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Microbial identification for an effective biocleaning: the case study of the *Santa Lucia alle Malve* rupestrian church

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Identifying the microbial community that lives on the lithic cultural heritage through phenotypic and genotypic approaches is fundamental for understanding the contribution of colonisers in biodeterioration and selecting the best cleaning solutions with environmentally-friendly products. This was done with the cultivable microbiota present on the internal walls of the Santa Lucia alle Malve (SLM) rock church, recognised by UNESCO as a World Heritage Site. The SLM church is in the Sasso Caveoso area (Matera, South Italy). It is fully excavated in the limestone rock. Numerous frescoes cover the internal surfaces, but the bacterial and fungal colonisation spoils its beauty. The results of this study clearly showed the predominance of bacteria of the phylum *Firmicutes* and precisely of the genus *Bacillus,* whose prevalence may be due to the specific environmental conditions, very similar in all sampling sites of the church, and to their ability to produce endospores. These dormant forms allow bacteria to survive in unfavourable conditions. The genotypic approach showed that the various *Bacillus* species isolated on the surfaces of the experimented church are closely related and similar but show a different phenotypic profile. This diversity of physiological and morphological traits reflects the potential complexity of the metabolomes present in the bacterial communities of the internal walls of the SLM and confirms the need to identify the colonisers correctly and proceed with a non-temporary bio-cleaning. The results of bio-cleaning using *Solanum nigrum* extracts were effective, but the durability of the treatment has yet to be verified.