



## The first documented record of *Sphagnum riparium* (Bryophyta: Sphagnaceae) from Spitsbergen

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**Abstract:** *Sphagnum riparium* (Bryophyta) is recorded and described from the Wedel Jarlsberg Land on Spitsbergen, the Arctic Svalbard Archipelago. It is the northernmost known population of the species in the Northern Hemisphere. The distribution of the two known *Sphagnum* species in the Hornsund area, viz. *S. riparium* and *S. squarrosum* is mapped and described.

Key words: Arctic, Spitsbergen, Hornsund, *Sphagnum riparium*, *Sphagnum* distribution.

### Introduction

*Sphagnum riparium* Ångström is a north-eastern species in Europe and is circumpolar in the northern part of the boreal and sub-arctic regions of the Northern Hemisphere (Daniels and Eddy 1985). In Europe, this peat moss has a slightly continental tendency and is most frequent in northern Scandinavia, being rare farther south; in northern and central Europe *S. riparium* is mostly confined to montane areas. In North America the species grows scattered from Newfoundland, Labrador and westward in northern Quebec, Manitoba and Alberta, to Arctic Mackenzie District, Yukon and Alaska, where it has its northernmost extension approximately at polar circle (Crum 1986). In Greenland the species is scattered up to 69°N, and its northernmost record is from 72°11'N 55°56'W, however it is based on a single plant in mixed collection (Lange 1984). *Sphagnum riparium* is also recorded from the West Coast region of Iceland, extending as far north as about 65°N (Lange 1984). In the Arctic Siberia it has been reported from the Chukotka Peninsula, Polar Ural and Yamal Peninsula, the last one being its northernmost extension to c. 73°N (Abramova *et al.* 1961). Until recently, the northernmost known

and well documented locality of *S. riparium* in Europe was the Bjørnøya Island in the Svalbard archipelago (Flatberg 1994).

The first record of *S. riparium* (as *S. recurvum* var. *riparium*) on Spitsbergen comes from Berggren (1875, after Flatberg and Frisvoll 1984), who found the species in Colesbukta (Isfjorden). Next, the species was reported by Eurola (1971) from Stormyra in Van Mijenfjorden. However, careful inspection of the herbarium specimens revealed them to be *S. obtusum* (Flatberg and Frisvoll 1984). In 1985 this peat moss was also reported from the central part of Reindalen from about 77°55'N (Serebryannyj *et al.* 1985), but this location still needs to be verified (Frisvoll and Elvebakk 1996).

The aim of this study is to characterize *S. riparium* morphologically at its new Arctic locality on Wedel Jarlsberg Land. So far it is the northernmost documented population of the species and thus worth a detailed study. Moreover, this paper describes the hitherto known occurrences of *Sphagnum* in the region of the Hornsund fjord.

## Investigated area and methods

In the morphological study of *Sphagnum riparium* six plants have been investigated. Measurements of five typical stem and branch leaves from each plant were taken. So, the values of the leaves' length and width (average and SD) mentioned in the population description derived from thirty measurements. The branch leaves were removed from the middle part of divergent branches, usually from three fascicles scattered on the stem. A Nikon Eclipse E200 microscope and Nikon SMZ645 stereoscopic zoom microscope was used for the leaf measurement and observation. Photographs of leaves and cells were taken with an Axioskop 2 plus (Zeiss) microscope using AxioVision v. 2.05 software. The Nikon microscopes were purchased with funds provided within project co-financed by European Union (European Regional Development Fund). Voucher specimens have been deposited in the Department of Botany and Plant Ecology herbarium (WRAB) of the Wrocław University of Environmental and Life Sciences and a few duplicates have been delivered to Institute of Botany of Polish Academy of Sciences herbarium (KRAM) and Norwegian University of Science and Technology herbarium (TRH).

The *Sphagnum riparium* locality is situated in the southern part of Spitsbergen, on Wedel Jarlsberg Land (77°04'03"N; 15°10'00"E; alt. *c.* 35 m), on the north-western side of Hornsund fjord (Fig. 1). The species occurs there in flat and slightly sloping terrain, and is associated with moss-rich tundra community, where it forms low and flat cushions in moderately wet habitats. This community is developed at the bottom of Ceglatoppen (Gulliksenfjellet) in the central part of Bratteggdalen and is dominated by *Warnstorfia sarmentosa*, *Straminergon stramineum* and *Sanionia*

