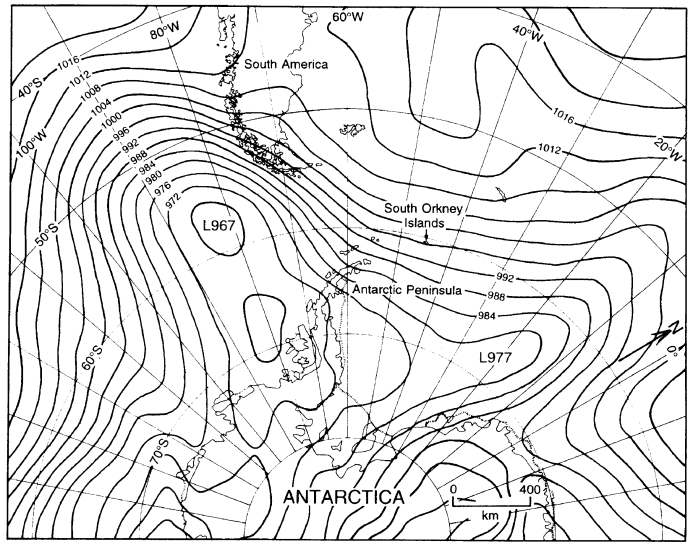
Biological particles over Antarctica

SIR — Antarctica is viewed by almost all as a continent in biological isolation. But recent aerobiological sampling in the maritime Antarctic has revealed a dramatic influx of material from South America when, within a single 24-hour period, the density of the air-spora increased 20-fold over normal levels. This was associated with a specific weather pattern which occurs with an estimated mean annual frequency of 1.5. This is the first time such an impressive transfer of biological material from another continent has been observed and it provides direct evidence of one way in which the Antarctic may have been recolonized since the last glacial maximum, about 18,000 years ago. Such events also provide a mechanism for organisms to extend their range into Antarctica as mean annual isotherms move south with regional warming, as in recent years[1–3].

I conducted an aerobiological sampling programme at three sites (111, 150 and 279 m above sea level) on Signy Island, South Orkney Islands in the maritime Antarctic (60° 43′ S, 45° 36′ W) between 14 December 1992 and 28 January 1994. Samples collected between 9:20 on 11 November 1993 and 11:00 on 12 November 1993 showed a massive increase in concentration of airborne biological particles, 24, 17 and 13 times above the mean for all samples collected at each of the three sites. This was more than three times that of the next largest concentration sampled at two of the sites and 1.6 times that at the third.

However, the concentration of airborne pollen and spores at Signy Island during this period was still much smaller than that at temperate sites (3.34 m^{-3} compared to 12,500 m^{-3} during the summer in southern England[4]). The massive increase in the air-spora at Signy Island represents a small proportion of spores that diffuse upwards beyond a point where they may be at risk of dry deposition in South America and that completed the 1,500-km intercontinental journey between Cape Horn and the South Orkney Islands (see figure).

Exotic pollen records collected over the past 100 years in snow, ice, moss and peat have provided much circumstantial evidence for long-distance transport of propagules into Antarctica. In the present study, I found large concentrations of southern beech (*Nothofagus* spp.) pollen in the air (mean from three sites, 0.47 grains m^{-3}), indicating that the material trapped on Signy Island on 11–12 November 1993 was from South America. Other material, not normally found in Antarctic air, included spores of the widely distributed fungi, *Tetraploa* spp. and *Sporormiella* spp., and pollen of South American *Podocarpus* spp. Examination of daily synoptic weather charts, of the South Atlantic and South Pacific sectors, between 40 and 90° S, for the period November 1983 to October 1995 revealed weather patterns very similar to the event of 11 November 1993 on 18 occasions (mean 1.5 per year).



Daily synoptic chart for 11 November 1993 showing the weather pattern resulting in the transport of biological material from southern South America to the South Orkney Islands in the maritime Antarctic. Tightly packed isobars indicate a corridor of strong winds between Tierra del Fuego and Antarctica as air flows clockwise around the area of low pressure (L967). Collections were made over 24-hour periods using four rotorod samplers on each of three sites[14].

During the last glacial maximum, ice covered all but the tallest mountain peaks and scoured marine habitats (up to 200 m below the present sea level) as far north as the sub-Antarctic islands[5,6]. Following this destruction of coastal terrestrial and benthic habitats[7] two mechanisms of recolonization are possible, the radiation of organisms from ice-free refuges and the immigration of organisms from more northerly land masses by long-distance dispersal. Ice-free land would be limited to isolated nunataks; pre-glacial relict species in the terrestrial environment are therefore nunatak specialists. In contrast, most organisms inhabiting the maritime and sub-Antarctic are less specialized and possibly arrived by long-distance airborne transport.

Chilean *Podocarpus* spp. pollen found in samples of red snow collected by the Scottish National Antarctic Expedition of 1902–04 (ref. 8) was the first reported evidence of long-distance airborne transport into the Antarctic. Recent examination of moss cushions for exotic pollens has indicated that immigration occurs in the maritime Antarctic but not continental Antarctica[9]. However, this is contradicted by the growth of exotic plants on volcanically warmed ground around fumaroles in continental Antarctica[10]. A coordinated aerobiological sampling programme in the Antarctic has been suggested several times since the 1960s (refs 11, 12). Previous studies have been summarized by Smith[12] and Wynn-Williams[13]. In this study I have found conclusive evidence of immigration into the maritime Antarctic, but only further sampling programmes in other regions of Antarctica will determine the full extent of this phenomenon.

The possible frequency of these events represents considerable potential for the input of biological material into the Antarctic biome since the last glacial maximum and, therefore, opportunities for colonization of the increasing snow-free area. If future climates continue to make pristine habitats available for colonization, phenomena like the one described here will be of major importance in defining which taxa are successful.

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