

The First Observation of Swarming Krill Aggregations near the Sea Bottom in Admiralty Bay (King George Island, Antarctica) Close to the Biggest Glaciers

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1. INTRODUCTION

Since the middle of the 20th century, the Southern Ocean, especially the Antarctic Peninsula, has been experiencing intense climate warming. On the west coast of the peninsula, there has been a marked increase in air and seawater temperatures, combined with a reduction in seasonal ice sea cover, the rapid retreat of glaciers and the collapse of ice shelves (Campos et al. 2013b). Observed changes not only have an impact on the physical environment, but also directly and indirectly affect marine organisms – disrupting their physiology, life cycles and thus also their feeding strategies, behaviour, and spatial distribution. Admiralty Bay – located on the northern coast of King George Island in the South Shetland – a glacially influenced coastal embayment and a key site for long-term Antarctic ecosystem monitoring is a region where intense climate change overlaps with anthropogenic pressure (Campos et al. 2013a).

Zooplankton play a key role in the trophic food webs of the Southern Ocean, with species composition and distribution shaped by environmental conditions such as melting glaciers and local water circulations (Leonor and Muxagata 2024). Antarctic krill, as a keystone species, link primary producers to higher trophic levels including seabirds and seals. Krill exhibit complex social behaviour that facilitates swarm formation and maintenance. They align their swimming direction and speed with near neighbours, enabling cohesive group movement and self-organization within swarms. Near the sea bottom, krill may aggregate to exploit localized food patches or seek refuge from predators. Several species of Euphausiacea, including the dominant *Euphausia superba* Dana, 1850 and *E. crystallorophias* Holt & Tattersall, 1906, have been recorded in the bay (Jackowska 1980; Stępnik 1982; Kittel et al. 2001). Recently the highest densities of Euphausiacea were recorded in the central part of the bay and in the outlet area,

influenced by local hydrography and water mass mixing (Kittel et al. 2001). The bay's glacial meltwater input affects water column stratification and turbidity, which in turn modulate krill feeding efficiency and thus their distribution (Kittel et al. 2001).

Krill aggregations are strongly dependent on environmental factors, among them are depth or tidal speed and direction. Their density near the bottom often correlates with predator diving dynamics (Annasawmy et al. 2023). In addition, krill exhibit a variety of foraging strategies including benthic foraging (Takahashi et al. 2003). Euphausiacea can occur near the seafloor throughout the year forming aggregations at depths of 200 to 2000 meters and thus playing an important role in the transfer between benthic and pelagic communities (Schmidt et al. 2011). Krill aggregations have previously been recorded in Antarctic regions including Bransfield Strait (Annasawmy et al. 2023); on the shelf edge in the southeastern Weddell Sea (Gutt and Siegel 1994); along the Western Antarctic Peninsula (Kane et al. 2021); and on the seafloor of Marguerite Bay in the western Antarctic Peninsula (Clarke and Tyler 2008). However, no studies or direct observations of this phenomenon have been conducted so far in Admiralty Bay.

The main goal of this study was to document, for the first time, the occurrence of near-bottom krill aggregations in Admiralty Bay and to characterize their community structure. We also aimed to compare environmental conditions between two consecutive summers and to explore potential drivers.

The zooplankton samples used in this study were collected vertically (mainly from the upper 50-meters) by WP-2 plankton net (180 μ m mesh size) during two summers (2023 and 2024) in AB. The sampling was carried out simultaneously with CTD (equipped with fluorescence, turbidity and oxygen sensors) and Underwater Vision Profiler (UVP) measurements of particle size and morphology. A drop camera (100 frames per second with HD) – recording the whole water column from the surface to the bottom – used only in 2024 revealed the presence of krill assemblages near the seafloor at 8 stations located close to the Lange Glacier, Ecology Glacier, Domeyko Glacier and in Ezcurra Inlet. Zooplankton samples have been analysed to verify the presence of krill and to assess whether their community structure differed between the two studied years. We also aim to assess krill faecal pellets clearly recorded by drop camera in AB.

Analyses of UVP and CTD data from both studied summers together with comparison of available historical data aim to broaden our knowledge dealing with environmental conditions at stations where krill was observed. Preliminary UVP and CTD data suggest that our study covered two different years concerning the seawater temperatures and the amount of marine snow in the AB water column.

Intensive glacial meltwater influx potentially reduces the size of krill aggregations near the sea bottom due to mortality from suspended inorganic particles and shift their composition by affecting certain life stages. Thus our observation of krill near very important tidewater – Lange Glacier located on the west side of AB (with retreat rate averaging 48 m/year in recent decades) is significant because the literature indicates that in the coastal area of the Antarctic Peninsula, a reduction in sea ice area correlates with general decrease in krill abundance, leading to changes in the structure and functioning of marine food webs (e.g., Atkinson et al. 2004; Murphy et al. 2007; Hofmann et al. 2011; Campos 2013a). Despite these challenges, coastal zones near glaciers remain critical refugia for krill, particularly during periods of low offshore productivity and reduced sea ice. The interplay between physical drivers (e.g., upwelling, freshwater input), biological processes (e.g., migration, feeding), and anthropogenic pressures (e.g., fisheries) underscores the need for integrated, circumpolar monitoring networks that can capture the complexity of krill dynamics in this rapidly changing Antarctic environment.

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