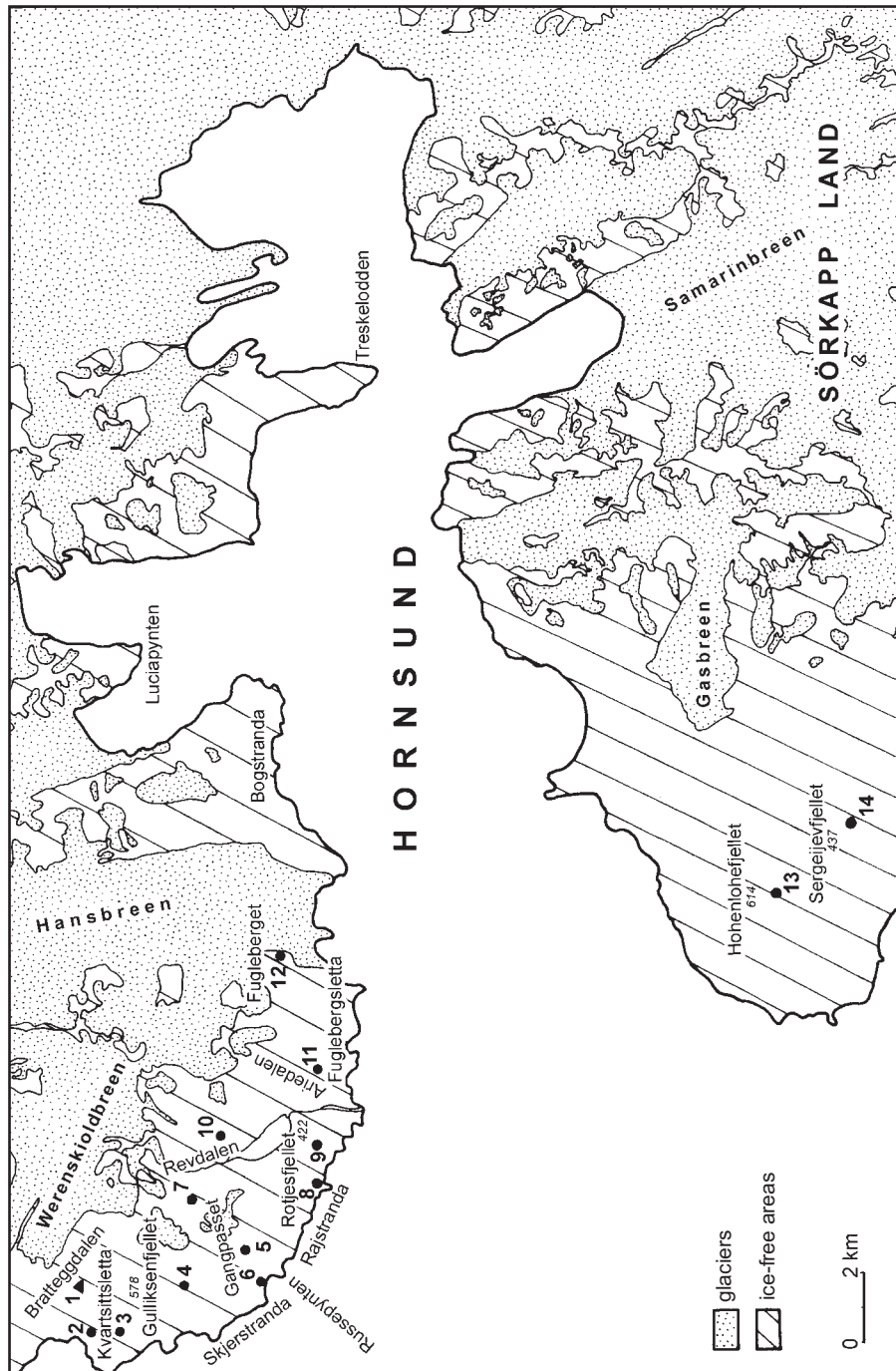


Fig. 1. Known distribution of *Sphagnum* in the Hornsund area, Spitsbergen.  $\blacktriangle$  - *S. riparium* and *S. squarrosum*;  $\bullet$  - *S. squarrosum*. Numeration of stands (1-14) correspond with that used in Specimen list.

*uncinata*. Along with *S. riparium*, *S. squarrosum* Crome occurs in this site. The water from the community has pH ranging from 6.05 to 6.64 and conductivity from 43 to 94  $\mu\text{S}$  (Marszałek and Wąsik, personal communication).

Serebryannyj *et al.* (1985) reported *S. riparium* to be abundant in very wet habitats of polygonal bog in the plain of Reindalen (Nordenskiöld Land). Populations of this species occur there in small pools in the centers of the polygons within floating mats of mosses where it is accompanied by *Drepanocladus fluitans*, *D. exannulatus* and *Calliargon giganteum*. However, according to Frisvoll and Elvebakk (1996), this determination should be verified.

