

Manganese-Induced Ultrastructural Alterations and Apoptotic-Like Responses in *Chlamydomonas acidophila* 137 Revealed by Electron Microscopy

Authors

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Introduction

Chlamydomonas acidophila is an extremophilic microalga adapted to acidic environments such as acidic mining lakes, with low pH and high concentrations of heavy metals. Its response to manganese remains largely unexplored despite Mn being a widespread and environmentally persistent contaminant.

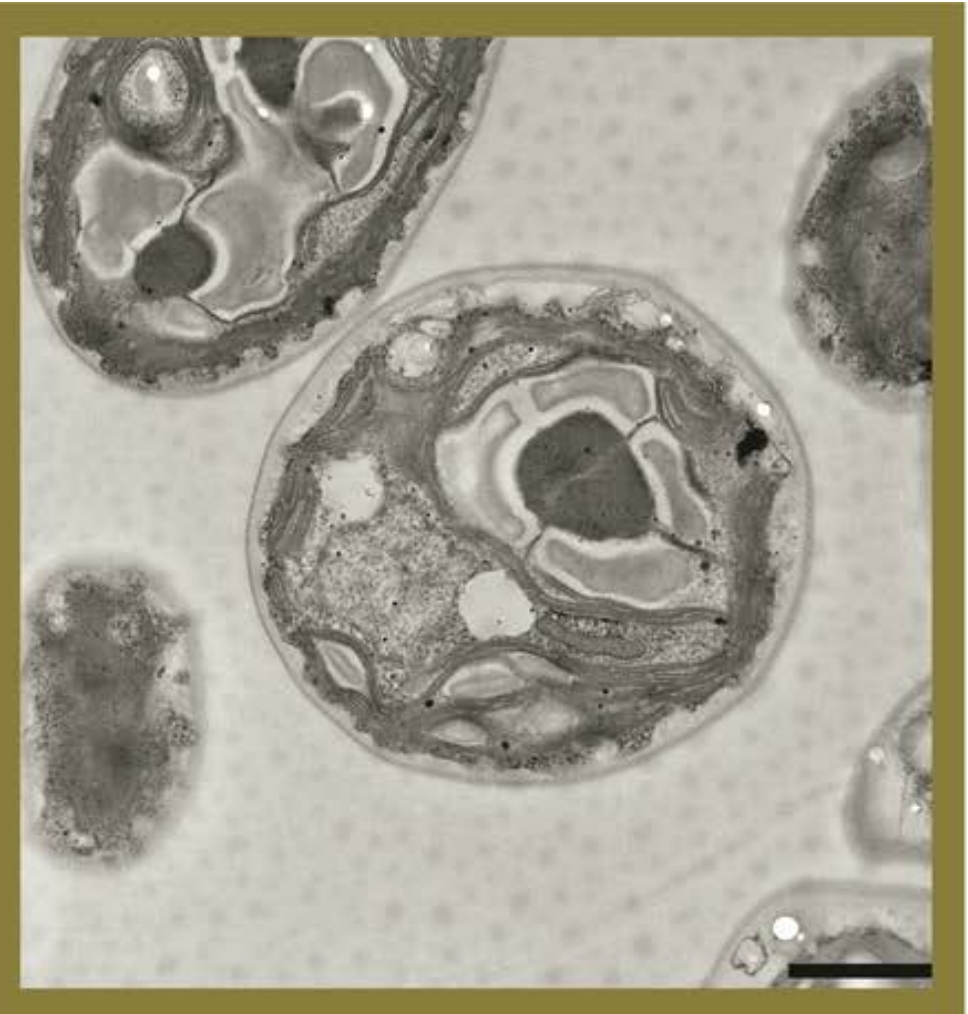
Results

Mn treatment induced two distinct cell types:
TYPE 1 Cells with mostly intact structure but minor damage:
Partial plasma membrane detachment.
Reduced protoplast area.
Smaller starch grains around the pyrenoid, suggesting possible impairment of photosynthesis.

TYPE 2 Cells with severe ultrastructural damage and signs of apoptotic-like cell death:
Plasma membrane rupture.
Nuclear pyknosis and karyorrhexis.
Extensive chloroplast disintegration.
Indications of apoptotic-like cell death.
Morphometric analysis: significant changes in protoplast dimensions after Mn treatment.



