Blight of moss caused by *Pythium sp.* in Greenland

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Abstract

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Pythium sp. actively attacks mosses (*Sanionia uncinata*) growing in Kangerlussuaq, Ammassalik, Kulusuk, and Ittoqqortoormiit, Greenland. This is the first report of the occurrence of Pythium moss blight in Greenland. All isolates from Greenland could grow at 0°C, and the mycelial growth rate of isolates from Greenland, compared with that of isolates from the Temperate Zone, were very low at temperatures above 10°C. However, the optimal growth temperature of Greenlandic isolates was the same as that of isolates from the Temperate Zone. These results suggest that isolates of Greenland originally developed from isolates from the Temperate Zone and adapted to growth under Arctic conditions.

Keywords: moss pathogenic fungi, *Pythium*, Pythium moss blight, *Sanionia uncinata*

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Introduction

Moss vegetation plays an important role as a producer in early stages of primary succession in the Arctic. Some fungi have been reported to actively attack mosses growing in the Arctic including Finnmark in northern Norway (Hoshino *et al.* 2000), Svalbard (Ridley *et al.* 1979, Hoshino *et al.* 1999, 2001b), Jan Mayen (Wilson 1951) and Ellesmere Island (Longton 1973). The same symptoms are also found in the maritime Antarctic (Longton 1973). We found that species of *Pythium* were parasitic on *Sanionia uncinata* and caused disease in the Arctic (Finnmark and Svalbard; Hoshino *et al.* 1999, 2000, 2001b) and maritime Antarctica (King George Is., Hoshino *et al.* 2001a). However, Pythium blight of mosses has not been reported from Greenland. In this paper, Pythium blight of moss colonies occurring in Greenland as a new locality is reported.

Materials and methods

Isolation of fungi from moss colonies. Moribund moss shoots (*Sanionia uncinata*) were collected to isolate parasitic fungi in Kangerlussuaq (67°01' N, 50°43' W), in August 2000 and Ammassalik (65°61' N, 37°69' W), Kulusuk (65°57' N, 37°17' W) and Ittoqqortoormiit (70°48' N, 21°97' W) on Greenland in July to August, 2002. We collected ca. 2000 shoots from 5 dead and 2

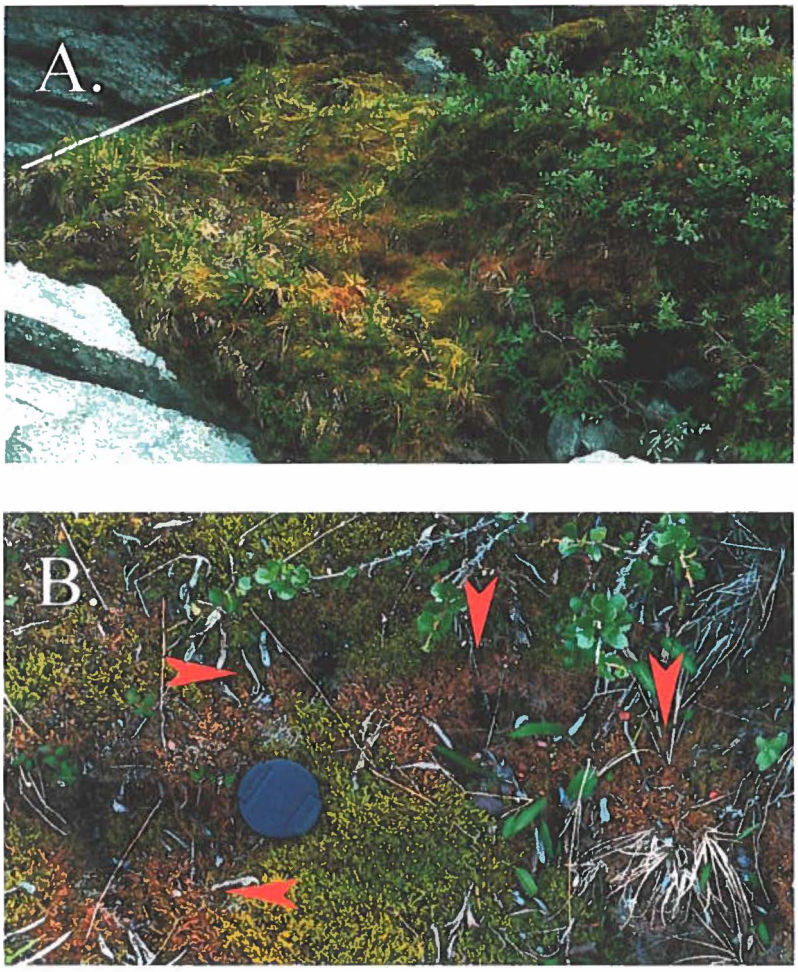

Fig. 1. Fungal infections in *Sanionia uncinata* in Kangerlussuaq, West Greenland. Red arrows showed dead moss shoots by fungal infection.

