Chapter 7

Molecular Identification of Fungi in Outdoor Sandstones of Cultural Heritage Buildings for Modeling Their Biodeterioration

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ABSTRACT

Our cultural heritage kept in sandstone is doubtless suffering from accelerated biodeterioration. Fungi play a key role, either by acid production, dye secretion or as microbiont in the symbiotic association of the lichen with algae. The use of the universal initiators for the amplification of conserved regions of the ribosomal genes has been serving as an excellent marker for the microorganism identification, due to the ubiquity and conservation of these regions present in the genome of the eucarionts. In this chapter, the different fungi species present in sandstone were identified using molecular analysis techniques, as amplifiers in genes chains and the sequentiation of the resultant fragments. A theoric model of the way that the fungus contributes to the biodeterioration of monuments is proposed, with the objective of a better understanding of the contributions of these microorganisms in the general process of biodeterioration.

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INTRODUCTION

The degradation of the stone is a natural phenomenon that occurs by the joint action of various factors and is part of the natural biogeochemical cycles that allow reuse compounds such as carbon, nitrogen, silicon, sulfur, etc. The deterioration of the stone may have different shapes and various factors act synergistically making it difficult to identify the degree of contribution that each part of the process. The current concern is for those stone materials have been used as construction materials and as part of the historical monuments and, therefore, of our cultural heritage. The study of these materials presents a complicated alternative to study because of the variety of materials used through history to the construction of the building historical monuments, and its study largely focuses on the particular situation and moment in which it is a monument, so it is difficult to generalize a case study since many of them are made with varying environmental conditions, different materials, different ages, etc. Environmental factors have been considered the main cause of deterioration in stone materials, including environmental pollution, especially on the premise that almost all monuments made of stone are exposed to weathering. The degradation of stones is promoted by phenomena such as acid rain, but other factors seem to play more important roles in this phenomenon. Sulfur oxides, nitrogen oxides, and carbon oxides are the main deteriorations of the stone since when combined with water they give rise to acid solutions that, when reacting with the materials of the stone, promote its solubilization. These pollutants are found in the environment in large quantities, due to the activities typical of urban areas. In addition, the use of pesticides, hydrocarbons generated by combustion, as well as other environmental pollutants have an indirect effect on the degradation of the stone, serving in some cases as a substrate for the development of microorganisms. (Kumar & Price 1999, p. 96).

BACKGROUND

In Mexico, the phenomenon of biodeterioration not been studied systematically, but in the few cases has been focused primarily in the case of the Mayan archaeological zone of the Yucatan Peninsula, on composed mainly of limestone (Videla et al., 2000). In these, we have found a heterotrophic microflora composed of bacteria, fungi, and cyanobacteria colonizing structural materials of such sites. They have identified fungal genus such as Aspergillus and bacteria such as Pseudomonas and Bacillus.

The few studies that have been done on the role of microorganisms in processes of deterioration of stone have shown that the activity of microorganisms has helped the stone is solubilized, which weakens its crystal structure (Videla et al., 2000). That is why it is of great interest to study the biodeterioration presented in the siliceous rock, particularly as a material of which are made largely of colonial buildings in cities both in Mexico and internationally.

The first step in the study of biodeterioration and the establishment of the conditions that generate this phenomenon is the identification of participant microorganisms. The micro-flora found in the stones of the buildings represents a complex ecosystem that develops regarding both the environment in which the stones, as the physic-chemical properties of the materials. We can divide them into the following groups: Photolithoautotrophs. (Cyanobacteria, mosses and higher plants), Chemolithoautotrophs (Thiobacillus, Nitrosomonas, and Nitrobacter) and Chemoorganotrophs (fungi, bacteria, lichens symbiotic-associations fungi and algae or cyanobacteria) (Warscheid et al., 2000).