Lead organisation: University of Bristol

Collaborating organisations:

Plymouth Marine Laboratory, UK Centre for Ecology and Hydrology (CEH).

Title: Exploring the impact of nitrogen-storage molecular crystals on microalgae blooms.

Supervisors: Prof. Benjamin Palmer, Prof. Richard Evershed (FRS), Prof Ian Bull

Duration: 3.5 years

Start date: September/October 2026

We are seeking talented and ambitious biologists and chemists for an exciting PhD opportunity - to understand the role of nitrogen(N) storage guanine crystals on algal bloom dynamics. The project will be supervised by Profs. Benjamin Palmer, Richard Evershed and Ian Bull at the School of Chemistry, University of Bristol. The work is part of an innovative ERC Consolidator Grant, 'CRYST_ALGAE' .

Background: Highly reflective molecular crystals such as guanine are known for producing striking optical effects in animals. In many animals, assemblies of nanometre-thin crystals generate vivid and highly efficient coloration—often outperforming man-made materials.[1,2] Using cryogenic electron microscopy and other physical characterization techniques, the Palmer lab discovered how animals exquisitely control the structure and morphologies of these crystals to optimize their optical properties.[3]

More recently, however, guanine crystals were also discovered to be widespread in photosynthetic microalgae, organisms that account for a substantial fraction of global biomass.[4] Here, guanine crystals act as high-capacity nitrogen(N) storage reservoirs.[5,6] When nutrients like nitrate or ammonium are available, microalgae convert the inorganic N into guanine crystals, stored in specialized vacuoles. During nutrient-poor periods, the crystals are dissolved, liberating organic N for exponential cell growth.[5,6] We showed[7] that microalgae such as dinoflagellates can also directly uptake many nitrogen containing organic molecules (N-heterocycles), crystalize them, and then metabolize them. This behaviour has important biogeochemical implications as the compounds are key components of dissolved organic nitrogen (DON)—a major and persistent nitrogen pool in aquatic environments. With anthropogenic activity increasing DON levels globally, understanding how microalgae process these compounds is essential for predicting nitrogen cycling and ecosystem dynamics.

Why this matters: These processes are directly linked to algal bloom formation—an increasingly frequent and globally significant environmental challenge.

Project: This project will investigate how N-storage crystals influence microalgae behavior on the population level, with a particular focus on bloom dynamics. Dinoflagellates, abundant single-cell eukaryotes present in marine and freshwater environments, are key-drivers of harmful algal blooms (HABs). These events, often

fueled by nutrient enrichment anthropogenic eutrophication can be devastating to ecosystems. In this project, you will:

- **Collect environmental samples** from two contrasting ecosystems: the Western Channel Observatory (with Plymouth Marine Laboratory) and UK lake systems (with the UK Centre for Ecology and Hydrology)
- **Quantify nitrogen storage and metabolism** in microalgae using advanced analytical platforms, including: GC/Q-TOF MS, GC-Orbitrap MS, LC-QQQ MS, and LC-Orbitrap MS
- **Visualise intracellular crystal formation** using state-of-the-art cryo-electron and optical microscopy
- **Link cellular processes to ecosystem dynamics** by analysing relationships between crystal abundance, nutrient availability, and population growth
- **Test mechanistic hypotheses** through numerical modelling and targeted experiments.

This PhD offers comprehensive training in advanced mass spectrometric, imaging techniques and biogeochemical analyses within two renowned/leading laboratories. You will be of a multidisciplinary research team, with opportunities to collaborate internationally and present at national and international conferences. At least two high impact publications are expected from this project.

You will be expected to meet the following criteria:

- Hold (or expect to obtain) at least a first-class or upper second-class honours degree in biology, marine biology, ecology, chemistry, environmental science or related disciplines from a UK institution. Equivalent qualifications from outside the UK are also accepted. **This studentship is only open to students who have a 'Home' fee status.**
- Have strong laboratory skills ideally with some experience in analytical techniques, microalgae, marine biology, or biogeochemistry.
- Demonstrate excellent organisational and time management abilities.
- Possess good mathematical, coding and statistical skills.

How to Apply

Please make an online application for this project at the following How to apply | Study at Bristol | University of Bristol

Funding

A full studentship will cover UK tuition fees, a training support fee and a stipend (£21,805 p.a. in 2026/27, updated each year) for 3.5 years. **This studentship is only open to students who have a 'Home' fee status.**

Getting in Contact

For informal inquiries, please contact Prof. Benjamin Palmer (Benjamin.palmer@bristol.ac.uk) if you have any queries or would like to discuss project.

1. T. Lemcoff, et. al., *Nature Photonics*, 2023, https://www.nature.com/articles/s41566-023-01182-4.
2. K. Shavit, et. al., *Science*, 2023, https://www.science.org/doi/abs/10.1126/science.add4099.
3. S. S. Indri, et. al., *Angew. Chemie*., 2026, https://onlinelibrary.wiley.com/doi/10.1002/anie.1347419
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5. P. Mojzes et. al., PNAS., 2020, https://www.pnas.org/doi/10.1073/pnas.2005460117
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