Viral Updates Week 5

(summary of [Kuhlisch et al](https://advances.sciencemag.org/content/7/25/eabf4680/tab-pdf))

**Context:**

Introduction:

Dissolved organic matter (DOM) is everywhere in the ocean and contains nutrients that microbes use to survive. Marine organic matter is largely produced by phytoplankton that turn carbon dioxide into organic carbon via photosynthesis. That organic matter can be broken into smaller pieces until it has completely dissolved into seawater through various processes. Viruses of phytoplankton can produce DOM by infecting and killing phytoplankton, bursting their cells open and causing small organic molecules to leak out. Understanding the unique characteristics of DOM produced by viruses aid scientists in diagnosing viral outbreaks among phytoplankton in the ocean. However, we are uncertain what chemical characteristics separate viral induced DOM (vDOM) from regular DOM. Kuhlisch et al used *E huxleyi*, the most abundant [coccolithophore](https://earthobservatory.nasa.gov/features/Coccolithophores), to investigate this question. *E. huxleyi* is a good phytoplankton to study because it is found in all oceans and can grow in massive blooms. Outbreaks of *E. huxleyi* virus (EhV) have been shown to end those blooms. Characterizing metabolites specific to vDOM with EhV outbreaks can help monitor the organic matter released during these outbreaks.

The authors produced vDOM by creating mini *E. huxleyi* blooms in mesocosms and killing them by adding EhV. To construct the mesocosms, four large semi-permeable bags were placed into the Raunefjord in southern Norway, allowing the bags to be in natural conditions. The authors added nutrients to induce phytoplankton growth and monitored changes in the DOM during bloom growth and eventual death by EhV. When analyzing DOM composition before, during, and after the bloom, the authors observed a release of metabolites during blooms and a consequently, a change in DOM composition. The authors then compared the DOM from the mesocosms to the surrounding fjord water to identify metabolites unique to the *E. huxleyi* blooms and viral outbreaks.

The next question to address was which molecules were specific to vDOM. The authors used a technique called mass spectrometry used to predict the elemental formulas of the molecules in the DOM they collected. It turns out that many of the molecules unique to vDOM contained elements called halogens (like chlorine, iodine, bromine).

Why would viral infections result in organic matter with lots of halogens? It turns out lots of different phytoplankton produce halogenated organic molecules to protect themselves from reactive oxygen species (ROS) such as hydrogen peroxide. ROS are generated when (infected) cells make energy to replicate. However, ROS can damage viral DNA and cause unsuccessful replication. Adding a halogen to organic molecules inside hosts cells allows the cells to absorb ROS before they can damage the DNA. The authors suggest that the halogenated organic molecules may be produced during viral infection to protect viral DNA from being destroyed by ROS in the host cell.

Understanding the feature of vDOM can help scientists diagnose viral outbreaks in the ocean. Using *E huxleyi*, the authors identified specific molecules that could be used to characterize whether a viral outbreak has occurred.

**Main Bullet Points:**

* Kuhlisch et al used *E. huxleyi* to identify molecules specific to viral-induced dissolved organic matter (vDOM).
* DOM composition changes during *E. huxleyi* blooms and consequent viral outbreaks, releasing different metabolites into the ocean.
* Viral induced DOM contains many halogenated metabolites, particularly with chlorine and iodine, that are not found in regular DOM.
* Halogenated metabolites may be produced as a larger defense strategy to protect viral DNA from reactive oxygen species.

**Glossary:**

Metabolites – a small organic molecule produced by a chemical reaction inside of a cell.

DOM – Dissolved organic matter. Refers to any organic material small enough to dissolve into water (traditionally, the size cutoff is >0.2 micrometers).

Coccolithophores – a type of phytoplankton that covers itself in calcium carbonate plates.

[Fjord](https://en.visitbergen.com/things-to-do/norway-fjords/what-is-a-fjord) – the deep sea between two cliffs.

Mesocosm – [go for it]