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BIODETERIORATION AND BIODEGRADATION OF ROMAN MONUMENTS: A COMPARISON OF THE CURRENT STATUS OF 18TH CENTURY PAINTINGS BY THE CANALETTOS

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Abstract

Worldwide there is an urgent need to monitor the conditions of monuments affected by biodeterioration and biodegradation, but no long term data exist for most of them. Here is an exception in the case of certain Roman monuments whose bioderioration and biodegradation agents were painted approximately 250 years ago by Giovanni Canal and Bernardo Bellotto, the Canalettos. In our study we compare four paintings with recent photographs of the same monuments by using grid counts. The mean area affected by visible biodeterioration and biodegradation decreased less than 2% since the time of the Canalettos´s paintings (Chi-Square $p < 0.004$) and the improvement mostly involves higher plants. We urge others to find old paintings and photographs that can be used for similar studies in other cultural resources.

Keywords: *Biodeterioration and biodegradation; Conservation; Stone monuments; Bacteria; Moss; Lichens*

Introduction

Worldwide, human cultural resources suffer from important degradation and deterioration caused by natural and human factors [1, 2]. However, the dangers of monument degradation and deterioration were not generally recognized until the 20th century and during the 19th century there was mention of tourists carrying in their luggage hammers and chisels, to take home pieces of the monuments they visited [3]. By the 1960´s the awareness about threats to monuments had increased and it was clear that besides humans and climatic factors, other organisms were also damaging monuments of cultural value [2, 4].

As a result of the deterioration problem, there is an urgent need to monitor the conditions of monuments over time [5] and new techniques are constantly being developed for this purpose, including, for example, the penetrating radar used in the Habib Sakakini Palace [6] and the hyperspectral imaging fluorescence lidars recently applied on the Roman Coliseum [7]. Unfortunately, no long term monitoring exists for most monuments anywhere in the world, so there is practically no objective knowledge of how conditions have changed in recent centuries. However, there is an exceptional case: some Roman monuments were realistically painted

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about 250 years ago by Giovanni Canal (1697 -1768) and Bernardo Bellotto (1721-1780), also known as the Canalettos and that allowed us to make an assessment of how the monuments conditions have changed since the 18th century.

The objective of this short article is to call attention to the potential that a technique using old paintings and photography has to assess historical changes in monument biodeterioration and biodegradation. For this purpose we used a statistical analysis to compare the presence of biodeterioration and biodegradation agents in some Roman monuments in the present time and in the times of the Canalettos.

Materials and Methods

We know that the Canalettos visited the Roman monuments and sketched them in detail before starting their paintings, and that their work was done in a period known as the *vedute* genre, in which realism was important [8]. That view of how an artist had to execute his painting was in agreement with the fact that they included stone cracks and missing parts and the vegetation growing over the monuments, rather than correcting them as they could easily have done in the paintings (Fig. 1).

We checked a catalogue of the paintings (http://fe.fondazionezeri.unibo.it) and selected four that presented known Roman monuments and their biodeterioration and biodegradation. We also visited the monuments, on January 2013, to check their current condition and used published photographs for our analysis (Fig. 2).

