

Two noteworthy additions to the moss flora of the Schirmacher Oasis in continental Antarctica

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Abstract – Two species of moss, *Grimmia plagiopodia* Hedw. (Grimmiaceae) and *Hennediella antarctica* (Ångstr.) Ochyra et Matteri (Pottiaceae), are recorded for the first time from the Schirmacher Oasis in continental Antarctica. The latter species has so far been known only from Enderby Land and its geographical range is now extended to Dronning Maud Land. Both species are briefly characterised and their Antarctic distribution is mapped. Accordingly, the moss flora of Dronning Maud Sector of Antarctica consists of 13 species, 12 of which are known to occur in the Schirmacher Oasis. One species, *Pohlia wilsonii* (Mitt.) Ochyra, found in a lake in the Schirmacher Oasis has yet to be confirmed.

Antarctica / austral polar biome / Bryophyta / distribution / Dronning Maud Land / *Grimmia* / *Grimmiaceae* / *Hennediella* / *Pottiaceae*

INTRODUCTION

Antarctica is unique amongst the continents because more than 99% of its surface is covered by ice. It has the lowest temperatures and the lowest precipitation, yet contains more than 70% of the world's resources of fresh water. Continental Antarctica, as distinct from the maritime Antarctic Peninsula and offshore archipelagoes, consists mostly of small enclaves of exposed rock in an otherwise icy desert. These enclaves in the vast polar desert are generally called oases, a term first used by Stephenson (1938) to describe the ice-free area at Ablation Point (70°50'S, 68°24'W) on the eastern side of Alexander Island. The area of "Schirmacher Ponds" in Dronning Maud Land was similarly designated by the Deutsche Antarktische Expedition of 1938-1939, apparently without being aware of Stephenson's earlier use of the term (Pickard, 1986). The term "oasis" was subsequently widely used in the western Antarctic literature after its adoption during the United States Navy "Operation Highjump" in 1946-1947. The concept of Antarctic oases has been summarised and defined, with most relevant references, by Lewis Smith (1997).

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The Schirmacher Oasis was named for its discoverer, Richard Heinrich Schirmacher, a pilot and member of the German Antarctic Expedition of 1938-1939 on the ship *Schwabenland* (Schirmacher & Mayr, 1942; Headland, 1989). He conducted aerial surveys of part of the Antarctic continent called New Swabia (Neuschwabenland) and on 3 February 1939 spotted both the oasis and the lake in its centre.

The Schirmacher Oasis is an extensive ice-free area situated approximately 70 km south of the Princess Astrid Coast in Dronning Maud Land in the north-western part of the Antarctic continent. It is a narrow strip of land having a mean width of 1.6 km, reaching about 3.5 km at its widest, between the ice shelf in the north and polar ice cap to the south at lat. 70°44'21''-70°46'04''S and stretching in a west-east direction for about 20 km between long. 11°26'03''-11°49'54''E. The oasis occupies about 34 sq. km of which snow and ice fields account for about 6.5 sq. km and the rest of the terrain consists of metamorphic rock exposures. It has a varied relief, extending from sea level to 236 m. A characteristic feature of the oasis are about 200 water bodies of varying size, depth and ice cover thickness. Two research stations are currently situated in the Schirmacher Oasis: the Russian Novolazarevskaya station, opened in January 1961, and the Indian Dakshin Gangotri station, established in 1983 but abandoned in 1990 and converted into a supply base, being replaced by the permanent Maitri station in 1989.

BRIEF HISTORY OF BRYOLOGICAL EXPLORATION

The moist and wet margins of the water bodies and numerous melt water channels, rills and streams in the Schirmacher Oasis provide a mosaic of various terrestrial habitats and microhabitats with relatively abundant cover of algae, lichens and mosses. This area has been investigated by Soviet and later Russian (since 1961), German (1976-1990) and Indian (since 1983) scientists, and these studies have resulted in a fairly good understanding of the flora. Of the main components of the terrestrial vegetation the best known are lichens, with 57 species (Olech & Singh, 2010).

