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South Georgia pipit nesting at Schlieper Bay, South Georgia

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An 18-strong international team is hard at work in South Georgia, undertaking the final phase of the world's largest rodent eradication project, run by the South Georgia Heritage Trust. Known collectively as 'Team Rat', its departure for South Georgia in January coincided with the discovery of a nest of five South Georgia pipit chicks (Fig. 1) in an area overrun with rats before being baited by the trust in 2013. The pipit is the world's most southerly songbird.

Fig. 1. South Georgia pipit nest. Photo Sally Poncet.

The South Georgia pipit is endemic to South Georgia, with an estimated 3000 pairs nesting on the island. It has an IUCN status of Near Threatened. Previous to the baiting work it bred only on offshore islands and areas of the southern coastline inaccessible to rats. In stark contrast, *Rattus norvegicus* has been thriving ever since it first reached the island as a stowaway on sealing vessels in the late 1800's. All of the small ground-nesting birds on the island, such as the pipits, prions and petrels, have had their nests decimated by the interloper, whose numbers are unknown but were reckoned to be in the millions before the baiting work began.

Rat populations range along the north coast of South Georgia. Their DNA varies from place to place, evidence that populations have been kept separate over the years by South Georgia's glacial divides. The same barriers have halted the rats' progress to areas on the south coast, and have allowed 'Team Rat' to bait the island over a number of years, confident that these natural boundaries will stop any re-invasion from neighbouring areas. However with glacial recession rats have been able to penetrate ever further into the pipits' territory. Even offshore islands are under threat of invasion from rodents given the right conditions (favourable currents and floating debris). The only way of ensuring the survival of the South Georgia pipit as a species is through the goal of eliminating every rat from South Georgia.

The discovery of the first pipit nest in an area cleared of rodents, was made at Schlieper Bay near Weddell Point to the very northwest of the island. The nest was found by Sally Poncet, an expert on South Georgia wildlife. Poncet was a member of Team Rat during its Phase 1 operation. She discovered the nest while on an expedition to survey wandering albatrosses. Many others have now reported pipits in numbers in the areas treated in 2013.

Experts estimate that the seabird population on South Georgia could increase by as much as 100 million in the absence of rodents.

Algal bloom in a melt pond on Canada Basin pack ice

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ABSTRACT. Melt ponds are common on the surface of ice floes in the Arctic Ocean during spring and summer. Few studies on melt pond

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algae communities have been accomplished. These studies have shown that these melt ponds were ultra-oligotrophic, and contribute little to overall productivity. However, during the 6th Chinese Arctic Cruise in the Arctic Ocean in summer 2014, a closed coloured melt pond with a chlorophyll *a* concentration of 15.32 μg/L was observed on Arctic pack ice in the Canada Basin. The bloom was caused by the chlorophyte *Carteria lunzensis* at an abundance of 15.49×10^6 cells/L and biomass of 5.07 mg C/L. Primary production within surface melt ponds may need more attention along with Arctic warming.

Introduction

Melt ponds are commonly observed on ice floes in the Arctic Ocean during spring and summer. Previous studies showed that biomass and primary production within the ponds are usually low (0.1 to 2.9 mg Chl *a* m^{-3} in the Canada Basin and 0.1 to 0.3 mg Chl *a* m^{-3} in the central Arctic Ocean) and contribute less than 1% to the total primary production in the Arctic Ocean (Lee and others 2012: C04030). During the 2014 Chinese Arctic Cruise, the last ice station was in the Canada Basin, Arctic Ocean. Sea ice physical, optical, chemical and biological observations were conducted on a large piece of 1.1 m thickness sea ice, which has 17 cm (average) thickness snow cover and 3 to 4 melt ponds. The researchers landed on the ice by a skiff. During the polar bear defence by telescope, two melt ponds with light brown algal bloom belt were observed and water samples of one of them were collected carefully (149°21.341W, 78°48.191N). In this note, the environmental features and microbial assemblage of this bloom are described, and the reason for, and significance of this melt pond algal bloom, are discussed.

Materials and methods

Sea ice physical, chemical, and biological studies were carried out in Canada Basin during the 6th Chinese Arctic Cruise in summer 2014. A melt pond on an ice station (Fig. 1) was studied on 29 August. Temperature and salinity were measured by a WTW thermosalinograph with a conductivity probe. A total of 4L melt pond water was collected by using an organic glass water sampler. Among them, 500 ml was filtered through 0.7 μM (GF/F) filters. The filter was collected for onboard Chlorophyll *a* (Chl *a*) measurement with a Turner Designs 7200 fluorometer according to the method of Parsons (Parsons and others 1984: 101–173). A 100 ml filtrate was examined for nutrient concentration measurement with a Skalar San ++ automatic analyser under the protocol of Grasshoff (Grasshoff and others 1999: 193–198). One liter melt pond water was filtered through 0.2 μM pore size filter and filter was frozen in –80 °C for parallel 454 pyrosequencing of the 18S rRNA gene (Zhang and others 2015). Ice cores from sea ice adjacent to the melt water ponds were collected with a Mark II ice auger (Kovacs). Ice core temperatures were measured at 5 cm intervals. Ice core subsamples for salinity measurements were cut at 10 cm and biological measurements at 20 cm intervals except for the bottom 5 cm. Samples for salinity and chlorophyll measurements were melted at room temperature; then salinity was measured as above. Filtered sea water was added to samples intended for biological analysis at a ratio of 1L : 20 cm (seawater : ice) to reduce osmotic pressure and melting damage in the low-temperature laboratory (4°C). Subsamples of 400 mL pond water and each melted water sample were filtered on a polycarbonate filter, DAPI stained, and frozen for later epifluorescence microscope analysis (He and others 2012: 36–45).

