Ocean virology: using RNA to understand viruses in nature

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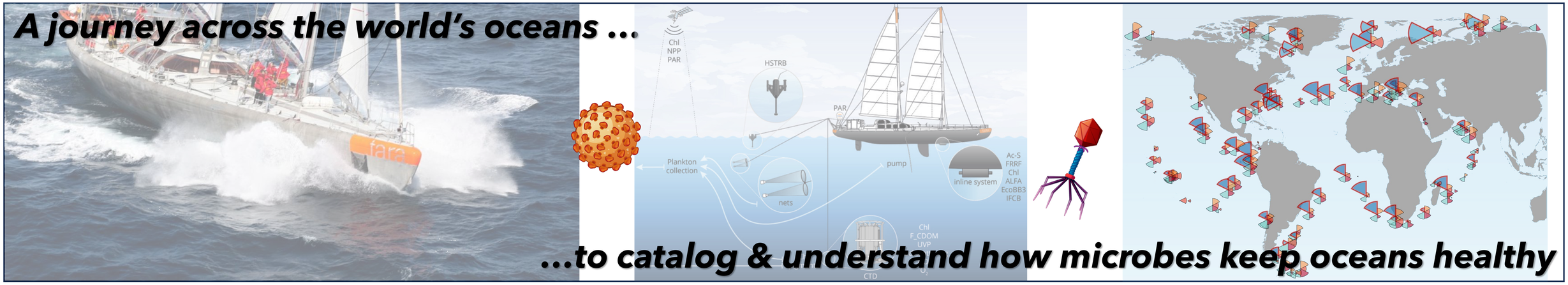


Virocells: a window into virus-host relationships

In the oceans, 1 in 3 cells are infected by viruses. We are using time-resolved multi-omics (DNA, RNA, protein, metabolites) infection experiments to study the "systems biology" of these virus-infected cells, or virocells.

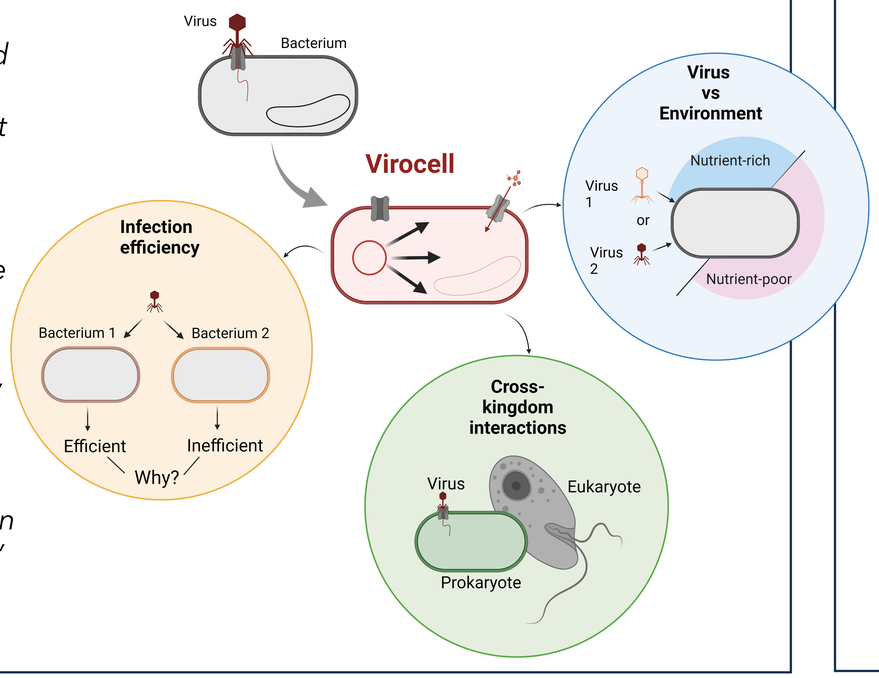
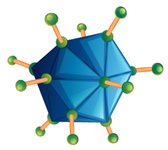


Figure 1. *Studying myriad biomolecules (DNA, RNA, proteins, metabolites) that encode complementary information that cells use to function has revealed what makes cells in nature resist virus infection, how that changes across environmental conditions, and how infection and grazing interact. These "virocell" studies help us understand how the ocean "biological carbon pump" works and may help fight climate change.*

RNA viruses – good viruses in the seas !!

Virologists have studied a few hundred RNA viruses because they infect plants or animals (including humans). However, RNA viruses are also normal components of the world's oceans. We study community RNA sequences sampled from the global oceans, and this doubled the number of known RNA virus phyla from 5 to 10 and systematic AI-powered discovery and taxonomic methods, as well as uncovering a missing link in early evolution of life!



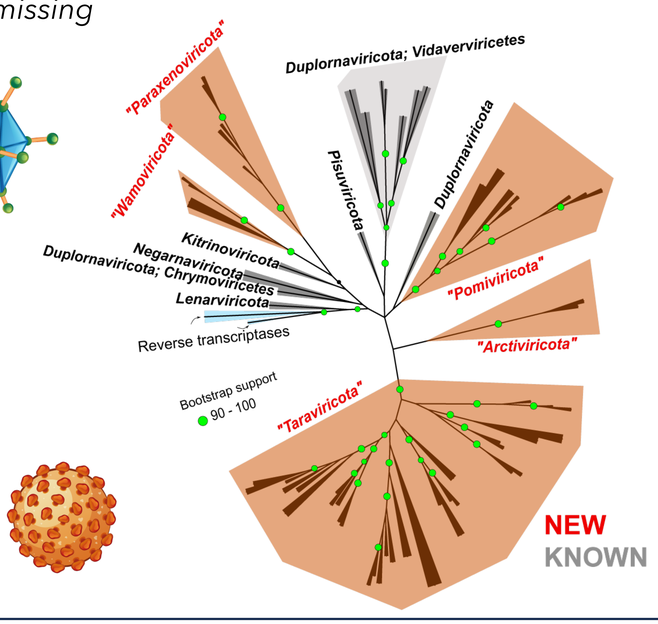


Figure 2. *Sequence comparison (phylogeny) that revealed entire new groups discovered in the oceans. One of these, the Taraviricota, are ubiquitous in the oceans and represent a missing link in the early evolution of life!*

Citations

- Dominguez-Huerta, G.†, Zayed, A.A.†, et al. 2022. Diversity and ecological footprint of Global Ocean RNA viruses. Science. 376: 1202-1208.
- Zayed, A.A.†, Wainaina, J.M.†, Dominguez-Huerta, G.†, et al. 2022. Cryptic and abundant marine viruses at the evolutionary origins of Earth's RNA virome. Science. 376: 156-162.
- Howard-Varona, C., et al. 2020. Phage-specific metabolic reprogramming of virocells. ISMEJ. 14:881-895.
- Howard-Varona, C., Hargreaves, K.R., Solonenko, N.E., Markillie, L.M., White, R.A., Brewer, H.M., Ansong, C., Orr, G., Adkins, J.N., & Sullivan, M.B. 2018. Multiple mechanisms drive phage infection efficiency in nearly-identical hosts. ISMEJ. 12:1605–1618.

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