

# Biocontamination assessment and microbiological characterization of outdoor sculptures: “O Guardador do Sol” case study

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## Introduction

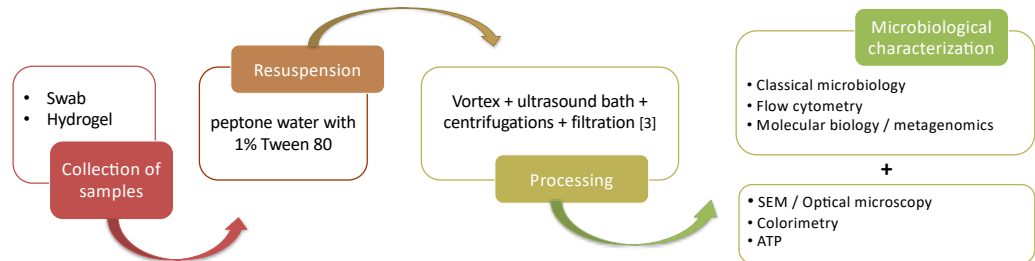
Outdoor sculptures are some of the most vulnerable cultural heritage objects due to their constant exposure to uncontrollable environmental elements, high levels of pollution, and a great variety of microorganisms growing on its surface. The combination of these factors causes aesthetic and physicochemical alterations on outdoor sculptures, which place them at high risk of deterioration and contribute to the loss of the artworks' value [1, 2].

Here we present the results on the biocontamination condition of the outdoor bronze sculpture “O Guardador do Sol” by José Rodrigues. This is one of the sculptures currently being studied under the scope of BIONANOSCUPL, an ongoing research project focused on the prevention of microbiological growth on the surface of outdoor metal and stone sculptures by developing non-toxic antimicrobial coatings based on natural and sustainable sources.

## Methods



O Guardador do Sol (1953) by José Rodrigues, Museum of the Faculty of Fine Arts of the University of Porto, Portugal.



## Results

### Flow cytometry

Table 1 – Quantification of microorganisms by flow cytometry, in samples collected in O Guardador do Sol sculpture.

Sample	Swab			Hydrogel		
	Average number of microorganisms / $\mu$ L	Viable cells (%)	Non-viable cells (%)	Average number of microorganisms / $\mu$ L	Viable cells (%)	Non-viable cells (%)
D1	497	47	45	174	50	46
D2	631	67	27	260	43	53
D3	2066	36	58	681	73	19
D4	475	60	33	119	26	68
D5	405	49	33	489	9	89

### Total ATP

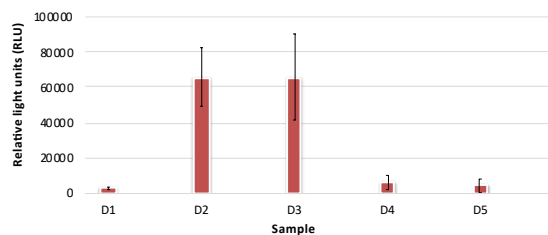


Figure 2 – Total ATP determination by bioluminescence in O Guardador do Sol sculpture.

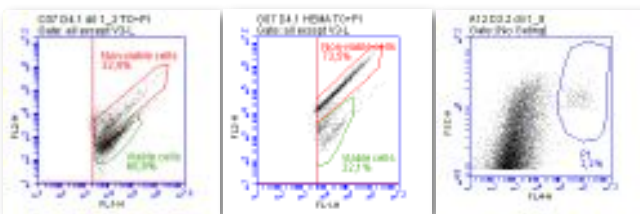


Figure 1 – Cytograms of samples collected in O Guardador do Sol sculpture, showing populations of viable (green) and non-viable (red) microbial cells, as well as a population of autofluorescent microorganisms (blue).

### Colorimetry

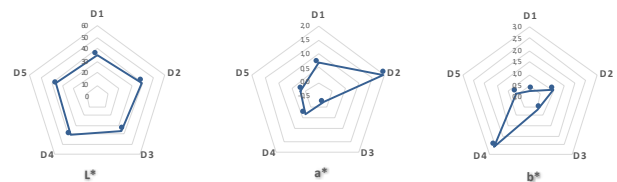


Figure 3 – Colorimetric measurements of O Guardador do Sol sculpture.

## Conclusions

- ✓ Quantification of microorganisms and cell viability was performed by flow cytometry, for samples collected either by swabbing the surface of the sculpture or by pressing small disks of hydrogels onto its surface.
- ✓ Higher concentrations of microorganisms were obtained using swabs rather than hydrogels.
- ✓ Samples collected in zones D2 and D3 of the sculpture have the highest average number of microorganisms/ $\mu$ L, which is in accordance with total ATP determination.

## References

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## Acknowledgements

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