

## CONTRIBUTIONS TO THE MOSS FLORA OF EDGEØYA AND BARENTSØYA, SVALBARD (NORWAY)

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**Abstract.** Results from the identification of mosses (Bryophyta) collected on the islands Edgeøya and Barentsøya of the high arctic Svalbard Archipelago in 1985–1988 are reported. The collections originated from 33 relevé plots analysed in the course of a myco-coenological study as well as from further locations on Edgeøya, Barentsøya, and the small islands Brimulen and Delitschøya. Of the 97 identified moss taxa, three are new reports for Svalbard (*Ditrichum zonatum*, *Pohlia lescuriana* and *Syntrichia ruraliformis*), all from Edgeøya. Fourteen further species are reported as new for Edgeøya, and four species are new for Barentsøya. The occurrence of six taxa on Svalbard is confirmed. The present results indicate that the bryoflora of Svalbard is still incompletely known and that the eastern islands of Svalbard are still bryologically underexplored. Challenges of species identification of bryophytes from the High Arctic are discussed.

**Key words:** Barentsøya, Edgeøya, mosses, new species, Svalbard

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### INTRODUCTION

The bryophyte flora of the high arctic Svalbard Archipelago (Norway) has been extensively reviewed by Kuc (1973) and Frisvoll and Elvebakk (1996). For the entire archipelago, including the more southerly islands Hopen and Bjørnøya, 288 species of mosses (Bryophyta) and 85 species of liverworts (Marchantiophyta) have been accepted (Frisvoll & Elvebakk 1996). Most species have been reported from the main island Vest-Spitsbergen, especially from the central fjord districts on the western side (Frisvoll & Elvebakk 1996). This may be due to the fact that this part of the archipelago is inhabited and relatively easily accessible, whereas the eastern islands, e.g. Barentsøya, Edgeøya, and Nordaustlandet, are uninhabited, difficult to access, and lack permanently staffed research stations. The reported high bryodiversity for Vest-Spitsbergen might also be caused by the more favorable climatic conditions in the southwestern part of the island. Temperature and precipitation gradients across Svalbard reach from high values in the southwest (SW Vest-Spitsbergen) to lower values in the northeast (Nordaustlandet, Kvitøya), except for precipitation during summer (Førland

*et al.* 2009, 2010). The lower temperatures on Barentsøya and NW Edgeøya during the growing season seem to be the most significant climatic difference with SW Vest-Spitsbergen. No information on the exact length of the growing season on the eastern islands is available, but we expect it to be shorter than in SW Vest-Spitsbergen. In addition to climatic differences, the geology and geomorphology of Barentsøya and Edgeøya are quite different from Vest-Spitsbergen (e.g., Hisdal 1985, Harland *et al.* 1997).

Although parts of Barentsøya and Edgeøya have been the target of collecting activities, e.g. by Hofmann (1968), Philippi (1973) and Heinemeijer (1979) (see also Heinemeijer & van Dijk 2004), resulting in a number of at least 112 bryophyte species known from NW Edgeøya / SW Barentsøya (Philippi 1973), it can be expected that the bryophyte flora of these islands is still incompletely known. The aim of the present study is to contribute new data on the bryophyte flora of still undercollected parts of Svalbard. Fieldwork in the course of a myco-coenological study in the mid-1980s (Jalink & Nauta 2004) resulted in a number

of bryophyte collections from different parts of Barentsøya, Edgeøya as well as the small islands Brimulen, situated in the Freemansundet between Barentsøya and Edgeøya, and Delitschøya just off the coast of southern Edgeøya. A list of mosses (Bryophyta) identified from these collections is presented and discussed with respect to the present knowledge of the bryoflora of Svalbard. Ecological aspects and vegetation composition as well as liverworts collected from the same study areas will be treated in forthcoming papers.

#### MATERIAL AND METHODS

Fieldwork was conducted by mycologists L. M. Jalink (second author) and J. J. Barkman in August 1985, as well as by L. M. Jalink and M. N. Nauta in August 1986 and July 1988, and focused on 44 research plots (relevé plots PQ1–44) set out in the vicinity of the small unstaffed field station near Kapp Lee (Dolerittneset) in NW Edgeøya (78°00'N, 21°00'E; PQ1–39, PQ44) and in SW Barentsøya (78°01'N, 21°00'E; PQ41–43). Bryophyte collections were obtained from 33 of these plots (Table 1). Plot sites were selected to include several types of high arctic tundra, ranging from very moist tundra in marshes, along small streams, and in snow beds to dry, almost desert-like tundra on exposed sites and on banks of sand and shingle in large riverbeds. Plot sizes were chosen to encompass homogeneous representative vegetation of the local stands of cryptogamic vegetation on soil determined by the composition and cover of mosses and lichens. Hence, the plots vary considerably in size (Table 1), and the present collections almost completely consist of terrestrial species. Most vouchers date from 1986 when all plots were sampled by making vegetation relevés of vascular plants, bryophytes, and lichens according to Braun-Blanquet's (1964) procedure. As many bryophyte species proved to be morphologically plastic and hard to identify in the field, probably because of the harsh arctic climatic conditions, an intensive collection method was employed. In each plot a voucher of each morphotype was collected for microscopic identification, often including the bryophytes that grew intermingled with the target species. Collections outside the plots were mainly done as evidence for autecological notes on collected fungi. Additional collections were made on Edgeøya at Andréetangen (77°25'N, 22°40'E) as well as on Brimulen (78°11'N, 20°49'E) and Delitschøya (77°23'N, 22°35'E).

All collections are kept in herbarium L. Classification of higher taxa follows Frey and Stech (2009),

**Table 1.** Localities and sizes of 33 relevé plots (PQs) set out for a myco-coenological study in 1985–1988 on the eastern islands Edgeøya (E) and Barentsøya (B) of the Svalbard Archipelago, from which bryophyte collections were identified.