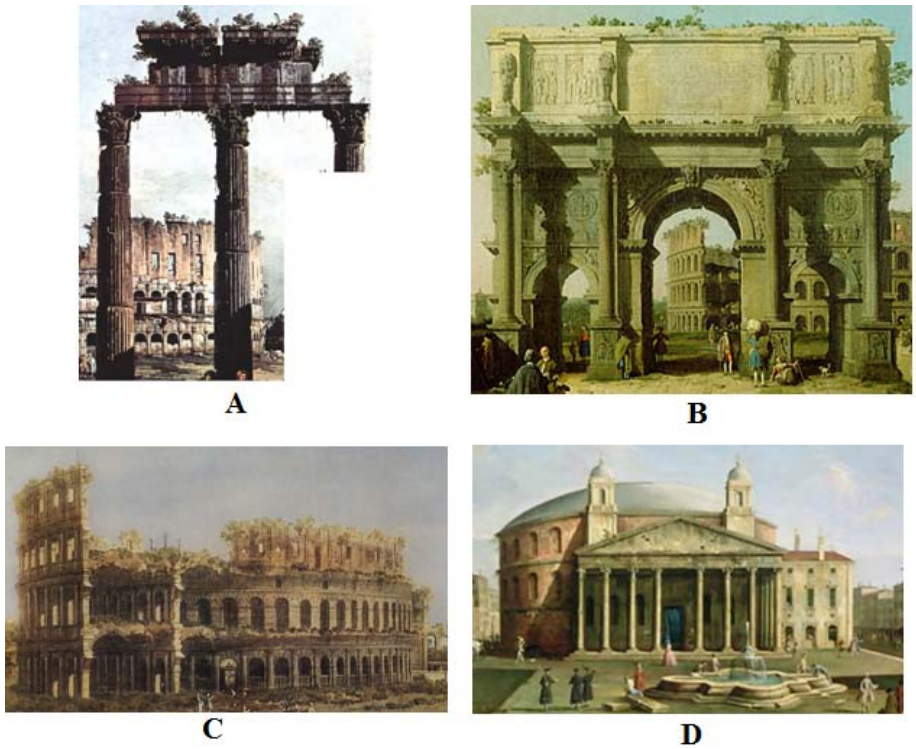

Fig. 1. Paintings used in this study: A. Capriccio Romano, Colosseum - Bernardo Bellotto, The National Gallery, London; B. Arco di Costantino con il Colosseo, Giovanni Canale; C. Il Colosseo, Antonio Canaletto, Lampronti, Milano; D. Il Pantheon, Bernardo Bellotto, Museum of Fine Arts, Budapest, Hungary.

On every image we applied a technique commonly used in lichen studies: we superimposed a grid (mean 45.5 cells per image) on each image and for each cell we

determined the dominant condition as descriptions: "Stone without visible biodeterioration and biodegradation agents", “Stone on which bacterial growth dominates” and "Stone with higher plant growth" (Fig. 3). That data amounted to an assessment of the total number of cells with each condition for our statistical test and we also calculated the mean values for figure 4.

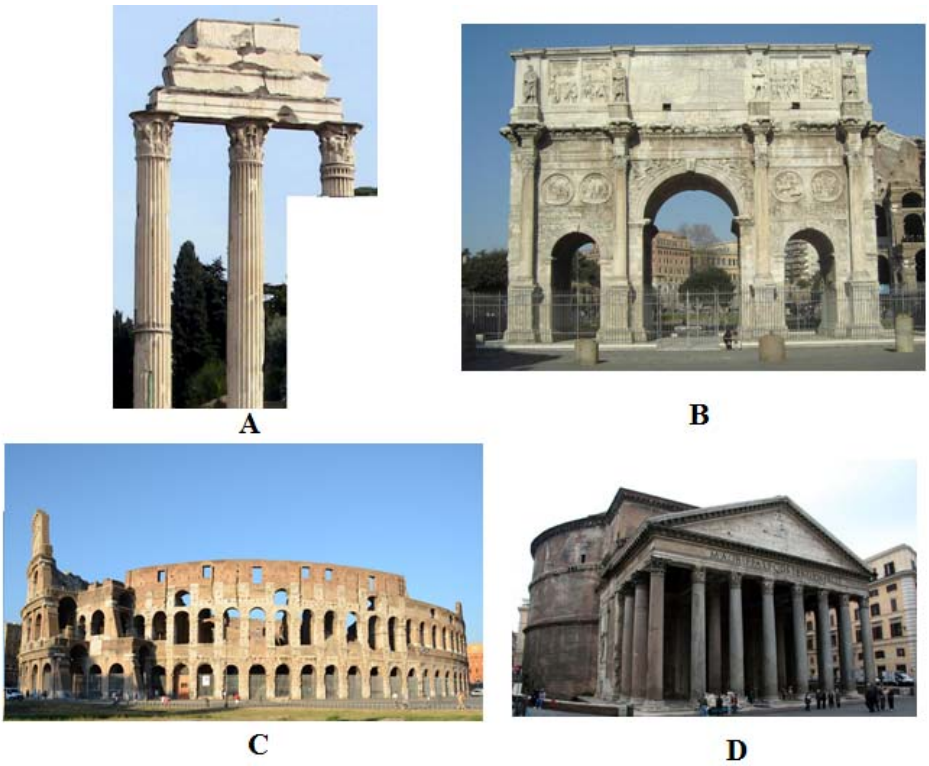

Fig. 2. Corresponding photographs used for the comparison (source: Wikimedia Commons).

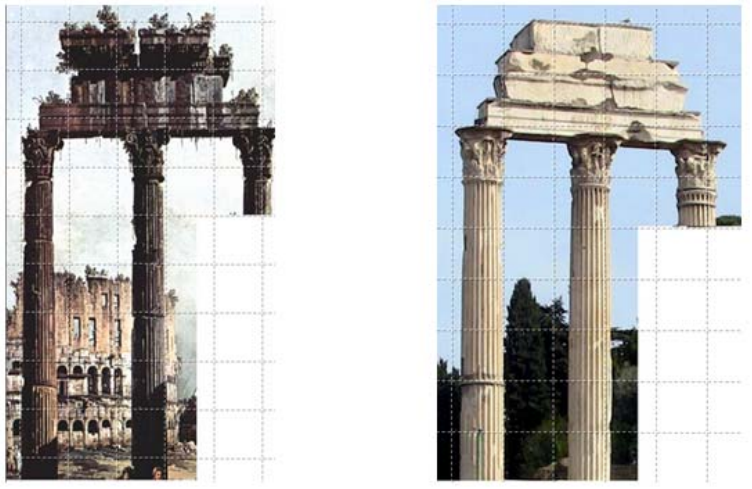

Fig. 3. Sample of the grid used to quantify the dominant biodeterioration agents in the images.

