An integrated approach to the preventive conservation of cultural heritage: indoor biological environmental monitoring

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In cultural-heritage-related indoor environments, biological particles represent a hazard not only to artefacts, but also to operators and visitors. Biological environmental monitoring is essential to assess any potential risk to the integrity of cultural objects and human health. We propose an integrated approach to the study of biological pollution in indoor environments, such as museums, libraries and archives, based on a methodological model for measuring microbial air and surface contamination, as well as allergens. The proposed approach relies on the analysis of 1) airborne microorganisms with active and passive methods; 2) surfaces of artefacts with non-destructive and non-invasive techniques based on nitrocellulose membrane filters; 3) fungal spores with a spore trap (Hirst type) and microscope; 4) surface and airborne allergens with immunoenzymatic assays; 5) airborne particles, with a laser particle counter; and 6) indoor microclimatic conditions, with a data logger monitoring air temperature, relative humidity, air velocity and mean radiant temperature, all combined with infrared measurements of surface temperatures. The Computational Fluid Dynamics (CFD) application for transient simulations, integrated with experimental data and applied to three dimensional models of the studied environment, is used to assess the indoor microclimate conditions. CFD plays an important role in the prediction of damage and risk, as it helps evaluate the efficiency, adequacy and reliability of ventilation systems. The CFD application can also provide critical indications for air quality control and energy saving, and can help establish maintenance criteria. Thanks to a grant by Cariparma Foundation, the proposed approach has been applied at the Palatina Library in Parma. For air microbial monitoring, a DUO-SAS 360 was used to measure the concentration of microorganisms in the air, expressed as CFU/m^3 (colony forming units per cubic metre), while settle plates were used to measure the rate at which airborne microorganisms settle on surfaces (Index of Microbial Air contamination, IMA). For surface contamination, two parameters were measured using nitrocellulose membranes: the Microbial Buildup (MB, the total number of microorganisms accumulated on a surface in an unknown period of time prior to the sampling) and the Hourly Microbial Fallout (HMF, the number of microorganisms that settle on a specific surface during one hour). A spore trap sampler (VPPS 1000) was also used for direct detection at the microscope of fungal spores, both viable and nonviable, and to measure the temporal distribution of the particulate. The results obtained represent a contribution towards the definition of standardized biological environmental contamination assessment methods that will help researchers define levels and environmental classes of biological contamination. This integrated biological (air and surfaces) and microclimatic approach represents a starting point to study the *environment-artefact-man* system and can lead to a better understanding and prevention of biological risks both to cultural materials and to the health of operators and visitors.

Topic: New methodologies for intervention, preventive conservation and maintenance

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