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Heavy metal pollution in Antarctica and its potential impacts on algae

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ABSTRACT

Antarctica is not free from environmental pollutants although it is often perceived as the last pristine continent on Earth. Research stations represent one of the largest forms of anthropogenic activity and are the main source of locally derived contamination in Antarctica. Elevated levels of heavy metals such as copper (Cu), lead (Pb) and mercury (Hg) have been detected in Antarctica. Fuel combustion, accidental oil spills, waste incineration and sewage disposal are amongst the primary sources of heavy metal contaminants in Antarctica, besides natural sources such as animal excrements and volcanism. Studies on the impacts of heavy metals on biota in Antarctica have been focused mainly on invertebrates and cryptogams but not on algae. However, adverse impacts of heavy metals on sensitive algae may affect organisms at the higher trophic levels, and consequently disrupt Antarctic food chains. Heavy metals may be accumulated by algae and biomagnified through the food chain. The sensitivity and response of Antarctic algae to heavy metal toxicity have not been well studied. Robust toxicity protocols for the testing of the impacts of heavy metals on Antarctic algae need to be developed. This review aims to give an overview of the status of heavy metal pollution in Antarctica and its potential impacts on algae.

1. Introduction

The Antarctic continent is predominantly covered in permanent ice, with only c. 0.18% or about 25,000 km^2 of its area consisting of ice-free exposed ground and rock (Burton-Johnson et al., 2016). Although Antarctica is regarded as the last pristine continent, it is not totally free from pollution. This is despite the isolation of the continent from the input of lower latitude contaminants by natural barriers such as circumpolar atmospheric and oceanic currents (Barker and Thomas, 2004). Available data suggest that heavy metals, pesticides, and other persistent organic pollutants (POPs) could reach Antarctica via Long-range Atmospheric Transport (LRAT) from other continents in the Southern Hemisphere and even beyond (Bargagli, 2008).

There has been concern over the environmental impact arising from increasing human activities in Antarctica. Since the International Geophysical Year (1957/58), scientific activities have expanded significantly, with an estimate of 5000 national operator staff working in Antarctica annually, of which around 1000 overwinter (COMNAP, 2012). In addition, tourism has increased, with more than 39,000 tourists visiting Antarctica in the 2015/16 season alone (IAATO, 2016). Some areas in Antarctica have been designated as Antarctic Specially Protected Areas (ASPAs), with the aim of protecting such environments from human disturbance (Shaw et al., 2014). Fifty-five of the currently existing ASPAs are in ice-free areas and designated for their biodiversity values (Shaw et al., 2014).

A majority of human activities in Antarctica take place within ice-free environments, which account for just 0.18% of the continental area (Burton-Johnson et al., 2016). Human activities, especially in the vicinity of research stations, are the major local cause of pollution in Antarctica (Bargagli, 2008). The location of most Antarctic research stations are in ice-free areas within 5 km of the coast, which represents only 0.05% of the total land area of the continent (Poland et al., 2003). Although this constitutes a small proportion of the land area, these regions are extremely important as they host most of the terrestrial floral and faunal diversity of Antarctica. Amongst the various terrestrial habitats, Antarctic soils are amongst the most vulnerable to human

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