In the early 1960s the Soviet Antarctic Expeditions discovered the deep-water moss *Plagiothecium simonovii* L.I.Savicz et Smirnova in Lake Glubokoe in the eastern part of the oasis (Savicz-Lyubitskaya & Smirnova 1964a, 1965). This species represents a highly modified, due to deep submergence, phenotype of *P. georgicoantarcticum* (Müll.Hal.) Kindb. (Bednarek-Ochyra *et al.*, 1999), for which the oldest available name is currently *P. orthocarpum* Mitt. (Ochyra *et al.*, 2008a). The only other moss record from that period is *Bryum pseudotriquetrum* (Hedw.) P.Gaertn., B.Mey. et Scherb. (Savicz-Lyubitskaya & Smirnova, 1972 as *B. algens* Cardot).

The first bryological survey of the Schirmacher Oasis was made by Richter (1990, 1995) who provided five additional species which, following current nomenclature (Ochyra *et al.*, 2008a) include: *Ceratodon purpureus* (Hedw.) Brid., *Syntrichia sarconeurum* Ochyra et R.H.Zander, *Bryum argenteum* Hedw., *Coscinodon lawianus* (J.H.Willis) Ochyra and *Bryoerythrophyllum recurvirostrum* (Hedw.) P.C.Chen. However, no voucher specimens are available and the latter two species should be excluded from the moss flora of the Schirmachaer Oasis

(Ochyra & Zander, 2002; Ochyra, 2004), especially as their presence has not been confirmed by subsequent surveys. The same is also true for the type variety of *Bryum argenteum* and it is very likely that reports of this species refer to highly modified plants of *B. pseudotriquetrum*. There is a tendency towards “hyalinisation” of the uppermost leaves on the shoots of plants living in the extremely harsh climatic conditions of the Antarctic continent. Consequently, they develop a silvery appearance typical for *B. argenteum*. Many voucher specimens labelled as *B. argenteum* from Queen Mary Land by Savicz-Lyubitskaya & Smirnova (1964b) and from Enderby Land by Horikawa & Ando (1961, 1967) proved, on detailed examination, to be *B. pseudotriquetrum*. *Bryum argenteum* var. *argenteum* is absent from the major part of continental Antarctica and it is only frequent in Victoria Land and very occasional in Marie Byrd Land (Ochyra *et al.*, 2008a).

Tewari & Pant (1996) recorded another benthic moss from Lake Zub in the Schirmacher Oasis as *Leptobryum* sp. Again, no original material is available for study but on the basis of the fairly good illustrations provided it is likely that this moss represents *Pohlia wilsonii* (Mitt.) Ochyra, a South American species known from a few lakes in the Skarvness region in Enderby Land (Ochyra *et al.*, 2008a). Additional species of mosses from the study area were reported by Singh & Semwal (2000) and Lal (2004), including several strange species of *Bryum* (*B. atropurpureum* Bruch *et* Schimp., *B. bornholmense* Wink. *et* R. Ruthe and *B. mildeanum* Jur.), but these records cannot be considered as reliable. Unfortunately, the voucher specimens are not available to verify these records but they most likely represent various phenotypes of the highly polymorphous *B. pseudotriquetrum* which occurs commonly and abundantly in the Schirmacher Oasis. Finally, Ochyra & Singh (2008) reported two species and one variety for the first time from the Schirmacher Oasis, namely *Bryum orbiculatifolium* Cardot *et* Broth., *B. archangelicum* Bruch *et* Schimp. and *B. argenteum* Hedw. var. *muticum* Brid.

In the austral summer 2010-2011 the first author collected mosses in various parts of the Schirmacher Oasis and on adjacent nunataks. Examination of this material revealed two species, *Grimmia plagiopodia* Hedw. and *Hennediella antarctica* (Ångstr.) Ochyra *et* Matteri, which have not hitherto been reported from this oasis. In addition, the latter species is reported for the first time in the north-western part of continental Antarctica.

NEW MOSS RECORDS

Grimmia plagiopodia Hedw., *Spec. Musc. Frond.*: 78, f. 6-13. 1801.

