Hostless and Hungry: Investigating the Osmotrophic Capabilities of Free-Living Syndiniales

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Background

Syndiniales, is a parasitic Order of unicellular protists within the Phylum Dinoflagellata that play a vital role in marine ecosystem dynamics and biogeochemical cycling[1]. *Syndiniales* known members of this Order are parasites that can infect plankton, including photosynthetic and heterotrophic protists[2]. Despite their significance, there remains limited knowledge about the infectivity and survival of Syndiniales outside of the host. The ability to have a flexible metabolism beyond parasitism would provide an ecological advantage for survival during periods where host abundance is low. Investigating host-parasite interactions with Syndiniales (Figure 1) is critical for predicting and managing phytoplankton blooms initiation and demise, as well as addressing issues related to marine food webs and carbon cycles[3].

Syndiniales spp. Infectious Life Cycle

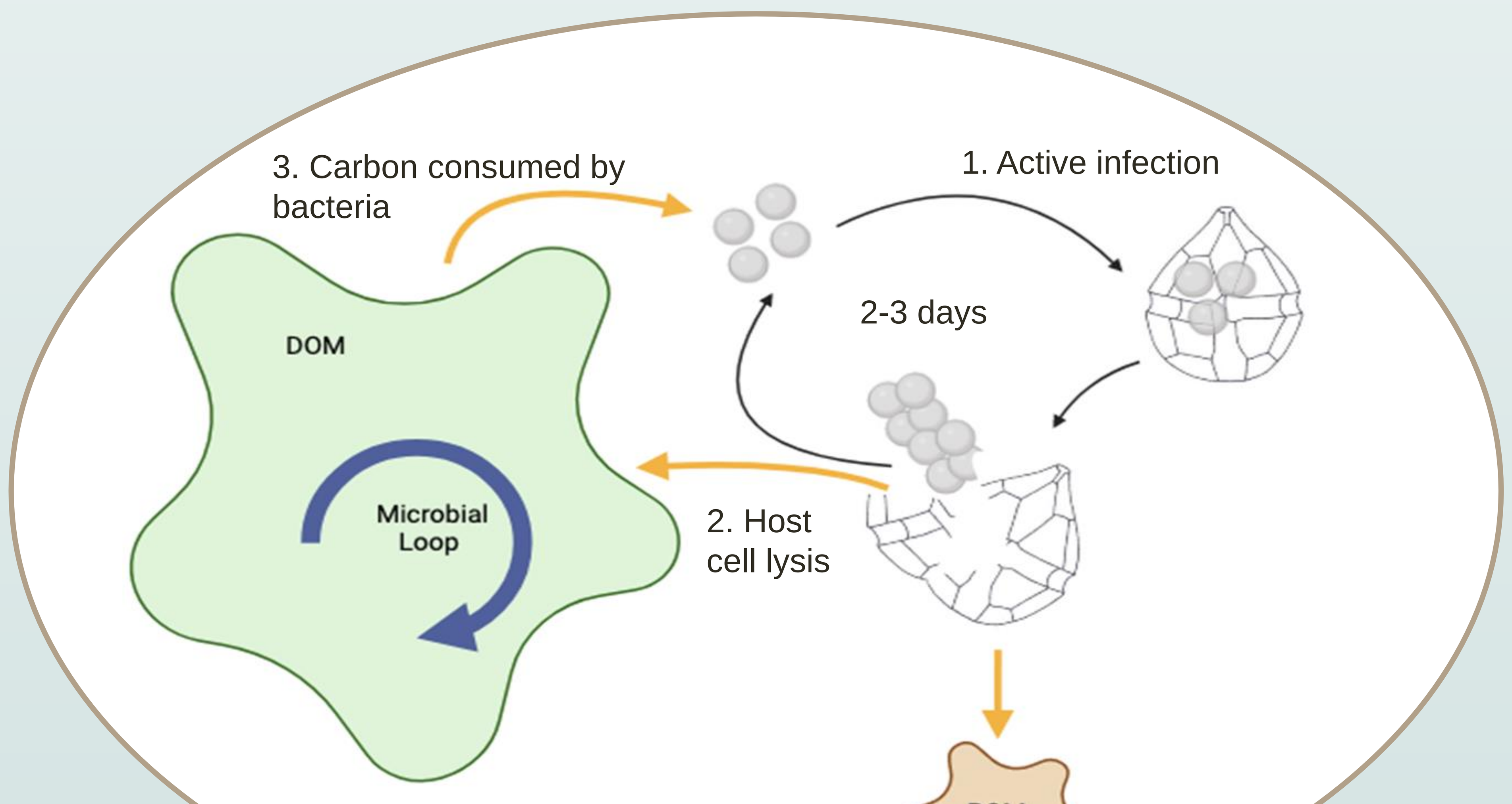

Figure 1. Diagram of the infection cycle of parasitic Syndiniales infecting the host *Scrippsiella spp.* (Figure credit: Dr. Elizabeth Harvey)

Research Questions

