



*The course provides the basics to use lichens for the interpretation of environmental conditions and the development of a responsible scientific-based environmental management*

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Lichens are among the most sensitive organisms to environmental changes at the ecosystem level. Climate change, increasing/decreasing pollution and eutrophication are factors to which lichen communities respond in few years. It means that "reading" lichens we can obtain useful information about the status of the environment and its progression.

Since the nineteenth century, observations based on changes in lichen community composition and species frequency have been used for biomonitoring purpose. Nowadays, new approaches based on functional groups and lichen physiological response are being developed. Respect to the past these methods are more precise and respond more rapidly to changing conditions. Moreover, linking physiological mechanisms and ecological impacts they provide trustable bases for the development of suitable environmental policies.

Five modules identify the main themes of the course, from the functioning of the symbiosis to the data collection and interpretation. The course will be organized in frontal lessons, lab experiences and a one-day excursion for the application of selected bioindication methods.

**Module 1 (Lichen symbiosis and metabolism)** An introduction on the symbiosis functioning will be given. We'll present the different typologies of lichen thallus, the role and the vantages of each symbiont, the reproduction and dissemination methods and the strategies adopted for surviving in extreme environmental conditions. The role of lichens at ecological level will be also highlighted. Particular attention will be given to the characteristics that make lichens suitable for air pollution and climate changes indication.

**Module 2 (Systematic)** The module will cover the basic principals of lichen biology and identification and the main notions for determination of lichens will be given. We'll present the most important genus and growth forms: foliose, fruticose and crustose lichens. Determination methods based on morphological and chemical characteristics will be taught in theoretical/practical lessons. The techniques and topics will include microscopy of the vegetative structures and reproductive structures (preparation and observation of the samples), chemistry of lichens and the use of a wide range of determination keys. A list of useful digital tools available in the internet will be shown. Lichen material will be provided.

**Module 3 (Ecophysiology)** This module will examine modern approaches in lichen ecophysiology, detailing examples from both the laboratory and field, and highlighting the integration of molecular, physiological and ecological techniques. The scope is to assess the impact of biological stresses on lichen functioning. In particular, we will focus on how lichen respond to environmental changes and which selected parameters can be used to demonstrate cause and effect of human-induced environmental disturbance on organisms.

**Module 4 (Bioindication)** This module will present the main protocols using lichens as biomonitors. Methods based on biodiversity and bioaccumulation will be described, as well as the functional groups approach. Case-studies carried out in different environments (urban, natural and industrial) will be produced highlighting the link with human health. The LDV (Lichen Diversity Value) method will be applied by participant in a field excursion.

**Module 5 (Data analysis)** In this module we'll show different ways to organize and represent the data collected as described in previous modules. Theory and practical examples will be given