EPIBOOST is funded by the European Union (EU) through the Grant 101078991 - views and opinions expressed those of the authors only and do not necessarily reflect those of the EU or the European Research Executive Agency; neither the EU nor the granting authority can be held responsible for them

Effects of Cadmium in *Acartia tonsa*

Epigenetic and phenotypic responses

Ana Beatriz Rodrigues[1], Ilias Semmouri[3], Albano Pinto[1,2], Inês P.E. Macário[1,2], Sérgio M. Marques[1,2], Joana Lourenço[1,2], Inês Domingues[1,2], **Joana Luísa Pereira**[1,2]✉ jpereira@ua.pt, Jana Asselman[3]

[1] Department of Biology, University of Aveiro, Aveiro, Portugal
[2] CESAM – Centre for Environmental and Marine Studies, University of Aveiro, Portugal
[3] Blue Growth Research Lab, Ghent University, Bluebridge Building, Ostend Science Park 1, 8400, Ostend, Belgium

Background

Increasing anthropogenic activities are impacting aquatic ecosystems, leading to contamination events that pose potential deleterious effects to organisms [1]. Cadmium is a trace metal with no essential biological role known and particularly harmful due to its high toxicity, persistence, and bioaccumulative properties[2].

Epigenetic and phenotypic responses that are responsive to Cd exposure can be integrated to understand the toxicity of the metal to copepods.

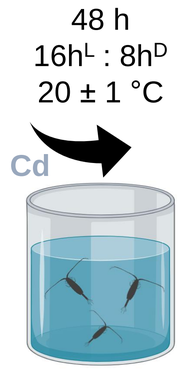
Aim

This study aims to understand the effects of short-term cadmium exposure on the copepod ***Acartia tonsa***, a zooplanktonic marine species with important ecological role [3], integrating total **DNA methylation** changes with phenotypic changes concerning **DNA damage** and **oxidative stress** at the sub-individual level, as well as **behaviour** at the individual level.

