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Soil fungal community composition does not alter along a latitudinal gradient through the maritime and sub-Antarctic

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ABSTRACT

We investigated the relationships between fungal community composition, latitude and a range of physicochemical parameters in 58 soils sampled from a 2370 km latitudinal gradient between South Georgia (54°S, 38°W) in the sub-Antarctic and Mars Oasis (72°S, 68°W) on Alexander Island in the southern maritime Antarctic. Our study, which is based on approximately ten times the number of samples used in previous similar studies, indicates that latitude and its associated environmental parameters are not related to fungal community composition. Significant changes in the composition of soil fungal communities were observed in relation to gradients of the ratio of total organic carbon to nitrogen, and, to a lesser extent, soil pH.

Introduction

The harsh environmental conditions that prevail along the Antarctic Peninsula result in isolated ice-free patches of land that typically have extremely sparse vegetation cover. This is advantageous in the context of investigations concerning relationships between patterns of microbial biogeography and latitude, because the effects of latitude-related environmental parameters, such as temperature, are not obscured by differences in plant biomass and diversity. Observations indicate that soil fungal communities may alter in composition along the Antarctic Peninsula and through into the continental Antarctic. Although fruit bodies of basidiomycetes such as *Galerina* spp. are present in the maritime and sub-Antarctic

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(Pegler et al. 1980), they appear to be very infrequent beyond 66°S, and have only been reported from a few maritime Antarctic sites, such as the Danco Coast (Gamundí & Spinedi 1988). In contrast, yeasts and zoosporic fungi appear to be frequent in soils at higher latitudes (Bridge & Newsham 2009). A previous report supports this view, with a change in fungal denaturing gradient gel electrophoresis (DGGE) profiles being recorded between Signy Island (60°S) in the South Orkney Islands and Coal Nunatak (72°S) on southern Alexander Island (Yergeau et al. 2007). Another study, however, found no change in soil fungal community composition, as determined by cloning and sequencing of eukaryotic SSU rRNA genes, between Signy Island and the La Gorce Mountains (86°S) in the continental Antarctic (Lawley et al. 2004). However, as both of these studies were based on soils sampled from between four and six locations in the Antarctic, it is not possible to draw any conclusions concerning the strength of any relationship between latitude and fungal community composition.

To determine whether or not soil fungal community composition alters at higher latitudes in the maritime and sub-Antarctic, we collected soil samples from multiple sites, of which 58 are considered in this report, along a 2370 km latitudinal gradient covering South Georgia, the South Orkney and South Shetland Islands, and the Antarctic Peninsula and its offshore islands. We generated fingerprints of fungal community composition and determined a range of environmental parameters for each sample. We then tested the hypothesis that latitude and its associated environmental parameters determine the composition of soil fungal communities.

Materials and methods

Soil sampling and physicochemical characterisation

During the 2008–2009 austral summer, with logistic support from the UK Royal Navy and the British Antarctic Survey, soil samples from vegetation-free sites were collected along a latitudinal gradient ranging from 54°S to 72°S (Fig 1). The uppermost 5 cm of soil was collected in 50 ml tubes, immersed in a mixture of dry ice and ethanol (c. −80 °C) in the field, and then transferred to −80 °C freezers within a few hours of collection.

Soil pH and electrical conductivity (EC; μS) were measured in a 1:2.5 and 1:5 soil:water (vol:vol) slurry, respectively. Total nitrogen and organic carbon were determined using an Exeter Analytical CE440 Elemental Analyzer (EAI, Coventry, UK) following desiccation at 105 °C and treatment with HCl to remove inorganic carbon. Total soil contents of Ca, Cu, Fe, K,