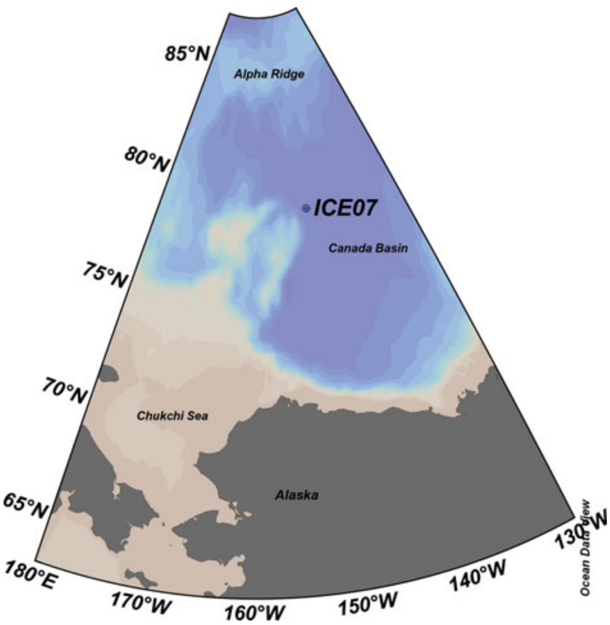

Fig. 1. Sampling site in the Canada Basin (ICE07) during the 2014 Chinese Arctic cruise.

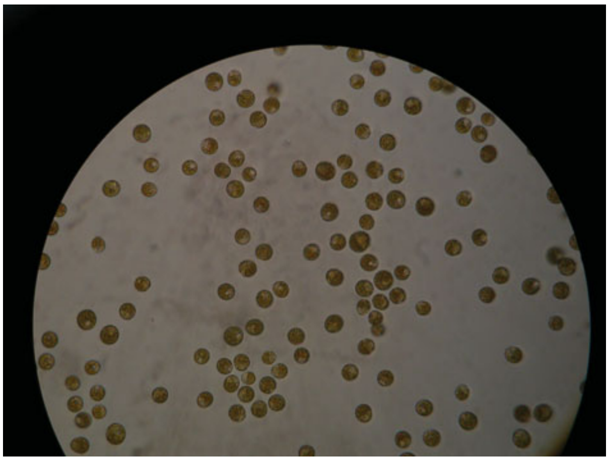

Fig. 2. Photomicrograph of the dominant species: chlorophyte *Carteria lunzensis* Pascher and Jahoda (x 400).

Results and discussion

Pond water temperature was –0.1°C and salinity was 0.2 (Table 1). The algal bloom had a chlorophyll *a* concentration of 15.32 mg m^{-3}, and it was dominated by a chlorophyte (Fig. 2), identified as *Carteria lunzensis* (Pascher and Jahoda) on the basis of 18S DNA analysis (similarity of 97%), with an abundance of 15.5×10^6 cells/L. Cell diameters were between 11.9 and 21.6 μm, with an average of 16.2 μm (n = 100). The microbial community associated with the bloom was very simple (Table 2). Analysis of DAPI stained sample showed that the bacterial abundance was lower than that within surface ice and protozoa were almost absent.

As noted above, the melt pond habitat on Arctic pack ice floes has previously been thought to be ultra-oligotrophic. A previous study showed that a snow alga, *Chlamydomonas nivalis* (Bauer) Wille was common and dominant on the surface

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Table 1. The environmental factors and chlorophyll *a* concentrations in the surface ice (0~20 cm), melt pond, and underlying water.

Parameters	Melt pond	Surface ice	Underlying water
Air temperature (°C)	0.4	0.4	—-
Water/Ice temperature (°C)	– 0.1	– 0.1	– 1.6
Salinity (psu)	0.2	0.0	26.8
Nitrate+Nitrite (μM)	0.00	0.18	0.41
Phosphate (μM)	0.12	0.02	0.25
Silicate (μM)	1.27	1.32	2.58
Chlorophyll *a* (mg m^{-3})	15.32	0.32	0.19

Table 2. The microbial assemblages in the melt pond and surface ice (0~20 cm).

