Geophysical Research Abstracts, Vol. 9, 06711, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06711

Community structure and micro-scale distribution in endolithic microbial desert ecosystems

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The microbial colonization of rock fissures and cavities leads to the formation of endolithic biofilms, harbouring different species that interact with each other and with the substrate. Endolithic biofilms support life under a relatively broad range of environmental conditions, and are often the dominant or even the only biological components of extreme terrestrial environments, such as those of hot and cold desserts. Given the role of endolithic communities as carbon reservoirs across large areas and their potential involvement in different biogeomorphological processes, there is currently mounting interest in the geomicrobiological analysis of these extreme ecosystems.

Identifying endolithic desert microorganisms is problematic since most of them are typically difficult to culture and the morphology of laboratory cultures may not always represent their native forms. For a more holistic picture of endolithic microbial diversity, combined molecular/ultrastructural studies are needed. In this study, both molecular and ultrastructural techniques were used to explore the microbiota of endolithic microbial ecosystems from desserts such as the Dry Valleys in Continental Antarctica, the Negev (Israel) and the Atacama (Chile), and the microhabitats colonized by the different microorganisms were characterized by a combined microstructural approach. Through this integrated study, not only were endolithic microorganisms identified but we were also able to establish the micro-scale distribution of these species, and hence the potentially specific interactions occurring in the system. Further, by jointly analysing microorganisms and their microhabitats insight can be gained into the function of biodiversity in these environments. Different patterns of micro-scale species distribution could be recognized, in which the formation of distinct microenvironments was detected. These observations suggest that endolithic micro-scale distribution in these environments depends not only on environmental factors and the physico-chemical properties of the lithic substrate but also on the nature of its biological components. Biomobilization and biomineralization processes were associated with certain species and close relationships between microorganisms belonging to different groups such as heterotrophic bacteria and cyanobacteria were frequently observed. Our data clearly indicate a much greater biocomplexity of these microbial ecosystems than previously imagined.