Alga of the Year 2016: Ice alga Melosira arctica – winner or loser of climate change?

Arctic Diatom in the Focus of a New AWI Research Project
[06. January 2016]

https://www.awi.de/nc/en/about-us/service/press/press-release/alge-des-jahres-2016-eisalge-melosira-arctica-gewinnerin-oder-verliererin-des-klimawandels.html

Researchers have chosen one of the most important algae of the Arctic, the *Melosira arctica,* as Alga of the Year. The scientists are planning to use it to study the impact of climate change. "Because so far, nobody can predict whether the *Melosira* will be a victim or a beneficiary of the melting sea ice, and so far nobody knows why it is the most productive alga in this inhospitable world," says biologist Dr Klaus Valentin of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI). He is a member of the Phycology Section of the German Botanical Society (DBG), which brings together all algae researchers who voted for the *Melosira* as Alga of the Year 2016.

- 
- 

"The ice alga and diatom *Melosira arctica* is by far the most productive alga in the Arctic Ocean, as the latest genetic studies indicate," Klaus Valentin explains. In 2013, for example, it was responsible for almost half - around 45 percent - of primary production in the Arctic. This means that this species generates a lot of biomass while consuming carbon dioxide and producing oxygen.

The shells of the small algae, which are only 30 microns in diameter, are made of silica and are surrounded by a jellylike protective outer layer made from polysaccharides. The single-cell *Melosira* thus form chains and algal mats that are several metres long and hang off the bottom of the sea ice like curtains. Polar researchers have also found the diatom in salt brines and in pools of melt water, where they often grow in large quantities.

The polar researchers had already noticed these algal mats around Fridtjof Nansen. During their polar expedition at the end of the 19th century, Nansen and his companions gathered samples that are still being kept today at the Friedrich Hustedt Centre for Diatom Research at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research.

It is still largely unknown how the *Melosira arctica* survives the long polar night and the harsh frost of the Arctic winter and is then so prolific that it dominates the Arctic Ocean in the spring. "We don't know how it grows and which environmental factors, such as light, nutrients or salinity, regulate their way of life. And this is the case even though diatoms are at the bottom of the food chain and the *Melosira arctica* is a key organism in the Arctic ecosystem," says Klaus Valentin. This is the reason why the alga is now the focus of a new research project at the AWI.

Systematic analyses possible for the first time

The project entitled "*Melosira arctica in a changing Arctic Ocean*" began as one of the first strategic projects of the AWI. As part of this project, Klaus Valentin's team collected various algae samples in the Arctic and used them to grow pure cultures in the lab. On this basis it is now possible for the first time to get answers to the biologists' many questions.

One of the questions the researchers are interested in is whether and, if so, how the diatoms will react to climate change. The sea ice cover of the Arctic has shrunk significantly since the start of the satellite measurements in 1979. According to some climate models, the Arctic may be ice-free during the summers of the second half of this century. "What will happen then to the *Melosira*, which mostly exist by and in several-year-old ice?" Klaus Valentin wonders.

Physiological reactions of the ice algae

"As the sea water gets warmer and the sun gets stronger, most algae grow better. This may be completely different for the *Melosira,"* the AWI biologist reminds us.

Algae perform photosynthesis to gain energy and produce oxygen, which in the case of the *Melosira* gets stuck as gas bubbles in the gelatin, which in turn gives the algae buoyancy. Perhaps it will be able to live on in the surface water this way, if the ice floes that have carried it so far melt.

The scientists therefore want to find out what the optimal temperature is in which the algae thrive and can carry out photosynthesis. They also wonder how the algae will deal with the range of nutrients that will change as temperatures change. Will it lack important nutrients such as nitrate? What lighting conditions are best for the alga, given that too much light could also inhibit growth as the ice surface shrinks? All these things can be simulated more easily and measured more accurately in the laboratory than in the wild.

Adaptability over several generations

The team is planning a long-term experiment in the lab. They will grow various strains of *Melosira* - for about 150 generations - under different conditions in order to find out whether there are individual strains or subspecies that can cope in the long term with temperatures up to eight degrees. This strain would then have the potential to adapt to the changing climate. If the alga can withstand the changes, this would have far-reaching effects on the entire Arctic ecosystem.

Genetic variants

And finally, the scientists are also planning to analyse the genome of the available *Melosira* samples. This will allow them to find out whether different subspecies of *Melosira* exist in the North Sea than in Northern Canada.

Dr Regine Jahn of the Botanic Garden and the Botanical Museum of the Free University of Berlin together with a Canadian colleague had already identified intra-species taxa ten years ago. Jahn, currently the vice chairperson of the Phycology Section, examined the samples from the Ehrenberg collection of Berlin's Natural History Museum using an electron microscope; these were the same samples that taxonomists in 1852 used to describe the species for science for the first time.

The comparison of the original samples from Melville Bay in Greenland with other diatom populations off the coasts of Alaska and Canada showed significant differences in the microstructure of their silica shells. If several genetic variants could indeed be found in the polar sea, this would increase the chance of a subspecies adapting to climate change.

Melosira impacts the deep sea

In the years in which a lot of sea ice melts during the Arctic summer, the algae carpets sink several thousand metres to the bottom of the sea where they are eaten by sea cucumbers and feather stars. Bacteria then decompose the remains of the *Melosira*, as was observed by members of the new research project during a Polarstern expedition in the summer of 2012. As the decomposition takes place, these organisms deprive their environment of vital oxygen, which means that the diatom *Melosira arctica* ultimately also influences life in the deep sea. They take with them on their journey into the depth up to 85 percent of the bound carbon of the Arctic, which the *Melosira* had previously turned into biomass. This way, the *Melosira* also shapes the Arctic carbon cycle.

Information about the Phycology Section in the DBG

The members of the Phycology Section (www.dbg-phykologie.de) scientifically investigate the algae and use the micro and macro algae to work on ecological, physiological, taxonomic and molecular biological issues. The Section promotes research into algae and fosters young scientists. It is one of the six Sections of the German Botanical Society (Deutsche Botanische Gesellschaft e. V.) (DBG: www.deutsche-botanische-gesellschaft.de).