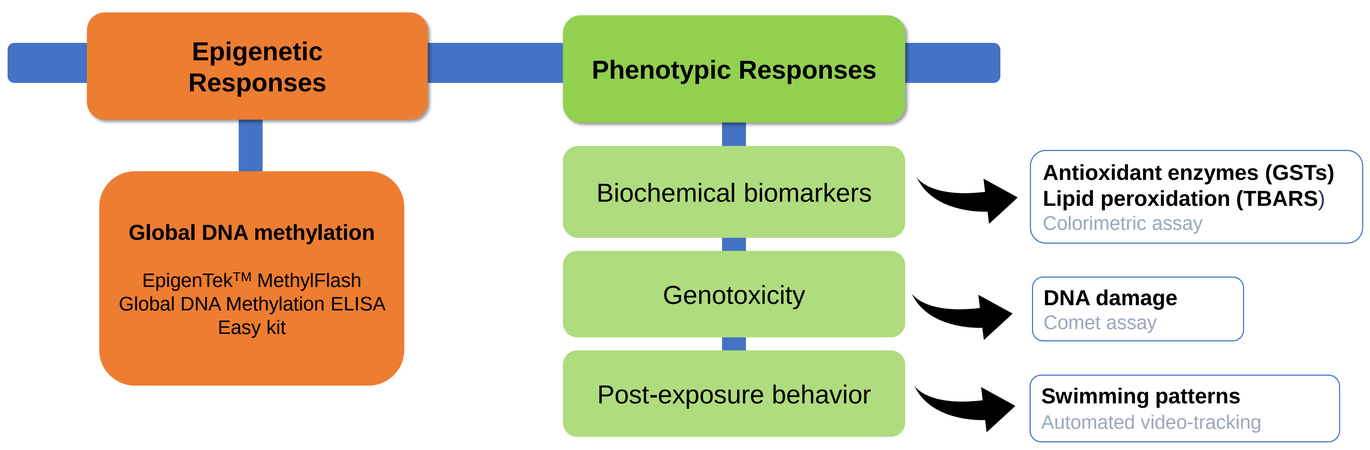
Methods

1 Exposure

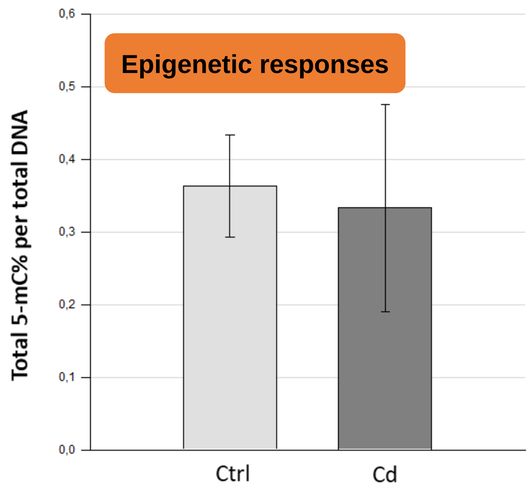
Evaluated endpoints	Exposure [Cd] µg/L	Replication
DNA	EC_{20} = 238.76	10 replicates | 70 adults/replicate
Genotoxicity	EC_{20} = 238.76	5 replicates | 30 adults/replicate
Oxidative Stress and Damage	EC_{20} = 238.76	4 replicates | 80 adults/replicate
Behaviour	904.258, 324.64, 281.6963, 238.76 (EC_{20})	68 adult individuals per treatment