(1) What are the survival mechanisms of Syndiniales dinospores in the absence of their dinoflagellate host, *Scrippsiella acuminata*?

(2) How does the presence of specific dissolved organic compounds influence the growth, survival, and infectivity of free-living dinospores?

Acknowledgements

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Methods

Culturing

- Parasite strains RCC 4390 and RCC 4401 are from Roscoff Culture Collection (RCC) in France.
- The host culture, *Scrippsiella,* is maintained independently in filtered seawater supplemented with nutrients.
- Parasites are sustained by infecting a host every 3-4 days (Figure 2).

Experimental Set-up

- A, B, and C will be the replicates
- Each well will have 2 ml of parasite culture and 20 µl of antibiotics
- There will be five 12-well plates for each compound tested: fructose, glucose, inosine, mannose, and succinic acid (Figure 3).

Data Analysis

- A flow cytometer will be used to measure spore abundance as well as host abundance after reinfection of *Scrippsiella* from osmotrophic spores (Figure 4).
- Through R-programming, a t-test will be utilized to compare infection rates and mortality between parasite strains RCC 4390 and RCC 4401.

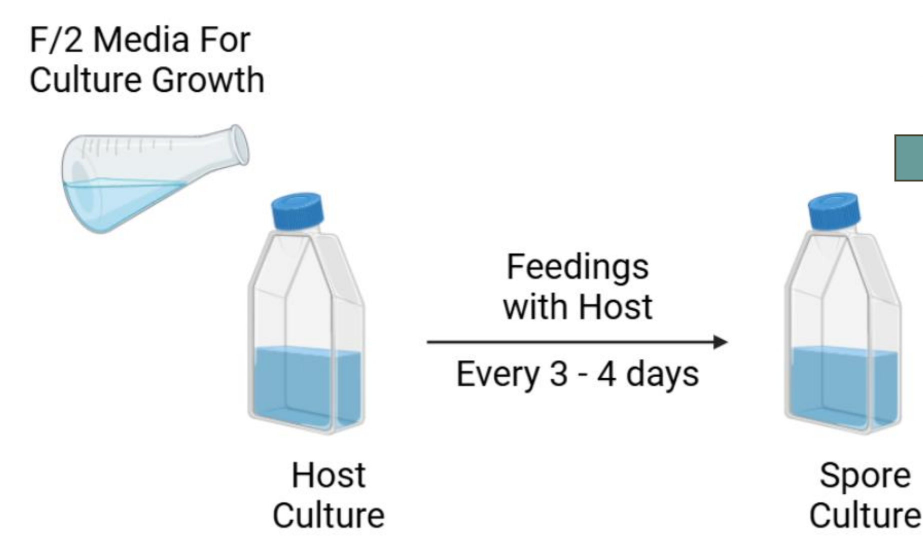

Figure 2. Demonstration of cultures being maintained for both spores and host.

