

# **A COMPREHENSIVE STUDY OF BIOFILMS GROWING ON THE BUILT HERITAGE OF A CARIBBEAN INDUSTRIAL CITY IN CORRELATION WITH CONSTRUCTION MATERIALS**

Euler Gallego-Cartagena; Héctor Morillas; Maite Maguregui; Karen Patiño-Camelo; Iker Marcaida; Wendy Morgado-Gamero; Luis F.O. Silva; Juan Manuel Madariaga

## **Abstract**

Biodeteriogens growing on constructions belonging to the built heritage is one of the leading natural pathologies that cause aesthetical and in some cases, physical-geochemical problems in the materials. In this study, for the first time, the chemical composition of construction materials of the built heritage from an industrialized city (Barranquilla) of Colombia have been evaluated in correlation with the algal, cyanobacterial and fungal biodeteriogens present in biofilms by applying a multianalytical methodology. To achieve this objective, samples of biofilms and construction material were taken from different historical and modern constructions. For the mineralogical characterization of the construction materials, X-ray diffraction, Raman microscopy and energy dispersive X-ray fluorescence spectrometry (EDXRF) were used. In addition, microscopic observations and cultures were employed for the microbiological characterization. Most of the construction materials analyzed belong to calcareous mortars, and others to different types of cement (portlandite, ettringite and larnite identification). The EDXRF analysis through single point and imaging strategies allowed to identify differences in the elemental composition of the external and internal parts of the materials. The role of certain elements in the mortars, which will assist the growth of specific microorganisms, is also discussed in this work. The main biodeteriogens identified in the biofilms were

cyanobacteria *Oscillatoria* sp., *Lyngbya* sp., *Leptolyngbya* sp. and Ascomycota *Aspergillus niger*, *Aspergillus fumigatus*, *Penicillium* sp. and *Fusarium* sp fungi. These microorganisms promote biodeterioration processes causing aesthetic, physical and chemical damage to the façades of the studied buildings. The mineralogical composition of the construction material together with environmental conditions contributes to the development of biofilms on the constructions and monuments of Barranquilla city. The results obtained in this study will be used in the future to design and implement conservation protocols and strategies useful to preserve the built heritage of Caribbean cities with similar climate conditions, geographical position and kind of construction materials

## **Keywords**

Biofilms, Cyanobacteria, Fungi, Barranquilla, EDXRF spectrometry, Micro-Raman, XRD