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Introduction to the Festschrift dedicated to Professor Eva Barreno

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This special issue is centered on lichens because they have been the main focus of the scientific career of Professor Eva Barreno, to whom the issue is dedicated, on occasion of her 70th birthday, and in recognition of her contributions to lichenology. This Festschrift issue gathers original researches covering many aspects of the lichen symbiosis. The traditional view of lichens as symbiotic phenotypes, originating from the interactions of a single fungal partner and one or few photosynthetic partners, has been extended in recent years. There have been several discoveries which uncovered an unexpected complexity and diversity in the lichen symbiotic system.

The issue begins with a tribute to Eva Barreno's scientific and academic career, and this is followed by twelve scientific contributions. The short biography with two anecdotes was prepared by Ana Crespo, Pradeep Divakar and Arnoldo Santos, Eva's friends and colleagues. They provide a remarkable and valued portrait of the chapters in Eva Barreno's professional life.

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The twelve contributions, herein, range from the traditional approaches to studying lichen diversity and their physiology, by means of morpho-anatomical analyses using light and electron microscopy, culture isolations and phylogenetic systematics, to the most modern sequencing techniques and development of computer-aided key to facilitate species recognition. The studies on lichens, and their individual symbiotic fungal and algal partners, reveal diverse ecologies, growth forms and genetic diversity worldwide. In addition, there are peculiar physiological responses to different environmental conditions that are models for the study of symbiosis.

Pino-Bodas et al. use distribution models based on several algorithms to estimate the potential distribution of *C. subturgida,* an overlooked Mediterranean species, that is apparently restricted to the Iberian Peninsula and Canary Islands, but there may be regions with suitable climatic conditions where it has not been reported yet. Another lichen whose range includes the Canary Islands is described by Moya et al. who apply a multidisciplinary approach to describe the diversity of the photobiont genus *Trebouxia* in a peculiar, circum-Mediterranean/Macaronesian lichen species. This is *Buellia zoharyi*, that usually occurs in semi-arid areas in these islands.

Garrido-Benavent et al. explore the amphitropical phylogeographic structure of the green algae that are involved in the symbiosis with species in the genus *Pseudephebe* (Parmeliaceae), including those found in Arctic and Antarctic regions. The endemic Antarctic species *Himatormia lugubris* has been investigated by Sancho et al. to elucidate which functional strategy, possibly linked with thallus anatomy and the distribution of the photosynthetic algal cells, enables this lichen to be a successful species in the maritime Antarctic.

Exposito et al. study whether fluorescent DNA-binding probes are effective in detecting cell apoptosis in *Ramalina farinacea* when the lichen undergoes oxidative stress caused by desiccation/rehydration cycles.

De las Heras Gonzales & Català present an innovative application in which the lichen photobiont *Asterochloris erici,* grown in in vitro culture, can be used to develop a sensitive and fast microbioassay to test the effects of pollutants in terrestrial microalgae. This may be used for monitoring contamination efficiently and developing control strategies. In

another experimental approach, Molina et al. tested axenic cultures of six lichen mycobionts, known to produce secondary metabolites of biotechnological interest, to find optimal culture conditions. Such investigations may enable the production of sufficient biomass for further studies and for biochemical applications. Cultures of six other lichen mycobionts and photobionts were used by Pichler et al. to study cellular and extracellularly released phytohormones for designing experiments aimed at elucidating the roles of phytohormones in the process of lichenization.

Cernajova & Škaloud cultured soredia from *Cladonia* species to test the suitability of these lichen diaspores for isolating the mycobiont and the photobionts. The authors make important observation on other fungi and airborne contaminants that are co-dispersed together with the soredia. Another approach by Muggia et al. used mixed culture experiments to explore the association of the extremely halotolerant fungus *Hortaea werneckii* with the algae *Dunaliella atacamensis* and *D. salina*. This enabled the study of lichen-like symbiotic interactions, and the implications are discussed.

Smith et al. analyze metagenomic shotgun sequences to characterize better lichen mycobiomes, *i.e.* the range of fungi associated within lichen thalli. Five groups of lichens in the family Parmeliaceae, were examined and revealed that closely related mycobionts tend to have more similar mycobiomes.

Last but not least, Nimis & Martellos present a paper on the development of a computer-aided key to all the lichens known to occur in Italy. This, in due course, will be freely available online, and as an app for mobile devices. Such a key will enable and facilitate access to information about the lichens of Italy to the general public, who will come to understand the amazing diversity of lichens.