	Melt pond		Surface ice	
Taxa	Abundance (cells/L)	Biomass (μg/L)	Abundance (cells/L)	Biomass (μg/L)
Bacteria	1.93×10^8	3.86	2.28×10^8	4.56
Algae	15.49×10^6	5070.70	2.11×10^6	69.54
Protozoa	VL	VL	2.10×10^6	58.32

of Arctic pack ice (Gradinger and Nürnberg 1996: 35–43), however, a bloom in an Arctic surface melt pond of the intensity seen here has never previously been reported.

Two parameters are important for supporting this bloom: a suitable algal 'seed', and nutrients. Fig. 3 shows the profiles of temperature, salinity, and chlorophyll *a* concentrations within the ice column. Chlorophyll *a* concentrations in the surface were comparable to those of bottom ice and much lower than in the meltwater pond. Compared with values in the surface ice, pond nitrate and nitrite were exhausted, probably due to utilisation by algae (Table 1). Silicate was similar to that in the surface ice, but as a chlorophyte dominated the algal assemblage, little silicate would be expected to be consumed during the bloom. Phosphate in pond water was higher than that in surface ice. Comparatively, the nitrogen was much lower, but the silicate was much higher, while phosphate was similar with those in the closed melt pond in 2005 and 2008 examined by Lee and others (2012: C04030). This suggests that there was a replenishment mechanism or that nutrients were inhomogeneously distributed in the ice or snow and would release during the pond formation process (Tovar-Sanchez and others 2010: C7). The nutrients can be replenished in many ways, such as wind, snowfall, animal faeces, etc. Algae 'seed' to the surface ice during autumn and winter. This ice could be the blooming site in the melt pond.

Sea ice is an important habitat. It has been estimated that sea ice biota constitute about 4~25% of the total primary production in seasonal ice-covered waters in the Arctic Ocean (Legendre and others 1992: 429–444) or even more in the central Arctic Ocean (Gosselin and others 1997: 1623–1644). As physio-chemical factors distributes continuously in snow and ice, the microflora in the ice-associated habitats may be the same anywhere (Bursa 1963: 239–262). Both marine diatom and freshwater green algae, as well as other flagellate has been found in the sea ice, melt pond and water under sea ice (Bursa 1963: 239–262; Mundy and others 2011: 1869–1886). The ecosystem of the Arctic ice represents the poorest oligohaline condition during a short duration and is thought to be of small importance as far as general plankton production in the ocean is concerned (Bursa 1963: 239–262). However, under-ice blooms are a widespread phenomenon in polar regions, due to the Arctic's thinning ice cover and subsequent increase in transmitted irradiance to the under-ice environment (Mundy and others 2009: L17601). A massive phytoplankton bloom was observed under the Arctic sea ice in the Chukchi Sea (Arrigo and others 2012: 1408). Gradinger (1996: 301–305) reported

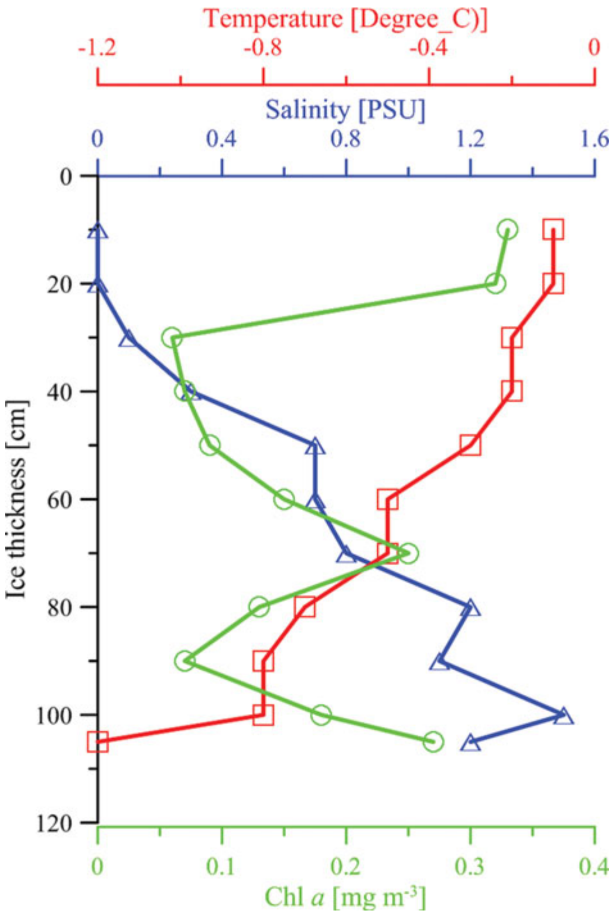

Fig. 3. The vertical profiles of temperature (red line), salinity (blue line), and chlorophyll *a* concentration (green line) in the ice core at site ICE07.

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a chlorophyte (*Pyramimonas* sp.) bloom in a melt pond under pack ice with an abundance of 19.1×10^3 cells ml^{-1} and a pigment concentration of 29.6 mg m^{-3}. Primary production of the surface melt pond is thought very low (Bursa 1963; Lee and others 2011: 302–308). However, the algal bloom reported in this study suggests that phytoplankton community and primary production within surface melt ponds may need more attention with Arctic warming.

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