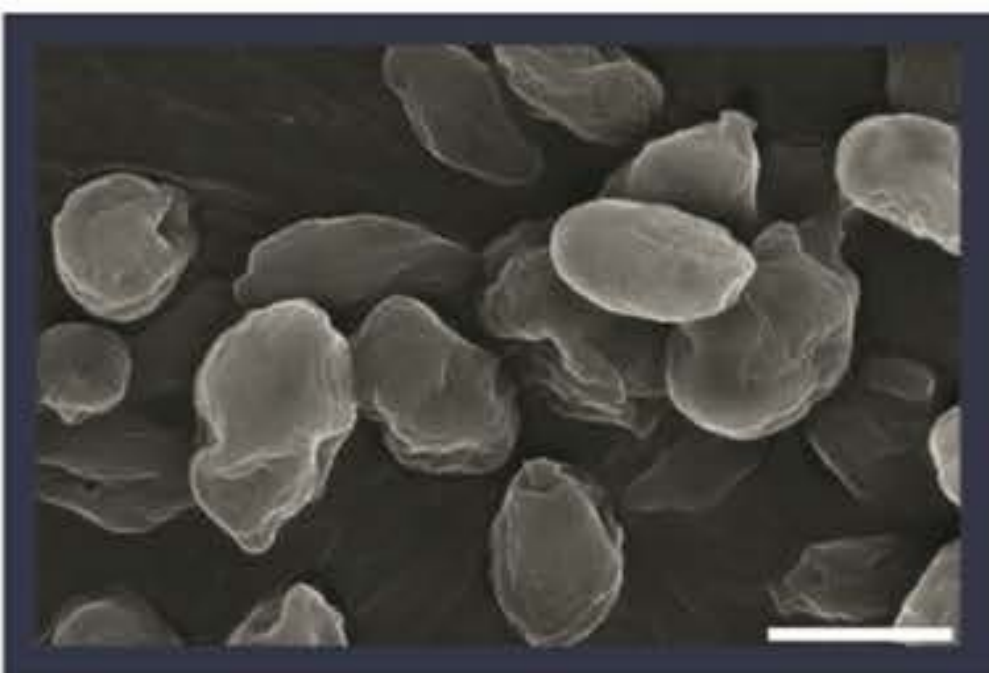
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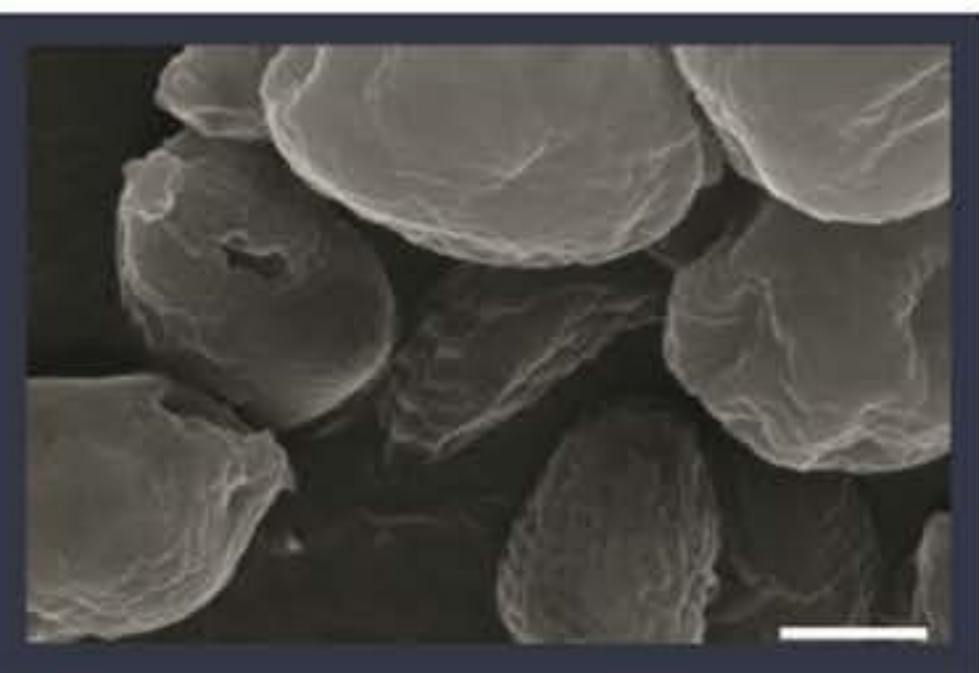
Mn treated cell type 1



