

Lichens and biofilms on the engraved rocks of Valle Camonica (UNESCO site n.94, Italy): Five years of investigations on biodiversity, biodeterioration and control strategies

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The negative impact of lithobiontic communities on the appearance and legibility of engravings is a major cause of concern for the management of rock art areas. Accordingly, periodic cleaning of engraved rocks is a common practice -first of all to avoid the disappointment of visitors and scholars-, but the efficacy of adopted protocols has rarely been experimentally verified as well as their sustainability for the substrate stability and the safety of surrounding environment. In this context, five years of investigations on lichens, microcolonial fungi, and cyanobacteria-dominated biofilms which colonize the engraved sandstones of Valle Camonica (UNESCO site n.94, N-Italy) will be reported and discussed to illustrate the potential contribution of biological diagnostics to management decisions in rock art areas. The focus will be first on the variability of the patterns of interactions of lithobionts with their substrate, determining different effects on the stone durability and, consequently, potential advantages and/or threats from their removal. As a second step, the recognition of environmental factors favoring rapid (re-)colonization phenomena on cleaned surfaces will be considered as crucial approach to develop preventive conservation strategies. Focus will also be given on the necessity of experimentally assessing the efficacy of devitalization treatments which are usually coupled with mechanical approaches to remove lithobionts: for both chemical and physical methods, including traditional and innovative ones, the application protocol and the metabolic state of target organisms at the time of treatment may significantly affect the devitalization efficacy and, finally, the medium-term success of cleaning interventions. Moreover, the importance of rock preservation treatments (application of biocides, consolidants, ...) after cleaning to delay (re-)colonization processes will be examined at the light of a four-years monitoring program. Finally, proposals for management strategies combining a sustainable control of biodeterioration issues and the valorization of lithobiontic biodiversity as an additional cultural value in rock art areas, of potential interest for visitors, will be illustrated.