Distribution, abundance and population demographics of *Salpa thompsoni* on the Kerguelen Plateau

Natasha Henschke*[1], Stéphane Blain[2], Yves Cherel[3], Cedric Cotte[4], Boris Espinasse[1,5], Brian P.V. Hunt[1,5] and Evgeny A. Pakhomov[1,5]

*nhenschke@eoas.ubc.ca

[1]Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, British Columbia, Canada; [2]Sorbonne Universités, CNRS, Laboratoire d'Océanographie MICrobienne, F-66650, Banyuls sur Mer, France; [3]Centre d'Etudes Biologiques de Chizé (CEBC), UMR 7372 CNRS-La Rochelle Université, 79360 Villiers-en-Bois, France; [4]LOCEAN, Sorbonne Universités (UPMC, Univ Paris 06) CNRS-IRD-MNHN, Paris, France; [5]Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, British Columbia, Canada

What are salps?

The salp, *Salpa thompsoni,* is a prominent grazer in the Southern Ocean that often occurs in dense swarms in the warmer waters of the Antarctic Polar Frontal (APF) zone[1]. Unlike crustacean zooplankton that are keystone species in the Kerguelen food web[2], *S. thompsoni* have few known predators. However, salps have high filtration rates, allowing them to have a grazing impact that can exceed the total daily primary production when they are abundant[3]. Additionally, as they can feed on a range of particles over three orders of magnitude in size[4], they are potentially important competitors with other phytoplankton grazers.

Background

The Kerguelen Plateau, south-east of the Kerguelen Islands, is a major barrier to the eastward flowing Antarctic Circumpolar Current (ACC) in the Indian sector of the Southern Ocean[5]. Interactions with the bottom topography supply iron and the Kerguelen plateau is associated with elevated chlorophyll concentrations with a dynamic and prolonged bloom beginning in late October, usually peaking in early November and late December and ending by late February[6]. As a result, the Kerguelen Plateau region is a crucial feeding ground for significant midwater and demersal fish populations as well as numerous top predators including sea birds, seals and whales[7].

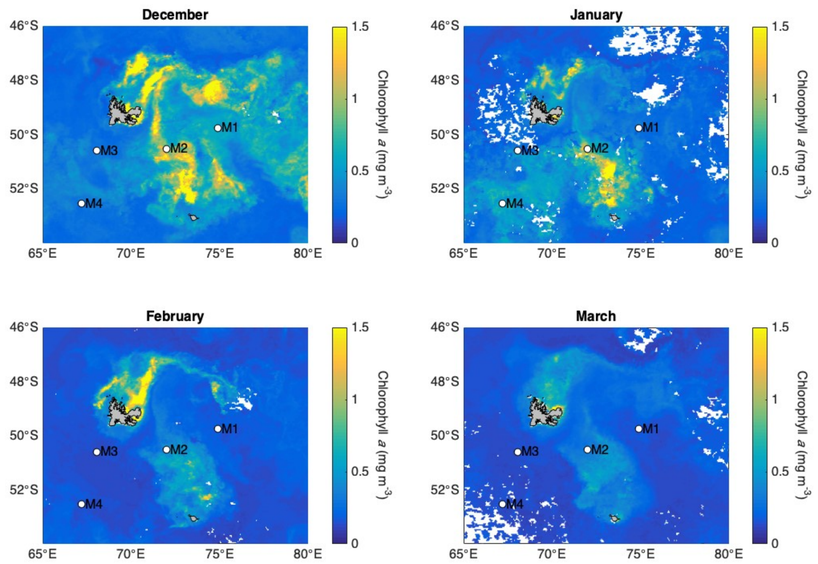

Figure 1. Location plot showing sampling sites with monthly mean chlorophyll *a* concentrations from prior to (December – January) and during (February – March) sampling overlaid. Areas with no data (cloud cover) are indicated in white. Chl. *a* data obtained from GlobColour.

Oceanographic sampling

- In late summer to early autumn of 2018, the MOBYDICK expedition sampled the micronekton community, including salps, at stations on the Kerguelen Plateau with contrasting hydrological conditions.
- Four stations were sampled: one station M2 on the plateau, two off-plateau stations (M3, M4) to the west of Kerguelen, and one off-plateau station M1 located to the east of Kerguelen.
- Prior to sampling, a large chlorophyll *a* bloom occurred at stations M1 and M2 whereas M3 and M4 were typical HNLC stations (Fig. 1).
- At the time of sampling, chlorophyll *a* concentrations at M1 and M2 remained higher than at M3 and M4.
- Temperatures were similarly warm across each station (4 – 5 °C).