## Results and discussion

**Plant description.** — Plants delicate, small to medium-sized (shoots 5–9 cm long, including green portion of 2–5 cm), green to pale-green. Capitulum flat, about 7–15 mm in diameter, with straight and acute branches, terminal bud visible to distinct. Branch fascicles well spaced; 5(–6) dimorphic branches, 2–3 divergent and 2–3(–4) pendent branches; divergent branches are decurved and as long as or slightly longer than the pendent ones. Stems thin to moderately thick,  $0.82 \pm 0.10$  mm (range 0.71–0.95 mm,  $n = 9$ ) mm diameter, grey; not clearly differentiated cortex consists of small and thin-walled cells (Fig. 2H); internal cylinder of slightly thickened cells. Stem leaves (Fig. 2F, G)  $1.31 \pm 0.11$  mm long (range 1.12–1.50 mm),  $0.86 \pm 0.09$  mm wide (range 0.66–1.00 mm); B/L ratio  $0.66 \pm 0.03$ ; mostly hanging, slightly concave, lingulate-triangular to lingulate, mostly not deeply (about 1/10 of the leaf length) bifid at the apex, occasionally torn or entire and acute; hyalocysts near apex enlarged, rhombic, rhombic-subquadrate to rhombic S-shaped or narrowly S-shaped, efibrose or more often incompletely fibrose, septated or occasionally unseptated, aporose. Branch leaves  $1.83 \pm 0.18$  mm long (range 1.56–2.12 mm),  $0.88 \pm 0.10$  mm wide (range 0.72–1.12 mm); B/L ratio  $0.48 \pm 0.03$ ; non-ranked, broadly ovate-lanceolate or rarely narrowly ovate-lanceolate, widest in lower half of leaf, straight; broadly involute apex consists of undifferentiated green cells (Fig. 2C); pores on the outer surface dimorphic: toward the apex with 1–2 small (*c.* 2.5  $\mu\text{m}$ ) pores in ends, and with larger (20–27  $\mu\text{m}$ ), window-like pores (Fig. 2E) at the upper ends in the lower two-thirds of the leaf (these being repeated on the inner surface); on the inner surface (except for large perforated pores opposite outer window-like pores) with 1–7 round pore-like wall-thinnings (Fig. 2D); chlorocysts in transverse section trapezoidal and broadly exposed on the concave surface. Sterile.

*Sphagnum riparium* is one of the largest and the most robust species of the Cuspidata section in central and northern Europe. It is characterized by a well-developed capitula and large terminal bud (Daniels and Eddy 1985). However, the Spitsbergen specimens of this species consist of small and delicate ecads with relatively small capitula and visible but often inconspicuous terminal