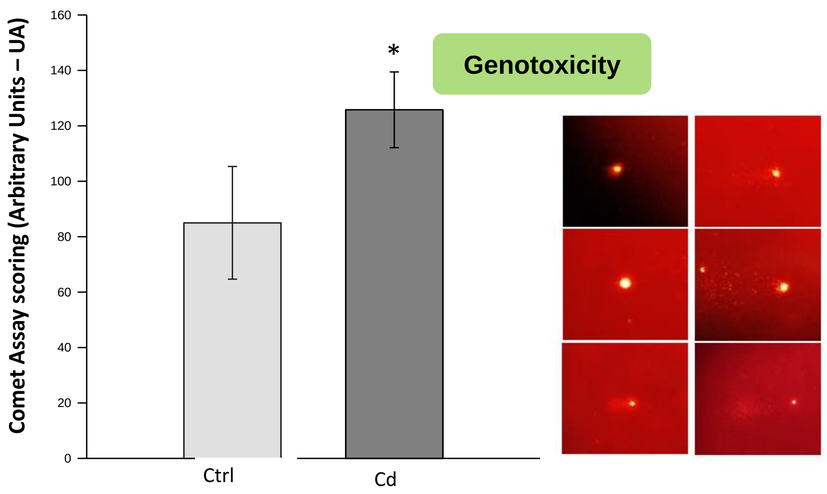


2 Biomarkers

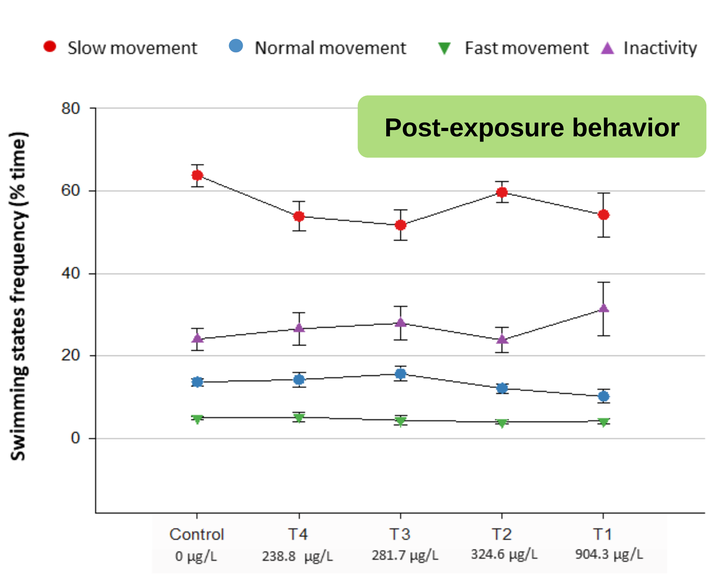


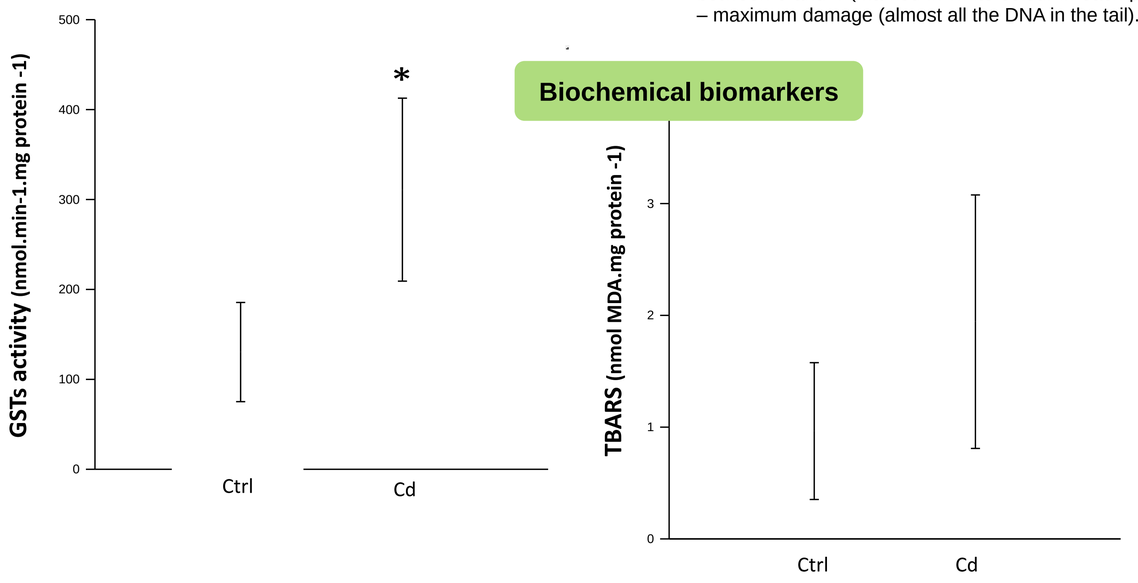
Results





Each comet is classified in five different classes for visual scoring class is given a value between 0 and 4 (marked in white colour in each photography): 0 – undamaged (no tail) and 4 – maximum damage (almost all the DNA in the tail).





- Global 5-mC DNA methylation levels slightly decreased among exposed copepods, but not significantly compared to the control group.
- Results indicate a significant increase in GST activity and genotoxicity due to cadmium exposure (t-test, $p < 0.05$). Lipid peroxidation also increased, although this change was not statistically significant.
- Swimming behaviour was affected at cadmium concentrations higher than that eliciting changes in other biomarkers, though the effects were not statistically significant.

Takeaway

- These findings highlight the sub-lethal effects of cadmium on *Acartia tonsa* and the convenience of multi-level biomarkers in assessing ecosystem health under human-induced stress.
- Despite limited knowledge on copepod epigenetics, evidence suggests epigenetic changes may aid rapid adaptation and phenotypic plasticity.
- This approach may clarify the links between epigenetic changes, gene expression, and phenotypic responses, helping to characterize the molecular basis of Adverse Outcome Pathways (AOPs) for cadmium-induced toxicity in *Acartia tonsa*.

References

[1] Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2023: Synthesis report. Contribution of Working Groups I, II, and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H. Lee & J. Romero, Eds.). IPCC. https://doi.org/10.59327/IPCC/AR6-9789291691647

[2] Sharma, M., Kant, R., Sharma, A. K., & Sharma, A. K. (2024). Exploring the impact of heavy metals toxicity in the aquatic ecosystem. *International Journal of Energy and Water Resources*, *Table 1*. https://doi.org/10.1007/s42108-024-00284-

[3] Turner, J. T. (2019). Trends in Copepod Studies. Distribution, Biology and Ecology. *Journal of Plankton Research*, *41*(2), 203–205. https://doi.org/10.1093/plankt/fbz001

Acknowledgements
This work was developed under the specific scope of the project EPIBOOST, funded by the European Union through the Grant 101078991. AP is grateful to FCT for the awarded individual PhD grant with the reference 2022.10817.BD