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Original

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Biocorrosion of speleothems driven by lampenflora: preliminary observations in Bossea show cave (NW Italy)

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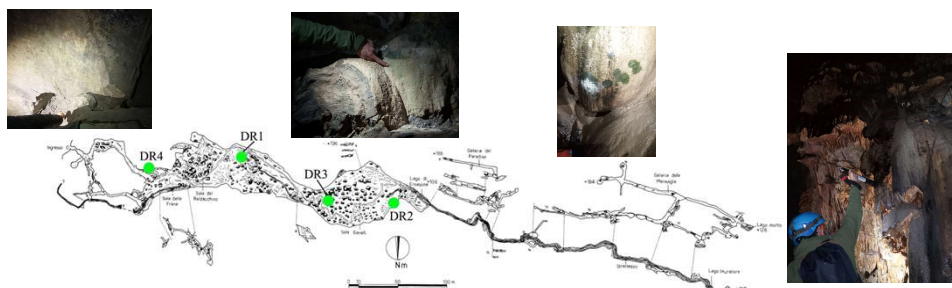
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Introduction

Speleothems in show caves are often subjected to tourism-driven alterations, including corrosion due to CO₂ increase, undersaturated water and photosynthetic biofilms. In particular, the growth of the so-called “lampenflora” causes physical, chemical and aesthetic damage to speleothems (Piano et al., 2015). In this work we investigated for the first time the biocorrosion of speleothems at microscopic level due to lampenflora from a geo-mineralogical point of view.

Materials and methods

We developed our study in Bossea show cave (NW-Italy) that represents the first cave opened to the public in Italy. Four sampling sites have been selected along the tourist path and, for each of them, 2 or 3 rock samples of 1x1 cm of 0.5 maximum thickness were taken on speleothems in close proximity of the lamps (halogen lamps until 2019, subsequently replaced with LED ones). Samples were assigned to one of the four subsequent categories, i.e. W: without lampenflora, LG: light green lampenflora, G: green lampenflora, DG: dark green lampenflora (Figure 1 and table 1).



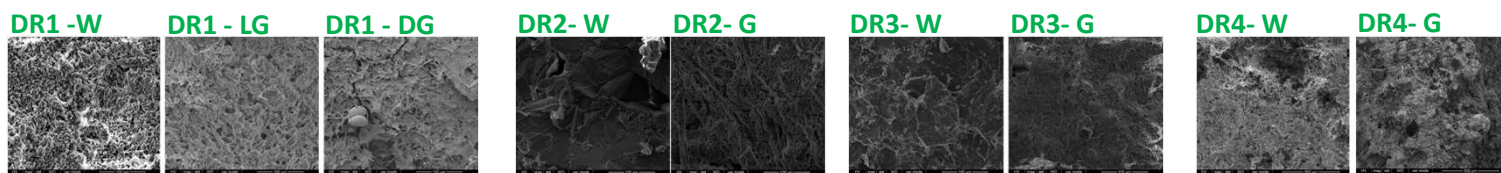
Sampling sites	samples
DR1	DR1- W
	DR1- LG
	DR1- DG
DR2	DR2- W
	DR2- G
DR3	DR3- W
	DR3- G
DR4	DR4- W
	DR4- G

During in situ sampling, the concentration of the main photosynthetic groups composing lampenflora (cyanobacteria, diatoms, and green algae) was measured with a portable fluorimeter (Benthotorch®).

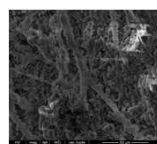
The substrate samples were analysed in laboratory by means of scanning electron microscopy (SEM) with Energy Dispersive X-ray spectroscopy (EDX), in order to assess the alteration degree of the rock substrate and the presence of lampenflora.

Results

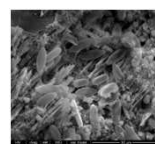
SEM images of speleothem samples show high abundance of diatoms and the presence of bacteria, algae, fungi, archea, and textile fibres. In the future, a direct relation between the results of the two investigations techniques and the weathering conditions of speleothems will be evaluated.



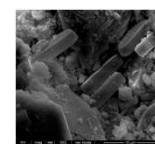
Sampling sites	samples	fluorimeter values			observation from SEM
		Diatoms	Cyanobacteria	Green Algae	
DR1	DR1- W	0.05	0.04	0.00	bacteria, archea
	DR1- LG	0.25	0.88	0.00	diatoms, bacteria, fungi
	DR1- DG	0.52	4.45	0.72	algae, bacteria, fungi
DR2	DR2- W	0.66	0.06	0.00	fungi
	DR2- G	3.30	6.56	0.00	fungi, bacteria
DR3	DR3- W	0.36	0.01	0.00	fungi
	DR3- G	4.81	6.86	0.23	all not recognized
DR4	DR4- W	0.32	0.04	0.00	nothing
	DR4- G	0.34	1.67	2.67	bacteria, diatoms



Bacteria and fungi in DR2- G



Diatoms: *Nupela trogliphila* + *Humidophila pyrenaica* In DR1- LG



Diatoms: *Humidophila pyrenaica* - DR4- G

In light of a long-term study aiming at evaluating changes in calcite crystal habits over time, a homogenous and newly formed speleothem was collected and divided into several parts, observed and photographed with SEM, and placed along the tourist path in areas colonized by lampenflora, near the new LED lamps, where they will remain for about a year. The samples will then be collected and re-examined at SEM to verify and eventually quantify the degree of biocorrosion after at least one year of exposition.