healthy moss colonies at each site. The collected dead and healthy moss shoots were untied and rinsed twice with sterilized water. Each shoot was cut up into 1 cm pieces. Fifty dead and 20 healthy moss shoots from each site were immediately placed on potato dextrose agar (PDA, Difco) plates. Fungi growing on moss shoots were cultivated at room temperature (ca. 15-20°C) for 2-5 days. Single fungal colonies were selected from each plate and subcultured on PDA slants.

Morphology. Isolates were pre-grown on corn meal agar (CMA, Difco) plates at 15°C, and agar discs 7 mm in diameter were taken from actively growing colony margins and inoculated onto CMA plates. Cultures were incubated for 7 to 30 days at 15°C for morphological observation. The morphological characteristics examined were: dimensions of hyphal swelling, and width of the main hyphae. The isolates were also grown on autoclaved grass leaves for 3 to 7 days at 5 and 15°C to determine zoospore production (Martin 1992). At least 30 hyphal swellings were examined for each isolate for all characteristics.

Growth temperature. Mycelial discs 5 mm in diameter were cut from the margin of an actively growing fungal colony in subcultured PDA plates, transferred to the centers of PDA plates (9 cm in diameter), and inoculated at 9 different temperatures from 0 to 40°C, in duplicate. After 1, 2 and 3 days following inoculation, the colony diameters were determined. The linear mycelial growth rate per day was calculated after the initial lag period.

Results and Discussion

Fungal infection pattern. Dead moss colonies were found and collected in Kangerlussuaq (67°01'N,

50°43'W), West Greenland on 11-15 August 2000 and Ammassalik (65°61'N, 37°69'W), Kulusuk (65°57'N, 37°17'W) and Ittoqqortoormiit (70°48'N, 21°97'W), East Greenland on 27 July – 10 August 2002. *Sanionia uncinata* (Hedw.) Loeske form small moss carpets (5 x 10 m) along lakes, rivers and fjords. Many dead moss colonies in Kangerlussuaq have been found in the moss carpets near the small waterfall of the stream from Lake Ferguson to Søndre Strømfjord (Fig. 1). On the other hand, dead moss colonies were never found in the relatively dry area around Kangerlussuaq and Ittoqqortoormiit.

Mycological characteristics of pathogenic fungi. All isolates from dead moss shoots from each sampling site in Greenland produced only non-sexual organs, hyphal swellings on CMA plates and grass leaves (Fig. 2: none of them had any oogonia production). In addition, isolates did not produce zoospores under artificial conditions. Hyphal swellings of isolates from Greenland were terminally globose and sometimes intercalary (Fig. 2). Diameters of hyphal swellings were 20-25 µm. Hyphal swellings had an outer wall like chlamydospores (Fig. 2). Similar morphological characteristics were reported from species of *Pythium* from Alaska (Hamm *et al.* 1988), Finnmark in northern Norway (Hoshino 2000) and Svalbard (Hoshino 2001b). Morphological comparisons between these characteristics and reference data from van der Plaats-Niterink (1981) indicate that the isolate was *Pythium* sp. HS group. Previously, *Pythium* spp. were isolated in Alaska (Hamm *et al.* 1988), Devon Island (Booth and Barrett 1971), Finnmark (Hoshino *et al.* 2000), Kola peninsula in Russian Arctic (Petrov 1983), and Svalbard (Gaertner 1954).