Grimmia plagiopodia is a species which might have been expected to be discovered in the Schirmacher Oasis since there are no phytogeographical or ecological reasons why it could not occur in this area. It is known from all sectors of the Antarctic (Savicz-Lyubitskaya & Smirnova, 1970; Ochyra, 1993; Ochyra *et al.*, 2008a) (Fig. 1). Additionally, it is one of very few species reaching the highest latitudinal limits on the Antarctic continent and has been recorded on Mt. Harcourt in the Transantarctic Mountains of Ross Sea Sector at lat. 83°49'S (Seppelt & Green, 1998). The two nearest localities to those in the Schirmacher Oasis are situated to the west in Queen Maud Sector in the Theron Mountains of

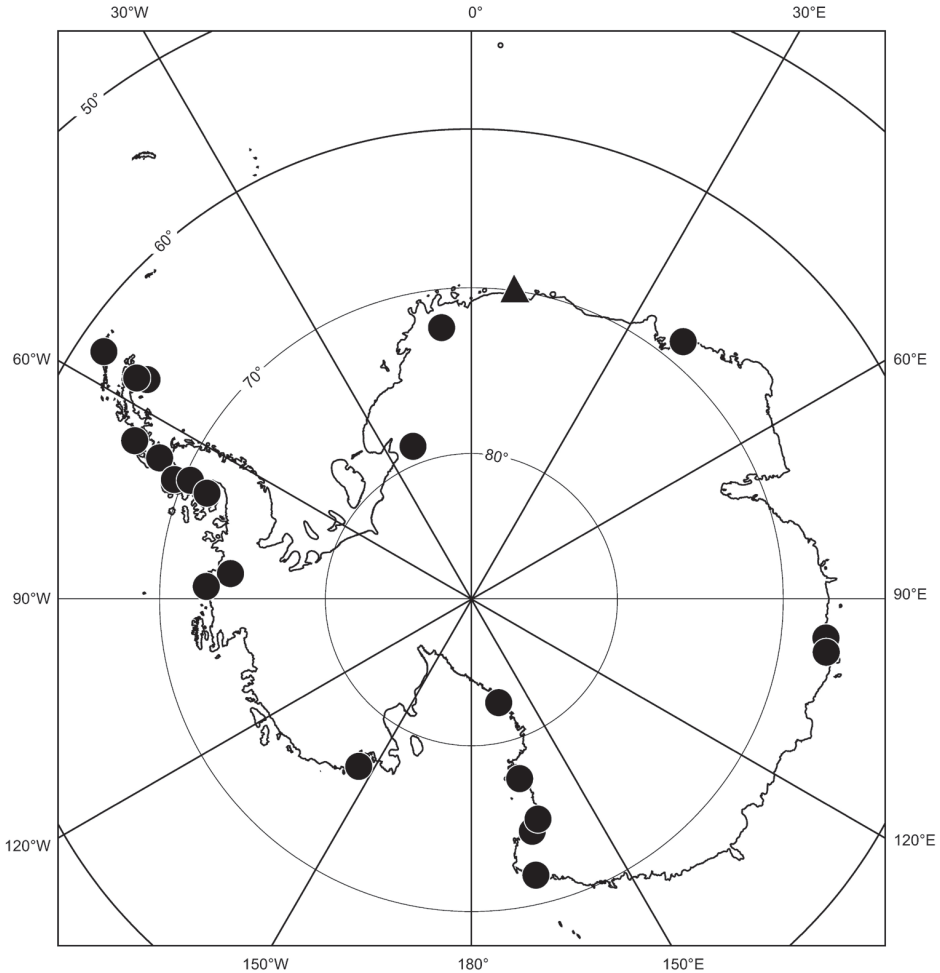


Fig. 1. Distribution map for *Grimmia plagiopodia* Hedw. in the Antarctic. New locality on the continent marked with a triangle.

Coats Land and on the isolated nunatak “Grunehogna - 1285” of the Princess Martha Coast in Dronning Maud Land (Ochyra *et al.*, 2008a).

