Arctic microalgae show photosynthesis in near darkness is possible

September 4 2024

MOSAiC Ocean City during Leg 3. Credit: Alfred-Wegener-Institut / Saga Svavarsdottir (CC-BY 4.0)

Photosynthesis can take place in nature even at extremely low light levels. This is the result of an international study that investigated the

development of Arctic microalgae at the end of the polar night. The measurements were carried out as part of the MOSAiC expedition at 88° northern latitude and revealed that even this far north, microalgae can build up biomass through photosynthesis as early as the end of March.

At this time, the sun is barely above the horizon, so that it is still almost completely dark in the microalgae's habitat under the snow and ice cover of the Arctic Ocean. The results of the study now published in the journal *Nature Communications* show that photosynthesis in the ocean is possible under much lower light conditions, and can therefore take place at much greater depths than previously assumed.

Photosynthesis converts sunlight into biologically usable energy and thus forms the basis of all life on our planet. However, previous measurements of the amount of light required for this have always been well above the theoretically possible minimum. The study shows that the build-up of biomass can actually take place with a quantity of light that is close to this minimum.

The researchers used data from the international MOSAiC research project for their work. As part of the expedition, they froze the German research icebreaker Polarstern in the icepack of the central Arctic for a year in 2019, in order to investigate the annual cycle of the Arctic climate and ecosystem. The team led by Dr. Clara Hoppe from the Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research (AWI) focused on studying phytoplankton and ice algae.

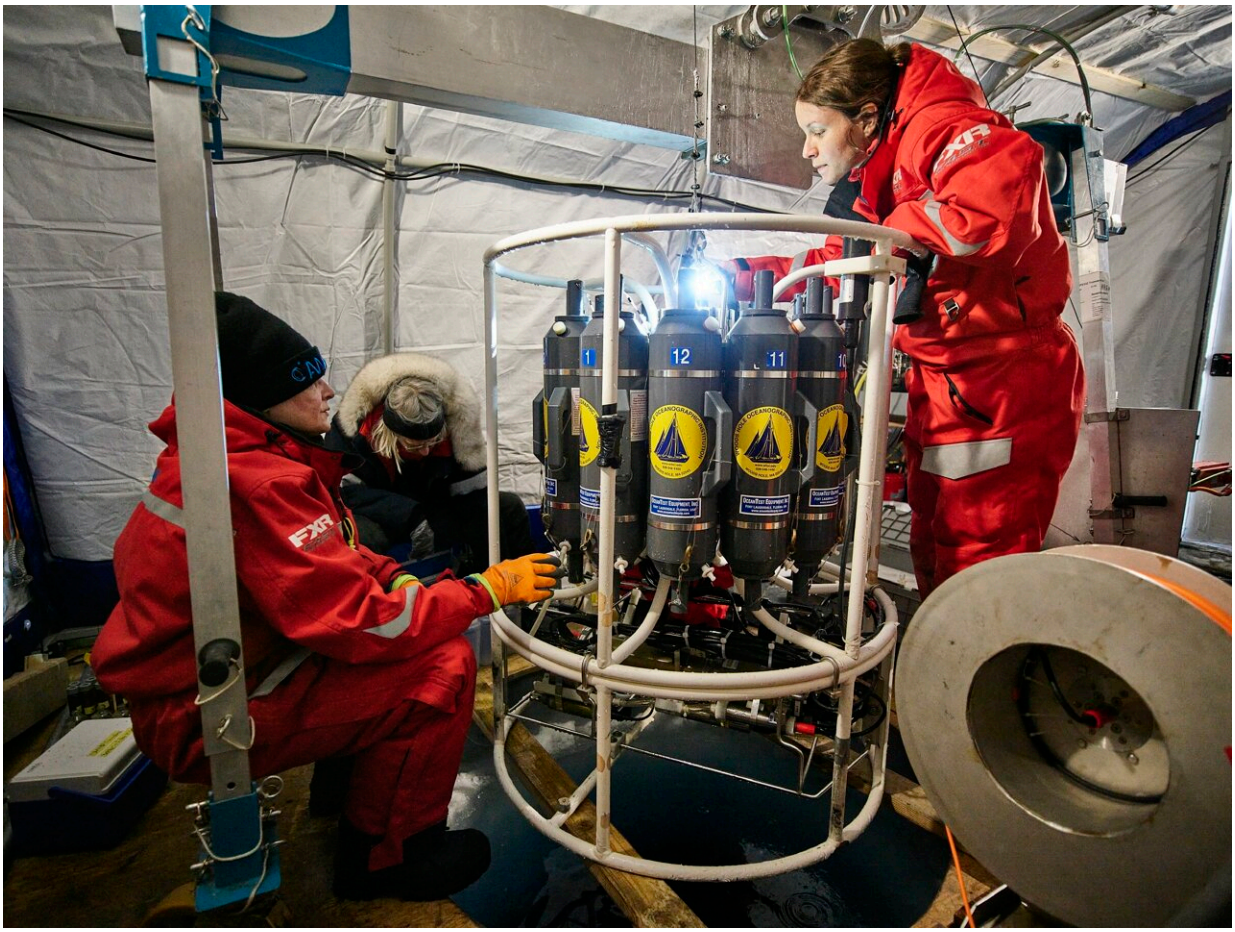
These are responsible for the majority of photosynthesis in the central Arctic. Unexpectedly, the measurements showed that just a few days after the end of the month-long polar night, plant biomass was built up again, for which photosynthesis is absolutely essential. Extremely sensitive light sensors in the ice and water made it possible to measure the amount of light available.

The results were particularly surprising because photosynthesis in the Arctic Ocean took place under snow-covered sea ice, which only allows a few photons of incident sunlight to pass through: The microalgae only had about one hundred thousandth of the amount of light of a sunny day on the Earth's surface available for their growth.

"It is very impressive to see how efficiently the algae can utilize such low amounts of light. This shows once again how well organisms are adapted to their environment," says Hoppe.

The study was made possible by the close collaboration of researchers from various disciplines. Sea ice researchers Dr. Niels Fuchs and Prof Dirk Notz from the Institute of Marine Research at the University of Hamburg were responsible for combining measurements of the light field with the biological measurements.

"To measure such low light levels under the harsh conditions of the Arctic winter, we had to freeze special, newly developed instruments into the ice in the middle of the polar night," explains Fuchs. His colleague Dirk Notz adds that it was particularly difficult to take into account irregularities in the light field under the ice due to variations in ice thickness and snow. "But in the end we could be sure: There was just not more light."



Janin Schaffer (right) lowering the CTD-rosette with 12 big waterbottles into the ocean. Credit: Alfred-Wegener-Institut / Michael Gutsche (CC-BY 4.0)

The results of the study are important for the entire planet. "Even though our results are specific to the Arctic Ocean, they show what photosynthesis is capable of. If it is so efficient under the challenging conditions of the Arctic, we can assume that organisms in other regions of the oceans have also adapted so well," says Hoppe.

This means that there could also be enough light to produce usable energy and oxygen through photosynthesis in deeper areas of the oceans, which would then be available for fish, for example. The corresponding

photosynthetic habitat in the global ocean could therefore be significantly larger than previously assumed.

More information: Clara J.M. Hoppe, Photosynthetic light requirement near the theoretical minimum detected in Arctic microalgae, *Nature Communications* (2024). DOI: 10.1038/s41467-024-51636-8

Provided by Alfred Wegener Institute