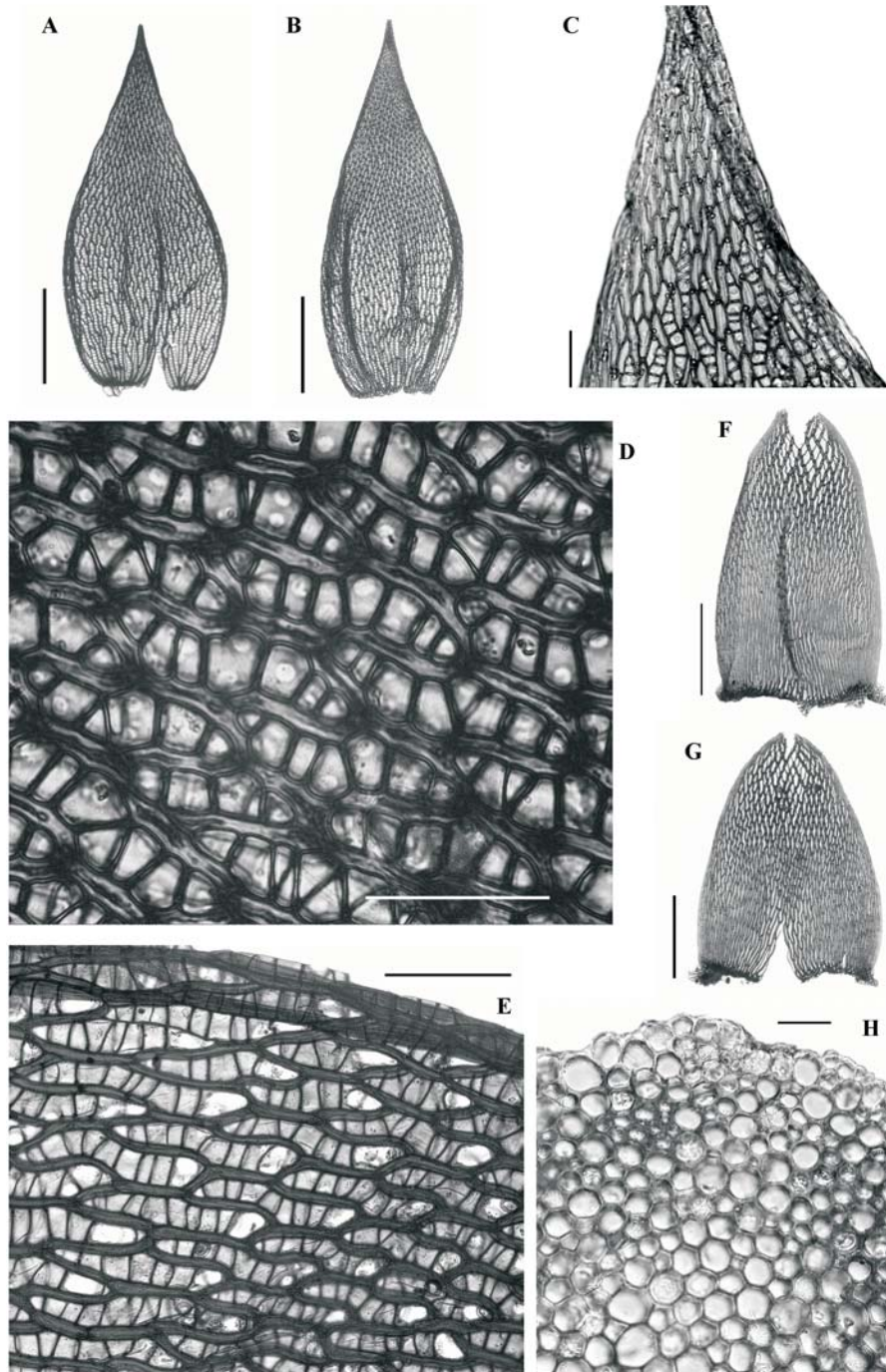


Fig. 2. Shape of leaves and cell structure of *Sphagnum riparium*. **A–B.** Branch leaves. **C.** Branch leaf tip. **D–E.** Cell structure of branch leaves: **D.** At the upper concave surface. **E.** At the lower convex surface. **F–G.** Stem leaves. **H.** Cross-section of stem. Scales are 500  $\mu\text{m}$  for leaves and 50  $\mu\text{m}$  for cells.

bud. In comparison to the data supplied by Daniels and Eddy (1985) and Hill (2004), the plants of *S. riparium* from Spitsbergen are markedly shorter (9 versus 25 cm), the diameter of the stems is smaller (0.95 versus 1.1 mm) and their stem leaves are both shorter (1.5 versus 1.6–1.7 mm) and narrower at insertion (1.0 versus 0.9–1.3 mm). Furthermore, the branch leaves are also markedly shorter (2.1 versus 2.6–3.0 mm). However, no diagnostic morphological differences have been found, suggesting taxonomical heterogeneity between the populations in Svalbard and mainland Europe. This conclusion is in accordance with observations of Flatberg and Frisvoll (1984), regarding many peat moss species from Svalbard, e.g. *S. girgensohnii* Russ. and *S. obtusum* Warnst.

**The distribution and abundance of *Sphagnum* in the Hornsund area.** — Two species of peat moss have been found in the region of the Hornsund fjord, i.e. *S. riparium* and *S. squarrosum*. The first was found only in one, above described locality. The latter occurs in many localities (Fig. 1), mostly in the northern part of the Hornsund area, in Wedel Jarlsberg Land, whereas in the southern part (Sørkapp Land) this species was observed in two localities only. The altitudinal range extends from 15 to 200 m a.s.l., however most of the localities are situated below 60 m a.s.l. *Sphagnum* mosses are a not important component of vegetation in Hornsund area. They grow as single specimens among other species or form little cushions and tufts. According to Kuc's (1963) and author's own observations, the occurrence of *S. squarrosum* in the Hornsund area is restricted to the moderately moist habitats in moss-rich tundra and Arctic mire communities. Similarly, Dubiel and Olech (1990) recorded this species from *Saxifraga hyperborea*–*Ranunculus spitsbergensis* community, which occurs in permanently flooded places with thick peat layer.

