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MARINE NIGHT

BIODIVERSITY AND FOOD WEB STRUCTURE OF THE ARCTIC POLAR NIGHT

| 2013 |

Solving the mysteries of the **marine night**

The severe nature of researching ecosystems in the Arctic midwinter night is reflected in the dearth of knowledge and data concerning this period. However, **Professor Jørgen Berge** explains how new research is drastically improving understanding of these ecologies

Having first worked within the field of invertebrate taxonomy, later studying Arctic marine ecology, what has been the most exciting period of your research to date?

Without any doubt the most exciting period has been the last few years. The discoveries we have made concerning polar night biology have provided me with a huge amount of motivation and inspiration. Not least, it has strengthened my belief that the approach we have developed is the right way to move forward.

Can you summarise the key research objectives of your current projects?

Principally, we aim to gain insight into the patterns and processes that characterise the polar night. In one way, it is a bit like bio-prospecting – so little is understood about the processes and adaptations relevant for the polar night that we have started out by sampling and collecting data very broadly. We have made lots of discoveries and will increasingly turn towards targeted case studies in which we carry out specific experiments to understand the processes and mechanisms involved. Our studies of the polar night are very important in relation to the expanding oil and gas industry in the High North – in order to make reliable risk analyses and educated scenarios for development, we need to know how the system works during the polar night. At the moment, this is more like a black box for which we know surprisingly little about its content.

What would you identify as the main gap in knowledge hindering a comprehensive understanding of the processes that govern the Arctic marine system?

Reliable field data is key: we know much about the system during spring, summer and autumn, whereas there are many assumptions as to the polar night. We need to fill these gaps with real data in order to gain insight into seasonal development and annual routines of organisms.

Why is the Arctic system so strongly influenced by climate change? What do you see as the future repercussions of both global and localised climate change within the region?

The Arctic is a node in ocean circulation, with the Fram Strait representing an especially important area for the exchange of water masses in and out the Arctic. This exchange not only relates to transport of energy (temperature of the water), it is also an important vector for the transport and distribution of all marine organisms that, in one way or another undergo a planktonic life stage, ie. most organisms. As temperatures change, so will the number and composition of species that are transported via ocean currents. This has both direct and ecological cascading effects on the Arctic system.

Do you collaborate externally? What value is derived from these partnerships?

The project is very demanding logistically and we depend to a very large degree on help and aid from new underwater technologies. Our national and international partners provide such competence, and will be closely involved in our field and analytical efforts. Furthermore, Russian and Polish partners bring a unprecedented knowledge of biodiversity and faunistics from Arctic systems – another aspect that is central for our success.

Are there any planned outreach activities, workshops or conferences on the horizon that you would like to highlight?

During the Arctic Frontiers conference in January 2014, we will host a special session on the polar night. This will be organised together with a new MSc/PhD course on underwater robotics and polar night ecology. Through Marine Night, we will organise a two-week field campaign in Ny-Ålesund on Svalbard in early January involving a total of 40 students and researchers, all of which will take part in the Arctic Frontiers conference following immediately after the field campaign. Including the research vessels from both the University of Tromsø and the University Centre of Svalbard (UNIS), this will constitute a major contribution towards marine night science. So far, two artists and three media representatives have been invited on the campaign.

Manoeuvres in the **dark**

Recent studies of Arctic ecosystems have highlighted how little is understood about the life cycles supported by this region. Pioneering research into the darkest period of the polar night is beginning to dispel a number of long-held assumptions

CLIMATE RESEARCHERS GENERALLY agree that the Arctic is likely to be experiencing ice-free summers in a relatively near future – an environmental shift that has not taken place for at least 8,000 years, and is expected to have a huge impact on the ecosystems it sustains. At the base of those food chains are planktonic taxa, some of which – such as the crustacean *Apherusa glacialis* – are thought to be entirely dependent on Arctic sea ice. It was also once thought, however, that the harsh environment of the Arctic landscape supported no life at all. Due to the region's adverse weather conditions, extensive study has often been difficult to implement, but this state of affairs is changing. It is now clear that not only is the role of the natural habitat of certain plankton misunderstood but there are knowledge gaps in their life cycle as a whole.

Professor Jørgen Berge of the University of Tromsø, Norway, leads Marine Night, a collaborative four year-long project located on Svalbard that is challenging assumptions about the behaviour and life-history of Arctic marine organisms – especially with regards to the notion that most enter a state of hibernation during the polar night's total darkness. Also, the project is challenging the idea of the Arctic polar night as a marine desert void of life.

With funding of NOK 11.2 million from the Research Council of Norway – total funding NOK ~30 million – and the involvement of a raft of experts from around the world, the project represents a significant international effort to better understand the biological processes taking place in the polar environment. The main collaborators hail from the St Petersburg State University, the Institute of Oceanology – Polish Academy of Sciences, the Scottish Association of Marine Sciences, the University of Delaware, Akvaplan-niva AS, The Norwegian University for Science and Technology, the University Centre in Svalbard (UNIS) and the ARCTOS research network. "Combined," says Berge, "this group provides state-of-the-art competence in underwater technologies as well as a unique experience and knowledge regarding Arctic marine ecology".

