



University of Genova

**Department of Earth, Environmental
and Life Sciences**

**Doctorate Course in Earth and
Environmental Science and
Technology**



Curriculum in biology applied to agriculture and the environment

Research Theme n. 2

Titolo

Il microclima come fattore determinante della biodiversità: verso modelli predittivi delle risposte dei licheni epifiti ai cambiamenti climatici.

Title

Microclimate as a driver of biodiversity: towards predictive models of epiphytic lichens responses to climate change.

Tutor

Prof. Paolo Giordani

Co-tutor

To be decided

Program description including the formation program abroad

A substantial fraction of terrestrial biodiversity operates within a thin, pervasive layer at the interface between vegetation and the atmosphere, where environmental conditions are defined not by regional climate, but by highly dynamic microclimates. This “hidden dimension” of ecosystems remains largely unresolved, yet it may critically mediate how organisms experience and respond to global change.

Forest ecosystems host a vast diversity of epiphytic organisms, including lichens, bryophytes, and associated microbiota, which inhabit exposed biological surfaces. At these interfaces, temperature, water availability, and radiation vary sharply over very small spatial and temporal scales, generating complex and often decoupled conditions relative to macroclimate. Despite their ecological importance, these fine-scale dynamics are rarely integrated into current frameworks used to predict biodiversity responses to climate change.

Lichens, as self-sustaining symbiotic systems lacking protective tissues, are particularly sensitive to such microenvironmental variability. Their physiology is tightly coupled to external conditions through poikilohydry and direct thermal exchange, making them especially suitable for investigating how environmental heterogeneity translates into biological responses.

Aims

The proposed project aims to uncover how microclimatic processes shape the responses of epiphytic organisms to climate change, linking fine-scale environmental variability to organism performance and, ultimately, to broader ecological patterns. Specifically, the project will investigate the relationships between (i) microscale variation in temperature and water availability, (ii) functional traits of lichens and other epiphytes, and (iii) their eco-physiological responses.

By integrating these components, the project will assess how microclimatic buffering or amplification influences organismal sensitivity to climate change, and how these effects scale up to determine

patterns of resilience, vulnerability, and ecosystem functioning. Particular emphasis will be placed on thermal ecology and water relations as key processes mediating these responses.

Methods

The PhD project will adopt a multidisciplinary approach combining field observations, controlled experiments, and modelling. High-resolution microclimatic measurements will be obtained using advanced sensor technologies and imaging approaches to quantify temperature dynamics and water content at biologically relevant scales. Eco-physiological responses will be assessed through measurements of photosynthetic efficiency (e.g. chlorophyll fluorescence), respiration, and water-use dynamics.

Functional trait analyses will be used to link species-specific characteristics to environmental responses. These datasets will be integrated using advanced statistical and mechanistic modelling approaches, with the goal of predicting organism performance and explicitly incorporating microclimatic variability into models of biodiversity response to climate change.

Formation periods abroad

For a period of no less than three months, the PhD candidate will carry out part of their research at leading European research centres. These secondments will provide complementary expertise in (i) conceptual and theoretical development of microclimatic and epiphyte ecology, including scientific synthesis and review writing, and (ii) mechanistic and process-based modelling aimed at scaling organism-level responses to broader spatial and temporal contexts.

Through these experiences, the candidate will develop an interdisciplinary skill set bridging empirical ecology, eco-physiology, and predictive modelling, and will contribute to advancing a new generation of frameworks that explicitly account for microclimate in understanding biodiversity responses to global change.

Financial support: Financial support for research activities associated with the project (excluding the PhD scholarship) is guaranteed through the PI's independent funding, derived from internal budget reallocations across ongoing research projects and third-party commissioned activities. These resources will cover laboratory materials and consumables, experimental work, field campaigns, and research missions, ensuring full support for the implementation of the project.

Tutor's publications of the last 3 years

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