How algae survive the harsh world of sea ice

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New research from the University of East Anglia has revealed new clues into how algae survive within polar sea ice.

The findings give fresh insight into how diatoms—microalgae that produce the oxygen for every fifth breath we take—survive their harsh environment.

Most diatoms produce a sticky, slimy substance called EPS (extracellular polymeric substances) which protects them from changes in the environment.

The study, led jointly by researchers at UEA and the University of Essex, is a world first in showing how this slime is produced by a key polar diatom species for which the genome sequence recently became available.

Diatoms are found in nearly all marine and freshwater habitats and are important to the world's eco-system as they are responsible for 20 per cent of the world's photosynthesis – the process by which organisms harvest energy from the sun – and play a key role in the ecology of sea ice.

Global warming is resulting in major changes in the amount of sea ice present in the Arctic and Southern Oceans.

The research, funded by the Natural Environment Research Council (NERC), and also involving Bangor University, focused on sea ice as it changes its dynamics, melting and freezing depending on the seasons.

The study involved simulating sea ice in the lab with different temperatures and salt content and observing how the chemistry, biology and genetic programming changed. The laboratory results were then compared with material from the Antarctic.

Published in the leading *ISME Journal*, the study, led by Prof Thomas Mock from UEA's School of Environmental Sciences and Prof Graham Underwood at Essex, focused on the polar diatom Fragilariopsis cylindrus, which is able to thrive under the harsh conditions of sea ice.

Prof Underwood has been working on EPS for over 25 years, in coastal mudflats and salt marshes, rivers, lakes, coral reefs, and more recently sea ice. Prof Mock has been leading the genome project with Fragilariopis cylindrus, and Dr. Jan Strauss was leading the analysis of gene expression across the entire genome, which provided key insights into the metabolic pathway for the production of EPS.

EPS protect diatom cells from the environment, helping them move and float and influence the formation of sea ice. They can trap bubbles and get carried into the atmosphere, get eaten by bacteria and enter the food chain or get buried in sediment.

"We knew how important EPS were in the ecology of diatoms, but had never discovered how they adapt to the changing environment, or shown the links between field measurements, cell culture work and gene expression," explained Prof Underwood.

"Our work is the first to show the metabolic pathway and changing chemistry of the EPS that protect the diatoms."

Looking to future research on diatom EPS, Prof Mock added: "Using the latest genome-editing tools such as CRISPR/Cas, we are very keen to target some of the genes involved in the production of EPS to identify their specific role, which can be very relevant for biotechnological applications such as tolerance to freezing or enhancing secretion of bioactive compounds."

Provided by University of East Anglia

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