PQ	Island	Location	Plot size (in m <sup>2</sup> )
1	E	Kapp Lee/Rosenbergdalen	100
2	E	Rosenbergdalen	62.7
3	E	Kapp Lee	155.7
4	E	Kapp Lee	44.8
5	E	Kapp Lee/Rosenbergdalen	17
6	E	Kapp Lee	70
7	E	Kapp Lee	66
8	E	Rosenbergdalen	47
9	E	Kapp Lee/Rosenbergdalen	135.4
10	E	Kapp Lee	77.2
11	E	Rosenbergdalen	111
12	E	Rosenbergdalen	80
13	E	Kapp Lee	77.5
14	E	Visdalen	40
15	E	Rosenbergdalen	48.4
26	E	Kapp Lee/Rosenbergdalen	99
27	E	Rosenbergdalen	96
28	E	Kapp Lee	45.3
29	E	Kapp Lee	15
30	E	Kapp Lee	3
31	E	Kapp Lee	123.2
32	E	Kapp Lee/Rosenbergdalen	100
33	E	Kapp Lee/Rosenbergdalen	115
34	E	Kapp Lee	114
35	E	Rosenbergdalen	385
36	E	Rosenbergdalen	100
37	E	Kapp Lee	121
38	E	Rosenbergdalen	100
39	E	Rosenbergdalen	120
41	B	Sundneset	100
42	B	Sundneset, close to Sorelvatn	32
43	B	?	96
44	E	Kapp Lee	500

abbreviations of authors follow Brummit and Powell (1992). Microscopic identifications were based on Nyholm (1954–1969, 1986–1998), Mogensen (1973), Frisvoll (1978, 1983), Brassard (1979, 1980, 1984), Smith (1980, 2004), Flatberg and Frisvoll (1984), Long (1985), Touw and Rubers (1989), Hedenäs (1993, 2003), Zander (1993), Damsholt (2002), Hedenäs and Bisang (2004), Frey *et al.* (2006) and Hallingbäck *et al.* (2006, 2008). Further specimens from mainly arctic regions kept in L, GRO (now trans-

ferred to L) and S were used as reference material in the identification process. Species were considered new for Svalbard if they were not listed in Frisvoll and Elvebakk (1996) nor indicated for Svalbard in the respective identification works. New species records for Edgeøya and Barentsøya are indicated as far as the available literature (e.g., Hofmann 1968, 1969; Kuc 1973; Philippi 1973; Heinemeijer 1979; Frisvoll 1983; Frisvoll & Elvebakk 1996) allows assessment of their distribution on Svalbard.

## RESULTS

In total, 860 bryophyte collections were studied. From these, 97 moss taxa could be identified, which are listed below with numbers of collections per taxon, plot numbers (where applicable), and collection numbers (in italics) of the individual collections. Information on which collections were mixed collections and which species were growing intermingled are available on request. Species rejected by Frisvoll and Elvebakk (1996) but confirmed for Svalbard as well as newly reported species for Barentsøya and Edgeøya, or Svalbard in general, are indicated.

### Sphagnaceae Dum.

*Sphagnum fimbriatum* Wilson subsp. *concinnum* (Berggr.) Flatberg & Frisvoll

3 collections. EDGEØYA: PQ2, 2875A; PQ2, 2875B; PQ12, 2085.

*Sphagnum squarrosum* Crome

3 collections. EDGEØYA: PQ2, 2874; PQ2, 2879Y; PQ2, 2898Y.

*Sphagnum teres* (Schimp.) Ångström

3 collections. EDGEØYA: PQ2, 2951YX; PQ27, 8111; PQ38, 3162X.

### Polytrichaceae Schwägr.

*Polytrichum juniperinum* Hedw.

5 collections. BARENTSØYA: PQ41, 1776. EDGEØYA: PQ8, 3066; PQ11, 3106; PQ12, 2097Q; ROSENBERGDALEN: 8183.

NOTES. New for Barentsøya. Probably rare on Svalbard and frequently confused with other species (Frisvoll & Elvebakk 1996) or treated in a broad sense to include *P. strictum* (Long 1985).

*Polytrichum piliferum* Hedw.

5 collections. EDGEØYA: PQ11, 3110; PQ37, 1772; PQ39, 2227; PQ39, 2243; PQ39, 2244 (few material).

*Polytrichum strictum* Brid.

6 collections. EDGEØYA: PQ2, 2886XXY, scanty material; PQ2, 2888; PQ8, 3064Y; PQ12, 2097; PQ39, 2243Y; ROSENBERGDALEN: 8187.

*Polytrichastrum alpinum* (Hedw.) G. L. Sm.  
var. *alpinum* sensu Long (1985)

31 collections. BARENTSØYA: PQ41, 2303; SUNDNESET: 8178. EDGEØYA: PQ1, 2425; PQ2, 2872YX; PQ2, 2951; PQ2, 2875X; PQ2, 2896; PQ2, 2962YX; PQ5, 2139; PQ6, 2036; PQ8, 3063; PQ8, 3064; PQ8, 3086; PQ12, 8872; PQ12, 2121; PQ12, 2099; PQ15, 8873; PQ27, 2835; PQ27, 8874; PQ27, 2857; PQ28, 8875; PQ30, 1766; PQ30, *s.n.*; PQ36, 2391; PQ37, 1773; PQ39, 2239; PQ39, 2227Y; PQ39, 8181; PQ39, 8901; PQ39, *s.n.*; ROSENBERGDALEN: 3311XYZ.

*Polytrichastrum sexangulare* (Flörke ex Brid.) G. L. Sm.

2 collections. EDGEØYA: PQ11, 3117A; PQ30, 2262, c.fr.

### Timmiaceae Schimp.

*Timmia austriaca* Hedw.

29 collections. EDGEØYA: PQ2, 2953; PQ12, 2123; PQ13, 2434; PQ13, 8121; PQ27, 2857; PQ27, 2860; PQ28, 2512; PQ29, 2513; PQ29, 8136; PQ30, 1767; PQ30, 2255; PQ30, 2258; PQ30, 8191; PQ30, *s.n.*; PQ31, 2542XX; PQ31, 2544; PQ31, 2546; PQ33, 2351; PQ33, 2356; PQ33, 2357; PQ33, 2337; PQ36, 2387; PQ36, 2391X; PQ36, 8167; PQ37, 2632; PQ39, 2244; PQ39, *s.n.*; ROSENBERGDALEN: 8200; 8207B.

***Timmia megapolitana*** Hedw.  
subsp. *megapolitana*

1 collection. EDGEØYA: PQ5, 2135, c.fr.

