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Deception Island, Antarctica, harbors a diverse assemblage of wood decay fungi

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ABSTRACT

Very little is known about fungal diversity in Antarctica as compared to other biomes and how these important organisms function in this unusual ecosystem. Perhaps one of the most unusual ecosystems is that of Deception Island; an active volcanic island part of the South Shetland Islands of the Antarctic Peninsula. Here we describe the fungal diversity associated with historic wood from structures on the island, which reveals a diverse fungal assemblage of known wood decay fungi as well as the discovery of undescribed species. The major group of wood decay fungi identified were species of *Cadophora* and as shown in previous studies in other geographic regions of Antarctica, they caused a soft-rot type of decay in the introduced woods. Additionally, unlike other areas of Antarctica that have been studied, filamentous basidiomycetes (*Hypochniciellum* spp. and *Pholiota* spp.) were also identified that have different modes of degradation including brown and white rot. Matches of fungal sequences to known species in temperate regions likely introduced on building materials indicates human influences and volcanic activity have greatly impacted fungal diversity. Lahars (mudslides from volcanic activity) have partially buried many of the structures and the buried environment as well as the moist, warm soils provided conditions conducive for fungal growth that are not found in other regions of Antarctica. The diverse assemblage of decay fungi and different forms of wood decomposition add to the difficulty of conserving wooden structures at these important polar heritage sites.

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Introduction

Deception Island, part of the South Shetlands, is a small Antarctic island with unique ecological characteristics, unusual geological features and a rich historical past. The island is an active volcano that has a flooded caldera with narrow entrance to the interior (Fig 1). Early sealers and whalers utilized this geologic feature for protection from the open ocean when they visited the island as early as 1820. Historic wooden

structures still exist on the island today and are listed as Historic Sites and Monuments. Hektor whaling station (Norwegian) on Whalers Bay was established in 1911 as a land based operation and numerous factory whaling ships used the harbour in subsequent years. Later, in 1944 following the crash of the whale oil market, the British used the site and added a wooden building called Base B. Following that, the British Antarctic Survey (BAS) used the site as a base for aerial surveys of the Peninsula, at which time a runway was made

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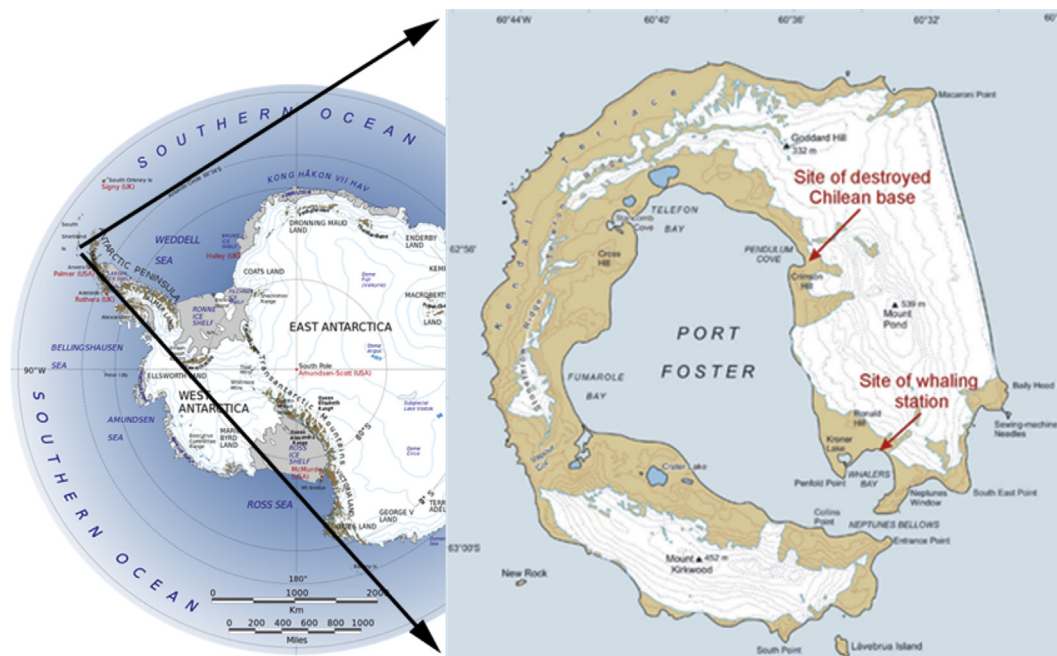


Fig 1 – Map of Antarctica (left) and Deception Island (right) showing the sites where samples were collected.

and airplane hangar built. Many buildings, structures, and remnants from the whaling station and later activities on the island are still present today in varying stages of deterioration and are protected as an Antarctic Historic Site or Monument (HSM-71), under the Antarctic Treaty.

Pendulum Cove, approximately 4 km north of Whalers Bay is the location of an additional historic site, the Chilean research base, Presidente Pedro Aguirre Cerda Station (Fig 1). This station was built in 1955 and used until 1967 when it was destroyed by volcanic activity. While very little of the station is remaining, the site and remaining structures are protected as an Antarctic Historic Site and Monument (HSM-76).

The geological history of the Island includes an eruption of the volcano approximately 10000 years ago that created Port Foster and the interior bay (Olsacher 1956). Numerous other eruptions have occurred, including several during the past two centuries that have changed the topography of the island significantly. Subsequently, ash has covered glaciers, which occupy 57 % of the island. Many areas on the island have geothermal activity that produce fumaroles, heated soils, and steaming beaches. These unusual environmental conditions in the polar environment provide a unique opportunity for microbial activity to take place that is not seen in other parts of Antarctica. Investigations on the island also provide an opportunity for comparative analysis of microbial diversity with other areas of Antarctica where wood and other introduced nutrient sources have been deposited, such as the historic expedition huts of the Ross Sea and historic structures on the Antarctic Peninsula. Compared to temperate biomes, very little is known about fungal diversity and decomposition in polar environments. However, previous research on fungal diversity and degradation of wooden structures and artifacts in Antarctica has shown that fungi are important decomposers despite the extreme environment (Held et al. 2005;

Arenz et al. 2006; Duncan et al. 2006; Held et al. 2006; Arenz & Blanchette 2009; Arenz et al. 2010; Blanchette et al. 2010). The only type of wood decay previously found occurring in Antarctica has been classified as a soft rot caused by Ascomycota and occurs primarily in wood that is in contact with soil on Ross Island (Blanchette et al. 2004; Arenz et al. 2006; Held et al. 2006; Blanchette et al. 2010) and on the Antarctica Peninsula (Arenz & Blanchette 2009). The common types of decay in temperate and tropical areas, brown and white rot caused by basidiomycetes, have not previously been found.

The study objectives were to identify fungi associated with and causing decay of historic wood on Deception Island and to further understand the microbial diversity and decomposition processes that exist in this unusual polar environment where soil temperatures range from freezing to 90 °C. This work also provides a unique opportunity to investigate alien fungi presumably introduced on building materials into a polar environment. In addition to advancing knowledge of fungal biology and ecology in Antarctica, the outcomes of this study will provide needed information on the fungi causing decay in historic wooden structures and will benefit conservation strategies to protect these valuable cultural resources.

Materials and methods

Samples were collected from wooden structures and artifacts at Whalers Bay and Pendulum Cove, Deception Island (62°57'S, 60°38'W) that appeared to be decayed and in various stages of decomposition. Small segments (approximately 1 mm × 0.5 mm) of wood were collected and placed in sterile plastic bags and kept cool while transporting them back to the laboratory. Under sterile conditions in the laboratory, the wood samples were cut and placed onto the following types of

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