

Introduction to the special issue on polar night studies conducted onboard RV *Helmer Hanssen* in the Svalbard area

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Introduction

Polar night studies at high latitudes have during the last years become a major research focus for ARCTOS researchers, spearheaded by research cruises lead by UiT and MSc/PhD courses lead by UNIS. During the last 4 years, the RV *Helmer Hanssen* have been assigned to conduct research well into the nautical polar night (Berge et al. [in press](#)), a temporal and spatial part of the Arctic Ocean that until now have remained more or less unstudied.

For a long time, ice-covered areas of the Arctic were presumed to be unproductive and early scientific studies in the Arctic generally supported this paradigm (Nansen 1902). Evidence of human settlements in the high Arctic over several thousand years, however, conflicted with these early observations and constituted a paradox as to how human populations could subsist in regions considered to be biological deserts. Further investigations revealed the existence of productivity hot spots on par with some of the most productive places on earth and provided the first indications of complexity and the importance of the links

between ice, ocean, and land in Arctic ecosystems. During the last 20 years, culminating with the third International Polar Year (IPY 2007–2009), however, national and international research efforts in the Arctic have sharply increased. This increase in attention and research efforts are paralleled by an increased awareness of both the fisheries and petroleum resources available at high latitudes as well as new shipping routes emerging following a reduction of the Arctic ice cover (see e.g. Barber et al. [in press](#)). Despite the fact that attention, awareness and research efforts have increased, there are still major and fundamental gaps in knowledge, preventing a holistic understanding of the Arctic as a single, linked system undergoing unprecedented change and in an earth science perspective. Perhaps the most obvious and largest of these known gaps is centred around the widely accepted paradigm that Arctic marine ecosystems are best compared with a marine desert during the long and dark polar night. Just as the paradigm of the Arctic Ocean being an unproductive biotope was refuted a hundred years ago, the prevailing view of the polar night as devoid of biological activity has recently been challenged (Berge et al. [in press](#) for a review).

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Highlights and outlook

Here we report on a diverse set of biological studies, all conducted onboard the RV *Helmer Hanssen* in January 2012 and 2013, reporting on various aspects of polar night biology (Fig. 1). This special issue can roughly be divided into three categories: (1) studies with light as the main theme, including solar, lunar, and biologically produced light; Johnsen et al. (2014) on bioluminescence, Webster et al. (2013) on influence of moon on nekton, Morata, and Soreide (2013) on effect of light on *Calanus* spp., and

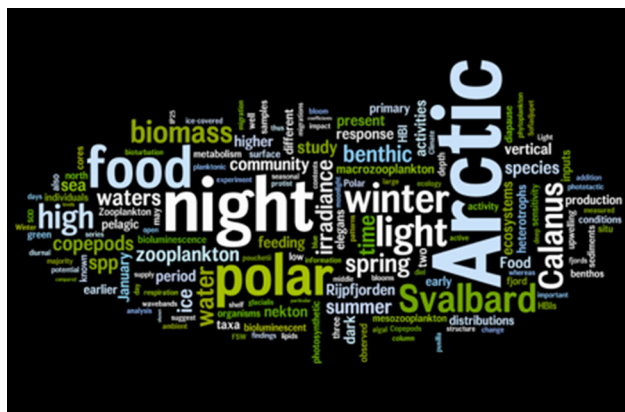


Fig. 1 Word cloud highlighting the most common used words in the titles and keywords of all the 10 papers included in this special issue. The size of the word reflect how many times they are occurring in titles, abstracts, and keywords

Båtnes et al. (2013) on detection limits of light in *Calanus* spp.; (2) Process studies on linkages between pelagic/sympagic and benthos, including biomarker indicators: Morata et al. (2013) on benthic activities, Brown et al. (2013) on biomarkers, Falk-Petersen et al. (2014) on upwelling processes assumed to fuel biological production regimes; (3) Pelagic communities and biology: Grigor et al. (2014) on chaetognaths, Vader et al. (2014) on phototrophs, and Blachowiach-Samolyk et al. (2014) on mesozooplankton communities.