NOTES. This specimen is morphologically intermediate between *T. megapolitana* subsp. *bavarica* (Hessl.) Brassard and *T. megapolitana* subsp. *megapolitana*, showing most affinity with the latter by its 9–12(–14) µm wide lamina cells (cf. Brassard 1984). Earlier records of *T. megapolitana* s.l. from Svalbard and the High Arctic were assigned to *T. megapolitana* subsp. *bavarica* (Brassard 1984; Frisvoll & Elvebakk 1996), but the present collection tentatively confirms the presence of *T. megapolitana* subsp. *megapolitana* in Svalbard.

***Timmia norvegica*** J. E. Zetterst. var. *norvegica*

13 collections. EDGEØYA: PQ1, 2434X; PQ13, 2478; PQ26, 2450; PQ27, 2868; PQ31, 2539X; PQ31, 2547; PQ32, 2201; PQ32, 2202X; PQ34, 8194; PQ35, 2813; PQ36, 2388; PQ39, 2229; KAPP LEE: 8193.

Encalyptaceae Schimp.

***Encalypta alpina*** Sm.

16 collections. EDGEØYA: PQ1, 2427, c.fr.; PQ2, 2897, c.fr.; PQ3, 2174B, c.fr.; PQ4, 2549, c.fr.; PQ6, 2046, c.fr.; PQ12, 2098; PQ13, 2481, c.fr.; PQ15, 8204A, c.fr.; PQ15, 8218, c.fr. (single stem with immature sporophyte, *E.* cf. *alpina*); PQ15, 9101; PQ15, *s.n.*, c.fr.; PQ28, 2500, c.fr. (few material); PQ33, 2343, c.fr.; PQ34, 8159 c.fr.; PQ34, 8185, c.fr.; PQ36, 2380, c.fr.

***Encalypta rhapsocarpa*** Schwägr.  
var. *rhapsocarpa*

13 collections. EDGEØYA: PQ4, 2552, c.fr.; PQ9, 2415, c.fr.; PQ27, 2840, c.fr.; PQ28, 2497, c.fr.; PQ28, 2508; PQ28, 2510A; PQ35, 2802, c.fr.; PQ35, 2811, c.fr.; PQ35, 2821, c.fr.; PQ35, 2816, c.fr.; PQ35, 2829, c.fr.; PQ37, 2618 c.fr.; PQ39, 2242, c.fr.

Grimmiaceae Arn.

***Racomitrium canescens*** (Hedw.) Brid.

2 collections. EDGEØYA: PQ9, 2413; PQ39, 2240.

***Racomitrium ericoides*** (F. Weber ex Brid.) Brid.

3 collections. EDGEØYA: PQ10, 2565; PQ15, 8218 (single stem, *R.* cf. *ericoides*); PQ 37, 2626 (few material).

***Racomitrium lanuginosum*** (Hedw.) Brid.

1 collection. EDGEØYA: PQ39, 2219.

***Racomitrium panschii*** (Müll. Hal.) Kindb.

4 collections. EDGEØYA: PQ35, 2800; PQ37, 1772; PQ37, 2622; PQ39, 2238. New for Edgeøya (cf. Frisvoll 1983).

***Schistidium abrupticostatum*** (Bryhn) Ignatova & H. H. Blom

1 collection. EDGEØYA: PQ10, 2577, c.fr.

NOTE. Widespread in Svalbard according to Blom in Nyholm (1998) [as *S. platyphyllum* subsp. *abrupticostatum* (Bryhn) Blom].

Dicranellaceae Stech

***Dicranella grevilleana*** (Brid.) Schimp.

1 collection. EDGEØYA: PQ35, 2821.

NOTE. New for Edgeøya.

Oncophoraceae Stech

***Oncophorus virens*** (Hedw.) Brid.

4 collections. BARENTSØYA: PQ41, 2306. EDGEØYA: PQ10, 2570; PQ37, 2635; PQ37, 8173.

***Kiaeria glacialis*** (Berggr.) I. Hagen

2 collections. EDGEØYA: PQ12, 2121; PQ38, 3158.

## Dicranaceae Schimp.

***Dicranum acutifolium*** (Lindb. & Arnell) C. E. O. Jensen

3 collections. EDGEØYA: PQ10, 2576; PQ13, 2488; PQ37, 2617.

NOTE. New for Edgeøya.

***Dicranum elongatum*** Schleich. ex Schwägr.

5 collections. EDGEØYA: PQ2, 2876; PQ2, 2894; PQ27, 2869; PQ38, 3155; PQ39, 2245.

***Dicranum groenlandicum*** Brid.

1 collection. EDGEØYA, ROSENBERGDALEN: 8151.

NOTES. Confirmed for Svalbard; new for Edgeøya.

***Dicranum laevidens*** R. S. Williams

3 collections. BARENTSØYA: PQ41, 2309. EDGEØYA: PQ12, 2122; PQ27, 2855.

***Dicranum spadiceum*** J. E. Zetterst.

2 collections. EDGEØYA: PQ8, 3087; PQ39, *s.n.* (single stem, small plant).

## Ditrichaceae Limpr.

***Ceratodon purpureus*** (Hedw.) Brid.

4 collections. EDGEØYA: PQ1, 2438; PQ3, 2175; PQ15, 8211; PQ33, 2357.

***Distichium capillaceum*** (Hedw.) Bruch & Schimp.

24 collections. EDGEØYA: PQ1, 2429; PQ1, 2433, c.fr.; PQ3, 2170, c.fr.; PQ6, 2053; PQ9, 2410; PQ9, 2418, c.fr. (few material); PQ9, *s.n.*, c.fr.; PQ13, 2487, c.fr.; PQ14, 8217, c.fr. (with antheridia); PQ27, 2839, c.fr.; PQ27, 2834; PQ28, 2509, c.fr. (with antheridia); PQ28, 2510A; PQ31, 2534; PQ31, 2548, c.fr.; PQ32, 2206 (with antheridia); PQ33, 2335, c.fr. (with immature sporophytes and antheridia); PQ33, 2335PP, c.fr.; PQ33, 2353 (with antheridia); PQ34, 3131; PQ34, 8146,

c.fr.; PQ35, 2829 (few material); PQ38, 3159 (with antheridia); ROSENBERGDALEN: 8147, c.fr.

