Viral Updates Week 4

(summary of Pelusi et al)

**Context**

Some phytoplankton switch between different life stages to endure harsh environmental conditions in the ocean. For example,the phytoplankton *Emiliania huxleyi* [add link to an explainer page like this https://earthobservatory.nasa.gov/images/146897/channeling-a-bloom] usually takes on a form covered in scales made out of calcium carbonate, but sometimes changes to a form with no scales that has a flagellum for swimming (Mordecai et al 2017). The attributes of different life stages can be better suited to particular environments – for example, the scaly *E. hux* form offers protection from larger predators, but is susceptible to viral infection. The swimming form, however, is resistant to viral infection, but lacks the protection of the tough scales. Diatoms of the species *Chaetoceros socialis* can become dormant as a similar adaptation. Dormant diatoms form a durable spore with an extra thick silica shell for protection from harsh environmental conditions. However, it is uncertain whether viral infection *causes* *C. socialis* to form spores, and if these spores can survive post infection. [Pelusi et al](https://nph.onlinelibrary.wiley.com/doi/pdf/10.1111/nph.16951?casa_token=9TOZFEMF9fIAAAAA:bRQ9bgY9x6tKyEPE-BSXwc8AqfH6u5lmGFluWoJkjYd3J8XN5hLhKRDmiHNEUx4g7aKHKQ5juZsPBnoI) explored this question by conducting experiments with *C. socialis* strains from Japan (L-4) and Italy (APC12).

The authors were able to successfully infect both the L-4 strain, isolated from Hiroshima Bay in Japan and APC12, isolated from the Mediterranean sea by Italy, with the same diatom virus (CsfrRNAV). This result was surprising because diatom viruses usually specifically infect only one host strain. The virus may be able to infect both host strains despite their geographic distance because both hosts are very closely related genetically. Interestingly, the CsfrRNAV created more new viruses per infection while infecting APC12 than its original host, L-4.

The authors monitored the how many diatoms formed spores and the number of viral particles inside of individual diatoms over the course of their infection experiment. They found both strains did form spores, although the APC12 strain formed more than the L-4 strain. They also were able to see that dormant cells and spores had viruses replicating inside them, suggesting the cells began to form spores once they were already infected. Viruses normally take over a host cell and replicate until they destroy the cell, allowing the viruses inside the cell to leak out into the environment. However, the authors found that viruses inside the spores were unable to break through the spore’s outer shell, preventing them from entering the water and infecting new hosts. The authors also demonstrated that the infected spores could be revived as healthy diatoms once they were moved to a virus-free environment, indicating spore formation is a defense strategy against viral infection.

The authors compared the spore formation response of diatoms infected by viruses to the response of nitrogen stress, which is known to induce spore formation. In the nitrogen-limited environment, 99% of the APC12 strains formed spores compared to the 1% for L-4, indicating that L-4 are less likely to form spores even in harsh environments. The authors also found that spores formed under nitrogen limitation revived faster than spores formed via exposure to viruses, showing that the diatom spores react differently to different stresses.

Diatoms are a common type of phytoplankton around the world. They sink very effectively due to their heavy silica shells, playing an important role in exporting carbon from the ocean surface to the deep. When they form spores, diatoms become even denser and sink even faster. Therefore, understanding what causes spore formation bears relevance to how the ocean carbon cycle operates. We usually think of viruses as infecting cells, killing them, and then bursting out of the cell, leaving tiny shreds of phytoplankton remains in the ocean surface. However, this study shows that viral infection can cause diatoms to form heavy spores, which can sink out of the ocean surface instead. Further understanding the physiological response of phytoplankton to viral infection will help us clarify the role that ocean viruses play in controlling the transport of carbon from the ocean surface to the deep.

**Main Bullet Points:**

* Some phytoplankton have different life stages that are thought to increase their survival in harsh environmental conditions.
* Though diatom viruses are known to be specific to their host, two genetically similar but geographically distanced host strains could be infected by the same virus strain.
* Infected host diatom cells which formed spores could survive post-infection.
* Viruses replicated inside infected spores but could not escape their host cells, kill their host, or infect other hosts.
* Spore formation may be a defense mechanism against viral infection for *C socialis*.
* The spores formed by *C socialis* from viral infection had different properties than spores induced by a different stressor. This suggests the spore-formation response is different for the same diatom experiencing different types of stress.