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Influence of heavy metals on the occurrence of Antarctic soil microalgae

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Abstract: Human- and animal-impacted sites in Antarctica can be contaminated with heavy metals, as well as areas influenced by underlying geology and naturally occurring minerals. The present study examined the relationship between heavy metal presence and soil microalgal occurrence across a range of human-impacted and undisturbed locations on Signy Island. Microalgae were identified based on cultures that developed after inoculation into an enriched medium. Twenty-nine microalgae representing Cyanobacteria, Bacillariophyta, Chlorophyta and Tribophyta were identified. High levels of As, Ca, Cd, Cu and Zn were detected in Gourlay Peninsula and North Point, both locations hosting dense penguin rookeries. Samples from Berntsen Point, the location of most intense human activity both today and historically, contained high levels of Pb. The contamination factor and pollution load index confirmed that the former locations were polluted by Cd, Cu and Zn, with these being of marine biogenic origin. Variation in the microalgal community was significantly correlated with concentrations of Mn, Ca, Mg, Fe, Zn, Cd, Co, Cr and Cu. However, the overall proportion of the total variation contributed by all metals was low (16.11%). Other factors not measured in this study are likely to underlie the majority of the observed variation in microalgal community composition between sampling locations.

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Introduction

Human activities in Antarctica can cause both immediate and cumulative impacts on the environment (Naveen 1996, Convey 2020). Coastal areas in particular have suffered the impacts of the establishment of national scientific research stations since the mid-twentieth century, on both the Antarctic Peninsula and Continental Antarctic (Vodopivez *et al.* 2015), as well as from the earlier marine exploitation industries targeting seals and whales in the Scotia Arc archipelagos and the sub-Antarctic islands (Convey & Lebouvier 2009). Increasing research activities in Antarctica, especially after the International Geophysical Year (1958–1959), have led to a range of impacts, including anthropogenic contamination in the environment, particularly in the limited available ice-free areas (Santos *et al.* 2005, Brooks *et al.* 2019). More recently, Antarctic tourism, predominantly based on cruise ships, has shown exponential growth since the late 1970s, when there were only a few hundred visitors each year (Naveen 1996), to a total of 56 168 tourists in the 2018/2019 summer (https://iaato.org/wp-content/uploads/2020/03/IP140-IAATO-Overview-of-Antarctic-Tourism-2018-19-Season-and-Preliminary-Estimates-for-2019-20-Season.pdf). Although there is currently a hiatus in both national research activity and tourism in Antarctica resulting from the COVID-19 pandemic, leading to a temporary reduction in pressure on the Antarctic environment, both are expected to recover in future years (Hughes & Convey 2020).

Human activities can contaminate soils with heavy metals. However, as heavy metals are also natural components of the Earth's crust, it can be difficult to distinguish between their natural and anthropogenic