FILLING IN THE GAPS

As early as 2009, Berge had already contributed to a paper that shed light on nocturnal planktonic activities. The diurnal vertical migration (DVM) of zooplankton constitutes a vast mass of aquatic fauna that is of paramount importance in sustaining the food chain. Most of their predators use their vision to forage, which demands a certain degree of light being present to illuminate their prey. In response to this, zooplankton spend the daylight hours in the depths of the ocean and ascend to nutrient rich waters during darkness. It is therefore natural to assume that DVM ceases during the dark polar night. Using an acoustic doppler current profiler (ACDP) to measure biomass, Berge and his colleagues analysed the backscatter and found that DVM was still taking place in the midwinter polar night, a time when the human eye perceives total darkness.

Tying together aspects from three projects currently underway in the fjords of Svalbard, Marine Night proposes to provide a comprehensive picture of the biological

What effect environmental damage may have in the Arctic relies on a thorough understanding of the system, not just snapshots

INTELLIGENCE

MARINE NIGHT

OBJECTIVES

To achieve a basic understanding of Arctic biodiversity and food web structure during the Arctic polar night, and how reproduction, growth, trophic interactions and life-history traits during this near-unstudied time contribute to functioning of Arctic ecosystems.

PARTNERS

Akvaplan niva AS, Norway

University Centre in Svalbard, Norway

Norwegian University for Technology and Science, Norway

Institute of Oceanology Polish Academy of Science, Poland

Scottish Association of Marine Science, UK

St Petersburg State University, Russia

University of Delaware, USA

FUNDING

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PROFESSOR JØRGEN BERGE completed his PhD at the University of Tromsø in 2000. His main scientific focus centres on two topics; ecosystem responses to climate change and the pioneering discoveries of biological processes during the polar night. Currently he is a Professor at the University of Tromsø and an adjunct professor at University Centre of Svalbard (UNIS).

A black guillemot. The project poses questions, such as how this species finds its food during the darkest part of the polar night. © G Johnsen (NTNU)

processes occurring in the polar night. In spite of the breakthrough in 2009 and further investigations around DVM and bioluminescence, there is still much to be learnt.

In 2012, Berge and his colleagues demonstrated just how much was missing from collective knowledge of the region as they pondered the life cycle of *A. glacialis*. Allowing for an approach with a more evolutionary understanding than the functional, mechanistic work that has so far taken place in the Arctic, the team was able to show that understanding of the life cycle of the crustacean was based on untenable beliefs. Total dependency on sea ice as a natural habitat could not be a valid assertion because these 'homes' break away and melt, and when new ice is formed the amphipods can be found in them just as numerously. Moreover, this plankton has existed for millions of years, meaning they successfully survived the last spell of iceless oceans.

"My background," highlights Berge, "enabled me to examine patterns and processes more from an evolutionary point of view". This ability means that the future of the ice-dwelling amphipod, though not certain, is far less doubtful than previously assumed. Due to their appearance in deep plankton nets in the Arctic sea, Berge and his colleagues have theorised that plankton can migrate for 10 months before descending to a depth where return currents would bring them back to the point of departure within two to three months.

SPREADING THE WORD

Continuing to explore the as yet still mysterious mechanisms that enable life to thrive in the arctic sea, plans to disseminate the project's findings are already taking shape as an umbrella website (www.mare-incognitum.no) has been established. Hosting several larger research projects on the one site, Berge and his colleagues hope to take advantage of each other's efforts towards a wider communication of results as well as offering a broad spectrum of relevant information collected under one website. In this respect, the Marine Night participants are deeply committed to the use of national and international media to both promote new results as well as attracting attention towards the fields of science they are working in.

Furthermore, ARCTOS' annual Arctic Frontiers conference, which this year focuses on the theme of humans in the Arctic, attracts significant research and media attention both nationally and internationally and is an important arena for promoting communication with a broad spectrum of end-users. Marine Night's results are expected to provide useful information that goes beyond the bounds of marine zoology and have an application in management and risk assessments. New shipping routes through the Northwest and Northeast Passage and expanding oil and gas industries will increase the risk of environmental damage in the Arctic. What effect this may have relies on a thorough understanding of the system, not just snapshots from the light part of the year.

"What effect will an oil spill from a ship that crashes on the shores on Franz Josef Land have if it occurs during the darkest part of the polar night?" asks Berge. In such a hypothetical situation, a response team would need to know which species were present in the system at that time of year and what behaviour they were exhibiting. Since many species across all phyla and trophic levels utilise the polar night for reproduction more than previously assumed, Berge believes that "knowledge of such issues will be of vital importance for a correct and educated management of resources in the Arctic".

A juvenile polar cod: another visual predator studied by Marine Night. © G Johnsen (NTNU)