In combination, these ten papers represent a major increase in our general knowledge, concerning biological patterns and processes characteristic of the polar night. Also, and equally important, all ten papers are directly based upon two relatively short (10 days) scientific cruises north of Svalbard in January 2012 and 2013. The fact that these ten papers, in addition to other papers published elsewhere (Berge et al. 2012; Kraft et al. 2012; Daase et al. 2014) are all direct outcomes of two such short cruises, illustrate the fact that the polar night at high latitude constitute one major gap in current knowledge. The magnitude of this gap has only recently have become evident (see Berge et al. *in press* for a review). Herein, we present ten dedicated and focused studies on different aspects of polar night ecology and biological oceanography (see Fig. 1). Results include studies on the small green alga *Micromonas pusilla* and the haptophyte *Phaeocystis pouchetii*—two key phototrophs in the Arctic, commonly blooming during the arctic spring and summer. As was expected, chlorophyll concentrations were very low during our study period and across our study area (78°–81°N). Vader et al. (2014) showed, using a molecular approach, that *M. pusilla* and *P. pouchetii* are widely distributed in Svalbard waters also at the height of the polar night. Both species were

detected in pelagic samples from both fjords and the open ocean, ice-covered and ice-free locations, shallow and deep water and from Atlantic, Arctic, and Coastal water masses. The presence of these phytoplankton species shows that overwintering cells are present and ready to bloom as soon as the sun returns in late March. In a different study, Błachowiak-Samołyk et al. (2014) showed that a large part of the herbivorous community had already started to migrate into the upper water layers, both in Rijpfjorden and the Fram Strait. This upward migration occurred 2 months before the return of the sunlight and onset of the primary production. In another study, Falk-Petersen et al. (2014) were able to relate the absence of ice and prevailing wind directions with a pronounced upwelling along the continental slope North of Svalbard. This upwelling event, driven by the combination of little ice and easterly winds, is hypothesised to create a similar condition to those that once supported the large stocks of bowhead whales before they were hunted to near extinction in the late 1700s (Falk-Petersen et al. 2014).

The three papers highlighted here (section above) represent only three out of ten papers, and only three out of several topics, all centred around polar night in the Arctic. As is evident from the summary of all titles and keywords (Fig. 1), there is a general focus on “light” and “food” among the studies—both “topics” generally considered to be limited during the polar night. Polar marine ecosystem processes, as in all other ecosystems, are direct consequences of the complex behaviours and interactions between organisms, many of which are driven by the physical environment. Accordingly, a classical paradigm in Arctic marine ecology suggests that most biological processes stop during the polar night at high latitudes due to low food availability and the lack of light (Smetacek and Nicol 2005; Piepenburg 2005). Recently, this assumption was challenged by presenting evidence of diel vertical migration (DVM) of zooplankton during the polar night (Berge et al. 2009). This discovery initiated a large range of diverse studies, most presenting unexpected new discoveries of a system in full operation and with high activity levels. The results presented in this volume is a natural extension of the work published so far on polar night ecology and is an important contribution towards our general understanding of the Arctic marine system. Not the least, and based on the findings both included in this volume and previous reports (see Berge et al. *in press* for a review), the current reduction of Arctic sea ice is likely to have both a direct and indirect impact on marine organisms, their interactions, and ultimately ecosystem processes. But without a more fundamental perception of Arctic ecosystem function, such impacts will remain largely impossible to understand and predict. *Winter ecology of Arctic marine systems, then, is a largely new field of*

science with the potential for radically altering our fundamental perception of basic Arctic ecosystem processes, current state of the ecosystem and connections between the biosphere, hydrosphere and cryosphere within the Polar Region. To this end, this volume and the ten papers included are important and significant steps towards a more holistic and general understanding of the Arctic marine ecosystem.

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