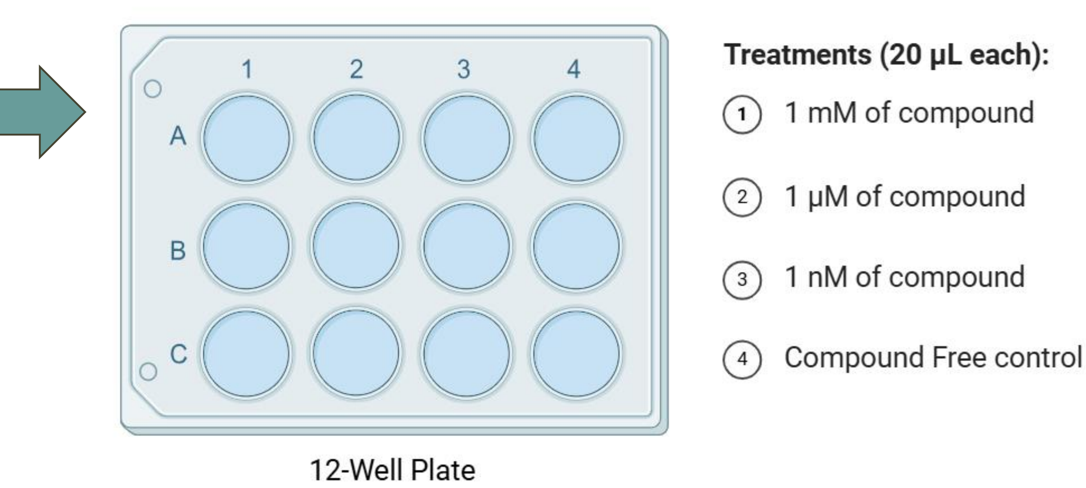

Figure 3. Template of the Syndiniales free-living dinospores osmotrophic capability experiment.

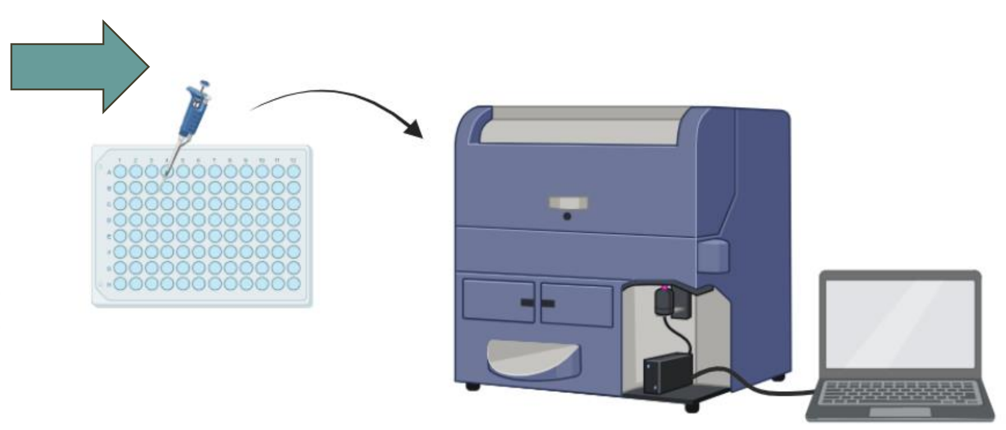

Figure 4. A flow cytometer run setup for measuring the spore and host abundance in cells/ml.