***Distichium inclinatum*** (Hedw.) Bruch & Schimp.

14 collections. EDGEØYA: PQ5, 2131; PQ6, 2038, c.fr.; PQ6, 2049, c.fr.; PQ6, 2054; PQ15, 8211, c.fr.; PQ15, 8218; PQ15, *s.n.*; PQ28, 2510B; PQ31, 2543; PQ34, 1768; PQ35, 2829, c.fr. (*D. cf. inclinatum*; juvenile sporophytes); PQ36, 2384; PQ37, 2634; PQ39, *s.n.*, c.fr.

***Ditrichum flexicaule*** (Schimp.) Hampe

22 collections. EDGEØYA: PQ1, 2421; PQ1, 2426; PQ10, 2560; PQ10, 2568; PQ10, 2574; PQ11, 3100, c.fr.; PQ13, 2479; PQ13, 2480; PQ15, 8211; PQ27, 2837; PQ33, 2341; PQ33, 2350; PQ34, 8148; PQ35, 2812; PQ35, 2816; PQ36, 2381; PQ37, 1772; PQ37, 2621; PQ37, 2623; PQ38, 3140YX; PQ38, 3146; PQ39, 2229.

***Ditrichum gracile*** (Mitt.) Kuntze

In Frisvoll and Elvebakk (1996) as *D. crispatissimum* (Müll. Hal.) Paris.

4 collections. EDGEØYA: PQ15, 8218; PQ34, 3131; PQ37, 1772; PQ38, 3151.

***Ditrichum zonatum*** (Brid.) Kindb.

1 collection. EDGEØYA: PQ9, 2412.

NOTE. New to Svalbard.

## Pottiaceae Schimp.

***Bryoerythrophyllum recurvirostre*** (Hedw.) Chen

10 collections. EDGEØYA: PQ9, 2045A (minute plants); PQ11, 3119, c.fr.; PQ13, 2483; PQ26, 2447; PQ28, 2500; PQ28, 2506, c.fr.; PQ 32, 2209, c.fr.; PQ 32, 2217 (small plant); PQ34, 8142; PQ38, 3156.

***Hennediella heimii*** (Hedw.) R. H. Zander

2 collections. EDGEØYA: PQ28, 2497, c.fr.; PQ44, 2584, c.fr. [cf. *H. heimii* var. *arctica* (Lindb.) R. H. Zander].

***Syntrichia ruralis*** (Hedw.) F. Weber & D. Mohr

7 collections. EDGEØYA: PQ3, 2168; PQ8, 3062B; PQ8, 3079, c.fr.; PQ9, *s.n.*; PQ15, 8205; PQ33, 2336; PQ35, 2821.

***Syntrichia ruraliformis*** (Besch.) Cardot

15 collections. EDGEØYA: PQ6, 2048; PQ8, 3086; PQ15, 8209; PQ27, 2837 (cf. *S. ruraliformis*); PQ28, 2497; PQ33, 2339 (few material); PQ35, 2816; PQ35, 2818; PQ35, 2821; PQ35, 2829; PQ36, 2395; PQ36, 8167; PQ39, 2230; PQ39, 2231; PQ39, *s.n.*

NOTES. New to Svalbard. Southern species reaching the coastal areas of SW Norway, S Sweden, and W Iceland (Hallingbäck *et al.* 2008), and occurring in NW Edgeøya not far from the coast as well.

***Tortula laureri*** (Schultz) Lindb.

1 collection. EDGEØYA: PQ2, 2897.

NOTE. New for Edgeøya.

***Tortula leucostoma*** (R. Br.) Hook. & Grev.

*Desmatodon suberectus* (Hook.) Limpr. (e.g., Hofmann 1969).

1 collection. EDGEØYA: PQ33, 2339.

## Bartramiaceae Schwägr.

***Bartramia ithyphylla*** Brid.

10 collections. EDGEØYA: PQ2, 2882, c.fr.; PQ2, 2886; PQ2, 2897X; PQ8, 3061, c.fr.; PQ8, 3061XY, c.fr.; PQ27, 2832; PQ27, 2834; PQ 39, 2235, c.fr.; PQ39, 2229; PQ39, 2246A.

***Philonotis fontana*** (Hedw.) Brid.

7 collections. BARENTSØYA: PQ43, 8153 (few material). EDGEØYA: PQ11, 3106; PQ11, 3117; PQ31, 2539X; PQ32, 2216; PQ33, 2354; PQ36, 2724.

NOTES. Reconfirmed for Svalbard as separate from *P. tomentella* (cf. Frisvoll & Elvebakk 1996); new for Barentsøya.

***Philonotis tomentella*** Molendo

18 collections. BARENTSØYA: PQ43, 2318. EDGEØYA: PQ1, 2424; PQ2, 2886; PQ11, 3103; PQ12, 2092; PQ13, 2480; PQ13, 2483; PQ13, 2491; PQ26, 2449; PQ26, 2467; PQ26, 2468; PQ26, 8172; PQ34, 1769; PQ34, 1771; PQ34, 3131; PQ36, 2378; PQ36, 2392; PQ38, 3145.

## Splachnaceae Grev. &amp; Arn.

***Aplodon wormskioldii*** (Hornem.) R. Br.

4 collections. EDGEØYA: PQ2, 2872X (with perigonia); PQ38, 3153 (with perigonia); PQ38, 8112, c.fr.; ROSENBERGDALEN: 8138, c.fr.

***Splachnum vasculosum*** Hedw.

17 collections. EDGEØYA: PQ2, 2872, c.fr.; PQ2, 2883 (with fertilised archegonia); PQ2, 2961, c.fr.; PQ7, 8188, c.fr.; PQ11, 3104, c.fr.; PQ12, 2092, c.fr.; PQ26, 8186, c.fr.; PQ26, 2455, c.fr.; PQ26, 2460 (with antheridia); PQ27, 2854, c.fr.; PQ31, 8212XY, c.fr. (few material); PQ32, 2207, c.fr.; PQ32, 2214, c.fr.; PQ38, 3141, c.fr.; PQ38, 3159X, c.fr.; PQ38, 3159YX (with antheridia); ROSENBERGDALEN: 8114, c.fr.