Grimmia plagiopodia grows in dry and exposed habitats in the Schirmacher Oasis. The plants are sterile and form fairly large, pure patches or small cushions, 5-12 cm in diameter, which occupy an area of 1.5-15 sq. metres. They grow on gritty soil covering stones and boulders and parts of the patches are often colonised by crustose lichens. Grimmialean mosses are generally difficult to determine, especially when sterile, since they are often considerably modified by the harsh environmental conditions in Antarctica. However, *G. plagiopodia* is relatively easy to recognise, even in the barren state. Most Antarctic continental populations of this species are sterile and so far only two fertile collections are known, one from Dustin Island on the Eights Coast and another from northern

Victoria Land (Ochyra *et al.*, 2008a). Sporophytes are more frequently encountered on plants from the milder maritime Antarctic region.

Sterile plants of *Grimmia plagiopodia* have oval to oblong-ovate, deeply concave leaves which are obtuse, piliferous or epilose at the apex. They are broadly concave and U-shaped in transverse section and the laminal cells are entirely unistratose. These features are all typical of the plants from the Schirmacher Oasis. Generally, they are epilose but in some larger plants the leaf apex is terminated with a short, flat and serrulate hair-point but in all other aspects the plants match perfectly the features of this species.

Specimens examined: ANTARCTICA. DRONNING MAUD LAND. SCHIRMACHER OASIS: (1) between Privalnoe Lake and Karovoe Lake, lat. 70°45.768'S, long. 11°49.239'E, alt. 87 m, on gritty soil in dry situations on stony slope, forming rather large patches, 5-7 cm wide covering an area of about 1.5 sq. m, 13 December 2010, *Kurbatova S003-1* (KRAM, LE); (2) Nunatak Aerodromnaya, lat. 70°47.374'S, long. 11°37.916'E, alt. 389 m, on dry grit on stony slope, forming fairly large patches, partly covered with lichens, 10-12 cm wide on an area of about 15 sq. m, 11 January 2011, *Kurbatova S110-1* (KRAM, LE).

Hennediella antarctica (Ångstr.) Ochyra *et* Matteri, *Fragm. florist. geobot.* 41: 1006. 1996.

Although widely scattered, *Hennediella antarctica* is a relatively rare and localised species in Antarctica (Fig. 2). It is most frequent in the South Orkney and South Shetland Islands in the northern maritime Antarctic, extending southwards to Anvers Island off the Danco Coast of the western Antarctic Peninsula. It has once been collected on Vindication Island, South Sandwich Islands (Ochyra *et al.*, 2008a), but it is frequent on subantarctic South Georgia (Matteri, 1977). In continental Antarctica, the species is extremely rare and hitherto it is known only from two stations in Enderby Land, namely from the Sôya Coast (Kanda, 1981 as *Desmatodon* sp.) and Amundsen Bay west of the Tula Mountains (Kanda, 1987).

Hennediella antarctica is here reported for the first time from Dronning Maud Land where it was collected twice in the Schirmacher Oasis. The species usually produces sporophytes in great profusion in the maritime Antarctic but, in contrast, the plants collected from the continent, except those from Amundsen Bay, are sterile. Hence, the species can be mistaken for its congener *H. heimii* (Hedw.) R.H.Zander which is widely distributed in the Antarctic. *Hennediella antarctica* is readily distinguished by its rigid, erect to erect-spreading leaves which are distinctly bordered and coarsely dentate in the upper part. The laminal cells of continental Antarctic plants of *H. heimii* are often not or only very weakly papillose and the upper lamina margins only weakly bordered and denticulate. In addition, the laminal cells are smaller, 10-14(-16) µm wide and obscured by the dense papillosity. Fertile plants of the species are distinguished by their very large, not readily fugacious calyptrae, which most often cover the entire capsules, and in having the operculum attached to the columella after dehiscence. Therefore the capsules in *H. antarctica* are never systylious.

Two collections of *Hennediella antarctica* were found in the Schirmacher Oasis, both in the barren state. The plants grow in small to quite large, compact patches, 2 × 3-4 cm to 15-20 cm in diameter in dry rock fissures or on fine gritty soil in depression together with *Bryum archangelicum*.