Results

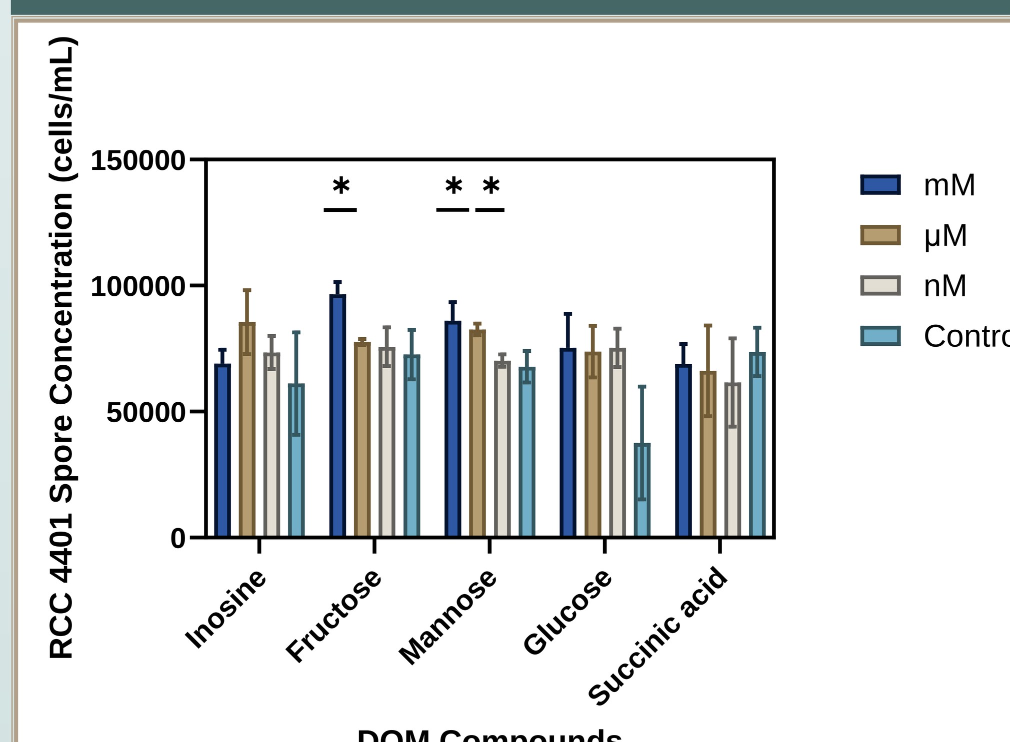

Figure 5. Effect of DOM Compounds on RCC 4401 Spore Concentration

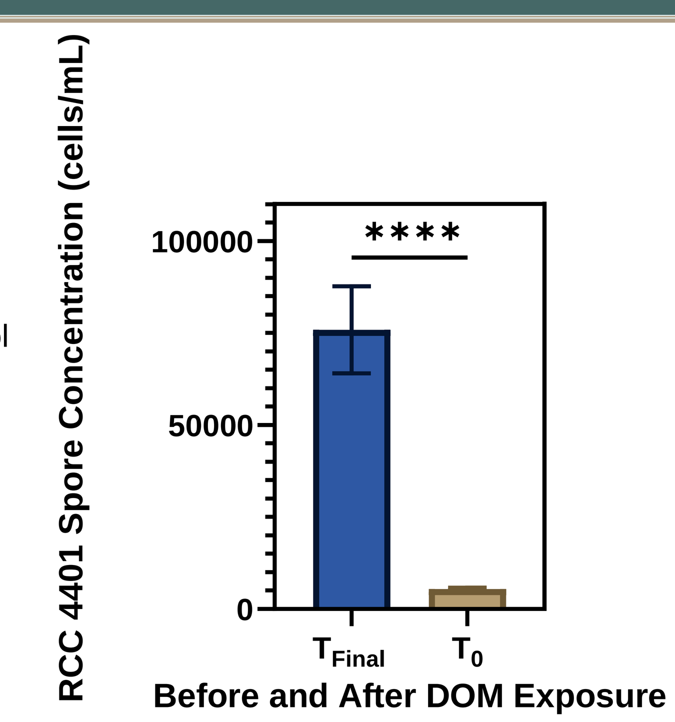

Figure 6. Comparison of Spore Concentration Before and After DOM Exposure in RCC 4401

- Inosine, fructose, and mannose significantly boosted RCC 4401 concentration, suggesting selective osmotrophic uptake (Figure 5).
- DOM exposure led to a significant increase in RCC 4401 spore concentration ($p < 0.0001$), supporting the role of DOM in survival (Figure 6).

