Zooplankton, the most important animal in the Arctic

In parts of the northern Arctic region, the delicate balance of the food chain depends heavily on the diminutive copepod Calanus glacialis. This herbivorous Arctic zooplankton species is specially adapted to melting sea ice and the blooming of a few small algal species.

With funding from Climate Change and Impacts in Norway (NORKLIMA), one of the Research Council's Large-scale Programmes, researchers at the University Centre in Svalbard (UNIS) have made new discoveries about the relationship between sunlight, phytoplankton and zooplankton, and about the critical role that sea ice plays for plankton. Their research project, "Climate effects on planktonic food quality and trophic transfer in Arctic Marginal Ice Zones", is nicknamed Cleopatra.

Changes in the ice conditions of the polar continental shelf could have an impact on the algae that cling to the ice or float free in the water masses. This could have major ramifications for *Calanus glacialis* and all of its predators.

Eat and be eaten

The zooplankton *Calanus* is a genus of marine copepods – tiny crustaceans related to krill, crabs and shrimp. In the North Sea, the predominant copepod species is *Calanus finmarchicus*, just 4-5 mm in length. But in the relatively shallow continental shelf surrounding the Arctic Ocean, the larger and fattier *Calanus glacialis* is the most important.

Calanus glacialis is perhaps the Arctic's most important species. Researchers have now been able to document how this zooplankton has adapted perfectly to an extreme natural environment. Notice the lipid sac that comprises nearly the entire organism. (Photo: Janne Søreide / UNIS)

Terrestrial areas of the Arctic comprise a polar desert. In the ocean, however, a fertile combination of melting ice, nutrients and sunlight gives rise to a virtual explosion of life in the summer half of the year. In the Arctic food chain, the most sought-after nutritional compounds are the omega-3 fatty acids – produced exclusively by marine algae (sea ice algae and phytoplankton). *Calanus glacialis* graze on these algae and are a key source of nutrients in the Arctic food chain. To survive the long Arctic winters, *Calanus glacialis* stores a large amount of fat (lipids), which can amount to as much as 70 percent of its body mass. This lipid-rich zooplankton is the primary food source for Arctic cod, marine birds and bowhead whales. Arctic cod, in turn, are the main course for seals, which are the favourite meal of polar bears.

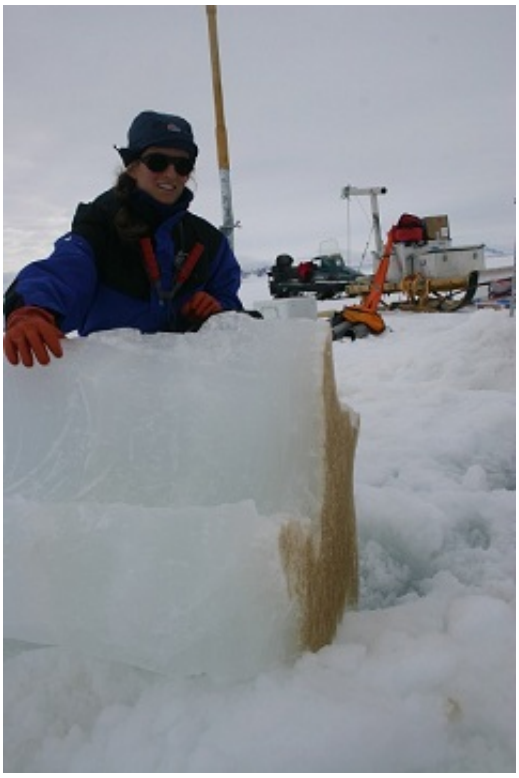
The ocean's "grass and grazers"

"In the Arctic Marginal Ice Zones, the ocean is covered with ice in the winter. When the ice finally releases its grip with the advent of Arctic springtime, an explosive production of biomass occurs," explains Jørgen Berge, a professor of biology at UNIS and Cleopatra project manager.

The Cleopatra project was launched to enhance knowledge about the most important food chain links: ice algae and phytoplankton, which can be thought of as the grass of the ocean, while zooplanktons are the ocean's cows.

Cold, nutrient-rich waters

For nearly a full year, the researchers tracked the development of plankton in the frigid Arctic Ocean climate of Rijpfjorden, a fjord of Nordaustlandet island in the Svalbard archipelago.



(Photo: Janne Søreide / UNIS)

"We are the first to have documented how *Calanus glacialis* is able to e the Arctic," asserts Professor Berge.

April is when the algae living on the underside of the ice initially bloom. These ice algae are specially adapted to utilising the minute amounts of sunlight that penetrate the ice and snow cover on the earliest spring days. The resulting algal bloom – and the critical value of these algae as a food source – were the focus of post-doctoral research fellow Eva Leu's studies. She has now documented these algae's seasonal cycle and their dependence on various environmental factors.

The project's researchers were also able to follow the development of *Calanus glacialis* as it rose from the ocean depths in April to graze on ice algae growing on the underside of sea ice. The mature females utilise this initial bloom peak of biomass production for sex development and egg production. Post-doctoral research fellow Janne Søreide has carried out important work in this area.

Not until July does the sea ice in Rijpfjorden melt away. This triggers another, larger bloom peak of biomass, this time in the form of phytoplankton that swim in the ice-free waters. By this time, the offspring of *Calanus glacialis* have grown large enough to feed greedily on this bounty of nutrients.

Perfectly timed

The second part of the Cleopatra project was carried out in Svalbard's Kongsfjorden and in the UNIS laboratory. Kongsfjorden is the fjord where Dr Leu conducted trials exposing algae to various amounts of light, while Dr Søreide and her colleagues were tracking *Calanus glacialis* through its first six developmental stages, recording what happened when the zooplankton consumed various amounts and qualities of food. Dr Leu and Dr Søreide have documented through this research how the stages of *Calanus glacialis* development are perfectly synchronised with the two distinct algal blooms of the northern Arctic.

Rijpfjorden, in the island of Nordaustlandet, opens to the north. This is the coldest part of the Svalbard archipelago. A field hut built by polar bear researchers 30 years ago served as the project base. (Photo: Janne Søreide)

The main conclusion drawn from the research project is that *Calanus glacialis*, an all-important species of the polar continental shelf, is perfectly adapted to its environment – and that changes in the melting of Arctic sea ice could well disrupt its cycle.

Too rapid sea ice melting in April could expose the ice algae to excessive sunlight, which the researchers found from their trials can kill the algae; at the very least the shock causes the algae to produce less omega-3. The ice melting too quickly may also induce phytoplankton to bloom prematurely in summer, which means the *Calanus glacialis* offspring could arrive too late for their first banquet.

In their next studies, the researchers intend to map the impact of faster melting sea ice on the Arctic's overall food

web.

The Cleopatra project involved researchers from UNIS, the Norwegian Polar Institute, the University of Oslo and the University of Tromsø. Researchers from Germany, Poland, Russia, Sweden and the UK also participated, and there was collaboration with Canadian and EU projects as well.

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