# Short circuit in the food web

July 9 2014

They are amongst the most numerous inhabitants of the sea: tiny haptophytes of the type Emiliania huxleyi. Not visible to the naked eye, when they are in bloom in spring, they form square kilometer sized patches, they are even visible on satellite images. "Together with other phytoplankton, Emiliania huxleyi is responsible for approximately half of the global photosynthesis output," states Prof. Dr. Georg Pohnert of the Friedrich Schiller University Jena (Germany). In the process the greenhouse gas carbon dioxide – $CO_2$ – is extracted from the atmosphere and oxygen is set free. "Additionally the microalgae use $CO_2$ to produce tiny calcified discs which re-enforce their outer skin," the chair for Instrumental Analysis and Bio-organic Analysis continues. Thus the unicellular algae are a decisive factor for a stable world climate.

However the annual bloom of Emiliania huxleyi regularly comes to a rapid ending: the algae are massively affected by viruses and thus die off. Until now it remained unclear exactly how the viruses killed the algae. But together with scientists of the Weizman Institute in Israel the team around Prof. Pohnert has now analyzed the complex interaction between the algae and the viruses. In the science magazine 'The Plant Cell' the researchers describe how they could clarify the molecular mechanisms of the relationship between the virus and the algae, which crucially influences the food chain of the oceans.

To find this out, the researchers infected algae in controlled conditions in a laboratory and afterwards analyzed the whole metabolism of the microalgae. "The viruses intervene massively with the metabolism of the algae," Pohnert sums up the results. So for instance they use chemical components of the algae to multiply themselves, because for viruses replication is only possible with the active help of a host organism. "The viruses prompt the algae to produce exactly the molecular components which they, the viruses, need for themselves," Pohnert says. As early as one hour after the beginning of the infection the viruses completely turned the metabolism of the algae upside down. The algae then increase the production of certain sphingolipids, which the viruses need to multiply. After a few hours the infected algae burst and each one sets free about 500 new viruses.

But the micro algae don't succumb to their fate without a fight, as the scientists were able to show in their new study. "They fight back by drastically reducing the biosynthesis of so-called terpenes," Pohnert explains. The viruses also rely on these hydrocarbons. If their production is switched off by so-called inhibitors in model experiments, the production of viruses decreases distinctly.

The Jena researchers and their Israeli colleagues are now planning to double-check their results from the laboratory in real life – in the sea. Emiliania huxleyi and its viruses thereby serve as a model system to better our understanding of the marine food chain. Until recently, the food web of the oceans was mostly considered a linear organization, according to Prof. Pohnert: Algae, which store solar energy and combine with CO2, are the basic food resource for small animals and fish, which in turn are being eaten by bigger fish. The viruses however create a kind of 'short circuit' in this chain. "Thus the viruses divert a substantial part of the whole fixed carbon from the food chain as we know it so far, and supply deep sea bacteria with it," Pohnert says. Which consequences this will have for other organisms in the sea and the whole ecological system will be shown by future studies.

**More information:** Rosenwasser S et al. "Rewiring host lipid

metabolism by large viruses determines the fate of Emiliania huxleyi, a bloom-forming alga in the ocean," *Plant Cell* 2014, DOI: 10.1105/tpc.114.125641

Provided by Friedrich Schiller University of Jena