University of Genova

Department of Earth, Environmental and Life Sciences

Doctorate Course in Earth and Environmental Science and Technology

Università degli Studi di Genova

STAT

Dottorato in Scienze e Tecnologie per l'Ambiente e il Territorio

Curriculum in biology applied to agriculture and the environment

Research Theme n. 3

Titolo
Acclimatazione, adattamento e resilienza dei licheni al cambiamento climatico

Title
Acclimation, adaptation and resilience of lichens to climate change

Tutor
Prof. Paolo Giordani

Co-tutor
Dr. Christopher Ellis, Edinburgh Royal Botanical Garden (https://www.rbge.org.uk/about-us/who-we-are/our-people/conservation-science-staff/dr-christopher-ellis/)

Program description including the formation program abroad

Lichens have recently been defined as self-sustaining micro-ecosystems formed by the interaction of an exhabiting fungus and an extracellular array of one or more photosynthetic partners and an indeterminate number of other microscopic organisms.
The phenotype resulting from this symbiosis is a structure, the thallus, which, in the absence of protective tissues, has evolved a unique water management strategy, called pokylohydry, which allows it to manage repeated cycles of hydration/dehydration. Due to these physiological properties, changes in temperature trends and water availability caused by climate change threaten the normal biological processes and relationships between partners in the lichen symbiosis, making them excellent model organisms for studying the effects of climate change.

Aims
Using lichens as model organisms, the proposed project aims to investigate the response of lichens to climate change, in terms of three interrelated biological processes: resilience, adaptation and acclimation. Together, these processes operate across different temporal and biological scales to shape species responses to changing environments. Resilience refers to the ability of ecosystems to absorb disturbance while maintaining essential structure and functions, and includes both resistance to change and recovery from disturbance. At the organismal level, responses to environmental stress can occur through genetic adaptation or acclimation. Genetic adaptation involves heritable changes in allele frequencies over generations that increase fitness in a given environment. In contrast, acclimation is a form of phenotypic plasticity in which individuals adjust their physiological and morphological traits over their lifetime in response to environmental variation.

Methods
To study these processes in lichens, the proposed PhD project will use a multidisciplinary approach that encompasses a wide range of field, laboratory and modelling techniques, including ecological and ecophysiological methods to investigate photosynthetic efficiency (e.g. measurements of chlorophyll fluorescence,

CO_2 efflux in respiration) and water management in lichens (e.g., visualization of water content and dynamic by Near Infrared Imaging), along with transcriptomic and metabolomic approaches to determine their adaptive capacity.

Formation periods abroad
For a period of no less than three months, the PhD candidate will carry out part of their work at leading European research centres in the field. In particular, at the Royal Botanical Garden in Edinburgh, under the guidance of Dr. Christopher Ellis (who will also act as the co-tutor of the project), the PhD candidate will have the opportunity to develop the theoretical framework of the project idea by preparing a scientific review paper, as well as setting up field activities.
In a later phase of the project, at the University of Hamburg under the supervision of Prof. Philipp Porada (https://www.biologie.uni-hamburg.de/forschung/oekologie-biologische-ressourcen/oekmodel/mitarbeiter/porada-philipp.html), the candidate will develop mechanistic statistical models which, using data collected during the experimental phases of the project, will be able to predict and extend the response of lichens to climate change on larger spatial and temporal scales.

Financial support:

The financial support for the proposed project will come from funds from scientific collaboration contracts on behalf of third parties and from savings in the management of overheads from the PRIN PNRR ACCLIMATE project, funded by the Ministry of Universities, of which the proposing tutor is the Principal Investigator.

Tutor's publications of the last 3 years

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3. Alfei, S., **Giordani, P.**, Zuccari, G., 2024. Synthesis and Physicochemical Characterization of Gelatine-Based Biodegradable Aerogel-like Composites as Possible Scaffolds for Regenerative Medicine. International Journal of Molecular Sciences 25. https://doi.org/10.3390/ijms25095009
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5. Canali, G., Di Nuzzo, L., Benesperi, R., Nascimbene, J., **Giordani, P.**, 2024. Functional traits of non-vascular epiphytes influence fine scale thermal heterogeneity under contrasting microclimates: insights from sub-Mediterranean forests. Botanical Journal of the Linnean Society 205, 75–83. https://doi.org/10.1093/botlinnean/boad063
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