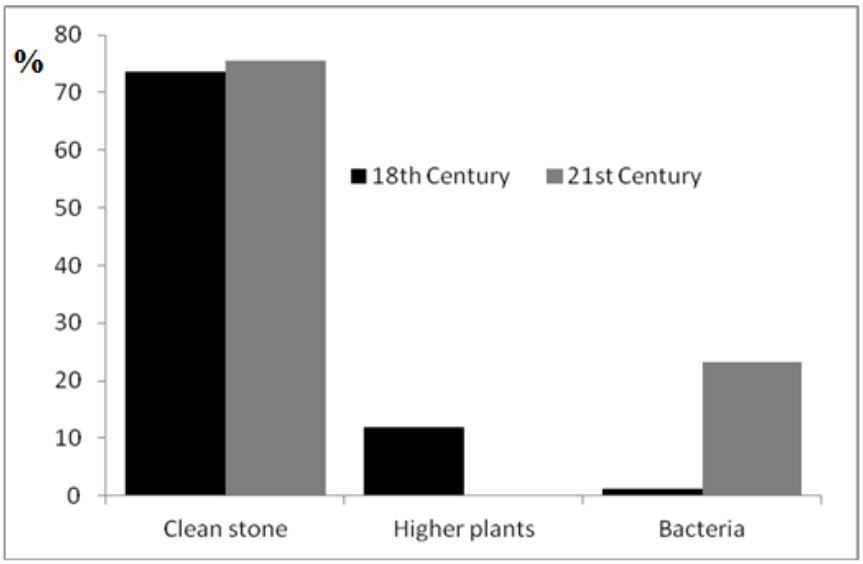

Fig. 4. Mean percentage of grid cells dominated by clean stone, stone covered with higher plants and stone covered with cyanobacteria. Range bars not included because sample size is 4.

Results

According to the scenes painted by the Canalettos, the Roman monuments considered in this study were relatively clean of visible biodeterioration and biodegradation agents at the time they were painted, with only a mean value of 26% of threatened cover (mostly affected by higher plants, Fig. 1). In 2013 the proportion of clean areas was slightly higher and most of the threatened cover was affected by bacteria (around 24%, Fig. 2). The proportions of biodeterioration and biodegradation agents were significantly different in the paintings and in the photographs (Contingency Chi-Squared Test = 7.97, $p < 0.004$).

Discussion

We did not find any previously published study that used old paintings to assess the biodeterioration and biodegradation of stone monuments, so we cannot compare our results with equivalent previous works. However, a valid question is how reliable the paintings are for assessing the condition of the monuments. We cannot think of any reason why the artists would add biodeterioration and biodegradation agents to paintings and the other option, that they removed such agents from the paintings is also improbable, because at least plants are conspicuously painted on the stone walls and the surrounding ground. Thus, the paintings can be reasonably accepted as rough representations of what they saw at the time [8].

The fact that the Canalettos´s work shows Roman monuments that were mostly clean of visible biodeterioration and biodegradation agents may suggest that some maintenance work was done in their time, but that would fail to explain the abundance of higher plants growing on the walls and beams. The absence of bacteria and lower plants. such as mosses and lichens, in the paintings may represent their real condition, if the climate was drier in the 18th century [9], but this is unlikely [10, 11]. In any case, visible color modifications are normally indicative of biodeterioration and biodegradation [12] and that would be a detail expected to be noticed by

painters, who work with light and color. Thus, if bacteria and lower plants were there, the artists may not have chosen to paint them.

It may be surprising that despite the limited resources currently allocated to preservation the proportion of clean stone in those Roman monuments is only slightly higher today than in the 18th century, but at least there were no higher plants in our January 2013 sample pictures.

Our results agree with previous works [10], in that bacteria are important biodeterioration and biodegradation agents in Rome. Curiously, a common deterioration agent of Roman structures today is *Erigeron karvinskianus* DC, a plant from Latin America [13] that had apparently replaced the unknown species that appear in the Canalettos paintings.

The ecology of biodegradation and biodeterioration is still in its infancy and while factors such as the effect of stone type and porosity on damage and on the establishment of biodeterioration and biodegradation agents are known, [14] other factors, such as the role of birds as vectors of seeds that germinate on monuments [15], require much more attention from researchers.

The reason that the known threats to stone, such as mosses, are present in those Roman monuments today, albeit not in large patches, may be the lack of resources allocated for conservation and the fact that treatment must be limited to avoid the damages that cleaning itself may produce [16, 17].