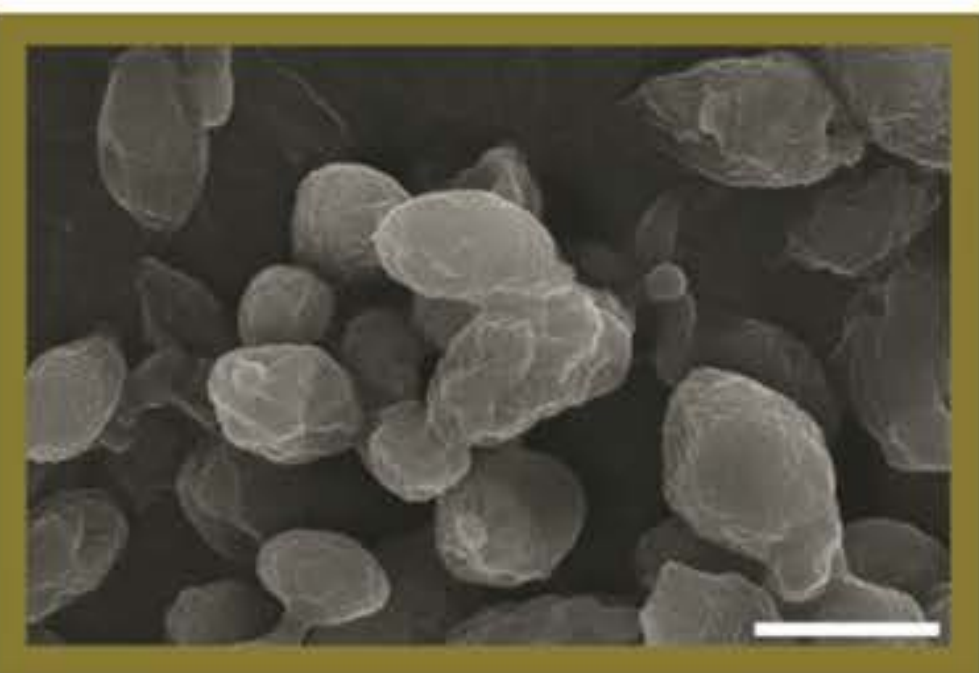
Mn treated cell type 2



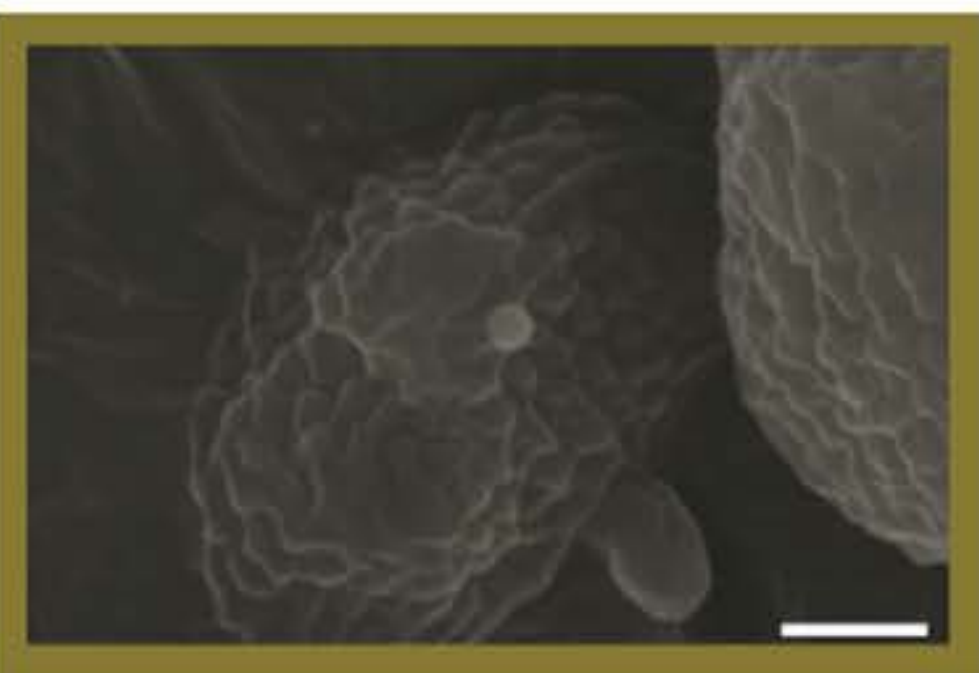
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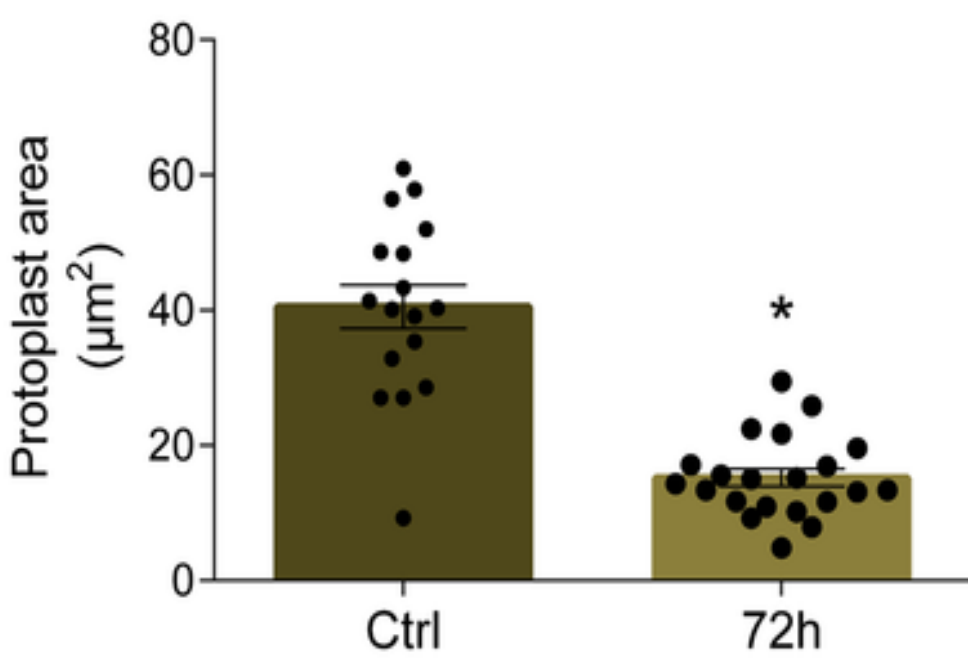
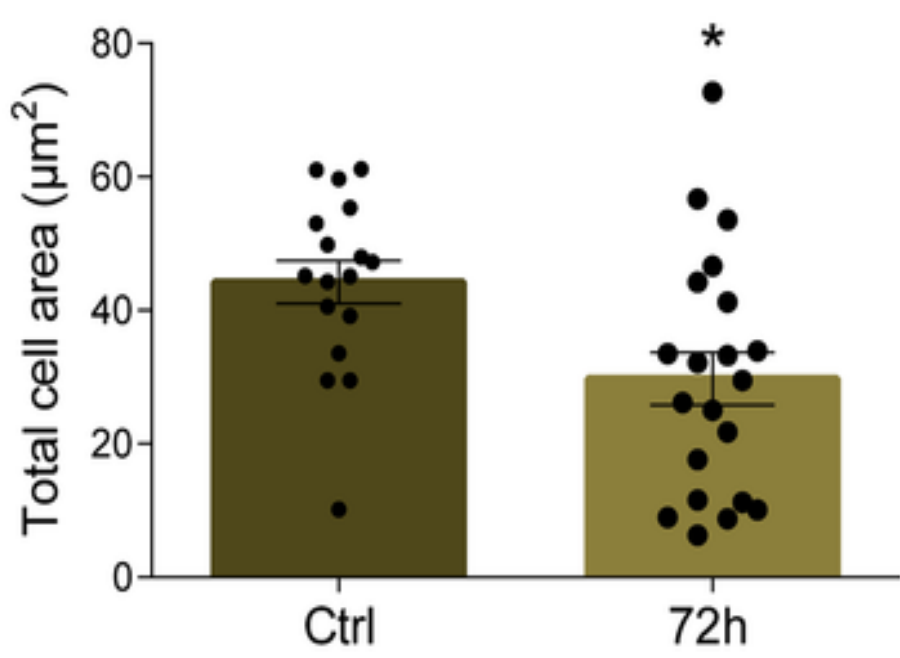
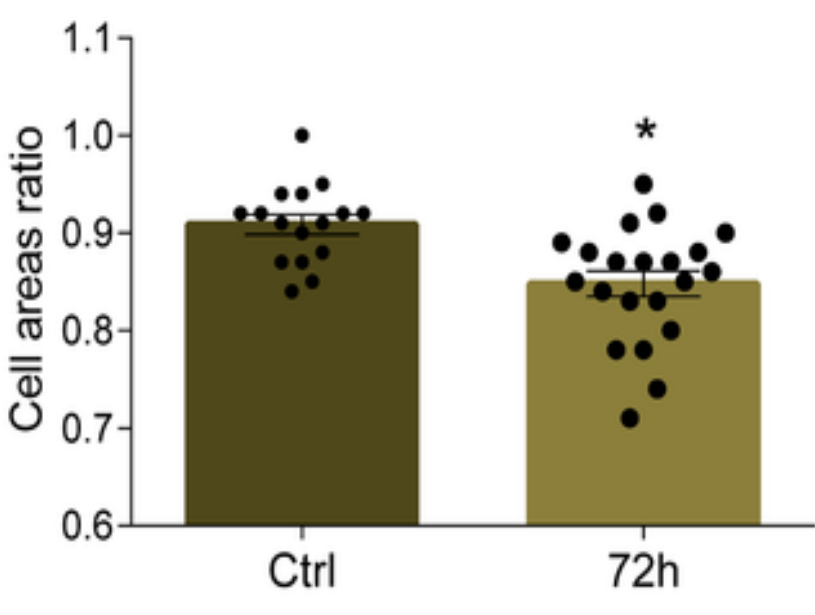
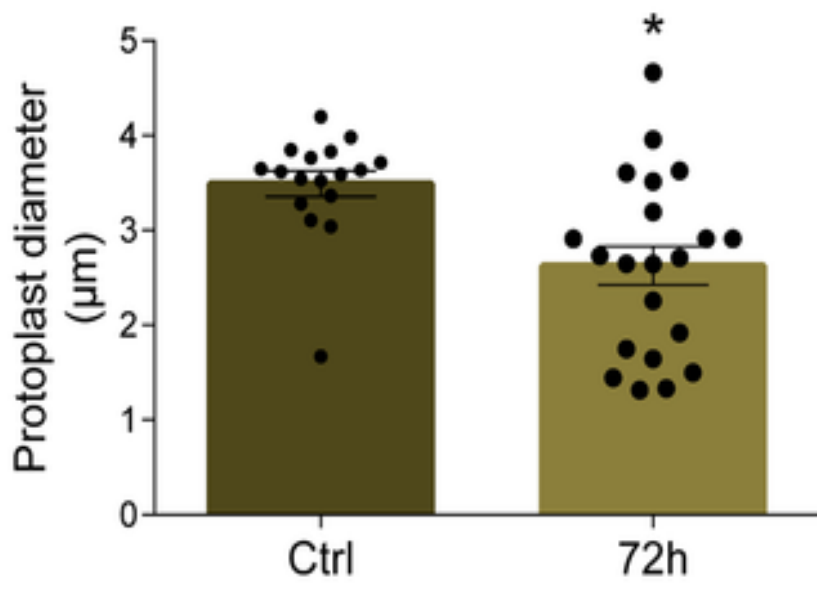
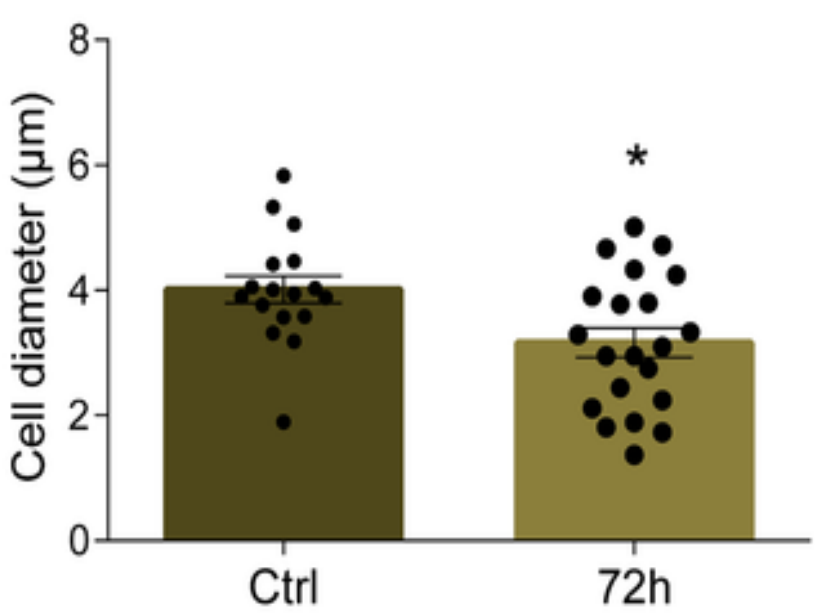


2mM MnCl2



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SEM analysis: no major changes in overall cell morphology or mucilage secretion, indicating stability at the cell surface.
Vesicle-like structures (200–400 nm):
Observed in both control and Mn-treated cells.
Similar to extracellular vesicles reported in microalgae.
May have roles in cell communication and stress adaptation.



Conclusion

Mn exposure induces pronounced intracellular alterations while maintaining external cellular morphology, highlighting a complex stress response involving both adaptive mechanisms and cell death pathways.

Related Literature

[1] F Puente-Sánchez, S Díaz and V Penacho, Aquatic Toxicology 200 (2018), p. 62.
[2] S Elmore, ToxicolPathol 35 (2007), p. 495.
[3] L Garaeva, E Tolstyko et al, Plants 14 (2025), p. 2354.

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