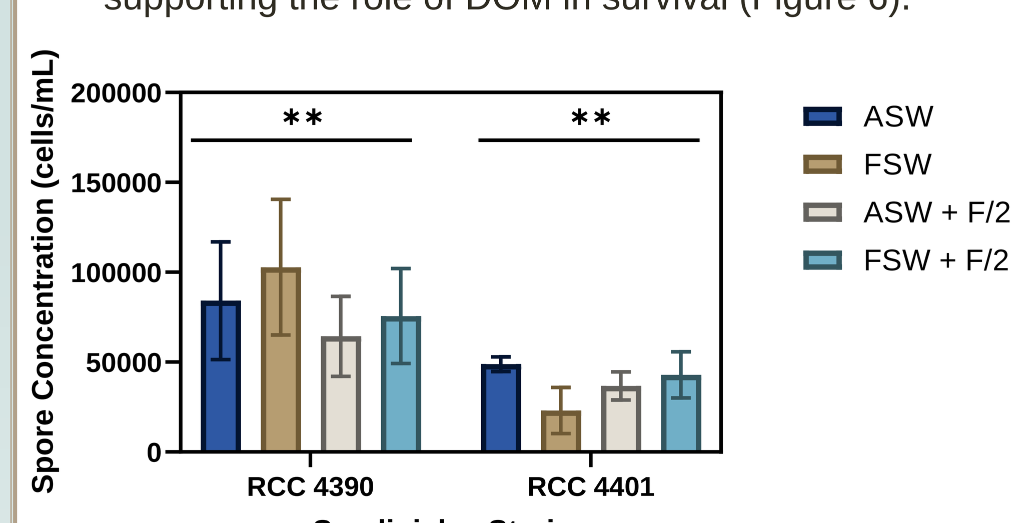

Figure 7. Average Spore Concentration by Strain and Treatment

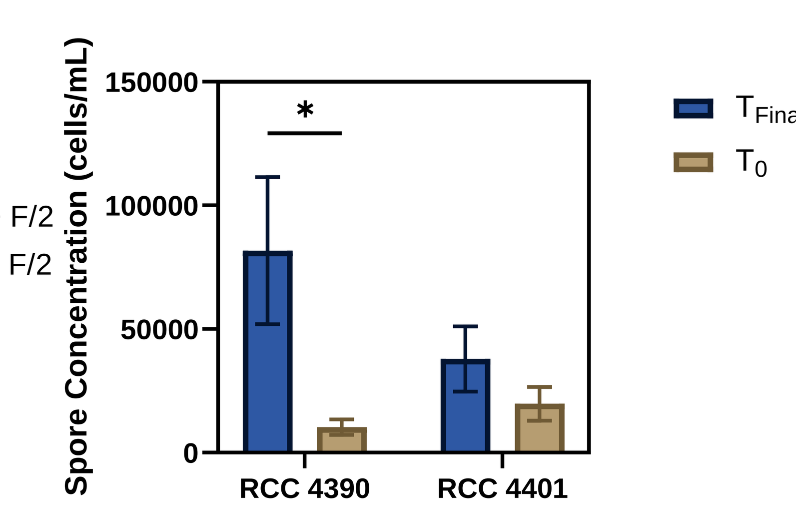

Figure 8. Spore Concentration at T_0 vs. T_F for Each Strain

- RCC 4390 consistently showed higher spore concentrations than RCC 4401, regardless of treatment ($p = 0.0002$) (Figure 7).
- RCC 4390 showed a significant increase from T_0 to T_F, while RCC 4401 did not, indicating strain-specific survival strategies (Figure 8).

Discussion

- DOM exposure increased spore concentrations in RCC 4401, with inosine, fructose, and mannose having the most pronounced effects.
- Strain RCC 4390 consistently exhibited higher spore concentrations than RCC 4401 across all treatments, suggesting strain-level differences in environmental survival.
- These results indicate that certain Syndiniales dinospores can persist in the absence of a host.
- DOM uptake experiments were only conducted with RCC 4401; future work will include RCC 4390 and additional Syndiniales strains.
- The ability to utilize dissolved organic compounds may allow dinospores to remain viable even when host abundance is low.
- This could create a constant risk of infection for phytoplankton populations and influence bloom dynamics.
- Understanding these interactions is essential for predicting parasite impacts in marine ecosystems, especially in fisheries and aquaculture.

References

1. Wang, Z., Wang, C., Li, W., Wang, M., & Xiao, L. (2021). Interspecies competition between Scrippsiella acuminata and three marine diatoms: Growth inhibition and allelopathic effects. *Aquatic Toxicology, 237*, 105878. https://doi.org/10.1016/j.aquatox.2021.105878
2. Jephcott, T. G., Sime-Ngando, T., Gleason, F. H., & Macarthur, D. J. (2016). Host–parasite interactions in food webs: Diversity, stability, and coevolution. *Food Webs*, 6, 1–8. https://doi.org/10.1016/j.fooweb.2015.12.001
3. Anderson, S. R., & Harvey, E. L. (2020). Temporal Variability and Ecological Interactions of Parasitic Marine Syndiniales in Coastal Protist Communities. *mSphere*, 5(3), e00209-20. https://doi.org/10.1128/mSphere.00209-20