***Tetraplodon mnioides*** (Sw. *ex* Hedw.) Bruch & Schimp.

1 collection. EDGEØYA: PQ31, 8212XY, c.fr. (few material).

***Tetraplodon pallidus*** I. Hagen

2 collections. EDGEØYA: PQ2, 2961, c.fr. (few material); PQ15, 8196X, c.fr.

NOTE. New for Edgeøya.

***Tetraplodon paradoxus*** (R. Br.) I. Hagen

9 collections. EDGEØYA: PQ1, *s.n.*, c.fr.; PQ2, 2961, c.fr.; PQ27, 2854, c.fr.; PQ31, 8212XY, c.fr.; PQ33, 2347, c.fr. (*T. cf. paradoxus*); PQ34, *s.n.*, c.fr.; PQ33, 2356, c.fr.; PQ38, 3159X, c.fr.; KAPP LEE: 8190, c.fr.

NOTE. New for Edgeøya.

***Voitlia hyperborea*** Grev. & Arn.

9 collections. EDGEØYA: PQ1, 8189; PQ2, 2961, c.fr.; PQ14, 8222, c.fr.; PQ31, 2538, c.fr.; PQ31, 2539X, c.fr.; PQ31, 8212XY, c.fr.; PQ33, 2356, c.fr.; PQ34, *s.n.*, c.fr. (a single fruiting gametophyte); KAPP LEE: 8190, c.fr.

Meesiaceae Schimp.

***Leptobryum pyriforme*** (Hedw.) Wilson

2 collections. EDGEØYA: PQ4, 2553, c.fr. (sporophytes numerous; few shoots with distinct, dark brown tubers in leaf axils); PQ10, 2574.

***Paludella squarrosa*** (Hedw.) Brid.

2 collections. BARENTSØYA: PQ41, 2311XYZ. EDGEØYA: PQ38, *s.n.*

***Meesia triquetra*** (L. ex Jolycl.) Ångström

5 collections. BARENTSØYA: PQ41, 2311; PQ41, 8137C; PQ41, 8202. EDGEØYA: PQ11, 3102; ROSENBERGDALLEN: 3954A.

***Meesia uliginosa*** Hedw.

2 collections. BARENTSØYA: PQ41: 8137F. EDGEØYA: PQ11, 3111, c.fr. (one immature sporophyte covered by calyptra).

Bryaceae Schwägr.

***Bryum algovicum*** Müll. Hal.

7 collections. EDGEØYA: PQ1, 2431, c.fr.; PQ1, 2435; PQ9, 2410, c.fr.; PQ15, 8206, c.fr.; PQ27, 2840N, c.fr.; PQ30, 2261, c.fr.; PQ34, 1769, c.fr.

***Bryum arcticum*** (R. Br.) Bruch & Schimp.

1 collection. EDGEØYA: PQ34, 3123, c.fr.

***Bryum argenteum*** Hedw.

1 collection. EDGEØYA: PQ4, 2558, c.fr.

***Bryum capillare*** Hedw.

2 collections. EDGEØYA: PQ5, 2132; PQ5, 2133.

NOTES. Confirmed for Svalbard; new for Edgeøya.

***Bryum cryophilum*** Martensson

7 collections. BARENTSØYA: PQ41, 2301; PQ43, 8153. EDGEØYA: PQ7, 2084, c.fr.; PQ7, 8144 (few old setae); PQ12, 2091, c.fr.; PQ26, 2454; PQ32, 2208.

***Bryum pseudotriquetrum*** (Hedw.) P. Gaertn., B. Mey. & Scherb.

30 collections. BARENTSØYA: PQ42, 2316 (few material); PQ42, 8162; PQ42, 8203. EDGEØYA: PQ1, 2435 (juvenile); PQ2, 2889; PQ2, 2891 c.fr. [*B. pseudotriquetrum* var. *neodamense* (Itzigs.) Büse]; PQ2, 2963, c.fr.; PQ5, 2130; PQ5, 2137; PQ6, 2050; PQ6, 2053; PQ7, 8150; PQ8, 3072X; PQ11, 3096; PQ11, 3117; PQ12, 2091 c.fr. (*B. pseudotriquetrum* var. *neodamense*); PQ12, 2124 (juvenile); PQ13, 2482; PQ13, 2490 (few material); PQ26, 2445; PQ26, 8155; PQ26, *s.n.* (axillary filamentous gemmae); PQ28, 2518; PQ31, 2532, c.fr.; PQ31, 2541 (few material); PQ33, 2349; PQ33, 2349X; PQ37, 2624; PQ39, 2237. DELITSCHØYA: 8132.

***Bryum salinum*** Limpr.

1 collection. EDGEØYA: PQ6, 2052, c.fr.

NOTES. Mainly maritime species (Nyholm 1993); listed in Hofmann (1969) and Möller (1999).

Mniaceae Schwägr.

***Cinclidium arcticum*** (Bruch & Schimp.) Schimp.

5 collections. BARENTSØYA: PQ41, 1777. EDGEØYA: PQ11, 3095; PQ11, 3105; PQ11, 3112; PQ38, 3150 (male plant with antheridia).

***Cinclidium stygium*** Sw.

3 collections. EDGEØYA: PQ26, 2468; PQ 36, 2382; KAPP LEE: 8149.

NOTE. New for Edgeøya.

***Cinclidium subrotundum*** Lindb.

2 collections. EDGEØYA: PQ11, 3097X; PQ11, 3114. New for Edgeøya.

***Cyrtomnium hymenophyllum*** (Bruch & Schimp.) Holmen

2 collections. BARENTSØYA: PQ43, 8153. EDGEØYA: PQ11, 3106.

***Mnium blyttii*** Bruch & Schimp.

2 collections. EDGEØYA: PQ7, 8117 (small plants, cf. *M. blyttii*); PQ26, 8170.

***Plagiomnium ellipticum*** (Brid.) T. J. Kop.

17 collections. BARENTSØYA: PQ41, 2310X. EDGEØYA: PQ2, 2871; PQ2, 2962A; PQ5, 2134; PQ6, 2043; PQ11, 3120; PQ12, 2096 [aff. *P. curvatulum* (Lindb.) Schljakov]; PQ12, 2124A; PQ13, 2493; PQ26, 2451; PQ26, 2468Y; PQ27, 2831; PQ32, 2204; PQ33, 2345; PQ33, 2348X; PQ38, 3151 (aff. *P. curvatulum*); PQ38, 3152.

