Viral Updates Week 2

The current nutrient-limitation metric still stands the test of time!

**Historical Context**

Phytoplankton in the open ocean have adapted to grow in the world’s wettest desert – they have to survive in an environment with vanishingly small concentrations of nutrients. To determine if organisms have enough nutrients for survival, scientists must identify limiting nutrients within the ocean. Phytoplankton compose the base of many food webs, and their presence is currently being threatened (I know I read somewhere that the number of phytoplankton on the surface of oceans are decreasing, but I forgot the article, I’m sure I can find it). Research into discovering potential survival inhibitors can aid in mitigating decreasing phytoplankton levels, which could cause food web disruption and exacerbate ocean acidification.

Experimentally identifying which specific nutrients (usually nitrogen (N), phosphorus (P), or iron (Fe)) limit phytoplankton growth in the ocean, unfortunately, is a strenuous process. Through bottle experiments involving incubating phytoplankton in differing nutrient conditions (ex: with added Fe, N, and P), scientists have been able to identify the limiting nutrients in the ocean for different organisms. Still, scientific models have difficulty systematically determining nutrient stress across the global ocean, forcing scientists to rely on continued laborious bottle experiments.

Recent research by Lucas J. Ustick et al [compared](https://science.sciencemag.org/content/372/6539/287/tab-pdf) previous results from bottle experiments, the current standard for confirming nutrient limitation, with two indirect, but higher throughput ways of assessing of Prochlorococcus nutrient limitation from the surfaces of the Atlantic, Pacific, and the Indian Ocean. *Prochlorococcus* is a type of cyanobacteria, and one of the most abundant phytoplankton in ocean waters. *Prochlorococcus* is specially adapted to low nutrient environments, as its small size allows it to absorb the nutrients available very effectively, grows very quickly and is the most abundant phytoplankton in low-nutrient regions. Because of these adaptations, one can argue that there is too much of a generalization being made between *Prochlorococcus* and nutrient limitation involving other phytoplankton. However, the authors believe there was significance established between the bottle experiments and their metagenome analysis and suggest that their predictions for Prochlorococcus can be applied generally to the physiological state of the Atlantic, Pacific, and the Indian Ocean. Therefore, the authors hypothesized that if even Prochlorococcus were experiencing some nutrient stress, then the general phytoplankton community in the region also experiences similar nutrient stress.

Limiting nutrients for *Prochlorococcus* were inferred from DNA sequencing samples by looking at the prevalence of genes associated with stress for nitrogen, phosphorus and iron. The presence of stress genes in different oceans was compared to bottle experiments from nearby, as well as the limiting nutrient predicted by the [climate model]. It turned out that all three independent methods tended to agree on which regions were primarily iron, phosphorus, or nitrogen stressed.

The biogeochemical cycles in the ocean are affected nutrient availability and which organisms are absorbing available nutrients. Phytoplankton make up the base of aquatic food webs, so scientists can easily use them to represent the physiological states of specific ocean regions. Therefore, understanding how phytoplankton might respond to changing environments (like what might happen due to climate change) is important for understanding the impact on the whole food web, all the way to large fish and whales. Besides food web dynamics, we rely on phytoplankton to remove CO2 from the atmosphere, and nutrient limitation is one thing that determines how fast they can do that.

**Main Bullet Points:**

* Write main points after summary.

**Glossary:**

* Nutrient stress –
* Metagenome –
* Primary producers