The taxonomic status of *Hennediella antarctica* has long been uncertain and it was usually placed in the genus *Pottia* Fűrnr. or *Desmatodon* Brid. (Kanda, 1981; Ochyra *et al.*, 1986). The current concept of the genus *Hennediella* Paris was outlined by Zander (1993) and now consists of 15 species, most of which occur in

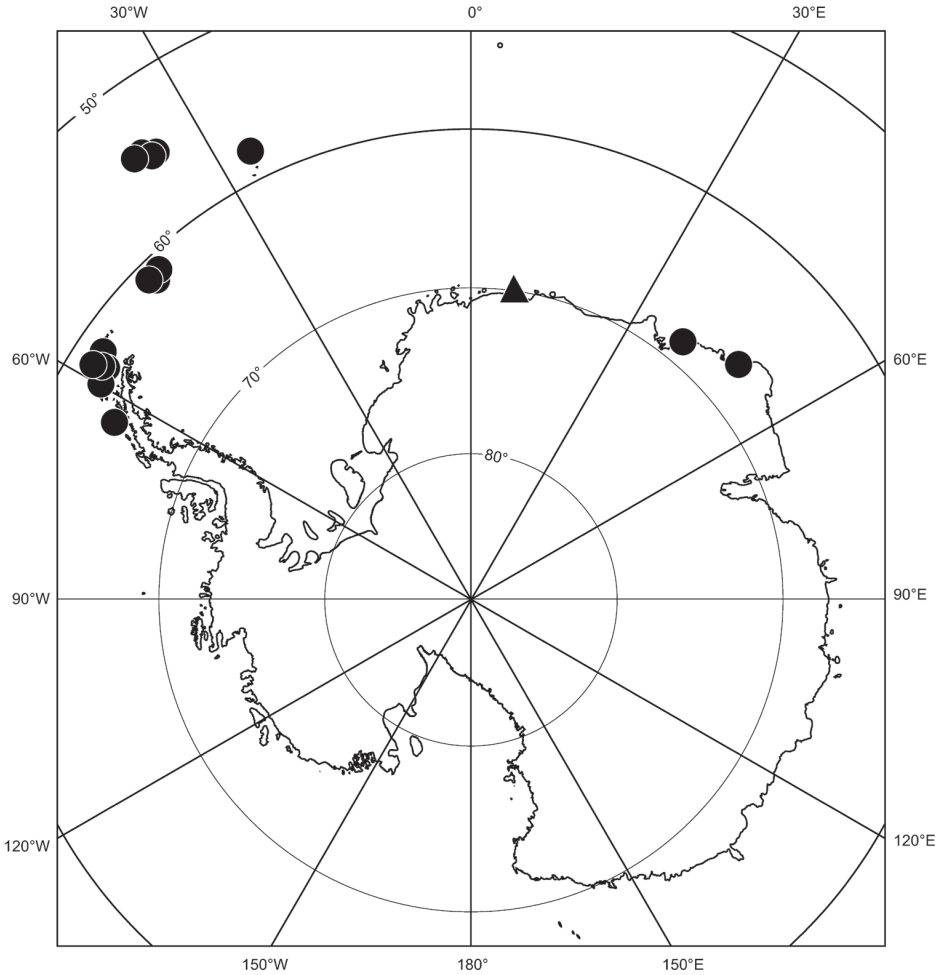


Fig. 2. Distribution map for *Hennediella antarctica* (Ångstr.) Ochyra *et* Matteri in the Antarctic. New locality on the continent marked with a triangle.

the Southern Hemisphere (Cano, 2008). *Hennediella antarctica* was considered to be a bipolar species (Ochyra, 1998) because of the acceptance of its conspecificity with *H. macrophylla* (R.Br.bis) Paris, a species native to New Zealand and which has been recently introduced to Britain (Blockeel, 1990). However, Cano (2008) showed convincingly that *H. antarctica* and *H. macrophylla* are distinct species. Accordingly, the phytogeographical status of the former has to be changed. In accordance with its name, *H. antarctica* is considered to be an amphiatlantic subantarctic species having optimum occurrence on South Georgia (Matteri, 1977 as *Pottia austrogeorgica* Cardot *et* Broth.), Îles Kerguelen (Ochyra *et al.*, 2008a), as well as on Heard Island from where it was initially reported by Lightowers (1986) as *Tortula filaris* (Müll.Hal.) Broth. (Ochyra *et al.*, 2008a; Blockeel *et al.*, 2010). It was also reported from Île de la Possession in the Îles Crozet archipelago

(Blockeel *et al.*, 2006) on the basis of sterile plants which correctly belong to *Hennediella marginata* (Hook.f. *et* Wilson) R.H.Zander, a species characterised by its strongly differentiated 2-3-stratose border of 8-13 rows of cells. This species was long known only from the type material from Îles Kerguelen and subsequently it was recorded from Îles Crozet where is currently known from several fruiting specimens (Cano, 2008).