NOTE. New for Barentsøya.

***Plagiomnium rostratum*** (Schrad.) T. J. Kop.

2 collections. EDGEØYA: PQ13 2494YX; PQ31, 2530.

NOTES. Confirmed for Svalbard; new for Edgeøya.

***Pohlia andrewsii*** A. J. Shaw

1 collection. EDGEØYA: PQ2, 2890 (numerous bulbils).

NOTE. New for Edgeøya.

***Pohlia cruda*** (Hedw.) Lindb.

13 collections. EDGEØYA: PQ2, 2951A, c.fr.; PQ8, 3061XY; PQ8, 3072X, c.fr.; PQ8, 3077 (*P. cf. cruda*); PQ8, 3092, c.fr.; PQ13, 2485; PQ26, 2466; PQ30, 2259; PQ31, 2532, c.fr.; PQ35, 2820, c.fr.; PQ36, 2386, c.fr.; PQ38, 3151; PQ39, 2237.

***Pohlia lescuriana*** (Sull.) Ochi

2 collections. EDGEØYA: PQ2, 2879 (numerous tubers); PQ12, 2124C (small plant, *P. cf. lescuriana*).

NOTE. New for Svalbard.

***Pohlia nutans*** (Hedw.) Lindb.

5 collections. EDGEØYA: PQ2, 2954, c.fr. (few material, synoicous) PQ8, 3061X (*P. cf. nutans*); PQ8, 3076 (*P. cf. nutans*); PQ27, 2835; PQ35, 2821.

***Rhizomnium andrewsianum*** (Steere) T. J. Kop.

1 collection. EDGEØYA: PQ12, 3042.

## Aulacomniaceae Schimp.

***Aulacomnium palustre*** (Hedw.) Schwägr.

5 collections. BARENTSØYA: PQ41, 2303XY; PQ41, 8137A. EDGEØYA: PQ11, 3115; PQ15, 8195; PQ38, 3146.

***Aulacomnium turgidum*** (Wahlenb.) Schwägr.

27 collections. BARENTSØYA: PQ41, 1778; PQ41, 2303XY; PQ41, 2303XYZ; PQ41, 2311YX. EDGEØYA: PQ2, 2872XYZ; PQ2, 2874X; PQ2, 2886; PQ8, 3060 (few material); PQ12, 2097X (few material); PQ12, 2092; PQ12, 2097X (few material); PQ12, 3042; PQ15, 8196; PQ15, 8209; PQ15, 8211 (few material); PQ15, *s.n.*; PQ26, 8140; PQ27, 2853X (few material); PQ27, 2857; PQ27, 2865X; PQ32, 2205X; PQ33, 2340; PQ36, 2375; PQ36, 2381X; PQ38, 3151; PQ38, 3158; PQ39, 2230.

## Climaciaceae Kindb.

***Climacium dendroides*** (Hedw.) F. Weber & D. Mohr

4 collections. EDGEØYA: PQ33, 2348; PQ33, 2349X; PQ33, 2352YX; PQ39, *s.n.* (all small plants).



## Amblystegiaceae G. Roth.

*Campylium stellatum* (Hedw.) C. E. O. Jensen

11 collections. BARENTSØYA: PQ43, 2320. EDGEØYA: PQ6, 2053; PQ7, 8120; PQ10, 2566; PQ10, 2569YX; PQ11, 3097; PQ11, 3099; PQ11, 3101; PQ11, 3103; PQ11, 3113. BRIMULEN: 8143.

*Cratoneuron filicinum* (Hedw.) Spruce

3 collections. BARENTSØYA: PQ43, 2319; EDGEØYA: PQ7, 8150; PQ7, 8117.

*Drepanocladus arcticus* (R. S. Williams) Hedenäs

In Frisvoll and Elvebakk (1996) as *Campylium arcticum* Williams.

2 collections. EDGEØYA: PQ7, 8117; PQ37, 2617.

*Hygrohypnum luridum* (Hedw.) Jenn.

2 collections. EDGEØYA: PQ5, 2136; PQ26, 2463.

*Hygrohypnum polare* (Lindb.) Loeske

*Hygrohypnella polaris* (Lindb.) Ignatov & Ignatova

1 collection. EDGEØYA, ANDRÉETANGEN: 8129.

*Pseudocalliergon turgescens* (T. Jensen) Loeske

3 collections. BARENTSØYA: PQ42, 8203; PQ43, 2319. EDGEØYA: PQ37, 2623 (all small plants).

## Plagiotheciaceae M. Fleisch.

*Myurella julacea* (Schwägr.) Schimp.

14 collections. EDGEØYA: PQ1, 2436; PQ3, 2173; PQ8, 3074; PQ9, 2416; PQ11, 3116; PQ11, 3117; PQ13, 2486; PQ15, 8171; PQ15, 8210; PQ15, *s.n.*; PQ27, 2867; PQ33, 2344; PQ36, 2385; PQ38, 3137.

*Myurella tenerrima* (Brid.) Lindb.

3 collections. EDGEØYA: PQ 9, 2416 (*M. cf. tenerrima*); PQ36, 2385; PQ38, 3137.

Calliergonaceae Vanderpoorten, Hedenäs,  
C. J. Cox & A. J. Shaw*Calliergon giganteum* (Schimp.) Kindb.

17 collections. BARENTSØYA: PQ43, 2318A; PQ43, 2320; PQ43, 2328; SUNDNESET, WÜRZBURGERHYTTA: 8199. EDGEØYA: PQ11, 3101; PQ11, 3106; PQ11, 3097; PQ11, 3115; PQ 13, 2477; PQ26, 2461; PQ32, 2209; ROSENBERGDALEN: 8157; 8215; KAPP LEE: 8124; 8156; *s.n.*; LEEHOVDEN: 8123.

NOTES. According to Hedenäs in Frisvoll and Elvebakk (1996), the Svalbard material reported as *C. giganteum* belongs to *C. richardsonii*, but the presence on Svalbard is reconfirmed here. Both species were also distinguished by Möller (1999).

