

Article

Biological Control of Phototrophic Biofilms in a Show Cave: The Case of Nerja Cave

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Abstract: Cyanobacteria and microalgae are usually found in speleothems, rocks and walls of show caves exposed to artificial lighting. These microorganisms develop as biofilms coating the mineral surfaces and producing aesthetic, physical and chemical deterioration. A wide number of physical, chemical and environmental-friendly methods have been used for controlling the biofilms with different results. Natural biological control has been suggested by some authors as a theoretical approach but without direct evidence or application. Here we report the finding of a natural biological control of phototrophic biofilms on the speleothems of Nerja Cave, Malaga, Spain. The formation of plaques or spots where the phototrophic microorganisms disappeared can be assumed on the basis of processes of predation of bacteria, amoebas and some other organisms on the phototrophic biofilms. This study aims at investigating the potentialities of the biological control of phototrophic biofilms in caves, but the originality of these data should be confirmed in future studies with a larger number of biofilm samples in different ecological scenarios.

Keywords: phototrophic biofilms; show caves; biological control; bacteria; cyanobacteria; amoeba

1. Introduction

Traditionally, caves have been considered as extreme environments characterized by low nutrient inputs. Although this may be possible in a few caves, most of the show caves cannot be considered extreme or oligotrophic environments because natural factors are often modified due to different anthropogenic impacts, being one of the most evident the installation of electrical lighting to facilitate visits. In fact, when caves are illuminated by natural or artificial lighting, phototrophic microorganisms become predominant. Under these conditions, complex communities develop on speleothems, walls and ground, mostly composed of cyanobacteria and algae, heterotrophic bacteria and fungi, and other eukaryotic organisms embedded in a matrix of extracellular polymeric substances. In further steps, mosses, ferns and other plants may also colonize caves. Examples of these communities have been studied in artificially illuminated show caves and catacombs, because their unconstrained growth can induce damage on valuable archeological or natural rock surfaces [1–3].

The biofilms cause aesthetic, physical and chemical damage [4,5], subject of great concern in general, and in particular in cases of caves with rock art paintings [6]. In addition, this invasion of foreign microorganisms induces great changes on the autochthonous microbial population, adapted to minimal inputs of C and N, and on the cave ecology.