Specimens examined: ANTARCTICA. DRONNING MAUD LAND. SCHIRMACHER OASIS: (1) near Tyuleniy Point, lat. 70°44.613'S, long. 11°36.585'E, alt. 67 m, in dry rock crevices on gravelly soil associated with *Bryum archangelicum*, forming rather small tufts, 6-8 sq. cm, 1 February 2011, *Kurbatova S251-1* (KRAM, LE); (2) near Novolazarevskaya Station, on top of a ridge near Glubokoe Lake, lat. 70°46.171'S, long. 11°49.988'E, alt. 127 m, in depression on fine gritty soil in dry situation forming large patches to 30 sq. cm occupying an area of about 10-12 sq. m, in association with *Bryum archangelicum*, 8 February 2011, *Kurbatova S322-1* (KRAM, LE).

CONCLUDING REMARKS

Of the total of 111 species and two varieties of moss that are documented from the entire Antarctic biome (Ochyra *et al.*, 2008a, b), only 24 species, and one variety are known from continental locations. However, in 2009, one more species, *Notoligotrichum trichodon* (Hook. *et* Wilson) G.L.Sm. was discovered in Byrd Sector (Andreev & Kurbatova, 2009). Of this total, two species may be considered as doubtfully occurring on the continent because they are either not confirmed (*Dicranella hookeri* (Müll.Hal.) Cardot) or collected in man-made habitats in a horticultural greenhouse (*Funaria hygrometrica* Hedw.) (Ochyra *et al.*, 2008a). Thus, realistically, only 23 species may be considered as native to continental Antarctica.

Hitherto, 12 species of moss have been reported from the entire Dronning Maud Sector and one species (*Pohlia wilsonii*) must be included with some reservation. Of these, ten species (plus *P. wilsonii*) are known from the Schirmacher Oasis (Ochyra *et al.*, 2008a). If the two present additions are considered, the moss flora of Dronning Maud Sector consists of 13(+1) species, of which 12(+1) occur in the Schirmacher Oasis. These are as follows:

- Bryum archangelicum* Bruch *et* Schimp.
- B. argenteum* Hedw. var. *muticum* Brid.
- B. orbiculatifolium* Cardot *et* Broth.
- B. pseudotriquetrum* (Hedw.) P.Gaertn., B.Mey. *et* Scherb.
- Ceratodon purpureus* (Hedw.) Brid.
- Grimmia plagiopodia* Hedw.
- Hennediella antarctica* (Ångstr.) Ochyra *et* Mattered
- H. heimii* (Hedw.) R.H.Zander
- Orthogrimmia sessitana* (De Not.) Ochyra *et* Żarnowiec
- Plagiothecium orthocarpum* Mitt.
- ? *Pohlia wilsonii* (Mitt.) Ochyra
- Schistidium antarctici* (Cardot) L.I.Savicz *et* Smirnova
- Syntrichia sarconeurum* Ochyra *et* R.H.Zander

Coscinodon lawianus is the only other species known from Dronning Maud Sector which has not hitherto been recorded from the Schirmacher Oasis. However, its occurrence is very likely since this species is known from adjacent

inland nunataks on the Princess Martha Coast (Heimerfrontfjella) and on the Princess Astrid Coast (Filchnerfjella). It is also worth noting that *Pohlia nutans* (Hedw.) Lindb. has recently been recorded from lake sediment cores at the Schirmacher Oasis and ^{14}C analysis showed that the age of the sediment layer containing this moss is 10.65 kyr (Singh *et al.*, 2012).

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