*Calliergon richardsonii* (Mitt.) Kindb.

5 collections. BARENTSØYA: PQ43, 2317; PQ43, 8153. EDGEØYA: PQ11, 3099; ROSENBERGDALEN: 3954A. DELITSCHØYA: 8133.

*Straminergon stramineum* (Dicks. *ex* Brid.) Hedenäs

4 collections. EDGEØYA: PQ2, 2889; PQ12, 2093; ROSENBERGDALEN: 8139; 8163.

*Sarmentypnum sarmentosum* (Wahlenb.) Tuom. & T. J. Kop.

In Frisvoll and Elvebakk (1996) as *Warnstorfia sarmentosa* (Wahlenb.) Hedenäs.

17 collections. BARENTSØYA: PQ41, 2300; PQ43, 2320. EDGEØYA: PQ11, 3097; PQ11, 3097X; PQ11, 3098; PQ11, 3106; PQ11, 3106; PQ11, 3107; PQ11, 3110; PQ26, 2462 (few material); PQ26, 2468 (*cf. S. sarmentosum*, few material); PQ38, 3140YX; PQ38, 3143X; PQ38, 3146; PQ38, 3167; ROSENBERGDALEN: 3954A, 8124, 8216.

## Scorpidiaceae Ignatov &amp; Ignatova

*Hamatocaulis vernicosus* (Mitt.) Hedenäs

1 collection. EDGEØYA: PQ13, 2481Y.

NOTES. Only one older collection could be confirmed, whereas the other reported collections were identified as *Scorpidium revolvens* s.l. (Frisvoll & Elvebakk 1996). Here we report the second specimen of *H. vernicosus* from Svalbard and the first from Edgeøya.

***Sanionia uncinata*** (Hedw.) Loeske

33 collections. BARENTSØYA: PQ41, 2303XYZ; PQ43, 8153. EDGEØYA: PQ2, 2963Y; PQ6, 2053; PQ8, 3086X; PQ9, s.n.; PQ10, 2572; PQ11, 3101; PQ11, 3115; PQ11, 3120; PQ12, 2124B; PQ15, 8209; PQ26, 2451; PQ26, 2454; PQ26, 2455Y; PQ26, 2467Y; PQ26, 2468; PQ26, 8170; PQ27, 2865; PQ33, 2357; PQ35, 2814; PQ36, 2376; PQ36, 8160; PQ36, 8161; PQ36, s.n.; PQ37, 2633; PQ38, 3143 (few material); PQ38, 3146; PQ38, 3158; PQ39, 2230; PQ39, 2244 (few material); ROSENBERGDALEN: 8124. DELITSCHØYA: 8132.

***Scorpidium cossonii*** (Schimp.) Hedenäs

7 collections. BARENTSØYA: PQ42, 8162. EDGEØYA: PQ11, 3099; PQ11, 3110; PQ13, 2480; PQ32, 2203; PQ38, 3151; ANDRÉETANGEN: 8130.

NOTES. Probably new for Barentsøya and Edgeøya. Although being common on Svalbard (Frisvoll & Elvebakk 1996), this species has not been reported explicitly from both islands.

***Scorpidium revolvens*** (Sw.) Rubers

13 collections. BARENTSØYA: PQ41, 2303 XYZ; PQ41, 2302; PQ42, 8125; PQ42, 8221; PQ43, 8153; SUNDNESET: 8203. EDGEØYA: PQ10, 2572; PQ15, 8209; PQ38, 3140Y; PQ38, 3151; PQ38, 3167; ROSENBERGDALEN: 8124; 8163.

***Scorpidium scorpioides*** (Hedw.) Limpr.

2 collections. BARENTSØYA: PQ42, 8125X; PQ42, 8162.

NOTE. New for Barentsøya.

Brachytheciaceae G. Roth

***Brachythecium turgidum*** (Hartm.) Kindb.

1 collection. EDGEØYA: PQ32, 2202.

Hypnaceae Schimp.

***Hypnum bambergeri*** Schimp.

1 collection. EDGEØYA: PQ1, 2421.

***Hypnum callichroum*** Brid.

1 collection. EDGEØYA: PQ38, 3140.

***Hypnum revolutum*** (Mitt.) Lindb.

19 collections. EDGEØYA: PQ3, 2169; PQ8, 3069; PQ9, 2417; PQ9, 8208; PQ15, 8209; PQ27, 2838; PQ30, 2256; PQ31, 2540; PQ33, 8168; PQ35, 2801; PQ35, 2818; PQ35, 2822; PQ36, 2389; PQ36, 2393; PQ36, 8167; PQ39, 2230; PQ39, 2237; PQ39, 8169; PQ39, s.n.

***Orthothecium chryseum*** (Schwägr.) Schimp.

5 collections. EDGEØYA: PQ14, 8223; PQ15, 8218 (few plants, *O. cf. chryseum*); PQ34, 8174; PQ37, 2620; KAPP LEE: 8175.

***Tomentypnum nitens*** (Hedw.) Loeske

56 collections. BARENTSØYA PQ41, 2311XYZ; PQ41, 8115; PQ41, 8166; PQ43, 2317. EDGEØYA: PQ1, 2434; PQ1, s.n.; PQ2, 2872XYZ; PQ2, 2889; PQ2, 2951XX; PQ2, 2951Y; PQ2, 2962X; PQ10, 2572; PQ11, 3098; PQ11, 3105X; PQ11, 3106; PQ11, 3115; PQ12, 2091; PQ12, 2091X; PQ12, 2097; PQ12, 3042; PQ13, 2477; PQ13, 2480; PQ13, 2482; PQ13, 2489; PQ13, 2491; PQ13, 2494X; PQ13, 2710; PQ14, 2311X; PQ15, 8211; PQ15, 8218; PQ15, 8220; PQ15, s.n. (few material); PQ26, 2468; PQ31, 2531; PQ32, 2218; PQ33, 2352X; PQ33, 2353X; PQ33, 8165; PQ34, 8145A; PQ35, 2814; PQ36, 2377; PQ36, 2388; PQ36, 2389; PQ36, 2390; PQ36, 2382; PQ36, 8161; PQ37, 2617; PQ38, 3146; PQ38, 3151; PQ38, 8112A; PQ39, s.n.; KAPP LEE: 8149X; 8164; 8184; ROSENBERGDALEN: 8114A; 8124.

