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Habitat and leaf cytogenetic characteristics of *Deschampsia antarctica* Desv. in the Maritime Antarctica

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Abstract

Antarctic hairgrass (*Deschampsia antarctica* Desv.) was studied in the Maritime Antarctica with respect to general ecological characteristics, soil conditions, viral contamination, cell nucleus area, and relative DNA content. Material was gathered in six localities that were highly diverse in terms of the nature of soil-like substrata, presence of viral antigen determinants, and the average nucleus area and relative DNA content in leaf epidermis and parenchyma cells. Our results show that Antarctic hairgrass lives upon soils that are variable with respect to trace elements, pH, and other soil characteristics. The hairgrass is susceptible to a number of viruses, and shows substantial variation in DNA content and nucleus size.

Keywords: Antarctic hairgrass; DNA content; Habitat; Soils; Viruses

1. Introduction

The Antarctic's natural flora of vascular plants comprises by only two species: Antarctic hairgrass *Deschampsia antarctica* Desv. and Antarctic pearlwort *Colobanthus quitensis* (Kunth.) Bartl. (Alberdi et al., 2002; Fowbert and Lewis Smith, 1994; Lewis Smith, 1994, 1984). These species inhabit the western shore of the Antarctic Peninsula and adjacent islands (Edwards, 1972). The maritime Antarctic zone is characterized by temperatures below freezing throughout most of the year. It is only during the short Antarctic summer that the air temperature rises above 0 °C, rarely reaching 10–15 °C (Lewis Smith, 2003). It remains unclear as to why only these two species of vascular plants have successfully colonized Antarctica, when more than 100 different species of vascular plants occur in the corresponding Arctic latitudes. None of the previous studies of *D. antarctica* have provided an answer to this question (Lewis Smith, 2003).

The tissues of plants adapted to the extreme conditions of Arctic and mountainous regions often commonly contain polyploid cells (Hagerup, 1932;

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Stebbins, 1985), and an increase in ploidy level is sometimes accompanied by increased nucleus volume (see the study by Maletskii (2005) on genotype–phenotype interaction, in particular the effect of ploidy on cell parameters such as nucleus area). A similar adaptive mechanism is also expected to exist in the Antarctic plants. The studies undertaken by Strogonov (1973)—a study on the metabolic adaptations of plants to soil salinity, particularly its influence on ploidy—and Nkongolo et al. (2001) demonstrate that polyploidy is induced by an increased level of certain cations and trace elements in the soil, as well as by viral contamination of the plants (see Topchiy and Dulevitch (1977), who undertook an experimental study on polyploidy induced by viral contamination).

In this context, we carried out detailed soil analyses in areas in which Antarctic hairgrass and Antarctic pearlwort are found, and analyzed plant samples for viral contamination. Neither of these factors has been analyzed previously in this context (Lewis Smith, 2003), which is of special interest given the increasing scale of human impact in Antarctica. We investigated the nucleus area and relative DNA content in the leaf tissues of *D. antarctica* tufts collected from several scattered locations within the Maritime Antarctica. The same locations were investigated with respect to vegetation conditions, including soil composition and plant viral contamination.

2. Materials and methods

2.1. Study areas

Tufts of hairgrass were collected during the 9th Ukrainian Antarctic Expedition (March, 2005) at six locations in the Maritime Antarctica (Fig. 1): Petermann Island (Site 1); Berthellot Island (Site 2); Cape Rasmussen, on the continental part of the peninsula (Site 3); Galindez Island (Site 4); and two sites on Yalour Island (Sites 5 and 6). The geographic coordinates of the sampling locations were determined using GPS. The habitats and population states of hairgrass were described in terms of the following phytocenological parameters: hill slope and exposure, total vegetation cover, and vegetation cover of hairgrass. We also determined the percentage of fruiting and dying hairgrass, where each root tuft was taken as an individual plant of *D. antarctica*.

The phytocenological characteristics of the studied habitats were as follows.

Site 1. Petermann Island, S 65°10.453′, W 64°08.452′. The study area (size, 10 m^2) was located on the middle part of a hill (eastern exposure, 20–40° inclination), dominated by rock crevices approximately about 15 cm wide and 1 m long. There were no fruiting or dying specimens at this site. Total vegetation cover was 60%, made up of lichens (50%), bryophytes (5%) and *D. antarctica* (5%). Above there are colonies of *Pygoscelis papua* and *Pygoscelis adeliae* located upslope of the site supplying the tufts with guano.

Site 2. Berthellot Island, S 65°19.731′, W 64°08.613′. The study area (size, 8 m^2) was located on a west-facing slope inclined at 20–40°. Total vegetation cover was 50%, made up of bryophytes (30%) and *D. antarctica* (20%). Of the *D. antarctica* specimens, 60% were fruiting and 30% were dying. The island is inhabited by *Phalacrocorax atriceps* and *P. adeliae*.

Site 3. Cape Rasmussen, S 65°14.819′, W 64°05.156′. The study area (size, 10 m^2) was located on a west-facing slope inclined at 10°. Total vegetation cover was 40%, made up of bryophytes (30%) and *D. antarctica* (10%). Of the *D. antarctica* specimens, 20% were fruiting and 40% were dying. The study area is a nesting site for *Catharacta maccormicki* and *Larus dominicanus*.

Site 4. Galindez Island, S 65°14.783′, W 64°14.799′. The study area (size, 10 m^2) was located on upper part of an east-facing slope inclined at 10°. Total vegetation cover was 25%, made up of bryophytes (10%) and *D. antarctica* (15%). Of the *D. antarctica* specimens, 10% were fruiting and 50% were dying. The island is a nesting place for *C. maccormicki* and *Oceanites oceanicus*.

Site 5. Yalour Island, S 65°14.139′, W 64°09.330′. The first study area on this island (size, 6 m^2) was located on the upper part of a west-facing slope inclined at 20°. Total vegetation cover was 45%, made up of bryophytes (25%) and *D. antarctica* (20%). Of the *D. antarctica* specimens, 40% were fruiting and 30% were dying. The island is inhabited by *P. atriceps* and *P. adeliae*.

Site 6. Yalour Island, S 65°14.039′, W 64°09.761′. The second study area on this island (size, 12 m^2) was located on the upper part of a north-facing slope inclined at 30°. Total vegetation cover was 10%, made up of bryophytes (1%) and *D. antarctica* (9%); we found no dying plants of *D. antarctica*. The island is a nesting site for *P. papua* and *P. atriceps*.

From every location listed, we collected more than one visibly undamaged generative tuft. The plants were delivered to Kyiv within a 1 week of sampling, transported in impenetrable paper bags. Leaves, floriferous shoots and roots were fixed for cytogenetic analysis, while the remaining biomass was used to determine viral contamination. The soil under each tuft was also analyzed for trace elements and content of biogens.