Salp abundance and distribution

- *S. thompsoni* were more abundant at M1 and M2 during the night (Fig. 2).
- Overall mean salp abundance (4.2 individuals 1000 m^3) was within the range sampled in comparable Atlantic sector APF waters.
- *S. thompsoni* made up a larger proportion of total micronekton biomass at M1 and M2 (42%) than M3 (5%) and M4 (3%), however, the biomass of other micronekton did not differ significantly across stations.
- Population demographics indicated that M1 and M2 populations were more mature, with left-skewed stage distributions indicative of a typical autumn population, whereas M3 and M4 populations were younger, right-skewed stage distributions, more typical of a less developed summer population

S. thompsoni growth rates

- Cohort analysis of *S. thompsoni* blastozooid and oozoid populations identified 2 – 4 distinct cohorts at each station. The means of each cohort were linked to determine the growth trajectories for each cohort based on sampling dates.
- *S. thompsoni* growth rates were similar across stations and did not differ significantly (Fig. 3). Growth rates ranged from 1.57 – 6.02 % d^{-1} (0.38 – 1.18 mm d^{-1}) for blastozooids and 0.45 – 7.01 % d^{-1} (0.34 – 3.25 mm d^{-1}) for oozoids and declined with increasing size.

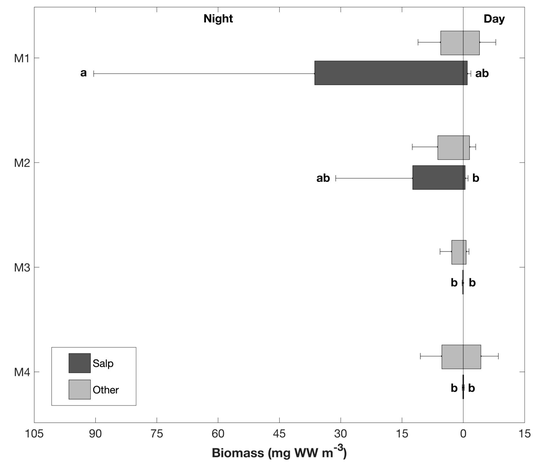

Figure 2. Day and night mean biomass (±SD) of *S. thompsoni* (salp) and other micronekton (other) sampled at stations M1 – M4. Letters denote significant difference in *S. thompsoni* biomass at $p < 0.05$.

Potential impact on the Kerguelen Plateau ecosystem

The impact of *S. thompsoni* blooms on the local Kerguelen ecosystem may be prominent, particularly in late summer. As the Mesopelagos trawl is designed for micronekton, these results highlight that *S. thompsoni* are an important part of the potential prey field of vertebrate predators. Recent genetic studies have highlighted the dietary significance of gelatinous zooplankton, including salps for fish and penguins[8,9]. It is, therefore, particularly important to assess the impact that *S. thompsoni* may have on the local pelagic ecosystem as both a potential competitor or as micronekton prey.

Future implications

The Kerguelen Plateau region is unique because it deflects a branch of the ACC southward into the Cooperation Sea[10]. This deflection of warmer waters to the south, is likely a precursor of large salp blooms observed further south in the northern Prydz Bay Region[11]. As krill in the Indian sector may be more sensitive to increased competition compared to krill in the Atlantic sector[12], there is a need to increase our understanding of salp populations from this area. More studies on *S. thompsoni* across multiple seasons are needed to understand better their dynamics on the Kerguelen Plateau as well as their 'invasion' potential into the Prydz Bay Region and adjacent regions.

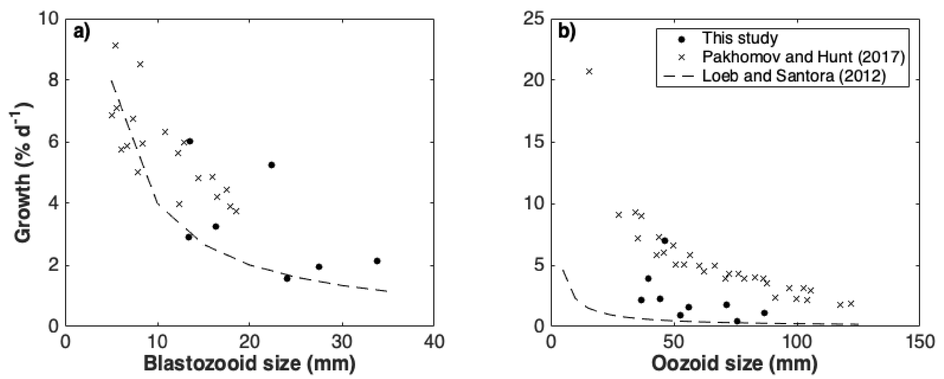

Figure 3. *S. thompsoni* mean relative growth rates for a) blastozooids and b) oozoids calculated from repeated sampling at stations M2, M3 and M4 (circles). Overlaid are mean relative growth rates for *S. thompsoni* from repeated sampling in the Antarctic Polar Front (crosses; Pakhomov and Hunt, 2017) and Antarctic Peninsula (dashed line; Loeb and Santora, 2012). Values from Loeb and Santora (2012) are presented as growth curves as raw data were not available.

References: 1. Foxton, 1966; 2. Bocher et al., 2001; 3. Dubischar and Bathmann, 1997; 4. Henschke et al., 2016; 5. Park et al., 2008; 6. Blain et al., 2007; 7. Cherel et al., 2005; 8. Clarke et al., 2019; 9. Cavallo et al., 2018; 10. Lanin et al., 1987; 11. Pakhomov, 2000; 12. Murphy et al., 2017