The *Sphagnum* flora of Hornsund area is very poor. In contrast, the peat moss flora of the whole Svalbard archipelago is by far more diverse and comprises 13 *Sphagnum* species (Frisvoll and Elvebakk 1996). In Svalbard, Nordenskiöld Land of central Spitsbergen is the richest one and includes all the species (Flatberg and Frisvoll 1984). This paucity of *Sphagnum* flora in Hornsund area can be related to two environmental factors which characterize Spitsbergen. Most significant is the influence of substrate chemistry. Generally, most of *Sphagnum* species is restricted to acidic conditions and species richness increases with decreasing pH and cations concentrations. The bedrock of the Hornsund area is distinctly circumneutral (pH 5.5–7.2) (CAVM Team 2003), consisting mainly of schists enriched in carbonate, and metabasalts (Majka and Budzyń 2006). In most areas of central of Spitsbergen however, conditions are distinctly acidic (pH <5.5) (CAVM Team 2003) as the bedrock consists mainly of sandstones (Gee and Tebenkov 2004). The climate is the other factor which account for this poor *Sphagnum* flora. Central Spitsbergen has more favorable climatic regime with the Middle Arctic tundra zone and with the highest mean

temperature of the warmest month (July) of 5–7°C (Elvebakk 1985, 1994). In contrast, the Hornsund area belongs mostly to the Northern Arctic-tundra zone distributed within the range of 3–5°C of the warmest month (Elvebakk 1997). Thus, a lack of suitable habitats and cooler climate in Hornsund area can limit *Sphagnum* spatial distribution and abundance. As a result, peat moss flora is here limited and dominated by *S. squarrosum*.

### Specimen list and literature records

#### *Sphagnum riparium* Ångstrom 1864

**Specimen examined:** Norway. Svalbard: Spitsbergen, Wedel Jarlsberg Land: 1. Brattegaldalen, bottom of Ceglatoppen (Gulliksenfjellet), c. 35 m, leg. B. Wojtuń, 27.07.2003 (herb. Wojtuń).

#### *Sphagnum squarrosum* Crome 1803

**Specimens examined:** Norway. Svalbard: Spitsbergen, Wedel Jarlsberg Land: 1. Brattegaldalen, bottom of Ceglatoppen (Gulliksenfjellet), alt. c. 35 m, leg. B. Wojtuń, 27.07.2003 (herb. Wojtuń). 2. Kvartsittsletta N, alt. c. 55 m, W side of lake, leg. B. Wojtuń, 27.07.2003 (herb. Wojtuń). 3. Kvartsittsletta: 18.08.1957, leg. A. Środoń, 10168 (KRAM) and S part, alt. c. 60 m, 15.08.1957, leg. A. Środoń, 4326 (KRAM). 5. Skjerstranda: 01.07.1958, 25243 (KRAM) and nearby Gangpasset, alt. c. 40 m, marine terrace at the foot of Trulsefjellet, leg. B. Wojtuń, 27.07.2003 (herb. Wojtuń). 6. Russepynten, alt. c. 15 m, marine terrace near the sea, leg. B. Wojtuń, 27.07.2003 (herb. B. Wojtuń). 8. Rålstranda, nearby Torbjörnensfjellet, alt. c. 18 m, 12.08. 1957, leg. A. Środoń, 7973 (KRAM). 9. Rotjesfjellet: S, alt. c. 200 m, 24.06.1958, 025245 (KRAM) and SW slope, alt. 156 m, 1957, leg. A. Środoń, 4624 and 4625 (KRAM). 10. Revdalen, screes close behind Revvatnet, 09.08.1957, leg. A. Środoń, 11574 (KRAM). 11. Fuglebergsletta at Ariekammen, alt. c. 15 m, 26.08.1957, leg. A. Środoń, 4627 (KRAM). 12. Fugleberget, SE and E slope, 21.07.1958, 11298 (KRAM).

**Literature records:** Norway, Svalbard, Spitsbergen. Wedel Jarlsberg Land: st. 4, Gulliksenfjellet, W side at Skjerstranda (Kuc 1963); st. 7, Brattegga, E side at Revbotnen, alt. c. 200 m (Kuc 1963); st. 9, Rotjesfjellet NW, alt. c. 178 m (Kuc 1963); st. 12, Fugleberget, E slope, 150–200 m (Kuc 1963). Sørkapp Land: st. 13. Hohenloheskardet, alt. c. 130 (Dubiel and Olech 1990); st. 14. Sergeijevfjellet, at the foot of W side, alt. c. 115 (Dubiel and Olech 1990).

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