The morphological characteristics of hyphal swellings of isolates from Greenland correspond to those of isolates from the Temperate Zone (Japan) and other Arctic areas (Finnmark and Svalbard). Isolates from Finnmark, Greenland and Svalbard showed different responses to temperature (Fig. 3). All isolates from the Arctic could grow at 0°C, but the isolates from Japan did not grow at 0°C. On the other hand, the mycelial growth rate of Arctic isolates, compared with that of isolates from the Temperate Zone, were very low at temperatures above 10°C. However, the optimal growth temperature of Arctic isolates was the same as that of isolates from Japan. These results suggest that Arctic isolates originally developed from isolates from the Temperate Zone and adapted to growth under Arctic conditions.

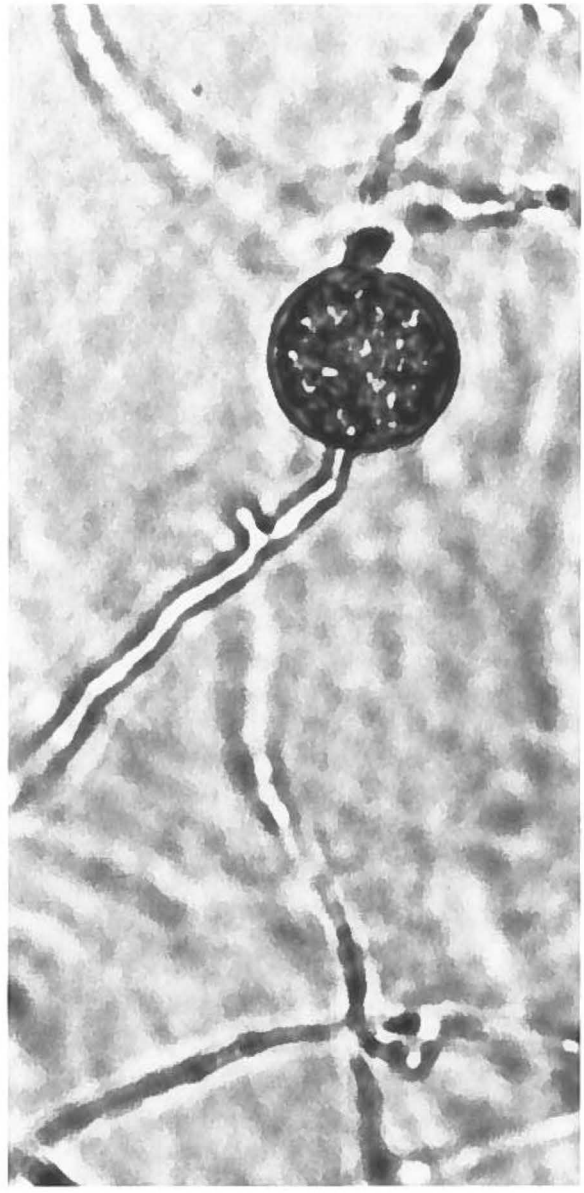

Fig. 2. Mycological characteristics of moss pathogenic fungus from Kangerlussaq, West Greenland. Terminal hyphal swellings in CMA plates.

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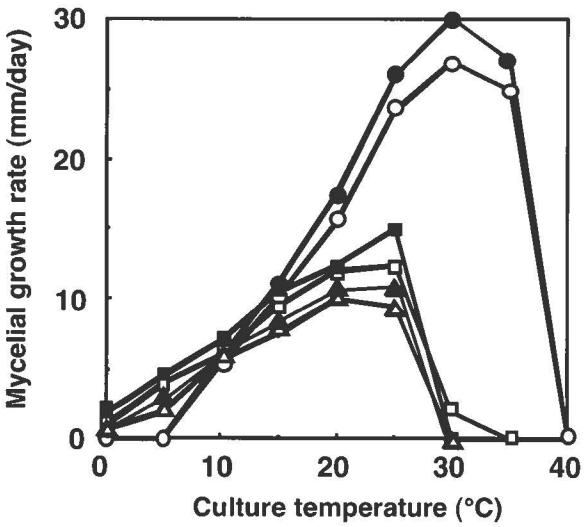

Fig. 3. Effects of culture temperature on mycelial growth of Arctic and temperate zone isolates, *Pythium* HS group. Temperate isolates (94Py 1-4: open circles, 94 Rh-1: closed circles) were isolated from Yamaguchi prefecture in Japan. Arctic isolates were isolated from Kangerlussuaq in West Greenland (open triangles), Ittoqqortoormiit in East Greenland (closed triangles), Alta in Finnmark (open squares) and Barentsburg in Svalbard (closed squares).

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