrough provides a foundation for the experiments proposed in this project.

#### **Project description:**

The sex-inducing pheromone produced by diatoms is active at remarkably low concentrations, in the femtomolar range. It remains a mystery how algae can detect such minuscule amounts of a signaling molecule in seawater and convert this chemical information into a physiological response. In this project, we will use synthetic analogues provided by our collaborators from the Malins-lab (Canberra, Australia) to search for the receptors in diatoms. Since no pheromone receptors have been characterized in diatoms, this research has the potential to be groundbreaking. Initially, we will conduct structure-activity relationship studies to pinpoint the structural elements of the pheromone molecule that can be chemically modified without compromising its activity. Using this information, we will design modified pheromones, such as those incorporating photoaffinity labels, to bind and identify the receptors. Once captured, the receptors will be characterized, laying the foundation for further investigations into downstream cellular signaling pathways. PhD candidates involved in this project will also have the opportunity to conduct fieldwork,

applying pheromones on a large scale to manipulate natural diatom populations and to analyze data from the tara Europa expedition (<https://fondationtaraocean.org/en/expedition/tara-europa/>), that can reveal the impact of pheromone chemistry into the community metabolome in the coastal areas or European oceans.

**Candidate profile:**

We welcome applications from highly motivated and curious students from any country who have

- A Master's degree in chemistry, biology, chemical biology, or other disciplines related to environmental sciences.
- A passion for solving analytical puzzles and assembling a bigger global picture
- Curiosity for analytical techniques, including mass spectrometry and bioassays.

**Reading (available open access):**

On the pheromone identification:

<https://onlinelibrary.wiley.com/doi/full/10.1002/anie.202307165>

On the synthesis of the pheromone by our collaboration partners:

<https://pubs.acs.org/doi/full/10.1021/acs.orglett.4c02004>

On diatom pheromones

<https://onlinelibrary.wiley.com/doi/10.1111/tpj.12496>

On the tara-expeditions

<https://fondationtaraocean.org/en/home/>