Conclusions

We want to warn researchers that results from a temperate place such as Italy cannot simply be applied to cultural monuments in tropical countries, where the environmental and biological factors are different [18]. We hope this study will inspire others to find old paintings and photographs that can be used for similar studies on other cultural resources: only this way can we reach the goal of a long term view of how our monuments have been affected by biodeterioration and biodegradation and, more significantly, of how they can be protected.

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References

[1] J.M. Garcia De Miguel, L. Sanchez-Castillo, J.J. Ortega-Calvo, J.A. Gil, C. Saiz-Jimenez, *Deterioration of building materials from the Great Jaguar Pyramid at Tikal, Guatemala,* **Building and Environment, 30**(4),1995, pp. 591-598.

[2] G. Pope,T. Meierding, T. Paradise, *Geomorphology's role in the study of weathering of cultural stone,* **Geomorphology, 47**(2–4), 2002, pp. 211-225.

[3] M. Twain, The Innocents Abroad (first edition), American Publishing Company, New York, 1869 , p. 685.

[4] UNESCO. *Monumentos en peligro,* **El Correo, 18**, 1965, pp. 4-6.

[5] M. El-Gohary, *The Contrivance Of New Mud Bricks For Restoring Andpreserving The Edfa Ancient Granary - Sohag, Egypt,* **International Journal of Conservation Science, 3**(2), 2012, pp. 67-78.

[6] S. Hemeda, *Ground Penetrating Radar Investigations for Architectural Heritage Preservation of the Habib Sakakini Palace, Cairo, Egypt,* **International Journal of Conservation Science, 3**(3), 2012, pp. 153-162.

[7] J. Hällström , K. Barup, R. Grönlund, A. Johansson, S. Svanberg, L. Palombi, D. Lognoli, V. Raimondi, G. Cecchi, C. Conti, *Documentation of soiled and biodeteriorated facades: A*

case study on the Coliseum, Rome, using hyperspectral imaging fluorescence lidars. **Journal of Cultural Heritage, 10**, 2009, pp. 106-115.
[8] K. Baetjer, J.G. Links, **The Canalettos** (First edition), The Metropolitan Museum of Art, New York, 1989, p. 387.
[9] G. Caneva, E. Gori, T. Montefinale, *Biodeterioration of monuments in relation to climatic changes in Rome between 19–20th centuries*, **Science of The Total Environment, 167**(1–3), 1995, pp. 205-214.
[10] M.R.D. Seaward, C. Giacobini, M.R. Giuliani, A. Roccardi, *The role of lichens in the biodeterioration of ancient monuments with particular reference to central Italy*, **International Biodeterioration, 25**(1–3), 1989, pp. 49-55.
[11] A. Danin, G. Caneva, *Deterioration of limestone walls in Jerusalem and marble monuments in Rome caused by cyanobacteria and cyanophilous lichens*, **International Biodeterioration and Biodegradation, 26**(6),1990, pp. 397-417.
[12] A. Sakr, M.F. Ali, M. F. Ghaly, M. El-Sayed, F. Abdel-Haliem, *Discoloration of Ancient Egyptian Mural Paintings by Streptomyces Strains and Methods of its Removal*, **International Journal of Conservation Science, 3**(4), 2012, pp. 249-258.
[13] A.M. Bellinzoni, G. Caneva, S. Ricci, *Ecological trends in travertine colonisation by pioneer algae and plant communities*, **International Biodeterioration and Biodegradation, 51**(3), 2003, pp. 203-210.
[14] A. Kumbaric, S. Ceschin, V. Zuccarello, G. Caneva, *Main ecological parameters affecting the colonization of higher plants in the biodeterioration of stone embankments of Lungotevere (Rome)*, **International Biodeterioration and Biodegradation, 72**, 2012, pp. 31-41.
[15] M. Lisci, M. Monte, E. Pacini, *Lichens and higher plants on stone: a review*, **International Biodeterioration and Biodegradation, 51**(1), 2003, pp.1-17.
[16] S. Hemeda, *Geomechanical Investigations for Architectural Heritage Preservation. The Habib Sakakini Palace in Cairo,Egypt*, **International Journal of Conservation Science, 4**(1), 2013, pp. 43-52.
[17] F. Valentini, A. Diamanti, G. Palleschi, *New bio-cleaning strategies on porous building materials affected by biodeterioration event*, **Applied Surface Science, 256**, 2010, pp. 6550-6563.
[18] C. McNamara, T.D. Perry IV, K. Bearce, G. Hernandez-Duque, R. Mitchell, *Epilithic and Endolithic Bacterial Communities in Limestone from a Maya Archaeological Site*. **Microbial Ecology, 51**(1), 2006, pp. 51-64.

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