Antarctic cryptoendolithic communities

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The Antarctic cryptoendolithic communities are self-supporting assemblages of phototrophic and heterotrophic microorganisms, including bacteria, Cyanobacteria, Chlorophyta and both free-living and lichen-forming fungi. These are among the most stress-resistant organisms known to date, constantly living to the edge of their physiological adaptability.

Keywords: Antarctica ; Drylands ; Climate Change ; Cryptoendolithic communities ; Fungi ; Bacteria ; Extremophiles

1. Introduction

Rocks represent an ancient terrestrial ecological niche, where microbes were the sole forms of life [1]. At present, microbial lithobionts still dominate environments where conditions prevent the settlement of less resistant and adapted organisms, eventually exploiting the endolithic airspaces when external environmental parameters become incompatible with active life. In fact, airspaces within rocks supply a shielded and buffered microenvironment for microbiota, providing protection from intense solar irradiation, desiccation, thermal fluctuations, and access to mineral nutrients [2]. Therefore, the ability to develop endolithically confers to specialized microbial communities the chance to thrive under different extreme conditions. Endolithic microorganisms have colonized many environments that border on the extreme limits of life, i.e., hot and cold deserts or geothermal environments [2][3][4][5] and all drylands worldwide [6]. These microbial communities play an important ecological role mediating inputs and outputs of gases, nutrients and water uptake from desert rock surfaces, regulating weathering, nutrient cycles and assuring the balance and functionality of these harshest ecosystems, creating positive feedback for further colonization and weathering [6][7]. Rock prokaryotic and eukaryotic microbial communities are, therefore, crucial in the preservation of drylands and a deep understanding of their diversity and functionality is of high importance in an era of global warming and rapid expansion of desertification.

Bare rocks dominate the landscape in the ice-free areas of Continental Antarctica as from the McMurdo Dry Valleys to mountain peaks rising from the Polar Plateau along the Victoria Land. They are the primary substratum for life, supporting the highest permanent biomass in these regions [8][9][10], described as the harshest cold and hyper-arid deserts on Earth. Despite different rock typologies, as dolerites and granites are present in this area, sandstone is by far the most widespread and suitable substratum for cryptoendoliths [11][12][13]. Among the typologies of cryptoendolithic colonization, the lichen-dominated community is the most complex and widespread [11]. These communities are self-supporting assemblages of phototrophic and heterotrophic microorganisms, including bacteria, Cyanobacteria, Chlorophyta and both free-living and lichen-forming fungi [4][14]. These are among the most stress-resistant organisms known to date, constantly living to the edge of their physiological adaptability [3][11].

2. Datas

Recent molecular studies are providing new insights into the distribution, biodiversity and composition of the Antarctic cryptoendolithic communities and a new understanding of their response to environmental pressure is arising [13][14][15][16][17][18][19]. Besides, these studies clearly highlighted that biodiversity is highly variable in rock samples, not only from different localities, but also for rocks coming right from the same locality [13]. The uncertainty in gathering the complete metacommunity hampers a deep understanding and an appropriate description of the biodiversity and functionality of these border ecosystems. Planning a proper sampling, assuring a reliable estimation of microbial biodiversity, is of importance for different reasons. Firstly, reaching these remote locations is risky and also requires tremendous logistical and economical efforts; therefore, each campaign should be well-planned to gain the highest results and avoid the necessity of successive re-sampling. Secondly, most of these locations are strictly protected, representing a nearly pristine environment, largely undisturbed and uncontaminated by humans. The McMurdo Dry Valleys, for instance, as a whole, are designated as ASMAs (Antarctic Specially Managed Areas), and include five different ASPAs (Antarctic

Specially Protected Areas) to protect these outstanding environments. Specific permits are required to enter and the possibility of sampling is limited. Hence, the thorough definition of a proper sampling amplitude for biodiversity studies is critical to minimize the environmental impacts.

In an era of global warming and rapid desertification, the study of these self-supporting microbial communities dwelling inside rocks in arid areas is of utmost importance since they play a pivotal role in the balance and functioning of these ultimate ecosystems, regulating water retention and nutrient cycles and creating positive feedback for further colonization.

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