Hylocomiaceae M. Fleisch.

*Hylocomium splendens* (Hedw.) Schimp.

19 collections. BARENTSØYA: PQ41, 2310. EDGEØYA: PQ1, 2420; PQ2, 2886; PQ2, 2960; PQ8, 3062A; PQ10, 2569; PQ12, 2095; PQ12, 2097; PQ27, 2834YX; PQ27, 2853X; PQ27, 2859; PQ31, 2545; PQ33, 2342; PQ39, 2220; PQ39, 2230; PQ39, 2244; PQ39, 2782; PQ39, *s.n.*; ROSENBERGDALEN: 8207.

DISCUSSION

Bryophytes, especially mosses, contribute significantly to the biodiversity of arctic terrestrial ecosystems. For example, the bryoflora of Svalbard comprises about twice as many bryophyte species as angiosperm species (cf. Frisvoll & Elvebakk 1996). However, identification of bryophyte species is, for several reasons, particularly difficult in the Arctic. One long-lasting problem has been the paucity of floristic treatments and identification keys of bryophytes of arctic regions, which considerably hampered the identification of collections in the early stages of the present study. The annotated checklist of Svalbard bryophytes by Frisvoll and Elvebakk (1996) was a major improvement, but the availability of comprehensive identification keys, including high quality illustrations, has only improved quite recently (e.g., Damsholt 2002; Hedenäs & Bisang 2004; Hallingbäck *et al.* 2006, 2008). Apart from technical limitations, the harsh environmental conditions in the Arctic can cause extremely deviating morphologies, which further complicate species recognition.

The large number of species rejected for Svalbard by Frisvoll and Elvebakk (1996) indicated that species identifications of several earlier bryological studies were unreliable. On the other hand, recent studies (Stech & Kruijer 2010, this study) report new moss species for Svalbard and confirm a number of species excluded or questioned for Svalbard by Frisvoll and Elvebakk (1996). This study reports three bryophyte species as new to Svalbard: *Ditrichum zonatum*, *Pohlia lescuriana* and *Syntrichia ruraliformis*, and confirms the occurrence on Svalbard for six taxa: *Bryum capillare*, *Calliergon giganteum*,

*Dicranum groenlandicum*, *Philonotis fontana*, *Plagiomnium rostratum* and *Timmia megapolitana* subsp. *megapolitana*. All new and confirmed species were collected on Edgeøya, but *Calliergon giganteum* and *Philonotis fontana* were found on Barentsøya as well. Species numbers thus seem to be still incompletely known even for relatively well-studied arctic regions such as Svalbard.

Exact numbers of species new to Edgeøya and Barentsøya are difficult to give. According to the available references, at least 17 species reported here are new for Edgeøya: *Bryum capillare*, *Cinclidium stygium*, *C. subrotundum*, *Dicranella grevilleana*, *Dicranum acutifolium*, *Ditrichum zonatum*, *Hamatocaulis vernicosus*, *Plagiomnium rostratum*, *Pohlia andrewsii*, *P. lescuriana*, *Racomitrium panschii* (although possibly found in Early Holocene near-shore marine sediments, Bennike & Hedenäs 1995), *Scorpidium cossonii*, *Syntrichia ruraliformis*, *Tetraplodon pallidus*, *T. paradoxus*, *Timmia megapolitana* subsp. *megapolitana*, and *Tortula laureri*; and four species are new for Barentsøya: *Philonotis fontana*, *Polytrichum juniperinum*, *Scorpidium cossonii*, and *S. scorpioides*. Further species reported here that were not listed for Edgeøya in the older literature are: *Bryum algovicum*, *B. arcticum*, *Calliergon richardsonii*, *Dicranum laevidens*, *D. spadiceum*, *Ditrichum gracile*, *Drepanocladus arcticus*, *Kiaeria glacialis*, *Myurella tenerima*, *Pohlia nutans*, and *Tetraplodon mnioides*. The same applies to *Plagiomnium ellipticum* from Barentsøya. As these species are common in Svalbard in general, Frisvoll and Elvebakk (1996) didn't provide information about known collection localities, which makes it difficult to infer whether the species are in fact reported here for the first time for Edgeøya or Barentsøya, respectively. Similarly, *Schistidium abrupticosatum* was considered to be common on Svalbard by Blom in Nyholm (1998), although no specific locations were indicated. Nevertheless, we can at least confirm the occurrence of these species on the respective islands. The considerable number of bryophyte species new to Edgeøya and Barentsøya confirms that the eastern islands of Svalbard are still bryologically underexplored. As the present collections only covered terrestrial habitats, even

more bryophyte species new for the eastern islands are likely to be discovered if, e.g., saxicolous habitats are similarly minutely explored.

The availability of modern literature, which allows more reliable morphological species identification, and the intensive collection method by Jalink and co-workers (see above) probably facilitated the discovery of new or previously rejected species. Nevertheless, morphological identification of arctic bryophyte specimens remains difficult. Identification of bryophyte collections made by an intensive approach such as the one for the present study is time consuming, due to the high number of small, poorly developed or depauperate specimens in the collected material. A more basic problem is that species circumscriptions of many bryophyte species are still unclear. In the Arctic, this problem is increased by the morphological variability and deviating morphologies, which were observed, to some degree, in nearly all material of almost all species identified for this study. Such bryophyte entities with deviating morphologies may in fact represent separate arctic species or infraspecific taxa, but they may simply represent morphological forms of a variable, more widespread species as well. Among the most difficult genera to identify, in which we expect such artificial taxa to occur, are, e.g., *Bryum*, *Calliergon*, *Ditrichum*, *Encalypta*, *Hypnum*, *Pohlia*, and *Schistidium*. Molecular approaches are necessary to achieve clear species delimitations in complexes of closely related species (e.g., Stech 2009) and to infer whether deviating morphologies of arctic plants actually represent different taxa. Respective molecular studies on a number of moss genera, such as *Bryum*, *Calliergon*, and *Racomitrium*, with a focus on Svalbard, are on the way (own unpublished data). Developing tools for molecular species identification (DNA barcoding) will be a major advancement to achieve a more complete species inventory of arctic regions.

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