ID	Site	Lat	Long	Alt (m)
1	South Georgia - Bird Island	54.03	38.31	480
2	South Georgia - Bird Island	54.23	38.05	430
3	South Georgia - Bird Island	54.24	38.05	422
4	Signy Island - Wynn Knolls	60.72	45.85	199
5	Signy Island - Wynn Knolls	60.72	45.85	199
6	Signy Island - Wynn Knolls	60.72	45.85	199
7	Signy Island - Wynn Knolls	60.72	45.85	199
8	Signy Island - Wynn Knolls	60.72	45.85	199
9	Signy Island - Wynn Knolls	60.72	45.85	199
10	Signy Island - Wynn Knolls	60.72	45.85	199
11	King George Is - C. Ferraz	62.13	58.66	65
12	King George Is - Round Point	62.16	58.47	12
13	Nelson Island - Edward Point	62.63	59.66	26
14	Greenwich Island - North Beach	62.64	59.95	16
15	Greenwich Island - North Beach	62.67	59.78	13
16	Livingston Is - Byers Peninsula	62.70	61.23	75
17	Livingston Is - Byers Peninsula	62.73	61.19	64
18	Livingston Is - Byers Peninsula	62.74	61.20	64
19	Livingston Is - Byers Peninsula	62.74	61.20	64
20	Deception Island - Whalers Bay	63.13	60.77	104
21	Deception Island - Whalers Bay	63.14	60.59	91
22	Peninsula - Pass nunatak	63.72	57.95	612
23	James Ross Is - Cape Lachmann	63.83	57.94	104
24	Trinity Island - Spert Island	64.02	57.79	81
25	Trinity Island - Spert Island	64.02	60.98	93
26	James Ross Is - Cape Lachmann	64.02	61.18	92
27	Trinity Island - Spert Island	64.03	60.96	102
28	James Ross Is - Cape Lachmann	64.04	57.84	85
29	Alectoria	64.16	59.14	25
30	Alectoria	64.16	59.14	50
31	Seymour Island - Marambio	64.28	56.77	160
32	Seymour Island - Marambio	64.28	56.77	160
33	Seymour Island - Marambio	64.28	56.77	190
34	Gand Island	64.51	62.98	25
35	Port Lockroy	64.82	63.48	4
36	Port Lockroy	64.82	63.48	10
37	Wiencke Island	64.89	63.76	2
38	Wiencke Island	65.06	63.59	6
39	Wiencke Island	65.07	63.60	6
40	Berthelot Island - Berthelot Island	65.50	64.29	52
41	Cape Evenson - Peninsula	66.33	65.83	31
42	Cape Evenson - Peninsula	66.33	65.83	12
43	Detaille Island	66.89	66.86	26
44	Detaille Island	67.01	66.78	21
45	Rothera - ASPA	67.58	68.35	35
46	Rothera - East Beach	67.60	68.34	6
47	Blaiklock Island	67.69	67.44	7
48	Lagoon Island	67.76	68.46	20
49	Jenny Island	67.97	68.60	12
50	Alexander Island - NW Peninsula	69.37	72.02	62
51	Alexander Island - NW Peninsula	69.37	72.03	62
52	Alexander Island - NW Peninsula	69.39	72.02	66
53	Alexander Island - NW Peninsula	69.53	72.00	64
54	Alexander Island - Mount Holt	69.54	71.89	501
55	Alexander Island - NW Peninsula	69.62	71.99	70
56	Mars Oasis - Near Melon hut	71.98	68.38	15
57	Mars Oasis - Near Melon hut	71.98	68.38	15
58	Mars Oasis - Near Melon hut	71.98	68.38	15

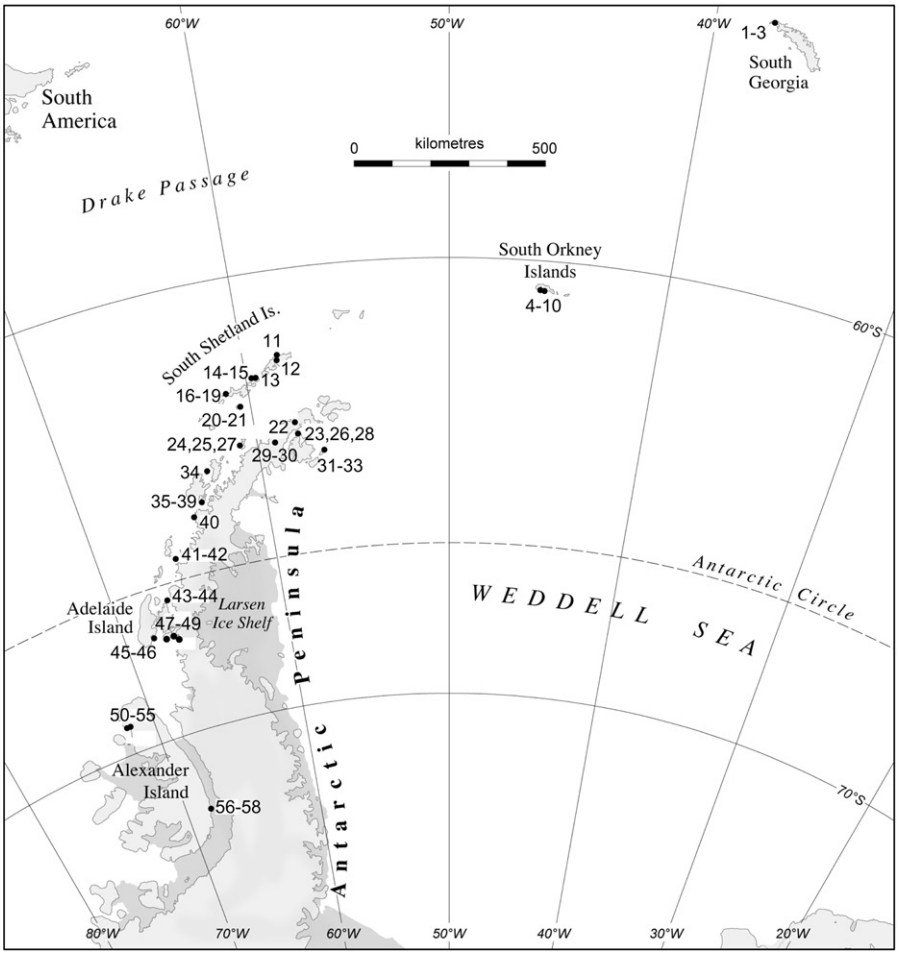

Fig 1 – Approximate locations of sampling sites in the maritime and sub-Antarctic.